APPENDIX H
LONG-TERM PERFORMANCE ASSESSMENT RESULTS

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A primary focus of the assessment of long-term performance[1] is estimation of human health impacts for the four alternatives proposed for remediation or closure of the site (Sitewide Removal, Sitewide Close-In-Place, Phased Decisionmaking, and No Action). This appendix presents details of the estimates of health impacts for both radiological and hazardous chemical constituents.

The first section of this appendix presents an introduction that first briefly recapitulates the definition of each alternative. The locations and activities associated with each receptor are also described. The second section presents the analysis of the Sitewide Removal Alternative. The third section describes analyses performed for alternatives for which radioactive materials remain onsite – the Sitewide Close-In-Place Alternative and the No Action Alternative. The information is presented in three subsections.

- *Impacts given indefinite continuation of institutional controls*: These impacts take credit for institutional controls to prevent access to the waste management areas, to maintain the integrity of structures such as the Main Plant Process Building, together with engineered features such as erosion control structures and engineered caps. See Section H.2.2.1 for further definition of indefinite continuation of institutional controls.

- *Impacts assuming loss of institutional controls*: In this case it is assumed that institutional controls will be lost after 100 years. (This assumption is conservatively adapted from U.S. Department of Energy (DOE) Manual 435.1-1, which states that for performance assessments prepared by DOE for low-level radioactive waste disposal facilities, "institutional controls shall be assumed to be effective in deterring intrusion for at least 100 years following closure" [DOE 1999]). In particular, it is assumed that there are no more efforts to contain radionuclides and hazardous chemicals within the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farms. Conservatively, these are assumed to fail as soon as institutional controls fail. This subsection reexamines the analysis for the offsite receptors and also considers failure of institutional controls that would allow intruders to enter the Western New York Nuclear Service Center (WNYNSC) and various waste management areas. See Section H.2.2.2 for further definition of loss of institutional controls.

- *Loss of institutional controls leading to unmitigated erosion*: The offsite receptors are again reanalyzed. In addition, this section considers onsite receptors on the banks of Franks Creek and Erdman Brook who would be exposed to direct radiation shine from eroded surfaces. See Section H.2.2.2.6 for further discussion of unmitigated erosion.

Finally, there is a section that presents the results of sensitivity analyses related to human health impacts.

Note that this appendix is intended only to present the results of the long-term performance assessment. Interpretations, comparisons with regulatory guidelines, and comments on acceptability are provided in Appendix L.

[1] *"Long-term" means until after peak dose or risks have occurred and ranges up to 100,000 years. Note that the analysis assumes that radioactive decay continues to occur throughout this period.*

H.1 Introduction

A set of four alternatives has been proposed to investigate the effects of a range of site closure plans. In addition, a set of potential human receptors has been selected as the basis for estimation of health impacts. The alternatives and receptors are described in the following paragraphs.

H.1.1 The Waste Management Areas

For the convenience of the reader, and to facilitate the discussion of alternatives and receptors, a brief description of the Waste Management Areas (WMAs) is included in **Table H–1** and the locations of WMAs 1-10 are plotted in **Figure H–1**.[2] A detailed description of the WMAs is provided in Appendix C, Section C.2.

Table H–1 Description of Waste Management Areas

Area	*Description*
WMA 1	Main Plant Process Building and Vitrification Area
WMA 2	Low-Level Waste Treatment Facility Area
WMA 3	Waste Tank Farm Area, including High-Level Waste Tanks 8D-1, 8D-2, 8D-3, and 8D-4.
WMA 4	Construction and Demolition Debris Landfill [a]
WMA 5	Waste Storage Area [a]
WMA 6	Central Project Premises [a]
WMA 7	NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area (NDA) and Associated Facilities
WMA 8	State-Licensed Disposal Area (SDA) and Associated Facilities
WMA 9	Radwaste Treatment System Drum Cell [a]
WMA 10	Support and Services Area [a]
WMA 11	Bulk Storage Warehouse and Hydrofracture Test Well Area [a]
WMA 12	Balance of Site [a] (includes steam sediment)
North Plateau Groundwater Plume	A zone of groundwater contamination that extends across WMAs 1, 2, 3, 4, and 5. See Appendix C, Figure C–12, of the EIS.
Cesium Prong	An area of surface soil contamination extending from the Main Plant Process Building in WMA 1 northwest to a distance of 6.0 kilometers (3.7 miles) beyond the boundary of the West Valley Demonstration Project. See Appendix C, Figure C–14.

WMA = Waste Management Area.

[a] These areas do not appear explicitly in any of the results below because they have either already been remediated or do not contain sufficient inventories of radioactive materials or hazardous chemicals to contribute to risks above the noise level.

[2] *WMA 11 is not shown in Figure H–1. It contains two self-contained areas in the southeast corner of WNYNSC outside the 84 hectares (200 acres) of the Project Premises and the State-Licensed Disposal Area (SDA) and outside the area shown in Figure H–1. WMA 12 is not explicitly shown: it is the balance of the site.*

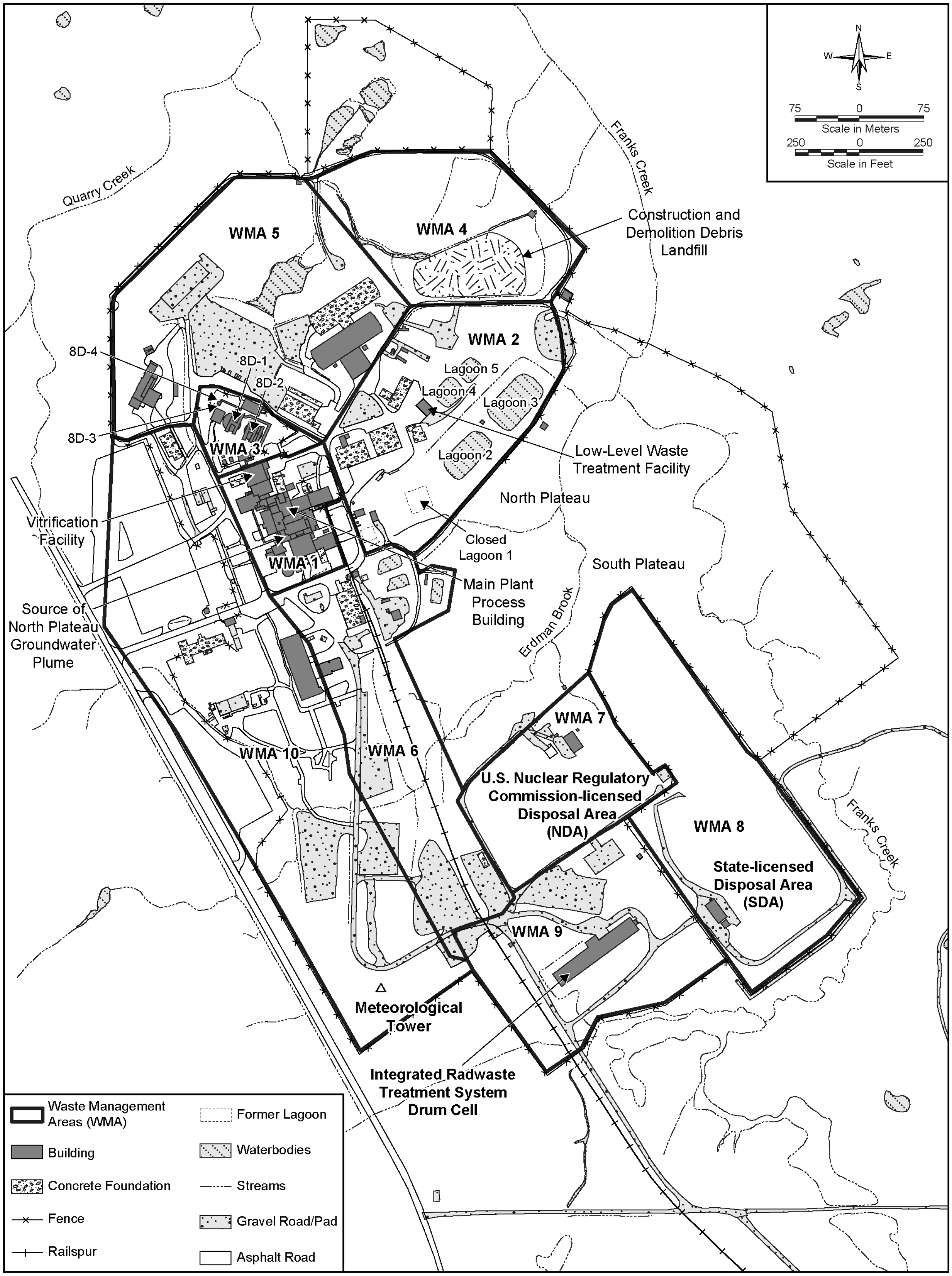

Figure H–1 Location of Waste Management Areas

H.1.2 The Four Alternatives

The alternatives analyzed in this environmental impact statement (EIS) are discussed in detail in Chapter 2 and in Appendix C.[3] In summary, these alternatives are:

- **Sitewide Removal –** All site facilities assumed remaining at the EIS starting point (see Chapter 2, Table 2–2) would be removed. Soils, waters, etc. would be removed or remediated. All radioactive, hazardous, and mixed low-level radioactive waste would be characterized, packaged as necessary, and shipped offsite for disposal. This alternative would generate waste for which there is currently no offsite disposal location (e.g., non-defense transuranic waste, commercial B/C low-level radioactive waste, Greater-Than-Class C waste). Since this alternative is estimated to require approximately 60 years to be completed, it is anticipated that this orphan waste and the high-level radioactive canisters would be shipped offsite as part of this alternative. The entire WNYNSC would be available for release for unrestricted use. The Sitewide Removal Alternative is one type of bounding alternative that would remove facilities and contamination so that the site could be reused with no restrictions.

  The U.S. Nuclear Regulatory Commission (NRC)-Licensed portion of the site would meet the criteria of the NRC License Termination Rule (10 *Code of Federal Regulations* [CFR] 20.1402). The New York State-licensed portion of the site (the SDA) would meet similar state criteria. Residual hazardous contaminants would meet applicable Federal and state standards. A final status survey performed in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) and the Resource Conservation and Recovery Act (RCRA) guidance would demonstrate that the remediated site meets the standards for unrestricted release, which would be confirmed by independent verification surveys.

- **Sitewide Close-In-Place –** Most site facilities would be closed in place as described in Chapter 2, Section 2.4.2.1. The residual radioactivity in facilities with larger inventories of long-lived radionuclides would be isolated by specially designed closure structures and engineered barriers. The Sitewide Close-In-Place Alternative is another type of bounding alternative where the major facilities and sources of contamination would be managed at its current location.

- **Phased Decisionmaking (Preferred Alternative) –** The decommissioning would be completed in two phases:

  – Phase 1 decisions would include removal of all WMA 1 facilities (such as the Main Plant Process Building, Vitrification Facility, and 01-14 Building), the lagoons in WMA 2, and the source area of the North Plateau Groundwater Plume, as well as other activities as described in Chapter 2, Section 2.4.3. No decommissioning or long-term management decisions would be made for the Waste Tank Farm and its support facilities, the Construction and Demolition Debris Landfill (CDDL), the nonsource area of the North Plateau Groundwater Plume, or the NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area (NDA). The State-Licensed Disposal Area (SDA) would continue under active management consistent with its New York State Department of Health (NYSDOH) license and a New York State Department of Environmental Conservation (NYSDEC) permit for up to 30 years. Phase 1 activities would also include additional

[3] *Appendix C, Section C.4, of the EIS describes the various engineered features and barriers that are proposed for each alternative (e.g., Table C-53, "Proposed New Construction for Each Action Alternative," Figure C–21, "Conceptual NDA Barrier Wall and French Drain Layout," Figure C–24, "North Closure Cap Conceptual Plan View," Figure C–25, "Plan View of Cap and Barrier Wall in Waste Management Area 2," Figure C–26, "Location and Conceptual Design for Long-Term Erosion Control," etc. Rather than trying to represent these complex structures on Figures H–1 or H–3, the reader is referred to Appendix C.*

characterization of site contamination and studies to provide information to support additional evaluations to determine the approach to be used to complete the decommissioning.

- Phase 2 would complete the decommissioning or long-term management decisionmaking, following the approach determined through the additional evaluations to be the most appropriate.

- **No Action—**No actions toward decommissioning would be taken. The No Action Alternative would involve the continued management and oversight of the remaining portion of WNYNSC and all facilities located on the WNYNSC property as of the starting point of this EIS.

Table H–2 summarizes the important features of the alternatives that are analyzed in the EIS.

H.1.3 The Receptors

The approach used for estimation of health impacts is development and analysis of a set of scenarios comprising sources of hazardous material, facility closure designs, environmental transport pathways, and human receptor locations and activities. A detailed description of this approach is presented in Appendix D. This section summarizes the selection of receptors, and describes the locations and activities that are the primary attributes contributing to potential impacts on receptors.

H.1.3.1 Summary List – Receptor Locations

Receptor[4] locations are selected based on comparison of environmental transport pathways, current demography, and regulatory guidance. Receptor locations considered in the analysis include those located outside the boundaries of the WNYNSC (offsite) and those located within the boundaries proposed for control under a given alternative (onsite). The reasons for the choice of receptors are given in Appendix D, Section D.3.1.3, which also contains a more detailed description of those receptors than does the summary below. Table D–4 contains a summary of receptor exposure modes. Offsite receptors would be affected for both assumed continuation of institutional controls and assumed loss of institutional controls. Onsite receptors are considered under assumed loss of institutional controls. Offsite receptor locations are:

- Cattaraugus Creek – just downstream of Buttermilk Creek – "Cattaraugus Creek Receptor"
- Cattaraugus Creek – person living on the Seneca Nation of Indians Cattaraugus Reservation – "Seneca Nation of Indians Receptor"
- Drinkers of water from municipal water system intakes at Sturgeon Point near Derby, New York and in the Niagara River. These receptors do not necessarily live on the shores of Lake Erie or the Niagara River.

The locations of offsite receptors and one onsite receptor (Buttermilk Creek) are shown in **Figure H–2**.

[4] *Throughout this appendix all receptors are hypothetical and should not be equated with currently living, real receptors.*

Table H–2 Summary of Alternatives

	Sitewide Removal	***Sitewide Close-In-Place***	***Phased Decisionmaking Phase 1 Activities (up to 30 years)*** [a]	***No Action***
Canisters	Storage in new Interim Storage Facility until they can be shipped offsite	Storage in new Interim Storage Facility until they can be shipped offsite.	Storage in new Interim Storage Facility until they can be shipped offsite	No decommissioning action
Process Building	Decontamination, demolition and removal from site	Decontamination, demolition. Rubble used to backfill underground portions of the Main Plant Process Building and Vitrification Facility, and to form the foundation of a cap.	Decontamination, demolition and removal from site	No decommissioning action
High-Level Waste Tanks	Removal, including associated contaminated soil and groundwater in WMA 3	Filled with controlled, low-strength material. Strong grout placed between the tank tops and in the tank risers. Waste tank pumps to be removed, sectioned, and packaged for offsite disposal. Underground piping to remain in place and filled with grout. Closed in an integrated manner with the Main Plant Process Building, Vitrification Facility, and North Plateau Groundwater Plume source area with a common circumferential hydraulic barrier and an upgradient subsurface barrier wall, and beneath a common multi-layer cap.	Remain in-place, monitored and maintained with the Tank and Vault Drying system operating as necessary. Waste tank pumps to be removed, sectioned, and packaged for offsite disposal.	No decommissioning action
NDA	Removal	Liquid pretreatment system removed and disposed of offsite. Trenches and holes emptied of leachate and grouted. Buried leachate transfer line to remain in place. Existing NDA geomembrane cover replaced with a robust multi-layer cap. Installation of erosion control features.	Continued monitoring and maintenance	No decommissioning action
SDA	Removal	Trenches emptied of leachate and grouted. Waste Storage Facility removed to grade. Existing SDA geomembrane cover replaced with robust multi-layer cap. Installation of erosion control features. SDA lagoons left in place.	Active management for up to 30 years	No decommissioning action
North Plateau Groundwater Plume	Removal	Plume source area closed in an integrated manner with the Main Plant Process Building, Vitrification Facility and Waste Tank Farm within a common circumferential barrier. Permeable treatment wall installed before decommissioning would remain in place and replaced approximately every 20 years. Plume allowed to decay in place. Groundwater Recovery System decommissioned.	Removal of source area. Permeable treatment wall installed before decommissioning would remain in place and replaced after approximately 20 years. Groundwater Recovery System left in place in a standby condition.	No decommissioning action
Cesium Prong	Removal	Restrictions on use until sufficient decay has taken place for unrestricted use.	Managed in place	No decommissioning action

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] Up to 30 years is the period for all Phase 1 activities. Decommissioning activities will be completed within 8 years.

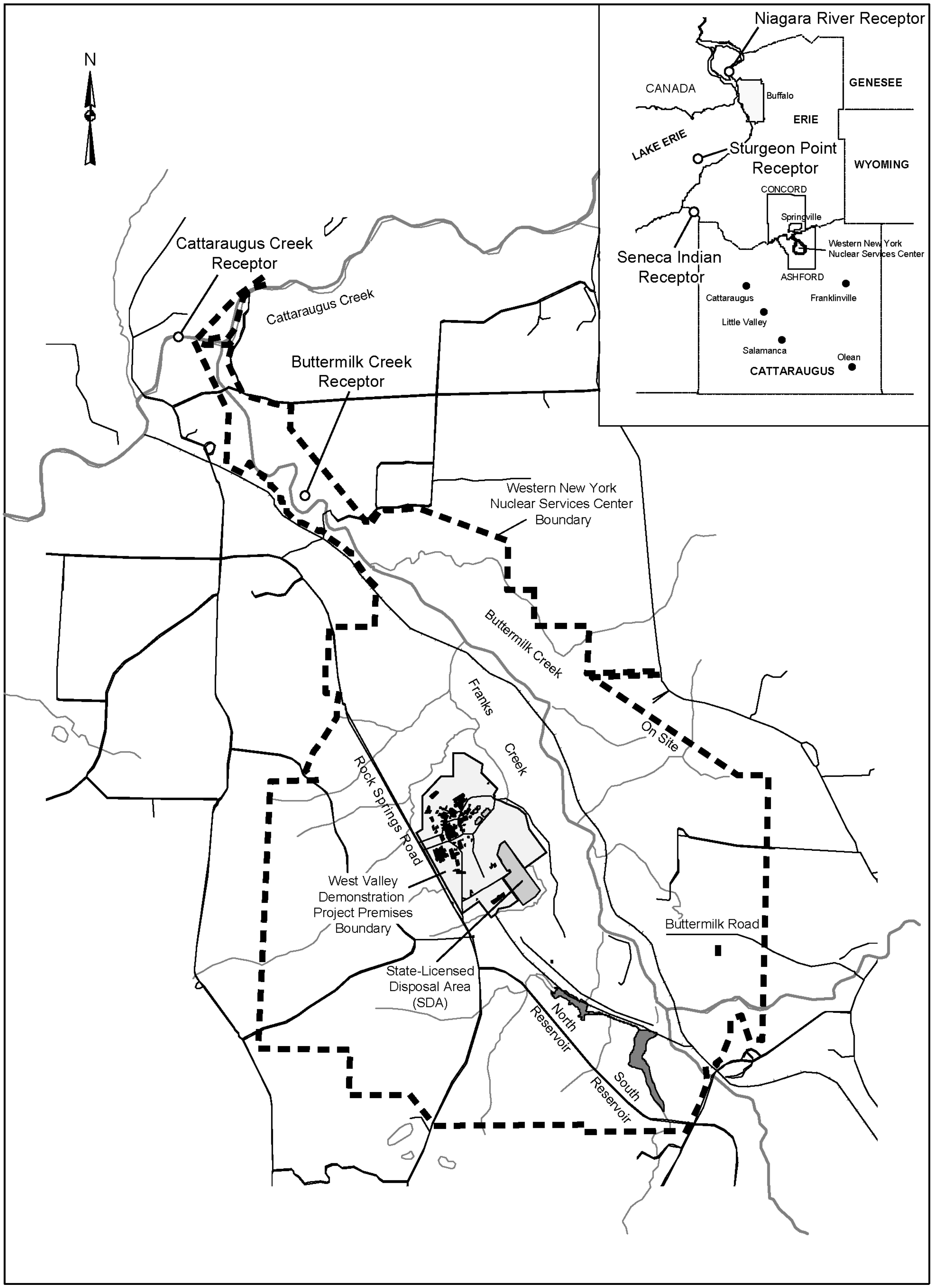

Figure H–2 Location of Offsite Receptors and Buttermilk Creek Receptor

Onsite receptor locations are selected based on the location of existing contamination in the environment, the location and function of engineered barriers for closure systems, and regulatory guidance. Locations selected for the North and South Plateaus include:

- Onsite North Plateau
  - Main Plant Process Building (WMA 1)
  - Vitrification Facility (WMA 1)
  - Low-Level Waste Treatment Facility (WMA 2)
  - Waste Tank Farm (WMA 3)
  - North Plateau Groundwater Plume
  - Cesium Prong
- Onsite South Plateau
  - NDA (WMA 7)
  - SDA (WMA 8)
- Onsite adjacent to Buttermilk Creek.[5]
- Receptors for unmitigated erosion analysis
  - On the East bank of Franks Creek opposite the SDA
  - On the West bank of Erdman Brook opposite the NDA
  - In the area of the Low-Level Waste Treatment Facility

Figure H–3 shows the locations of the receptors for the unmitigated erosion analysis. It also shows the assumed location of wells that are used in subsequent calculations involving the use or consumption of contaminated groundwater.

H.1.3.2 Types of Receptors

Types of receptors selected to provide a basis for EIS analysis are individuals involved in home construction, well drilling, recreational hiking, maintaining a home and garden (resident farmer), and a non-farming resident. In the cases of home construction and well drilling the receptors are workers directly contacting contaminated material during activities that intrude into the waste.

For *home construction*, worker exposure pathways include inhalation of contaminated dust, and exposure to external radiation from the walls of an excavation for the foundation of a home. Assumed locations for home construction are directly on top of facilities such as the Main Plant Process Building, Vitrification Facility, lagoons, Waste Tank Farm, or within areas such as the NDA and SDA for the No Action Alternative (see Figure H–1). Values of parameters for the home construction worker receptor and scenario are summarized in **Table H–3**.

[5] *This receptor is located below the Franks Creek discharge into Buttermilk Creek and above the Buttermilk Creek discharge into Cattaraugus Creek. The predicted radiation dose to such a receptor would be the same anywhere along this entire length because there is very little dilution of the flow until Cattaraugus Creek is reached because very little water enters from tributaries.*

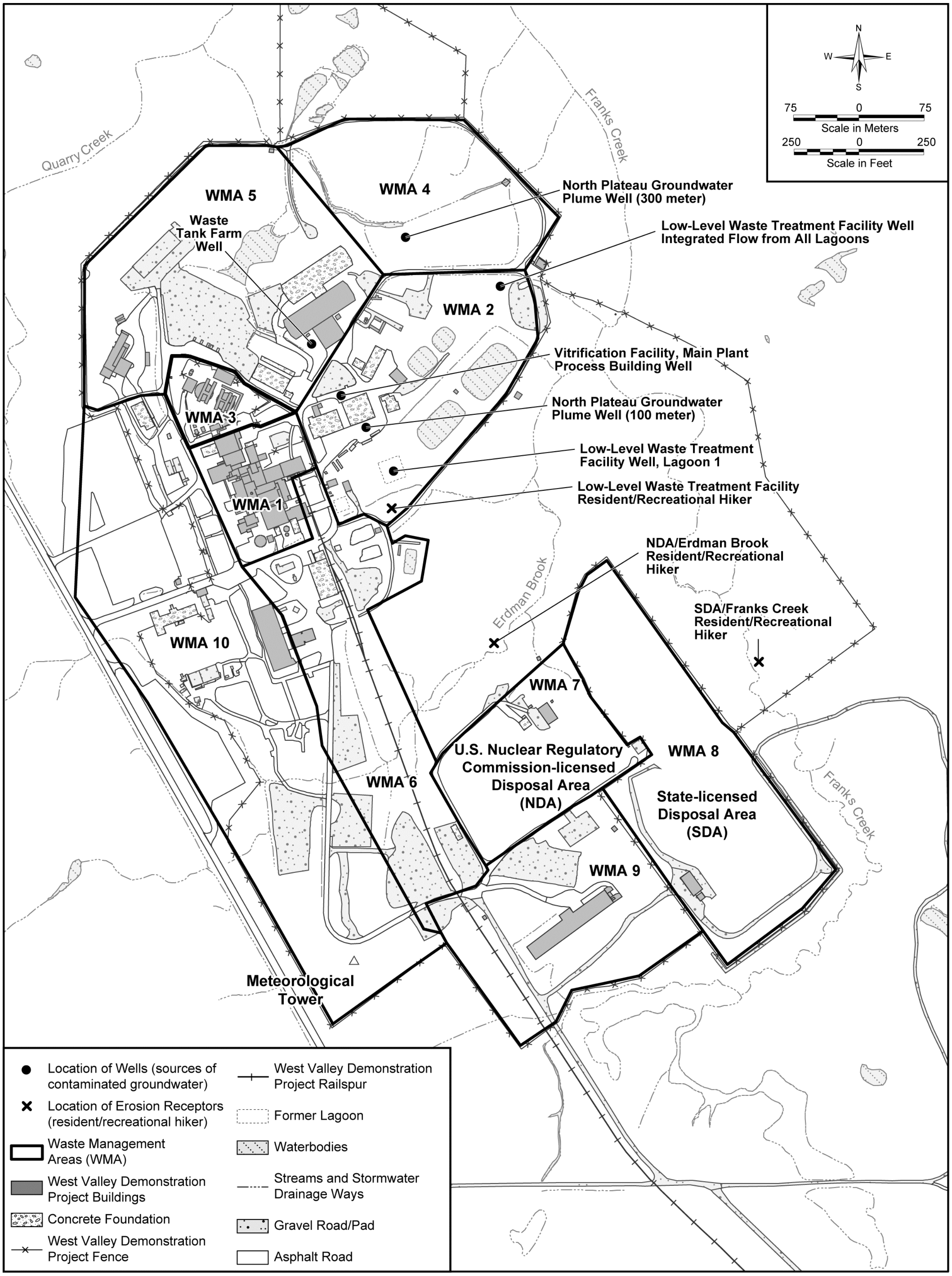

Figure H–3 Location of Wells and Resident/Recreational Hikers

Table H–3 Values of Parameters for the Home Construction Scenario

Parameter	*Value*	*Source*
Excavation Length and Width	23 meters	Oztunali and Roles 1986
Excavation Depth	3 meters	Oztunali and Roles 1986
Dust Mass Loading for Inhalation	0.538 milligrams per cubic meters	Beyeler et al. 1999
Duration of Construction Work	500 hours	Oztunali and Roles 1986
Inhalation Rate	8,400 cubic meters per year	Beyeler et al. 1999

Note: To convert meters to feet, multiply by 3.2808; cubic meters to cubic feet, multiply by 35.314.

For *well drilling*, worker exposure pathways include inhalation of contaminated dust, and direct exposure to external radiation from contaminated water in a cuttings pond. Assumed locations for well drilling are directly on top of facilities such as the Main Plant Process Building, Vitrification Facility, lagoons, Waste Tank Farm, or within areas such as the NDA and SDA for the No Action Alternative and the Low-Level Waste Treatment Facility for the Sitewide Close-In-Place Alternative (see Figure H–1). Values of parameters characterizing this receptor and scenario are summarized in **Table H–4**. Because all waste at the West Valley Site is within thirty meters of the ground surface, depth to waste is not a constraint that limits occurrence of the well-drilling scenario.

Table H–4 Values of Parameters for the Well Drilling Scenario

Parameter	*Value*	*Source*
Drill Hole Diameter	20 centimeters	Oztunali and Roles 1986
Maximum Hole Depth	61 meters [a]	Oztunali and Roles 1986
Well Completion Time	6 hours	Oztunali and Roles 1986
Cuttings Pond Length	2.7 meters	Oztunali and Roles 1986
Cuttings Pond Width	2.4 meters	Oztunali and Roles 1986
Cuttings Pond Depth	1.2 meters	Oztunali and Roles 1986
Cuttings Pond Water Shielding Layer Depth	0.6 meters [b]	Oztunali and Roles 1986
Inhalation Rate	8,400 cubic meters per year	Beyeler et al. 1999

[a] All waste at the West Valley Site is within 30 meters of the surface. Therefore, because the maximum hole depth is 61 meters, wells drilled from above waste will always completely penetrate the underlying waste layer.

[b] The analysis takes credit for the shielding provided by a 2-foot (0.6-meter) layer of water, consistent with the discussion of this scenario in NUREG/CR-4370 (Oztunali and Roles 1986).

Note: To convert centimeters to inches, multiply by 0.3937; meters to feet, multiply by 3.2808; cubic meters to cubic feet, multiply by 35.314.

Exposure modes for *recreational hiking* are inadvertent ingestion of soil and inhalation of fugitive dust for both radionuclides and hazardous chemicals and exposure to direct radiation for radionuclides. For radionuclides, values of parameters for these pathways are summarized in Tables H–9 and H–10. For hazardous chemicals, values of parameters are those presented in Table H–15 for the inadvertent soil ingestion and inhalation of fugitive dust pathways. For both radionuclides and hazardous chemicals, exposure time for recreational hiking is determined by time spent in the contaminated area. Parameters determining exposure time for the recreational hiker exposure pathway are length of the contaminated area, rate of hiking through the area, and frequency and duration of exposure. Values for these parameters are summarized in **Table H–5**. These parameters are based on the known dimensions of the Process Building, high-level waste tanks, SDA, and NDA. Exposure modes for a hiker include inadvertent ingestion of soil, inhalation of fugitive dust, and exposure to direct radiation. Exposure through recreational hiking pathways is evaluated for onsite receptors for both groundwater and erosion-release scenarios. Results for erosion-release scenarios are presented in Table H–62 and associated text, where hiking along an active erosion front is considered to be the bounding scenario. This EIS does not analyze the less conservative scenario of a downstream hiker coming into contact with contaminated creek-bank sediments. For groundwater release scenarios, exposure through the recreational hiking pathways contributes a small fraction of the total impact. The method for calculating the dose for the recreational hiking pathways is described in Appendix G, Section G.4.2.4.

