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January 2010

Final Environmental Impact Statement for

Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center


The West Valley Site

Volume 2

(Appendices A through R)

Availability of the Final EIS for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center

For further information on this Final EIS, or to request a copy of the EIS or references, please contact:

Catherine Bohan, EIS Document Manager
West Valley Demonstration Project
U.S. Department of Energy
Ashford Office Complex
9030 Route 219
West Valley, NY 14171
Telephone: 716-942-4159
Fax: 716-942-4703
E-mail: catherine.m.bohan@wv.doe.gov

Printed with soy ink on recycled paper

COVER SHEET

Co-Lead Agencies: U.S. Department of Energy (DOE)
New York State Energy Research and Development Authority (NYSERDA)

Cooperating Agencies: U.S. Nuclear Regulatory Commission (NRC)
U.S. Environmental Protection Agency (EPA)
New York State Department of Environmental Conservation (NYSDEC)

Involved Agencies: New York State Department of Health (NYSDOH)
New York State Department of Environmental Conservation (NYSDEC)

Title: *Final Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (DOE/EIS-0226)

Location: Western New York Nuclear Service Center, 10282 Rock Springs Road, West Valley, New York 14171-0191 (Erie and Cattaraugus Counties)

For additional information on this Final Environmental Impact Statement (EIS) or for references, contact:

Catherine Bohan, EIS Document Manager
West Valley Demonstration Project
U.S. Department of Energy
Ashford Office Complex
9030 Route 219
West Valley, NY 14171
Telephone: 716-942-4159
Fax: 716-942-4703
E-mail: catherine.m.bohan@wv.doe.gov

For general information on the DOE National Environmental Policy Act (NEPA) process, contact:

Carol M. Borgstrom, Director
Office of NEPA Policy and Compliance
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0103
Telephone: 202-586-4600, or leave a message at 1-800-472-2756

For general questions and information about NYSERDA, contact:

Paul J. Bembia, Program Director
West Valley Site Management Program
New York State Energy Research and Development Authority
Ashford Office Complex
9030 Route 219
West Valley, NY 14171
Telephone: 716-942-9960 x4900
Fax: 716-942-9961
E-mail: pjb@nyserda.org

For general information on the State Environmental Quality Review Act (SEQR) process, contact:

David A. Munro, Deputy Counsel
New York State Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203
Telephone: 1-866-697-3732
Fax: 518-862-1091
E-mail: dam@nyserda.org

Abstract: The Western New York Nuclear Service Center (WNYNSC) is a 1,351-hectare (3,338-acre) site located 48 kilometers (30 miles) south of Buffalo, New York and owned by NYSERDA. In 1982, DOE assumed control but not ownership of the 68-hectare (167-acre) Project Premises portion of the site in order to conduct the West Valley Demonstration Project (WVDP), as required under the 1980 West Valley Demonstration Project Act. In 1990, DOE and NYSERDA entered into a supplemental agreement to prepare a joint EIS to address both the completion of WVDP and closure or long-term management of WNYNSC. A Draft EIS was issued for public comment in 1996: the *Draft Environmental Impact Statement for*

Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center, also referred to as the 1996 *Cleanup and Closure Draft EIS*, DOE/EIS-0226D, January 1996. The 1996 Draft EIS did not identify a preferred alternative.

Based on decommissioning criteria for WVDP issued by NRC since the publication of the 1996 *Cleanup and Closure Draft EIS* and public comments on that EIS, DOE and NYSERDA issued the *Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (also referred to as the *Decommissioning and/or Long-Term Stewardship EIS*) in December 2008, revising the 1996 Draft EIS. This *Decommissioning and/or Long-Term Stewardship EIS* has been prepared in accordance with NEPA and the State Environmental Quality Review Act (SEQR) to examine the potential environmental impacts of the range of reasonable alternatives to decommission and/or maintain long-term stewardship at WNYNSC. The alternatives analyzed in this EIS include the Sitewide Removal Alternative, the Sitewide Close-In-Place Alternative, the Phased Decisionmaking Alternative (Preferred Alternative), and the No Action Alternative. The analysis and information contained in this EIS are intended to assist DOE and NYSERDA with the consideration of environmental impacts prior to making decommissioning or long-term management decisions.

Phased Decisionmaking Alternative (Preferred Alternative): Under the Preferred Alternative, decommissioning would be accomplished in two phases: Phase 1 would include removal of all Waste Management Area (WMA) 1 facilities, the source area of the North Plateau Groundwater Plume, and the lagoons in WMA 2. Phase 1 activities would also include additional characterization of site contamination and scientific studies to facilitate consensus decisionmaking for the remaining facilities or areas. Phase 2 actions would complete decommissioning or long-term management decisionmaking according to the approach determined most appropriate during the additional Phase 1 evaluations. In general, the Phased Decisionmaking Alternative involves near-term decommissioning and removal actions where there is agency consensus and undertakes characterization work and studies that could facilitate future decisionmaking for the remaining facilities or areas. Phase 1 activities are expected to take 8 to 10 years to complete. The Phase 2 decision would be made no later than 10 years after issuance of the initial DOE Record of Decision and NYSERDA Findings Statement, if the Phased Decisionmaking Alternative is selected. In response to public comments, the Preferred Alternative has been modified since the Revised Draft EIS was issued.

Public Comments: In preparing this Final EIS, DOE considered comments received during the scoping period (March 13 through April 28, 2003) and public comment period on the Revised Draft EIS (December 5, 2008 through September 8, 2009). Public hearings on the Revised Draft EIS were held in Albany, Irving, West Valley, and Buffalo, New York during the public comment period. In addition, a videoconference with the DOE Assistant Secretary for Environmental Management, the President of NYSERDA, and various stakeholders was held on September 4, 2009. Comments on the Revised Draft EIS were requested during the 9-month period following publication of the U.S. Environmental Protection Agency's (EPA's) Notice of Availability in the *Federal Register*. All comments, including late comments and those presented during the September 4, 2009 videoconference, were considered during preparation of this Final EIS.

This Final EIS contains revisions and new information based in part on comments received on the 2008 Revised Draft EIS. Vertical change bars in the margins indicate the locations of these revisions and new information. Volume 3 contains the comments received during the public comment period on the Revised Draft EIS including late comments, and DOE's and NYSERDA's responses to the comments. DOE will use the analysis presented in this Final EIS, as well as other information, in preparing its Record(s) of Decision (RODs) regarding actions to complete WVDP. DOE will issue ROD(s) no sooner than 30 days after EPA publishes a Notice of Availability of this Final EIS in the *Federal Register*. NYSERDA will use the analysis presented in this Final EIS, as well as other information, in preparing its Findings Statement, which will be published in the *New York State Environmental Notice Bulletin* no sooner than 10 days after the Final EIS is issued.

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ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ALARA	as low as is reasonably achievable
AMCG	average member of the critical group
BEIR	Biological Effects of Ionizing Radiation
CDD	Chemical Dispersal Device
CDDL	Construction and Demolition Debris Landfill
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CMS	Corrective Measures Study
C-R-D	remote-handled Class C
DCGL	Derived Concentration Guideline Levels
DDE	deep-dose equivalent
DHS	U.S. Department of Homeland Security
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EDE	effective dose equivalent
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guideline
FEHM	Finite Element Heat and Mass Transfer Code
FEMA	Federal Emergency Management Agency
FR	*Federal Register*
GTCC	Greater-Than-Class C waste
HEPA	high-efficiency particulate air
HEC	Hydrologic Engineering Center
HIC	high-integrity container
HRU	hydrologic response unit
ICRP	International Commission on Radiological Protection
IDA	intentional destructive acts
IRIS	Integrated Risk Information System
ISCORS	Interagency Steering Committee on Radiation Standards
LCF	latent cancer fatality
LLW	low-level radioactive waste
MAR	material at risk
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	maximum contaminant level
MEI	maximally exposed individual
NAAQS	National Ambient Air Quality Standards
NDA	NRC-licensed Disposal Area
NEPA	National Environmental Policy Act
NFS	Nuclear Fuel Services, Inc.
NRC	U.S. Nuclear Regulatory Commission
NRF	National Response Framework

NRIA	Nuclear/Radiological Incident Annex
NTS	Nevada Test Site
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSERDA	New York State Energy Research and Development Authority
OSL	optically stimulated luminescence
PCB	polychlorinated biphenyl
PM	particulate matter
PMF	probable maximum flood
PVC	polyvinyl chloride
QRA	quantitative risk assessment
rad	radiation absorbed dose
RCRA	Resource Conservation and Recovery Act
RDD	Radiological Dispersal Device
rem	roentgen equivalent man
RH	remote-handled
RMSE	root-mean-square-error
ROD	Record of Decision
SDA	State-Licensed Disposal Area
SEQR	State Environmental Quality Review Act
SPDES	State Pollutant Discharge Elimination System
SSR	sum of the square of the residuals
STOMP	Subsurface Transport Over Multiple Phases
STS	Supernatant Treatment System
SWMU	Solid Waste Management Unit
TEDE	total effective dose equivalent
TRAGIS	Transportation Routing Analysis Geographic Information System
TRU	transuranic
U.S.C.	United States Code
USGS	U.S. Geological Survey
USLE	Universal Soil Loss Equation
WEPP	Waste Erosion Prediction Project
WIPP	Waste Isolation Pilot Plant
WMA	Waste Management Area
WNYNSC	Western New York Nuclear Service Center
WVDP	West Valley Demonstration Project
WVNS	West Valley Nuclear Services Company, Inc.
° C	degrees Celsius
° F	degrees Fahrenheit

CONVERSIONS

METRIC TO ENGLISH			ENGLISH TO METRIC		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area					
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Hectares	2.471	Acres	Acres	0.40469	Hectares
Concentration					
Kilograms/square meter	0.16667	Tons/acre	Tons/acre	0.5999	Kilograms/square meter
Milligrams/liter	1 [a]	Parts/million	Parts/million	1 [a]	Milligrams/liter
Micrograms/liter	1 [a]	Parts/billion	Parts/billion	1 [a]	Micrograms/liter
Micrograms/cubic meter	1 [a]	Parts/trillion	Parts/trillion	1 [a]	Micrograms/cubic meter
Density					
Grams/cubic centimeter	62.428	Pounds/cubic feet	Pounds/cubic feet	0.016018	Grams/cubic centimeter
Grams/cubic meter	0.0000624	Pounds/cubic feet	Pounds/cubic feet	16,025.6	Grams/cubic meter
Length					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
Temperature					
Absolute					
Degrees C + 17.78	1.8	Degrees F	Degrees F - 32	0.55556	Degrees C
Relative					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
Velocity/Rate					
Cubic meters/second	2118.9	Cubic feet/minute	Cubic feet/minute	0.00047195	Cubic meters/second
Grams/second	7.9366	Pounds/hour	Pounds/hour	0.126	Grams/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
Volume					
Liters	0.26418	Gallons	Gallons	3.78533	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.314	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1233.49	Cubic meters
Weight/Mass					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons
ENGLISH TO ENGLISH					
Acre-feet	325,850.7	Gallons	Gallons	0.000003046	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. This conversion is only valid for concentrations of contaminants (or other materials) in water.

METRIC PREFIXES

Prefix	Symbol	Multiplication factor
exa-	E	1,000,000,000,000,000,000 = 10^{18}
peta-	P	1,000,000,000,000,000 = 10^{15}
tera-	T	1,000,000,000,000 = 10^{12}
giga-	G	1,000,000,000 = 10^{9}
mega-	M	1,000,000 = 10^{6}
kilo-	k	1,000 = 10^{3}
deca-	D	10 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	µ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}

APPENDIX A
SUMMARY OF COMMENTS RECEIVED ON THE 1996 DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR COMPLETION OF THE WEST VALLEY DEMONSTRATION PROJECT AND CLOSURE OR LONG-TERM MANAGEMENT OF FACILITIES AT THE WESTERN NEW YORK NUCLEAR SERVICE CENTER

APPENDIX A
SUMMARY OF COMMENTS RECEIVED ON THE 1996 DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR COMPLETION OF THE WEST VALLEY DEMONSTRATION PROJECT AND CLOSURE OR LONG-TERM MANAGEMENT OF FACILITIES AT THE WESTERN NEW YORK NUCLEAR SERVICE CENTER

A.1 Background

In March 1996, the U.S. Department of Energy (DOE) published the *Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center (Cleanup and Closure Draft EIS*) (DOE/EIS-0226-D) (DOE 1996a). In accordance with the provisions of the National Environmental Policy Act (NEPA) (42 *United States Code* [U.S.C.] 4321 et seq.) and the related Council on Environmental Quality (CEQ) implementation regulations (40 *Code of Federal Regulations* [CFR] 1500–1508), DOE and the New York State Energy Research and Development Authority (NYSERDA) and the U.S. Environmental Protection Agency (EPA) announced the availability of the document in *Federal Register* (FR) notices (61 FR 11620 [DOE 1996b] and 61 FR 11836 [EPA 1996]) and invited interested parties to provide comments. NYSERDA issued a notice of completion for the 1996 *Cleanup and Closure Draft EIS* in the New York State Environmental Notice Bulletin, pursuant to the regulations implementing the New York State Environmental Quality Review Act (SEQR). Both the DOE and NYSERDA notices appear in Appendix B of this EIS.

A.2 The Public Comment Process

The 1996 *Cleanup and Closure Draft EIS* was distributed to interested individuals and organizations, including appropriate state clearinghouses, regulatory agencies, and American Indian Tribes. NEPA regulations mandate a minimum 45-day comment period after the publication of the EPA notice of availability of a draft environmental impact statement (EIS) to provide an opportunity for the public to comment. The comment period for the *Cleanup and Closure Draft EIS* was 6 months long and began on March 21, 1996. During the public comment period, four information sessions were held in late April during which DOE and NYSERDA were available to explain and discuss topics and issues that pertained to the Draft EIS. Sessions were held in Hamburg and Ashford, New York, for the public, and similar sessions were held in Irving and Salamanca, New York, expressly for members of the Seneca Nation of Indians. During the 6-month comment period, DOE received 113 letters from individuals and organizations. Further, there were three public meetings held in August 1996 in the West Valley area to receive oral comments, which were transcribed by a registered stenographer. Approximately 1,170 comments were identified in the letters and transcripts.

Over a decade has passed since the comments were received, during which time actions have been taken either in response to the public comments on the *Cleanup and Closure Draft EIS* or, while not directly in response to the comments, to help answer some of the issues raised by them. These activities include the development of additional waste characterization information; clarification of some of the regulatory requirements, most notably, the issuance of the U.S. Nuclear Regulatory Commission's (NRC's) *Decommissioning Criteria for the West Valley Demonstration Project (M-32) at the West Valley Site; Final Policy Statement* (Policy Statement) and the 6 New York Code of Rules and Regulations Part 373 and Resource Conservation and Recovery Act regulations as they apply to units on the site; issuance of Records of Decision (RODs) by DOE related to disposal options for various classes of DOE radioactive waste; revision of alternatives for decommissioning and long-term stewardship; and revision of analytical methods and models. A Citizen Task Force was established to provide input to DOE and NYSERDA regarding the Preferred Alternative. The *West Valley*

Citizen Task Force Final Report (CTF 1998) was issued July 28, 1998. In July 2000 DOE and the Seneca Nation of Indians signed a Memorandum of Agreement concerning the shipment of high-level radioactive waste and spent nuclear fuel across their lands (Seneca Nation 2000). Since the 1996 *Cleanup and Closure Draft EIS* was published, there has been ongoing interaction with the local population surrounding the site.

In March 2003, DOE and NYSERDA issued notices in the *Federal Register* (68 *Federal Register* 12044) and the New York State Environmental Notice Bulletin, respectively, of their intent to prepare this *Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (DOE/EIS-0226) (*Decommissioning and/or Long-Term Stewardship EIS*), and indicated that the EIS would revise the 1996 *Cleanup and Closure Draft EIS*.

Following the 2003 Notice of Intent and scoping meetings, DOE, with input from NYSERDA and the cooperating agencies (EPA, NRC, and New York State Department of Environmental Conservation [NYSDEC]), refined the definition of five alternatives and prepared a preliminary internal Draft EIS in September 2005 that analyzed the environmental impacts of the five alternatives. The preliminary internal Draft EIS did not present a preferred alternative and did not address the issue of which agency is responsible for specific portions of the Western New York Nuclear Service Center (WNYNSC). The preliminary internal Draft EIS was reviewed by the co-lead (DOE and NYSERDA) and cooperating agencies, and their comments revealed different expectations about the purpose and content of the EIS. To resolve differences about alternatives to be analyzed and the type of analyses, and to help identify a preferred alternative, DOE established a core team comprising the co-lead and cooperating agencies to discuss and, where practical, resolve the issues raised by the review of the September 2005 preliminary internal Draft EIS. The November 2008 Revised Draft *Decommissioning and/or Long-Term Stewardship EIS* reflects discussions with the core team regarding alternatives to be analyzed, the nature of the analyses, and the nature of the Preferred Alternative.

The November 2008 Revised Draft *Decommissioning and/or Long-Term Stewardship EIS,* with revised alternatives including the Preferred Alternative, was prepared with a clearer understanding of the major regulatory requirements, including criteria applied by NRC for decommissioning of the West Valley Demonstration Project (WVDP) and for license termination, and Resource Conservation and Recovery Act regulations as they apply to units on the site. Updated long-term performance assessment models for groundwater and erosion releases, and updated closure designs that include waste isolation barriers have been used in preparation of this *Decommissioning and/or Long-Term Stewardship EIS*. Analyses include short-term and long-term impacts, local impacts, and impacts associated with transportation. The analyses are intended to provide decisionmakers and the public with a fuller understanding of the environmental impacts of each alternative.

The public comment period for the November 2008 Revised Draft *Decommissioning and/or Long-Term Stewardship EIS* ran from December 5, 2008 through September 8, 2009. Initially scheduled for 6 months, the comment period was extended for another 90 days in response to requests from the public. Four public hearings were held on the Revised Draft EIS in the cities of Albany, Ashford, Buffalo, and Irving, New York. In addition, the DOE Assistant Secretary for Environmental Management and the President of NYSERDA held a videoconference on September 4, 2009, with various stakeholders to hear their concerns about some of the alternatives in the Revised Draft EIS, especially after the August 9 and 10, 2009 heavy rainfall events. Comments received during the public comment period, including those presented at the hearings and videoconference, were considered in finalizing this EIS and are addressed in the Comment Response Document, Volume 3, of this EIS. Changes to this EIS made in response to public comments are identified in Chapter 1, Section 1.8.

This appendix contains summaries of the oral and written comments received on the 1996 *Cleanup and Closure Draft EIS*, and explanations of how comments that relate to the scope and analysis of this *Decommissioning and/or Long-Term Stewardship EIS* were considered, and where practical, incorporated into this EIS.

A.3 Categorization of Issues Raised During the 1996 Public Comment Period

All the documents received during the public comment period on the 1996 *Cleanup and Closure Draft EIS*, as well as the transcripts from the formal hearings, were reviewed. Specific comments were delineated and organized into the following 13 major categories for which responses are presented in Section A.4 of this appendix:

1. Inadequate or inaccurate characterization of the site, waste, contamination, or presentation of data in the EIS
2. Reasonableness of alternatives
3. Design or operational details
4. Near-term impact analysis issues
5. Long-term erosion analysis issues
6. Long-term hydrologic transport analysis issues
7. Erosion control strategies
8. Long-term performance assessment issues
9. Preferences for or against a particular alternative
10. Specific recommendations for the Preferred Alternative
11. Regulatory compliance
12. Understanding the purpose and content of the EIS and its relationship to decisionmaking and agency involvement
13. Out-of-scope comments

The remainder of this appendix contains the 13 summarized categories of comments, responses to those comments, and an explanation of how those comments were considered in the development of the November 2008 Revised Draft *Decommissioning and/or Long-Term Stewardship EIS*. For the out-of-scope comments, an explanation is provided as to why they were placed in that category.

A.4 Summary of and Response to Comments by Category

A.4.1 Inadequate or Inaccurate Characterization of the Site, Waste, Contamination, or Presentation of Data in the Environmental Impact Statement

Specific aspects of characterization discussed in the comments include contamination levels for soils, sediments, vegetation, and animals; characterization of facilities and buried waste; geologic characterization, including bedrock and till fractures; structural geology fault data and unresolved geology issues; seismic characterization; and understanding of hydrologic and erosion processes that could move contamination from its existing location to potential receptors. Some commentors stated that full characterization and categorization of wastes was needed for a thorough analysis of regulatory compliance. Other commentors questioned the accuracy or presentation of data in the 1996 *Cleanup and Closure Draft EIS*.

Response: More than a decade of additional scientific study, environmental monitoring, and characterization data for the environment and conditions at WNYNSC and the surrounding region since preparation of the 1996 Cleanup and Closure Draft EIS, including data compiled in Annual Site Environmental Reports, have been taken into consideration in this Decommissioning and/or Long-Term Stewardship EIS and have contributed to understanding the impacts of natural phenomena at the site. Studies have been performed to improve understanding of chemical and radiological contamination levels for soils, sediments, vegetation, and animals; to characterize facilities and buried waste; and to improve the understanding of hydrologic, hydrogeologic, and erosion processes capable of transporting contamination to potential receptors. Revised estimates of the radiological and hazardous chemical inventories for major facilities on the site were made. Geologic characterization, including bedrock and till fracture data and more-recent seismic characterization data, has been reviewed, analyzed, and added as appropriate. For example, the following reference documents were used to enhance geologic and seismologic characterization at the site: Fakundiny and Pomeroy 2002; Gill 2005; Jacobi and Fountain 2002; Ouassaa and Forsyth 2002; Tuttle, Dyer-Williams, and Barstow 2002; URS 2002, 2004; and USGS 2002, 2008. Chapter 3 of this EIS, Affected Environment, provides site characterization by resource area, and cites references used in developing the chapter.

Chapter 4, Section 4.3, of this EIS includes a specific discussion of incomplete and unavailable information and its effect on the environmental impact analysis. The state of characterization of the site, waste, and contamination would be considered by the co-lead agencies when they make their respective decisions and would also be considered by the regulatory authorities during their approval process for any actions.

Comments on the 1996 Cleanup and Closure Draft EIS that identified inconsistent, incomplete, or inaccurate presentation of data have been reviewed, and changes or clarifications have been made, as appropriate. These comments are reflected in revised descriptions of the affected environment in Chapter 3 and in the descriptions of impact methodologies in the appendices associated with Chapter 4 of this EIS.

A.4.2 Reasonableness of Alternatives

Some commentors did not consider alternatives in the 1996 *Cleanup and Closure Draft EIS* to be reasonable or questioned their underlying assumptions. In particular, some commentors stated that the EIS did not offer any realistic alternatives for the disposal of radioactive waste at WNYNSC or that the proposed alternatives were overly simplistic and did not adequately protect the public and environment.

Some commentors called for specific detail or description of the various alternatives, requesting clarification or additional information on how (or why) a particular alternative would be implemented in the manner described. In some instances, the commentors suggested variations on the alternatives to make them more protective of people and the environment. Comments were received questioning or requesting clarification on the specific short-term actions proposed for the alternatives to manage the North Plateau Groundwater Plume. Other comments included the following:

1. Questioning why the reservoirs would be removed for Alternatives I (Removal) and II (Removal and Decay), which would destroy rose pink habitat

2. Questioning why onsite permanent disposal as an option under Alternative II was not considered

3. Suggesting the use of existing vitrification and cement solidification facilities for treatment of sludge and liquids generated during decontamination and decommissioning under Alternatives I and II, or for other identified wastes currently on site

4. Suggesting that the description, design, and method of waste removal, storage, and disposal needed clarification or updating to ensure protection of the population and environment

5. Defining ownership of the wastes and identifying potential offsite disposal facilities and timing of disposal for each identified waste type

6. Questioning how mitigation measures could be generally the same for all alternatives

7. Questioning why the *Cleanup and Closure Draft EIS* did not evaluate alternatives for the remediation of groundwater contamination on the North Plateau, because, in the commentor's opinion, the system in use at the time of the *Cleanup and Closure Draft EIS* did not adequately capture the contamination plume or efficiently remove radionuclides from the groundwater

8. Questioning potential locations for new waste storage and treatment facilities in relation to floodplains and long-term erosion considerations

9. Suggesting that waiting 100 years for decommissioning may be appropriate for some Waste Management Areas (WMAs), but the beta plume (North Plateau Groundwater Plume) should be remediated immediately.

Response: Following the Notice of Intent and scoping meetings of early 2003, DOE, with input from NYSERDA and the cooperating agencies, identified differences among the agencies regarding their expectations about the purpose and content of the EIS. To resolve the differences about alternatives to be analyzed and the type of analyses, and to help identify a preferred alternative, DOE established a core team comprising the co-lead and cooperating agencies to discuss and, where practical, resolve the issues. This Decommissioning and/or Long-Term Stewardship EIS reflects discussions with the core team regarding alternatives to be analyzed, the nature of the analyses, and the nature of the Preferred Alternative.

The alternatives evaluated in this Decommissioning and/or Long-Term Stewardship EIS include the Sitewide Removal Alternative, which would allow unrestricted release of the entire WNYNSC; the Sitewide Close-In-Place Alternative, under which all existing facilities and contamination would be managed in their current locations, and engineered barriers would be used to control contamination in areas with higher levels of long-lived contamination; the Phased Decisionmaking Alternative, under which there would be initial (Phase 1) decommissioning actions for some facilities and a variety of activities intended to expand the information available to support later additional decommissioning decisionmaking (Phase 2) for those facilities and areas not addressed in Phase 1; and the No Action Alternative.

The comments on the 1996 Cleanup and Closure Draft EIS, which included comments from the public as well as the agencies involved in the core team discussions, have helped to inform the development and clarification of the approaches, analyses, and descriptions of alternatives presented in this Decommissioning and/or Long-Term Stewardship EIS. For example, comments about long-term performance assessment were among the factors leading to the development of the Phased Decisionmaking Alternative. Potential short- and long-term impacts from implementation of the alternatives have been analyzed and results updated in this Decommissioning and/or Long-Term Stewardship EIS. For example, details on managing the North Plateau Groundwater Plume are provided in Appendix C of this EIS. The description, proposed design, and method of waste removal, storage, and disposal for each alternative has been updated and revised for clarity. The alternatives presented and analyzed in this Decommissioning and/or Long-Term Stewardship EIS are considered to represent reasonable alternatives consistent with the guidance of NEPA and SEQR.