Table H–5 Values of Parameters for Exposure Time in Recreational Hiking

Parameter	*Value*	*Source*
Length of Contaminated Area		
Process Building	10 to 40 meters	Site Specific
Vitrification Facility	7 to 10 meters	Site Specific
High-level waste tanks 8D-1 and 8D-2	30 meters	Site Specific
High-level waste tanks 8D-3 and 8D-4	6 meters	Site Specific
NDA	60 meters	Site Specific
SDA	400 meters	Site Specific
Velocity of hiking	1.6 kilometers (approximately 1 mile) per hour	A conservative hiking speed of 1.6 kilometers (approximately 1 mile) per hour
Exposure frequency	365 days per year	EPA 1999a
Exposure duration	30 years	EPA 1999a

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area.
Note: To convert meters to feet, multiply by 3.2808.

Exposure pathways for the *resident farmer* are based on contact with surface soil and involve a set of activities including living in a home, maintaining a garden, harvesting fish and deer, and recreational hiking. The scenario may be initiated by existing residual contamination of surface soil, by irrigation with contaminated groundwater or surface water, by deposition of contaminated soil from the home construction excavation on the ground surface, by deposition of contaminated soil from the well drilling cuttings pond on the ground surface, or by exposure of contaminated material during erosion. The locations of wells that could potentially supply contaminated groundwater are shown in Figure H–3. The locations of the farmer's gardens are not explicitly located in Figure H–3. It is simply assumed that those gardens are somewhere nearby and that they are contaminated by water piped from one of the wells or by contaminated waste deposited after home construction or well drilling.

For both radionuclides and hazardous chemicals, maintenance of a home and garden involves inadvertent ingestion of soil, inhalation of fugitive dust, and consumption of crops and animal products. For radionuclides, there is an additional pathway, exposure to external radiation.

The location and mode of transport of contaminated material and the nature and location of the receptor determine the degree of exposure to each of the exposure pathways of the resident farmer scenario. General assumptions connecting exposure modes and receptor locations and activities are:

- Exposure pathways related to maintenance of a home and garden apply to both onsite and offsite receptors.

- When surface soil is contaminated by irrigation with groundwater or surface water, exposure by drinking water involves consumption of the primary source of groundwater or surface water rather than by consumption of water infiltrating through the contaminated soil. The pathways other than consumption of drinking water are termed water independent pathways.

- When the source of contamination is residue on surface soil rather than irrigation water, infiltration through the soil is the source of drinking water. The combined pathways are termed water dependent pathways.

- Consumption of fish occurs for the Buttermilk Creek onsite receptor and for offsite receptors.
- Discharge of contaminated groundwater to surface water contaminates soils and plants along onsite creek banks, initiating the deer consumption and recreational hiking pathways. Therefore, these two pathways apply for onsite receptors.

Because human health impacts related to radionuclides and hazardous chemicals involve differing physiological mechanisms, differing sets of parameters characterize receptors for these two classes of materials. Sets of parameters used to estimate health impact due to exposure to radionuclides during residence in a home and maintenance of a garden are presented in **Tables H–6** through **H–11** and the exposure pathways for residing in a home and maintaining a garden are summarized in **Table H–12**. Unit dose and risk factors for these pathways, calculated using the RESRAD, Version 6.4 computer code (Yu et al. 1993, 2001) are presented in **Tables H–13** and **H–14** for the water dependent and water independent pathways, respectively.

Table H–6 Data Values for Residential and Garden Exposure Pathways for Radionuclides on the North and South Plateaus: Contaminated Zone Data

Parameter	***Parameter Value*** [a]	***Source***
Area	6,850 square meters	NUREG/CR-5512 [b]
Thickness	1 meter	Site specific
Length parallel to aquifer flow	85 meters	Site specific
Bulk density	1.7 grams per cubic centimeter	WVNS 1993c, 1993d
Erosion rate	1×10^{-5} meters per year	WVNS 1993a
Total porosity	0.36 (for both North and South Plateaus)	WVNS 1993c
Field Capacity	0.20	WVNS 1993c
Hydraulic conductivity	3,500 meters per year (North Plateau) 0.01 meters per year (South Plateau)	WVNS 1993b
b Parameter [c]	1.4	NUREG/CR-5512 [b]
Evapotranspiration coefficient	0.78	WVNS 1993c
Wind speed	2.6 meters per second	WVNS 1993c
Precipitation	1.16 meters per year	WVNS 1993e
Irrigation rate	0.47 meters per year (water dependent) 0.0 meters per year (water independent)	NUREG/CR-5512 [d]
Irrigation mode	Overhead	Site specific
Runoff coefficient	0.41	WVNS 1993c

[a] Parameter values are the same for the North and South plateaus with the exception of hydraulic conductivity.
[b] NUREG/CR-5512, Vol. 3 (Beyeler et al. 1999).
[c] Value for loamy sand (based onsite conditions).
[d] National average rates for irrigation have been used in the absence of site-specific data.
Note: To convert square meters to square feet, multiply by 10.764; meters to feet, multiply by 3.2808; grams per cubic centimeter to pounds per cubic feet, multiple by 62.428.

Table H–7 Data Values for Residential and Garden Exposure Pathways for Radionuclides on the North and South Plateaus: Saturated Zone Hydrologic Data

Parameter	*Parameter Value* [a]	*Source*
Bulk density	1.7 grams per cubic centimeter	WVNS 1993d, 1993c
Total porosity	0.36 (for both North and South Plateaus)	WVNS 1993c
Field capacity	0.20	WVNS 1993c
Effective porosity	0.25	WVNS 1993c
Hydraulic conductivity	3,500 meters per year (North Plateau) 0.01 meters per year (South Plateau)	WVNS 1993b
Hydraulic gradient	0.03	WVNS 1993b
Water table drop rate	0 meters per year	Site Specific
Well pump intake depth	2 meters (below water table)	Site specific
Mixing model	Non-dispersion	Site specific
Well pumping rate	3,300 cubic meters per year (water dependent) 0 cubic meters per year (water independent)	NUREG/CR-5512 [b, c]

[a] Parameter values are the same for the North and South plateaus with the exception of hydraulic conductivity.
[b] NUREG/CR-5512, Vol. 3 (Beyeler et al. 1999).
[c] Sum of domestic use and irrigation rate.
Note: To convert grams per cubic centimeter to pounds per cubic feet, multiply by 62.428; meters to feet, multiply by 3.2808; cubic meters to cubic feet, by 35.314.

Table H–8 Data Values for Residential and Garden Exposure Pathways for Radionuclides on the North and South Plateaus: Uncontaminated and Unsaturated Zone Hydrologic Data

Parameter	*Parameter Value* [a]	*Source*
Number of strata	1	Site specific
Thickness	2 meters	Site specific
Bulk density	1.7 grams per cubic centimeter	WVNS 1993d, 1993c
Total porosity	0.36 (for both North and South Plateaus)	WVNS 1993c
Effective porosity	0.25	WVNS 1993c
Hydraulic conductivity	3,500 meters per year (North Plateau) 0.01 meters per year (South Plateau)	WVNS 1993b
b Parameter [b]	1.4	NUREG/CR-5512 [c]

[a] Parameter values are the same for the North and South plateaus with the exception of hydraulic conductivity.
[b] Value for loamy sand (based onsite conditions).
[c] NUREG/CR-5512, Vol. 3 (Beyeler et al. 1999).
Note: To convert meters to feet, multiply by 3.2808; grams per cubic centimeter to pounds per cubic feet, multiply by 62.428.

Table H–9 Data Values for Residential and Garden Exposure Pathways for Radionuclides: Dust Inhalation and External Gamma Data

Parameter	*Parameter Value*	*Source*
Inhalation rate	8,400 cubic meters per year	NUREG/CR-5512 [a]
Mass loading for inhalation	4.5×10^{-6} grams per cubic meter	NUREG/CR-5512 [b]
Exposure duration	1 year	NUREG/CR-5512
Indoor dust filtration factor	1	NUREG/CR-5512
Shielding factor, external gamma	0.59	NUREG/CR-5512 [c]
Fraction of time indoors, onsite	0.66	NUREG/CR-5512
Fraction of time outdoors, onsite	0.12	NUREG/CR-5512
Shape factor, external gamma	1	RESRAD [d]

[a] NUREG/CR-5512, Vol 3 (Beyeler et al. 1999).
[b] Activity and time average of NUREG/CR-5512 values.
[c] Sum of products of the means of the fraction of time and shielding factors for indoor and outdoor exposure.
[d] RESRAD (Yu et al. 1993).
Note: To convert cubic meters to cubic feet, multiply by 35.314; grams per cubic meter to pounds per cubic feet, multiply by 0.0000624.

Table H–10 Data Values for Residential and Garden Exposure Pathways for Radionuclides: Dietary Data

Parameter	*Parameter Value*	*Source*
Fruit, vegetable and grain consumption rate	112 kilograms per year	NUREG/CR-5512 [a, b]
Leafy vegetable consumption rate	21 kilograms per year	NUREG/CR-5512
Milk consumption	233 liters per year	NUREG/CR-5512
Meat and poultry consumption	65 kilograms per year	NUREG/CR-5512 [c]
Soil ingestion rate	43.8 grams per year	EPA/540-R-00-007 [d] NUREG/CR-5512
Drinking water intake rate	730 liters per year (water dependent) 0 liters per year (water independent)	NUREG/CR-5512
Fraction contaminated drinking water	1	NUREG/CR-5512
Fraction contaminated livestock water	1	NUREG/CR-5512
Fraction contaminated irrigation water	1	NUREG/CR-5512
Fraction contaminated plant food	1	NUREG/CR-5512
Fraction contaminated meat	1	NUREG/CR-5512
Fraction contaminated milk	1	NUREG/CR-5512

[a] NUREG/CR-5512, Vol 3 (Beyeler et al. 1999).
[b] Sum of individual means for other vegetables, fruit and grain.
[c] Sum of individual means for meat and poultry.
[d] Soil Screening Guidance for Radionuclides.
Note: To convert kilograms to pounds, multiply by 2.2046; liters to gallons, multiply by 0.26418; grams to ounces, multiply by 0.035274.

Table H–11 Data Values for Residential and Garden Exposure Pathways for Radionuclides: Nondietary Data, North Plateau

Parameter	*Parameter Value*	*Source*
Livestock fodder intake for meat	27.3 kilograms per day	NUREG/CR-5512 [a]
Livestock fodder intake for milk	64.2 kilograms per day	NUREG/CR-5512 [b]
Livestock water intake for meat	50 liters per day	NUREG/CR-5512
Livestock water intake for milk	60 liters per day	NUREG/CR-5512
Livestock intake of soil	0.5 kilograms per day	RESRAD [c]
Mass loading for foliar deposition	4×10^{-4} grams per cubic meter	NUREG/CR-5512 [d]
Depth of soil mixing layer	0.15 meters	NUREG/CR-5512
Depth of roots	0.9 meters	RESRAD
Fraction of drinking water from groundwater	1	NUREG/CR-5512
Fraction of livestock water from groundwater	1	NUREG/CR-5512
Fraction of irrigation water from groundwater	1	NUREG/CR-5512

[a] NUREG/CR-5512, Vol 3 (Beyeler et al. 1999).
[b] Sum of individual medians for forage, hay and grain.
[c] Default parameter value from RESRAD (Yu et al. 1993).
[d] Value for gardening.
Note: To convert kilograms to pounds, multiply by 2.2046; liters to gallons, multiply by 0.26418; grams per cubic meter to pounds per cubic feet, multiply by 0.0000624; meters to feet, multiply by 3.2808.

Table H–12 Summary of Exposure Modes for Residential and Garden Exposure to Radionuclides

Exposure Mode	*Water-Dependent Pathways*	*Water-Independent Pathways*
External gamma	Active	Active
Inhalation	Active	Active
Plant ingestion	Active	Active
Meat ingestion	Active	Active
Milk ingestion	Active	Active
Drinking water ingestion	Active	Inactive
Soil ingestion	Active	Active

Table H–13 RESRAD Unit Dose Factors for Water-Dependent Pathways

Nuclide	*Distribution Coefficient* [a] *(milliliters per gram)*	*Unit Dose Factor [(rem per year / (picocuries per gram)]*	*Unit Risk Factor (1 per year)*
Tritium	1	2.4×10^{-5}	2.2×10^{-8}
Carbon-14	20.9	1.1×10^{-3}	9.4×10^{-7}
Cobalt-60	1,000	7.4×10^{-3}	5.9×10^{-6}
Nickel-63	37.2	1.4×10^{-5}	2.3×10^{-8}
Selenium-79	115	5.4×10^{-4}	4.9×10^{-7}
Strontium-90	5	6.0×10^{-3}	5.0×10^{-6}
Technetium-99	7.4	1.7×10^{-3}	3.0×10^{-6}
Antimony-125	174	1.0×10^{-3}	7.6×10^{-7}
Iodine-129	4.6	1.5×10^{-2}	2.3×10^{-6}
Cesium-137	447	2.3×10^{-3}	1.7×10^{-6}
Promethium-147	5,010	4.0×10^{-7}	9.8×10^{-10}
Samarium-151	993	1.6×10^{-7}	3.6×10^{-10}
Europium-154	955	3.5×10^{-3}	2.7×10^{-6}
Lead-210	2,400	1.0×10^{-2}	5.0×10^{-6}
Radium-226	3,550	2.1×10^{-2}	1.2×10^{-5}
Radium-228	3,550	1.8×10^{-2}	1.1×10^{-5}
Actinium-227	1,740	2.6×10^{-3}	9.3×10^{-7}
Thorium-228	5,890	4.1×10^{-3}	3.2×10^{-6}
Thorium-229	5,890	1.2×10^{-3}	6.8×10^{-7}
Thorium-230	5,890	1.7×10^{-2}	9.1×10^{-6}
Thorium-232	5,890	2.4×10^{-2}	1.5×10^{-5}
Protactinium-231	2,040	6.9×10^{-3}	1.4×10^{-6}
Uranium-232	10	4.5×10^{-3}	3.2×10^{-6}
Uranium-233	10	1.7×10^{-3}	5.6×10^{-7}
Uranium-234	10	1.6×10^{-3}	5.5×10^{-7}
Uranium-235	10	1.7×10^{-3}	6.1×10^{-7}
Uranium-236	10	1.6×10^{-3}	5.2×10^{-7}
Uranium-238	10	1.6×10^{-3}	7.0×10^{-7}
Neptunium-237	7.1	5.3×10^{-3}	6.3×10^{-7}
Plutonium-238	955	1.5×10^{-4}	2.9×10^{-8}
Plutonium-239	955	1.6×10^{-4}	3.0×10^{-8}
Plutonium-240	955	1.6×10^{-4}	3.0×10^{-8}
Plutonium-241	955	4.5×10^{-6}	1.1×10^{-9}
Americium-241	1,450	1.5×10^{-4}	3.6×10^{-8}
Curium-243	6,760	3.7×10^{-4}	2.2×10^{-7}
Curium-244	6,760	7.5×10^{-5}	1.8×10^{-8}

[a] Site-specific data for strontium and uranium (Dames and Moore 1995a, 1995b), balance of data from NUREG/CR-5512, Vol. 3 (Beyeler et al. 1999).

Table H–14 RESRAD Unit Dose Factors for Water-Independent Pathways

Nuclide	*Distribution Coefficient* [a] *(milliliters per gram)*	*Unit Dose Factor [(rem per year)/ (picocuries per gram)]*	*Unit Risk Factor (1 per year)*
Tritium	1	4.2×10^{-6}	3.9×10^{-8}
Carbon-14	20.9	1.1×10^{-3}	9.4×10^{-7}
Cobalt-60	1,000	7.4×10^{-3}	5.9×10^{-6}
Nickel-63	37.2	1.4×10^{-5}	2.3×10^{-8}
Selenium-79	115	5.4×10^{-4}	4.9×10^{-7}
Strontium-90	5	6.0×10^{-3}	5.0×10^{-6}
Technetium-99	7.4	1.8×10^{-3}	3.0×10^{-6}
Antimony-125	174	1.0×10^{-3}	7.6×10^{-7}
Iodine-129	4.6	3.0×10^{-3}	2.4×10^{-6}
Cesium-137	447	2.3×10^{-3}	1.7×10^{-6}
Promethium-147	5,010	4.0×10^{-7}	9.8×10^{-10}
Samarium-151	993	1.6×10^{-7}	3.6×10^{-10}
Europium-154	955	3.5×10^{-3}	2.7×10^{-6}
Lead-210	2,400	1.0×10^{-2}	5.0×10^{-6}
Radium-226	3,550	2.1×10^{-2}	1.2×10^{-5}
Radium-228	3,550	1.8×10^{-2}	1.1×10^{-5}
Actinium-227	1,740	2.6×10^{-3}	9.3×10^{-7}
Thorium-228	5,890	4.1×10^{-3}	3.2×10^{-6}
Thorium-229	5,890	1.2×10^{-3}	6.8×10^{-7}
Thorium-230	5,890	7.7×10^{-3}	4.2×10^{-6}
Thorium-232	5,890	2.4×10^{-2}	1.5×10^{-5}
Protactinium-231	2,040	6.9×10^{-3}	1.4×10^{-6}
Uranium-232	10	4.6×10^{-3}	3.3×10^{-6}
Uranium-233	10	9.0×10^{-5}	4.6×10^{-8}
Uranium-234	10	8.6×10^{-5}	4.5×10^{-8}
Uranium-235	10	4.4×10^{-4}	3.1×10^{-7}
Uranium-236	10	8.2×10^{-5}	4.3×10^{-8}
Uranium-238	10	1.5×10^{-4}	1.1×10^{-7}
Neptunium-237	7.1	1.7×10^{-3}	6.3×10^{-7}
Plutonium-238	955	1.5×10^{-4}	3.3×10^{-8}
Plutonium-239	955	1.6×10^{-4}	3.0×10^{-8}
Plutonium-240	955	1.6×10^{-4}	3.0×10^{-8}
Plutonium-241	955	4.5×10^{-6}	4.2×10^{-10}
Americium-241	1,450	1.5×10^{-4}	3.6×10^{-8}
Curium-243	6,760	3.7×10^{-4}	2.2×10^{-7}
Curium-244	6,760	7.5×10^{-5}	1.8×10^{-8}

[a] Site-specific data for strontium and uranium (Dames and Moore 1995a, 1995b), balance of data from NUREG/CR-5512, Vol. 3 (Beyeler et al. 1999).

Table H–15 Values of Parameters for Exposure to Hazardous Chemicals

Parameter	*Value*	*Source*
Drinking Water Ingestion		
Ingestion Rate	2.35 liters per day	EPA/600/C-99/001
Exposure Frequency	365 days per year	EPA/600/C-99/001
Exposure Duration	30 years	EPA/600/C-99/001
Inadvertent Soil Ingestion		
Ingestion Rate	120 milligrams per day	EPA/540-R-00-007
Exposure Frequency	365 days per year	EPA/540-R-00-007
Exposure Duration	30 year	EPA/540-R-00-007
Fugitive Dust Inhalation		
Particulate emission factor	1.32×10^9 cubic meters per kilogram	EPA/540-R-00-007
Inhalation Rate	20 cubic meters per day	EPA/540-R-00-007
Exposure Frequency	365 days per year	EPA/540-R-00-007
Exposure Duration	30 years	EPA/540-R-00-007
Outdoor exposure time fraction	0.073	EPA/540-R-00-007
Indoor exposure time fraction	0.683	EPA/540-R-00-007
Dilution factor for indoor inhalation	0.4	EPA/540-R-00-007
Crop Ingestion		
Vegetable and fruit ingestion rate	112 kilograms per year	NUREG/CR-5512
Leafy vegetables ingestion rate	21 kilograms per year	NUREG/CR-5512
Exposure duration	30 years	EPA/540-R-00-007
Meat Ingestion		
Ingestion Rate	65 kilograms per year	NUREG/CR-5512
Exposure Duration	30 years	EPA/600/C-99/001
Milk Ingestion		
Ingestion Rate	233 liters per year	NUREG/CR-5512
Exposure Duration	30 years	EPA/600/C-99/001

Note: To convert liters to gallons, multiply by 0.26418; cubic meters to cubic feet, multiply by 35.314; kilograms to pounds, multiply by 2.2046.

The degree of contamination for the deer consumption pathway involves consideration of the portion of deer diet obtained in the contaminated area and the amount of deer meat consumed. Values for these parameters are presented in **Table H–16**. The amount of deer consumed (65 kilograms per year) is the difference between the 95th percentile estimate for meat consumption during a year (EPA 1999b) and the estimate of home production meat and poultry (Beyeler et al. 1999) used in the RESRAD simulation of the residential and garden pathways. Note that in practice the deer pathway contributes only a very small fraction of predicted doses.

Table H–16 Values for the Deer Ingestion Pathway

Parameter	*Value*	*Source*
Ingestion Rate	65 kilograms per year	EPA 1999b, Beyeler et al. 1999
Length of Contaminated Area		
Process Building	10 to 40 meters	Site Specific
Vitrification Facility	7 to 10 meters	Site Specific
High-level waste tanks 8D-1 and 8D-2	30 meters	Site Specific
High-level waste tanks 8D-3 and 8D-4	6 meters	Site Specific
NDA	60 meters	Site Specific
SDA	400 meters	Site Specific
Deer range area	2.5 square kilometers	State of Missouri 2004
Deer rate of consumption of vegetation	2.25 kilograms per day	State of North Carolina 2004
Exposure frequency	365 days per year	EPA 1999a
Exposure duration	30 years	EPA 1999a

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area.
Note: To convert kilograms to pounds, multiply by 2.2046; meters to feet, multiply by 3.2808; square kilometers to square miles, multiply by 0.3861.

In addition to the residential and garden exposure pathways, offsite receptors may harvest fish from surface water downstream of the WNYNSC. Exposure pathways data for offsite receptors are summarized in **Table H–17**.

Table H–17 Exposure Pathway Data for Offsite Receptors [a]

Receptor Location	*Scenario*	*Consumption of Drinking water (liters per day)*	*Consumption of Impacted Fish (kilograms per year)*	*Use of Water for Garden Irrigation*
Cattaraugus Creek, downstream of confluence with Buttermilk Creek	Resident farmer	2.35 [b]	9.0 [b]	Yes
Cattaraugus Creek at Seneca Nation of Indian reservation	Resident farmer	2.35	62.0 [b]	Yes
Sturgeon Point water user	Drinking water user, fish consumer	2.35	0.1 [c]	Yes
Niagara River water user	Drinking water user, fish consumer	2.35	0.1 [c]	Yes

[a] Offsite receptors are not exposed via the deer pathway or as recreational hikers. This is not because the predicted radiation dose from such activities is exactly zero. It is because, if included, it would only be a small fraction of the dose accumulated via other pathways.

[b] These values for water and fish consumption are taken from EPA's *Exposure Factors Handbook* (EPA 1999a). The 9 kilograms per year is the 95th percentile fish consumption for recreational anglers. The 62 kilograms per year is the 95th percentile fish consumption for subsistence fishermen.

[c] The population dose for each alternative is that for the population using the water from Sturgeon Point and several intakes in the East Channel of the Niagara River along with the assumption that each member of this population consumes 0.1 kilograms per year of fish that has been contaminated due to releases from the West Valley Site. The 0.1-kilogram per year is based on a five-year average New York fish yield from Lake Erie (102,000 kilograms) distributed over the population that uses the water.

Note: To convert liters to gallons, multiply by 0.26418; kilograms to pounds, multiply by 2.2046.

Finally, as noted previously, there is a receptor on the East bank of Franks Creek (opposite the SDA), one on the North bank of Erdman Brook (opposite the NDA), and one in the vicinity of the Low-Level Waste Treatment Facility and lagoons to model radiation dose from exposure to contaminated ground water and soils uncovered by *erosion* of the stream's banks. This receptor is assumed to live in a house on the opposite side of the eroded bank and so is exposed to direct shine. This receptor does not keep a garden on the eroding bank (and thus is not exposed to the drinking water, crop, and animal ingestion pathways) and does not consume deer. In addition, the receptor is assumed to be affected by the inhalation and inadvertent ingestion pathways of the recreational hiking exposure pathway (see Table H–5 and associated text).

H.2 Long-Term Impacts

The purpose of this section is to present estimates of long-term impacts for each of the alternatives. The organization of this section closely parallels that of Section 4.1.10, but more detail is provided.

H.2.1 Sitewide Removal

The Sitewide Removal Alternative is addressed separately because it would require decontamination of the entire site so it is available for unrestricted use. This means that the radiation dose to any reasonably foreseeable onsite receptor would be less than 25 millirem per year. The precise residual contamination is not known with enough precision to warrant an offsite dose analysis, but offsite dose consequences would be substantially below that for the Sitewide Close-In-Place Alternative or the No Action Alternative.

Radioactive Contamination

Under this alternative, WNYNSC would be decontaminated during the Decommissioning Period so that any remaining residual radiological contamination would be below the unrestricted use dose criteria of 10 CFR 20.1402. To demonstrate that decontamination is adequate would require analysis of a number of representative, reasonably conservative scenarios to ensure that none of the range of potential human activities on the site would lead to the accumulation of individual radiation doses exceeding the unrestricted use dose criteria. One possible way of achieving this would be to use the analysis of the scenarios to estimate derived concentration guideline levels (DCGLs) that could be used as decontamination targets in various parts of the site. The NRC, for example, has published screening level DCGLs for some common radionuclides for soil contamination levels (NRC 2006). These screening level DCGLs are reproduced in **Table H–18**. In practice, project-specific DCGLS will be developed through the Decommissioning Plan preparation and review process.

Table H–18 Examples of Derived Concentration Guideline Levels of Some Common Radionuclides for Soil Screening Surface Contamination Levels [a, b, c]

Nuclide	*Derived Concentration Guidelines (picocuries per gram)*	*Nuclide*	*Derived Concentration Guidelines (picocuries per gram)*
Tritium	110	Europium-154	8
Carbon-14	12	Iridium-192	41
Sodium-22	4.3	Lead-210	0.9
Sulfur-35	270	Radium-226	0.7
Chlorine-36	0.36	Actinium-227	0.5
Scandium-46	15	Thorium-228	4.7
Manganese-54	15	Thorium-230	1.8
Iron-55	10,000	Thorium-232	1.1
Cobalt-57	150	Protactinium-231	0.3
Cobalt-60	3.8	Uranium-234	13
Nickel-59	5,500	Uranium-235	8
Nickel-63	2,100	Uranium-238	14
Strontium-90	1.7	Plutonium-238	2.5
Technetium-99	19	Plutonium-239	2.3
Iodine-129	0.5	Plutonium-241	72
Cesium-134	5.7	Americium-241	2.1
Cesium-137	11	Curium-242	160
Europium-152	8.7	Curium-243	3.2

[a] Source: NUREG-1757 (NRC 2006).
[b] These values represent surficial surface concentrations of individual radionuclides that would be deemed in compliance with the 25 millirem per year(0.25 milliSievert per year) unrestricted dose release limit in 10 CFR 20.1402.
[c] For radionuclides in a mixture, the "sum of fractions" rule applies, see Section 2.7 of NUREG-1757 Vol. 2.

Hazardous Chemical Contamination

Under this alternative, WNYNSC would be decontaminated during the Decommissioning Period so that residual hazardous material contamination would not result in a situation where the concentration would exceed criteria for clean closure. The criteria could include NYSDEC TAGM-4046, *Determination of Soil Cleanup Objectives and Cleanup Levels* and NYSDEC Division of Water, Technical and Operational Guidance Series 1.1.1, *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent*

Limitations or other agency-approved cleanup objectives that are protective of human health and the environment (e.g., risk-based action levels).

H.2.2 Sitewide Close-In-Place and No Action Alternatives

This section addresses the estimated impacts that would result from implementing the Sitewide Close-In-Place Alternative and the No Action Alternative, respectively.[6] These two alternatives would have some amount of hazardous and radioactive material remaining onsite but the Sitewide Close-In-Place Alternative would have additional engineered barriers to increase the isolation of the hazardous and radioactive material. The analysis of the Sitewide Close-In-Place and No Action Alternatives is organized as follows:

Section H.2.2.1 discusses the major elements of the long-term performance assessment and identifies the major conservative assumptions made in the analysis. The section also presents a summary description of hydrologic transport parameters used in the impact analysis. Values of parameters characterizing receptor behavior are those already summarized in Section H.1.3. The section concludes with a summary as to why the deterministic results presented in this EIS are considered to be conservative.

Section H.2.2.2 deals with impacts given assumed indefinite continuation of institutional controls. These impacts take credit for institutional controls to prevent access to the waste management areas, to maintain the integrity of structures such as the Main Plant Process Building, together with engineered features such as erosion control structures and engineered caps. These results are for offsite receptors and are considered to represent a lower bound on environmental consequences of the alternatives.

Section H.2.2.3 deals with impacts assuming loss of institutional controls after 100 years. In particular, it is assumed that there are no more efforts to contain radionuclides and hazardous chemicals within the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farms. Conservatively, these facilities are assumed to fail as soon as institutional controls fail. These scenarios considered in this section are ones that could occur over a relatively short period (week to a few years) following the loss of institutional controls. This subsection reexamines the analysis for the offsite receptors and also considers the consequences to potential intruders that could enter the WNYNSC and various waste management areas following the loss of institutional controls. These results are considered to represent on upper bound on the environmental consequences of the alternatives.

Section H.2.2.4 considers a special case of long-term loss of institutional controls thereby allowing unmitigated erosion to occur. The offsite receptors are again reanalyzed. In addition, this section considers onsite receptors on the banks of Franks Creek and Erdman Brook who would be exposed to direct radiation, inadvertent ingestion of soil and inhalation of resuspended soil due to eroded surfaces of waste.[7] Because unmitigated erosion involves the long-term failure of institutional controls the scenario is considered less likely than the scenarios analyzed in Section H.2.2.3, but the unmitigated erosion scenario is still evaluated to provide insight into the consequences from such a scenario.

H.2.2.1 Parameters in the Impact Analysis

This section discusses the major conceptual elements of the long-term performance assessment, identifies specific parameters and other elements of conservatism in the analysis. The presentation is organized around

[6] *There is no quantitative long-term performance assessment for the preferred alternative, Phased Decisionmaking, because the long-term impact depends on the final condition, which is yet to be defined. There is a qualitative discussion of long-term impacts for the preferred alternative in Section H.2.3.*

[7] *In this appendix, calculations of dose from external irradiation are performed using the Microshield computer model and include both direct shine from eroded surfaces and skyshine. However, the modeling did not consider ground shine from radioactive materials deposited directly onto creek banks.*

the topics of inventory estimates, groundwater flow rates, engineered and natural barriers, hydrologic release models, erosion predictions, surface stream transport, and human actions. The section concludes with a general discussion of the basis for considering the calculated dose consequences as being conservative.

Inventory Estimates. Inventory estimates were developed for the various waste management areas. In many cases, there were multiple estimates developed reflecting the uncertainty in the inventory. When there were multiple estimates, one of the more conservative (i.e., larger) inventory estimates was used in the analysis. Estimates of radiological and chemical constituent inventories are presented in Appendix C.

Groundwater and surface water flow rates. For groundwater release scenarios involving local concentrations of contamination, such as at the Main Plant Process Building on the North Plateau or the disposal areas on the South Plateau, groundwater is assumed to move through the waste volume, remove contamination, and transport that contamination through the aquifer to onsite wells and receptors and to discharge to surface water and offsite receptors. For contamination spatially distributed in the North Plateau Groundwater Plume, flow of groundwater moves the distributed contamination through the aquifer to onsite wells and receptors and to discharge to surface water and offsite receptors. Thus, a primary set of information used in impact analysis consists of the conditions of groundwater flow.

The sitewide and near-field flow models used to develop this description of groundwater flow conditions are described in Appendix E. In that appendix, results of solute transport simulations with three-dimensional models indicated that plumes originating from given locations on the North Plateau followed northeastly trending paths to points of discharge (Figures E–42 and E–43). In addition, one-dimensional simulation of concentration of strontium-90 in the North Plateau Groundwater Plume provided a reasonable match with the results of three-dimensional transport simulation and with measured concentrations along the centerline of the plume. On this basis, one-dimensional groundwater flow models were selected for human health impacts analysis. The value of longitudinal dispersivity is 1/10 of the distance from the source to the point at which a receptor contacts the groundwater for all sources except for the North Plateau Groundwater Plume for which the value of 5 meters determined by comparison to data (see Appendix E) is used. In addition, the one-dimensional model introduces an element of conservatism by ignoring lateral dispersion that reduces downstream concentrations in the field.

Values of groundwater flow velocities extracted from the three-dimensional model results for use in one-dimensional models are summarized in **Table H–19**. The lower velocities for the Close-In-Place Alternative are the result of engineered hydrologic barriers above and upgradient of the various facilities that reduces water flow into the area surrounding the facilities. In addition to this flow information, estimation of concentrations of contaminants in the North Plateau Groundwater Plume at the initiation time (calendar year 2020) of long-term performance assessment is required. The approach taken to the development of this information was to use the inventory estimate for the North Plateau Groundwater Plume presented in Appendix C and the one-dimensional flow model to estimate the concentration of contaminants in the plume in calendar year 2020 given a release in calendar year 1968. The results of this calculation, assumed applicable for both the No Action and Sitewide Close-In-Place Alternatives, are presented in **Table H–20**. Consistent with the relatively rapid movement of groundwater in the thick-bedded unit and the slack-water sequence on the North Plateau, relatively mobile radionuclides such as tritium-3, technetium-99 and iodine-129 would have discharged from the aquifer prior to calendar year 2020.

Table H–19 Groundwater Flow Velocities for Human Health Impact Analysis

Facility	Geohydrologic Unit	Average Linear Velocity (meters per year)	
		Sitewide Close-In-Place Alternative	No Action Alternative
North Plateau			
Main Plant Process Building	Slack-water Sequence	161	161
Vitrification Facility	Slack-water Sequence	161	161
Waste Tank Farm	Thick-bedded Unit	103	146
Low-Level Waste Treatment Facility	Thick-bedded Unit	161	161
South Plateau			
NDA [a]			
Horizontal	Weathered Lavery Till	0.69(P),0.47(H),0.67(W)	0.69(P),0.47(H),0.67(W)
Vertical	Unweathered Lavery Till	0.077(P),0.18(H),0.096(W)	0.077(P),0.18(H),0.096(W)
SDA			
Horizontal	Weathered Lavery Till	0.92	0.92
Vertical	Unweathered Lavery Till	0.061	0.061

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area.
[a] The parenthetical labels P and H denote the Nuclear Fuel Services process and hulls disposal areas of the NDA while the label W denotes the West Valley Demonstration Project disposal area of the NDA.
Note: To convert meters to feet, multiply by 3.2808.

Table H–20 Estimated Concentrations in the North Plateau Groundwater Plume for Calendar Year 2020

Distance [a] (meters)	Concentration (picocuries per liter)				
	Carbon-14	Strontium-90	Uranium-238	Neptunium-237	Plutonium-239
0	0	0.4	0	0	0.01
50	0.1	4,790	0.15	0.02	35.0
100	2.3	106,000	0.39	0.44	90.0
150	6.6	294,000	0.02	1.20	5.0
200	2.6	118,000	0	0.50	0.007
250	0.16	6,910	0	0.03	0
300	0.001	60	0	0	0

[a] Coordinates for the source initially located at distance of 20 meters.
Note: To convert meters to feet, multiply by 3.2808.

The concept adopted for estimation of contaminant concentration in surface water following the discharge of contaminated groundwater is to assume constant rate of flow of surface water and uniform mixing of the two flows. In this concept, the concentration of contamination in the surface water is reduced relative to that in groundwater in approximate proportion to the ratio of the flow rates of the groundwater and the surface water. Rates of flow of surface water used in the calculations are summarized in **Table H–21** for the five surface water receptor locations. For example, with horizontal cross-sectional area of aquifer flow ranging from 300 square meters for the Main Plant Process Building to 40 square meters for the NFS Hulls Area, effective porosity of 0.35 and 0.324, and the groundwater velocities presented in Table H–19, flow rates of contaminated ground water range from approximately 6 to 16,900 cubic meters per year. Complete mixing into the flow of Buttermilk Creek would produce dilution ratios ranging from one in ten million to one in twenty-five hundred. Greater dilution ratio would be estimated for the other four surface water locations due to increased surface water flow at those locations.

Table H–21 Surface Water Flow Rates for Estimation of Human Health Impacts

Location	***Volumetric Flow Rate (cubic meters per year)***
Buttermilk Creek	4.15×10^{7}
Cattaraugus Creek [a]	3.15×10^{8}
Cattaraugus Creek [b]	6.64×10^{8}
Sturgeon Point	6.64×10^{8}
Niagara River	1.84×10^{11}

[a] Near confluence with Buttermilk Creek.
[b] Near Gowanda (Seneca Nation of Indians).
Note: To convert cubic meters to cubic feet, multiply by 35.314.

Engineered and Natural Barriers. Engineered barriers and natural materials considered in this performance assessment include ones with the ability to divert or control flow, some of which also have absorptive properties to retard the movement of hazardous constituents. The flow control structures considered for the Sitewide Close-In-Place Alternative analysis include the drainage and underlying clay layers of engineered caps, the circumferential subsurface slurry walls on the North and South Plateaus, the Controlled Low Strength Material (a form of grout) used to fill the tanks of the Waste Tank Farm, and the grout used to stabilize sediments at lagoons 1, 2, and 3 of the Low-Level Waste Treatment Facility. Flow control structures identified in the preliminary closure designs in the Sitewide Close-In-Place Alternative Technical Report (WSMS 2009) but not considered in this performance assessment include the upgradient barrier wall designed to redirect groundwater flow from the North Plateau circumferential slurry wall, the surface drainage from the multi-layered caps on the North and South Plateaus, and the geomembrane layer in the multi-layered caps on the North and South Plateaus. Not including these barriers in the long-term performance assessment will result in higher estimates of water flow through the waste, more rapid movement of contaminants through the environment, and therefore higher doses to downgradient receptors. For the engineered barriers considered in the analysis, the values of hydraulic conductivity that control the functional capacities of these barriers are well defined by design at the time of installation but may degrade over time. No credit is taken for retardation of contaminants by the slurry walls included in the analysis. Because the rate of degradation would be difficult to predict, degraded values of hydraulic conductivity are conservatively assumed to apply over the entire time period of the long-term performance assessment, irrespective of whether institutional controls are maintained or fail.

Literature review of the performance of drainage layers identified particulate plugging and biofilm growth as the primary modes of degradation (Rowe et al. 2004). However, it is also reported that proper choice of gravel size and with quality assurance for installation, coarse gravel can maintain high hydraulic conductivity in operation (Rowe et al. 2004). Based on these considerations and in order to provide a conservative assessment of performance, a value of hydraulic conductivity of 0.03 centimeters per second was adopted for drainage layers in the engineered caps. This value is two orders of magnitude less than the design value of the gravel and at the upper end of the range of values reported for sand (Meyer and Gee 1999).

Literature review of performance of clay layers identified dessication as the primary failure mechanism for this type of barrier (Rowe et al. 2004). The study also reported excellent performance when the layers were maintained in the saturated state. On this basis, a degraded valued of hydraulic conductivity of clay layers in the center of engineered caps of 5×10^{-8} centimeters per second was adopted. This value is one order of magnitude higher than the design value.

Also based on these considerations, degradation of performance is assumed for slurry walls extending to the ground surface. Although the offset in hydraulic conductivity between the slurry wall and the surrounding natural material is large and would be expected to maintain near saturated conditions in a humid environment such as West Valley, a two-order of magnitude degradation in design value of hydraulic conductivity was assumed for this analysis. The value adopted for hydraulic conductivity of slurry walls was 1×10^{-6} centimeters per second. Values of hydraulic conductivity reported for intact concrete range from 1×10^{-10} to 1×10^{-8} centimeters per second (Clifton and Knab 1989). In order to account for degradation and potential effectiveness of placement, a value of 1×10^{-5} centimeters per second was used for Controlled Low Strength Material and grout in the long-term performance assessment.

The above cited values of hydraulic properties are used in the near-field groundwater flow models to estimate rates of flow through waste materials. The results of these calculations for facilities on the North Plateau are presented in **Tables H–22** and **H–23** for the No Action and Sitewide Close-In-Place Alternatives, respectively. Differences in volumetric flow rates reported in these two tables are related to placement of engineered barriers while differences in waste volume between the No Action and Close-In-Place Alternatives are related to decontamination and closure activities. Placement of the engineered barriers for the Close-In-Place Alternative decreases the volume of flow and, in some cases, the direction of flow relative to the No Action Alternative. On the South Plateau, waste is simulated as mixed with soil in holes and trenches and groundwater velocities through the waste are those reported in Table H–19 for the geohydrologic unit in which the waste is located. Flow areas and waste volumes used in simulation of the South Plateau facilities are presented in **Table H–24**. These areas and volumes are the same for both the No Action and the Sitewide Close-In-Place Alternatives.

Table H–22 Flow Rates Through Waste Disposal Volumes for North Plateau Facilities for the No Action Alternative

Facility	*Flow Area Through Waste (square meters)*	*Disposal Volume (cubic meters)*	*Flow Direction*	*Volumetric Flow Rate Through Waste (cubic meters per year)*
Main Plant Process Building				
General Purpose Cell	3	42	Horizontal	27
Liquid Waste Cell	102	102	Vertical	26
Fuel Receiving and Storage Pool	12	240	Horizontal	129
Rubble Pile	3,200	14,000	Vertical	835
Vitrification Facility	45	340	Horizontal	190
Waste Tank Farm				
Tank 8D-1	19	357	Horizontal	56
Tank 8D-2	19	357	Horizontal	60
Tank 8D-3	3	10	Horizontal	10
Tank 8D-4	3	10	Horizontal	10
Low-Level Waste Treatment Facility				
Lagoon 1	35	605	Horizontal	566
Lagoon 2	34	2,020	Horizontal	871
Lagoon 3	17	1,020	Horizontal	469
Lagoon 4	1.1	29	Horizontal	30
Lagoon 5	1.1	29	Horizontal	33

Note: To convert square meters to square feet, multiply by 10.764; cubic meters to cubic feet, multiply by 35.314.

Table H–23 Flow Rates Through Waste Disposal Volumes for North Plateau Facilities for the Sitewide Close-In-Place Alternative

Facility	*Flow Area Through Waste (square meters)*	*Disposal Volume (cubic meters)*	*Flow Direction*	*Volumetric Flow Rate Through Waste (cubic meters per year)*
Main Plant Process Building				
General Purpose Cell	45	7	Vertical	1.2
Liquid Waste Cell	102	245	Vertical	2.8
Fuel Receiving and Storage Pool	260	40	Vertical	5.9
Rubble Pile	12,000	12,000	Vertical	482
Vitrification Facility	79	340	Vertical	2.2
Waste Tank Farm				
Tank 8D-1	357	357	Vertical	5.7
Tank 8D-2	357	357	Vertical	3.5
Tank 8D-3	10	10	Vertical	0.17
Tank 8D-4	10	10	Vertical	0.17
Low-Level Waste Treatment Facility				
Lagoon 1	35	605	Horizontal	0.70
Lagoon 2	34	2,020	Horizontal	11
Lagoon 3	17	1,020	Horizontal	6.5
Lagoon 4	3.3	86	Horizontal	85
Lagoon 5	3.3	86	Horizontal	90

Note: To convert square meters to square feet, multiply by 10.764; cubic meters to cubic feet, multiply by 35.314.

Table H–24 Flow Areas and Disposal Area Volumes for Facilities on the South Plateau

Facility	*Disposal/Waste Area Volume (cubic meters)*	*Flow Area (square meters)*	
		Horizontal Flow Path	*Vertical Flow Path*
NDA			
Nuclear Fuel Services Process	11,000	220	2,200
Nuclear Fuel Services Hulls	3,000	40	200
West Valley Demonstration Project	12,800	160	1,600
SDA	120,000	1,200	20,000

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area.
Note: To convert cubic meters to cubic feet, multiply by 35.314; square meters to square feet, multiply by 10.764.

Values of distribution coefficient characterizing retention in natural and engineered materials are also applied for analysis of transport of solutes. Values of distribution coefficient used for aquifer soils, concrete and Controlled Low Strength Material are presented in **Table H–25**. The approach taken for these selections is to use values for un-degraded material for short-lived constituents expected to decay during the expected life of the engineered material, such as strontium-90 and cesium-137, and degraded values for those elements expected to remain for long periods of time. The expected lifetimes of the engineered grouts are on the order of 500 years (Clifton and Knab 1989, Atkinson and Hearn 1984). The value of distribution coefficient of technetium in concrete and controlled low strength material is based upon measurement of values of effective diffusivity of 5×10^{-9} square centimeters per second for technetium (PNNL 2001) and of 3×10^{-2} square centimeters per second for nitrate, a conservative constituent (Lockrem 2005), in grout. While decrease in retention of elements on cement with degradation has been reported (Bradbury and Sarott 1995), high retention of actinide elements is reported even for degraded cements.

Table H–25 Values of Distribution Coefficient for Long-term Impact Analysis

Element	Distribution Coefficient (milliliters per gram)		
	Aquifer	*Concrete*	*Controlled Low Strength Material*
Hydrogen	0	1.0	1.0
Carbon	5	5	5
Strontium	5	15	15
Technetium	0.1	1.0	1.0
Iodine	1	1	1
Cesium	280	280	280
Uranium	10	10	35
Neptunium	5	5	60
Plutonium	550	550	550
Americium	1,900	1,900	1,900

The Controlled Low Strength Material is a grout-based mixture that is used inside the tanks and in the annual space between tanks and vaults and includes zeolite and apatite minerals as aggregates. Characterization of grouted materials has established that cesium and strontium are retained primarily on the aggregates used in the concrete, while other elements are retained both on the aggregate and on the calcium silicate hydrogel matrix of the concrete (Stinton et al. 1984). High retention of cesium on zeolite (Lonin and Krasnopyorova 2004) and of strontium and heavier elements on apatite (Krejzler and Narbutt 2003) has been documented.

For high-density concrete as used in contaminated portions of site facilities, retention of strontium and cesium is expected to occur on the sand ballast while retention of actinides is expected to occur on the degraded cement material. On the basis of the above considerations, the values of Table H–25 primarily characteristic of sand (Sheppard and Thibault 1990) are proposed for cement materials. The increased value for neptunium in Controlled Low Strength Material is related to presence of apatite. For aquifer soils, the values are derived from site specific measurements for strontium and uranium (Dames and Moore 1995a, 1995b) and from national survey data for sand (Sheppard and Thibault 1990). These values are applied to both the sandy units of the North Plateau and the silt-clay soils underlying both the North and South Plateaus.

Hydrologic Release Model. Contaminants are assumed to be released from the initial waste form according to a partitioning model where there is equilibrium between the concentration of contaminants in solid phase and the concentration of contaminants in the interstitial liquid phase. This is a commonly-used model and appears to be appropriate for many of the waste forms and radionuclides, but it is conservative (i.e., predicts higher release rates) for instances when the radionuclides are incorporated into the original waste matrix such as some of the irradiated material in the SDA, the leached hulls in the NDA, and the adsorbed radionuclides on the tank wall and gridwork in Tank 8D-2.

Long-term Erosion. For the long-term period of time extending out 10,000 years from the present, the rate of soil loss and related changes in elevation of the site and Buttermilk Creek watershed due to erosional processes has been evaluated using the CHILD landscape evolution model. Detailed description of the approach and analysis are presented in Appendix F. Results were derived for a range of environmental and site physical conditions and indicated for the Sitewide Close-In-Place Alternative stable elevations in the vicinity of the Main Plant Process Building and Waste Tank Farm but vulnerability to erosion in the vicinity of the Low-Level Waste Treatment Facility, NDA, and SDA. The statement that the area of the Main Plant Process Building and Waste Tank Farm were not disturbed by erosion under the Sitewide Close-In-Place Alternative is dependent upon the tendency for water to flow off the tumulus and for the configuration of nearby gullies to orient in the direction that captures drainage area to support continued growth of the gully. That is, the elevation structure of the tumulus in connection with the surrounding topography tends to divert the heads of large gullies away from the tumulus. A primary mechanism for soil loss and related onsite and offsite potential human health impacts is development of gullies. For conditions of elevated precipitation and reduced infiltration (see Section F.3.1.6.4, Case NPTwet), the CHILD model predicted development of a large gully extending southward from the north edge of the North Plateau. Contour plots of this gully at times of 100 and 4,000 years are presented in **Figures H–4** and **H–5**, respectively, and time-dependent dimensions of this gully are presented in **Table H–26**. The approach adopted for estimation of potential human health impacts is evaluation of impacts of development of this gully in areas identified as vulnerable to erosion in the CHILD simulations. These areas are the Low-Level Waste Treatment Facility, the NDA, and SDA. The human health impacts of unmitigated erosion were evaluated using the single gully and erosion release dose models described in Appendix G.5. The analysis proceeds in two steps. In the first step, the single gully model characterized by time dependent rates of advance and downcutting is calibrated to the characteristics of the CHILD single large gully (see Table H–26) and used to estimate the rate of release from the waste volume. In the second step, human health impacts due to the rate of release calculated in the first step are calculated for either onsite or offsite receptors. In addition to configuration of the gully, estimates of human health impact depend on waste area inventories and dimensions and configuration of sources summarized in Appendix C. The model used to develop estimates of human health impacts of erosion releases is described in Section G.5 in Appendix G.

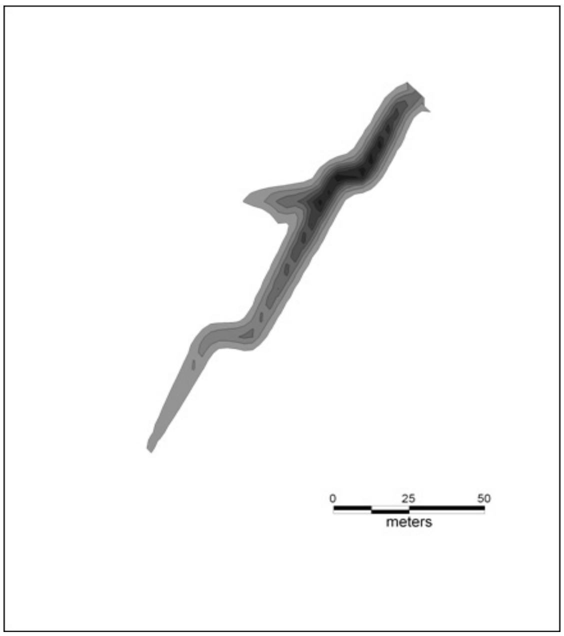

Figure H–4 CHILD Landscape Evolution Model Single Large Gully at 100 Years

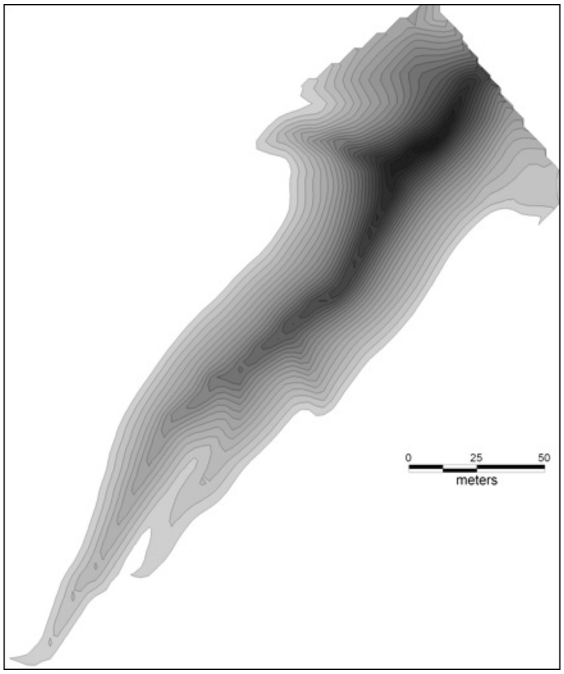

Figure H–5 CHILD Landscape Evolution Model Single Large Gully at 4,000 Years

Table H–26 Dimensions of CHILD Simulation Gully for Elevated Precipitation, Low Infiltration Conditions

Time (years)	*Volume (cubic meters)*	*Length (meters)*	*Width (meters)*	*Depth (meters)*
100	4,510	153	12	7.7
200	5,330	160	15	7.5
300	6,590	154	16	9.7
400	11,640	202	18	11.7
500	12,300	202	21	10.8
600	15,310	202	22	13.8
700	16,510	202	24	12.4
800	20,500	213	26	13.8
900	24,250	218	28	15.6
1,000	25,520	218	30	15.0
4,000	106,050	276	67	23.8
9,100	225,120	392	85	32.0

Note: To convert cubic meters to cubic feet, multiply by 35.314; meters to feet, multiply by 3.2808.

Monitoring and maintenance activities could slow down the erosion rate while human intrusion activities that change the ground cover or local topography could locally accelerate erosion. The development and use of such predictions for establishing estimates of long-term environmental consequences along with the disclosure of unquantifiable uncertainty due to unpredictable future human actions is consistent with National Environmental Policy Act (NEPA) requirements.

Surface Water Transport. The EIS makes the conservative assumption that there is no contaminant removal from surface waters as the contaminated water flows downstream. In reality some removal will occur depending on the chemical form of the contaminants and the minerals and plants in the stream channel. In addition, the EIS assumes no dilution of Cattaraugus Creek water as it flows from its discharge into Lake Erie to the Sturgeon Point intake structure because of the uncertainty and variability of the flow between the two points.

Human actions. The EIS also makes conservative assumptions about the nature and timing of human actions that would result in human exposure consequences. For on-plateau receptors, the wells and gardens were assumed to be located in positions that would result in higher exposures (e.g., wells in plume center lines, gardens in areas with drill cuttings and other contaminated material). The EIS also assumed that there is no water treatment (e.g., filtration or ion exchange) before the on-plateau water is consumed or used or irrigation. For off-plateau receptors the EIS analysis also assumes there would be no water treatment and that the off-plateau receptors consumed fish living and/or stocked near the same location where they obtain their contaminated water. Details of the major parameters are discussed in Section H.1.3.

Bioaccumulation. Mathematical expressions used to calculate estimates of dose for human health exposure pathways are presented in Appendix G. For the fish consumption pathway, contamination in surface water is simulated as accumulating in fish that are subsequently consumed by a human receptor. For the deer consumption pathway, contamination in groundwater is simulated as distributing onto soil and transferring to plants consumed by deer that are subsequently consumed by a human receptor. Values of fish and meat (deer) bioaccumulation factors and soil-to-plant transfer factors used in these calculations are presented in **Table H–27**. Distribution coefficients representing transfer between groundwater and soil are presented in Table H–13.

Conclusions. Based on these series of conservative assumptions about inventory, the nature of the engineered barriers, the location and actions of receptors, it is believed that the estimates of doses to potential individuals presented in the EIS are conservative.

H.2.2.2 Indefinite Continuation of Institutional Controls

This section presents long-term radiological dose and long-term radiological and hazardous chemical risk to offsite receptors. Assuming that institutional controls continue indefinitely represents a lower bound on potential health impacts. This section is organized by receptor beginning with the nearest offsite receptor and progressing to the farthest and discusses the impacts to these receptors following releases to the local groundwater, discharges to the onsite streams (Erdman Brook, Franks Creek and Buttermilk Creek), and flow into Cattaraugus Creek.

In this case of indefinite continuation of institutional controls, it is assumed that maintenance actions for the Main Plant Process Building, the Vitrification Facility, and the Waste Tank farm would keep engineered systems (e.g., drying systems, and roofs) operating indefinitely. The doses from these units would be minimal as long as the engineered systems function as originally designed and institutional controls prevent releases. These maintenance actions and their associated costs are described in the No Action technical report, which is a primary reference for this EIS.

Table H–27 Bioaccumulation and Transfer Factors for Fish and Deer Consumption Pathways

Nuclide	*Bioaccumulation Factor in Fish [a] [(pCi/kg)/(pCi/L)]*	*Soil-to-Plant Transfer Factor [b] [(pCi/g)/(pCi/g)]*	*Bioaccumulation Factor in Meat [c] [pCi/kg)/(pCi/d)]*
Tritium	1	4.8	1.2×10^{-2}
Carbon	4,600	0.7	3.1×10^{-2}
Cobalt	330	0.08	3.0×10^{-2}
Nickel	100	0.05	5.0×10^{-3}
Selenium	170	0.1	1.0×10^{-1}
Strontium	50	0.3	1.0×10^{-2}
Technetium	15	5.0	1.0×10^{-4}
Antimony	200	0.01	1.0×10^{-3}
Iodine	500	0.02	4.0×10^{-2}
Cesium	2,000	0.04	5.0×10^{-2}
Promethium	25	0.002	2.0×10^{-3}
Samarium	25	0.002	2.0×10^{-3}
Europium	25	0.002	2.0×10^{-3}
Thallium [d]	100,000	0.2	2.0×10^{-2}
Lead	100	0.004	8.0×10^{-4}
Bismuth	15	0.1	2.0×10^{-3}
Polonium	500	0.001	5.0×10^{-3}
Astatine	500	0.02	4.0×10^{-2}
Radium	70	0.04	1.0×10^{-3}
Actinium	25	0.001	2.0×10^{-5}
Thorium	100	0.001	1.0×10^{-4}
Protactinium	11	0.01	5.0×10^{-6}
Uranium	50	0.002	8.0×10^{-4}
Neptunium	250	0.02	1.0×10^{-3}
Plutonium	250	0.001	1.0×10^{-4}
Americium	250	0.001	5.0×10^{-5}
Curium	250	0.001	2.0×10^{-5}

d = day, g = grams, kg = kilograms, L = liter, pCi = picocuries.
[a] Data from Beyeler et al. 1999.
[b] Data from Yu et al. 2000.
[c] Data from Yu et al. 2001 for meat assumed applicable for deer.
[d] Value for thallium not reported, value for indium substituted due to chemical similarity.

H.2.2.2.1 Cattaraugus Creek Receptor

This sub-section focuses on the Cattaraugus Creek receptor (just outside the site boundary) and first considers exposures to radionuclides, followed by a discussion of exposures to chemicals. The Cattaraugus Creek receptor is a postulated offsite receptor who is closest to the site boundary and receives the impact of liquid release from all portions of the site. This receptor is conservatively assumed to drink water from Cattaraugus Creek, eat fish, and irrigate his garden, also with untreated water from Cattaraugus Creek.

Radiological Dose and Risk

This section covers total effective dose equivalent (TEDE), dominant doses and pathways, and radiological risk.

Total Effective Dose Equivalent

Table H–28 presents the magnitude and timing of the peak annual TEDE to a Cattaraugus Creek receptor located just outside the WNYNSC boundary. This hypothetical individual is postulated to drink water from Cattaraugus Creek, use the water for irrigation and consume fish living and/or stocked in the creek. The models used to predict the doses presented in Table H–28 and in many of the subsequent tables and figures are described in Appendix G. The analyses were performed consistent with the general approach outlined in Appendix D.

Table H–28 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Cattaraugus Creek Receptor (year of peak exposure in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	0.019 (200)	0 [b]
Vitrification Facility – WMA 1	0.000037 (1,000)	0 [b]
Low-Level Waste Treatment Facility – WMA 2	0.00026 (100)	0.015 (100)
Waste Tank Farm – WMA 3	0.0019 (300)	0 [b]
NDA – WMA 7 [c]	0.010 (8,700) [c]	0.010 (8,700) [c]
SDA – WMA 8 [c]	0.23 (37,300) [c]	0.23 (37,300) [c]
North Plateau Groundwater Plume [c]	0.51 (34) [c]	0.51 (34) [c]
Total	0.51 (34)	0.51 (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action alternatives, therefore peaks are the same for both alternatives.

Table H–28 shows that the North Plateau Groundwater Plume provides the largest peak annual TEDE, 0.51 millirem per year at 34 years. In the longer term, the largest peak annual TEDE, 0.23 millirem per year at approximately 37,000 years, originates from the SDA. These peaks (and others displayed in subsequent tables and figures) arrive at different times because pathways of differing length are involved and different radionuclides leach from the various areas on the sites at different rates and percolate through the ground at different rates. **Figure H–6** presents the annual TEDE to the Cattaraugus Creek receptor as a function of time for the Sitewide Close-In-Place Alternative. The North Plateau Groundwater Plume peak at 34 years does not appear on the figure because, on the time-scale used, it essentially lies on the y-axis. The figure shows the aforementioned SDA peak at approximately 37,000 years, and a subsidiary SDA peak at approximately 1,000 years.

Figure H–7 provides the same information for the No Action Alternative. The figures are virtually identical. This is a consequence of the degradation of the SDA and NDA engineered barriers as described in Section H.2.2.1, which means that the rates of groundwater flow through areas such as the NDA and SDA are nearly the same for both alternatives for the period for which analysis was performed.