A.4.3 Design or Operational Details

Comments were submitted related to design and operational details of the proposed decommissioning actions. A commentor suggested the use of an existing facility rather than the construction of a new facility. Another commentor questioned the basis for the cost estimate and the discussion of the cost differences, and another requested more information on how a specific alternative would be implemented. In other instances, commentors asked for more information on the monitoring and maintenance activities that would occur if waste remained on site, or what the consequences of an accident during operations would be. Commentors called for site management, including visible markings, to ensure protection of humans and the environment.

Some commentors called for additional information on the institutional controls that would be in place if waste remained on site, including identification of mechanisms for implementing long-term controls and monitoring plans. Some questioned the effectiveness of and reliance on long-term institutional controls. Others questioned whether long-term institutional controls could be guaranteed, especially in light of past failures to prevent releases of radioactive materials into the environment. Some commentors called for modification or restructuring of the environmental monitoring plan. Others stated an opinion on how a particular portion of the site, such as the North Plateau Groundwater Plume, should be managed or maintained. In particular, some questioned the strategy that relies on dilution to bring contamination to within acceptable limits.

Response: Comments on the 1996 Cleanup and Closure Draft EIS related to the proposed design elements and operational aspects associated with implementation of the alternatives were reviewed and considered in the development and clarification of the approaches, analyses, and description of design and operational details presented in this Decommissioning and/or Long-Term Stewardship EIS, including environmental monitoring programs described in the technical reports prepared to support each of the alternatives, postulated accident scenarios, and the design and effectiveness of long-term institutional controls.

The purpose of the engineering documents (called technical reports) that support this Decommissioning and/or Long-Term Stewardship EIS is to provide a basis to estimate environmental impacts, which includes providing a preliminary estimate of the cost for monitoring systems. The engineering data contained in these reports are preliminary. After an alternative is selected, more-detailed engineering analysis would be performed, and detailed monitoring plans would be developed in consultation with regulators, as appropriate. The technical reports explain the need for the construction of new facilities, particularly if there is an existing facility that does or could perform the same service. The technical reports also have a more-extensive discussion and characterization of the monitoring and maintenance activities than is contained in this EIS and an expanded discussion of the implementation actions, particularly if the information is relevant to the environmental impact analysis. The technical reports also provide the basis for the cost estimates presented in this Decommissioning and/or Long-Term Stewardship EIS. They are available in public reading rooms, on the DOE Decommissioning and/or Long-Term Stewardship EIS website (http://www.westvalleyeis.com), and upon request.

A.4.4 Near-term Impact Analysis Issues

Some commentors requested additional explanation of the assumptions, assessment methods, models, and parameters used for the near-term impact analysis. Specific comments were made on the transportation analysis, including the concern that the impact analysis (e.g., accident risk models, radiation exposure pathways, latent and acute cancer fatalities) was much more conservative than the nontransportation radiological impact analysis. Other commentors questioned the adequacy of the socioeconomic impact analysis or the environmental justice analysis or requested a more-detailed assessment of airborne emissions. Still other commentors recommended different measures of consequences or requested a discussion of impacts on fish and wildlife resources or their habitats and an ecological risk assessment. Comments were also made on the evaluation of radiological doses and their associated health effects.

Response: The near-term impact analysis in this Decommissioning and/or Long-Term Stewardship EIS is based on the revised description of the proposed project and alternatives, new data, and standard NEPA analytical tools and methods. Assumptions, assessment methods, and models used for analysis of near-term impacts are presented in Chapter 4 and applicable appendices of this EIS. Section 4.3 contains a discussion of incomplete and unavailable information and its relevance to the evaluation of transportation and environmental impacts. The transportation analysis was revised between the Revised Draft and Final EISs to reduce the conservatism where possible: state-specific accident and fatality rate data replaced the national mean accident and fatality rates, and the possibility of under-reporting of truck accident and fatality data has been accounted for by using published correction factors. The impacts of air emissions, both radiological and nonradiological, were analyzed. Both the methods and results of these analyses are discussed in the body of this EIS, as well as in appropriate appendices. The socioeconomic impact analysis has been updated to reflect current data from the U.S. Department of Commerce about economic multipliers and the location of low-income and minority populations. The potential dose to the public and workers from each of the four alternatives is presented in Chapter 4, Section 4.1.9, of this EIS. The level of detail for presentation of impacts in this EIS is consistent with CEQ and DOE guidance to discuss impacts "in proportion to their significance," focusing attention on significant environmental issues.

A.4.5 Long-term Erosion Analysis Issues

Commentors called for the erosion analysis to include recognition of the uncertainty in such analysis. Other commentors called for the EIS to include identification of specific erosion processes, such as gully advancement and the potential for stream capture, and a discussion of Buttermilk Creek erosion issues. Several commentors called for analysis of the impacts of erosion on downstream populations. Still other commentors called for a specific duration of the long-term performance assessment in the context of erosion or questioned the timeframe used in the analysis. Some commentors questioned the appropriateness of the use of average precipitation rates in the development of erosion predictions. One commentor offered a Monte Carlo–based erosion model. Multiple commentors expressed concern regarding impacts from the erosion collapse scenario or the reasonableness of the erosion assumptions, estimates, and modeling efforts.

Response: Analyses in this Decommissioning and/or Long-Term Stewardship EIS use different erosion models than were used for the 1996 Cleanup and Closure Draft EIS. The CHILD model is a landscape evolution model recognized by geomorphology professionals, and was calibrated using longer-term data consistent with recommendations from erosion experts. The CHILD model provides gully advancement predictions that are used for the long-term performance assessment. The CHILD model is discussed in Appendix F of this EIS. The dose consequences of long-term erosion predictions (erosional collapse) are presented in Chapter 4, Section 4.1.10 and Appendix H. This long-term analysis estimates timing and magnitude of peak annual dose commitment for various receptors including downstream populations. The uncertainty in the long-term dose estimates is discussed in Chapter 4, Section 4.3. This discussion also lists the factors that contribute to the conservatism in the long-term dose estimate.

A.4.6 Long-term Hydrologic Transport Analysis Issues

Specific commentors raised concerns about the effects of till fractures and bedrock hydrology on the hydrology of contaminant transport. Commentors also pointed out the potential for sediment transport to be an element of hydrologic contaminant transport. Some commentors called for consideration of the "bathtub" scenario, as occurred in the past. Other comments requested a mass balance as part of the hydrologic analysis.

Response: This Decommissioning and/or Long-Term Stewardship EIS uses groundwater models (numerical and analytical) both for flow and transport analyses. The revised analyses make use of available hydrologic and contaminant transport information. A description of the updated groundwater modeling effort is provided in Appendix E of this EIS. Water balances were performed as part the modeling and comparisons made with existing data. Sensitivity analyses were conducted to provide insight into the uncertainty in the long-term impact estimates. Geohydrological analysis of a bathtub scenario was not performed because improvements in the structure and maintenance of the burial area caps make it unlikely that this scenario would occur. However, in the long-term performance assessment, lateral transport through a weathered Lavery till saturated zone was modeled using groundwater velocities estimated in the geohydrological modeling.

A.4.7 Erosion Control Strategies

Several commentors questioned the erosion control strategies, and some viewed the global erosion strategy, which was intended to be maintenance free, as impractical and potentially harmful. Some commentors stated that erosion control measures should be justified, and that backup systems should be provided to prevent the possible release of contaminants.

Response: This Decommissioning and/or Long-Term Stewardship EIS relies on a strategy consistent with what was termed "local erosion control" in the 1996 Cleanup and Closure Draft EIS. This Decommissioning and/or Long-Term Stewardship EIS considers only a local erosion control strategy and no longer proposes or evaluates the global erosion strategy that was discussed in the 1996 Cleanup and Closure Draft EIS. The erosion control features for the engineered covers evaluated for the Sitewide Close-In-Place Alternative (see Appendix C, Section C.4.13) have been developed consistent with NRC guidance.

A.4.8 Long-term Performance Assessment Issues

Some commentors requested additional explanations of the assumptions, models, and parameters used for the long-term impact analysis. Commentors called for consideration of the impacts on all users of potentially contaminated surface waters used as sources for drinking water. Other commentors stated that a 1,000-year analytical timeframe was too short, and a 10,000-year timeframe should be used. Commentors also requested a discussion of long-term environmental and health and safety impacts in the event of immediate loss of institutional controls. Several commentors called for an analysis of the effects of erosion on downstream water users. Other commentors called for inclusion of an analysis of the impacts of hazardous material releases in the long-term performance assessment. One commentor discussed the sensitivity of the dose predictions to the solubility of radionuclides. Several commentors questioned the groundwater and surface-water flow paths and hydrologic properties. Other commentors called for additional explanation of natural phenomena expected over the long term, such as loading due to high winds and earthquakes. Other commentors raised concerns about the long-term structural performance analysis of selected reinforced concrete structures.

Response: The long-term performance assessment was updated between issuance of the 1996 Cleanup and Closure EIS and this Decommissioning and/or Long-Term Stewardship EIS. The analysis examines the effects of short-term and long-term releases on a spectrum of downstream water users including Lake Erie and Niagara River water users. The analysis also identifies the year of peak annual exposure for each receptor regardless of whether that peak occurs in the early years or more than 10,000 years in the future. This Decommissioning and/or Long-Term Stewardship EIS also includes an analysis of the impacts from the release of hazardous materials, and an assessment of high winds and earthquakes. With respect to the long-term performance assessment, high winds are not expected to have a significant role, while the influence of earthquakes on erosional processes is implicitly addressed in the revised calibration of the erosion model covering the entire post-glacial period. Also, given the revised alternatives, the concern about the long-term structural performance of reinforced concrete structures is no longer applicable. The level of presentation for *the impacts in this Decommissioning and/or Long-Term Stewardship EIS is consistent with CEQ and DOE instructions to discuss impacts "in proportion to their significance."*

All available data were reviewed, including the identification of potential contaminant flow paths and path properties. In addition, DOE and NYSERDA solicited the technical assistance of the cooperating agencies in the review of the long-term performance assessment methods and results. DOE and NYSERDA also solicited input from independent technical experts who assessed several other aspects of the EIS. The long-term human health impacts are presented in Chapter 4, Section 4.1.10, and the methods, models, and results of this assessment are discussed in detail in Appendices D, E, F, G, and H of this EIS. As previously discussed, this Decommissioning and/or Long-Term Stewardship EIS involves the use of revised models and includes long-term performance assessment of the alternatives where residual radioactivity remains on site. The long-term performance assessment estimates impacts out to year of peak impact for both radioactive and hazardous constituents. A number of different scenarios were analyzed for different offsite receptors, possible intruders, and the general population.

A.4.9 Preference For or Against a Particular Alternative

In some instances, commentors expressed a preference for a specific alternative analyzed in the 1996 *Cleanup and Closure Draft EIS*. A number of commentors expressed a preference for either the Removal Alternative or the On-Premises Storage Alternative. In other instances, commentors stated their opposition to the Sitewide Close-In-Place Alternative or the No Action Alternative. Some commentors stated in general terms that the Preferred Alternative could involve a "combination" alternative that would treat different portions of the site differently. Many comments were received expressing a preference for or opposition to one or more of the alternatives.

A number of commentors supported Alternative I (Removal) over Alternative II (On-Premises Storage), while some expressed support for a combination of the two alternatives to address the responsibility of stewardship and to avoid the risk of transporting wastes off site into somebody else's backyard. Some favored safely exhuming and packaging all radioactive and mixed waste and storing it so that it could be easily retrieved and monitored, while others just wanted the wastes properly packaged and transported off site as soon as possible to a less populated and more-geologically stable location. Other commentors cited reasons for favoring initial on-premises storage to provide protection of the surrounding communities, to allow time for the radioactive wastes to continue to decay, and to use the time to explore technology that would eventually solve the contamination problem. There was also a preference for Alternative IV (No Action), as it was believed by some to afford the highest level of protection. A number of commentors specifically opposed Alternative III (In-Place Stabilization), while others supported either Alternative I or II. Many were opposed to the idea of backfilling contaminated facilities and leaving radioactive wastes buried. The most frequently cited reasons for opposition included concerns about the following:

1. Human health risks posed by the radioactive waste left in the ground without the option of retrieval and exacerbated by long-term erosion, loss of institutional control, and seismic activity

2. Long-term consequences for downstream communities and the human health risk of contaminated drinking water

3. Cost being the primary factor in selecting a preferred alternative

4. Unacceptable, adverse, and irreversible effects on the environment

Other commentors voiced opposition to Alternative IV (No Action) because of unacceptable risks to the health and safety of present and future generations. Many others opposed Alternative V (Discontinue Operations), citing that it was not considered a viable alternative by DOE or NYSERDA.

Response: The comments on the 1996 Cleanup and Closure Draft EIS, which included comments from the public as well as the agencies involved in the core team discussions, have helped to inform the development and clarification of the approaches, analyses, and description of alternatives presented in this Decommissioning and/or Long-Term Stewardship EIS. For example, comments about long-term performance assessment were among the factors leading to the development of a Phased Decisionmaking Alternative. Potential short- and long-term impacts from implementation of the alternatives have been analyzed and the results updated in this Decommissioning and/or Long-Term Stewardship EIS. For example, details about managing the North Plateau Groundwater Plume are provided in Appendix C. The description, proposed design, and method of waste removal, storage, and disposal for each alternative have been updated and revised in this EIS. The alternatives presented and analyzed in this EIS are considered to represent reasonable alternatives consistent with the guidance of NEPA and SEQR.

A.4.10 Preferred Alternative

Some commentors called for more than one preferred alternative. Many commentors indicated that a preferred alternative should have been presented in the 1996 *Cleanup and Closure Draft EIS* to give interested parties ample opportunity to review and comment on the methodology and data used in its development. A commentor stated that New York State law and regulations require description of the Proposed Action, and identification of the Preferred Alternative is needed prior to issuance of the ROD and SEQR findings.

Response: At the time the 1996 Cleanup and Closure Draft EIS was issued, a Preferred Alternative had not been determined by the lead agencies. Since then the lead agencies have reviewed the various comments, suggestions, and recommendations on actions that should be taken at WNYNSC, including recommendations of the Citizen Task Force. This information was considered as they developed the alternatives that are analyzed in this Decommissioning and/or Long-Term Stewardship EIS. To resolve the differences about alternatives to be analyzed and the type of analysis, and to help identify a Preferred Alternative, DOE established a core team comprising the co-lead and cooperating agencies to discuss and, where practical, resolve these issues. The Preferred Alternative is described (see Chapter 2, Section 2.4) and analyzed in this Decommissioning and/or Long-Term Stewardship EIS.

A.4.11 Regulatory Compliance

Several commentors made statements about whether a specific alternative complied with the regulations based on information in the 1996 *Cleanup and Closure Draft EIS* and the individual commentor's assertion of applicable regulations. Other commentors asked for clarification on how specific alternatives would comply with RCRA regulations, while others pointed out the uncertainty of compliance given lack of West Valley decommissioning criteria, as called for in the WVDP Act (Public Law 96-368). Many commentors used information in the 1996 *Cleanup and Closure Draft EIS* to support a position about how a specific alternative complied with regulations that they thought were applicable. Two frequently cited regulations were 10 CFR Part 60 (NRC requirements for disposal of high-level radioactive waste) and 10 CFR Part 61 (NRC requirements for disposal of low-level radioactive waste). Comments were made about State-Licensed Disposal Area and NRC-Licensed Disposal Area issues and meeting existing NRC regulations regarding site suitability requirements for land disposal of radioactive material. Other commentors based their assessment of acceptability on RCRA regulations or the 15-millirem-per-year standard in the proposed NRC Decontamination and Decommissioning Rule that was available at the time of the 1996 *Cleanup and Closure Draft EIS*. Others pointed out that some of the alternatives may not comply with all applicable guidance, laws, regulations, and settlements, including the WVDP Act, Safe Drinking Water Act, and New York standards for fresh groundwater, while others were concerned that not all applicable Federal and state regulatory and permit requirements were identified.

Response: NRC issued decommissioning criteria for WVDP after the 1996 Cleanup and Closure Draft EIS was issued. The NRC Policy Statement and License Termination Rule provide several options for decommissioning and, if appropriate, license termination. Appendix L of this Decommissioning and/or Long-Term Stewardship EIS includes a discussion of compliance with the dose standards in the License Termination Rule, as prescribed in the Policy Statement. NRC's assessment of compliance with the Policy Statement/License Termination Rule would occur only when the entire plan for completing WVDP is established and the actions to implement that plan are documented in a Decommissioning Plan. A Decommissioning Plan for Phase 1 of the Phased Decisionmaking Alternative, the Preferred Alternative identified in this EIS, has been submitted to NRC. The Phase 1 Decommissioning Plan is currently under review.

Appendix L also includes a discussion of compliance with RCRA. Official determination of compliance would occur through the regulatory review process, which would occur as part of the implementation of the selected alternative. It is possible that the regulatory review process would identify additional information needed to support regulatory determinations for the selected alternative. If this is the case, the additional information would be collected and provided to the regulatory authority.

A.4.12 Understanding the Purpose and Content of the Environmental Impact Statement and Its Relationship to Decisionmaking

A commentor asked who chose the five alternatives. Others commentors stated that the EIS process should be slowed down, with more time provided for commenting. A commentor asked who would issue the Final EIS as well as the ROD and SEQR findings, and another expressed concern that a decision had already been made. One commentor included requests for clarification of the responsibilities of DOE and NYSERDA as they relate to decisionmaking at the site and funding of the decommissioning work. A commentor suggested DOE should establish criteria to address the safe hand-off of responsibility for the site from DOE to NYSERDA. Another requested that DOE and NYSERDA work together to share in the cost and expertise required to effectively clean up the site. Commentors expressed concern about the criteria that the agencies would use in their decisionmaking. Concern was expressed that decisions would be made to minimize near-term cost or offset cost by accepting offsite wastes and would not adequately consider long-term hazards. Some commentors wanted NRC's role in the decisionmaking process clearly stated. Others want to be involved or kept informed about actions and decisions concerning the site.

Response: DOE, with input from NYSERDA and the cooperating agencies, has refined the definition of the alternatives. A sequence of steps is prescribed by NEPA and SEQR, including public involvement and comment periods (see Chapter 1, Figure 1–2). DOE and NYSERDA agreed to a 6-month public comment period for the Revised Draft Decommissioning and/or Long-Term Stewardship EIS, which exceeds the 45-day comment period required by CEQ regulations. In addition, in response to requests from the public, the comment period was extended another 90 days, making the public comment period for this EIS 9 months long.

As the EIS process has progressed, the various agencies involved in EIS preparation have developed a clearer understanding of the major regulatory requirements, including the criteria prescribed by NRC for decommissioning of WVDP and for license termination, along with RCRA regulations as they apply to the site. Chapter 1 of this Decommissioning and/or Long-Term Stewardship EIS contains information that clarifies the purpose of this EIS and the relationship between the Final EIS and agency decisionmaking.

The lead agencies have noted the concerns expressed in the comments, will keep the public informed through the EIS process, and will consider the comments expressed on impacts on the public, workers, and the environment in their decisionmaking.

A.4.13 Out-of-Scope Comments

Comments on the 1996 *Cleanup and Closure Draft EIS* that were considered "out of scope" were not addressed specifically in the *Decommissioning and/or Long-Term Stewardship EIS*. The term "out of scope" refers to comments that do not directly affect or pertain to the alternatives, affected environment or analyses performed as part of the preparation of this EIS. Comments related to the lead agencies' decision processes or the basis for selecting an alternative are considered out of scope because those issues will be addressed in the decision documents (i.e., the ROD or the Findings Statement) that follow the completion of this EIS. Comments relating to the funding or operation of WNYNSC were also categorized as out of scope. The following comments have been considered out of scope. Responses are provided following each comment.

1. Concerns were expressed about the criteria for decisionmaking, how alternatives could be evaluated or selected without fully understanding regulatory requirements, and how the alternatives compared with the requirements.

   Response: This EIS is only one of several factors that will be considered by decisionmakers when making decisions that will be announced in the ROD and Findings Statement. The bases for the decisions will be explained in those documents. This EIS provides a preliminary discussion of compliance with regulations in Appendix L, but regulatory compliance will be determined by the regulators during implementation of the selected alternative.

2. Concerns were expressed about the availability of funding and about the Federal Government unfairly burdening the State of New York; requests were made for financial assistance to local communities.

   Response: Funding decisions for activities at WNYNSC are made through Federal and New York State budget processes. While the analyses and results in this EIS may be used by the agencies to support the budget processes, discussion of those processes is not within the scope of an EIS, which is a document focused on identifying the environmental impacts associated with implementing alternatives for accomplishing a proposed action.

3. Request was made for funding for an unbiased technical consultant to serve on a citizen's committee.

   Response: Both DOE and NYSERDA have involved independent technical experts in the development and review of this Decommissioning and/or Long-Term Stewardship EIS and have met routinely through the course of its development with the cooperating agencies, the Citizen Task Force, and the general public in the vicinity of WNYNSC.

4. Request was made for a comprehensive operational plan and Program Evaluation Review Technique chart every 2 years.

   Response: A request for a periodically updated and published schedule of activities related to the implementation of the decision(s) coming out of the EIS process is not within the scope of the EIS analysis. As part of their ongoing site management responsibilities, DOE and NYSERDA will address mechanisms to involve and communicate with the public during implementation of the EIS decision(s).

5. Request was made for DOE to analyze compliance with treaty rights of the Seneca Nation of Indians.

   Response: The site is not on the Seneca Nation of Indian's land, so discussion of compliance with Seneca Nation of Indians treaty rights is not within the scope of this EIS. However, DOE does have a Memorandum of Agreement with the Seneca Nation of Indians regarding transportation of high-level radioactive waste and spent nuclear fuel across tribal land. On July 21, 2008, DOE sent a letter to the Seneca Nation of Indians requesting consultation regarding preparation of this EIS, and met with the Tribal Council on December 18, 2008, for the formal consultation. A public meeting on the 2008 Revised Draft EIS was held at the William Seneca Building on March 31, 2008, during which the Seneca Nation resolution stating the Tribe's position on the EIS was read. This resolution, submitted on the record as formal comment on the November 2008 Revised Draft EIS, completed the consultation process.

6. Request was made for the Seneca Nation of Indians to be included in cultural resource and traditional use surveys and cultural resource planning.

   Response: Activities analyzed in this EIS would occur primarily on the WNYNSC site. The State Historic Preservation Office will be consulted as necessary concerning specific compliance requirements and cultural resource preservation planning during activities implementing decisions that will be announced in the Record of Decision for this EIS. Consultation with the Advisory Council on Historic Preservation may also be required and extended to appropriate local historical organizations and interested individuals. Should any traditional cultural resources be discovered during these activities, representatives of the appropriate American Indian Tribes will be notified. This process is not a specific function of this EIS, however, the requirement for and status of such consultations is discussed in Chapter 5 of this EIS. Potential impacts on cultural resources from the proposed decommissioning alternatives are discussed in Chapter 4, Section 4.1.7, of this EIS.

7. A commentor suggested that cleanup criteria for radiological contamination should be set at background radiation levels.

   Response: Decommissioning criteria for the WNYNSC have been set by NRC in its License Termination Rule (10 CFR 20, Subpart E) and its Policy Statement on Decommissioning Criteria for the West Valley Demonstration Project. The License Termination Rule includes criteria for both unrestricted and restricted use of the site. The License Termination Rule and Policy Statement are discussed in Chapter 5, Section 5.2, of this EIS. A Decommissioning Plan for Phase 1 of the Phased Decisionmaking Alternative, the Preferred Alternative identified in this EIS, has been submitted to NRC and is currently under review.

8. A request was made for a low-income population representative to be added to a working group of agencies and be provided with technical assistance to participate.

   Response: Both DOE and NYSERDA have involved independent technical experts in the development and review of this Decommissioning and/or Long-Term Stewardship EIS and have met routinely through the course of the development of this EIS with the cooperating agencies, the Citizen Task Force, and the general public in the vicinity of WNYNSC. The NEPA process requires and incorporates public involvement through scoping and public meetings and allows for comment submittal (both oral and written) and consideration of those comments in preparing both the Draft and Final EISs.

9. It was suggested that disposition of radioactive wastes become a national program in which all appropriate Federal and state agencies work together as one organization to isolate nuclear waste as long as possible, to eliminate duplication of effort, and to avoid spending money needlessly.

Response: The focus of this EIS remains on the environmental impacts of decommissioning WVDP and the long-term management or stewardship of WNYNSC. Suggestions for different approaches to the issue of radioactive waste disposition are best suited to national, state, or local political processes.

10. It was suggested that after the site has been cleaned up, the land be developed into a tourist attraction with a national park and museum that focuses on the atomic age.

    Response: Future potential land uses for the site are being explored by NYSERDA.

11. It was suggested that safe disposal is not possible, and we should stop making nuclear waste.

    Response: This comment is beyond the scope of this EIS. Policies regarding nuclear waste are decided through national political processes. However, WNYNSC is not an active nuclear operations site. Radioactive wastes generated at WNYNSC now and in the future would result from site decommissioning and removal of wastes and facilities contaminated from previous nuclear operations.

12. A commentor suggested preparation of a supplement to the Draft EIS after the Preferred Alternative is selected, followed by an ecological risk assessment to address ecological impacts in more detail.

    Response: A Preferred Alternative was identified in the 2008 Revised Draft EIS, and as required by NEPA regulations, in this Final EIS. A screening level ecological risk assessment was performed for the 2008 Revised Draft EIS and has been refined for this Final EIS. Results of this assessment are described in Chapter 4, Section 4.1.6 of this EIS.

13. It was suggested that DOE and NYSERDA identify any short-term activities which, if not performed, could significantly increase the difficulty of site closure, for example, immediate efforts needed to prevent the spread of contamination in the North Plateau Groundwater Plume.

    Response: As reported at Citizen Task Force and quarterly public meetings, actions are being taken to increase the isolation of the North Plateau Groundwater Plume, the NRC-Licensed Disposal Area, and the Waste Tank Farm. The agencies have not, however, identified any actions which, if not performed, would significantly increase the decommissioning effort.

14. Transportation-related comments were made regarding the following: (1) the need for inclusion of design and safety detail on the high-level radioactive waste transportation containers; (2) selection of a transportation method and route; and (3) when and how the first "test" shipment of low-level radioactive waste via truck is going to take place, what prior involvement local representatives are going to have, and what advance notification will be made.

    Response: Potential impacts from transportation of wastes generated as a result of activities proposed in this EIS are addressed in Chapter 4, Section 4.1.12 and Appendix J of this EIS. Both rail and truck transport have been evaluated using routes selected using regulatory criteria for the specific waste type. Low-level radioactive waste is routinely shipped from WNYNSC, and is done so in accordance with Federal and state regulations, including those for advance notice, although advance notification is not required for most low-level radioactive waste shipments.

    No high-level radioactive waste is anticipated to be generated as a result of activities evaluated in this EIS. Disposition of high-level radioactive waste generated by previous activities at WNYNSC was evaluated in the Final Environmental Impact Statement, Long-Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center, West Valley

(DOE/EIS-0081) (DOE 1982). Chapter 1, Section 1.6, of this EIS identifies other NEPA documents relevant to this EIS. A number of NEPA documents included in Section 1.6 address disposition and transportation of high-level radioactive waste. In particular, transportation of high-level radioactive waste has been addressed in the following NEPA documents: (1) Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (DOE/EIS-0250), February 2002; (2) Final Supplemental Environmental Impact Statement for Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (DOE/EIS-0250F-S1), June 2008; (3) Final Supplemental Environmental Impact Statement for Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada – Nevada Rail Transportation Corridor and Final Environmental Impact Statement for a Rail Alignment for the Construction and Operation of a Railroad in Nevada to a Geologic Repository at Yucca Mountain, Nye County, Nevada (DOE/EIS-0250F-S2 and DOE/EIS-0369), June 2008).

15. Commentors requested that DOE make a commitment that the site will not become a dumping ground for other DOE, commercial, or imported radioactive or hazardous wastes. There were also inquiries about the availability of (and need for selection of) an offsite waste disposal area and removal of the WVNS (sic) from the Federal list of possible sites for a mixed waste repository.

    Response: From a DOE perspective, these concerns were addressed in the Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (DOE/EIS-0200-F, May 1997) (DOE 1997). Table 1.6-1 of that document states that WVDP is designated as a waste site, but wastes from other sites will not be shipped there for treatment or disposal.

16. A request was made for setting required timeframes for regular inspections of site storage and temporary weather structures over excavation areas.

    Response: Official determination of timeframes for compliance inspections will occur through the regulatory review process, which will occur as part of the implementation of the selected alternative.

17. Commentors requested that DOE consider the special concerns and needs (including legal assistance, technical training, and managing potential problems related to waste) of the local communities.

    Response: Partially in response to these types of comments, NYSERDA established the Citizen Task Force, which has served both as a source of community input to the NEPA process and as a venue for DOE and NYSERDA to convey updated technical and status information related to this EIS. DOE and NYSERDA continue to provide financial assistance to help the Citizen Task Force review and comment on the information provided.

Some of these issues (e.g., clarification of responsibilities, considerations in decisionmaking, and review frequencies) may be addressed in the DOE ROD or the NYSERDA Findings Statement for the *Decommissioning and/or Long-Term Stewardship EIS.*

Table A–1, "Index of Commentors," lists the comment documents that were received, including the hearing transcripts, and identifies in which of the preceding summary categories or subcategories the comments were included.

Table A–1 Index of Commentors

		Comment Categories
Federal Agencies		
U.S. Department of the Interior Andrew L. Raddant	37	4.4, 4.9, 4.10, 4.11, 4.13
U.S. Environmental Protection Agency, Region 2 Robert W. Hargrove	106	4.1, 4.2, 4.3, 4.4, 4.2(7), 4.9, 4.9(1)(4), 4.10, 4.11, 4.13(5)
U.S. Nuclear Regulatory Commission Gary C. Comfort, Jr.	113	4.1, 4.2, 4.2(4)(8), 4.4, 4.5, 4.6, 4.8, 4.9, 4.10, 4.11
State and Local Officials, State Agencies, American Indian Tribal Governments, and Nongovernmental Organizations		
Allegany County Board of Health, Ronald Truax	40	4.9
Ashford Concerned Citizens, Machias, New York	72	4.1, 4.2, 4.2(4), 4.2(5), 4.3, 4.5, 4.9, 4.11, 4.12, 4.13(2)(3)
Biomedical Metatechnology, Inc., Irwin D. Bross	23	4.1, 4.2, 4.8, 4.9
Buffalo, New York, City Clerk’s Office	38	4.5, 4.9
Cattaraugus County Legislature (New York) Donald E. Furman & Messrs. Felton, Fitzpatrick, Gowan, Haberer, Hall, Zimbardi, Ellis, Mack, Williams, Anastasia, Eade; Mrs. McLaughlin, Ms. Blake; and Ms. Ginter	32	4.9, 4.13(2)
Cattaraugus County Legislature, Little Valley, New York, D. John Zimbardi	107	4.1, 4.2, 4.8, 4.9, 4.13
Cattaraugus County Legislature, Little Valley, New York, Richard E. Haberer	83	4.9(3), 4.13(2)
Chenango North Energy Awareness Group (Chenango North) South Plymouth, New York, Susan B. Griffin	44	4.3, 4.9, 4.13
Citizens Against Radioactive Dumping, Cincinnatus, New York, Jim Weiss	91	4.2, 4.3, 4.9
Citizens’ Environmental Coalition, Albany, New York, Anne Rabe and Michael Purcell	64	4.3, 4.9
Coalition on West Valley Nuclear Wastes, Raymond C. Vaughan, Carol Mongerson, Betty J. Cooke, James L. Pickering	66	4.9, 4.13(4)
Coalition on West Valley Nuclear Wastes, East Concord, New York, Carol Mongerson	78	4.1, 4.2, 4.2(1) 4.3, 4.4, 4.6, 4.7, 4.9, 4.9(3), 4.11, 4.13(9)
Coalition on West Valley Nuclear Wastes, Raymond C. Vaughan	98	4.1, 4.2, 4.4, 4.5, 4.6, 4.7, 4.8, 4.11
Coalition on West Valley Nuclear Wastes, Raymond Vaughan	8	4.1, 4.5, 4.6, 4.9, 4.11, 4.12
Coalition on West Valley Nuclear Wastes, James Rauch	76	4.1, 4.2, 4.4, 4.9, 4.9(3), 4.11, 4.13, 4.13(2)
Concerned Citizens of Clarence, Inc., Pat Melancon, Lois Bono, Robert McLean, Aldine Tarbell, Calvin Tarbell	17	4.9(1)(3)
Environmental Coalition on Nuclear Power, State College, Pennsylvania	108	4.2, 4.3, 4.9, 4.12, 4.13, 4.13(2)
Great Lakes United, Margaret Wooster	42	4.3, 4.8, 4.9, 4.13
New York State Department of Environmental Conservation	94	4.1, 4.2, 4.2(4)(6)(7)(9), 4.3, 4.4, 4.5(4), 4.7, 4.8, 4.10, 4.11, 4.12, 4.13
Niagara Swim League, Colin J. Adams	89	4.9

		Comment Categories
Nuclear Awareness Project, Ontario, Canada, Irene Kock	22	4.2, 4.3, 4.5, 4.13(4)
Nuclear Information and Resource Service, Diane D'Arrigo	80	4.3, 4.9, 4.9(1)(3), 4.13
Presbyterian Women, Presbytery of Western New York, Ruby Sentman	82	4.9
Seneca Nation of Indians, Michael W. Schindler	109	4.1, 4.2, 4.3, 4.4, 4.5, 4.7, 4.9, 4.9(1)(2), 4.10, 4.11, 4.12, 4.13, 4.13(2)(6)
Springville Youth, Inc., Springville, New York, E. Joseph Giroux, Jr.	68	4.9
Square Y Consultants, Lynn C. Yuan	67	4.1, 4.4, 4.6
State of New York Environmental Protection Bureau, William S. Helmer	99	4.11, 4.12
State of New York, Office of the Attorney General, William S. Helmer (with comments from the New York State Law Department)	112	4.3, 4.11
The State University of New York at Buffalo, Fred M. Snell	39	4.3
The State University of New York at Buffalo, Department of Ecology, Robert Jacobi, John Fountain	93	4.1, 4.4
Town of Ashford, New York, William King	75	4.1, 4.12, 4.13(2)
Town of Concord, Springville, New York	63	4.9
Town of Ellicottville, New York, John Widger	104	4.9, 4.12, 4.13(2)
Town of Ellicottville, New York, Rodney G. Sergel, Cathy Stokes	69	4.9
Village of Springville, New York, Deborah A. Murphy	31	4.9
Individuals		
Betty J. Cooke	10	4.9
Betty Stephan	74	4.9
Beverly Horozko	19	4.3, 4.9, 4.9(1)
Beverly Spross	96	4.2, 4.9
Brenda Ticen Runk	25	4.9
Charles Couture	34	4.13(2)
Cynthia Dayton	79	4.1, 4.2, 4.3, 4.9
Delone Scharf	15	4.9
Dennis and Violet Dick	9	4.9, 4.9(1)(2), 4.13
Dennis and Violet Dick Norbert and Gladys Kruse Donald and Vivian Mosher Jeff Dick Sonya Vura Norman Uliedeman Robert Kruse Susan Dick	35	4.9, 4.13
Donna Ebel	30	4.9
Elizabeth A. Obad	29	4.9
Elizabeth and Dave Buckley	70	4.2, 4.9, 4.11
Elizabeth Kay Keffe	4	4.9(4)

		Comment Categories
Emil and Dorothy Lacs	14	4.9
Emil Zimmerman	101	4.8, 4.9
Gail Hall	5	4.8, 4.9
Gary R. and Sharon J. Mathe	71	4.2, 4.9
Gary W. Bauer	2	4.9, 4.9(1)
H. M. Gerwitz	97	4.3, 4.7, 4.9, 4.13(2)
Helen Feraldi	28	4.9, 4.13(11)
Ivan S. Fifield	65	4.9
James L. Pickering	62	4.1, 4.2, 4.3, 4.4, 4.9, 4.11, 4.12, 4.13
James R. Wolf	18	4.11, 4.12
Janis J. Lathrop	33	4.9(3)
Jenny Weide and Craig R. Weide	26	4.9(1)
Jerry S. Helfer	3	4.9, 4.9(3)
Joanne E. Hameister	85	4.1, 4.9
John A. Pfeffer	84	4.1, 4.2, 4.2(5), 4.9, 4.12, 4.13(2), 4.13
John M. Burn	24	4.3
John M. Cairns and Dorothy Cairns	61	4.5, 4.9
John T. Thompson	20	4.13
John T. Thompson	21	4.13
Kathleen Duwe	105	4.9
Kathy Hussein	27	4.2, 4.9
Kathy Kellogg	81	4.1, 4.13(8), 4.5, 4.9
Kim Labarbera	59	4.9
Linda Spors	60	4.9
M. John Winston	92	4.9
Marianne Isbister and David Isbister	110, 111	4.9
Mary Plonka	43	4.2, 4.9, 4.12
Maureen Kelley	16	4.9(3)
Michael Kelly	1	4.3
Michael P. Wilson	95	4.4, 4.5, 4.7, 4.9, 4.9(1)
Nancy E. Ryther	13	4.9, 4.9(1)(2)
Philip D. Feraldi	41	4.9
Phyllis J. Hanson	6	4.9, 4.13(11)
Richard Steinberg	11	4.2, 4.9
Robert C. Hurd	102	4.2, 4.3, 4.5, 4.8, 4.9, 4.9(1)(3)(4)
Robert L. Potter	73	4.1, 4.9, 4.10, 4.12, 4.13(2)
Robert W. and Barbara M. Engel	90	4.9
Ruth M. Stratton	100	4.9
Sally Coleman and Sara B. Coleman	49	4.9
Sharon Myers	36	4.9
Stephen Koscherak	7	4.9, 4.9(1)
Suzanne M. Pfleger	12	4.2, 4.9(1)(2)
The Dunbar Family	114	4.9

		Comment Categories
Campaigns and Petitions		
Strongly Oppose Alternative III		4.9, 4.9(1)
Margaret J. Leyonmark	58	
Glenda Leyonmark and Pete Leyonmark	46	
Margaret E. Woolley	47	
Mary Stalskesky	48	
Elizabeth E. Winegar	50	
Gordon (last name illegible)	51	
Marilyn Monckton	52	
Dorothy F. Harrington	53	
Kase D. Danforth	54	
Wayne F. Nolan	56	
Donald W. Robinson	57	
Timothy Miller	45	
Support for Alternative I		4.9, 4.13(4)
Coalition on West Valley Nuclear Wastes		
Nelson W. Hegeman	86	
Thomas P. O'Conner	87	
Roberta Hegeman	88	
Sandra P. Galac	103	
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Dibble, Bill	115	4.9, 4.13(10)
Margrey, Kenneth	115	4.9, 4.13, 4.13(15)
Snell, Fred	115	4.3, 4.13(9)
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Burlingham, Gilly	116	4.9
Gifford, Gladys	116	4.1, 4.11
Keil, Angelici	116	4.9
Kennedy, Elizabeth	116	4.9
Lambert, Leonore	116	4.9
Mongerson, Carol	116	4.1, 4.2, 4.2(1), 4.3, 4.7, 4.9
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Chisolm, Larry	117	4.9
Dibble, Bill	117	4.9, 4.13(14)
Gilpin, George	117	4.5, 4.6, 4.8, 4.9
Goldstein, Andrew	117	4.13(11)
Kaiser, Sam	117	4.9
Lercher, Aaron	117	4.9
Mongerson, Carol	117	4.9
Pfleger, Sue	117	4.6, 4.9
Vaughan, Ray	117	4.1, 4.5, 4.7, 4.9, 4.13(1)
Vaughan, Ray	117	4.9
Shelly, Patricia	117	4.9

A.5 References

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URS (URS Corporation), 2002, *An Update of the Structural Geology in the Vicinity of the Western New York Nuclear Service Center, West Valley, New York*, West Valley, New York, May.

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USGS (U.S. Geological Survey), 2002, "Interpolated Probabilistic Ground Motion for the Conterminous 48 States by Latitude Longitude, 2002 Data," (search for Latitude 42.504 North, Longitude -78.6543 West [West Valley Demonstration Project centroid, New York]); page last updated June 14, 2005 (accessed September 2, 2005, http://eqint.cr.usgs.gov/eqprob/2002/index.php), September 2.

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APPENDIX B
NEW YORK STATE ENVIRONMENTAL NOTICE BULLETINS AND FEDERAL REGISTER NOTICES

ENB - Region 9 Notices 6/17/2009

Public Notice

The New York State Energy Research and Development Authority (NYSERDA) and the United States Department of Energy has determined there will be a 90 day extension of comments on the Draft Environmental Impact Statement (Draft EIS) pursuant to the completion of the West Valley Demonstration Project (WVDP) and the decommissioning and/or long-term management or stewardship of the Western New York Nuclear Service Center. This includes the decontamination and decommissioning of the waste storage tanks and facilities used in the solidification of high-level radioactive waste, and any material and hardware used in connection with the WVDP. **The comment period will close on September 8, 2009**. For further information, the original Notice of Acceptance was published December 10, 2008.

Contact: Paul J. Bembia, Director, NYSERDA, 9030-B Route 219, West Valley, NY 14171, Phone: (716) 942-9960 ext. 4900, E-mail: pjb@nyserda.org.

ENB - Region 9 Notices 12/10/2008

Notice of Acceptance of Draft EIS and Public Hearings

Cattaraugus and Erie Counties - The United States Department of Energy (US DOE) and New York State Energy Research and Development Authority (NYSERDA), as joint lead agency, have accepted a Draft Environmental Impact Statement on the proposed Decommissioning and/or Long-term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center. **Public hearings on the Draft EIS will be held on March 31, 2009 at 6:00 p.m., at the Seneca Nation of Indians, William Seneca Building, 12837 Rte 438, Irving, NY; April 1, 2009 at 6:30 p.m. at the Ashford Office Complex, 9030 Route 219, West Valley, NY; and on April 2, 2009 at 6:30 p.m. at the Clarion Hotel - McKinley's Banquet and Conference Center, S-3950 McKinley Parkway, Blasdell, NY.** Written comments on the Draft EIS will be accepted until June 8, 2009. A hard copy of the DEIS/FEIS is available at the following locations: Concord Public Library, 18 Chapel Street, Springville, NY 14141 and Ashford Office Complex Reading Room, 9030 Route 219 West Valley, NY 14171. The online version of the DEIS is available at the following publically accessible web site: www.westvalleyEIS.com.

The action involves the completion of the West Valley Demonstration Project (WVDP) and the decommissioning and/or long-term management or stewardship of the Western New York Nuclear Service Center. This includes the decontamination and decommissioning of the waste storage tanks and facilities used in the solidification of high-level radioactive waste, and any material and hardware used in connection with the WVDP.

US DOE needs to determine the manner in which facilities, materials, and hardware for which DOE is responsible will be managed or decommissioned in accordance with applicable Federal and State requirements. NYSERDA needs to determine what, if any, material or structures for which it is responsible will remain on site, and what, if any, institutional controls, engineered barriers, or stewardship provisions would be needed. The project is located at 10282 Rock Springs Road and West Valley, New York. The majority of the facility (3,300 acres) is located in Cattaraugus County, and 15 acres of the facility are located in Erie County.

Contact: Paul J. Bembia, West Valley Site Management Program, 9030 Route 219, West Valley, NY 14171, Phone: (716) 942-9960, E-mail: pjb@nyserda.org.

ENB - STATEWIDE NOTICES

Completed Applications
Consolidated SPDES Renewals

Public Notice

Availability of Notice of Intent to Prepare an Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center

SUMMARY: The U.S. Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA) are announcing their intent to prepare an Environmental Impact Statement (EIS) for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project (WVDP) and Western New York Nuclear Service Center (also known as the "Center"). The U.S. Nuclear Regulatory Commission (NRC), the U.S. Environmental Protection Agency (EPA), and the New York State Department of Environmental Conservation (NYSDEC) will participate as cooperating agencies under the National Environmental Policy Act (NEPA, 42 USC 4321 et seq.). In addition, NYSDEC will participate as an involved agency under the New York State Environmental Quality Review Act (SEQRA) with respect to NYSERDA's proposed actions. DOE, under NEPA, and NYSERDA, under SEQRA, plan to evaluate the range of reasonable alternatives in this EIS to address their respective responsibilities at the Center, including those under the West Valley Demonstration Project Act (Public Law 96-368), Atomic Energy Act of 1954 (as amended), and all other applicable Federal and State statutes.

This EIS will revise the Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center (DOE/EIS-0226-D, January 1996, also referred to as the 1996 Cleanup and Closure Draft EIS). Based on decommissioning criteria for the WVDP issued by NRC since the Cleanup and Closure EIS was published, DOE and NYSERDA propose to evaluate five alternatives: Unrestricted Site Release, Partial Site Release without Restrictions, Partial Site Release with Restrictions, Monitor and Maintain under Current Operations, and No-Action.

DATES: DOE and NYSERDA are inviting public comments on the scope and content of the Decommissioning and/or Long-Term Stewardship EIS. Comments must be received by April 28, 2003. DOE and NYSERDA will hold two public scoping meetings on the EIS at the Ashford Office Complex, located at 9030 Route 219 in the Town of Ashford, NY, from 7:00 to 9:30 p.m. on April 9, 2003 and April 10, 2003.

ADDRESSES: Address comments on the scope of the Decommissioning and/or Long-Term Stewardship EIS to the DOE Document Manager:

Mr. Daniel W. Sullivan
West Valley Demonstration Project
U.S. Department of Energy, WV-49
10282 Rock Springs Road
West Valley, New York 14171
Telephone: (800) 633-5280
Facsimile: (716) 942-4199
E-mail: sonja.allen@wvnsco.com

FOR FURTHER INFORMATION, CONTACT: For information regarding the WVDP or the EIS, contact Mr. Daniel Sullivan as described above. Those seeking general information on DOE's NEPA process should contact:

Ms. Carol M. Borgstrom, (EH-42)
Director
Office of NEPA Policy and Compliance
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585
Telephone: (202) 586-4600
Facsimile: (202) 586-7031
or leave a message at 1-800-472-2756, toll-free.

Questions for NYSERDA should be directed to:

Mr. Paul J. Bembia
New York State Energy Research and Development Authority
10282 Rock Springs Road
West Valley, New York 14171
Telephone: (716) 942-4900
Facsimile: (716) 942-2148
E-mail: pjb@nyserda.org

Those seeking general information on the SEQRA process should contact:

Mr. Hal Brodie
Deputy Counsel
New York State Energy Research and Development Authority
17 Columbia Circle
Albany, New York 12203-6399
Telephone: (518) 862-1090, ext. 3280
Facsimile: (518) 862-1091
E-mail: hb1@nyserda.org

DOE and NYSERDA have prepared a detailed Notice of Intent for the Environmental Impact Statement which is available on the internet at www.nyserda.org/programs/ and at http://tis.eh.doe.gov/nepa under "What's New."

Additional information about NYSERDA's West Valley Site Management Program is available on the internet at www.nyserda.org/programs/ Additional information about the WVDP is available on the internet at www.wv.doe.gov/linkingpages/insidewestvalley.htm

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ENB

Official Publication of the New York State Department of Environmental Conservation

Produced weekly by Business Environment Publications, Inc.

Environmental Notice Bulletin

(USPS 0371-670) (ISSN: 0740-5847)

Issue No. 12

March 20, 1996

***Highlights** in this Issue:*

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Moving?

Please send entire mailing label from this issue with your changes to us at the above address or call (518) 383-1471.

The project is located immediately west of NYS Route 242 between Sunset Hill Road and Maple Valley Road. The dike for the Bundle Wildlife Marsh will be 65 feet north of, and parallel to, Sunset Hill Road.

Contact: Jeffrey E. Dietz, Environmental Analyst I, NYSDEC - Region 9, 270 Michigan Ave., Buffalo, NY 14203-2999, (716)851-7165

Positive Declaration and Public Scoping Session

Erie County - The Town of Amherst, as lead agency, has determined that the proposed **Boulevard Consumer Square** may have a significant environmental impact and a draft Environmental Impact Statement must be prepared.

The action involves a rezoning of 37.2 acres of land from Research Development (RD) to General Business (GB) to allow construction of 445,893 sq. ft. of retail space and 2026 parking spaces. This area is proposed to be developed in conjunction with a 10.8 acre parcel located adjacent westerly that fronts on Niagara Falls Blvd. Proposed totals for entire development are as follows: 48 acres, eleven buildings, 554,860 gross square feet of retail space and 2816 parking spaces. The proposal also includes an easterly extension of existing Romney Dr. to North Bailey Ave.

The project is located at 1621 Niagara Falls Blvd. Town of Amherst, Erie County.

Final date for written comments is **March 28, 1996.** The Draft Scope is available for review at the Town of Amherst Planning Department, 5583 Main St., Williamsville, NY 14221.

Contact: Joseph J. Gillings, Planning Director, Town of Amherst Planning Dept., 5583 Main St., Williamsville, NY 14221, (716)631-7051

Draft EIS

Cattaraugus County - The NY State Energy Research and Development Authority, as lead agency, has accepted a draft EIS on the proposed **Completion of West Valley Demonstration Project and Closure or Long-Term Management of the Facilities at the Western NY Nuclear Service Center.** Comments are requested on the Draft EIS and will be accepted by the contact person until **September 22, 1996.**

The action involves the Western New York Nuclear Service Center (Center) is the site of a former spent nuclear fuel reprocessing facility and other radioactive materials management facilities. The NY State Energy Research and Development Authority (NYSERDA) holds title to the site on behalf of the people of the State of NY. A central 200-acre portion of the site includes the reprocessing building and associated facilities, tanks containing high-level radioactive waste from reprocessing operations, waste storage facilities, and two radioactive waste disposal areas. the West Valley Demonstration Project is a joint federal-state cleanup under which the United State Department of Energy (DOE), in cooperation with NYSERDA, will solidify the high-level radioactive waste, transport the solidified waste for disposal at an appropriate federal repository, dispose of the low-level and transuranic waste produced by the solidification of the high-level waste and decontaminate and decommission all facilities used in solidifying the high-level waste. In 1982, a Final EIS was issued by DOE concerning Long-Term Management of the Liquid High-Level Wastes.

This Draft EIS addresses the completion of the West Valley Demonstration Project by DOE and long-term management of the balance of the site by NYSERDA and was prepared jointly by the two agencies. DOE is the lead agency for review under the National Environmental Policy Act. NYSERDA is the lead under the State Environmental Quality Review Act.

This Draft EIS analyzes the impacts of five alternatives for completion of the Demonstration Project and closure or long-term management of the facilities at the Center.

The project is located on Rock Springs Road in the Town of Ashford, Cattaraugus County, with a small portion extending into the Town of Concord, Erie County. The Center is located with Region 9 of the NYS DEC.

Contact: Tom Attridge, NYS Energy Research & Development Authority, PO Box 191, WV-17, West Valley, NY 14171-0191, (716)942-2453

Contact: Gerard Pietraszek, NYSDEC, Region 9, 270 Michigan Ave., Buffalo, NY 14203-1299

DEPARTMENT OF ENERGY

Notice of Extension of Public Comment Period for the Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center, DOE/EIS–0226D (Revised)

AGENCY: Department of Energy.

ACTION: Notice of extension of public comment period.

SUMMARY: This notice announces an extension of the public comment period initially published in the December 5, 2008 Notice of Availability (73 FR 74160) for the Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center [DOE/EIS–0226–D (Revised)] (referred to as the ''Draft Decommissioning and/or Long-Term Stewardship EIS'' or ''Draft EIS.''). The comment period will now close on September 8, 2009.

DATES: The comment period will be extended from June 8, 2009 to September 8, 2009.

ADDRESSES: Copies of this Draft EIS are available for review at the Concord Public Library, 18 Chapel Street, Springville, New York 14141, (716) 592–7742, the Ashford Office Complex Reading Room, 9030 Route 219, West Valley, New York 14171, (716) 942–4555 and the U.S. Department of Energy, FOIA Reading Room, 1E–190, Forrestal Bldg., 1000 Independence Ave., SW., Washington, DC 20585, 202–586–3142.

This Draft EIS is also available at *http://www.westvalleyeis.com.*

Written comments may be mailed to Catherine Bohan, EIS Document Manager, West Valley Demonstration Project, U.S. Department of Energy, P.O. Box 2368, Germantown, MD 20874. Comments or requests for information may also be submitted via e-mail at *http://www.westvalleyeis.com* or by faxing toll-free to 866–306–9094. Please mark all envelopes, faxes and e-mail: ''Draft Decommissioning and/or Long-Term Stewardship EIS Comments.'' All comments received during the comment period, as extended, will be considered during preparation of the Final EIS.