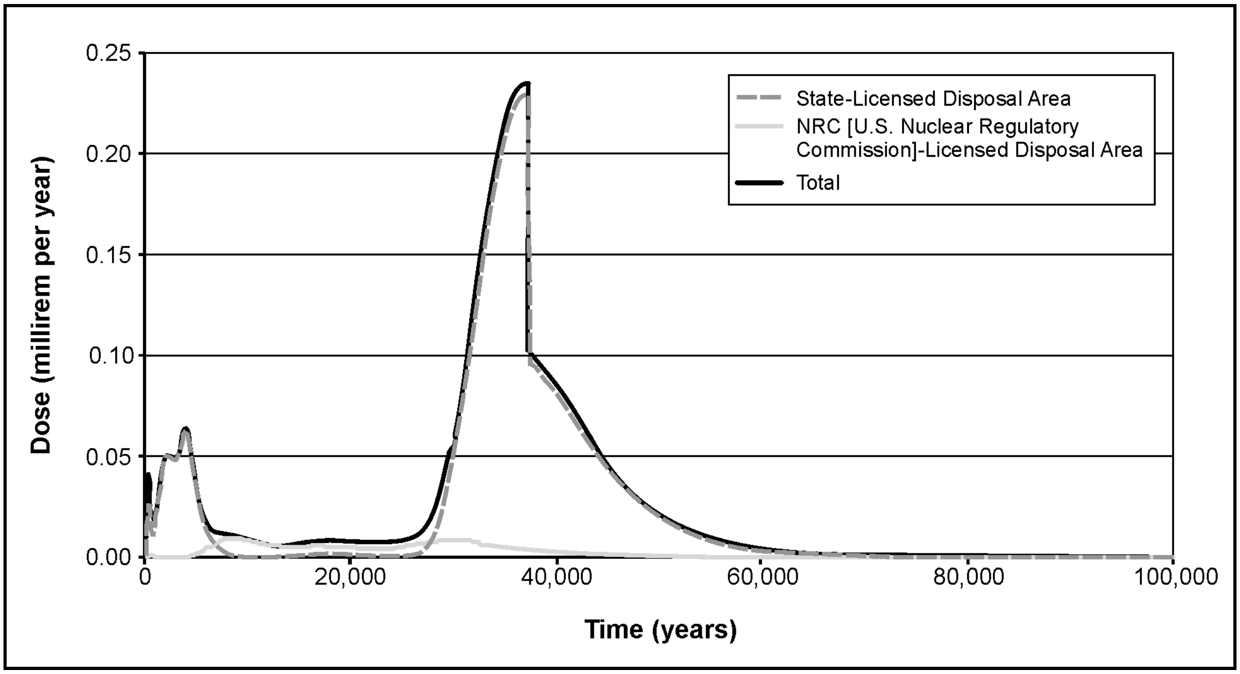

Figure H–6 Annual Total Effective Dose Equivalent for the Cattaraugus Creek Receptor with the Sitewide Close-In-Place Alternative and Indefinite Continuation of Institutional Controls

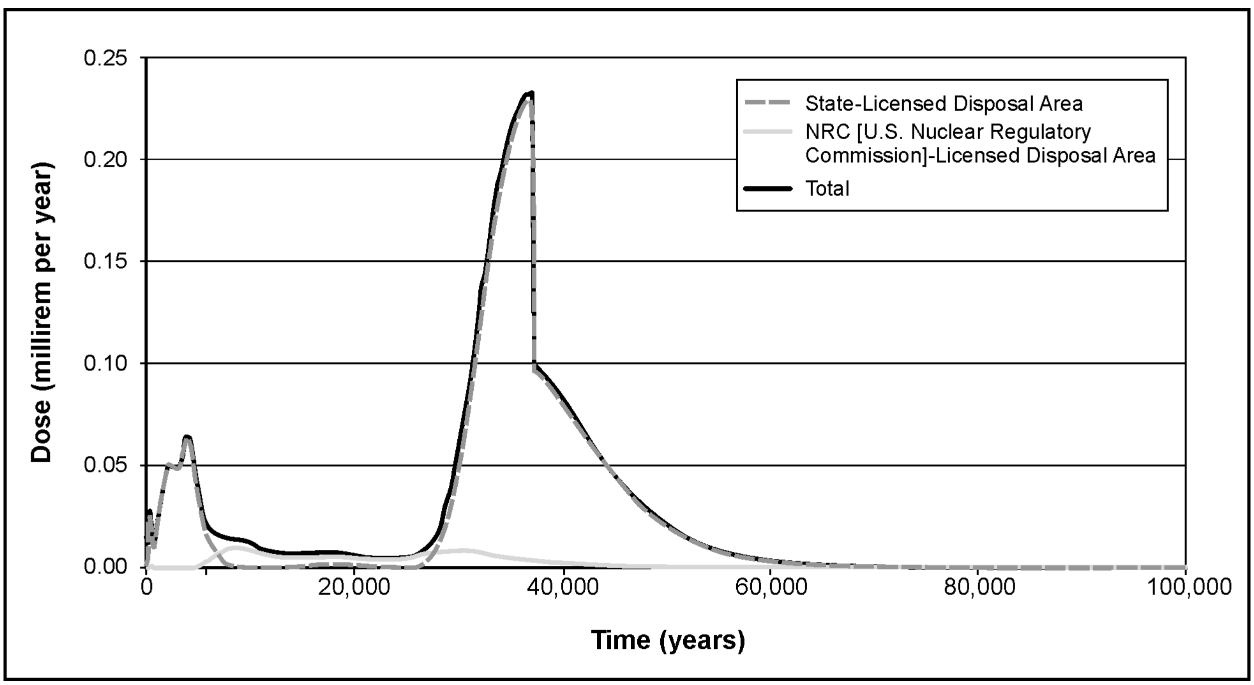

Figure H–7 Annual Total Effective Dose Equivalent for the Cattaraugus Creek Receptor with the No Action Alternative Indefinite Continuation of Institutional Controls

Detailed Analysis of Total Effective Dose Equivalent

Table H–29 provides further detailed breakdown of Table H–28 organized by components. As previously noted, the North Plateau Groundwater Plume at 34 years provides the largest peak. The SDA is the largest contributor to the long-term annual TEDE. The SDA is broken into two components, which consist of different pathways whereby radionuclides migrate through the groundwater and eventually end up in Cattaraugus Creek. The first of these is horizontal groundwater flow through the weathered till disposal area, and the second is vertical flow through the SDA into a lower-lying horizontally flowing aquifer. Aspects of this are further described in Appendix E. The NDA also exhibits the two flowpaths (horizontal and vertical/horizontal) and is further broken down into three components of the waste disposal area, the Nuclear Fuel Services, Inc. (NFS) process, NFS hulls, and WVDP. These are three distinct components of the NDA containing different mixes of hazardous materials and radionuclides. Their geometry also differs (e.g., depth). Radionuclide releases from the hulls provide the largest contribution to the portion of the peak TEDE stemming from the NDA.

Controlling Nuclides and Pathways

It is of interest to understand the controlling nuclides and pathways at the years of peak TEDE. **Table H–30** provides this information. As noted above, the North Plateau Groundwater Plume contributes the largest peak at about 34 years. The controlling nuclide and pathway for this are strontium-90 in drinking water. In addition, the SDA provides the largest long-term peak for both alternatives, with the vertical/horizontal pathway contributing the most. Ingestion of uranium-234 via fish is the dominant contributor for this SDA pathway.

Excess Cancer Risk

A complementary measure is the peak lifetime risk (excess risk of morbidity, or risk of contracting cancer, both fatal and non-fatal) to the Cattaraugus Creek receptor arising from radiological discharges. This risk is calculated assuming a lifetime exposure at the peak predicted dose rate. This introduces an element of conservatism. Note also that the risk is not calculated by the simple method of taking the peak TEDE and multiplying by 6×10^{-4}. The risks are calculated by summing the risks for individual radionuclides using data from Federal Guidance Report 13 (EPA 1999b). **Table H–31** shows how this risk varies from different WMAs and what it is for the entire WNYNSC for each alternative. Since the doses from which the latent cancer morbidity risk is calculated differ little between the alternatives, neither do the risks. The largest peak risk originates from the North Plateau Groundwater Plume. The much later peak risk arising from the SDA is considerably smaller.

Hazardous Chemical Risk

Estimates of the risk to the Cattaraugus Creek receptor from hazardous chemicals have also been prepared. Three measures are used: lifetime cancer risk, Hazard Index and comparison to maximum contaminant levels (MCLs) for drinking water that have been issued under the Safe Drinking Water Act. A listing of the hazardous chemicals that were included in the risk analysis is presented in Appendix C.

Table H–29 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Cattaraugus Creek Receptor Broken Down by Waste Management Area Components (year of peak exposure in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Waste Management Area Components*	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	Rubble Pile	0.0040 (400)	0 [b]
	General Purpose Cell	0.017 (200)	0 [b]
	Liquid Waste Cell	0.0032 (300)	0 [b]
	Fuel Receiving Storage Pad	0.00011 (29,400)	0 [b]
	Total Main Plant Process Building	0.019 (200)	0 [b]
Vitrification Facility – WMA 1		0.000037 (1,000)	0 [b]
Low-Level Waste Treatment Facility – WMA 2	Lagoon 1	0.00017 (100)	0.012 (100)
	Lagoon 2	0.000092 (100)	0.0036 (100)
	Lagoon 3	2.4×10^{-7} (200)	7.2×10^{-6} (100)
	Lagoon 4	6.8×10^{-7} (100)	2.4×10^{-7} (200)
	Lagoon 5	2.1×10^{-7} (200)	2.1×10^{-7} (200)
	Total Low-Level Waste Treatment Facility	0.00026 (100)	0.015 (100)
Waste Tank Farm – WMA 3	8D-1	0.0012 (200)	0 [b]
	8D-2	0.00071 (300)	0 [b]
	8D-3	7.6×10^{-7} (2,900)	0 [b]
	8D-4	0.00013 (200)	0 [b]
	Total Waste Tank Farm	0.0019 (300)	0 [b]
NDA – WMA 7 Horizontal	Process	0.0017 (18,600)	0.0017 (18,600)
	Hulls	0.00089 (7,800)	0.00089 (7,800)
	WVDP	0.000014 (16,700)	0.000014 (16,700)
	Total NDA – Horizontal	0.0021 (18,000)	0.0021 (18,000)
NDA – WMA 7 Vertical/ Horizontal	Process	0.0071 (30,900)	0.0071 (30,900)
	Hulls	0.0089 (8,600)	0.0089 (8,600)
	WVDP	0.000083 (26,500)	0.000083 (26,500)
	Total NDA – Vertical/Horizontal	0.0089 (8,600)	0.0089 (8,600)
Total NDA [c]		0.010 (8,700)	0.010 (8700)
SDA – WMA 8 [c]	Horizontal	0.050 (2,400)	0.050 (2,400)
	Vertical/Horizontal	0.23 (37,200)	0.23 (37,200)
	Total SDA	0.23 (37,300)	0.23 (37,300)
North Plateau Groundwater Plume [c]		0.51 (34)	0.51 (34)
Total Site		0.51 (34)	0.51 (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area, WVDP = West Valley Demonstration Project.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Table H–30 Controlling Nuclides and Pathways for the Cattaraugus Creek Receptor Broken Down by Waste Management Area Components at Year of Peak Annual Total Effective Dose Equivalent – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Waste Management Area Components*	*Controlling Nuclide/Pathway*	
		Sitewide Close-In-Place Alternative	*No Action Alternative*
Main Plant Process Building	Rubble Pile	Iodine-129/Fish	0 [b]
	General Purpose Cell	Neptunium-237/Fish	0 [b]
	Liquid Waste Cell	Iodine-129/Fish	0 [b]
	Fuel Receiving Storage Pad	Plutonium -239/Fish	0 [b]
Vitrification Facility		Neptunium-237/Fish	0 [b]
Low-Level Waste Treatment Facility	Lagoon 1	Iodine-129/Fish	Strontium-90/DW
	Lagoon 2	Strontium-90/DW	Strontium-90/DW
	Lagoon 3	Uranium-234/DW	Uranium-234/DW
	Lagoon 4	Uranium-234/DW	Uranium-234/DW
	Lagoon 5	Uranium-234/DW	Uranium-234/DW
Waste Tank Farm	8D-1	Technetium-99/RF [c]	0 [b]
	8D-2	Technetium-99/RF [c]	0 [b]
	(8D-2g) [d]	Technetium-99/RF [c]	0 [b]
	(8D-2r) [d]	Technetium-99/RF [c]	0 [b]
	8D-3	Uranium-233/DW	0 [b]
	8D-4	Iodine-129/Fish	0 [b]
NDA – Horizontal	Process	Uranium-233/DW	Uranium-233/DW
	Hulls	Carbon-14/Fish	Carbon-14/Fish
	WVDP	Uranium-233/DW	Uranium-233/DW
NDA – Vertical/ Horizontal	Process	Uranium-233/DW	Uranium-233/DW
	Hulls	Carbon-14/Fish	Carbon-14/Fish
	WVDP	Uranium-233/DW	Uranium-233/DW
SDA	Horizontal	Carbon-14/Fish	Uranium-234/Fish
	Vertical/Horizontal	Uranium-234/Fish	Uranium-234/Fish
North Plateau Groundwater Plume		Strontium-90/DW	Strontium-90/DW

DW = drinking water, NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, RF = resident farmer, SDA = State-Licensed Disposal Area, WMA = Waste Management Area, WVDP = West Valley Demonstration Project.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] RF means resident farmer and includes a number of pathways such as eating contaminated vegetables, inhalation, etc.

[d] 8D-2g and 8D-2r are the grid (lower) and ring (upper) contaminated portions of Tank 8D-2.

Table H–31 Peak Lifetime Radiological Risk (risk of latent cancer morbidity) for the Cattaraugus Creek Receptor (year of peak risk in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	4.20×10^{-7} (200)	0 [b]
Vitrification Facility – WMA 1	3.12×10^{-10} (300)	0 [b]
Low-Level Waste Treatment Facility – WMA 2	6.45×10^{-9} (100)	3.3×10^{-7} (100)
Waste Tank Farm – WMA 3	7.84×10^{-8} (300)	0 [b]
NDA – WMA 7 [c]	2.61×10^{-7} (8,600)	2.61×10^{-7} (8,600)
SDA – WMA 8 [c]	2.89×10^{-6} (37,300)	2.89×10^{-6} (37,300)
North Plateau Groundwater Plume [c]	1.10×10^{-5} (34)	1.10×10^{-5} (34)
Total	1.10×10^{-5} (34)	1.10×10^{-5} (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Lifetime Cancer Risk

Table H–32 shows the peak lifetime cancer risk from chemical exposure broken down by WMA.

Table H–32 Peak Lifetime Risk from Hazardous Chemicals (risk of latent cancer morbidity) for the Cattaraugus Creek Receptor (year of peak risk in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	1.4×10^{-9} (5,000)	0 [b]
Vitrification Facility – WMA 1	1.3×10^{-10} (11,700)	0 [b]
Waste Tank Farm – WMA 3	1.1×10^{-10} (8,900)	0 [b]
NDA – WMA 7 [c]	1.4×10^{-9} (85,900)	1.4×10^{-9} (85,900)
SDA – WMA 8 [c]	2.1×10^{-8} (100)	2.1×10^{-8} (100)
Total	2.1×10^{-8} (100)	2.1×10^{-8} (100)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] The limited information available on hazardous chemical inventories in the Low-Level Waste Treatment Facility suggest it will not make a noticeable contribution to the overall long-term risk from hazardous chemicals. There is no hazardous chemical inventory available for the Construction and Demolition Debris Landfill in WMA 4.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Table H–32 shows that, for both alternatives, the SDA is the dominant contributor. The NDA peaks are less than 10 percent of those from the SDA. The NDA peak occurs much later because the dominant chemical constituent in the NDA is much less mobile than that in the SDA. Comparing the radiological risk information in Table H–31 with the chemical risk information in Table H–32, it can be seen that the peak lifetime cancer risk to the Cattaraugus Creek receptor is dominated by radionuclides rather than hazardous chemicals. The peak radiological risk is on the order of 100 times greater than the peak chemical risk.

This comparison of lifetime cancer risk from radionuclides and chemicals for the Cattaraugus Creek receptor is also shown in **Figures H–8 and H–9**. The greatest risk is from the radionuclides except far into the future when both risks are very small. The slight increase in chemical risk far into the future is due to the presence of arsenic, an element whose movement through the groundwater is strongly retarded.

Hazard Index

Another measure of chemical risk that is appropriate for non-carcinogenic chemicals is the Hazard Index[8] for an individual receptor. If the Hazard Index is greater than 1, an observable non-carcinogenic health effect may occur. **Table H–33** presents the Hazard Index peaks for the Cattaraugus Creek receptor in expected conditions. As can be seen, the Hazard Index peaks are much less than one for both alternatives.

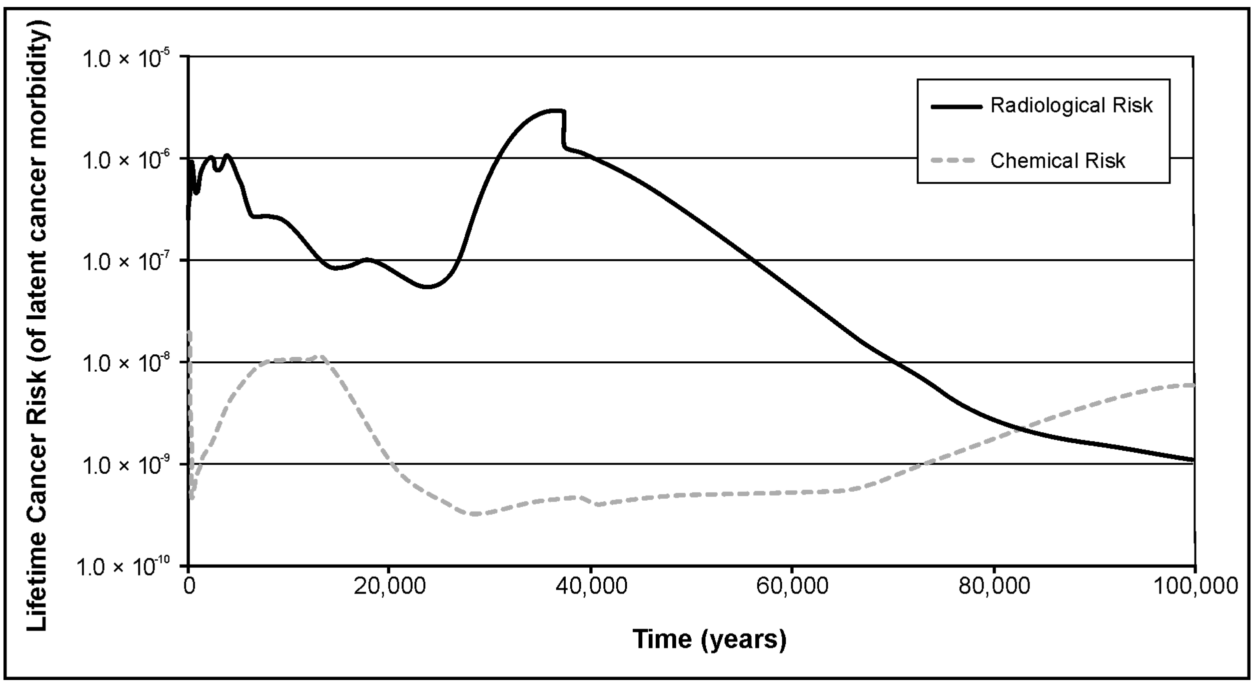

Figure H–8 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Cattaraugus Creek Receptor with the Sitewide Close-In-Place Alternative and Indefinite Continuation of Institutional Controls

[8] The Hazard Index is defined as the sum of the Hazard Quotients for substances that affect the same target organ or organ system. The Hazard Quotient for a specific chemical is the ratio of the exposure to the hazardous chemical (e.g., amount ingested over a given period) to a reference value regarded as corresponding to a threshold of toxicity, or a threshold at which some recognizable health impact would appear. If the Hazard Quotient for an individual chemical or the hazard index for a group of chemicals exceeds unity, the chemical(s) may produce an adverse effect, but normally this will require a Hazard Index or Quotient of several times unity. A Hazard Index or Quotient of less than unity indicates that no adverse effects are expected over the period of exposure.

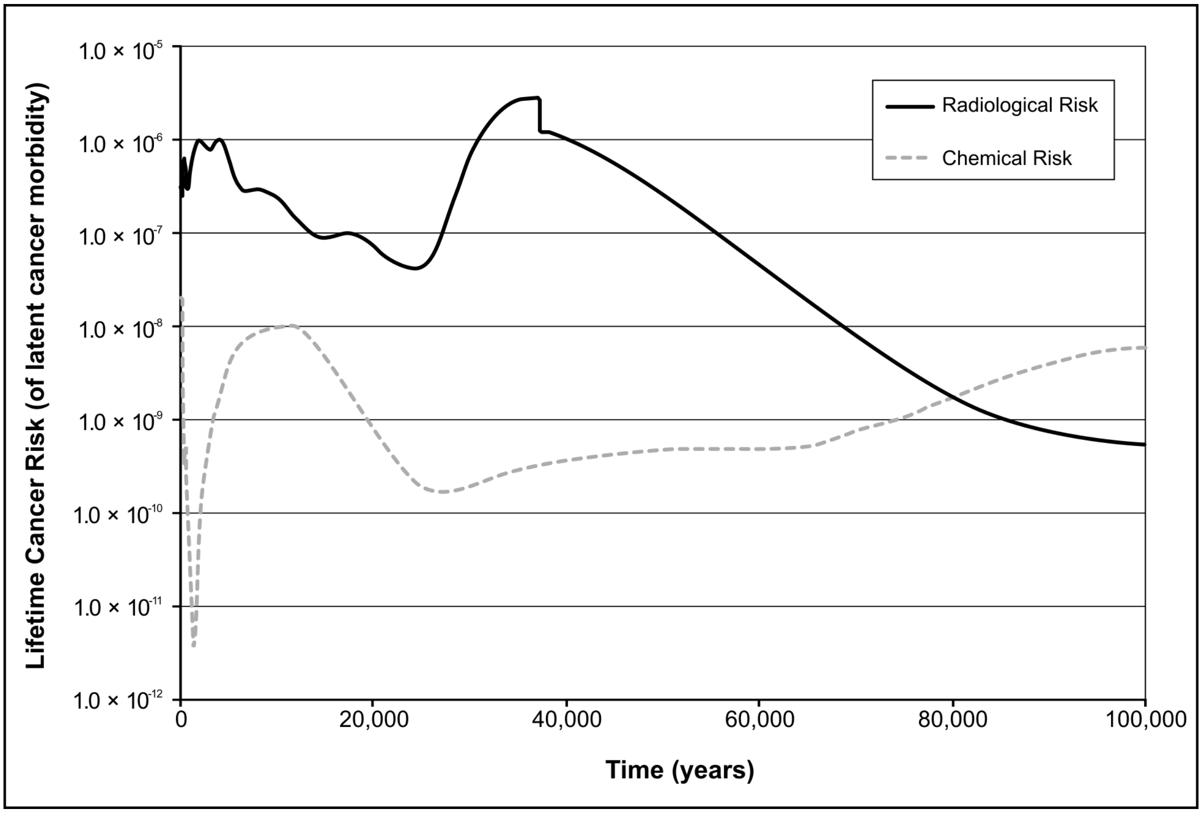

Figure H–9 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Cattaraugus Creek Receptor with the No Action Alternative and Indefinite Continuation of Institutional Controls

Table H–33 Peak Chemical Hazard Index for the Cattaraugus Creek Receptor (year of peak Hazard Index in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	5.8×10^{-4} (3,400)	0 [b]
Vitrification Facility – WMA 1	5.3×10^{-6} (15,100)	0 [b]
Waste Tank Farm – WMA 3	7.1×10^{-5} (9,900)	0 [b]
NDA – WMA 7 [c]	1.5×10^{-5} (30,100)	1.5×10^{-5} (30,100)
SDA – WMA 8 [c]	3.4×10^{-3} (3,900)	3.4×10^{-3} (3,900)
Total	3.5×10^{-3} (3,900)	3.4×10^{-3} (3,900)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] The limited information available on hazardous chemical inventories in the Low-Level Waste Treatment Facility suggest it will not make a noticeable contribution to the overall long-term risk from hazardous chemicals. There is no hazardous chemical inventory available for the Construction and Demolition Debris Landfill in WMA 4.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Fraction of Maximum Concentration in Liquid

There are some hazardous chemicals for which there is no carcinogenic slope factor or a reference dose, but they are recognized as hazardous materials and MCLs have been issued under the Safe Drinking Water Act. A primary example that is relevant to WNYNSC is lead. When the inventory for a known hazardous material could be estimated, but there was no slope factor or reference dose for the material, an analysis was conducted to determine the maximum concentration of the hazardous material in the year at peak risk and the year at peak Hazard Index. **Table H–34** shows the results of this analysis. This predicted ratio of peak concentration to MCL is always less than 0.01.

Table H–34 Chemicals with Largest Fraction of Maximum Contaminant Levels in Cattaraugus Creek at Year of Peak Risk and Year of Peak Hazard Index – Indefinite Continuation of Institutional Controls [a]

Year of Peak Risk in Parentheses		
Waste Management Areas [b]	***Sitewide Close-In-Place Alternative***	***No Action Alternative***
Main Plant Process Building – WMA 1	1.07×10^{-4} (8,500) Pb [d]	0 [c]
Vitrification Facility – WMA 1	1.89×10^{-7} (40,500) Pb [d]	0 [c]
Waste Tank Farm – WMA 3	7.25×10^{-7} (9,000) Tl [e]	0 [c]
NDA – WMA 7 [j]	1.3×10^{-6} (86,700) As [f]	1.3×10^{-6} (89,200) As
SDA – WMA 8 [j]	1.07×10^{-4} (100) Benzene [g]	1.07×10^{-4} (100) Benzene
Year of Peak Hazard Index in Parentheses		
Waste Management Areas	***Sitewide Close-In-Place Alternative***	***No Action Alternative***
Main Plant Process Building – WMA 1	9.47×10^{-5} (3,400) Pb [d]	0 [c]
Vitrification Facility – WMA 1	1.5×10^{-7} (26,000) Sb [h]	0 [c]
Waste Tank Farm – WMA 3	8.78×10^{-7} (12,400) Sb [h]	0 [c]
NDA – WMA 7 [j]	3.4×10^{-5} (30,200) Usol [i]	3.4×10^{-5} (30,200) Usol
SDA – WMA 8 [j]	9.03×10^{-3} (4,700) Usol [i]	9.03×10^{-3} (4,700) Usol

MCL = maximum contaminant level, NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] Presented as fraction of the applicable MCL / (years until peak exposure) / chemical.

[b] The limited information available on hazardous chemical inventories in the Low-Level Waste Treatment Facility suggest it will not make a noticeable contribution to the overall long-term risk from hazardous chemicals. There is no hazardous chemical inventory available for the Construction and Demolition Debris Landfill in WMA 4.

[c] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[d] Pb = lead, MCL (Action Level) = 0.015 milligrams per liter. There is no MCL for Pb, so the Action Level was used instead.

[e] Tl = thallium, MCL = 0.002 milligrams per liter.

[f] As = arsenic, MCL = 0.01 milligrams per liter.

[g] Benzene, MCL = 0.005 milligrams per liter

[h] Sb = antimony, MCL = 0.006 milligrams per liter

[i] Usol = soluble uranium, MCL = 0.03 milligrams per liter.

[j] NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives; therefore peaks are the same for both alternatives.

H.2.2.2.2 Seneca Nation of Indians Receptor

Another receptor of interest for the WNYNSC is an individual who may engage in subsistence fishing along Cattaraugus Creek. A Seneca Nation of Indian receptor is postulated to use Cattaraugus Creek near Gowanda for drinking water and irrigation of a garden and is also postulated to consume elevated quantities of fish living and/or stocked in these waters. This sub-section first considers exposure to radionuclides, followed by a discussion of exposure to chemicals. The timing of peaks from individual WMAs presented below are in many respects similar to those for the Cattaraugus Creek receptor although the peak doses themselves are slightly higher.

Radiological Dose and Risk

Total Effective Dose Equivalent

Figures H–10 and H–11 present the annual TEDE as a function of time to a Seneca Nation of Indians receptor located just outside the WNYNSC boundary. This hypothetical individual is postulated to drink water from Cattaraugus Creek, use the water for irrigation and consume fish living and/or stocked in the Cattaraugus Creek. The principal difference from the Cattaraugus Creek receptor is that the Seneca Nation of Indians receptor consumes more fish. Just as was the case for the Cattaraugus Creek receptor, the SDA is the dominant long-term contributor. However, the peak annual long-term TEDE is about 2.5 times larger than the corresponding peak for the Cattaraugus Creek receptor, due to the extra consumption of fish. As was the case for the Cattaraugus Creek receptor, the figure for the No Action Alternative is almost the same as the figure for the Sitewide Close-In-Place Alternative.

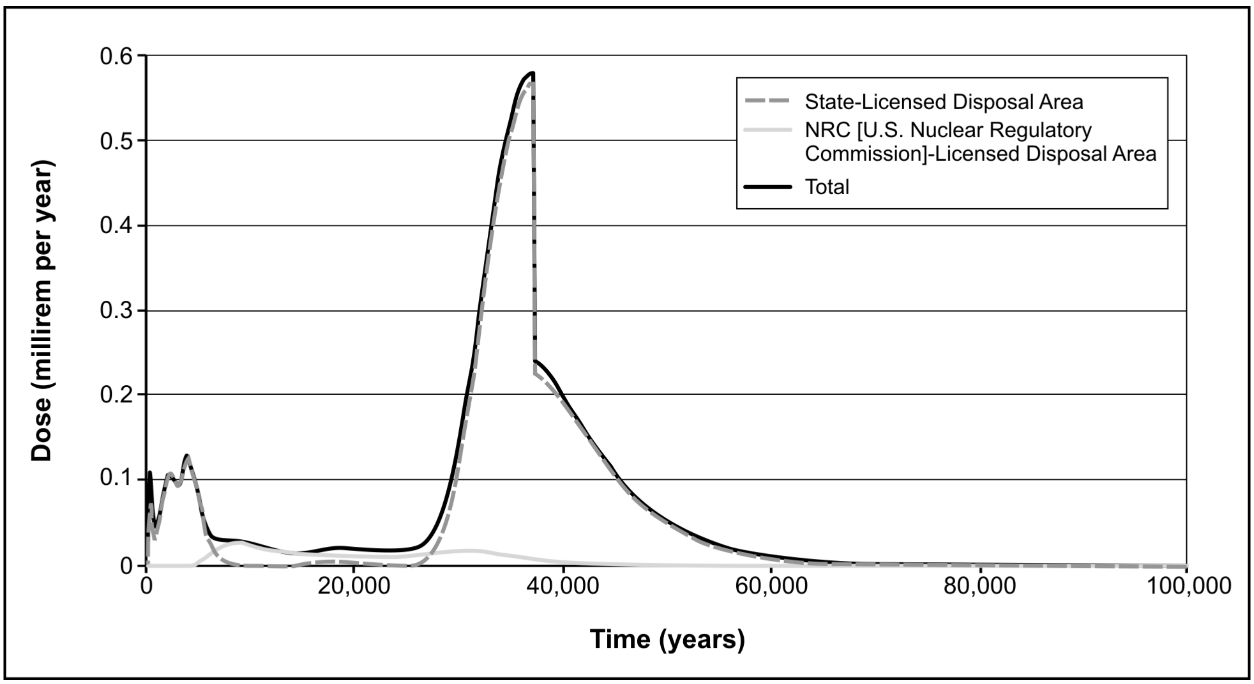

Figure H–10 Annual Total Effective Dose Equivalent for the Seneca Nation of Indians Receptor with the Sitewide Close-In-Place Alternative and Indefinite Continuation of Institutional Controls

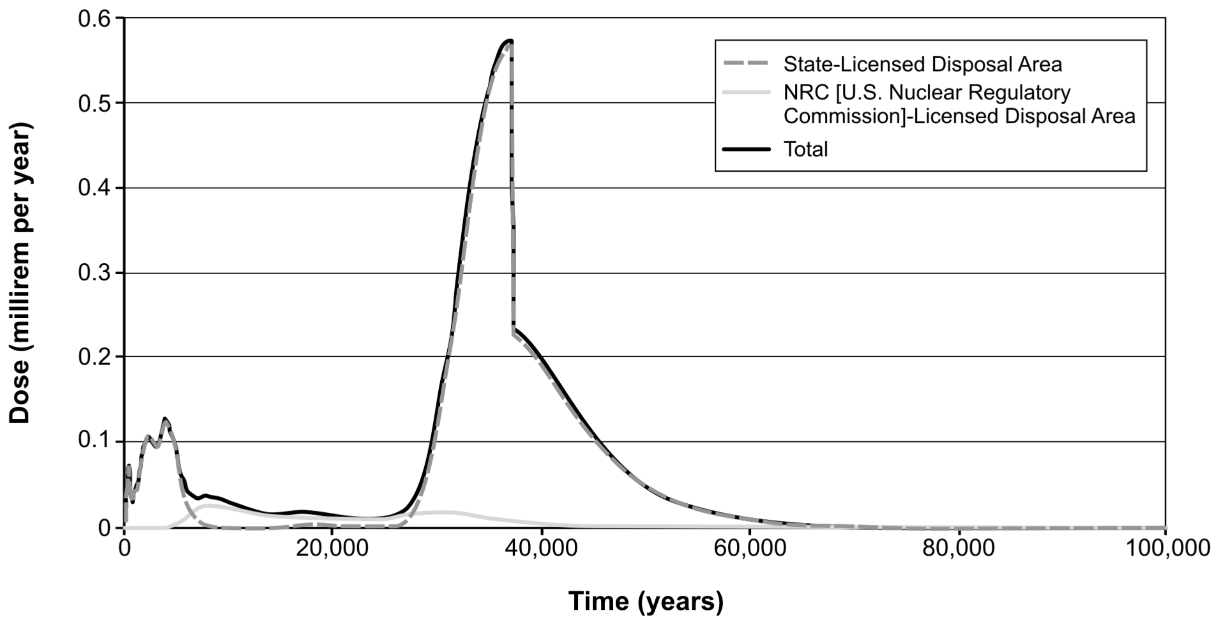

Figure H–11 Annual Total Effective Dose Equivalent for the Seneca Nation of Indians Receptor with the No Action Alternative and Indefinite Continuation of Institutional Controls

The magnitude and the year of the peak contribution from individual WMAs are shown in **Table H–35**. As was the case for Cattaraugus Creek, the largest peak originates from the North Plateau Groundwater Plume and occurs at 34 years. This peak does not show on Figures H–10 and H–11 because it would lie on top of the y-axis.

Table H–35 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Seneca Nation of Indians Receptor (year of peak exposure in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	0.053 (200)	0 [b]
Vitrification Facility – WMA 1	0.000090 (1,000)	0 [b]
Low-Level Waste Treatment Facility – WMA 2	0.00047 (100)	0.023 (100)
Waste Tank Farm – WMA 3	0.0019 (300)	0 [b]
NDA – WMA 7 [c]	0.027 (8,600)	0.027 (8,600)
SDA – WMA 8 [c]	0.56 (37,300)	0.56 (37,300)
North Plateau Groundwater Plume [c]	0.68 (34)	0.68 (34)
Total	0.68 (34)	0.68 (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

The peak annual TEDEs for the Seneca Nation of Indians receptor arising from the North Plateau Groundwater Plume are slightly higher than those for Cattaraugus Creek, and those arising from the SDA are 2-3 times higher. This is due of the large amount of local fish that is postulated to be consumed by this receptor. Table H–35 and Figures H–10 and H–11 show similar patterns to those for the Cattaraugus Creek receptor (Table H–28 and Figures H–6 and H–7) in terms of timing of dose peaks for individual WMAs. **Table H–36** provides further detailed breakdown of Table H–32 organized by components of each WMA. Table H–36 presents information for the Seneca Nation of Indians receptor similar to that presented in Table H–29 for the Cattaraugus Creek receptor.

Controlling Nuclides and Pathways

As for the Cattaraugus Creek receptor, it is of interest to understand the controlling nuclides and pathways at the year of peak TEDE for the Seneca Nation of Indians receptor. **Table H–37** provides this information and shows that, for the large early peak from the North Plateau Groundwater Plume, the dominant radionuclide is strontium-90 via fish (for the Cattaraugus Creek receptor, it was strontium-90 via drinking water, see Table H–30). For the long-term peak from the SDA, the dominant radionuclide is uranium-234 via fish, the same as it was for Cattaraugus Creek.

Excess Lifetime Cancer Risk

A complementary measure is the peak lifetime risk to the Seneca Nation of Indians receptor from radiological releases. **Table H–38** shows how this risk varies from different WMAs and what it is for the entire WNYNSC for each alternative. The North Plateau Groundwater Plume risk is about 1.5 times higher than that for Cattaraugus Creek, (see Table H–31). The SDA risk is 2 to 3 times higher than that for Cattaraugus Creek. In both cases, the higher risk is due to increased consumption of fish.

Hazardous Chemical Risk

Estimates of the risk to the Seneca Nation of Indians receptor from hazardous chemicals in the burial grounds, the Main Plant Process Building and the high-level waste tanks have also been prepared. As for the Cattaraugus Creek receptor, three measures are used: lifetime cancer risk, Hazard Index and comparison to MCLs for drinking water.

Lifetime Cancer Risk

Table H–39 shows the lifetime excess cancer morbidity risk from exposure to chemicals. As was the case for the Cattaraugus Creek receptor, the SDA dominates the risk. The radiological risk is at least two orders of magnitude higher.

The comparison of lifetime cancer risk from radionuclides and chemicals for the Seneca Nation of Indians receptor is also shown in **Figures H–12 and H–13**. These figures for the Seneca Nation of Indians receptor are quite similar to, and can be interpreted in the same way as, Figures H–8 and H–9 for the Cattaraugus Creek receptor.

Table H–36 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Seneca Nation of Indians Receptor Broken Down by Waste Management Area Components (year of peak exposure in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Waste Management Area Components*	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	Rubble Pile	0.00977 (400)	0 [b]
	General Purpose Cell	0.0470 (200)	0 [b]
	Liquid Waste Cell	0.00798 (300)	0 [b]
	Fuel Receiving Storage Pad	0.000272 (29,600)	0 [b]
	Total Main Plant Process Building	0.0526 (200)	0 [b]
Vitrification Facility – WMA 1		0.00009 (1,000)	0 [b]
Low-Level Waste Treatment Facility – WMA 2	Lagoon 1	0.000352 (100)	0.0182 (100)
	Lagoon 2	0.000116 (100)	0.00456 (100)
	Lagoon 3	3.48×10^{-7} (200)	0.0000102 (100)
	Lagoon 4	1.02×10^{-6} (100)	3.41×10^{-7} (200)
	Lagoon 5	3.10×10^{-7} (200)	3.10×10^{-7} (200)
	Total Low-Level Waste Treatment Facility	0.00047 (100)	0.0228 (100)
Waste Tank Farm – WMA 3	8D-1	0.00113 (200)	0 [b]
	8D-2	0.000678 (300)	0 [b]
	8D-3	1.29×10^{-6} (2,900)	0 [b]
	8D-4	0.000284 (200)	0 [b]
	Total Waste Tank Farm	0.00186 (300)	0 [b]
NDA – WMA 7 Horizontal	Process	0.0032 (18,800)	0.0032 (18,800)
	Hulls	0.00239 (7,700)	0.00239 (7,700)
	WVDP	0.0000262 (16,800)	0.0000262 (16,800)
	Total NDA – Horizontal	0.00393 (17,800)	0.00393 (17,800)
NDA – WMA 7 Vertical/ Horizontal	Process	0.0134 (30,900)	0.0134 (30,900)
	Hulls	0.0242 (8,600)	0.0242 (8,600)
	WVDP	0.000155 (26,400)	0.000155 (26,400)
	Total NDA – Vertical/Horizontal	0.0242 (8,600)	0.0242 (8,600)
Total NDA [c]		0.0270 (8,600)	0.0270 (8600)
SDA – WMA 8 [c]	Horizontal	0.107 (2,300)	0.107 (2,300)
	Vertical/Horizontal	0.565 (37,200)	0.565 (37,200)
	Total SDA	0.565 (37,300)	0.565 (37,300)
North Plateau Groundwater Plume [c]		0.684 (34)	0.684 (34)
Total Site		0.684 (34)	0.684 (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area, WVDP = West Valley Demonstration Project.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Table H–37 Controlling Nuclides and Pathways for the Seneca Nation of Indians Receptor Broken Down by Waste Management Area Components at Year of Peak Total Effective Dose Equivalent – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*WMA Components*	*Controlling Nuclide/Pathway*	
		Sitewide Close-In-Place	*No Action*
Main Plant Process Building – WMA 1	Rubble Pile	Iodine-129/Fish	0 [b]
	General Purpose Cell	Neptunium-237/Fish	0 [b]
	Liquid Waste Cell	Iodine-129/Fish	0 [b]
	Fuel Receiving Storage Pad	Plutonium -239/Fish	0 [b]
Vitrification Facility – WMA 1		Neptunium-237/Fish	0 [b]
Low-Level Waste Treatment Facility – WMA 2	Lagoon 1	Iodine-129/Fish	Strontium-90/Fish
	Lagoon 2	Strontium-90/Fish	Strontium-90/Fish
	Lagoon 3	Uranium-234/Fish	Uranium-234/Fish
	Lagoon 4	Uranium-234/Fish	Uranium-234/Fish
	Lagoon 5	Uranium-234/Fish	Uranium-234/Fish
Waste Tank Farm – WMA 3	8D-1	Iodine-129/Fish	0 [b]
	8D-2	N/A	0 [b]
	(8D-2g) [c]	Iodine-129/Fish	0 [b]
	(8D-2r) [c]	Neptunium-237/Fish	0 [b]
	8D-3	Uranium-233/Fish	0 [b]
	8D-4	Iodine-129/Fish	0 [b]
NDA – WMA 7 Horizontal	Process	Uranium-233/Fish	Uranium-233/Fish
	Hulls	Carbon-14/Fish	Carbon-14/Fish
	WVDP	Uranium-233/Fish	Uranium-233/Fish
NDA – WMA 7 Vertical/ Horizontal	Process	Uranium-233/Fish	Uranium-233/Fish
	Hulls	Carbon-14/Fish	Carbon-14/Fish
	WVDP	Uranium-233/Fish	Uranium-233/Fish
SDA – WMA 8	Horizontal	Carbon-14/Fish	Carbon-14/Fish
	Vertical/Horizontal	Uranium-234/Fish	Uranium-234/Fish
North Plateau Groundwater Plume		Strontium-90/Fish	Strontium-90/Fish

DW = drinking water, NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, RF = resident farmer, SDA = State-Licensed Disposal Area, WMA = Waste Management Area, WVDP = West Valley Demonstration Project.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] 8D-2g and 8D-2r are the grid (lower) and ring (upper) contaminated portions of Tank 8D-2.

Table H–38 Peak Lifetime Radiological Risk (risk of latent cancer morbidity) for the Seneca Nation of Indians Receptor (year of peak risk in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	1.24×10^{-6} (200)	0 [b]
Vitrification Facility – WMA 1	5.68×10^{-10} (1,000)	0 [b]
Low-Level Waste Treatment Facility – WMA 2	1.14×10^{-8} (100)	5.22×10^{-7} (100)
Waste Tank Farm – WMA 3	6.28×10^{-8} (300)	0 [b]
NDA – WMA 7 [c]	7.15×10^{-7} (8,800)	7.15×10^{-7} (8,800)
SDA – WMA 8 [c]	8.09×10^{-6} (37,300)	8.09×10^{-6} (37,300)
North Plateau Groundwater Plume [c]	1.56×10^{-5} (34)	1.56×10^{-5} (34)
Total	1.56×10^{-5} (34)	1.56×10^{-5} (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Table H–39 Peak Lifetime Risk from Hazardous Chemicals (risk of latent cancer morbidity) for the Seneca Nation of Indians Receptor (year of peak risk in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	2.8×10^{-9} (4,000)	0 [b]
Vitrification Facility – WMA 1	2.5×10^{-10} (11,500)	0 [b]
Waste Tank Farm – WMA 3	2.1×10^{-10} (8,800)	0 [b]
NDA – WMA 7 [c]	3.4×10^{-9} (85,800)	3.4×10^{-9} (85,800)
SDA – WMA 8 [c]	2.5×10^{-8} (11,100)	2.5×10^{-8} (11,100)
Total	2.6×10^{-8} (11,100)	2.5×10^{-8} (11,100)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] The limited information available on hazardous chemical inventories in the Low-Level Waste Treatment Facility suggest it will not make a noticeable contribution to the overall long-term risk from hazardous chemicals. There is no hazardous chemical inventory available for the Construction and Demolition Debris Landfill in WMA 4.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

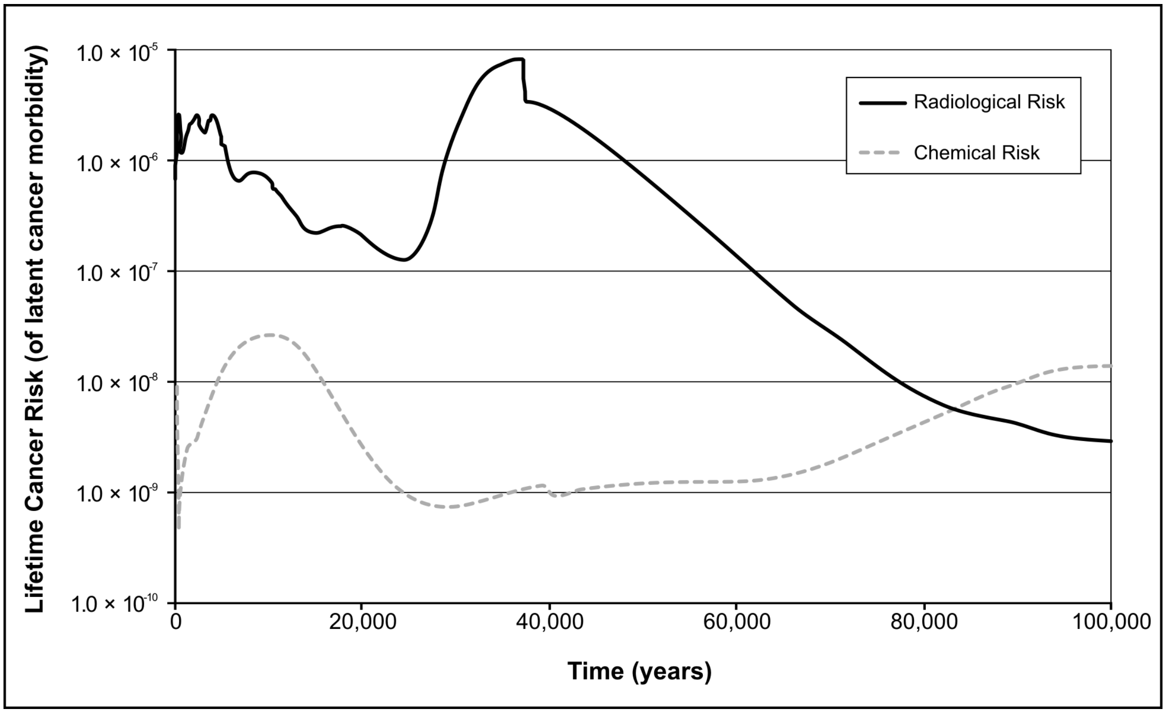

Figure H–12 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Seneca Nation of Indians Receptor with the Sitewide Close-In-Place Alternative and Indefinite Continuation of Institutional Controls

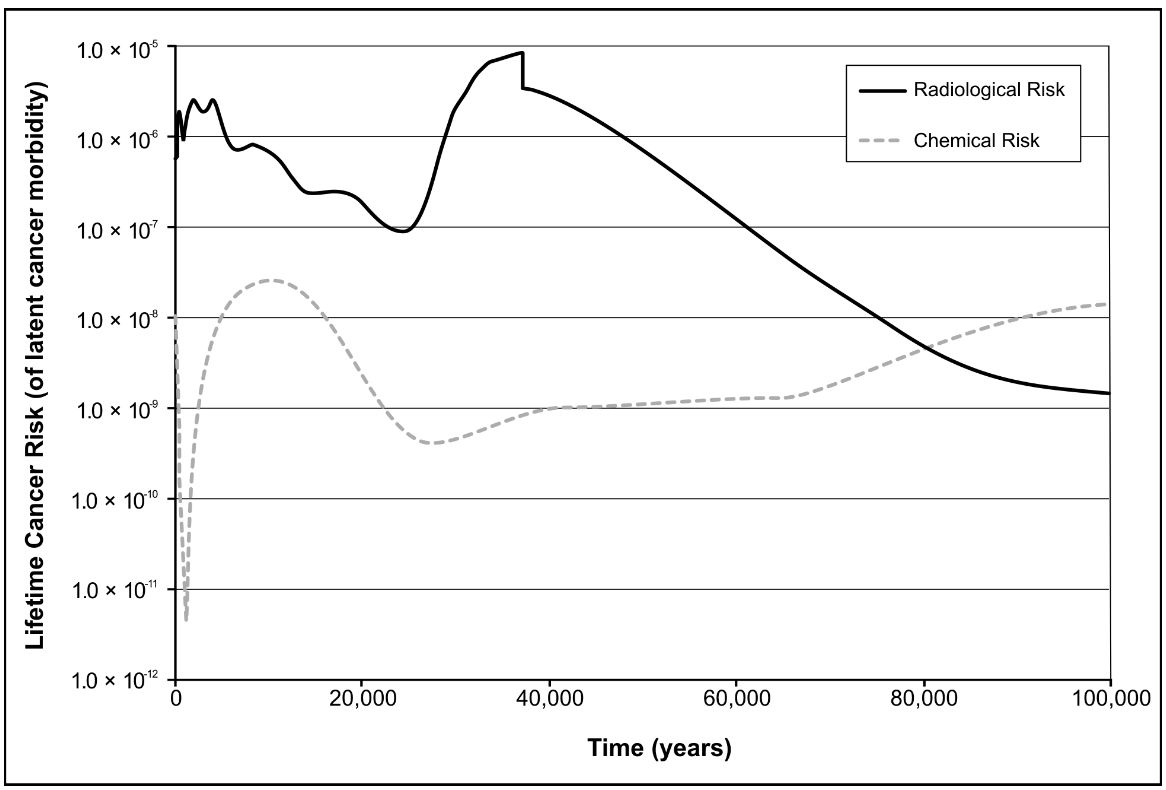

Figure H–13 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Seneca Nation of Indians Receptor with the No Action Alternative and Indefinite Continuation of Institutional Controls

Hazard Index

Another measure of chemical risk that is appropriate for non-carcinogenic chemicals is the Hazard Index for an individual receptor. If the Hazard Index is greater than 1, an observable non-carcinogenic health effect may occur. **Table H–40** presents the Hazard Index peaks for the Seneca Nation of Indians receptor for indefinite continuation of institutional controls.

Table H–40 Peak Chemical Hazard Index for the Seneca Nation of Indians Receptor (year of peak Hazard Index in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	0.00016 (3,400)	0 [b]
Vitrification Facility – WMA 1	0.000015 (14,800)	0 [b]
Waste Tank Farm – WMA 3	0.00021 (9,700)	0 [b]
NDA – WMA 7 [c]	0.000018 (85,900)	0.000018 (85,900)
SDA – WMA 8 [c]	0.0025 (3,900)	0.0025 (3,900)
Total	0.0028 (3,900)	0.0025 (3,900)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] The limited information available on hazardous chemical inventories in the Low-Level Waste Treatment Facility suggest it will not make a noticeable contribution to the overall long-term risk from hazardous chemicals. There is no hazardous chemical inventory available for the Construction and Demolition Debris Landfill in WMA 4.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

The peak annual Hazard Index for the postulated Seneca Nation of Indians receptor is similar to, and sometimes slightly higher than, the peak annual Hazard Index for the Cattaraugus Creek receptor. The peak index is always less than 1 percent. This confirms that the risk from non-carcinogenic hazardous chemicals is small.

Fraction of Maximum Concentration in Liquid

The MCL is inversely proportional to the flow rate, which, at the Seneca Nation of Indians receptor, is twice that at the Cattaraugus Creek receptor. It follows that fractions of MCL for the Seneca Nation of Indians receptor are about half those shown in Table H–36 for the Cattaraugus Creek receptor.

H.2.2.2.3 Lake Erie/Niagara Water River Users

This section discusses population dose, and individual exposures to radioactive materials and chemicals.

Population Dose

In addition to the Cattaraugus Creek and Seneca Nation of Indians individuals, peak annual and time-integrated population dose estimates have been prepared. These are summarized in **Tables H–41** and **H–42**, respectively. Lake Erie water users consume water taken from Sturgeon Point and Niagara River water users consume water from several structures in the eastern channel of the Niagara River. They are also assumed to eat fish from Lake Erie, and (conservatively) to all be resident farmers.

Most of the population dose shown in Table H–41 would be received by the users of water from the Sturgeon Point intake which would see higher radionuclide concentrations than the intake structures on the Niagara River. No credit is taken for dilution in the flow between the mouth of Cattaraugus Creek and the Sturgeon Point intake structure. Complete mixing in the flow of the Niagara River is assumed for water intake points in the Niagara River. The estimated annual dose from ubiquitous background and other sources of radiation (NCRP 2009) for the Sturgeon Point group[9] (565,000 people) would be approximately 350,000 person-rem. The peak annual dose received by this group for either alternative would be 95 person-rem.

Table H–42 presents the time-integrated population dose over periods of 1,000 and 10,000 years. For both alternatives, the total population dose accumulated over 10,000 years (approximately 35,000 person-rem) would be less than the background dose accumulated by Sturgeon Point users in one year (200,000 person-rem).

Table H–41 Peak Annual Total Effective Population Dose Equivalent in person-rem per year for the Lake Erie/Niagara River Water Users (year of peak dose in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	1.0 (200)	0 [b]
Vitrification Facility – WMA 1	0.0030 (1,000)	0 [b]
Low-Level Waste Treatment Facility – WMA 2	0.038 (100)	2.7 (100)
Waste Tank Farm – WMA 3	0.41 (300)	0 [b]
NDA – WMA 7 [c]	1.2 (30,100)	1.2 (30,100)
SDA – WMA 8 [c]	18 (37,300)	18 (37,300)
North Plateau Groundwater Plume [c]	95 (34)	95 (34)
Total	95 [d] (34)	95 [d] (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

[d] Almost all of this dose would be accumulated by the 565,000 Sturgeon Point users. This corresponds to a peak annual individual dose of approximately 0.2 millirem per year.

[9] *Almost all of the 95 person-rem in the bottom row of Table H–41 is accumulated by Sturgeon Point users.*

Table H–42 Time-Integrated Total Effective Population Dose Equivalent for Lake Erie/Niagara Water Users (person-rem over 1,000 and 10,000 years) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Integration Over 1,000 Years		
Main Plant Process Building – WMA 1	590	0 [b]
Vitrification Facility – WMA 1	2	0 [b]
Low-Level Waste Treatment Facility – WMA 2	13	340
Waste Tank Farm – WMA 3	130	0 [b]
NDA – WMA 7 [c]	150	150
SDA – WMA 8 [c]	710	710
North Plateau Groundwater Plume [c]	2,400	2,400
Total	4,000	3,600
Integration Over 10,000 Years		
Main Plant Process Building – WMA 1	940	0 [b]
Vitrification Facility – WMA 1	5	0 [b]
Low-Level Waste Treatment Facility – WMA 2	50	1,500
Waste Tank Farm – WMA 3	260	0 [b]
NDA – WMA 7 [c]	2,200	2,200
SDA – WMA 8 [c]	28,000	28,000
North Plateau Groundwater Plume [c]	2,500	2,500
Total	34,000	35,000

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Note: Totals may not add due to rounding.

Individual Exposure to Radioactive Material

Tables H–43 and **H–44** contain the predicted peak individual TEDEs from radioactive exposure for Sturgeon Point and the Niagara River, respectively.

Table H–43 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Sturgeon Point Receptor (year of peak dose in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	0.002 (200)	0 [b]
Vitrification Facility – WMA 1	0.000005 (1,000)	0 [b]
Low-Level Waste Treatment Facility – WMA 2	0.00007 (100)	0.005 (100)
Waste Tank Farm – WMA 3	0.0007 (300)	0 [b]
NDA – WMA 7 [c]	0.002 (30,100)	0.002 (30,100)
SDA – WMA 8 [c]	0.03 (37,300)	0.03 (37,300)
North Plateau Groundwater Plume [c]	0.17 (34)	0.17 (34)
Total	0.17 (34)	0.17 (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA. However, no single facility characterizes the burial grounds, so the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as these engineered systems function as originally designed and institutional control prevents releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Table H–44 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Niagara River Receptor (year of peak dose in parentheses) – Indefinite Continuation of Institutional Controls

Waste Management Areas	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	6.27×10^{-6} (200)	0 [b]
Vitrification Facility – WMA 1	1.88×10^{-8} (1,000)	0 [b]
Low-Level Waste Treatment Facility – WMA 2	2.43×10^{-7} (100)	0.0000171 (100)
Waste Tank Farm – WMA 3	2.59×10^{-6} (300)	0 [b]
NDA – WMA 7 [c]	7.57×10^{-6} (30,200)	7.57×10^{-6} (30,200)
SDA – WMA 8 [c]	0.000115 (37,300)	0.000115 (37,300)
North Plateau Groundwater Plume	0.000608 (34)	0.000608 (34)
Total	0.000608 (34)	0.000608 (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that proactive maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational indefinitely. The doses from these units would be minimal as long as institutional controls ensure that these engineered systems function as originally designed and prevent releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

The total peak annual TEDEs in Table H–43 (Sturgeon Point) arising from the North Plateau Groundwater Plume are all about a factor of 4 lower than those for the Seneca Nation of Indians receptor, and a factor of 3 lower than those for the Cattaraugus Creek receptor. The peak arising from the SDA is about a factor of 19 lower than that for the Seneca Nation of Indians receptor and a factor of 8 lower than that for the Cattaraugus Creek receptor. The total peak annual TEDEs in Table H–44 (Niagara River) are still lower by more than a further factor of 300. Similarly, predicted lifetime risks are comparably lower and are not further discussed here.

Note that the individual doses in Table H–43 are almost equal to the corresponding population doses in Table H–41 divided by the 565,000 Sturgeon Point users. Thus, the contribution to the population dose from the Niagara River users is only a small fraction of that of the Sturgeon Point users, a direct consequence of the individual doses in Table H–44 being so small.

Hazardous Chemical Risk

For the Niagara River and Sturgeon Point users, the peak Hazard Index, the peak lifetime risk, and the ratio of concentration in water to the MCLs are all smaller than for Cattaraugus Creek or the Seneca Nation of Indians receptor and are not discussed further here.

Conclusions Given Continuation of Institutional Controls

For alternatives where waste would remain onsite, the overall assessment is that the dose and risk are small for both alternatives. The risk is dominated by the radiological hazards. The peak annual dose to offsite receptors is less than 25 millirem per year when considering all WMAs, regardless of the alternative.[10] The radiological hazard for both alternatives is dominated at early times (approximately 30 years) by the North Plateau Groundwater Plume and at longer times (approximately 37,000 years) by the burial grounds with the SDA presenting the largest hazard over the longest time period.

H.2.2.3 Conditions Assuming Loss of Institutional Control

For analytical purposes, the loss of institutional controls is assumed to take place after 100 years. In the case of the No Action Alternative, loss of institutional controls means that all maintenance activities cease and, in particular, no effort is made to keep radionuclides confined within the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm. Conservatively, failure (e.g., collapse) of containment of these facilities is assumed to take place immediately upon loss of institutional controls. In addition, for both alternatives, loss of institutional controls means that intruders can enter the site and would be able to perform activities such as well-drilling, house construction, and farming in the various WMAs, including the SDA and NDA.

The scenarios considered below are: (1) loss of institutional control leading to intruders on Buttermilk Creek; (2) loss of institutional controls leading to intruders on or adjacent to the north and south plateaus; and (3) effect of loss of institutional controls on offsite receptors.[11] All of these analyses focus on the impacts of radionuclides being released and coming in contact with human receptors. For radiological health impacts, the discussion is confined to dose impacts only (except for offsite receptors), because there are dose standards for situations following loss of institutional control, but not risk standards.

[10] The statement that the doses are less than 25 millirem is not intended to support any regulatory conclusions. Regulatory analysis is presented in Appendix L.
[11] Three scenarios consider loss of institutional controls without erosion. For loss of institutional controls with unmitigated erosion, see Section H.2.2.4. Section H.2.2.4 also contains a qualitative discussion of the combination of doses received as a result of both erosion and releases into groundwater.