FOR FURTHER INFORMATION CONTACT: For information regarding the WVDP or this Draft EIS, contact Catherine Bohan at the above address. The following Web sites may also be accessed for additional information on the Draft EIS or the West Valley Site: *http://www.westvalleyeis.com* or *http://www.wv.doe.gov.*

Issued in Washington, DC, on June 5, 2009.

Michael C. Moore,

Director, Office of Small Sites.

[FR Doc. E9–13837 Filed 6–11–09; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Notice of Changes to Public Hearings for the Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center, DOE/EIS–0226D (Revised)

AGENCY: Department of Energy.

ACTION: Notice of changes to public hearings.

SUMMARY: This notice announces changes to the public hearings initially published in the December 5, 2008 Notice of Availability (73 FR 74160) for the *Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center [DOE/EIS–0226–D (Revised)]* (referred to as the ''Draft Decommissioning and/or Long-Term Stewardship EIS'' or ''Draft EIS.''). An additional public hearing will be held in Albany, NY and the location for the Blasdell, NY hearing has been changed to Buffalo, NY.

DATES: Public hearings on the Draft EIS will be held on March 30, 2009; March 31, 2009; April 1, 2009; and April 2, 2009.

ADDRESSES: Public hearings will be held at the following locations: Monday, March 30, 2009, from 6:30 p.m. to 9:30 p.m. at the Crowne Plaza Albany Hotel, State and Lodge Street, Albany, NY 12207; Tuesday, March 31, 2009, from 6 p.m. to 9 p.m. at the Seneca Nation of Indians, William Seneca Building, 12837 Route 438, Irving, NY 14081; Wednesday, April 1, 2009, from 6:30 p.m. to 9:30 p.m. at the Ashford Office Complex, 9030 Route 219, West Valley, NY 14177; and Thursday, April 2, 2009, from 6:30 p.m. to 9:30 p.m. at the Erie Community College/City Campus Auditorium, 121 Ellicott Street, Buffalo, NY 14203.

FOR FURTHER INFORMATION CONTACT: Oral and written comments on the Draft EIS will be accepted at the public hearings, or written comments may be mailed to Catherine Bohan, EIS Document Manager, West Valley Demonstration Project, U.S. Department of Energy, P.O. Box 2368, Germantown, MD 20874. Comments must be received by June 8, 2009 to be considered in the Final EIS. Comments may also be submitted via e-mail at *http://www.westvalleyeis.com* or by faxing toll-free to 866–306–9094. Please mark all envelopes, faxes, and e-mail: ''Draft Decommissioning and/or

Long-Term Stewardship EIS Comments.''

Issued in Washington, DC on March 11, 2009.

Michael C. Moore,

Acting Director, Office of Small Sites Projects.

[FR Doc. E9–5701 Filed 3–16–09; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Notice of Availability of the Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center

AGENCY: Department of Energy.

ACTION: Notice of availability.

SUMMARY: The U.S. Department of Energy (DOE) announces the availability of the *Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (DOE/EIS–0226–D [Revised]) (referred to as the ''Draft Decommissioning and/or Long-Term Stewardship EIS'' or ''Draft EIS''). This Draft EIS revises the *Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center* (DOE/EIS–0226–D) issued for public comment in January 1996 (referred to as the ''1996 Cleanup and Closure Draft EIS'').

This Draft EIS was prepared in accordance with the Council on Environmental Quality's National Environmental Policy Act (NEPA) Implementing Regulations (40 CFR parts 1500–1508) and the DOE NEPA Implementing Procedures (10 CFR part 1021). DOE and the New York State Energy Research and Development Authority (NYSERDA) are joint lead agencies for preparing the Draft EIS, while the U.S. Nuclear Regulatory Commission (NRC), the U.S. Environmental Protection Agency (EPA), and the New York State Department of Environmental Conservation (NYSDEC) are cooperating agencies. NYSDEC and the New York State Department of Health (NYSDOH) are involved agencies under the New York State Environmental Quality Review Act (SEQRA).

This Draft EIS analyzes alternatives for decommissioning the site and/or long-term stewardship, as well as a No Action Alternative as required by NEPA and SEQRA. The Proposed Action is the completion of the West Valley Demonstration Project (WVDP) and the decommissioning and/or long-term

management or stewardship of the Western New York Nuclear Service Center (WNYNSC). This includes the decontamination and decommissioning of the waste storage tanks and facilities used in the solidification of high-level radioactive waste, and any material and hardware used in connection with the WVDP. DOE needs to determine the manner in which facilities, materials, and hardware for which the Department is responsible will be managed or decommissioned in accordance with applicable Federal and State requirements. NYSERDA needs to determine what material or structures for which it is responsible will remain on site, and what institutional controls, engineered barriers, or stewardship provisions would be needed.

For the Proposed Action, the three action alternatives evaluated in the Draft EIS are *Sitewide Removal*, *Sitewide Close-In-Place*, and *Phased Decisionmaking*. A No Action Alternative is also evaluated in accordance with NEPA, which would continue management and oversight of the WNYNSC under the conditions that will exist at the Starting Point of this EIS in 2011.

DATES: The public is invited to comment on the Draft EIS, and all comments received which are postmarked no later than the end of the public comment period, June 8, 2009, will be addressed in preparing the Final EIS. Comments postmarked after this date will be considered to the extent practicable. Public hearings on the Draft EIS will be held at the following dates and locations in New York: Tuesday, March 31, 2009, Seneca Nation of Indians, William Seneca Building, 12837 Rte. 438, Irving, NY; Wednesday, April 1, 2009, Ashford Office Complex, 9030 Route 219, West Valley, NY; and Thursday, April 2, 2009, Clarion Hotel—McKinley's Banquet and Conference Center, S–3950 McKinley Parkway, Blasdell, NY. Information regarding these dates, times and locations will be announced via other means such as local press announcements. Oral and written comments will be accepted at the public hearings.

ADDRESSES: Copies of this Draft EIS are available for review at the Concord Public Library, 18 Chapel Street, Springville, NY 14141, (716) 592–7742, the Ashford Office Complex Reading Room, 9030 Route 219, West Valley, NY 14171, (716) 942–4555 and the U.S. Department of Energy, FOIA Reading Room, 1E–190, Forrestal Bldg., 1000 Independence Ave., SW., Washington, DC 20585, 202–586–3142.

This Draft EIS is also available at *http://www.westvalleyeis.com*.

Oral and written comments on the Draft EIS will be accepted at the public hearings, or written comments may be mailed to Catherine Bohan, EIS Document Manager, West Valley Demonstration Project, U.S. Department of Energy, P.O. Box 2368, Germantown, MD 20874. Comments or requests for information may also be submitted via e-mail at *http://www.westvalleyeis.com* or by faxing toll-free to 866–306–9094. Please mark all envelopes, faxes and e-mail: ''Draft Decommissioning and/or Long-Term Stewardship EIS Comments.'' All comments received or postmarked during the comment period will be considered during preparation of the Final EIS. Late comments will be considered to the extent practicable.

FOR FURTHER INFORMATION CONTACT: For information regarding the WVDP or this Draft EIS, contact Catherine Bohan at the above address. The following Web sites may also be accessed for additional information on the Draft EIS or the West Valley Site: *http://www.westvalleyeis.com* or *http://www.wv.doe.gov*.

For general information on DOE's NEPA process contact: Carol Borgstrom, Director, Office of NEPA Policy and Compliance (GC–20), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585; e-mail *AskNEPA@hq.doe.gov*; telephone 202–586–4600; or leave a message at 800–472–2756. The Draft EIS will also be accessible through the Department's NEPA Web site at *http://www.gc.energy.gov./NEPA*.

For general questions and information about NYSERDA, contact Paul Bembia, Program Director, West Valley Site Management Program, New York State Energy Research and Development Authority, Ashford Office Complex, 9030 Route 219, West Valley, NY 14171; telephone 716–942–9960, extension 4900; fax 716–942–9961; or e-mail *pjb@nyserda.org*.

SUPPLEMENTARY INFORMATION: The WNYNSC is located south of Buffalo, NY, owned by NYSERDA, on behalf of New York State, and was the site of a commercial nuclear fuel reprocessing facility. Spent fuel reprocessing operations conducted from 1966 to 1972 resulted in the generation of 2,500,000 liters (660,000 gallons) of high-level radioactive waste, which were stored in two underground tanks. WVDP was authorized by Congress in 1980 to demonstrate the solidification of the high-level radioactive waste remaining in the underground tanks at the WNYNSC site. Through a Cooperative Agreement between DOE and NYSERDA, DOE assumed control, but not ownership, of the project premises portion of the site (the area in which the WVDP is located) in order to conduct the WVDP. Solidification of the high-level radioactive waste was completed in 2002, and the solidified high-level radioactive waste is currently stored at the site and will ultimately be transported to an appropriate Federal repository for permanent disposal.

A Draft EIS for cleanup and closure of the WNYNSC was issued for public comment in 1996 (1996 Cleanup and Closure Draft EIS), but a Preferred Alternative was not identified, and a Final EIS was not issued. Instead, DOE and NYSERDA believed it was important to defer selection of a Preferred Alternative until more studies and analyses were completed and the NRC policy statement, including decommissioning criteria for the WVDP, were issued. Since that time, additional data have been collected on structural geology, local fractures, and seismicity. Designs for potential engineering approaches for decommissioning have been evaluated. Disposal area and facility inventory reports have been updated; improved methods for analyzing erosion and groundwater flow and transport have been developed and refined; a citizen task force has been consulted on the nature of a Preferred Alternative; and workshops to refine methods for long-term performance assessment have been conducted. Assumptions and design features for specific alternatives were reviewed and revised.

This Draft Decommissioning and/or Long-Term Stewardship revises the 1996 clean-up and closure EIS, and was prepared in accordance with the Council on Environmental Quality's National Environmental Policy Act NEPA Implementing Regulations (40 CFR Parts 1500–1508) and DOE NEPA Implementing Procedures (10 CFR Part 1021). DOE and NYSERDA are joint lead agencies for preparing the Draft EIS, while NRC, EPA and NYSDEC are cooperating agencies. NYSDEC and NYSDOH are involved agencies under SEQRA. DOE needs to determine what material or structures for which it is responsible will remain on site, and what institutional controls, engineered barriers, or stewardship provisions would be needed. NYSERDA needs to determine the manner in which facilities and property for which NYSERDA is responsible, including the State-licensed Disposal Area, will be managed or decommissioned, in accordance with applicable Federal and State requirements. To this end, NYSERDA needs to determine what material or structures for which it is responsible will remain on site, and what institutional controls, engineered barriers, or stewardship provisions would be needed.

This Draft EIS is intended to support DOE and NYSERDA decisions regarding the Proposed Action, which is the completion of the WVDP and the decommissioning and/or long-term management or stewardship of the WNYNSC. This would include the disposition of the high-level radioactive waste storage tanks, the former spent fuel reprocessing plant, the North Plateau Groundwater Plume, the Cesium Prong, the NRC-licensed Disposal Area (NDA), and the State-licensed Disposal Area (SDA). The three action alternatives evaluated for the Proposed Action are as follows:

Sitewide Removal: Under this alternative, all site facilities as outlined in this Draft EIS would be removed; all environmental media would be decontaminated; and all radioactive, hazardous, and mixed waste would be characterized, packaged as necessary, and shipped off site for disposal. Completion of these activities would allow unrestricted use of the site (i.e., the site could be made available for any public or private use). This alternative includes temporary onsite storage of vitrified high-level radioactive waste canisters pending the availability of a Federal repository.

Sitewide Close-In-Place: Under this alternative, most facilities would be closed in place. Residual radioactivity in facilities with larger inventories of long-lived radionuclides would be isolated by specially designed closure structures and engineered barriers. Major facilities and sources of contamination, such as the Waste Tank Farm and burial grounds, would be managed at their current locations. This would allow large areas of the site to be released for unrestricted use. The license for remaining portions of the WNYNSC could be terminated under restricted conditions, or those portions could remain under long-term NRC license or permit. Facilities that are closed in-place, and any buffer areas around them, would require long-term stewardship.

Phased Decisionmaking: Under this alternative, decommissioning would be completed in two phases. This alternative involves near-term removal actions where there is agency consensus and characterization studies to facilitate decisionmaking for the remaining facilities or areas.

Phase 1 would include removal of the Main Plant Process Building, the source of the North Plateau Groundwater Plume, and the lagoons on the WVDP premises. All facilities and the lagoons would be removed, except for the permeable treatment wall (an *in-situ* groundwater mitigation technology). Phase 1 decisions would also include removal of a number of other facilities on the WVDP premises. No decommissioning or long-term management activities would be conducted for the Waste Tank Farm and its support facilities, the construction and demolition debris landfill, the non-source area of the North Plateau Groundwater Plume, or the NDA. The SDA would continue under active management, consistent with its permit and license requirements. Phase 1 activities would make use of proven technologies and available waste disposal sites to reduce the potential near-term health and safety risks from residual radioactivity and hazardous contaminants at the site. Phase 1 would also include an ongoing assessment period during which DOE and NYSERDA would conduct additional studies, evaluations, and characterization of site contamination. The studies and evaluations would be conducted to clarify and possibly reduce technical uncertainties related to the decision on final decommissioning and long-term management of the site, particularly uncertainties associated with the long-term performance models, the performance of engineered barriers and other technologies for in-place containment, the viability and cost of technology for exhuming buried waste, and the availability of waste disposal sites. In consultation with NYSERDA and the cooperating and involved agencies on this Draft EIS, DOE would determine whether the new information warrants a new or supplemental EIS. NYSERDA also would assess the results of site-specific studies and other information during Phase 1 to determine the need for additional SEQRA documentation.

According to the approach determined most appropriate during the additional Phase 1 studies and evaluations, Phase 2 would complete decommissioning or long-term management decisionmaking. Under the Phased Decisionmaking Alternative, the Phase 2 decision would be made within 30 years.

No Action Alternative: Under this alternative, no actions toward decommissioning would be taken. This alternative would involve the continued management and oversight of all facilities located on the WNYNSC property as of the Starting Point for this EIS in 2011. The No Action Alternative does not meet the Purpose and Need for agency action, but analysis of the No Action Alternative is required under NEPA and SEQRA as a basis of comparison.

Preferred Alternative: The Phased Decisionmaking Alternative is DOE's and NYSERDA's Preferred Alternative.

Combination Alternatives: DOE and NYSERDA recognize that, after consideration of public comments, some combination of alternatives analyzed in the Draft EIS may be identified as the best way to meet agency goals and protect human health and safety and the environment. If a specific combination alternative is identified as preferred between the Draft and Final EISs, DOE would present the combination alternative and its potential impacts in the Final EIS. If a combination alternative is ultimately selected for implementation, the Record of Decision and Findings Statement (under SEQRA) would explain the reasons DOE and NYSERDA made that decision.

Following the end of the public comment period, DOE will consider and respond to the comments received, and issue the Final Decommissioning and/or Long-Term Stewardship EIS, including a Comment Response Document. DOE will issue a Record of Decision no sooner than 30 days after EPA issues a Notice of Availability of the final EIS in the Federal Register.

Signed in Washington, DC, November 25, 2008.

Ines R. Triay,

Acting Assistant Secretary for Environmental Management.

[FR Doc. E8–28806 Filed 12–4–08; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Notice of Intent to Prepare an Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center

AGENCY: Department of Energy.

ACTION: Notice of Intent.

SUMMARY: The U.S. Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA) are announcing their intent to prepare an Environmental Impact Statement (EIS) for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project (WVDP) and Western New York Nuclear Service Center (also known as the ''Center''). The U.S. Nuclear Regulatory Commission (NRC), the U.S. Environmental Protection Agency (EPA), and the New York State Department of Environmental Conservation (NYSDEC) will participate as cooperating agencies under the National Environmental Policy Act (NEPA, 42 U.S.C. 4321 *et seq.*). In addition, NYSDEC will participate as an involved agency under the New York State Environmental Quality Review Act (SEQRA) with respect to NYSERDA 's proposed actions. DOE, under NEPA, and NYSERDA, under SEQRA, plan to evaluate the range of reasonable alternatives in this EIS to address their respective responsibilities at the Center, including those under the West Valley Demonstration Project Act (Pub. L. 96–368), Atomic Energy Act of 1954 (as amended), and all other applicable Federal and State statutes.

This EIS will revise the Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center (DOE/EIS–0226–D, January 1996, also referred to as the 1996 Cleanup and Closure Draft EIS). Based on decommissioning criteria for the WVDP issued by NRC since the Cleanup and Closure EIS was published, DOE and NYSERDA propose to evaluate five alternatives: Unrestricted Site Release, Partial Site Release without Restrictions, Partial Site Release with Restrictions, Monitor and Maintain under Current Operations, and No-Action.

DATES: DOE and NYSERDA are inviting public comments on the scope and content of the Decommissioning and/or Long-Term Stewardship EIS during a public comment period commencing with the date of publication of this Notice and ending on April 28, 2003. DOE and NYSERDA will hold two public scoping meetings on the EIS at the Ashford Office Complex, located at 9030 Route 219 in the Town of Ashford, NY, from 7 to 9:30 p.m. on April 9, 2003 and April 10, 2003.

ADDRESSES: Address comments on the scope of the Decommissioning and/or Long-Term Stewardship EIS to the DOE Document Manager: Mr. Daniel W. Sullivan, West Valley Demonstration Project, U.S. Department of Energy, WV–49, 10282 Rock Springs Road, West Valley, New York 14171, Telephone: (800) 633–5280, Facsimile: (716) 942–4199, E-mail: *sonja.allen@wvnsco.com.*

The ''Public Reading Rooms'' section under **SUPPLEMENTARY INFORMATION** lists the addresses of the reading rooms where documents referenced herein are available.

FOR FURTHER INFORMATION, CONTACT: For information regarding the WVDP or the EIS, contact Mr. Daniel Sullivan as described above. Those seeking general information on DOE's NEPA process should contact: Ms. Carol M. Borgstrom, (EH–42), Director, Office of NEPA Policy and Compliance, U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585, *Telephone:* (202) 586–4600, *Facsimile:* (202) 586–7031, or leave a message at 1–800–472–2756, toll-free.

Questions for NYSERDA should be directed to: Mr. Paul J. Bembia, New York State Energy Research and Development Authority, 10282 Rock Springs Road, West Valley, New York 14171, *Telephone:* (716) 942–4900, *Facsimile:* (716) 942–2148, E-mail: *pjb@nyserda.org.*

Those seeking general information on the SEQRA process should contact: Mr. Hal Brodie, Deputy Counsel, New York State Energy Research and Development Authority, 17 Columbia Circle, Albany, New York 12203–6399, *Telephone:* (518) 862–1090, ext. 3280, *Facsimile:* (518) 862–1091, *E-mail: hb1@nyserda.org.*

This Notice of Intent will be available on the internet at *http://tis.eh.doe.gov/nepa,* under ''What's New.'' Additional information about the WVDP is also available on the internet at *http://www.wv.doe.gov/linkingpages/insidewestvalley.htm.*

SUPPLEMENTARY INFORMATION: DOE and NYSERDA intend to prepare a revised draft Environmental Impact Statement (EIS) for Decommissioning and/or Long-Term Stewardship at the WVDP and Western New York Nuclear Service Center to examine the potential environmental impacts of the proposed action to decommission and/or maintain long-term stewardship at the Center. The NRC, the EPA, and NYSDEC will participate as cooperating agencies under NEPA. NYSDEC will also participate as an involved agency under SEQRA with respect to NYSERDA 's proposed actions. DOE, under NEPA, and NYSERDA, under SEQRA, plan to evaluate the range of reasonable alternatives in this EIS to address their respective responsibilities at the Center, including those under the WVDP Act, Atomic Energy Act of 1954 (as amended), and all other applicable Federal and State statutes.

Background

The Western New York Nuclear Service Center consists of a 3,345-acre reservation in rural western New York that is the location of the only NRC-licensed commercial spent nuclear fuel reprocessing facility to have ever operated in the United States. Reprocessing operations resulted in the generation of approximately 600,000 gallons of liquid high-level waste (HLW), which was stored in large underground tanks adjacent to the reprocessing facility. NYSERDA holds title to the Center on behalf of the people of the State of New York. (See H. Rep. No. 96–1000 at 4 (1980) reprinted in 1980 U.S.S.C.A.N 3102, 3103.)

The WVDP Act of 1980 required DOE to solidify the HLW, transport it to a Federal geologic repository, dispose of the low-level waste (LLW) and transuranic (TRU) waste generated from Project activities, and decontaminate and decommission the facilities used for the Project. The Act also authorized NRC to prescribe decommissioning criteria for the WVDP. The NRC has placed NYSERDA 's NRC site license in abeyance during DOE's fulfillment of its WVDP Act requirements.

Pursuant to the WVDP Act, on October 1, 1980, DOE and NYSERDA entered into a Cooperative Agreement (amended September 19, 1981) that established a framework for the implementation of the Project. Under the agreement, NYSERDA has made available to DOE, without transfer of title, an approximately 200-acre portion of the Center, known as the ''Project Premises,'' which includes a formerly operated spent nuclear fuel reprocessing plant, spent nuclear fuel receiving and storage area, underground liquid HLW storage tanks, and a liquid LLW treatment facility with associated lagoons, as well as other facilities. Most of the facilities on the Project premises were radioactively contaminated from reprocessing operations and are located on a geographic area of the Center known as the North Plateau. Among the other facilities located within the Project Premises is a radioactive waste disposal area known as the NRC-licensed disposal area (NDA). Adjacent to the Project Premises is a radioactive waste disposal area known as the State Licensed Disposal Area (SDA) for which NYSERDA has operational responsibility. Both the NDA and SDA are located on the South Plateau geographic area of the Center.

In 1987, DOE agreed, in a Stipulation of Compromise settling a lawsuit filed by local citizens, to evaluate the feasibility of onsite disposal of LLW generated as a result of Project activities in a Cleanup and Closure EIS, and to initiate the EIS process by the end of calendar year 1988. DOE and NYSERDA jointly issued the resulting Draft EIS for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center (DOE/EIS–0226-D, also known as the ''Cleanup and Closure EIS'') in 1996. The Cleanup and Closure draft EIS evaluated a range of alternatives that included a broad scope of waste management and decontamination/ decommissioning activities. However, the draft EIS did not identify a preferred alternative.

In 2001, DOE revised its NEPA strategy to continue its EIS process in order to complete its obligations under the WVDP Act. DOE announced that it would prepare a separate EIS to address decontamination and near-term waste management activities for which it is solely responsible under the Act (66 FR 16647, March 26, 2001). In addition, DOE and NYSERDA would jointly prepare a second EIS for decommissioning and/or long-term stewardship to address activities for which each party is responsible. After considering public comments on the March 26, 2001, NOI and new information identified under ''New Information to be Evaluated'' below, DOE believes the scopes of both EISs should be further modified as follows. The first EIS, the West Valley Waste Management EIS, would address actions pertaining to waste accumulated in storage on site as a result of past Project activities as well as waste to be generated in the near term. The second EIS, this decommissioning and/or long-term stewardship EIS, would analyze various decommissioning and/or long-term stewardship alternatives and would include decontamination as well. It would also include the management of wastes generated by decommissioning and/or long-term stewardship actions. Because this second EIS addresses strategies that may be used to complete the WVDP and disposition the Center, DOE now intends that this EIS would replace the 1996 Cleanup and Closure EIS. (DOE issued an Advance Notice of Intent inviting preliminary public input to the scope of this EIS on November 6, 2001 [66 FR 56090].)

On February 1, 2002, the NRC published in the **Federal Register** (67 FR 5003) its Decommissioning Criteria for the West Valley Demonstration Project (M–32) at the West Valley Site; Final Policy Statement. The NRC decided that it would apply its License Termination Rule (10 CFR 20, Subpart E) as the decommissioning criteria for the WVDP and the decommissioning goal for the entire NRC-licensed site. The NRC intends to use this West Valley EIS to evaluate the environmental impacts of the various alternatives before deciding whether to accept the preferred alternative as meeting the criteria permitted by the License Termination Rule.

Purpose and Need for Action

DOE is required by the WVDP Act to decontaminate and decommission the tanks and facilities used in the solidification of the HLW, and any material and hardware used in connection with the WVDP, in accordance with such requirements as the NRC may prescribe. The NRC has prescribed its License Termination Rule as the decommissioning criteria for the WVDP. Therefore, DOE needs to determine the manner that facilities, materials, and hardware for which the Department is responsible are managed or decommissioned, in accordance with applicable Federal and State requirements. To this end, DOE needs to determine what, if any, material or structures for which it is responsible will remain on site, and what, if any, institutional controls, engineered barriers, or stewardship provisions would be needed.

NYSERDA needs to determine the manner that facilities and property for which NYSERDA is responsible, including the State-Licensed Disposal Area, will be managed or decommissioned, in accordance with applicable Federal and State requirements. To this end, NYSERDA needs to determine what, if any, material or structures for which it is responsible will remain on site, and what, if any, institutional controls, engineered barriers, or stewardship provisions would be needed. It is NYSERDA's intent to pursue termination of the existing 10 CFR Part 50 license for the Western New York Nuclear Service Center (currently held in abeyance) upon DOE's completion of decontamination and decommissioning under the WVDP Act in accordance with criteria prescribed by the NRC. NYSERDA plans to use the analysis of alternatives in the Decommissioning and/or Long-Term Stewardship EIS to support any necessary NRC or NYSDEC license or permit applications.

Areas of Disagreement With Respect to Responsibilities

DOE and NYSERDA currently do not agree on their respective responsibilities, including whether DOE is required under the WVDP Act to remediate the North Plateau groundwater plume and decommission the NDA, and which party is responsible for any long-term stewardship following the decommissioning actions required under the WVDP Act.

In accordance with their respective applicable legal requirements, DOE and NYSERDA each have unilateral decision-making authority for those actions for which they are responsible. DOE will determine the manner in which it will decommission Project facilities as required under the WVDP Act. NYSERDA will determine the manner in which non-Project facilities, not required to be decommissioned under the WVDP Act, will be managed.

Potential Range of Alternatives

DOE and NYSERDA intend to use the NRC's License Termination Rule and associated guidance provided in the NRC's Final Policy Statement as the framework to evaluate possible alternatives for decommissioning and/or long-term stewardship actions involving WVDP facilities, as well as decommissioning and/or long-term stewardship actions involving NYSERDA-controlled facilities and areas on the Center. In the Final Policy Statement, the NRC recognized that it does not have the regulatory authority to apply the License Termination Rule to the SDA, and said that a cooperative approach with the State will be utilized to the extent practical to apply the License Termination Rule in a coordinated manner.