H.2.2.3.1 Loss of Institutional Controls Leading to Buttermilk Creek Intruder/Resident Farmer

Table H–45 presents the peak annual TEDE for the Buttermilk Creek resident farmer for each alternative, assuming failure of the active controls that would detect and mitigate releases from the process building, the high-level waste tank and the North Plateau Groundwater Plume. See Figure H–2 for the location of this receptor.

Table H–45 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Buttermilk Creek Resident Farmer (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	0.14 (200)	2 (200)
Vitrification Facility – WMA 1	0.00028 (1,000)	0.79 (200)
Low-Level Waste Treatment Facility – WMA 2	0.0020 (100)	0.12 (200)
Waste Tank Farm – WMA 3	0.014 (300)	11 (200)
NDA – WMA 7 [b]	0.076 (8,700)	0.076 (8,700)
SDA – WMA 8 [b]	1.7 (37,300)	1.7 (37,300)
North Plateau Groundwater Plume [b, c]	3.9 (34)	3.9 (34)
Total	3.9 (34)	14 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA. However, the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

[c] The peak arising from the North Plateau Groundwater Plume at 34 years will have already passed by the time institutional controls fail. In practice, no one would be allowed to farm on Buttermilk Creek at that time, so the 34-year dose is conservative.

All of the projected doses for the Sitewide Close-In-Place Alternative would be less than 5 millirem per year. The No Action Alternative would result in the highest peak annual dose to this receptor (14 millirem per year), dominated by the Waste Tank Farm (11 millirem per year). If the loss of institutional controls were to occur earlier (i.e., prior to year 100), the dose would be higher because radionuclides from facilities such as the Main Plant Process Building could then migrate towards receptors and reach them sooner with less radioactive decay having taken place. For the Sitewide Close-In-Place Alternative, the SDA is the largest contributor to the long-term dose, while for the No Action Alternative the Waste Tank Farms would dominate.

H.2.2.3.2 Loss of Institutional Controls Leading to North and South Plateau Intruders

This section presents the estimated doses to a spectrum of intruders who could enter the North or South Plateau in the event of failure of institutional controls designed to limit site access. These scenarios are considered to be reasonably conservative ones and useful for understanding the potential magnitude of impacts if intruders come onto the plateaus. The specific intruders evaluated are: (1) direct intruder workers, (2) a resident farmer who has waste material directly deposited in his garden as a result of well drilling or home construction, and (3) a resident farmer who uses contaminated groundwater. Direct intruders are assumed to be located immediately above the waste in each WMA while contaminated groundwater is assumed to come from wells that are located approximately 150 meters downgradient from the edge of the waste, see Figure H–3. Additional information on these exposure scenarios is provided in Appendix D. For the purposes of analysis of the No Action alternative, the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm are assumed to have lost their structural integrity and collapsed at the time of loss of institutional controls after exactly 100 years.

Intruder Worker

Table H–46 presents the doses to the intruder worker. Two worker scenarios were considered, a well driller and a home constructor. For the well driller, exposure pathways include inadvertent ingestion of contaminated soil, inhalation of contaminated dust, and direct exposure to contaminated water in a cuttings pond. For home construction, exposure pathways include inadvertent ingestion of contaminated soil, inhalation of contaminated dust, and exposure to external radiation from the walls of an excavation for the foundation of a home. However, the home construction scenario is not considered credible when there is a thick-engineered cap (e.g., the South Plateau burial grounds under the Sitewide Close-In-Place Alternative).

Table H–46 Estimated Peak Annual Total Effective Dose Equivalent in Millirem Per Year to Intruder Worker (well driller or home construction worker) – Intrusion After 100 Years

Waste Management Areas	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	Not applicable	3,910 [a, b]
Vitrification Facility – WMA 1	Not applicable	28,000 [a, b]
Low-Level Waste Treatment Facility – WMA 2	1.0 [c]	45,000 [a, b]
Waste Tank Farm – WMA 3	Not applicable	133 [c]
NDA – WMA 7 [c]	Not applicable	19,000 [a, c]
SDA – WMA 8 [c]	Not applicable	3,110 [a, b]
North Plateau Groundwater Plume [c]	0.0000011 [b]	0.0000011 [b]
Cesium Prong – onsite	1.9 [b]	1.9 [b]

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] The doses for the No Action alternative are very high because, in this scenario, the well driller or home construction worker intrudes directly into volumes that contain high inventories of radionuclides. In the corresponding Sitewide Close-In-Place scenarios, the concentrated inventories have been covered by a cap that is thick enough to preclude a home construction worker from reaching the remaining inventories.

[b] Peak impact due to home construction scenarios.

[c] Peak impact due to well-drilling scenarios.

The results of this analysis are summarized in Table H–46, with the results presented for the scenario with the highest TEDE. The results presented assume the scenario occurs after 100 years of effective institutional controls.

Under the Sitewide Close-In-Place Alternative, none of the predicted doses would exceed 2 millirem per year.[12] However, the No Action Alternative peak annual doses could be substantial, up to 45,000 millirem per year. For the No Action Alternative, the highest dose would be for the Low-Level Waste Treatment Facility from the home construction scenario. In all cases, the radionuclide contributing the greatest portion of dose is cesium-137.

This analysis shows the importance of the thick, multi-layered engineered barrier in limiting the extent of direct intrusion into the waste, thereby limiting the dose under the Sitewide Close-In-Place Alternative.

[12] *This is merely an observation with no implied regulatory implications.*

Resident Farmer with Waste Material in His Garden

Table H–47 presents the doses to the resident farmer as a result of direct contact from contamination that would be brought to the surface and placed in a garden following a well drilling or home construction scenario. In all cases, the radionuclide contributing the greatest portion of dose is cesium-137. For the Sitewide-Close-In-Place alternative, none of the predicted annual TEDEs exceeds 10 millirem, but for the No Action Alternative the predicted peak annual TEDEs could exceed 200,000 millirem per year.

Table H–47 Estimated Peak Annual Total Effective Dose Equivalent in Millirem Per Year to Resident Farmer with a Garden Containing Contaminated Soil from Well Drilling or House Construction – Intrusion After 100 Years

Waste Management Areas	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	Not applicable	19,900 [a, c]
Vitrification Facility – WMA 1	Not applicable	235,000 [a, c]
Low-Level Waste Treatment Facility – WMA 2	7.0 [b]	65,400 [a, c]
Waste Tank Farm – WMA 3	Not applicable	2,080 [a, c]
NDA – WMA 7	Not applicable	61,500 [a, d]
SDA – WMA 8	Not applicable	2,150 [a, c]
North Plateau Groundwater Plume	0 [d]	0 [d]
Cesium Prong – onsite	4.4 [c]	4.4 [c]

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] The doses for the No Action Alternative are very high because, in this scenario, the well driller or home construction worker intrudes directly into volumes that contain high inventories of radionuclides. In the corresponding Sitewide Close-In-Place scenarios, the concentrated inventories have been covered by a cap that is thick enough to preclude a home construction worker from reaching the remaining inventories.

[b] In the case of the Low-Level Waste Treatment Facility, it is possible for the well driller to penetrate soil contaminated with radioactive waste, and spread radioactive material over a farmer's garden. However, the amount of material brought to the surface by a well driller is much less than that spread around during house construction.

[c] Peak impact due to home construction scenarios.

[d] Peak impact due to well-drilling scenarios. The predicted dose to the well drillers from the North Plateau Groundwater Plume is close to zero due to the cap.

Resident Farmer Using Contaminated Groundwater

Table H–48 presents the doses to the resident farmer whose contact with the waste would be through an indirect pathway – the use of contaminated water. The receptors for the North Plateau facilities (Main Plant Process Building, Low-Level Waste Treatment Facility, Waste Tank Farm, and North Plateau Groundwater Plume) have wells in the sand and gravel layer on the North Plateau. The scenario is not applicable to the NDA and SDA receptor because of the low hydraulic conductivity of the unweathered Lavery till and the unsaturated conditions in the Kent recessional sequence.

The results for the No Action Alternative clearly show that serious consequences are possible should institutional controls over facilities like the Main Plant Process Building or the Waste Tank Farm be lost.

Table H–48 Estimated Peak Total Effective Dose Equivalent in Millirem Per Year to a Resident Farmer using Contaminated Groundwater – Intrusion After 100 Years

Waste Management Areas	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	162	28,387 [a]
Vitrification Facility – WMA 1	1.9	101,000 [a]
Low-Level Waste Treatment Facility – WMA 2	31.6	1,448 [a]
Waste Tank Farm – WMA 3	157	397,988 [a]
NDA – WMA 7	Not applicable	Not applicable
SDA – WMA 8	Not applicable	Not applicable
North Plateau Groundwater Plume [b]	72	72
Cesium Prong – onsite	4.4	4.4

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] The doses for the No Action Alternative are very high because, in this scenario, the well intrudes directly into volumes that contain high inventories of radionuclides. In the Sitewide Close-In-Place scenario caps over the SDA, NDA, process building and vitrification facility prevent direct intrusion into the waste and the slurry wall and cap limit flow of water through the waste.

[b] North Plateau Groundwater Plume interstitial velocity calculated from STOMP model outputs was the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

The time series of dose for the North Plateau Groundwater Plume under the Sitewide Close-In-Place Alternative is presented in **Figure H–14** for receptors at 150 and 300 meters from the source of the plume. The figure illustrates the sensitivity of the dose to the time at which the intrusion occurs, and to where the intruder places his farm. The peak dose in Table H–48 for the North Plateau Groundwater Plume for the Sitewide Close-In-Place Alternative comes from the receptor at 300 meters at about 30 years. The distance of 150 meters is in the vicinity of the peak concentration of the plume at the first year of the period of analysis for both the No Action and Sitewide Close-In-Place Alternatives and just outside the downgradient slurry wall for the Sitewide Close-In-Place Alternative. The distance of 300 meters is located just upgradient of the North Plateau drainage ditch, the first location of discharge of the plume to the surface. For each alternative, the peak onsite concentration would occur during the period of institutional control when a receptor could not access the contaminated groundwater. As time proceeds, concentration in the plume decreases at locations near the source and increases and then decreases at locations further removed from the source. This behavior explains the occurrence of peak dose at a location removed from the original source for an analysis time of 100 years.

Dose from Multiple Sources

The previous discussion presented information on the dose to various receptors from individual WMAs. There is the potential for receptors to come in contact with contamination from multiple areas and therefore see higher doses than one would see from a single WMA. The highest doses are home construction intruders for the No Action Alternative (Table H–46), a resident farmer with contamination from home construction for the No Action Alternative (Table H–47) and a resident farmer using contaminated groundwater under either the Sitewide Close-In-Place Alternative or the No Action Alternative (Table H–48).

The greatest potential for a dose from multiple sources for the No Action Alternative would be the combination of a garden contaminated with material from a home construction and irrigated with contaminated groundwater. These combinations could result in peak doses approaching 200,000-500,000 millirem per year with the higher value occurring if the well is located near the Waste Tank Farm.

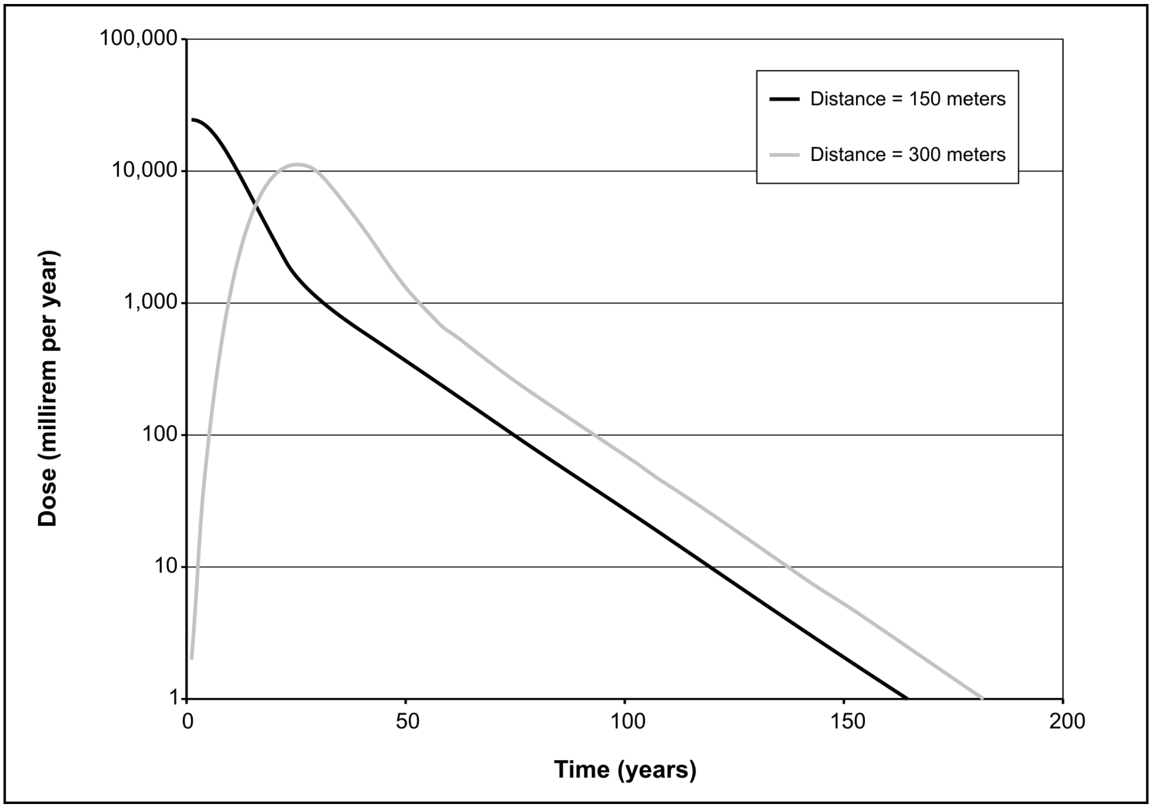

Figure H–14 Time Series of Dose for Onsite Receptors for North Plateau Groundwater Plume Under Sitewide Close-In-Place – Time Measured from Completion of Decommissioning

The greatest potential for the Sitewide Close-In-Place Alternative would appear to involve a water well on the North Plateau that would intercept the plumes from both the Main Plant Process Building and the Waste Tank Farm that would arise should there be loss of institutional controls. A conservative estimate of the combined dose from the Main Plant Process Building and the Waste Tank Farm would be about 500 rem per year (100 from the Vitrification Facility and 400 from the Waste Tank Farm [see Table H–48]).

H.2.2.3.3 Effect of Loss of Institutional Controls on Offsite Receptors

This Section is parallel to Section H.2.2.2, which presented the results of the long-term performance assessment for offsite receptors assuming indefinite continuation of institutional controls (but without unmitigated erosion, which is considered in Section H.2.2.4). However, in this Section it is assumed that institutional controls will be lost after 100 years and maintenance activities will cease. In particular, it is assumed that there are no more efforts to contain radionuclides and hazardous chemicals within WMAs on the North and South Plateaus. Conservatively, these are assumed to fail as soon as institutional controls fail. This subsection reexamines the analysis for the offsite receptors.

The principal effect of releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm is to considerably increase predicted doses and risks for the No Action Alternative. However, the predicted doses and risks for the Sitewide Close-In-Place Alternative are barely changed because the various engineered features that would be put in place around and above the facilities that would be closed in place (e.g., Main Plant Process Building, Waste Tank Farm, NDA, and SDA) and considered in the analysis would continue to function without maintenance even though their performance would be degraded. The result would be similar groundwater flow patterns and rates with or without maintenance for WMAs that are closed in place. Therefore, the discussion in Section H.2.2.2.3 focuses on the No Action Alternative. Tabular results for the

Sitewide Close-In-Place Alternative are included for comparison, but readers should turn to Section H.2.2.1 for discussions.

Cattaraugus Creek Receptor

As described previously, the Cattaraugus Creek receptor is a postulated offsite receptor who is closest to the site boundary and receives the impact of liquid release from all portions of the site. This receptor is conservatively assumed to drink untreated water from Cattaraugus Creek, eat fish, and irrigate his garden, also with untreated water from Cattaraugus Creek.

Radiological Dose and Risk

This section covers TEDE, dominant doses and pathways, and radiological risk.

Total Effective Dose Equivalent

Figure H–15 presents the annual TEDE as a function of time to the Cattaraugus Creek receptor for the No Action Alternative. See Figure H–6 for the comparable plot for the Sitewide Close-In-Place Alternative.

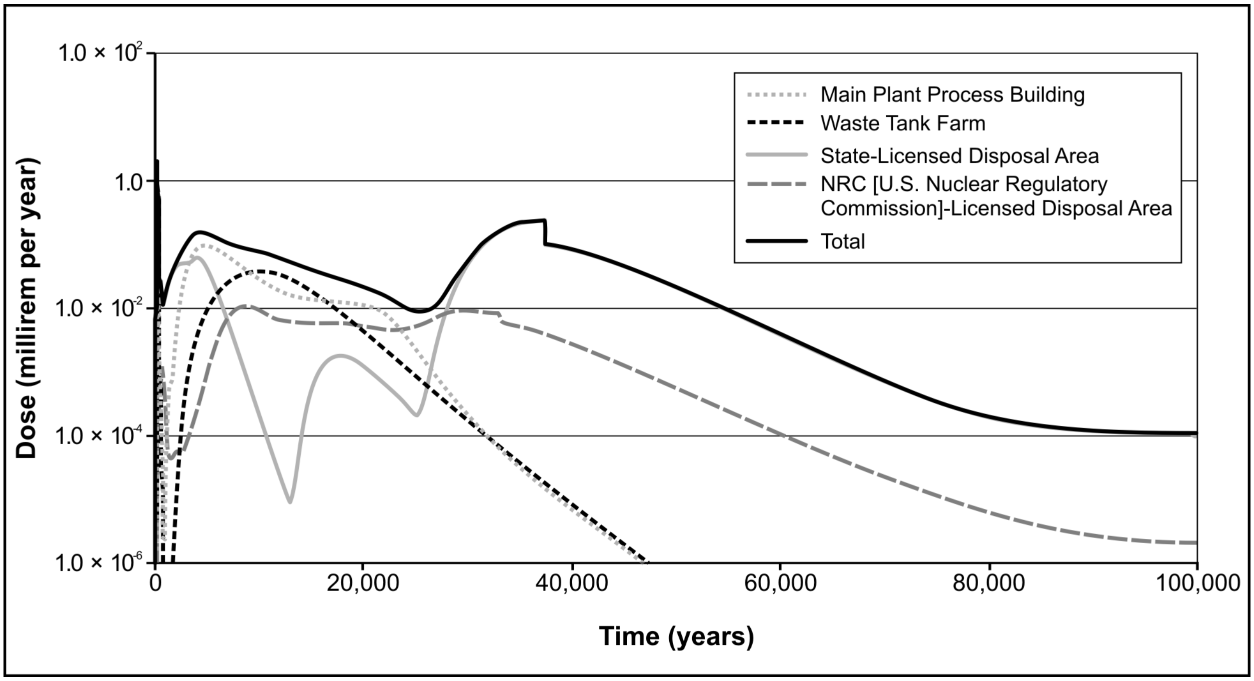

Figure H–15 Annual TotalEffective Dose Equivalent for the Cattaraugus Creek Receptor with the No Action Alternative and Loss of Institutional Controls after 100 Years

The figure shows a number of peaks that correspond to the arrival of "pulses" of radionuclides from different areas on the site. This is further clarified by **Table H–49**, which, for each alternative, displays the WMA, the predicted peak annual TEDE arising from radionuclides leaching from the WMA, and the predicted years until peak annual TEDE.

The results presented in Table H–49 show that the total peak annual dose to the Cattaraugus Creek receptor due to groundwater releases would be less than 2 millirem per year for both alternatives. However, whereas in Table H–28 the predicted peak total doses for the two alternatives were about the same, the peak total dose for the No Action Alternative is now about a factor of 4 larger. For the No Action Alternative, the peak annual dose would be dominated by the Waste Tank Farm and occurs at approximately 200 years. The dominant radionuclide from the Waste Tank Farm with the No Action Alternative is strontium-90 in drinking water. The doses for the Sitewide Close-In-Place Alternative with loss of institutional controls are much the same as they were for indefinite continuation of institutional controls, reflecting the conservative nature of the assumptions made with respect to degradation of barriers in the latter case.

Table H–49 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Cattaraugus Creek Receptor (year of peak exposure in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	0.019 (200)	0.26 (200) [b]
Vitrification Facility – WMA 1	0.000037 (1,000)	0.10 (200) [b]
Low-Level Waste Treatment Facility – WMA 2	0.00026 (100)	0.015 (100)
Waste Tank Farm – WMA 3	0.0019 (300)	1.5 (200) [b]
NDA – WMA 7 [c]	0.010 (8,700)	0.010 (8,700)
SDA – WMA 8 [c]	0.23 (37,300)	0.23 (37,300)
North Plateau Groundwater Plume [c]	0.51 (34)	0.51 (34)
Total	0.51 (34)	1.9 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Detailed Analysis of Total Effective Dose Equivalent

Table H–50 provides further detailed breakdown of Table H–49 organized by components. The parallel table in Section H.2.2.2 is Table H–29.

Table H–50 shows that the largest contributor to the radiological dose for the No Action Alternative is Tank 8D-2.

Controlling Nuclides and Pathways

It is important to understand the controlling nuclides and pathways at the year of peak TEDE. **Table H–51** provides this information. For the No Action Alternative, also as noted above, the high-level waste tanks, particularly 8D-2 provide the largest peaks. These are dominated by the ingestion of strontium-90 in drinking water, whereas the Sitewide Close-In-Place Alternative is dominated by uranium-234 from the SDA via fish. The early peak from the North Plateau Groundwater Plume is dominated by strontium-90 in drinking water.

Excess Cancer Risk

A complementary measure is the peak lifetime risk (excess cancer risk) to the Cattaraugus Creek receptor arising from radiological discharges. **Table H–52** shows how this risk varies from different WMAs and what it is for contributions from the entire WNYNSC for each alternative. As expected, this table closely parallels the dose table, Table H–46. Releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farms increase the predicted lifetime risk of cancer fatality by about a factor of 4 to approximately 4×10^{-5}.

Table H–50 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Cattaraugus Creek Receptor Broken Down by Waste Management Area Components (year of peak exposure in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Waste Management Area Components*	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	Rubble Pile	0.00404 (400)	0.0371 (200) [b]
	General Purpose Cell	0.0169 (200)	0.0829 (200) [b]
	Liquid Waste Cell	0.00324 (300)	0.138 (200) [b]
	Fuel Receiving Storage Pad	0.000113 (29,400)	0.00319 (200) [b]
	Total Main Plant Process Building	0.0191 (200)	0.262 (200) [b]
Vitrification Facility – WMA 1		0.0000367 (1,000)	0.105 (200) [b]
Low-Level Waste Treatment Facility – WMA 2	Lagoon 1	0.000171 (100)	0.0119 (100)
	Lagoon 2	0.0000919 (100)	0.00362 (100)
	Lagoon 3	2.38×10^{-7} (200)	7.17×10^{-6} (100)
	Lagoon 4	6.77×10^{-7} (100)	2.35×10^{-7} (200)
	Lagoon 5	2.14×10^{-7} (200)	2.14×10^{-7} (200)
	Total Low-Level Waste Treatment Facility	0.000264 (100)	0.0155 (100)
Waste Tank Farm – WMA 3	8D-1	0.00124 (200)	0.0744 (200) [b]
	8D-2	0.000707 (300)	1.11 (200) [b]
	8D-3	7.65×10^{-7} (2,900)	0.0000513 (200) [b]
	8D-4	0.000131 (200)	0.309 (200) [b]
	Total Waste Tank Farm	0.00186 (300)	1.49 (200) [b]
NDA – WMA 7 Horizontal [c]	Process	0.00172 (18,600)	0.00172 (18,600)
	Hulls	0.000888 (7,800)	0.000888 (7,800)
	WVDP	0.0000141 (16,700)	0.0000141 (16,700)
	Total NDA – Horizontal	0.00208 (18,000)	0.00208 (18,000)
NDA – WMA 7 Vertical/Horizontal [c]	Process	0.00709 (30,900)	0.00709 (30,900)
	Hulls	0.00890 (8,600)	0.00890 (8,600)
	WVDP	0.0000826 (26,500)	0.0000826 (26,500)
	Total NDA – Vertical/Horizontal	0.00890 (8,600)	0.00890 (8,600)
Total NDA [c]		0.0100 (8,700)	0.0100 (8700)
SDA – WMA 8 [c]	Horizontal	0.0503 (2,400)	0.0503 (2,400)
	Vertical/Horizontal	0.229 (37,200)	0.229 (37,200)
	Total SDA	0.229 (37,300)	0.229 (37,300)
North Plateau Groundwater Plume [c]		0.511 (34)	0.511 (34)
Total Site		0.511 (34)	0.187 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area, WVDP = West Valley Demonstration Project.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Table H–51 Controlling Nuclides and Pathways for the Cattaraugus Creek Receptor, Broken Down by Waste Management Area Components at Year of Peak Annual Total Effective Dose Equivalent – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*WMA Components*	*Controlling Nuclide/Pathway*	
		Sitewide Close-in-Place Alternative	*No Action Alternative*
Main Plant Process Building – WMA 1	Rubble Pile	Iodine-129/Fish	Strontium-90/DW
	General Purpose Cell	Neptunium-237/Fish	Strontium-90/DW
	Liquid Waste Cell	Iodine-129/Fish	Carbon-14/Fish
	Fuel Receiving Storage Pad	Plutonium -239/Fish	Strontium-90/DW
Vitrification Facility – WMA 1		Neptunium-237/Fish	Strontium-90/DW
Low-Level Waste Treatment Facility – WMA 2	Lagoon 1	Iodine-129/Fish	Strontium-90/DW
	Lagoon 2	Strontium-90/DW	Strontium-90/DW
	Lagoon 3	Uranium-234/DW	Uranium-234/DW
	Lagoon 4	Uranium-234/DW	Uranium-234/DW
	Lagoon 5	Uranium-234/DW	Uranium-234/DW
Waste Tank Farm – WMA 3	8D-1	Technetium-99/RF [b]	Strontium-90/DW
	8D-2	Technetium-99/RF [b]	Strontium-90/DW
	(8D-2g) [c]	Technetium-99/RF [b]	N/A
	(8D-2r) [c]	Technetium-99/RF [b]	N/A
	8D-3	Uranium-233/DW	Strontium-90/DW
	8D-4	Iodine-129/Fish	Strontium-90/DW
NDA – WMA 7 Horizontal	Process	Uranium-233/DW	Uranium-233/DW
	Hulls	Carbon-14/Fish	Carbon-14/Fish
	WVDP	Uranium-233/DW	Uranium-233/DW
NDA – WMA 7 Vertical/Horizontal	Process	Uranium-233/DW	Uranium-233/DW
	Hulls	Carbon-14/Fish	Carbon-14/Fish
	WVDP	Uranium-233/DW	Uranium-233/DW
SDA – WMA 8	Horizontal	Carbon-14/Fish	Uranium-234/Fish
	Vertical/Horizontal	Uranium-234/Fish	Uranium-234/Fish
North Plateau Groundwater Plume		Strontium-90/DW	Strontium-90/DW

DW = drinking water, N/A = not applicable, NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, RF = resident farmer, SDA = State-Licensed Disposal Area, WVDP = West Valley Demonstration Project, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA. However, no single facility characterizes the burial grounds, so the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] RF means resident farmer and includes a number of pathways such as eating contaminated vegetables, inhalation, etc.

[c] 8D-2g and 8D-2r are the grid (lower) and ring (upper) contaminated portions of Tank 8D-2.

Table H–52 Peak Lifetime Radiological Risk (risk of latent cancer morbidity) for the Cattaraugus Creek Receptor (year of peak risk in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	Sitewide Close-In-Place Alternative	No Action Alternative
Main Plant Process Building – WMA 1	4.20×10^{-7} (200)	5.62×10^{-6} (200) [b]
Vitrification Facility – WMA 1	3.12×10^{-10} (300)	2.28×10^{-6} (200) [b]
Low-Level Waste Treatment Facility – WMA 2	6.45×10^{-9} (100)	3.38×10^{-7} (100)
Waste Tank Farm – WMA 3	7.84×10^{-8} (300)	3.24×10^{-5} (200) [b]
NDA – WMA 7 [c]	2.61×10^{-7} (8,600)	2.61×10^{-7} (8,600)
SDA – WMA 8 [c]	2.89×10^{-6} (37,300)	2.89×10^{-6} (37,300)
North Plateau Groundwater Plume [c]	1.10×10^{-5} (34)	1.10×10^{-5} (34)
Total	1.10×10^{-5} (34)	4.06×10^{-5} (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Hazardous Chemical Risk

Estimates of the risk to the Cattaraugus Creek receptor from hazardous chemicals in the burial grounds, the process building and the high-level waste tank have also been prepared. Three measures are used: lifetime cancer risk, Hazard Index and comparison to MCLs for drinking water that have been issued under the Clean Water Act.

Lifetime Cancer Risk

Table H–53 shows the peak lifetime cancer risk from chemical exposure broken down by WMA. In contrast to the case for radiological doses, the additional releases from the Main Plant Process Building and Waste Tank Farm that occurring the case of the No Action Alternative do not cause a large increase in risk. This is because, when thinking purely of chemicals, inventories of hazardous chemicals are much larger and more mobile in the NDA and SDA than in the buildings and tanks.[13]

This comparison of lifetime cancer risk from radionuclides and chemicals for the Cattaraugus Creek receptor in the No Action Case is also shown in **Figure H–16**. The comparable figure for the No Action Alternative with indefinite continuation of institutional controls is given in Figure H–7. The two figures are similar.

[13] Note that, in general, organic chemicals experience less retardation than radionuclides. The controlling constituent of the NDA impact is more strongly retarded than that for the SDA impact, which is why the SDA peak occurs much earlier than the NDA peak. Note also that degradation of organic compounds was not addressed.

Table H–53 Peak Lifetime Risk from Hazardous Chemicals (risk of latent cancer morbidity) for the Cattaraugus Creek Receptor (year of peak risk in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	1.4×10^{-9} (5,000)	3.0×10^{-9} (4,000) [b]
Vitrification Facility – WMA 1	1.3×10^{-10} (11,700)	3.6×10^{-9} (1,100) [b]
Waste Tank Farm – WMA 3	1.1×10^{-10} (8,900)	1.3×10^{-9} (2,300) [b]
NDA – WMA 7 [c]	1.4×10^{-9} (85,900)	1.4×10^{-9} (85,900)
SDA – WMA 8 [c]	2.1×10^{-8} (100)	2.1×10^{-8} (100)
Total	2.1×10^{-8} (100)	2.1×10^{-8} (100)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] The limited information available on hazardous chemical inventories in the Low-Level Waste Treatment Facility suggest it will not make a noticeable contribution to the overall long-term risk from hazardous chemicals.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[c] NDA and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

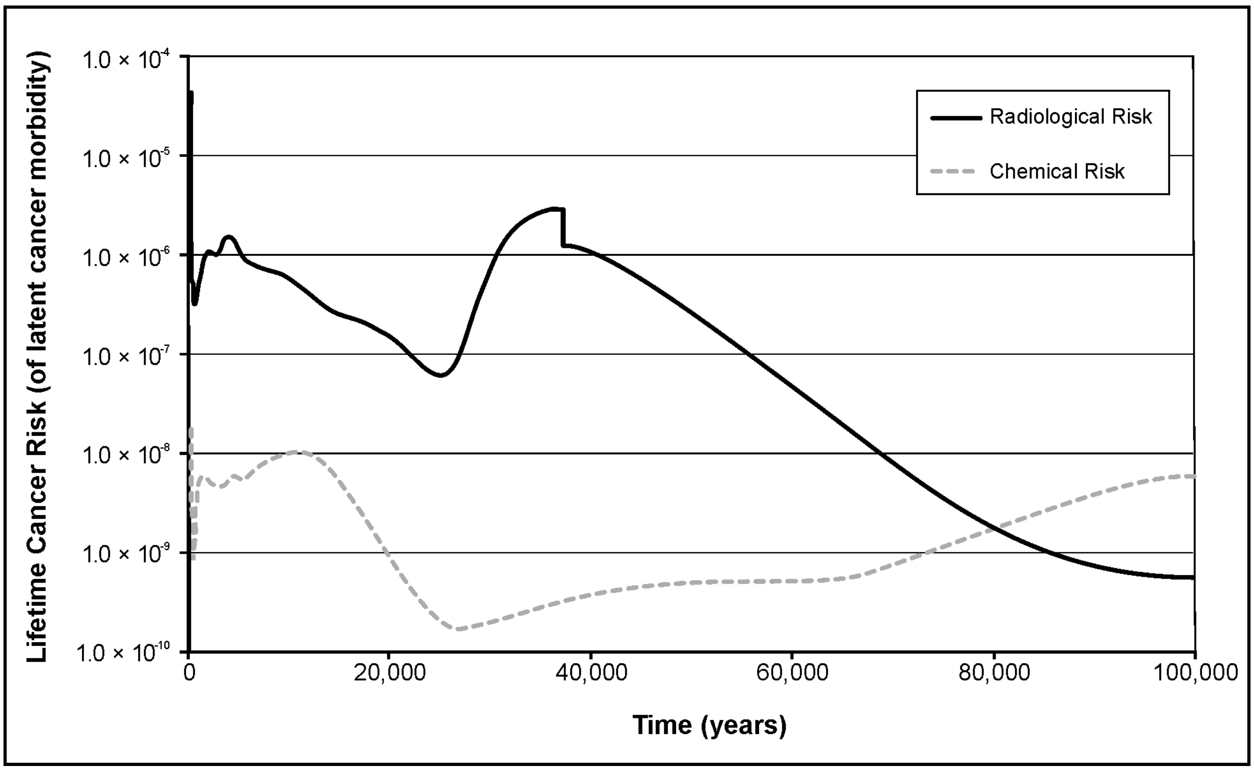

Figure H–16 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Cattaraugus Creek Receptor with the No Action Alternative and Loss of Institutional Controls After 100 Years

Hazard Index

Another measure of chemical risk that is appropriate for non-carcinogenic chemicals is the Hazard Index for an individual receptor. If the Hazard Index is greater than 1, an observable non-carcinogenic health effect may occur. **Table H–54** presents the Hazard Index peaks for the Cattaraugus Creek receptor in the case of loss of institutional controls after 100 years.

These hazard indices are all very small, with the totals being less than 1 percent. The Main Plant Process Building and the Vitrification Facility add only about 20 percent to the total Hazard Index for the No Action Alternative with loss of institutional controls.

Table H–54 Peak Chemical Hazard Index for the Cattaraugus Creek Receptor (year of peak Hazard Index in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	0.000058 (3,400)	0.00012 (2,800) [b]
Vitrification Facility – WMA 1	5.3×10^{-6} (15,100)	0.00015 (1,400) [b]
Waste Tank Farm – WMA 3	0.000071 (9,900)	0.00086 (3,100) [b]
NDA – WMA 7 [c]	0.000015 (30,100)	0.000015 (30,100)
SDA – WMA 8 [c]	0.0034 (3,900)	0.0034 (3,900)
Total	0.0035 (3,900)	0.0042 (3,700)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] The limited information available on hazardous chemical inventories in the Low-Level Waste Treatment Facility suggest it will not make a noticeable contribution to the overall long-term risk from hazardous chemicals.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[c] NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Fraction of Maximum Concentration in Liquid

Table H–55 shows the chemical that has the largest fraction of its MCL at the year of peak risk and the year of peak Hazard Index. The addition of releases from the Main Plant Process Building and the Waste Tank Farm for the No Action Alternative does not change the conclusion that the maximum ratios to the MCL are all less than one, nor does it introduce different chemicals.

Seneca Nation of Indians Receptor

As described previously, the Seneca Nation of Indians receptor is similar to the Cattaraugus Creek receptor but is postulated to consume a larger amount of fish (62 kilograms per year) living and/or stocked in the lower reaches of Cattaraugus Creek or in Lake Erie near the point where Cattaraugus Creek discharges into the lake. The results presented below are in many respects similar to those for the Cattaraugus Creek receptor, so the discussion that follows is less detailed than for Cattaraugus Creek.

Table H–55 Chemicals with Largest Fraction of Maximum Concentration Levels in Cattaraugus Creek – Loss of Institutional Controls After 100 Years [a]

Year of Peak Risk in Parentheses		
Waste Management Areas [b]	***Sitewide Close-In-Place Alternative***	***No Action Alternative***
Main Plant Process Building – WMA 1	0.000107 (8,500) Pb [d]	0.000215 (4,200) Pb [c, d]
Vitrification Facility – WMA 1	1.89×10^{-7} (40,500) Pb [d]	5.65×10^{-7} (4,300) Pb [c, d]
Waste Tank Farm – WMA 3	7.25×10^{-7} (9,000) Tl [e]	6.50×10^{-6} (2,600) Tl [c, e]
NDA – WMA 7 [j]	1.30×10^{-6} (86,700) As [f]	1.30×10^{-6} (89,200) As [f]
SDA – WMA 8 [j]	0.000107 (100) Benzene [g]	0.000107 (100) Benzene [g]
Year of Peak Hazard Index in Parentheses		
Waste Management Areas	***Sitewide Close-In-Place Alternative***	***No Action Alternative***
Main Plant Process Building – WMA 1	0.00009.47 (3,400) Pb [d]	0.000170 (2,800) Pb [c, d]
Vitrification Facility – WMA 1	1.50×10^{-7} (26,000) Sb [h]	2.41×10^{-6} (4,500) As [c, f]
Waste Tank Farm – WMA 3	8.78×10^{-7} (12,400) Sb [h]	9.15×10^{-6} (3,600) Tl [c, e]
NDA – WMA 7 [j]	3.40×10^{-5} (30,200) Usol [i]	3.40×10^{-5} (30,200) Usol [i]
SDA – WMA 8 [j]	9.03×10^{-3} (4,700) Usol [i]	9.03×10^{-3} (4,700) Usol [i]

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] Presented as fraction of the applicable MCL / (years until peak exposure) / chemical.

[b] The limited information available on hazardous chemical inventories in the Low-Level Waste Treatment Facility suggest it will not make a noticeable contribution to the overall long-term risk from hazardous chemicals.

[c] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[d] Pb = lead, MCL (Action Level) =0.015 milligrams per liter.

[e] Tl= thallium, MCL = 0.002 milligrams per liter.

[f] As = arsenic, MCL = 0.01 milligrams per liter.

[g] Benzene, MCL = 0.005 milligrams per liter

[h] Sb = antimony, MCL = 0.006 milligrams per liter

[i] Usol = soluble uranium, MCL = 0.03 milligrams per liter.

[j] NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives; therefore peaks are the same for both alternatives.

Radiological Dose and Risk

Total Effective Dose Equivalent

Figure H–17 presents the annual TEDE as a function of time to a Seneca Nation of Indians receptor located just outside the WNYNSC boundary. This hypothetical individual is postulated to drink water from Cattaraugus Creek, use the water for irrigation and consume fish living and/or stocked in Cattaraugus Creek. The principal difference from the Cattaraugus Creek receptor is that the Seneca Nation of Indians receptor consumes more fish. The figures show the relative contributions of the four WMAs that are the largest contributors to the predicted dose (the Main Plant Process Building, the Waste Tank Farm, the NDA, and the SDA). This figure is much the same as the comparable one for Cattaraugus Creek (Figure H–15) except that the curves are somewhat higher due to the aforementioned consumption of fish. The figure for the Sitewide Close-In-Place Alternative (not shown here) would be the same as Figure H–10.

The magnitude and the year of the peak contribution are shown in **Table H–56**.

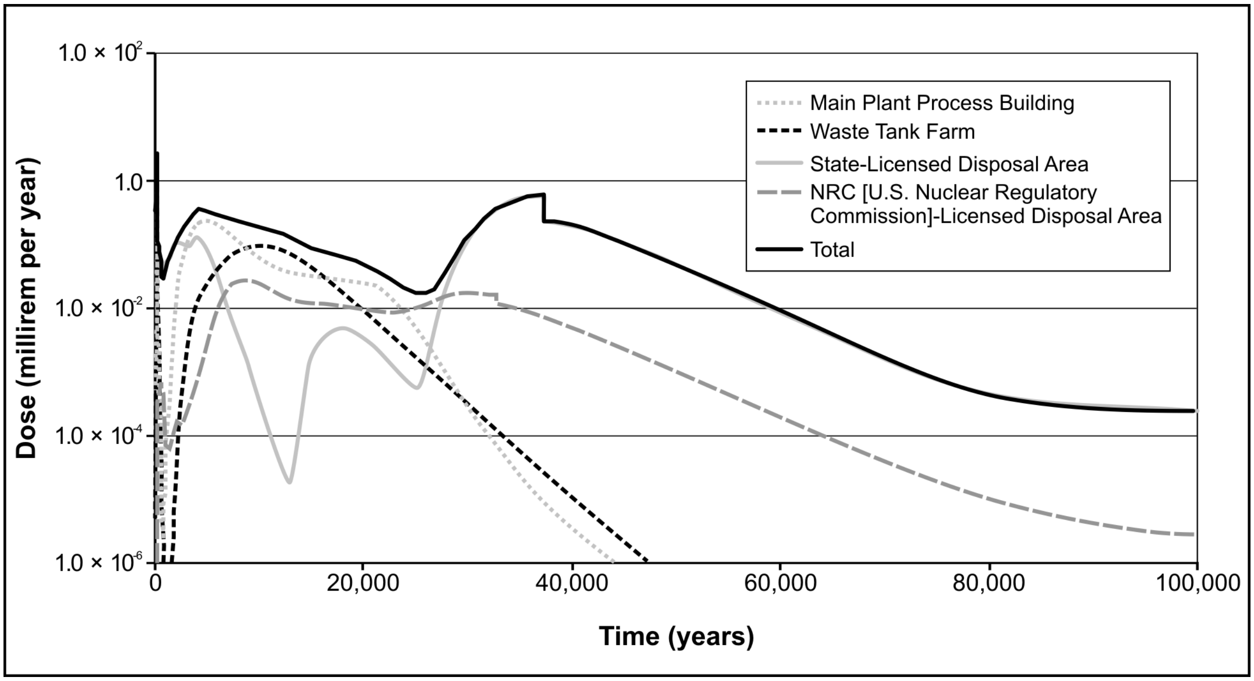

Figure H–17 Annual Total Effective Dose Equivalent for the Seneca Nation of Indians Receptor with the No Action Alternative and Loss of Institutional Controls After 100 Years

Table H–56 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Seneca Nation of Indians Receptor (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	0.053 (200)	0.49 (200) [b]
Vitrification Facility – WMA 1	0.000090 (1,000)	0.13 (200) [b]
Low-Level Waste Treatment Facility – WMA 2	0.00047 (100)	0.023 (100)
Waste Tank Farm – WMA 3	0.0019 (300)	1.9 (200) [b]
NDA – WMA 7	0.027 (8,600)	0.027 (8,600)
SDA – WMA 8[c]	0.56 (37,300)	0.56 (37,300)
North Plateau Groundwater Plume [c]	0.68 (34)	0.68 (34)
Total	0.68 (34)	2.5 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA. However, no single facility characterizes the burial grounds, so the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Comparing Table H–56 with Table H–49, the predicted peak annual TEDEs arising from the North Plateau Groundwater Plume would be a factor of about 1.3 higher than those of the Cattaraugus Creek receptor for both alternatives, again due to the aforementioned consumption of fish. The peak arising from the Waste Tank Farm at about 100 years is about a factor of 1.4 higher than that for Cattaraugus Creek.

Table H–57 provides further detailed breakdown of Table H–56 organized by components of each WMA. Table H–57 is similar to that for the Cattaraugus Creek receptor (Table H–50). Just as was the case for the Cattaraugus Creek receptor, Tank 8D-2 is the dominant contributor to the predicted dose for the No Action Alternative.

Table H–57 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Seneca Nation of Indians Receptor Broken down by Waste Management Area Components (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Waste Management Area Components*	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	Rubble Pile	0.00977 (400)	0.0607 (100) [b]
	General Purpose Cell	0.0470 (200)	0.154 (4,500) [b]
	Liquid Waste Cell	0.00798 (300)	0.303 (200) [b]
	Fuel Receiving Storage Pad	0.000272 (29,600)	0.00677 (4,700 [b])
	Total Main Plant Process Building	0.0526 (200)	0.486 (200) [b]
Vitrification Facility – WMA 1		0.00009 (1,000)	0.132 (200) [b]
Low-Level Waste Treatment Facility – WMA 2	Lagoon 1	0.000352 (100)	0.0182 (100)
	Lagoon 2	0.000116 (100)	0.00456 (100)
	Lagoon 3	3.48×10^{-7} (200)	0.0000102 (100)
	Lagoon 4	1.02×10^{-6} (100)	3.41×10^{-7} (200)
	Lagoon 5	3.10×10^{-7} (200)	3.10×10^{-7} (200)
	Total Low-Level Waste Treatment Facility	0.00047 (100)	0.0228 (100)
Waste Tank Farm – WMA 3	8D-1	0.00113 (200)	0.0938 (200) [b]
	8D-2	0.000678 (300)	1.42 (200) [b]
	8D-3	1.29×10^{-6} (2,900)	0.0000744 (200) [b]
	8D-4	0.000284 (200)	0.389 (200) [b]
	Total Waste Tank Farm	0.00186 (300)	1.90 (200) [b]
NDA – WMA 7 Horizontal	Process	0.0032 (18,800)	0.0032 (18,800)
	Hulls	0.00239 (7,700)	0.00239 (7,700)
	WVDP	0.0000262 (16,800)	0.0000262 (16,800)
	Total NDA – Horizontal	0.00393 (17,800)	0.00393 (17,800)
NDA – WMA 7 Vertical/ Horizontal	Process	0.0134 (30,900)	0.0134 (30,900)
	Hulls	0.0242 (8,600)	0.0242 (8,600)
	WVDP	0.000155 (26,400)	0.000155 (26,400)
	Total NDA – Vertical/ Horizontal	0.0242 (8,600)	0.0242 (8,600)
Total NDA [c]		0.0270 (8,600)	0.0270 (8600)
SDA – WMA 8 [c]	Horizontal	0.107 (2,300)	0.107 (2,300)
	Vertical/Horizontal	0.565 (37,200)	0.565 (37,200)
	Total SDA	0.565 (37,300)	0.565 (37,300)
North Plateau Groundwater Plume [c]		0.684 (34)	0.684 (34)
Total Site		0.684 (34)	2.55 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area, WVDP = West Valley Demonstration Project.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Controlling Nuclides and Pathways

It is important to understand the controlling nuclides and pathways at the year of peak TEDE. **Table H–58** provides this information. For both alternatives, there is an early North Plateau Groundwater Plume peak dominated by strontium-90 in fish. For the No Action Alternative, also as noted above, the high-level waste tanks, particularly 8D-2 provide the largest peak at about 200 years, also dominated by the ingestion of strontium-90 in fish. In the longer term (approximately 37,000 years) both alternatives exhibit an SDA peak dominated by uranium-234 in fish.

Table H–58 Controlling Nuclides and Pathways for the Seneca Nation of Indians Receptor Broken Down by Waste Management Area Components at Year of Peak Total Effective Dose Equivalent – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*WMA Components*	*Controlling Nuclide/Pathway*	
		Sitewide Close-in-Place	*No Action*
Main Plant Process Building – WMA 1	Rubble Pile	Iodine-129/Fish	Iodine-129/Fish
	General Purpose Cell	Neptunium-237/Fish	Strontium-90/Fish
	Liquid Waste Cell	Iodine-129/Fish	Carbon-14/Fish
	Fuel Receiving Storage Pad	Plutonium -239/Fish	Plutonium -239/Fish
Vitrification Facility – WMA 1		Neptunium-237/Fish	Strontium-90/Fish
Low-Level Waste Treatment Facility – WMA 2	Lagoon 1	Iodine-129/Fish	Strontium-90/Fish
	Lagoon 2	Strontium-90/Fish	Strontium-90/Fish
	Lagoon 3	Uranium-234/Fish	Uranium-234/Fish
	Lagoon 4	Uranium-234/Fish	Uranium-234/Fish
	Lagoon 5	Uranium-234/Fish	Uranium-234/Fish
Waste Tank Farm – WMA 3	8D-1	Iodine-129/Fish	Strontium-90/Fish
	8D-2	N/A	Strontium-90/Fish
	(8D-2g) [b]	Iodine-129/Fish	N/A
	(8D-2r) [b]	Neptunium-237/Fish	N/A
	8D-3	Uranium-233/Fish	Strontium-90/Fish
	8D-4	Iodine-129/Fish	Strontium-90/Fish
NDA – WMA 7 Horizontal	Process	Uranium-233/Fish	Uranium-233/Fish
	Hulls	Carbon-14/Fish	Carbon-14/Fish
	WVDP	Uranium-233/Fish	Uranium-233/Fish
NDA – WMA 7 Vertical/Horizontal	Process	Uranium-233/Fish	Uranium-233/Fish
	Hulls	Carbon-14/Fish	Carbon-14/Fish
	WVDP	Uranium-233/Fish	Uranium-233/Fish
SDA – WMA 8	Horizontal	Carbon-14/Fish	Carbon-14/Fish
	Vertical/Horizontal	Uranium-234/Fish	Uranium-234/Fish
North Plateau Groundwater Plume		Strontium-90/Fish	Strontium-90/Fish

N/A = not applicable, NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area, WVDP = West Valley Demonstration Project.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] 8D-2g and 8D-2r are the grid (lower) and ring (upper) contaminated portions of Tank 8D-2.

Excess Lifetime Cancer Risk

A complementary measure is the peak lifetime risk to the Seneca Nation of Indians receptor from radiological discharges. **Table H–59** shows how this risk would be apportioned between different WMAs and what it would be for the entire WNYNSC for each alternative. The lifetime radiological cancer risk to the postulated Seneca Nation of Indians receptor is similar to, sometimes slightly higher than, the risk to the Cattaraugus Creek receptor as presented in Table H–52. The higher risk is the result of the postulated higher fish consumption. The radiological risk for the No Action Alternative is dominated by the high-level waste tanks.

Table H–59 Peak Lifetime Radiological Risk (risk of cancer morbidity) for the Seneca Nation of Indians Receptor (year of peak risk in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	1.24×10^{-6} (200)	1.08×10^{-5} (200) [b]
Vitrification Facility – WMA 1	5.68×10^{-10} (1,000)	3.00×10^{-6} (200) [b]
Low-Level Waste Treatment Facility – WMA 2	1.14×10^{-8} (100)	5.22×10^{-7} (100)
Waste Tank Farm – WMA 3	6.28×10^{-8} (300)	4.27×10^{-5} (200) [b]
NDA – WMA 7 [c]	7.15×10^{-7} (8,800)	7.15×10^{-7} (8,800)
SDA – WMA 8 [c]	8.09×10^{-6} (37,300)	8.09×10^{-6} (37,300)
North Plateau Groundwater Plume [c]	1.56×10^{-5} (34)	1.56×10^{-5} (34)
Total	1.56×10^{-5} (34)	5.72×10^{-5} (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Hazardous Chemical Risk

Tables H–48 through H–50 and Figure H–15 show that the lifetime cancer risk from hazardous chemicals, the Hazard Index, and the ratio of concentration in water to the MCL for the Cattaraugus Creek receptor differ by only about 20 percent whether or not institutional controls are lost. The same conclusion holds for the Seneca Nation of Indians receptor.

Lake Erie/Niagara River Water Users

This section discusses population dose, and individual exposures to radioactive materials and chemicals.

Population Dose

In addition to the Cattaraugus Creek and Seneca Nation of Indians individuals, peak annual and time-integrated population dose estimates have been prepared. These are summarized in **Tables H–60** and **H–61**, respectively. Lake Erie water users consume water taken from Sturgeon Point and Niagara River users consume water from several structures in the eastern channel of the Niagara River. They are assumed to drink water from Lake Erie or the Niagara River, to eat fish from Lake Erie, and (conservatively) to all be resident farmers.

As described previously, most of the population dose shown in Table H–60 would be received by the users of water from Sturgeon Point intake which would see higher radionuclide concentrations than the intake structures on the Niagara River. The estimated annual dose from ubiquitous background and other sources of radiation (NCRP 2009) for this group (565,000 people) would be approximately 350,000 person-rem. The peak annual dose for the Sitewide Close-In-Place Alternative would be 95 person-rem for this postulated group of receptors, while the peak annual dose for the No Action Alternative would be 344 person-rem.

Table H–61 presents the time-integrated population dose over periods of 1,000 and 10,000 years. For the Sitewide Close-In-Place Alternative, the total population dose accumulated over 10,000 years would be (34,000 person-rem).

For the No Action Alternative, the total population dose to Sturgeon Point water users over 10,000 years would be 120,000 person-rem. The radiation dose accumulated by Sturgeon Point users in one year from ubiquitous background and other sources (NCRP 2009) not related to the WNYNSC would be 350,000 person-rem.

Table H–60 Peak Annual Total Effective Population Dose Equivalent in person-rem per year for Lake Erie/Niagara River Water Users (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	1.0 (200)	36 (200) [b]
Vitrification Facility – WMA 1	0.0030 (1,000)	20 (200) [b]
Low-Level Waste Treatment Facility – WMA 2	0.038 (100)	2.7 (100)
Waste Tank Farm – WMA 3	0.41 (300)	287 (200) [b]
NDA – WMA 7 [c]	1.2 (30,100)	1.2 (30,100)
SDA – WMA 8 [c]	18 (37,300)	18 (37,300)
North Plateau Groundwater Plume [c]	95 (34)	95 (34)
Total	95 (34) [d]	344 (200) [e]

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely. The doses from these units would be minimal as long as these engineered systems function as originally designed.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

[d] This total dose of 95 person-rem per year would be primarily accumulated by the 565,000 Sturgeon Point water users, giving a peak annual individual TEDE of approximately 0.2 millirem per year.

[e] This total dose of 344 person-rem per year would be primarily accumulated by the 565,000 Sturgeon Point water users, giving a peak annual individual TEDE of approximately 0.6 millirem per year.

Table H–61 Time-Integrated Total Effective Population Dose Equivalent for Lake Erie/Niagara River Water Users (person-rem over 1,000 and 10,000 years) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Integration Over 1,000 Years		
Main Plant Process Building – WMA 1	590	3,800 [b]
Vitrification Facility – WMA 1	2	2,000 [b]
Low-Level Waste Treatment Facility – WMA 2	13	340
Waste Tank Farm – WMA 3	130	31,000 [b]
NDA – WMA 7 [c]	150	150
SDA – WMA 8 [c]	710	710
North Plateau Groundwater Plume [c]	2,400	2,400
Total	4,000	40,000
Integration Over 10,000 Years		
Main Plant Process Building – WMA 1	940	41,000 [b]
Vitrification Facility – WMA 1	5	2,500 [b]
Low-Level Waste Treatment Facility – WMA 2	50	1,500
Waste Tank Farm – WMA 3	260	42,000 [b]
NDA – WMA 7 [c]	2,200	2,200
SDA – WMA 8 [c]	28,000	28,000
North Plateau Groundwater Plume [c]	2,500	2,500
Total	34,000	120,000

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Note: Totals may not add due to rounding.

Individual Exposure to Radioactive Material

Tables H–62 and **H–63** contain the predicted peak individual TEDEs from radioactive exposure for Sturgeon Point and Niagara River, respectively.

The total peak annual TEDE for the No Action Alternative in Table H–62 (Sturgeon Point) is about a factor of 4 lower than those for the Seneca Nation of Indians receptor, and a factor of 3 lower than those for the Cattaraugus Creek receptor. The total peak annual TEDEs in Table H–63 (Niagara River) are still lower by more than a further factor of 100.

Table H–62 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Sturgeon Point Receptor (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	0.0017 (200)	0.06 (200) [b]
Vitrification Facility – WMA 1	0.0000052 (1,000)	0.036 (200) [b]
Low-Level Waste Treatment Facility – WMA 2	0.000067 (100)	0.0047 (100)
Waste Tank Farm – WMA 3	0.00072 (300)	0.51 (200) [b]
NDA – WMA 7 [c]	0.002 (30,100)	0.0021 (30,100)
SDA – WMA 8 [c]	0.03 (37,300)	0.032 (37,300)
North Plateau Groundwater Plume [c]	0.17 (34)	0.17 (34)
Total	0.17 (34)	0.61 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Table H–63 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Niagara River Receptor (year of peak dose in parentheses) – Loss of Institutional Controls After 100 Years

Waste Management Areas [a]	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
Main Plant Process Building – WMA 1	6.27×10^{-6} (200)	0.000228 (200) [b]
Vitrification Facility – WMA 1	1.88×10^{-8} (1,000)	0.000129 (200) [b]
Low-Level Waste Treatment Facility – WMA 2	2.43×10^{-7} (100)	0.0000171 (100)
Waste Tank Farm – WMA 3	2.59×10^{-6} (300)	0.00183 (200) [b]
NDA – WMA 7 [c]	7.57×10^{-6} (30,200)	7.57×10^{-6} (30,200)
SDA – WMA 8 [c]	0.000115 (37,300)	0.000115 (37,300)
North Plateau Groundwater Plume [c]	0.000608 (34)	0.000608 (34)
Total	0.000608 (34)	0.00219 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

[a] For WMAs 1 through 3, the contributions to dose are presented for the key facilities that contain almost all of the radioactive materials in the WMA, while the NDA (WMA 7) and the SDA (WMA 8) are presented as entities in their own right. Other WMAs are not sources of radioactive materials.

[b] It is assumed that maintenance actions would keep engineered systems (geomembrane covers, drying systems, roofs, etc.) operational for 100 years, after which they would fail completely.

[c] North Plateau Groundwater Plume, NDA, and SDA interstitial velocity calculated from STOMP model outputs were the same for Close-In-Place and No Action Alternatives, therefore peaks are the same for both alternatives.

Hazardous Chemical Risk

For the Niagara River and Sturgeon Point users, the peak Hazard Index, the peak lifetime risk, and the ratios of the concentration in water to the MCLs are all smaller than for Cattaraugus Creek or the Seneca Nation of Indians receptor and are not discussed further here.

H.2.2.4 Loss of Institutional Controls Leading to Unmitigated Erosion

Erosion is recognized as a site phenomenon and so a conservative scenario of unmitigated erosion is analyzed to estimate the dose to various receptors. For the purposes of this analysis, unmitigated erosion is defined to mean that credit is not taken for the presence of erosion control structures or performance monitoring and maintenance of any kind. Predictions of unmitigated erosion for thousands of year into the future were developed with the help of a landscape evolution model that was calibrated to reproduce both historical erosion rates and current topography, starting from the topography estimated to exist after the last glacial recession. The development of the unmitigated erosion estimate is discussed in Appendix F. The chosen erosion scenario for the landscape evolution model corresponds to a case in which the site becomes partly forested and partly grassland.

The modeling below considers unmitigated erosion for only the Low-Level Waste Treatment Facility on the North Plateau and the SDA and NDA on the South Plateau. The landscape evolution model predicts very little erosion in the region of the Main Plant Process Building, Vitrification Facility, and Waste Tank Farm, and also predicts that the only places where any serious erosion would be expected in the foreseeable future would be in the vicinities of the Low-Level Waste Treatment Facility, SDA or NDA. In order to establish an upper bound on the potential impacts, the simplified single gully model described in Appendix G was used to estimate rate of soil loss for the Low-Level Waste Treatment Facility, NDA and SDA. The analysis was based on the size and configuration of a large gully predicted to develop at the north end of the North Plateau under conditions of elevated precipitation and reduced infiltration (see Section F.3.1.6.4 of Appendix F.) A more complete description of this gully is presented in Section H.2.2.

A spectrum of erosion-related receptors was examined: (a) three residents,[14] one on the west bank of Erdman Brook south of the Low-Level Waste Treatment Facility, one on the east bank of Franks Creek opposite the SDA and one on the west bank of Erdman Brook opposite the NDA, each of whom would be exposed to direct radiation from the eroded opposite bank and would spend some time hiking about the site; (b) a resident farmer along Buttermilk Creek; and (c) the same offsite receptors evaluated for the case of continuation of institutional controls (Section 4.1.10.3.1 – Cattaraugus Creek, Seneca Nation of Indians, and Lake Erie/Niagara River water users).

NDA/SDA Resident/Recreational Hiker

Table H–64 presents the peak annual TEDE for the resident/recreational hiker for the Low-Level Waste Treatment Facility, NDA and SDA for each alternative if unmitigated erosion of the site were allowed to take place. The table also shows the years until peak annual dose. The assumptions governing the behavior and exposure of the recreational hiker are given in Table H–5. Exposure modes as a hiker include inadvertent ingestion of soil, inhalation of fugitive dust, and exposure to direct radiation. This receptor does not ingest radionuclides through food and water pathways.