As required by NEPA, the EIS will present the environmental impacts associated with the range of reasonable alternatives to meet DOE's and NYSERDA's purposes and needs for action, and a no-action alternative. This range encompasses release of the Center for re-use under unrestricted and restricted conditions as allowed under the License Termination Rule. The EIS will present the health and environmental consequences of the alternatives in comparable form to provide a clear basis for informed decision making. DOE's and NYSERDA's preferred alternative will be identified in the Draft EIS. This Draft EIS will also include an evaluation of whether the alternatives would meet the NRC decommissioning criteria and other applicable requirements.

Alternative 1—Unrestricted Site Release

DOE and NYSERDA intend to evaluate an alternative that could satisfy the License Termination Rule criteria and permit termination of NYSERDA's NRC license without restrictions. DOE and NYSERDA are proposing that this alternative involve removal of WVDP and non-WVDP wastes, structures, and contaminated soils to the extent required so that the radiological criteria specified in 10 CFR 20.1402 can be met for Project and non-Project facilities and the balance of the 3,345-acre Center. This alternative includes exhumation and offsite disposal of waste and contaminated soils from the NDA and SDA on the South Plateau.

DOE and NYSERDA intend to evaluate the need for new onsite interim waste storage capacity under Alternative 1 for some waste types, such as Greater-Than-Class C waste, that may not be able to be disposed of in a time frame that would support timely implementation of this EIS alternative. Such an interim storage facility would remain under institutional control until the waste it contains is removed from the site. Following implementation of this alternative, including removal of any wastes in interim storage, the Center could be released without restrictions.

Alternative 2—Partial Site Release without Restrictions

DOE and NYSERDA intend to evaluate an alternative that could satisfy the radiological criteria specified in 10 CFR 20.1402 for facilities and areas on the North Plateau geographic area of the Center, including the North Plateau groundwater plume, as well as the balance of the 3,345-acre Center, with the exception of the NDA and SDA. This would include removal of WVDP and non-WVDP wastes, structures, and contaminated soils to the extent required so that the radiological criteria specified in 10 CFR 20.1402 can be met for the North Plateau. Appropriate infiltration controls would be evaluated for the NDA and the SDA. The NDA and SDA on the South Plateau would not be released but would be managed, monitored, and maintained under permit, license, or other appropriate regulatory oversight. With the exception of the NDA and SDA, the WVDP Project Premises and Center could be released without restrictions. DOE and NYSERDA also intend to evaluate the need for new onsite interim waste storage that may be required to support timely completion of this alternative.

Alternative 3—Partial Site Release with Restrictions

DOE and NYSERDA intend to evaluate an alternative that may permit release with restrictions of portions of the North Plateau geographic area and the balance of the 3,345-acre Center, with the exception of the NDA and SDA. DOE and NYSERDA are proposing that this alternative involve removal of wastes and structures to the extent technically and economically practical so that the radiological criteria specified in 10 CFR 20.1403 can be met for the North Plateau. This would involve in-place closure of the Process Building, Vitrification Facility, HLW Tank Farm, wastewater treatment facility lagoons, and the North Plateau contaminated groundwater plume in a manner that is protective of public health, safety, and the environment. Other ancillary North Plateau facilities would be removed. Appropriate infiltration controls would be evaluated for the NDA and the SDA. The application of institutional controls and engineered barriers would be required and evaluated. The NDA and SDA on the South Plateau would not be released but would be managed, monitored, and maintained under permit, license, or other appropriate regulatory oversight. With the exception of the NDA and SDA, the end state would be the release of the WVDP Project Premises and Center under restricted conditions. However, unimpacted and/or remediated areas of the Center could be considered for release without restrictions. DOE also intends to evaluate the need for new onsite interim HLW storage that may be required to support timely completion of this alternative.

Alternative 4—Monitor and Maintain under Current Operations

This alternative involves the continued management and oversight of the Center and all facilities located upon the Center property, including the WVDP, after DOE's implementation of its Record of Decision for the WVDP Waste Management EIS. No decommissioning decisions would be made nor actions taken to make progress toward decommissioning, including decontamination beyond the scope that DOE is currently performing. No facilities would be closed in place, but would be left in their current configuration and actively monitored and maintained as required by existing regulations to protect public, worker, and environmental health and safety. When required, remedial actions would be taken in response to any releases of contamination into the environment that may present a health and safety risk, such as would be experienced from the eventual failure of the underground HLW storage tanks. Under this alternative, no portion of the Project Premises or the Center would be released for any present or future use.

Alternative 5—No Action (Walk Away)

This alternative involves the cessation of all management and oversight of the Center and all facilities located upon the Center property, including the WVDP, immediately after implementation of DOE's Record of Decision for the WVDP Waste Management EIS. The Process Building, Waste Tank Farm, Vitrification Facility, North Plateau groundwater plume, NDA, SDA, and other smaller facilities would remain and would not be monitored or maintained. Unmitigated natural processes, including erosion, groundwater transport of contamination, and concrete degradation, would be assumed to occur. The purpose of evaluating this alternative is to establish the basis against which the environmental impacts from all other decommissioning and/or long-term stewardship alternatives are compared.

Alternatives Considered But Eliminated From Further Evaluation

DOE does not consider the use of existing structures or construction of new aboveground facilities at the WVDP for indefinite storage of Project and non-Project LLW and mixed low-level waste (MLLW) to be a reasonable alternative for further consideration. Under the Waste Management Programmatic Environmental Impact Statement (WMPEIS, DOE/EIS–0200–F) Record of Decision, DOE decided that sites such as the WVDP would ship their LLW and MLLW to other DOE sites that have disposal capabilities for these wastes. (This decision did not preclude the use of commercial disposal facilities as well.) The construction, subsequent maintenance, and periodic replacement over time of new facilities for indefinite onsite waste storage at West Valley would be impractical from a cost, programmatic, health, and environmental standpoint. Thus, given the capacity to safely and permanently disposition LLW and MLLW in available off site facilities, DOE would not consider indefinite onsite waste storage in new or existing facilities to be a viable waste management alternative for its decommissioning actions at the WVDP. For similar reasons, NYSERDA would use available commercial facilities for disposal of any non-Project LLW and MLLW that it may generate, in lieu of incurring the costs of new construction.

New Information To Be Evaluated

As discussed above, the NRC published its Final Policy Statement prescribing decommissioning criteria for the WVDP on February 1, 2002, stating that NRC intends to apply its License Termination Rule (10 CFR 20.1401 *et seq.*) as decommissioning criteria in assessing the health and environmental impacts of decommissioning the WVDP facilities. DOE and NYSERDA will utilize the NRC's Final Policy Statement and the License Termination Rule as the benchmark to develop and analyze their decommissioning alternatives in the Decommissioning and/or Long-Term Stewardship EIS.

For the 1996 Draft Cleanup and Closure EIS, DOE and NYSERDA developed or modified a variety of analytical tools specifically for that document. DOE has continued to refine many of these analytical tools as a result of public comments received on the 1996 Draft Cleanup and Closure EIS and ongoing interactions with stakeholders and regulatory agencies such as the NRC. DOE and NYSERDA intend to apply these improved analytical tools to the preparation of the Decommissioning and/or Long-Term Stewardship EIS. To address significant issues such as erosion, for example, DOE and NYSERDA have developed a site-specific erosion model, with ongoing advice from NRC, and integrated that model into a revised performance assessment methodology, incorporating the use of sensitivity and uncertainty analyses.

There are also some additional areas where new information has or will be obtained specifically for the Decommissioning and/or Long-Term Stewardship EIS. This work includes updated site characterization and census data and the performance of a seismic reflection survey in the vicinity of the Center. This seismic reflection survey, performed in consultation with academic, government, and industry participants, will contribute to knowledge about the regional structural geology as it may relate to the WVDP and the Center.

Additional information that has become available since publication of the 1996 Draft Cleanup and Closure EIS includes DOE's WM PEIS and its associated Records of Decision. The WM PEIS analyzed on a national scale the centralization, regionalization, or decentralization of managing HLW, transuranic waste, low-level radioactive waste, mixed radioactive low-level waste (containing hazardous constituents), and non-wastewater hazardous waste.

Potential Environmental Issues for Analysis

DOE has tentatively identified the following issues for analysis in the Decommissioning and/or Long-Term Stewardship EIS. The list is presented to facilitate early comment on the scope of the EIS. It is not intended to be all-inclusive nor to predetermine the alternatives to be analyzed or their potential impacts.

- Potential impacts to the general population and on-site workers from radiological and non-radiological releases from decommissioning and/or long-term stewardship activities.
- Potential environmental impacts, including air and water quality impacts, caused by decommissioning and/or long-term stewardship activities.
- Potential transportation impacts from shipments of radioactive, hazardous, mixed, and clean waste generated during decommissioning activities.
- Potential impacts from postulated accidents.
- Potential costs for implementation and long-term stewardship of alternatives considered.
- Potential disproportionately high and adverse effects on low-income and minority populations (environmental justice).
- Potential Native American concerns.
- Irretrievable and irreversible commitment of resources.
- Short-term and long-term land use impacts.
- Ability of alternatives to meet the Comprehensive Environmental Response, Compensation and Liability Act risk range.
- Ability of alternatives to satisfy WVDP decommissioning criteria.
- Compliance with applicable Federal, State, and local requirements.
- Identification of Derived Concentration Guideline Limits, where appropriate.
- The influence of, and potential interactions of, any wastes remaining at the Center after decommissioning.
- Unavoidable adverse impacts.
- Issues associated with long-term site stewardship, including regulatory and engineering considerations, institutional controls, and land use restrictions, including the need for buffer areas.
- Long-term health and environmental impacts, including potential impacts on groundwater quality.
- Long-term site stability, including erosion and seismicity.
- Waste Incidental to Reprocessing.
- Disposition of wastes generated as a result of decommissioning and/or long-term stewardship activities.

Other Agency Involvement

Nuclear Regulatory Commission: NRC has the regulatory responsibility under the Atomic Energy Act for the Center, which is the subject of the NRC license issued to NYSERDA pursuant to 10 CFR part 50, with the exception of the SDA. The NRC license is currently in abeyance pending completion of the WVDP.

The WVDP Act specifies certain responsibilities for NRC, including: (1) Prescribing requirements for decontamination and decommissioning; (2) providing review and consultation to DOE on the Project; and (3) monitoring the activities under the Project for the purpose of assuring the public health and safety. NRC will participate as a cooperating agency under NEPA on the West Valley Decommissioning and/or Long-Term Stewardship EIS. NRC may adopt this EIS for determining that the preferred alternative meets NRC's decommissioning criteria, assuming that NRC will find the preferred alternative acceptable.

Notwithstanding the WVDP, NRC retains the regulatory responsibility for the non-DOE activity in the non-Project area and non-SDA area to the extent that contamination exists both on and offsite resulting from activities performed when the facility was operating under its NRC 10 CFR part 50 license. Following completion of the WVDP and reinstatement of the license, NRC will have the regulatory responsibility for authorizing termination of the license, should NYSERDA seek license termination.

United States Environmental Protection Agency: The United States Environmental Protection Agency (USEPA) will participate as a cooperating agency under NEPA on the West Valley Decommissioning and/or Long-Term Stewardship EIS. As a cooperating agency, EPA will review the EIS and other documents developed by DOE in conjunction with NYSERDA to provide early input on the analyses of environmental impacts associated with the decommissioning alternatives to be analyzed.

New York State Department of Environmental Conservation: With respect to DOE proposed actions, NYSDEC will participate as a cooperating agency under NEPA on the West Valley Decommissioning and/or Long-Term Stewardship EIS. As a cooperating agency, NYSDEC will review the EIS and other documents developed by DOE in conjunction with NYSERDA to provide early input on the analyses of environmental impacts associated with the decommissioning alternatives to be analyzed, and as part of their regulatory responsibilities. NYSDEC will participate as an involved agency under SEQRA with respect to NYSERDA's proposed actions.

NYSDEC regulates the SDA through issuance of permits under 6 New York Codes, Rules and Regulations (NYCRR) Part 380 Rules and Regulations for Prevention and Control of Environmental Pollution by Radioactive Materials. NYSDEC also regulates hazardous and mixed waste at the Center pursuant to 6 NYCRR Part 370 Series. This includes permitting activities under Interim Status for RCRA regulated units and Corrective Action Requirements for investigation and if necessary, remediation of hazardous constituents from Solid Waste Management Units.

NYSDEC is also responsible for ensuring compliance with the 1992 joint NYSDEC/USEPA 3008 (h) [New York State Environmental Conservation Law, Article 27, Titles 9 and 13] Order issued to the DOE and NYSERDA. The Order required investigation of solid waste management units, performance of interim corrective measures, and completion of Corrective Measures Studies, if necessary. NYSDEC and EPA intend to accommodate the DOE's and NYSERDA's efforts to coordinate and integrate the EIS process pursuant to the Order.

Public Scoping Meetings

DOE and NYSERDA will hold two public scoping meetings on the Decommissioning and/or Long-Term Stewardship EIS at the Ashford Office Complex, located at 9030 Route 219 in the Town of Ashford, NY, from 7 to 9:30 p.m. on April 9 and April 10, 2003. The purpose of scoping is to encourage public involvement and solicit public comments on the proposed scope and content of the EIS. Requests to speak at the public meeting should be made by calling or writing the DOE Document Manager (*see* **ADDRESSES**, above). Speakers will be scheduled on a first-come, first-served basis. Individuals may sign up at the door to speak and will be accommodated as time permits. Written comments will also be accepted at the meeting. Speakers are encouraged to provide written versions of their oral comments for the record.

The meetings will be facilitated by a moderator. Time will be provided for meeting attendees to ask clarifying questions. Individuals requesting to speak on behalf of an organization must identify the organization. Each speaker will be allowed five minutes to present comments unless more time is requested and available. Comments will be recorded by a court reporter and will become part of the scoping meeting record.

These two public scoping meetings will be held during a public scoping comment period. The comment period begins with publication of this NOI and will formally close on April 28, 2003. Comments received after this date will be considered to the extent practical. Comments provided during scoping will be addressed in the revised draft Decommissioning and/or Long-Term Stewardship EIS. Written comments will be received during the scoping period either in writing, by facsimile, or by email to Mr. Daniel Sullivan, DOE Document Manager (*see* **ADDRESSES**, above, for contact information).

Schedule

The DOE intends to issue the draft Decommissioning and/or Long-Term Stewardship EIS as early as December 2003. A public comment period of up to 180 days will start upon publication of the EPA's **Federal Register** Notice of Availability. DOE will consider and respond to comments received on the draft Decommissioning and/or Long-Term Stewardship EIS in preparing the final EIS.

Comments received during the 1989 scoping process and from the public comment period on the 1996 Cleanup and Closure EIS (DOE/EIS–0226-D) will be considered in the Decommissioning and/or Long-Term Stewardship EIS.

Public Reading Rooms

Documents referenced in this Notice of Intent and related information are available at the following locations: Central Buffalo Public Library Science and Technology Department, Lafayette Square, Buffalo, New York 14203, (716) 858–7098; The Olean Public Library, 134 North 2nd Street, Olean, New York 14760, (716) 372–0200; The Hulbert Library of the Town of Concord, 18 Chapel Street, Springville, New York 14141, (716) 592–7742; West Valley Central School Library, 5359 School Street, West Valley, New York 14141, (716) 942–3261; Ashford Office Complex, 9030 Route 219, West Valley, New York 14171, (716) 942–4555.

Issued in Washington, DC on March 7, 2003.

Beverly A. Cook,

Assistant Secretary, Environment, Safety and Health.

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DEPARTMENT OF ENERGY

Revised Strategy for the Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center and Solicitation of Scoping Comments

AGENCY: Department of Energy.

ACTION: Notice of intent.

SUMMARY: The U.S. Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA) announce their intent to revise their strategy for completing the Draft Environmental Impact Statement (EIS) for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center (DOE/EIS–0226–D) (also referred to as the 1996 Completion and Closure Draft EIS) issued for public comment in March 1996. Under the revised strategy, DOE will prepare and issue a revised draft EIS for public comment focusing on DOE's actions to decontaminate West Valley Demonstration Project (WVDP) facilities and manage WVDP wastes controlled by DOE under the West Valley Demonstration Project Act (WVDP Act; Public Law 96–368). NYSERDA will not be a joint lead agency but will participate as envisioned under Section 6.03 of the Cooperative Agreement between United States Department of Energy and New York State Energy Research and Development Authority on the Western New York Nuclear Service Center at West Valley, New York (October 1, 1980, amended September 18, 1981) and as appropriate under the New York State Environmental Quality Review Act (SEQRA). Further, DOE intends to issue soon a Notice of Intent for a second EIS, with NYSERDA as a joint lead agency, on decommissioning and/or long-term stewardship of the WVDP and the Western New York Nuclear Service Center (WNYNSC). This approach is expected to facilitate decisions in a more tractable and timely fashion.

DATES: Although this notice expresses DOE's intent to prepare the revised Draft EIS, DOE welcomes, as part of the scoping process, comments on the plan for revising the strategy for completion of the 1996 Completion and Closure Draft EIS. Please provide comments on the plan and on the scope of the revised Draft EIS on WVDP Decontamination and Waste Management to DOE by April 25, 2001. Written comments postmarked, faxed, or e-mailed by that date will be considered in the preparation of the revised Draft EIS. Late comments will be considered to the extent practicable.

Also, DOE will hold a public scoping meeting at the Ashford Office Complex, located at 9030 Route 219 in the Town of Ashford, NY, from 7:00 to 9:30 p.m. on April 10, 2001. Make requests to speak at the public meeting by calling or writing the DOE Document Manager. (See **ADDRESSES**, below.)

ADDRESSES: Address comments on this plan for revising the strategy for completion of the 1996 Completion and Closure EIS and on the scope of the revised Draft EIS to the DOE Document Manager: Mr. Daniel W. Sullivan, West Valley Area Office, U.S. Department of Energy, 10282 Rock Springs Road, West Valley, NY 14171. Telephone: (716) 942–4016, facsimile: (716) 942–4703, or e-mail: daniel.w.sullivan@wv.doe.gov.

FOR FURTHER INFORMATION CONTACT: For information regarding the West Valley Demonstration Project or the EIS, contact Mr. Daniel Sullivan as described above. Those seeking general information on DOE's National Environmental Policy Act (NEPA) process should contact: Ms. Carol M. Borgstrom, Director, Office of NEPA Policy and Compliance, U.S. Department of Energy, 1000 Independence Avenue SW., Washington, DC 20585. Telephone: (202) 586–4600, facsimile: (202) 586–7031, or leave a message at 1–800–472–2756, toll-free.

SUPPLEMENTARY INFORMATION: The DOE and NYSERDA announce their intent to revise their strategy for completing the Draft EIS for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center (DOE/EIS–0226–D) (also referred to as the 1996 Completion and Closure Draft EIS). The Draft EIS was prepared by DOE and NYSERDA as joint lead agencies and issued for public comment in March 1996.

I. Revised NEPA Review Strategy

Under the revised strategy, DOE will prepare and issue for public comment a revised Draft EIS focusing on DOE's actions to decontaminate WVDP facilities and manage WVDP wastes controlled by DOE under the WVDP Act. The analyses and subsequent decision making with respect to this Decontamination and Waste Management EIS will focus exclusively on WVDP activities conducted by DOE and will not involve any decision making on the balance of the property at the WNYNSC. NYSERDA will not be a joint lead agency but will participate as envisioned under Section 6.03 of the Cooperative Agreement between United States Department of Energy and New York State Energy Research and Development Authority on the Western New York Nuclear Service Center at West Valley, New York (October 1, 1980, amended September 18, 1981) and as appropriate under SEQRA. The Nuclear Regulatory Commission does not intend to be a Cooperating Agency on the Decontamination and Waste Management EIS, because the Commission is not prescribing criteria for the activities to be considered in this revised EIS. DOE will inform the Commission of WVDP activities and progress as required under the WVDP Act and the Memorandum of Understanding between DOE and the Commission.

In accordance with Council on Environmental Quality regulations for implementing NEPA (40 CFR 1508.25) DOE has determined that the decontamination and waste management actions will not be connected within the meaning of the regulations to decommissioning and/or long-term stewardship actions because decontamination and waste disposal actions can be implemented without previous or simultaneous actions being taken, are not an interdependent part of a larger action, and do not depend on a larger action for their justification. Further, the WVDP decontamination and waste management actions being proposed by DOE do not limit or prejudge the range of alternatives to be considered or the decisions to be made for eventual decommissioning of Project facilities and/or long-term stewardship of the site, which would be the focus of a second EIS (described below in Section VI).

The decontamination and waste management actions being proposed merit evaluation in an EIS, however, including adequate analysis of cumulative impacts. While the decontamination and waste management actions will share common geography with subsequent decommissioning and/or long-term stewardship actions, the regulatory and physical nature of the two categories of actions are different, as are the timing needs for decisions. This approach is expected to facilitate decisions in a more tractable and timely fashion.

Under the revised strategy, the 1996 Draft EIS will be reissued in part as a revised Draft EIS retitled the West Valley Demonstration Project Decontamination and Waste Management Environmental Impact Statement. The analysis in the revised Draft EIS will support only those DOE decisions on WVDP facility decontamination and waste management alternatives. The revised Draft EIS will include updated baseline environmental data and new EIS alternative descriptions and use new analytical techniques developed at West Valley since publication of the 1996 Completion and Closure Draft EIS. Relevant comments received on the 1996 Completion and Closure Draft EIS will be considered in the preparation of the revised Draft EIS.

In the course of quarterly public meetings and Citizen Task Force meetings held since the issuance of the 1996 Completion and Closure Draft EIS, stakeholders have had considerable opportunities to discuss pertinent issues with DOE. DOE is now formally soliciting scoping comments, which DOE will consider in preparing the Draft Decontamination and Waste Management EIS. During preparation of this EIS, DOE intends to maintain informal communications with stakeholders through ongoing quarterly meetings, at a minimum, to ensure that interested individuals, organizations, and agencies are aware of the status of EIS preparation and have a continuing forum to ask questions and provide feedback to the Department. The revised Draft EIS, when completed, will be issued to the public for review and comment in accordance with Section V of this notice.

II. DOE Responsibilities

DOE is required by Public Law 96–368, the WVDP Act, to perform a number of actions involving facilities and wastes at the West Valley site. Section 2(a)(1–5) of the Act articulates the five actions that embody the WVDP. Actions 1 and 2 address high-level waste (HLW) solidification and development of appropriate containers for the solidified wastes. Action 3 requires DOE to transport the solidified HLW to a Federal geologic repository for permanent disposal. Action 4 requires DOE to dispose of low-level and transuranic wastes generated by HLW solifidification and in connection with the WVDP. Action 5 requires DOE to decontaminate and decommission the tanks, facilities, material, and hardware used in the solidification of HLW and in connection with the WVDP.

Actions 1 and 2 were the focus of the 1982 Final EIS (DOE/EIS–0081) and Record of Decision (47 FR 40705, September 15, 1982) on the HLW solidification. The 1996 Completion and Closure Draft EIS (DOE/EIS–0226–D) comprehensively examined the remaining actions, 3, 4, and 5. Based on the comments received on the 1996 Completion and Closure Draft EIS, feedback from the Citizen Task Force, and ongoing discussions between the joint lead agencies (DOE and NYSERDA) and the Nuclear Regulatory Commission, the DOE now intends to conduct the NEPA process for actions 3, 4, and 5 in two separate EISs.

For action 3, DOE will evaluate on-site activities related to transportation of the New York State-owned solidified HLW to a federal geologic repository in the Decontamination and Waste Management EIS. Off-site activities related to HLW transportation were evaluated in the Final Waste Management Programmatic Environmental Impact Statement (WM PEIS, DOE/EIS–0200–F, May 1997). For action 4, DOE will evaluate on-site activities for transportation of low-level waste generated in connection with the WVDP in the Decontamination and Waste Management EIS; off-site transportation activities were evaluated in the WM PEIS. DOE also will evaluate on-site and off-site transportation activities for transuranic waste associated with the WVDP in the Decontamination and Waste Management EIS.

For action 5, DOE will evaluate the decontamination of facilities, material, and hardware used in the solidification of HLW in the Decontamination and Waste Management EIS. DOE intends to analyze the decommissioning of the HLW tanks, facilities, material, and hardware used in connection with the WVDP in the EIS for decommissioning and/or long-term stewardship of the WVDP and WNYNSC, with NYSERDA as a joint lead agency.

III. Proposed Scope of the Decontamination and Waste Management EIS

A. Purpose and Need for Agency Action

Facility decontamination and waste disposal are the next DOE actions mandated by the WVDP Act that are ripe for evaluation and decision making. By implementing these actions in the near term, DOE may continue toward completion of the WVDP while decommissioning and/or long-term stewardship issues are being evaluated in a separate EIS, which DOE intends to develop jointly with NYSERDA in the near future (described below in Section VI).

The DOE needs to decide upon decontamination and waste management actions that are described below for facilities that are either no longer necessary or where decontamination will support the safer and more efficient continuation of WVDP site operations. DOE's primary objectives in this regard include both reducing risks posed to human health or the environment by removing and containing contamination and reducing the site management costs incurred by continuing to maintain unneeded facilities in a safe and operational condition.

B. Facilities and Waste Storage Areas To Be Evaluated

Potential decontamination of up to four facilities at the WVDP will be evaluated in the Decontamination and Waste Management EIS. The evaluation will include such activities as removal of loose radioactive contamination; removal of hardware and equipment; nonstructural decontamination of walls, ceilings, and floors; and flushing and/or removal of vessels and piping. The WVDP facilities that will be evaluated are:

—*Vitrification Facility*—Houses the HLW melter and supporting systems for combining liquid HLW with borosilicate glass formers, pouring the molten glass into stainless steel canisters, and transporting those canisters to the Process Building for storage.
—*01–14 Building*—Houses the Cement Solidification System, used to combine low-level liquid wastes from HLW pretreatment into a cement blend, which was then placed into drums and removed to an on-site storage facility. The 01–14 Building also houses the Vitrification Off-Gas System.
—*HLW Storage Area*—Includes the underground HLW storage tanks, along with supporting systems for maintenance, surveillance, and waste transfer.
—*Process Building*—Includes approximately 70 rooms and cells that comprised the original NRC-licensed spent nuclear fuel reprocessing operations in the late 1960s and early 1970s. Parts of this building have been decontaminated and modified to support WVDP operation, while other parts remain highly contaminated from fuel reprocessing operations. One of the large cells in the Process Building also serves as the storage facility for vitrified HLW canisters.

The WVDP storage areas that contain the Project's low-level radioactive wastes, which will be evaluated for removal and offsite disposal, are:

—*Lag Storage Area*—Includes several facilities used to store and manage the radioactive wastes generated from WVDP activities. Wastes currently in storage include Class A, B, and C low-level wastes, transuranic waste, and greater-than-Class C wastes.
—*Radwaste Treatment System Drum Cell*—Stores cement-filled drums of stabilized low-level waste produced by the Cement Solidification System.
—*Various Other Locations*—Soils estimated to contain very low levels of radioactive contamination are stored in large containers in various locations.

C. Proposed Action

DOE's Proposed Action under the Decontamination and Waste Management EIS will be to decontaminate the four Project facilities described above and to dispose of Project-generated low-level waste controlled by DOE under the WVDP Act. The remaining facilities for which the DOE is responsible, along with all final decommissioning and/or long-term stewardship actions to be taken by the DOE and NYSERDA, will be evaluated in a new EIS for decommissioning and/or long-term stewardship described in Section VI.

The WVDP Decontamination and Waste Management EIS will incorporate, as needed, analysis of environmental impacts at West Valley associated with implementing DOE's records of decision for the WM PEIS. Under those decisions, DOE will dispose of the Project low-level and low-level mixed waste in storage, and generated by decontamination activities, at either the Nevada Test Site or the Hanford Reservation near Richland, Washington (65 FR 10061, February 25, 2000), continue to store transuranic waste at West Valley (63 FR 3629, January 23, 1998), and continue to store the New York State-owned HLW at West Valley pending availability of a Federal geologic repository (64 FR 46661; August 26, 1999).

The WM PEIS LLW Record of Decision does not preclude DOE's use of commercial disposal facilities, consistent with current DOE Orders and appropriate site-specific NEPA analysis. Therefore, the revised Draft EIS will also assess shipment of WVDP low-level waste to the Envirocare commercial low-level waste disposal facility, near Tooele, Utah.

Any hazardous or mixed wastes generated as a result of decontamination activities will be managed in accordance with the Resource Conservation and Recovery Act (RCRA) and the WVDP Site Treatment Plan, respectively.[1]

D. Preliminary Alternatives To Be Evaluated

In the Decontamination and Waste Management EIS, DOE intends to evaluate the range of alternatives for decontamination of Project facilities. These include a "no action" alternative, which will evaluate continued current decontamination and waste management operations at the WVDP. The other alternatives will evaluate

[1] Any decontamination activities that may be performed following issuance of the Record of Decision for the Decontamination and Waste Management EIS will also provide information associated with RCRA hazardous wastes and mixed wastes, as well as potential future measures that may be needed to manage these wastes. Management of RCRA wastes identified and/or generated during these activities may be performed in accordance with the provisions of the RCRA 3008(h) Administrative Order on Consent between the DOE and NYSERDA, and the New York State Department of Environmental Conservation (DEC) and U.S. Environmental Protection Agency (EPA). This information will also be factored into long-term decision making associated with the decommissioning and/or long-term stewardship EIS, which will be coordinated with the DEC and EPA to meet the requirements of the RCRA 3008(h) Consent Order.

decontaminating different sets of WVDP facilities and areas within them. The three alternatives DOE is proposing to evaluate are summarized below. DOE will identify its Preferred Alternative in the Draft EIS.

No Action Alternative—Minimum Decontamination and Off-Site Waste Disposal Alternative

This alternative is considered the ''no action'' alternative required to be analyzed under Council on Environmental Quality and DOE NEPA regulations, and involves no change from the current in-progress or planned decontamination activities for WVDP facilities and waste management activities currently in progress.

These ongoing decontamination and waste management activities have already been considered under NEPA, as follows:

—1982 Final Environmental Impact Statement for Long-Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center, West Valley (DOE/EIS–0081), Record of Decision (47 FR 40705, September 15, 1982), and two Supplement Analyses (DOE/EIS–0081–SA1, September 24, 1993; DOE/EIS–0081–SA2, June 23, 1998).
—Environmental Checklist for Removal of Class A Low-Level Radioactive Waste for Commercial Disposal (OH–WVDP–96–01), an action that was categorically excluded from further NEPA review in October 1997.
—Environmental Checklist for Decontamination Activities for the Main Plant (OH–WVDP–2000–05), an action that was categorically excluded in November 2000.

Project Facility Decontamination and Off-Site Waste Disposal Alternative

This alternative involves extensive decontamination of the Vitrification Facility, 01–14 Building, HLW Storage Area, and Process Building. Activities would include: (1) Removing any nonessential vessels, hardware, piping, and components, (2) cleaning surfaces to remove loose contamination, (3) treating or otherwise fixing-in-place remaining contamination on surfaces, as appropriate, (4) deactivating and/or removing all support systems (ventilation and utilities) no longer necessary for safe operations and maintenance, and (5) collecting and treating for disposal any effluent from the decontamination activities.

Wastes currently in storage and wastes generated by decontamination activities would be processed as necessary and shipped offsite for disposal under this alternative. A combination of truck and rail shipment modes would be used, depending on the type and amount of waste, and the intended disposal site. Any wastes for which there currently are no suitable disposal sites, such as greater-than-Class C waste, HLW, and transuranic waste, would be retained in on-site storage pending the availability of an off-site disposal location. DOE will evaluate shipment of these wastes from West Valley, as appropriate, however, so that the environmental impacts would have already been evaluated in case an opportunity to move these wastes off-site should arise.

High Activity Waste Removal and Off-Site Waste Disposal Alternative

This alternative is similar to the alternative for Project Facility Decontamination and Off-site Waste Disposal in terms of the types of decontamination activities that would be performed, but only those areas of WVDP facilities that present high health and safety risk would undergo interim decontamination. Under this alternative, selected areas in the Vitrification Facility, HLW Storage Area, and Process Building would be decontaminated, namely, those that are estimated to contain high concentrations of long-lived radionuclides. The 01–14 Building would not be decontaminated under this alternative, however, because it does not contain substantial quantities of long-lived radionuclides and does not pose a health and/or safety risk comparable to the Vitrification Facility, HLW Storage Area, and Process Building. Waste management activities to be evaluated will be comparable, however, to those under the previous alternative.

E. Preliminary Impacts To Be Analyzed

DOE has identified the following impacts for analysis in this EIS. Additional issues may be identified as a result of public comments.

- Potential impacts to the general population and on-site workers from radiological and nonradiological releases from decontamination and waste management activities
- Potential environmental impacts, including air and water quality impacts, from decontamination and waste management activities
- Potential transportation impacts from shipments of radioactive or hazardous material or radioactive, hazardous, or mixed waste generated during decontamination and waste management activities
- Potential impacts from postulated accidents
- Short-term land use impacts
- Disproportionately high and adverse effects on low-income and minority populations (environmental justice)
- Irretrievable and irreversible commitment of resources
- Native American concerns
- Unavoidable adverse impacts
- Compliance with Federal, state, and local requirements
- Cumulative impacts

IV. Public Scoping Meeting

DOE will hold a public scoping meeting on the decontamination and waste management EIS at the Ashford Office Complex, located at 9030 Route 219 in the Town of Ashford, NY, from 7:00 to 9:30 p.m. on April 10, 2001. Requests to speak at the public meeting should be made by calling or writing the DOE Document Manager (see **ADDRESSES,** above). Speakers will be scheduled on a first-come, first-served basis. Individuals may sign up at the door to speak and will be accommodated as time permits. Written comments will also be accepted at the meeting. Speakers are encouraged to provide written versions of their oral comments for the record.

The meetings will be facilitated by a moderator. WVDP personnel and the moderator may ask speakers clarifying questions. Individuals requesting to speak on behalf of an organization must identify the organization. Each speaker will be allowed five minutes to present comments unless more time is requested and available. Comments will be recorded by a court reporter and will become part of the scoping meeting record.

V. Schedule

The DOE intends to issue the draft Decontamination and Waste Management EIS in Fall 2001. A 45-day public comment period will start upon publication of the Environmental Protection Agency's **Federal Register** Notice of Availability. DOE will consider and respond to comments received on the draft Decontamination and Waste Management EIS in preparing the final EIS.

Comments received during the 1989 scoping process and from the public comment period on the 1996 Completion and Closure EIS (DOE/EIS–0226–D) will be addressed in either the draft Decontamination and Waste Management EIS or the planned EIS for decommissioning and/or long-term stewardship, depending on the nature of the specific comments received.

VI. EIS for Decommissioning and/or Long-Term Stewardship

DOE anticipates a separate announcement soon in both the **Federal Register** and the New York State Environmental Notice Bulletin providing notice of a second EIS to be prepared by DOE and NYSERDA for decommissioning and/or long-term stewardship of the WVDP and WNYNSC and a public scoping process pursuant to NEPA and SEQRA.

DOE anticipates that it will be the lead Federal agency for purposes of compliance with NEPA, and NYSERDA will be the lead agency for purposes of compliance with SEQRA. DOE also anticipates that the Nuclear Regulatory Commission will participate as a cooperating agency under NEPA, and the New York State Department of Environmental Conservation will be an involved agency under SEQRA. Although DOE envisions that DOE and NYSERDA will jointly prepare this EIS for decommissioning and/or long-term stewardship, either agency may decide to proceed independently in support of its independent mission. The Notice of Intent will provide further information on this second EIS, including the alternatives proposed to be evaluated and the opportunities for stakeholder involvement.

Issued in Washington, D.C. on March 21, 2001.

Steven V. Cary,

Acting Assistant Secretary, Office of Environment, Safety and Health.

[FR Doc. 01–7370 Filed 3–23–01; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Advance Notice of Intent to Prepare an Environmental Impact Statement To Evaluate Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center

AGENCY: Department of Energy.

ACTION: Advance notice of intent.

SUMMARY: The U.S. Department of Energy (DOE) is announcing in advance its intent to prepare an Environmental Impact Statement (EIS) for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project (WVDP) and Western New York Nuclear Service Center (the Center). DOE has prepared this advance notice in accordance with the Department's regulations for implementing the National Environmental Policy Act (NEPA) [10 CFR 1021.311(b)], which state that DOE may publish an Advance Notice of Intent to provide an early opportunity to inform interested parties of a pending EIS or to solicit early public comments. DOE anticipates that the New York State Energy Research and Development Authority (NYSERDA) will participate in the preparation of the Decommissioning and/or Long-Term Stewardship EIS as a joint lead agency, that the U.S. Nuclear Regulatory Commission (NRC) will participate as a cooperating agency, and that the New York State Department of Environmental Conservation (NYSDEC) will participate as an involved agency under the New York State Environmental Quality Review Act (SEQRA).

DOE and NYSERDA plan to evaluate the range of reasonable alternatives in this EIS to address their respective responsibilities at the Center, including those under the West Valley Demonstration Project Act (Public Law 96–368) and other applicable requirements, including decommissioning criteria that may be prescribed by NRC in accordance with the Act.

DOE invites early public comment on the range of environmental issues and alternatives to be analyzed. DOE and NYSERDA will consider the comments received and other relevant information in developing a preliminary scope of the EIS for publication in a subsequent Notice of Intent, which would initiate a public scoping process in accordance with DOE's NEPA implementing regulations and those of SEQRA.

This Advance Notice of Intent is consistent with DOE's March 26, 2001, Notice of Intent (66 FR 16447) to revise the strategy for completing the *Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center* (DOE/EIS–0226-D, March 1996, also referred to as the 1996 Cleanup and Closure Draft EIS), which was issued jointly by DOE and NYSERDA. The March 2001 Notice of Intent announced that DOE intends to prepare a separate EIS on its decontamination of WVDP facilities and related waste management activities.

ADDRESSES: Address early comments on the preliminary scope of the Decommissioning and/or Long-Term Stewardship EIS to the DOE Document Manager: Mr. Daniel W. Sullivan, West Valley Demonstration Project, U.S. Department of Energy, 10282 Rock Springs Road, West Valley, New York 14171, Telephone: (716) 942–4016, facsimile: (716) 942–4703, e-mail: *daniel.w.sullivan@wv.doe.gov.*

The ''Public Reading Rooms'' section under **SUPPLEMENTARY INFORMATION** lists the addresses of the reading rooms where documents referenced herein are available.

FOR FURTHER INFORMATION, CONTACT: For information regarding the WVDP or the EIS, contact Mr. Daniel Sullivan as described above. Those seeking general information on DOE's NEPA process should contact: Ms. Carol M. Borgstrom, Director, Office of NEPA Policy and Compliance, U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, D.C. 20585, Telephone: (202) 586–4600, Facsimile: (202) 586–7031, or leave a message at 1–800–472–2756, toll-free.

Questions for NYSERDA should be directed to: Mr. Paul J. Bembia, New York State Energy Research and Development Authority, 10282 Rock Springs Road, West Valley, New York 14171, Telephone: (716) 942–4900, Facsimile: (716) 942–2148, email: *pjb@nyserda.org.*

Those seeking general information on the SEQRA process should contact: Mr. Hal Brodie, Deputy Counsel, New York State Energy Research and Development Authority, Corporate Plaza West, 286 Washington Avenue Extension, Albany,

New York 12203–6399, Telephone: (518) 862–1090, ext. 3280, Facsimile: (518) 862–1091, email: *hb1@nyserda.org.*

This Advance Notice of Intent will be available on the internet at *http://tis.eh.doe.gov/nepa,* under ''NEPA Announcements''. Additional information about the WVDP is also available on the internet at *http://www.wv.doe.gov/LinkingPages/insidewestvalley.htm.*

SUPPLEMENTARY INFORMATION: DOE announces its Advance Notice of Intent to prepare an EIS for Decommissioning and/or Long-Term Stewardship at the WVDP and the Center. DOE has prepared this Advance Notice of Intent in accordance with the Department's regulations for implementing NEPA [10 CFR 1021.311(b)], which state that DOE may publish an Advance Notice of Intent to provide an early opportunity to inform interested parties of a pending EIS or to solicit early public comments.

DOE intends to prepare this EIS jointly with NYSERDA, although either agency may, at any point, determine the need to proceed independently in support of their independent missions. In preparing this Advance Notice of Intent, DOE anticipates that the Department would be the lead Federal agency for purposes of compliance with NEPA, while NYSERDA would be the lead State agency for purposes of compliance with SEQRA. DOE also anticipates that NRC would participate as a cooperating agency under NEPA and that NYSDEC would be an involved agency under SEQRA.

Invitation to Comment

DOE invites the public to provide early assistance in identifying significant environmental issues and alternatives to be analyzed in the forthcoming Decommissioning and/or Long-Term Stewardship EIS. DOE and NYSERDA will consider public comments and other relevant information as the agencies jointly develop a Notice of Intent for publication in the **Federal Register** and a notice for publication in the New York State *Environmental Notice Bulletin.* DOE and NYSERDA expect the Notice of Intent to contain a preliminary range of reasonable alternatives proposed for analysis as agreed to by DOE and NYSERDA. Further, DOE and NYSERDA expect to publish the Notice of Intent within approximately a year of publishing this advance notice. Although a public scoping meeting will not be held until the public scoping process required by NEPA has been initiated, DOE and NYSERDA would give equal weight to written comments submitted in response to this Advance Notice of Intent and comments received during the public scoping process.

Background

The Center consists of a 3,345-acre reservation in rural western New York that is the location of the only NRC-licensed commercial spent nuclear fuel reprocessing facilities to have ever operated in the United States. NYSERDA holds title to the Center on behalf of the people of the State of New York. Pursuant to the WVDP Act, DOE and NYSERDA entered into a Cooperative Agreement effective October 1, 1980, that specifies the responsibilities and conditions agreed upon by each for the purpose of carrying out the WVDP. Under the agreement, NYSERDA has made available to DOE, without transfer of title, an approximately 200-acre portion of the Center, known as the ''Project Premises,'' which includes a formerly operated spent nuclear fuel reprocessing plant, spent nuclear fuel receiving and storage area, liquid high-level waste (HLW) storage tanks, a liquid low-level waste treatment facility with associated lagoons, and a radioactive waste disposal area licensed by the NRC. Adjacent to and in the vicinity of the Project Premises is an area referred to as the State Licensed Disposal Area, for which NYSERDA has responsibility.

The WVDP Act authorizes NRC to prescribe decommissioning criteria for the WVDP. At this time, DOE anticipates that the NRC would resume regulatory oversight of the Center, with the exception of the State Licensed Disposal Area, following DOE's completion of the WVDP.

Section 2(a)(1–5) of the WVDP Act articulates the five actions required of DOE. Actions 1 and 2 address HLW solidification and development of appropriate containers for the solidified wastes. Action 3 requires DOE to transport the solidified HLW to a Federal geologic repository for permanent disposal. Action 4 requires DOE to dispose of low-level and transuranic wastes generated by HLW solidification and in connection with the WVDP. Action 5 requires DOE to decontaminate and decommission the tanks, facilities, material, and hardware used in the solidification of HLW and in connection with the WVDP.

Actions 1 and 2 were the focus of a 1982 Final EIS (DOE/EIS–0081) and Record of Decision (47 FR 40705, September 15, 1982) on HLW solidification. The 1996 Cleanup and Closure Draft EIS examined the remaining actions, 3, 4, and 5. Considering the comments received on the 1996 Cleanup and Closure Draft EIS, ongoing discussions between the joint lead agencies (DOE and NYSERDA), and discussions with NRC, DOE now intends to conduct the NEPA process for actions 3, 4, and 5 in two separate EISs. Accordingly, DOE announced its intent to prepare a Decontamination and Waste Management EIS on March 26, 2001 (66 FR 16447), which will only address DOE's decision-making with respect to managing Project wastes and decontaminating Project facilities as stipulated in actions 3 and 4 and decontamination activities for Project facilities stipulated in action 5. DOE will need to conduct these activities regardless of future decommissioning and/or long-term stewardship decisions.

DOE expects the Decommissioning and/or Long-Term Stewardship EIS announced herein to address DOE's remaining activities under the WVDP Act as stipulated in action 5, any waste management activities under action 4 that could arise as a result of decommissioning activities, and NYSERDA's activities relative to decommissioning or long-term stewardship of land and facilities under its purview. DOE believes that the activities identified for the Decontamination and Waste Management EIS and for the Decommissioning and/or Long-Term Stewardship EIS are separate and distinct and are thus appropriate for analysis in two EISs, consistent with NEPA and its implementing regulations.

Purpose and Need for Action

DOE needs to determine the manner that facilities for which the Department is responsible under the WVDP Act are decommissioned, in accordance with the criteria yet to be prescribed by the NRC. NYSERDA needs to develop a strategy for decommissioning or long-term stewardship for land and facilities under its purview. To this end, DOE and NYSERDA would determine what, if any, material or structures would remain on the site and what, if any, institutional controls would be required, in accordance with their respective agency responsibilities.

Potential Range of Alternatives

DOE anticipates, at this time, that its alternatives to be proposed for analysis in the Decommissioning and/or Long-Term Stewardship EIS would range from complete removal of Project waste and facilities to in-place closure of Project facilities, including a No Action Alternative as required by NEPA, and that NYSERDA would propose a similar range of decommissioning and/or long-term stewardship alternatives to those proposed by DOE, for the facilities and areas for which NYSERDA is responsible. Additional alternatives may also be presented after consultation with NRC, NYSERDA and the public. However, DOE and NYSERDA expect the potential alternatives to be sufficiently consistent in concept with those identified in the1996 Draft Cleanup and Closure EIS to allow the use of technical information presented therein, supplemented as needed.

New Information To Be Evaluated

NRC has indicated that it intends to publish a draft policy statement on prescribing decommissioning criteria for the WVDP for public comment and subsequently issue a final statement that would include its response to comments. Based upon ongoing discussions with the Commission, DOE and NYSERDA intend at this time to apply the NRC's License Termination Rule (10 CFR 20.1401 *et seq.*) as draft decommissioning criteria in assessing the health and environmental impacts of decommissioning the WVDP facilities, pending NRC issuance of its final Policy Statement on decommissioning criteria for the WVDP. If the final decommissioning criteria are issued before completion of the EIS, the results in the EIS will reflect any changes in criteria.

In 1997, the NRC published the *Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities* (NUREG–1496) to support its decision-making on establishing explicit radiological criteria for decommissioning various types of facilities, including nuclear power plants, non-power reactors, fuel fabrication plants, uranium hexaflouride production plants, and independent spent fuel storage installations. This EIS analyzed courses of action that NRC would take in establishing radiological criteria for decommissioning and the cost and environmental impacts associated with those alternatives. Based on this analysis, the NRC promulgated its Final License Termination Rule (62 FR 39086, July 21, 1997). Although this EIS did not evaluate a reference spent fuel reprocessing facility, DOE and NYSERDA intend to use those aspects of NRC's EIS that may have specific relevance to the West Valley site.

Further, DOE and NYSERDA also intend to evaluate other available NRC NEPA documents to identify elements that would be applicable to decommissioning activities at the WVDP and the Center. NRC issued the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* (NUREG–0586) in 1988 to assist it in reevaluating its regulatory requirements for decommissioning of nuclear facilities. In this EIS, the NRC evaluated the areas of decommissioning alternatives, financial assurance, planning, and residual radioactivity levels. This EIS was prepared to support the *General Requirements for Decommissioning of Nuclear Facilities,* Final Rule (53 FR 24018, June 27, 1988) and analyzed a number of reference licensed facilities, including the Barnwell spent fuel reprocessing design, which was never demonstrated. The Barnwell facility, unlike the West Valley reprocessing facility, was designed for short-term liquid HLW storage and subsequent near-term HLW vitrification. The NRC is currently supplementing this EIS (65 FR 25395, May 1, 2000) to evaluate certain decommissioning alternatives for power reactor facilities in more detail.

For the 1996 Draft WVDP Cleanup and Closure EIS, DOE developed or modified a variety of analytical tools specifically for that document. DOE has continued to refine many of these analytical tools as a result of public comments received on the 1996 Draft Cleanup and Closure EIS and ongoing interactions with stakeholders and regulatory agencies such as the NRC. DOE intends to apply these improved analytical tools to the preparation of the Decommissioning and/or Long-Term Stewardship EIS. To address significant issues such as erosion, for example, DOE has continued to develop a site-specific erosion model, with ongoing advice from NRC, and integrated that model into a revised performance assessment methodology, incorporating the use of sensitivity and uncertainty analyses.

There are also some additional areas where new information will be obtained specifically for the Decommissioning and/or Long-Term Stewardship EIS. This work includes updated site characterization and census data and the performance of a seismic reflection survey in the vicinity of the WVDP. This seismic reflection survey, to be performed in consultation with academic, government, and industry participants, will contribute to knowledge about the regional structural geology as it may relate to the WVDP and the Center.

Additional information that has become available since publication of the 1996 Draft Cleanup and Closure EIS includes DOE's *Waste Management Programmatic Environmental Impact Statement* (WM PEIS, DOE/EIS–0200–F) and its associated Records of Decision. The WM PEIS analyzed on a national scale the centralization, regionalization, or decentralization of managing HLW, transuranic waste, low-level radioactive waste, mixed radioactive low-level waste (containing hazardous constituents), and non-wastewater hazardous waste. The Decommissioning and/or Long-Term EIS will incorporate, as appropriate, analyses from the WM PEIS so as to analyze site-specific activities necessary to implement the pertinent parts of the Records of Decision that apply to West Valley. The Decommissioning and/or Long-Term Stewardship EIS will also incorporate, as needed, information made available as a result of the Decontamination and Waste Management EIS.

Potential Environmental Issues for Analysis

DOE has tentatively identified the following issues for analysis in the Decommissioning and/or Long-Term Stewardship EIS. The list is presented to facilitate early comment on the scope of the EIS. It is not intended to be all-inclusive nor to predetermine the alternatives to be analyzed or their potential impacts.

- Potential impacts to the general population and on-site workers from radiological and non-radiological releases from decommissioning and/or long-term stewardship activities.
- Potential environmental impacts, including air and water quality impacts, caused by decommissioning and/or long-term stewardship activities.
- Potential transportation impacts from shipments of radioactive, hazardous, or mixed waste generated during decommissioning activities.
- Potential impacts from postulated accidents.
- Potential disproportionately high and adverse effects on low-income and minority populations (environmental justice).
- Potential Native American concerns.
- Irretrievable and irreversible commitment of resources.
- Short-term and long-term land use impacts.
- Decommissioning criteria for the WVDP.
- Compliance with Federal, State, and local requirements.
- The influence of, and potential interactions of, any wastes remaining at the Center after decommissioning.
- Unavoidable adverse impacts.
- Issues associated with decommissioning and long-term site

stewardship, including regulatory and engineering considerations.

• Long-term site stability, including erosion and seismicity.

Other Agency Involvement

NYSDEC and the U.S. Environmental Protection Agency entered into an Administrative Order on Consent with DOE and NYSERDA in March 1992, pursuant to section 3008(h) of the Hazardous and Solid Waste Amendments of 1984 under the Resource Conservation and Recovery Act. The purpose of the Order is to protect human health and the environment from releases of hazardous waste and/or hazardous constituents. DOE and NYSERDA expect to continue ongoing work with NYSDEC and the U.S. Environmental Protection Agency to integrate the requirements of the Order with the EIS process. DOE anticipates that NYSDEC therefore would participate in the Decommissioning and/or Long-Term Stewardship EIS to the extent required to address its regulatory responsibilities for the WVDP and the Center, including the State Licensed Disposal Area, as an involved agency under SEQRA.

Future Public Involvement

This Advance Notice of Intent does not serve as a substitute for the Notice of Intent that would initiate the public scoping process for the Decommissioning and/or Long-Term Stewardship EIS. After that Notice of Intent is published, DOE and NYSERDA expect to conduct the public scoping process in accordance with NEPA, the Council on Environmental Quality NEPA implementing regulations (40 CFR 1500—1508), the DOE's implementing regulations (10 CFR part 1021), and with New York's SEQRA and its implementing regulations (6 NYCRR 617). The scoping process will include a public meeting and a public comment period on the scope of the EIS.

Public Reading Rooms

Documents referenced in this Advance Notice of Intent and related information are available at the following locations.

Central Buffalo Public Library Science and Technology Department, Lafayette Square, Buffalo, New York 14203, (716) 858–7098

The Olean Public Library, 134 North 2nd Street, Olean, New York 14760, (716) 372–0200

The Hulbert Library of the Town of Concord, 18 Chapel Street, Springville, New York 14141, (716) 592–7742

West Valley Central School Library, 5359 School Street, West Valley, New York 14141, (716) 942–3261

Ashford Office Complex, 9030 Route 219, West Valley, New York 14171, (716) 942–4555

Issued in Washington, DC, on October 31, 2001.