The projected results are quite similar for the Sitewide Close-In-Place and the No Action Alternatives. Because of conservative assumptions in the unmitigated erosion model, the engineered cap only slightly reduces the rate of erosion for the Sitewide Close-In-Place Alternative. No credit is taken for stream erosion controls and no credit is taken for the erosion resistance of the rock along the side of the engineered cap. Additional detail on the unmitigated erosion release model is provided in Appendix G.

[14] The onsite resident differs from the onsite resident farmer in that the former has no garden and does not drink contaminated water. See Figure H–3 for the locations of these three receptors.

Table H–64 Peak Annual Total Effective Dose Equivalent in Millirem Per Year to a Resident/Recreational Hiker on the Low-Level Waste Treatment Facility, NDA and SDA (year of peak exposure in parentheses) – Unmitigated Erosion

Waste Management Areas	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
NDA – WMA 7	34 (200)	70 (160)
SDA – WMA 8	29 (190)	40 (160)
Low-Level Waste Treatment Facility – WMA 2	11 (180)	28 (140)
Total	68 (200)	129 (160)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

Buttermilk Creek Resident Farmer

Table H–65 presents the peak annual TEDE from the eroded Low-Level Waste Treatment Facility, NDA and SDA for the Buttermilk Creek resident farmer for the unmitigated erosion scenario. See Section H.1.3.1 for a discussion of the location of the Buttermilk Creek resident farmer. The table also shows the years until peak annual dose. For comparison, the predicted annual TEDEs for the case of loss of institutional controls without unmitigated erosion are 3.9 millirem per year for the Sitewide Close-In-Place Alternative and 14 millirem per year for the No Action Alternative, see Table H–45.

Table H–65 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Buttermilk Creek Resident Farmer (year of peak exposure in parentheses) – Unmitigated Erosion

Waste Management Areas	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
NDA – WMA 7	12 (490)	84 (200)
SDA – WMA 8	5 (420)	26 (160)
Low-Level Waste Treatment Facility – WMA 2	6 (200)	12 (170)
Total	16 (860)	115 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

Cattaraugus Creek Receptor

Table H–66 presents the peak annual TEDE from the Low-Level Waste Treatment Facility, NDA and SDA for the Cattaraugus Creek resident farmer for the unmitigated erosion scenario. For comparison, the peak annual TEDEs to the Cattaraugus Creek receptor for the case of loss of institutional controls without unmitigated erosion are 0.51 millirem per year for the Sitewide Close-In-Place Alternative and 1.9 millirem per year for the No Action Alternative, see Table H–49.

Table H–66 Peak Annual Total Effective Dose Equivalent in Millirem Per Year for the Cattaraugus Creek Receptor (year of peak exposure in parentheses) – Unmitigated Erosion

Waste Management Areas	*Sitewide Close-In-Place Alternative*	*No Action Alternative*
NDA – WMA 7	1.5 (490)	11 (200)
SDA – WMA 8	0.68 (420)	3.4 (160)
Low-Level Waste Treatment Facility – WMA 2	0.74 (200)	1.6 (170)
Total	2.1 (860)	15 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

The doses to the Cattaraugus Creek receptor, if unmitigated erosion were allowed to progress at WNYNSC, show a similar pattern to that seen for the Buttermilk Creek intruder, but the doses would be generally lower by a factor of about 8 to 10.

An illustration of how the peak annual dose to the Cattaraugus Creek receptor would vary as a function of time for the Sitewide Close-In-Place Alternative is presented in **Figure H–18**. The variation for the No Action Alternative is almost identical. The variations for the Buttermilk Creek farmer (above) and the Seneca Nation of Indians receptor (below) have the same shape, although the peaks are not of the same magnitude.

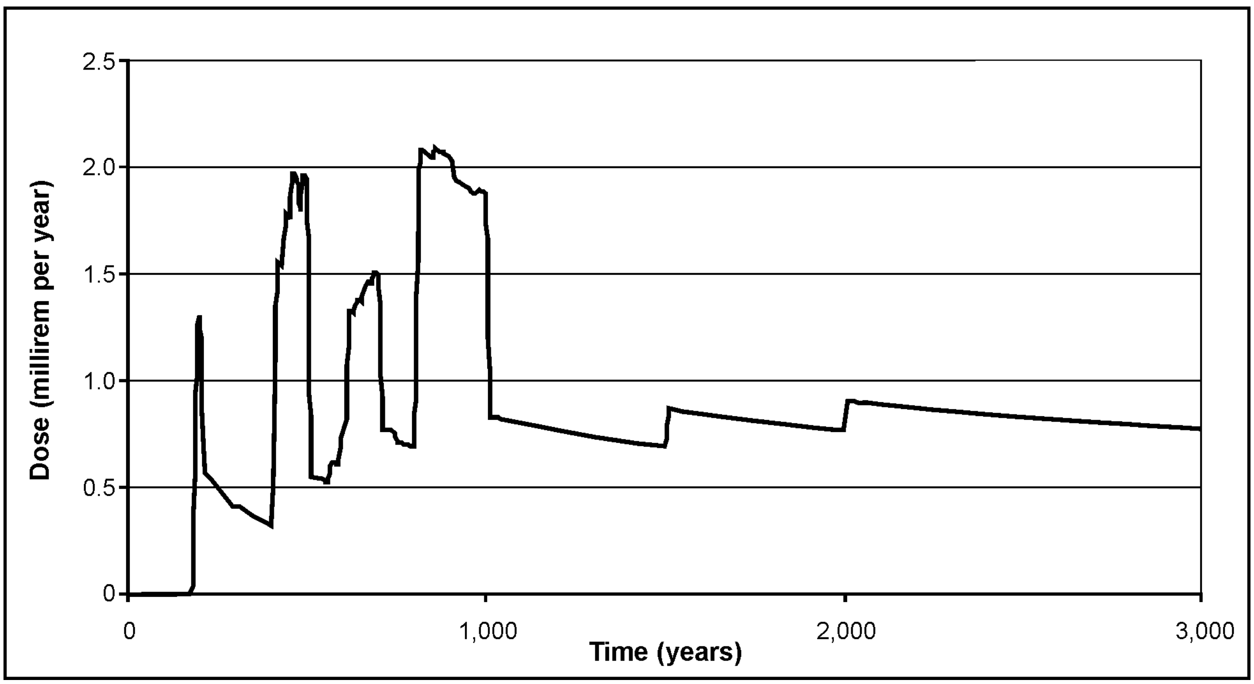

Figure H–18 Annual Total Effective Dose Equivalent (millirem per year) for the Cattaraugus Creek Receptor as a Function of Time with the Sitewide Close-In-Place Alternative and Unmitigated Erosion

Seneca Nation of Indians Receptor

A Seneca Nation of Indian receptor is postulated to use Cattaraugus Creek near Gowanda for drinking water and is also postulated to consume large quantities of fish living and/or stocked in these waters. The peak annual dose for this receptor is presented in **Table H–67**.

The doses to the Seneca Nation of Indians receptor, in the event of unmitigated erosion at WNYNSC, show a similar pattern to those seen for the Cattaraugus Creek receptor, but the numerical values of the total doses would be higher by a factor of about 2 as a result of the higher assumed fish consumption. For comparison, the peak annual TEDEs to the Seneca Nation of Indians receptor for the case of loss of institutional controls without unmitigated erosion are 0.68 millirem per year for the Sitewide Close-In-Place Alternative and 2.5 millirem per year for the No Action Alternative, see Table H–56.

Table H–67 Peak Annual Total Effective Dose Equivalent in Millirem Per Year to the Seneca Nation of Indians Receptor (year of peak exposure in parentheses) – Unmitigated Erosion

	-	***No Action Alternative***
NDA – WMA 7	4 (490)	26 (200)
SDA – WMA 8	1 (420)	7 (160)
Low-Level Waste Treatment Facility – WMA 2	2 (200)	3 (170)
Total	4 (490)	34 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WMA = Waste Management Area.

Lake Erie/Niagara Water Users

In addition to the Cattaraugus Creek and Seneca Nation of Indians individuals, peak annual and time-integrated population dose estimates have been prepared for the unmitigated erosion release scenario. These are summarized in **Tables H–68** and **H–69** respectively.

Table H–68 Peak Annual Total Effective Dose Equivalent Population Dose in Person-Rem per year to the Lake Erie/Niagara Water Users (year of peak exposure in parentheses) – Unmitigated Erosion

	-	***No Action Alternative***
Unmitigated Erosion	240 (860) [a, b]	1,500 (200) [a, b]

[a] These population doses would be mostly accumulated by the 565,000 Lake Erie (Sturgeon Point) water users, corresponding to peak annual individual TEDEs of about 0.4 millirem per year (Sitewide Close-In-Place Alternative) and 2.7 millirem per year (No Action Alternative).
[b] For comparison, the peak population dose without unmitigated erosion would be 95 and 344 person-rem for the Sitewide Close-In-Place and No Action Alternatives, respectively (see Table H–60).

Table H–69 Time-integrated Total Effective Population Dose Equivalent in Person-Rem to the Lake Erie Water Users – Unmitigated Erosion

	-	***No Action Alternative***
Integration over 1,000 years	170,000 [a]	450,000 [b]
Integration over 10,000 years	1,000,000 [a]	1,400,000 [b]

[a] For comparison, the time-integrated doses without unmitigated erosion would be approximately 4,000 and approximately 34,000 person-rem (see Table H–61).
[b] For comparison, the time-integrated doses in without unmitigated erosion would be approximately 40,000 and approximately 120,000 person-rem (see Table H–61).

As described previously, most of this population dose would be received by the estimated 565,000 receptors postulated to use water from the Sturgeon Point intake. Using an average dose rate from ubiquitous background and other sources of radiation (NCRP 2009) of 620 millirem per year, the annual population dose for this community would be approximately 350,000 person-rem. The peak annual population dose for the

Sitewide Close-In-Place Alternative and the No Action Alternative would be about 240 person-rem per year and 1,500 person-rem per year, respectively.

Additional perspective is provided by the cumulative population dose to 1,000 and 10,000 years. For comparison, the background population dose accumulated by the postulated Sturgeon Point water users would be approximately 200 million person rem over 1,000 years and 2 billion person rem over 10,000 years. The additional population doses accumulated from WNYNSC would be relatively small.

As was the case for the indefinite continuation of institutional controls (see the discussion following Table H–38), the individual dose for Sturgeon Point users is approximately equal to the total population dose for all users divided by the number of Sturgeon Point users – in this case 236/565,000 = 0.00042 person-rem and 1,486/565,000 = 0.00263 person-rem for the Sitewide Close-In-Place and the No Action Alternative, respectively.

Conclusions for Loss of Institutional Controls Leading to Unmitigated Erosion

The results for uncontrolled erosion of the SDA, NDA and Low-Level Waste Treatment Facility for the Sitewide Close-In-Place Alternative show TEDEs of up to about 68 millirem per year for the resident hiker, 16 millirem per year for the Buttermilk Creek resident farmer, 2 millirem per year for the Cattaraugus Creek receptor, and 4 millirem per year for the Seneca Nation of Indians receptor. For the two offsite receptors, these represent an increase by a factor of about 200 over the case without unmitigated erosion. The corresponding results for the No Action Alternative are 129, 115, 15, and 34 millirem per year, respectively – higher than those for the Sitewide Close-In-Place Alternative, as expected.

Integrated Groundwater/Erosion Model

In the foregoing, groundwater releases and erosion releases (i.e., particulate matter washed into rivers and streams) are modeled separately. At the present time, integrated models of groundwater releases and erosion releases are beyond the state-of-the art. This question of the effect of erosion on the performance of hydrologic barriers is addressed in sensitivity studies in the following section. However, peak annual dose impacts to offsite receptors are about 4-6 times greater in the unmitigated erosion scenarios than they are in the groundwater release scenarios for the Sitewide Close-In-Place Alternative, but erosion peaks occur later. In this case, one would not expect much difference in the results of an integrated model. For the No Action Alternative, the dose to offsite receptors from the erosion scenarios range from about 8-14 times the groundwater release scenarios, and the peaks occur in comparable timeframes but from different waste management areas. In this particular case, one might expect an integrated model to predict doses that are additive of the two individual results.

H.2.3 Some Observations on the Phased Decisionmaking Alternative

As previously discussed, it is not possible to do a long-term performance assessment for the Preferred Alternative, because the ultimate disposition of various areas of the site is not known. However, some general observations are possible.

Main Plant Process Building and Vitrification Facility – Waste Management Area 1

The plume source volume for the Main Plant Process Building and the Vitrification Facility would be completely removed. These actions most closely resemble those expected for these facilities under the Sitewide Removal alternative. Therefore, residual contamination from these two structures would contribute negligibly to potential health impacts under any final disposition of the site.

Low-Level Waste Treatment Facility and Lagoons – Waste Management Area 2

All facilities in WMA 2 would be removed except the permeable treatment wall, which would be periodically replaced. The removal actions would reduce the inventory of radioactive materials and hazardous chemicals and residual contamination in this area, with the exception of the north plateau plume which is discussed below, would contribute negligibly to potential health impacts under any final disposition of the site.

Waste Tank Farm – Waste Management Area 3

The underground tanks of the Waste Tank Farm would be isolated with residual contamination in a dry form at the start of decommissioning and this configuration is expected to be maintained during the Phase 2 actions. Releases are not reasonably foreseeable in the short term and longer term consequences from the Waste Tank Farm will depend on the Phase 2 decision for the WMA. If the Waste Tank Farm is closed in place the long-term impacts would be the same as Waste Tank Farm under the Sitewide Close-In-Place Alternative. If the Waste Tank Farm is removed, the long-term impacts would be small and consistent with those for the Sitewide Removal Alternative.

NDA – Waste Management Area 7

During Phase 1, the NDA would continue as at present, under monitoring and/or active management. For the immediate future, contamination would slowly migrate from this area consistent with the No Action Alternative, but there would be no offsite consequences in the short term. Over the longer term, consequences will depend on Phase 2 actions. If the NDA is closed in place, the long-term impacts for the NDA would be the same as under the Sitewide Close-In-Place Alternative. If the NDA is removed, the long-term impacts would be small and consistent with those for the Sitewide Removal Alternative

SDA – Waste Management Area 8

During Phase 1, the SDA could continue as at present, under monitoring and/or active management. For the immediate future, contamination would slowly migrate from this area consistent with the No Action Alternative, but there would be no offsite consequences in the short term. Over the longer term, consequences will depend on the future Phase 2 actions. If no further action is taken (i.e., the area remains under monitoring and/or active management) long-term consequences would be the same as those for the No Action Alternative. If the SDA is closed in place, the long-term impacts for the SDA would be the same as under the Sitewide Close-In-Place Alternative. If the SDA is removed, the long-term impacts would be small and consistent with those for the Sitewide Removal Alternative.

North Plateau Groundwater Plume

The source area of the North Plateau Groundwater Plume would be removed as in the Sitewide Removal Alternative. The offsite consequences from the migration of the non-source area of the North Plateau Groundwater Plume are that there will be a peak in the annual dose to offsite receptors around the year 2045. The dose will be on the order of 0.7 millirem per year for receptors along Cattaraugus Creek and less than 0.2 millirem per year to Sturgeon Point water users (see the results for the Sitewide Close-In-Place and No Action Alternatives). These peak annual doses would not be impacted by Phase 2 actions.

Conclusion – Phased Decisionmaking Alternative

The Phase 1 removal actions for the Main Plant Process Building, the Vitrification Facility, and lagoons would result in minimal long-term impact from residual contamination in these areas. The impacts from the North Plateau Groundwater Plume would peak around the year 2045 and are not sensitive to Phase 2 decisions. Long-term impacts from the Waste Tank Farm, the NDA, and the SDA depend on the Phase 2 actions. Long-term impacts for the Waste Tank Farm and the NDA are expected to be bounded by results already calculated for the Sitewide Removal and Sitewide Close-In-Place Alternatives. Long-term impacts for the SDA are expected to be bounded by results already calculated in the Sitewide Removal, Sitewide Close-In-Place, and the No Action Alternatives.

H.3 Sensitivity Analysis

Estimation of human health impacts depends in a complex manner on geologic and environmental conditions, facility closure designs, the structure of models used to represent these conditions and features and the values of parameters used in the models to characterize the conditions and features. These conditions and features may not be well known or have variability over space and time that contributes to uncertainty in estimates of health impacts. In this section, deterministic sensitivity analysis is used to provide insight into the potential range of uncertainty in estimates of health impacts. Key conditions or parameters selected for sensitivity analysis include: amount of precipitation (wetter or dryer conditions), degree of degradation of engineered caps, ability to retain technetium in grout, the impact of erosion on engineered structures designed to limit release to groundwater transport pathways, and the degree of degradation of the slurry wall on the North Plateau. The sensitivity analysis cases use the Sitewide Close-In-Place Alternative as the primary example but provide information relevant to all EIS alternatives.

H.3.1 Amount of Precipitation

Water reaching the ground surface as precipitation enters into estimation of human health impacts for both groundwater and erosion release scenarios. Precipitation infiltrating the ground surface influences rate of groundwater movement while run-off produced by precipitation influences rate of erosion. Rate of flow of creeks affects concentration of contaminants in the creek due to a given release and thereby influences estimates of health impacts. Available data characterizing the variability include annual rate of precipitation at Jamestown, NY reported by the National Climatic Data Center (DOC 2008) for 28 years between calendar years 1979 and 2006 and annual average flow of Cattaraugus Creek at Gowanda, NY reported by the U.S. Geological Survey (USGS 2008) for 64 years between calendar years 1941 and 2006. Annual precipitation varied between 0.89 and 1.41 meters with an average of 1.13 meters. Ten percent of years had precipitation greater than 1.23 meters while ten percent of years had precipitation less than 0.98 meters. A similar range of moderate variability is found in the flow rate data for Cattaraugus Creek. Ten percent of years had annual flow less than 16.5 meters per second while ten per cent of years had annual flow greater than 26.3 meters per second with an annual average of 21.2 meters per second. The minimum and the maximum annual flows for the period of record were 15.1 and 29.2 meters per second, respectively.

Three-dimensional near-field groundwater flow models for both the North and South Plateaus for the Sitewide Close-In-Place Alternative are described in Appendix E of the EIS. Features of these models relevant for evaluation of the importance of variability of precipitation are presence of a slurry wall on the North Plateau that limits flow through the system and the low rate of infiltration predicted for the South Plateau due to low hydraulic conductivity of geohydrologic units in that location. For the North Plateau, infiltration capacity is a fraction of the lowest value of annual precipitation reported in the period of record, so a decrease in annual average precipitation would not be expected to significantly reduce groundwater flow under conditions other than a dramatic shift in local climate to arid conditions. Because the rate of groundwater flow on the North Plateau is largely controlled by topography and the water table is within two meters of the ground surface under average annual precipitation conditions, increases in annual average precipitation would be expected to affect evapotranspiration and run-off rather than groundwater flow. A similar situation would occur on the South Plateau where recharge is a small percentage of the lowest rate of precipitation reported for the period of record. For erosion scenarios, variation in the rate of precipitation is implicitly incorporated into calibration of the landscape evolution model over a long period of time.

For the health impact models used in the EIS, variation in annual rate of flow of creeks produces an inverse but proportionate variation in estimate of impact. This behavior applies for both groundwater and erosion release scenarios. Because average rate of surface water flow is used in the analysis and only ten percent of annual flows have magnitude more than twenty-five percent below the annual average flow, the estimates of impacts would be more that twenty-five percent higher than that reported for average conditions for only ten percent of years.

H.3.2 Degree of Degradation of Engineered Caps

For the Sitewide Close-In-Place Alternative, the Main Plant Process Building, the Low-Level Waste Treatment Facility, the Waste Tank Farm, the NDA and the SDA are located under engineered caps. The primary design features limiting infiltration of each cap are a gravel drainage layer and an underlying layer of clay. Additional layers that are not considered in the EIS infiltration model are geotextiles and soil that function to protect and support the major functional layers. More detailed description of the engineered caps is presented in Appendix C of the EIS. With respect to control of infiltration, the EIS model simulates diversion of water through the drainage layer and impedance of downward flow of water through the clay layer. The design values of hydraulic conductivity for the drainage and clay layers are 3.0 and 5×10^{-9} centimeters per second, respectively. The response of rate of infiltration through the cap to variation in these principal parameters was simulated using a two-dimensional representation implemented with the Subsurface Over Multiple Phases (STOMP) computer code. Results of this analysis are presented in **Table H–70**. As would be expected, the rate of infiltration increases in proportion to increase in hydraulic conductivity of the clay layer but increases in a non-linear manner as hydraulic conductivity of the drainage layer decreases.

Table H–70 Dependence of Infiltration through an Engineered Cap on Values of Hydraulic Parameters

Hydraulic Conductivity of the Drainage Layer (centimeters per second)	*Infiltration Rate (centimeters per year)*		
	Hydraulic Conductivity of the Clay Layer (centimeters per second)		
	5×10^{-9}	5×10^{-8}	5×10^{-7}
3.0	0.015	0.15	1.44
0.03	0.11	1.12	10.3
0.003	0.31	3.02	24.6

Note: To convert centimeters to inches, multiply by 0.3937

For the rubble pile, Liquid Waste Cell, Fuel Receiving and Storage Pool, and General Purpose Cell of the Main Plant Process Building and the Vitrification Cell, the rate of movement through the contaminated material is controlled by the rate of infiltration through the cap and estimates of health impacts would increase in proportion to this rate of infiltration. For the Waste Tank Farm, the rate of downward movement through the tanks is determined by the rate of downward movement through the unweathered Lavery till and would not increase in response to increase in infiltration through the cap. Thus, a minor dependence of estimate of dose on amount of precipitation is expected at the Waste Tank Farm.

H.3.3 Retention of Technetium

Analysis of base cases for groundwater release scenarios for tanks 8D-1 and 8D-2 of the Waste Tank Farm identified technetium-99 as a major contributor to human health impacts. Grouts designed for stabilization of the tanks include fly ash material that is expected to reduce the valence state of technetium producing a precipitate with low solubility as well as sorbents designed to retain radionuclides by physical and chemical bonding. The EIS release models do not simulate solubility release but relate rate of release to degree of partitioning between the liquid and solid phases of the waste form. For technetium, a conservative value of 1.0 milliliters per gram, consistent with retention on a natural clay material (Sheppard and Thibault 1990), has been adopted as the value of distribution coefficient for the base case. A plausible lower bound value of distribution coefficient for technetium in the waste form is the value of 0.1 milliliters per gram reported for sand in natural deposits (Sheppard and Thibault 1990). A plausible higher value is that recommended for surface soil in analysis of decommissioning scenarios, 7.4 milliliters per gram (Beyeler et al. 1999). Estimates of impact for a resident farmer receptor for releases from Tank 8D-1 are presented in **Table H–71**. The results show a strong dependence on the value of distribution coefficient for technetium. For the lower values of distribution coefficient of technetium, technetium-99 is the radionuclide dominating dose and the year of peak impact occurs within approximately 100 years. For the higher value of technetium distribution coefficient, isotopes of uranium dominate impacts, impacts occur in the distant future and peak dose due to technetium-99 peak is approximately 25 millirem per year after approximately 170 years.

Table H–71 Dependence of Onsite Resident Farmer Peak Annual Dose on the Value of Technetium Distribution Coefficient for Groundwater Release from Tank 8D-1

Distribution Coefficient of Technetium in Grout (milliliters per gram)	*Peak Annual Dose (millirem per year)*			*Years to Peak Dose*
	Drinking Water	*Garden*	*Total*	
0.1	609	274	883	28
1.0	78	145	223	116
7.4	104	10	114	1,200

H.3.4 Erosion Damage of Groundwater Flow Barriers

The near-field groundwater flow models described in Appendix E are used as a basis for estimation of human health impacts for groundwater release scenarios. In these analyses, the engineered barriers are assumed to degrade due to natural processes, such as, clogging of gravel in drainage layers and dessication of clay in slurry walls but to remain unaffected by erosion processes. The potential influence of erosion damage on estimates of dose is considered in this section through introduction of segments of elevated hydraulic conductivity in the upgradient slurry wall of the Sitewide Close-In-Place Alternative. In the two cases considered, separate twenty-meter high hydraulic conductivity segments of the slurry wall were placed in the vicinity of the Waste Tank Farm and the General Purpose Call of the Main Plant Process Building.

In the first case, damage to the slurry wall in the vicinity of the Waste Tank Farm, Tank 8D-1 was selected as the example case and the near-field flow model predicts increased rate of flow into the tank excavation, increased horizontal flow through the tank but limited increase of vertical flow through the tank itself. Results of the flow analysis are summarized in **Table H–72** while results of the dose analysis for a resident farmer receptor located on the North Plateau 100 meters downgradient of the tank are presented in **Table H–73**. Estimates of dose were developed for both horizontal and vertical flow through the tank and the contribution of the horizontal flow was a small fraction of the contribution from vertical flow. The results indicate that damage to the slurry wall would increase impacts due to sources at the Waste Tank Farm, but that this increase would be less than a factor of 2.

Table H–72 Summary of Flow Conditions for Waste Tank Farm Slurry Wall Sensitivity Analysis

Condition	*Case*	
	No Erosion Damage to Slurry Wall	***Erosion Damage to Slurry Wall***
Rate of Groundwater flow into the Excavation (cubic meters per year)	963	1,622
Interstitial Velocity (meters per year)		
Vertical	0.132	0.137
Horizontal	0	0.153

Note: To convert cubic meters to cubic feet, multiply by 35.314; meters to feet, multiply by 3.2808.

Table H–73 Summary of Peak Annual Dose Estimates for Waste Tank Farm Slurry Wall Sensitivity Analysis

Condition	*Peak Annual Dose (millirem per year)*	
	Drinking Water Pathway	***Garden Pathway***
No Erosion Damage to Slurry Wall	78	145
Erosion Damage to Slurry Wall	119	149

For the case of damage to the slurry wall in the vicinity of the General Purpose Cell, interstitial velocity through the cell into the underlying slack-water sequence increases from 0.158 meters per year for the base case to 0.566 meters per year. The estimate of dose for a resident farmer receptor located on the North Plateau downgradient of the Main Plant Process Building due to releases from the General Purpose Cell increases from 188 millirem per year at year 100 for the base case with a degraded slurry wall to 6,960 millirem per year at year 180 for the case of damage to the slurry wall. Thus, the results indicate that local hydrologic conditions contribute to dependence of estimates of dose for below grade cells of the Main Plant Process Building on integrity of the slurry wall. Local damage to this hydraulic barrier could have a major impact on the amount of groundwater moving through the cells leading to the predicted strong sensitivity of the estimate of dose. Should the Sitewide Close-In-Place Alternative be chosen, it would be appropriate to consider the implications of this finding when designing groundwater flow barriers.

H.3.5 Degree of Degradation of Slurry Walls

For the Sitewide Close-In-Place Alternative, slurry walls are used on both the North and South Plateaus to limit the amount of groundwater reaching sub-surface waste. Because of greater offset in value of hydraulic conductivity between the slurry wall and the surrounding natural materials on the North Plateau than on the South Plateau, the slurry wall is more important to reduction of dose for facilities on the North Plateau. The closure design for the Main Plant Process Building and Waste Tank Farm on the North Plateau includes a circumferential slurry wall and additional slurry walls up- and downgradient of the circumferential slurry wall. The near-field flow model for the North Plateau includes only the upgradient slurry wall and analysis presented in this section investigates the sensitivity of estimates of dose for the General Purpose Cell of the Main Plant Process Building to variation in the value of hydraulic conductivity of this slurry wall.

For the base case for this EIS, the value of the hydraulic conductivity of the slurry wall for the long-term period is taken as 1×10^{-6} centimeters per second, two orders of magnitude greater than the design value of 1×10^{-8} centimeters per second. For comparison purposes, the average value of hydraulic conductivity of the thick-bedded unit intersected by the slurry wall is 2.5×10^{-3} centimeters per second. For this sensitivity analysis, the hydraulic conductivity of the slurry wall is increased by one order of magnitude in a first case and by an additional order of magnitude in a second case.

The analysis proceeds in two steps: the three-dimensional near-field groundwater model is used to establish the distribution of hydraulic head and groundwater flow velocities in the first step while the integrated dose model uses the results of the first step to estimate human health impacts in the second step. Because data are not available to calibrate conditions for the first step, infiltration rates upgradient of the slurry wall are iteratively varied to produce a water table near the ground surface at the slurry wall. For the base and sensitivity cases, total infiltration immediately upgradient of the slurry wall and the flow balance around the General Purpose Cell are summarized in **Tables H–74** and **H–75**, respectively. Doses estimated for the base, first sensitivity and second sensitivity cases are 220, 285 and 11,090 millirem per year, respectively. The large difference in estimate of dose is related to a change in flow regime indicated in the flow estimates presented in Tables H–70 and H–71. The General Purpose Cell extends from the ground surface downward toward the underlying Slack-water Sequence and with an effective slurry wall the primary flow is low and in the vertical direction. For the case of less than a two order of magnitude difference in hydraulic conductivity between the slurry wall and thick-bedded unit, the flow direction transitions to horizontal and flow rate approaches the value estimated for the location in the absence of the slurry wall.

Table H–74 Predicted Conditions for the North Plateau Three-dimensional Near-field Groundwater Flow Model, Slurry Wall Sensitivity Analysis

Case	*Hydraulic Conductivity of the Slurry Wall (centimeters per second)*	*Rate of Infiltration Upgradient of the Slurry Wall*		*Average Linear Velocity in the Slack-water Sequence (meters per year)*
		Volumetric (cubic meters per year)	*Flux (centimeters per year)*	
Base	1×10^{-6}	3,314	0.07	97
First Sensitivity	1×10^{-5}	4,059	0.09	103
Second Sensitivity	1×10^{-4}	10,537	0.22	131

Note: To convert centimeters to inches, multiply by 0.3937; cubic meters to cubic feet, multiply by 35.314; meters to feet, multiply by 3.2808.

Table H–75 Flow Balance for the General Purpose Cell, Slurry Wall Sensitivity Analysis

Direction	*Volumetric Flow Rate (cubic meters per year)*		
	Base Case	*First Sensitivity Case*	*Second Sensitivity Case*
Inflow			
Top	5.933	5.933	5.933
South	8.539	14.032	215.88
East	0.017	0.017	59.153
Outflow			
Bottom	14.246	19.691	24.615
North	0.235	0.283	255.03
West	0.007	0.007	1.355

Note: To convert cubic meters to cubic feet, multiply by 35.314.

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