Steven V. Cary,

Acting Assistant Secretary, Office of Environment, Safety and Health.

[FR Doc. 01–27841 Filed 11–5–01; 8:45 am]

BILLING CODE 6450–01–P

Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center

AGENCY: United States Department of Energy.

ACTION: Notice of availability and notice of wetlands involvement.

SUMMARY: The U.S. Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA) announce the availability for public review and comment of the Draft Environmental Impact Statement (EIS) for Completion of the West Valley Demonstration Project (Project) and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center (Center). DOE also gives public notice that the alternatives analyzed in the EIS include proposed actions that would occur in wetlands. The EIS evaluates alternatives for integrated sitewide actions to complete DOE decontamination and decommissioning activities and provide for NYSERDA's closure or long-term management of facilities at the Center. This joint EIS supports the selection of the site management strategy and will assist NYSERDA and DOE in making decisions for future site closure or management activities. DOE and NYSERDA will identify the selected site management strategy in a National Environmental Policy Act (NEPA) Record of Decision and in State Environmental Quality Review Act (SEQRA) Findings, respectively. If necessary, additional NEPA or SEQRA documents will be prepared for DOE and NYSERDA actions not specifically addressed in this document.

DATES: The comment period on the Draft EIS will continue until September 22, 1996. Comments postmarked after that date will be considered to the extent practicable. Public meetings will be held at the locations and dates listed in the supplementary information section of this notice.

ADDRESSES: Requests for information about, and copies of, the Draft EIS should be directed to the Community Relations Department of the West Valley Demonstration Project, P.O. Box 191, West Valley, NY 14171–0191, or by calling (800) 633–5280 or (716) 942–2152.

Written comments on the Draft EIS should be mailed to the following address:

Draft EIS, Community Relations Dept./MS–A, West Valley Demonstration Project, P.O. Box 191, West Valley, New York 14171. Fax: (716) 942–4703, Internet: http://freenet.buffalo.edu/wvdp/eisform.htp

For general information on the DOE NEPA process, call (800) 472–2756 to leave a message, or contact:

Carol Borgstrom, Director, Office of NEPA Policy and Assistance (EH–42), U.S. Department of Energy, 1000 Independence Avenue SW., Washington, DC 20585–0119, (202) 586–4600

For general information on the New York State Environmental Quality Review Act (SEQRA) process, call (518) 457–2224 to leave a message or contact:

Jack Nasca, Regulatory Services, New York State Department of Environmental Conservation, 50 Wolf Road, Room 538, Albany, NY 12233–1750

Availability of the Draft EIS: Copies of the Draft EIS have been distributed to federal, state, tribal and local officials, as well as agencies, organizations and individuals who may be interested or affected. Copies of the Draft EIS are also available for public review at the locations listed at the end of this Notice.

SUPPLEMENTARY INFORMATION:

Background

On December 27, 1988, DOE issued a Notice of Intent (53 FR 53052) to prepare the Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center. The Notice of Intent stated that the EIS would evaluate alternatives for completing the Project and closure or long-term management of facilities at the Center which is located near Buffalo, New York. The public comment period on the Notice of Intent extended from December 27, 1988 to February 23, 1989, with two public scoping meetings.

DOE issued an Implementation Plan in March 1995 that recorded the results of the scoping process.

The Center is the site of a former spent nuclear fuel reprocessing facility. NYSERDA holds title to the site on behalf of the people of the State of New York. The site includes the process building and associated facilities, waste storage facilities, two radioactive waste disposal areas, and tanks containing liquid high-level radioactive waste from past reprocessing operations. The West Valley Demonstration Project is a joint federal-state cleanup under which DOE, in cooperation with NYSERDA, will solidify the high-level radioactive waste, transport the solidified waste for disposal at an appropriate federal repository, dispose of the low-level and transuranic waste produced by the solidification of the high-level waste, and decontaminate and decommission all facilities used in solidifying the high-level waste. In 1982, a Final EIS was issued by DOE concerning long-term management of the liquid high-level wastes. On the basis of that earlier EIS, DOE decided to concentrate, chemically treat, and convert the liquid high-level wastes to a solid terminal waste form suitable for transportation offsite and eventual disposal in a federal geologic repository.

The current EIS evaluates alternatives for integrated sitewide actions to complete DOE decontamination and decommissioning activities and provide for NYSERDA's closure or long-term management of facilities at the Center. This EIS evaluates the treatment, storage, and disposal of high-level, low-level, low-level mixed, hazardous, and industrial waste and contaminated soil. This EIS is being prepared in accordance with the requirements of NEPA of 1969; with Council on Environmental Quality regulations implementing NEPA (40 CFR Parts 1500–1508), and DOE NEPA Implementing Procedures (10 CFR Part 1021); and with the New York State Environmental Quality Review Act (SEQRA). This joint EIS provides environmental information to support the selection of the site management strategy and will assist NYSERDA and DOE in making decisions for future site closure or management activities. The Nuclear Regulatory Commission is a cooperating agency in the preparation of this EIS. DOE and NYSERDA will identify the selected site management strategy in a NEPA Record of Decision and in SEQRA Findings, respectively. If necessary, additional NEPA or SEQRA documents will be prepared for DOE and NYSERDA actions not specifically addressed in this document.

Alternatives Considered

Five alternatives for Project completion and closure or long-term management of the facilities at the Center are analyzed in this EIS. These five alternatives were identified after considering comments received during the scoping process. The five alternatives are:

Alternative I: Removal and Release to Allow Unrestricted Use. Alternative I is the removal of existing facilities including buried waste so there are minimal remnants of nuclear operations. All waste would be disposed of offsite.

Alternative II: Removal, On-Premises Waste Storage, and Partial Release to Allow Unrestricted Use. Alternative II is the removal of existing facilities including buried waste so there are minimal remnants of nuclear operations, with the exception of on-premises storage of high-level, low-level, and low-level mixed waste. Hazardous and industrial waste would be disposed of offsite.

Alternative III: In-Place Stabilization and On-Premises Low-Level Waste Disposal. Alternative III is the in-place stabilization of contaminated structures and buried waste. Uncontaminated structures would be removed. Low-level waste would be disposed of onsite. All other waste would be disposed of offsite.

Alternative IV: No Action: Monitoring and Maintenance. Alternative IV is the management of the site in its current configuration. There would be long-term monitoring and maintenance. Only hazardous waste would be disposed of offsite.

Alternative V: Discontinue Operations. Alternative V is the discontinuation of operations; the site would be left in its current configuration. No closure actions would be taken. All waste would be left onsite.

Alternative IV (No Action: Monitoring and Maintenance) is required by NEPA and SEQRA regulations to be considered in order to establish a baseline for comparison with the environmental effects of the ''action'' alternatives. Alternatives II (On-Premises Storage) and V (Discontinue Operations) were evaluated in the EIS in response to comments received during the scoping process. Although Alternative V is not considered a reasonable alternative by either DOE or NYSERDA, it provides an environmental baseline for evaluating impacts. The long-term performance assessment (an analysis of the effects that contaminated facilities would have on human health and the environment over the long term) of Alternative V gives an understanding of the long-term public hazard and contribution of natural processes, such as surface water flow or erosion, to that hazard. Table S–1 in the EIS summarizes the actions for each alternative, including the disposition of newly generated and stored waste. Neither DOE nor NYSERDA has identified a preferred alternative.

The alternatives include proposed actions that would occur in wetlands. Pursuant to 10 CFR Part 1022, the Draft EIS includes an assessment of the potential impacts to wetlands .

Invitation to Comment

The public is invited to submit written and oral comments on any or all portions of the Draft EIS. Public information sessions on the Draft EIS will be held in the Western New York area in April 1996, including sessions planned specifically to share EIS information with members of the Seneca Nation of Indians. The dates, times and locations of the public information sessions are as follows:

Tuesday, April 23, 1996, 1:00–9:00 p.m., Seneca Nation Reservation, Irving, NY

Wednesday, April 24, 1996, 1:00–9:00 p.m., McKinley Park Inn, McKinley Parkway, Hamburg, NY

Thursday, April 25, 1996, 1:00–9:00 p.m., Seneca Nation Reservation, Salamanca, NY

Friday, April 26, 1996, 1:00–9:00 p.m., Ashford Office Complex, Route 219, Ashford, NY

These sessions will also be announced through public notices in area newspapers, press releases, Internet notifications and through Seneca Nation advertising media. These sessions will be conducted as ''poster presentations'' with the DOE, NYSERDA, and EIS contractor personnel available to explain and discuss topics and issues related to the Draft EIS.

In addition, DOE and NYSERDA are planning to hold one public hearing, on August 6, 1996, to receive oral and written comments on the Draft EIS. Further information regarding the EIS will be available by calling (800) 633–5280 (toll free), or, for those who receive a copy of the EIS, by contacting the personnel identified in the Summary of the Draft EIS.

Written comments on the Draft EIS will be accepted until September 22, 1996, at the New York address at West Valley (provided above). DOE and NYSERDA will consider these public comments in preparing the Final EIS.

Persons who wish to speak at the public hearing are asked to register in advance by calling the following toll-free number: (800) 633–5280. Requests to speak that have not been submitted before the hearing will be handled in the order in which they are received. DOE's and NYSERDA's responses to comments received during the public hearing or in writing will be included in the Final EIS.

WVDP Public Reading Rooms

The following is a list of public reading rooms where the Draft EIS and supporting technical documents are available:

Central Library, Lafayette Square, Buffalo, NY 14203, Phone: (716) 858–7098

Concord Hulbert Library, 18 Chapel Street, Springville, NY 14141, Phone: (716) 592–7742

Olean Public Library, 134 North 2nd Street, Olean, NY 14760, Phone: (716) 372–0200

West Valley Central School Library, West Valley, NY 14171, Phone: (716) 942–3293

Ashford Office Complex, 9060 Route 219, West Valley, NY 14171 Phone: (716) 942–4555

Issued in Washington, D.C., March 18, 1996.

Stephen Cowan,

Deputy Assistant Secretary for Waste Management.

[FR Doc. 96–6836 Filed 3–20–96; 8:45 am]

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APPENDIX C
DESCRIPTIONS OF FACILITIES/AREAS, DECOMMISSIONING ACTIVITIES, AND NEW CONSTRUCTION

APPENDIX C
DESCRIPTIONS OF FACILITIES/AREAS, DECOMMISSIONING ACTIVITIES, AND NEW CONSTRUCTION

C.1 Introduction

This appendix presents a description of the existing facilities and waste disposal areas associated with the 12 Waste Management Areas (WMAs) at the Western New York Nuclear Service Center (WNYNSC), including the North Plateau Groundwater Plume and Cesium Prong, that are being considered as part of the decommissioning and/or long-term stewardship of the West Valley Demonstration Project (WVDP) and WNYNSC. The descriptions are included in Section C.2. A summary of these descriptions is presented in Chapter 2, Section 2.3, of this environmental impact statement (EIS). The starting point of the EIS is discussed in Chapter 2, Section 2.3.1. Chapter 2 also includes summary information on the status of the Resource Conservation and Recovery Act (RCRA) units on the site.

Unless otherwise referenced, the information in this appendix was obtained from WNYNSC technical reports (WSMS 2009a, 2009b, 2009c, 2009d, 2009e).

Section C.3 of this appendix presents a description of the decommissioning activities for each action alternative evaluated in this EIS. The descriptions of the alternatives and summaries of the decommissioning activities for each alternative are also presented in Chapter 2, Section 2.4, of this EIS.

Section C.4 provides descriptions of the proposed new construction that would be required to support the decommissioning activities at WNYNSC under each action alternative.

C.2 Buildings, Facilities, and Waste Disposal Areas Analyzed in this Environmental Impact Statement

This section provides detailed descriptions of the facilities and areas at WNYNSC that are analyzed in this EIS. The descriptions include historical information, dimensions, status of radioactive and hazardous contamination, as well as radioisotopic and chemical material inventories. A large number of radioactive isotopes have been identified as present at the site. In order to facilitate presentation of data and conduct of the analysis, a dose-based screening analysis was performed to generate a more concise list of radionuclides for detailed analysis. Radionuclides identified for detailed analysis accounted for greater than 99 percent of dose on the screening analysis. Data are presented in this appendix for radionuclides identified for detailed analysis rather than for all radionuclides that may be present on the site.

C.2.1 Waste Management Area 1: Main Plant Process Building and Vitrification Facility Area

WMA 1 encompasses approximately 1.7 hectares (4 acres). Key facilities standing in WMA 1 at the starting point of this EIS will include the Main Plant Process Building, Vitrification Facility, 01-14 Building, Load-In/Load-Out Facility, Utility Room and Utility Room Expansion, Fire Pumphouse and Water Storage Tank, Plant Office Building, Electrical Substations, underground tanks, and Off-Gas Trench. These facilities are shown on **Figure C–1**. Also included in WMA 1 are underground pipelines and the source area of the North Plateau Groundwater Plume. The plume extends through WMAs 1 through 6. The North Plateau Groundwater Plume is described in Section C.2.13.

At the starting point of this EIS, several WMA 1 facilities, including the Fuel Receiving and Storage Ventilation Building; Fuel Receiving and Storage High Integrity Container Storage Area; Radwaste Process (Hittman) Building; Laundry Room; Cold Chemical Facility; Emergency Vehicle Shelter; and Contact Size-Reduction Facility, including the Master Slave Manipulator Repair Shop; will have been removed to grade. The disposition of the remaining concrete foundations and slabs is analyzed in this EIS.

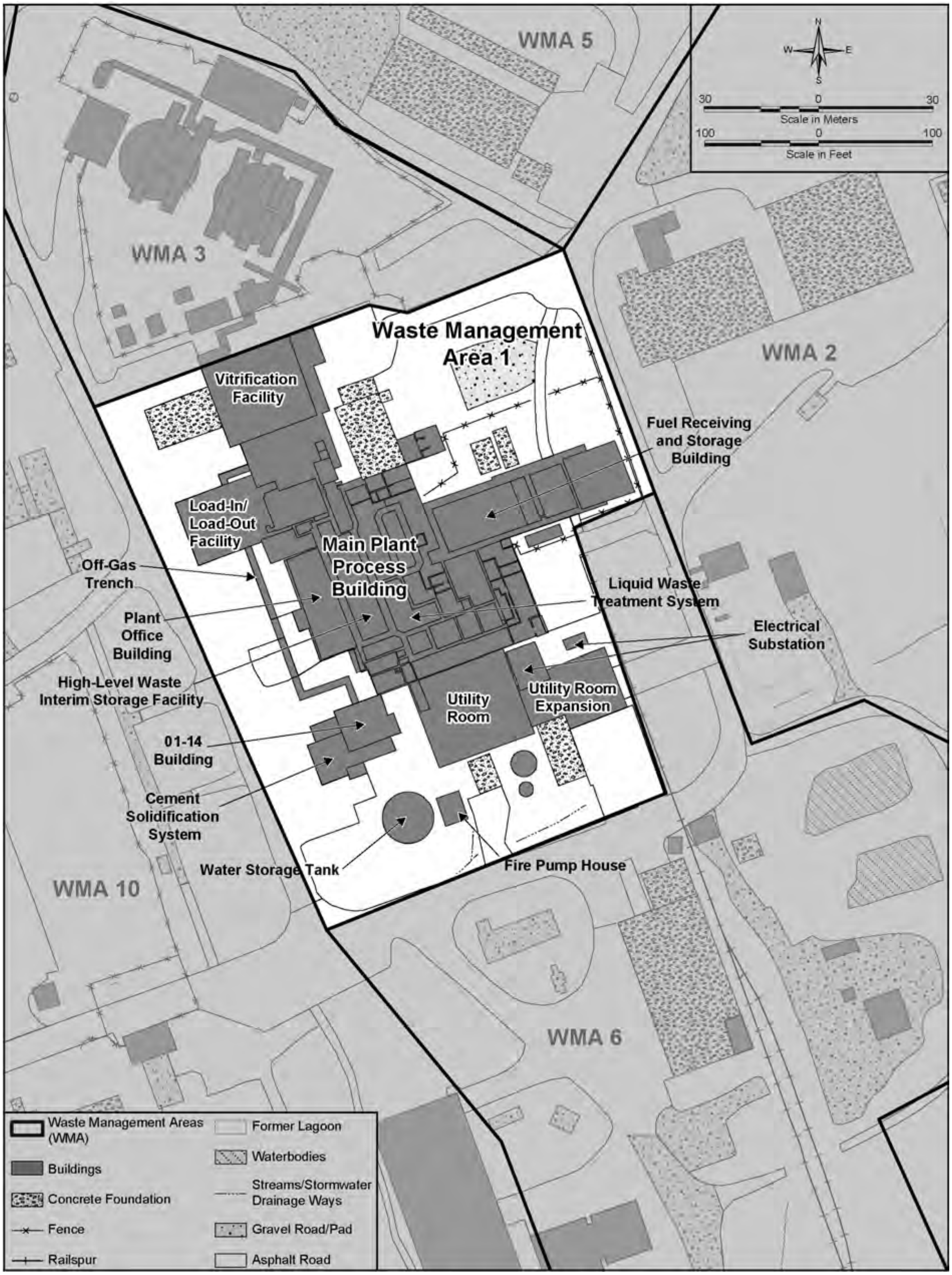

Figure C–1 Waste Management Area 1 – Main Plant Process Building and Vitrification Facility Area

C.2.1.1 Main Plant Process Building

With the exception of the area where the vitrified high-level radioactive waste canisters are stored, most of the Main Plant Process Building will have been decontaminated at the starting point of this EIS to a point where it could be demolished without containment. Areas still operational in support of high-level radioactive waste canister storage will include the Chemical Process Cell Crane Room, Equipment Decontamination Room, Ventilation Supply Room, Ventilation Exhaust Cell, and Head-End Ventilation Building, along with supporting plant utilities. Other equipment that will remain in the Main Plant Process Building is located in the Liquid Waste Cell, Off-Gas Cell, Uranium Product Cell, Ventilation Wash Room, and Off-Gas Blower Room. **Figure C–2** depicts the general arrangement of the building.

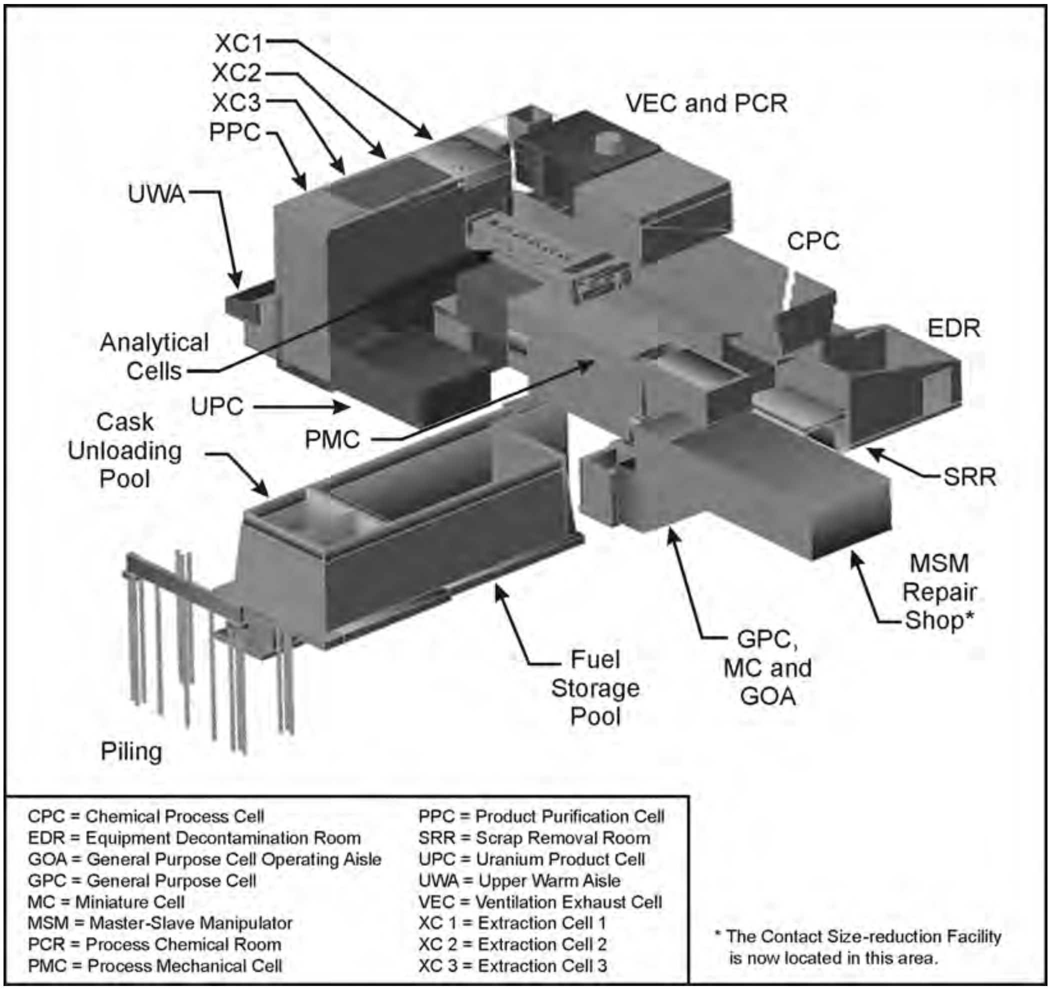

Figure C–2 General Arrangement of the Main Plant Process Building

The Main Plant Process Building was built between 1963 and 1966 and was used by Nuclear Fuel Services, Inc. (NFS) to recover thorium, uranium, and plutonium from irradiated nuclear fuel from 1966 to 1971. This multi-storied building is approximately 40 meters (130 feet) wide and 82 meters (270 feet) long, and it extends approximately 24 meters (79 feet) above the ground surface at its highest point. The major plant structure is founded on driven steel H-piles, which were used to limit differential settlements between cells. The building is composed of a series of cells, aisles, and rooms that are constructed of reinforced concrete and concrete block. The bottoms of the Main Plant Process Building cells are located in the sand and gravel unit. The reinforced concrete walls, floors, and ceilings are 0.3 to 1.8 meters (1 to 6 feet) thick. The reinforced concrete walls are surrounded by lighter concrete and masonry wall construction, with metal deck flooring. Most of the facility was constructed above-grade. However, a few of the cells extend below the reference ground surface elevation for the Main Plant Process Building. The General Purpose Cell, for example, extends to approximately 9 meters (30 feet) below reference ground elevation. The Cask Unloading Pool and the Fuel Storage Pool, located in the Fuel Receiving and Storage Area on the east side of the building, were used to receive and store spent nuclear fuel sent for reprocessing; they extend approximately 15 and 10 meters (49 and 34 feet) below the reference ground elevation, respectively.

Cells such as the Process Mechanical Cell, the Chemical Process Cell, and the extraction cells were constructed of reinforced high-density concrete 0.9 to 1.5 meters (3 to 5 feet) thick. These thicknesses were needed to provide radiation shielding for the remote mechanical and chemical processing of spent nuclear fuel or management of radioactive liquid waste. The operations performed in the cells were remotely controlled by individuals working in the various aisles of the Main Plant Process Building, which were formed by adjacent walls of the cells. The aisles contained the manipulators and valves needed to support operations in the cells. Rooms not expected to contain radioactivity, such as the Control Room, Ventilation Supply Room, and Extraction Chemical Room, were typically constructed with concrete block and structural steel framing. Such rooms were designed to support the reprocessing operations and typically were not shielded.

Portions of the Main Plant Process Building were modified to support the primary mission of solidifying high-level radioactive waste. Fuel reprocessing equipment was removed from the Chemical Process Cell to allow its use for storage of canisters of vitrified high-level radioactive waste. Currently, 275 vitrified high-level radioactive waste canisters are stored in the Chemical Process Cell. Fuel reprocessing equipment in Extraction Cell 3 and the Product Purification Cell was removed and replaced with equipment used to support the Liquid Waste Treatment System. The Liquid Waste Treatment System was used to treat supernatant and sludge wash solutions from Tank 8D-2, which contained high-level radioactive waste that was also an RCRA-characteristic hazardous waste based on the concentration of several metals.

An estimate of the total amount of residual radioactivity for both the above-grade and below-grade portions of the Main Plant Process Building at the starting point of this EIS is provided in **Table C–1**.

Table C–1 Estimated Radionuclide Inventory Within the Above- and Below-Grade Portions of the Main Plant Process Building

Radionuclide	*Estimate (curies)* [a]	*Radionuclide*	*Estimate (curies)* [a]	*Radionuclide*	*Estimate (curies)* [a]
Carbon-14	12.7	Uranium-234	0.196	Plutonium-240	46.6
Strontium-90	1,890	Uranium-235	0.0295	Plutonium-241	1,110
Technetium-99	4.85	Neptunium-237	0.567	Americium-241	272
Iodine-129	0.627	Uranium-238	0.0869	Curium-243	0.276
Cesium-137	2,570	Plutonium-238	202	Curium-244	6.33
Uranium-233	0.410	Plutonium-239	63.4		

[a] Decayed to 2011.
Source: WVES 2008a.

The Main Plant Process Building also contains a residual chemical inventory that is regulated under RCRA. This chemical inventory includes lead used for shielding purposes and in lead-based paints, mercury compounds used during fuel reprocessing and in mercury switches, and polychlorinated biphenyls (PCBs) in some electrical equipment. Several areas of the Main Plant Process Building are used for mixed waste treatment and storage.

The amounts of hazardous chemical inventory conservatively estimated to be present within both the above-grade and below-grade portions of the Main Plant Process Building are provided in **Table C–2**. The Main Plant Process Building is a RCRA interim status unit and is subject to RCRA closure.

Table C–2 Estimated Chemical Contamination Within the Above- and Below-Grade Portions of the Main Plant Process Building

Chemical	*Contamination (kilograms)*	*Chemical*	*Contamination (kilograms)*
Antimony	9.9	Lead [a]	187
Arsenic	28	Mercury	0.45
Barium	39	Nickel	254
Beryllium	2.8	Selenium	16
Cadmium	9.4	Silver	14
Chromium	80	Thallium	3.3

[a] Excludes lead glass viewing windows.
Note: To convert kilograms to pounds, multiply by 2.2046.
Source: URS 2008a.

Asbestos is generally present around pipe penetrations in the walls of the Main Plant Process Building, in floor tiles, and in ceilings and other places where it was used in insulation. While some of this material may be removed prior to the starting point of the EIS, it is expected that much of it will remain and will have to be removed as part of the scope of this EIS. Asbestos volume is reflected in waste generation estimates for construction and demolition debris for the different alternatives.

C.2.1.2 Vitrification Facility

At the starting point of this EIS, the Vitrification Facility will be in place and will have been decontaminated to allow uncontained demolition.

The Vitrification Facility is a structural steel–framed, sheet metal building that houses the Vitrification Cell, operating aisles, and a control room. The Vitrification Cell is 10.4 meters (34 feet) wide, 19.8 meters (65 feet) long, and 12.8 meters (42 feet) high. At the north end of the Vitrification Cell is the melter pit. The pit is 10.4 meters (34 feet) wide by 7.6 meters (25 feet) long. The bottom of the melter pit is about 4.3 meters (14 feet) below-grade. The Vitrification Cell is lined with a 0.32-centimeter-thick (0.125-inch-thick) stainless steel liner up to 6.7 meters (22 feet) above-grade. High-level radioactive waste transferred from Tank 8D-2 was mixed with glass formers and vitrified into borosilicate glass within the Vitrification Cell. The Vitrification Cell contained the Concentrator Feed Makeup Tank, Melter Feed Hold Tank, Slurry-Fed Ceramic Melter, Turntable, Off-Gas Treatment Equipment, Canister Welding Station, and Canister Decontamination Station. The Vitrification Cell is a mixed waste treatment and storage unit. Vitrification operations were performed remotely by operators in the operating aisles or in the control room. The Vitrification Cell is expected to be radiologically contaminated based on decommissioning activities performed during the removal of the treatment system equipment. It will have been decontaminated, however, and made "demolition-ready" prior to the start of the EIS activities. The operating aisles and control room are not contaminated. The bulk chemical storage tank in the Vitrification Facility would require closure under 6 New York Code of Rules and Regulations (NYCRR) Part 598. At the starting point of this EIS, the Vitrification Cell will be set up for use as a containment building to perform remote-handled size reduction of equipment removed from the Main Plant Process Building.

An estimate of the total amount of residual radioactivity and hazardous chemical inventory present in the Vitrification Facility as contamination at the starting point of the EIS is provided in **Tables C–3** and **C–4**.

Table C–3 Estimated Radionuclide Inventory in the Vitrification Facility

Radionuclide	*Estimate (curies)* [a]	*Radionuclide*	*Estimate (curies)* [a]	*Radionuclide*	*Estimate (curies)* [a]
Carbon-14	0.000216	Uranium-234	0.000621	Plutonium-240	0.347
Strontium-90	909	Uranium-235	0.0000171	Plutonium-241	8.66
Technetium-99	0.0376	Neptunium-237	0.00905	Americium-241	14.0
Iodine-129	1.76×10^{-7}	Uranium-238	0.000150	Curium-243	0.0865
Cesium-137	957	Plutonium-238	1.61	Curium-244	1.90
Uranium-233	0.00160	Plutonium-239	0.486		

[a] Decayed to 2011.
Source: WVES 2008b.

The amounts of hazardous chemical materials conservatively estimated to be present in the Vitrification Facility at the starting point of this EIS are provided in Table C–4. The Vitrification Facility is a RCRA interim status unit and is subject to RCRA closure.

Table C–4 Estimated Hazardous Chemical Inventory in the Vitrification Facility

Chemical	*Contamination (kilograms)*	*Chemical*	*Contamination (kilograms)*
Antimony	3.5	Lead [a]	66
Arsenic	10	Mercury	0.16
Barium	14	Nickel	90
Beryllium	1.0	Selenium	5.6
Cadmium	3.3	Silver	5
Chromium	28	Thallium	1.2

[a] Excludes lead glass viewing windows.
Note: To convert kilograms to pounds, multiply by 2.2046.
Source: URS 2008b.

C.2.1.3 01-14 Building

At the starting point of this EIS, the 01-14 Building will be in place and will have been decontaminated to allow uncontained demolition.

The 01-14 Building is a four-story, 18-meter-tall (60-foot-tall) concrete and steel–framed building located next to the southwest corner of the Main Plant Process Building. This building was built by NFS in 1971 to house an off-gas system and acid recovery system, which were to be located in the off-gas treatment cell and acid fractionator cell portions of the building. However, the building was never used to support NFS operations. The 01-14 Building currently houses the Vitrification Off-Gas System and the Cement Solidification System. The Vitrification Off-Gas System, located in the northeast section of the building, was used to treat off-gases generated from the melter in the WVDP Vitrification Facility. The Cement Solidification System was used to stabilize mixed low-level radioactive waste generated from the low-level waste treatment system in a cement matrix and to package this mixture in 270-liter (71-gallon) square drums that were stored in the Radwaste Treatment System Drum Cell (Drum Cell).

An estimate of the total amount of residual radioactivity present in the 01-14 Building at the starting point of this EIS is provided in **Table C–5**.

The 01-14 Building is a RCRA interim status unit and is subject to RCRA closure.

Table C–5 Estimated Radionuclide Inventory in the 01-14 Building

Radionuclide	*Estimate (curies)* [a]	*Radionuclide*	*Estimate (curies)* [a]	*Radionuclide*	*Estimate (curies)* [a]
Carbon-14	0.0000410	Uranium-234	0.00561	Plutonium-240	0.0642
Strontium-90	165	Uranium-235	0.00540	Plutonium-241	1.50
Technetium-99	0.170	Neptunium-237	0.00381	Americium-241	2.69
Iodine-129	3.20×10^{-8}	Uranium-238	0.00520	Curium-243	0.0156
Cesium-137	174	Plutonium-238	0.296	Curium-244	0.334
Uranium-233	0.0120	Plutonium-239	0.0910		

[a] Decayed to 2011.
Source: WVES 2008a.

C.2.1.4 Load-In/Load-Out Facility

The Load-In/Load-Out Facility is located adjacent to the west wall of the Equipment Decontamination Room of the Main Plant Process Building. The facility is a structural steel and steel–sided building that is 24.2 meters (80 feet) long, 16.9 meters (55 feet) wide, and 16.5 meters (54 feet) tall. The floor is poured concrete and the roof is metal sheeting with insulation. This facility was used to move empty canisters and equipment into and out of the Vitrification Cell. The Load-In/Load-Out Facility has a truck bay and a 13.7-metric ton (15-ton) overhead crane that is used to move canisters and equipment. The facility is not radioactively contaminated.

C.2.1.5 Utility Room and Utility Room Expansion

The Utility Room is a concrete block and steel–framed building located on the south end of the Main Plant Process Building. The Utility Room consists of two adjoining buildings that were built at different times, the original Utility Room and the Utility Room Expansion. The original Utility Room, which was built during construction of the Main Plant Process Building, makes up the western portion of the Utility Room and is 24 meters (80 feet) wide, 27 meters (88 feet) long, and 6 meters (20 feet) high. The Utility Room contains equipment that supplies steam, compressed air, and various types of water to the Main Plant Process Building and the Waste Tank Farm. Based on process history and the results of routine radiological surveys, the Utility Room is not expected to have significant radiological contamination. However, the pipe trench in the original Utility Room is reported to be radioactively contaminated and may have chemical contamination. Chemicals, such as mercury, acids, oils, biocides, and water treatment chemicals, have been used and stored in the Utility Room; some of these were spilled and subsequently cleaned up. The Utility Room also contains equipment contaminated with asbestos and PCBs.

An aboveground 37,850-liter (10,000-gallon) No. 2 fuel oil tank is located outside the Utility Room. The aboveground fuel oil tank would require closure under 6 NYCRR Part 613 regulations. Asbestos-containing material associated with the fuel oil tank would be managed as asbestos-containing waste in accordance with New York State and Toxic Substances Control Act requirements.

The Utility Room Expansion was built in the early 1990s immediately adjacent and connected to the original Utility Room. The Utility Room Expansion is approximately 26 meters (85 feet) long, 17 meters (56 feet) wide, and 7.6 meters (25 feet) high. Because this building is new, and because radioactive waste processing operations were not performed in it, the Utility Room Expansion is not expected to be contaminated. Routine radiological surveys have not detected any radiological contamination in this area.

C.2.1.6 Fire Pumphouse and Water Storage Tank

The Fire Pumphouse was constructed when the Main Plant Process Building was built in 1963. The footprint of the facility is 6 meters (20 feet) wide by 7.3 meters (24 feet) long. It is 2.4 meters (8 feet) high along one length and 3 meters (10 feet) high at the peak. It is supported on a concrete foundation wall that is 20 centimeters (8 inches) thick and extends 1.2 meters (4 feet) below-grade. The flooring is a concrete slab that is 10 centimeters (4 inches) thick. Construction materials include a steel-beam frame, metal siding with insulation, and a light metal roof. The Fire Pumphouse contains two pumps on concrete foundations. One is driven by an electric motor with a diesel engine backup, and the other is driven by a diesel engine. A 1,098-liter (290-gallon) double-wall, carbon steel diesel fuel day tank with No. 2 fuel oil is also located in the Fire Pumphouse. The fuel oil tank would require closure under 6 NYCRR Part 613. A light metal storage shed that is about 1.5 meters (5 feet) long and 0.9 meters (3 feet) wide rests on a concrete slab that is 2 meters (7 feet) long, 1.8 meters (6 feet) wide, and 20 centimeters (8 inches) thick. The shed is used to store fire hoses and fire extinguishers.

A 1.8 million-liter (477,000-gallon) Water Storage Tank stores water for firefighting purposes. The Fire Pumphouse and the Water Storage Tank are not expected to be radioactively contaminated based on process knowledge and routine radiological surveys.

C.2.1.7 Plant Office Building

The Plant Office Building is a three-story concrete block and steel–framed structure located adjacent to the west side of the Main Plant Process Building. The Plant Office Building is approximately 12 meters (40 feet) wide, 29 meters (95 feet) long, and 13.4 meters (44 feet) high; it contains offices and men's and women's locker rooms. The Plant Office Building is designated as an unrestricted occupancy area. However, an undetermined amount of radiological contamination is present beneath the floor in the men's shower room. This contamination originated during NFS operations from releases of radioactive acid from the Acid Recovery System from 1968 to 1970. Those releases and other leaks and spills are described in Chapter 3, Section 3.11.5. This system was housed in the southwest corner of the Main Plant Process Building. The leaking acid flowed down the walls of the off-gas cell and the adjacent southwest stairwell into the sand and gravel unit underlying the Main Plant Process Building.

C.2.1.8 Electrical Substation

The Electrical Substation is located adjacent to the southeast corner of the Main Plant Process Building. A 34.5-kilovolt/480-volt transformer rests on a concrete foundation behind a steel-framed structure. The transformer contains 2,220 liters (586 gallons) of oil containing PCBs at 292 parts per million. Disposition of PCBs would be in accordance with 40 *Code of Federal Regulations* (CFR) Part 761 and 6 NYCRR Parts 370 to 376. No radiologically contaminated areas have been identified at the Electrical Substation (DOE 1996a).

C.2.1.9 Underground Tanks

Tanks 35104, 7D-13, and 15D-6 are located underground in the vicinity of the Main Plant Process Building.

Tank 35104 is a 22,300-liter (5,900-gallon) stainless steel tank located in an underground concrete vault connected to the west end of the General Purpose Cell Crane Room. The tank serves as a collection and hold tank for liquid from drains in the Equipment Decontamination Room, Chemical Crane Room, and other contaminated areas. The tank also received liquid waste from the Supernatant Treatment System (STS). It contains mixed radioactive liquids (containing both radiological and RCRA components).

Tank 7D-13 is a 7,600-liter (2,000-gallon) stainless steel horizontal underground tank located southwest of the Main Plant Process Building. The bottom of the tank lies 4.3 meters (14 feet) belowgrade. The tank was used as a holding tank for liquid waste from the Laundry Room and the laboratories prior to transfer to the Low-Level Waste Treatment Facility. Due to an accumulation of solids in the bottom of the tank, it was taken out of service in 1988. Part of the contents, consisting of water and concrete fines characterized as transuranic waste, was removed. An inspection in 2000 disclosed that an estimated 568 to 1,140 liters (150 to 300 gallons) of cement solids remained at the bottom of the tank.

Tank 15D-6 is a 5,700-liter (1,500-gallon) vertical underground stainless steel tank located in an earthen and gravel vault outside the east wall of the Contact Size Reduction Facility. It is approximately 1.8 meters (6 feet) in diameter by 2.4 meters (8 feet) high, with the bottom of the tank lying 4.7 meters (16 feet) belowgrade. The tank was the waste catch tank for the Master Slave Manipulator Repair Shop and Contact Size Reduction Facility. The tank level recorded in April 2004 indicated that it contained approximately 860 liters (227 gallons) of radioactive contents.

C.2.1.10 Off-Gas Trench

The Off-Gas Trench is an underground shielded concrete transfer trench located on the west side of the Main Plant Process Building between the Vitrification Facility and the 01-14 Building. The final treatment of the off-gas that was generated by the vitrification cell melter and vessel vent system was performed in the 01-14 Building because it contained off-gas equipment and allowed access to the Main Plant Process Building stack. The off-gas generated by vitrification was scrubbed and passed through high-efficiency particulate air (HEPA) filters. The filtered off-gas stream was transferred to the 01-14 Building for further processing via an insulated 25-centimeter-diameter (10-inch-diameter) duct in the Off-Gas Trench. The duct has radioactive contamination. The Off-Gas Trench is not expected to be contaminated.

C.2.1.11 Underground Lines

At the starting point of this EIS, the underground pipelines within WMA 1 will still be in place. During construction of WMA 1 facilities, approximately 125 underground pipelines designed to convey radioactive liquids were installed in the vicinity of the Main Plant Process Building. These lines are buried at depths ranging from 1.4 to 3.7 meters (4.5 to 12 feet) belowgrade.

C.2.2 Waste Management Area 2: Low-Level Waste Treatment Facility Area

WMA 2, the Low-Level Waste Treatment Facility Area, is shown on **Figure C–3**. WMA 2 encompasses approximately 5.5 hectares (14 acres). It was used by NFS and WVDP to treat low-level radioactive wastewater generated on site. Facilities and areas analyzed in this EIS include the Low-Level Waste Treatment Facility; inactive filled Lagoon 1; active Lagoons 2, 3, 4, and 5; Neutralization Pit; New and Old Interceptors; Solvent Dike; Maintenance Shop Leach Field; and Fire Brigade Training Area. Included in WMA 2 is a portion of the North Plateau Groundwater Plume, which also extends through WMAs 1, 3, 4, 5, and 6.

At the starting point of this EIS, the 02 Building, Test and Storage Building, Vitrification Test Facility, Vitrification Test Facility Waste Storage Area, Maintenance Shop, Maintenance Storage Area, Vehicle Maintenance Shop, and Industrial Waste Storage Area will have been removed to grade. The disposition of the concrete foundations and slabs is analyzed in this EIS.

The Solvent Dike, Neutralization Pit, interceptors, and lagoons are radiologically contaminated and are known to contain hazardous chemical constituents originating from the management of wastewater containing chemical contaminants. Radiological inventories are shown in the following subsections. There is no data to describe or quantify any hazardous chemical constituents that are present (WVNSCO 1997).

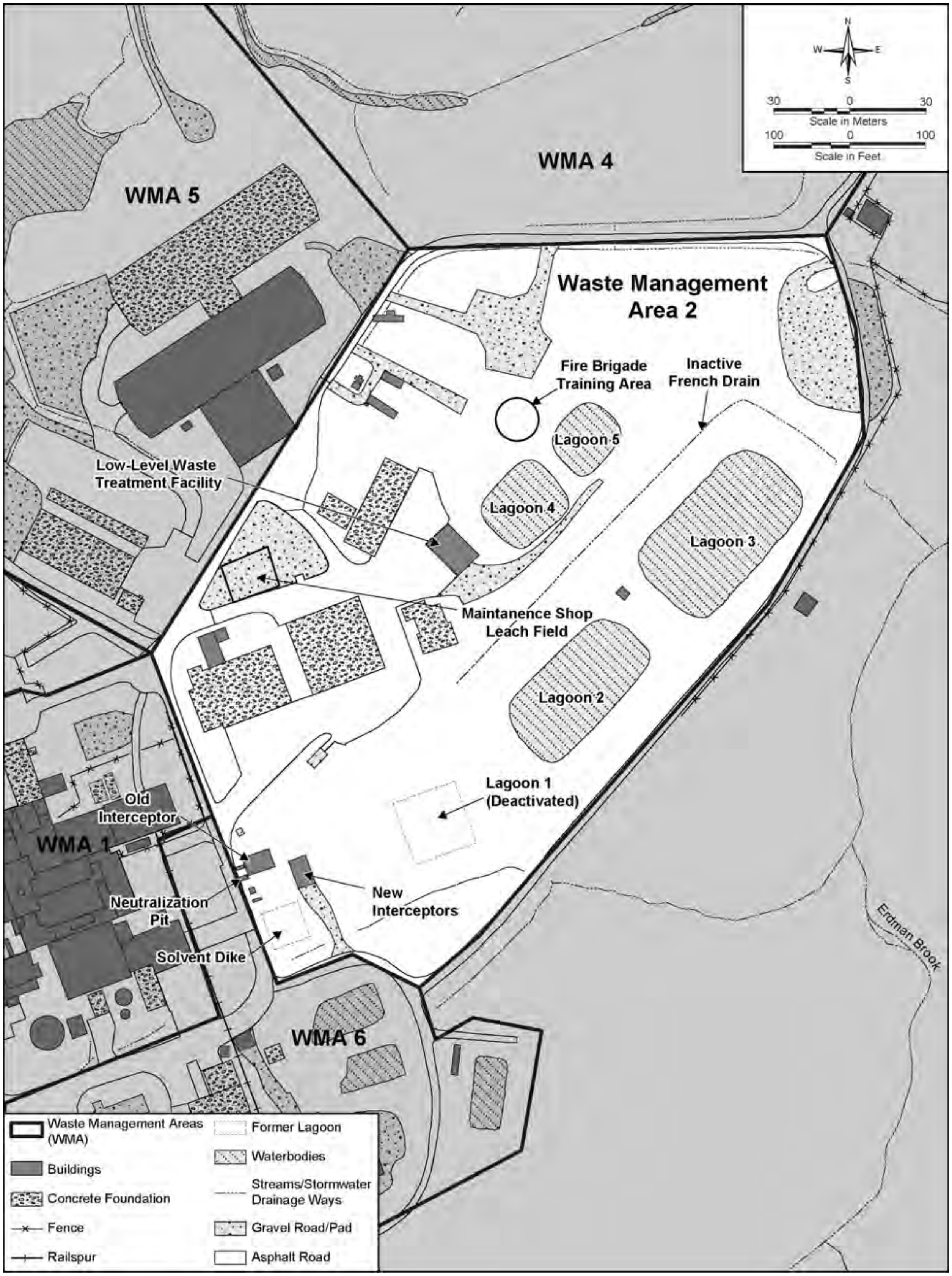

Figure C–3 Waste Management Area 2 – Low-Level Waste Treatment Facility Area

C.2.2.1 Low-Level Waste Treatment Facility

The Low-Level Waste Treatment Facility is located southwest of Lagoon 4; it is a pre-engineered, single-story, metal-sided building on a concrete foundation measuring 12 meters (40 feet) by 18 meters (60 feet). The 6- by 6-meter (20- by 20-foot) Packaging Room, which is typically used for resin handling, includes a 3,400-liter (900-gallon) sump and is ventilated by HEPA filters. The Low-Level Waste Treatment Facility houses two skid-mounted process equipment modules. One skid processes wastewater from the Main Plant Process Building, the Waste Tank Farm Area (WMA 3), and the NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area (NDA) and its associated facilities (WMA 7). The second skid is used to process radiologically contaminated groundwater from the North Plateau Groundwater Plume. The equipment in the facility is radiologically contaminated, including that in the Packaging Room. The Low-Level Waste Treatment Facility is identified as a Solid Waste Management Unit (SWMU) and is subject to Clean Water Act corrective action and closure requirements.

C.2.2.2 Lagoon 1

Lagoon 1 was an unlined pit excavated into the sand and gravel unit. It was fed directly from the Old and New Interceptors and had a storage capacity of approximately 1,140,000 liters (300,000 gallons). This lagoon was removed from service in 1984 after a determination was made that it was the source of tritium contamination to nearby groundwater. The liquid and a majority of the contaminated sediment were transferred to Lagoon 2. Lagoon 1 was filled with approximately 1,300 cubic meters (1,700 cubic yards) of radiologically contaminated debris from the Old Hardstand, including asphalt, trees, stumps, roots and weeds. It was capped with clay, covered with topsoil, and revegetated. Groundwater immediately downgradient of the Lagoon 1 area is routinely monitored with wells as part of a Sitewide Environmental Monitoring Program.

At the starting point of this EIS, Lagoon 1 is estimated to contain approximately 550 curies of cesium-137 and significant quantities of transuranic radionuclides, predominantly in the sediment. **Table C–6** presents the radionuclide inventory that is estimated to be present in Lagoon 1 at the starting point. Lagoon 1 is identified as a SWMU subject to corrective action requirements pursuant to the RCRA 3008(h) Consent Order. A Corrective Measures Study is being prepared.

Table C–6 Estimated Radionuclide Inventory in Lagoon 1

Radionuclide	*Estimate [a] (curies)*	*Radionuclide*	*Estimate [a] (curies)*
Carbon-14	0.0529	Uranium-238	0.025
Strontium-90	18.8	Neptunium-237	0.00315
Technetium-99	0.204	Plutonium-238	6.55
Iodine-129	0.0285	Plutonium-239	3.78
Cesium-137	547	Plutonium-241	156
Uranium-233	0.225	Americium-241	10.9
Uranium-234	0.0118	Curium-244	0.216
Uranium-235	0.0027		

[a] Decayed to 2011.
Source: WVNS 1995.

C.2.2.3 Lagoons 2, 3, 4, and 5

Lagoon 2 is an unlined pit that was excavated through 3 to 4.6 meters (10 to 15 feet) of sand and gravel into the top 0.6 to 2.1 meters (2 to 6.9 feet) of the Lavery till. Water levels are maintained 0.9 meters (3 feet) below the sand and gravel/till interface. It has a storage capacity of 9.1 million liters (2.4 million gallons). It is used as a storage basin for wastewater discharged from the New Interceptors before its contents are transferred to the Low-Level Waste Treatment Facility for treatment. Prior to installation of the Low-Level Waste Treatment Facility, wastewater was routed through Lagoons 1, 2, and 3, in series, before discharge to Erdman Brook.

Lagoon 2 became the initial receiving lagoon for the wastewater treatment system after closure of Lagoon 1. Radioactive contamination is known to be present in Lagoon 2 sediment. A French drain is located on the northwest sides of Lagoons 2 and 3 and the northeast side of Lagoon 3. The drain was installed to prevent groundwater in the sand and gravel unit from flowing into Lagoons 2 and 3. The French drain was used to collect groundwater and discharge it to Erdman Brook through a permitted outfall. The French drain was closed in May 2001 (WVES and URS 2008) due to elevated levels of lead and with a subsequent lack of discharges to Erdman Brook. RCRA hazardous chemical constituents have been identified in shoreline sediments (WVNSCO 1997).

Lagoon 3 is an unlined pit with a storage capacity of 12.5 million liters (3.3 million gallons) that was excavated through 3 to 4.6 meters (9.8 to 15 feet) of sand and gravel into the top 2.7 to 4.3 meters (8.9 to 14 feet) of the Lavery till. Water levels were maintained 1.5 to 2.4 meters (4.9 to 7.9 feet) below the sand and gravel/till interface. After installation of the 02 Building, Lagoon 3 was disconnected from Lagoon 2 and emptied, and its sediment was removed and buried in the NDA in WMA 7. Currently, Lagoon 3 only receives treated water from Lagoons 4 and 5. Treated wastewater in Lagoon 3 is periodically discharged to Erdman Brook in batches through a State Pollutant Discharge Elimination System (SPDES)-permitted outfall. Process knowledge and available data indicate that Lagoon 3 contains much less radioactivity than Lagoon 2 (WVNS 1995). Sampling results do not indicate the presence of RCRA hazardous chemical constituents (WVNSCO 1997).

The upgradient part of Lagoon 4 was excavated into the sand and gravel, and the excavated material was used to create berms in the downgradient end. The lagoon was lined with an ethylene propylene diamine membrane. In the late 1990s, the liner was replaced with concrete grout and a geomembrane liner with a capacity of 772,000 liters (204,000 gallons). The liner was added after the first few years of operation as the lagoon was considered a potential source of tritium contamination. It receives treated water from the Low-Level Waste Treatment Facility and discharges it to Lagoon 3. Low levels of radioactive contamination are expected both above and below the lagoon liner. Sampling results do not indicate the presence of RCRA hazardous chemical constituents (WVNSCO 1997).

The upgradient part of Lagoon 5 was also excavated into the sand and gravel, and the excavated material was used to create berms in the downgradient end. The lagoon was lined with an ethylene propylene diamine membrane. In the late 1990s, the liner was replaced with concrete grout and a geomembrane liner with a capacity of 628,000 liters (166,000 gallons). The liner was added after the first few years of operation as the lagoon was considered a potential source of tritium contamination. It receives treated water from the Low-Level Waste Treatment Facility and discharges it to Lagoon 3. Low levels of radioactive contamination are expected both above and below the lagoon liner. Sampling results do not indicate the presence of RCRA hazardous chemical constituents (WVNSCO 1997).

Lagoons 2 through 5 are identified as SWMUs and are subject to Clean Water Act corrective action and closure requirements.

The residual radionuclide inventory in Lagoon 2 is estimated to be approximately two orders of magnitude lower than that in Lagoon 1, and the inventories in Lagoons 3 through 5 are expected to be one or more orders of magnitude lower than the Lagoon 2 inventory. The residual radioactivity in Lagoons 2 and 3 is expected to be located in the top several inches of the bottom sediment; in Lagoons 4 and 5 it is expected to be in sediment on and under the lagoon liners. The projected radionuclide inventory of Lagoon 2 at the starting point of this EIS is presented in **Table C–7**. The inventory is not presented for Lagoons 3 through 5 because the inventories would be three or more orders of magnitude lower than the Lagoon 1 inventory (DOE 1996a, WVNS 1995).

Table C–7 Estimated Radionuclide Inventory in Lagoon 2

Radionuclide	***Estimate [a] (curies)***	***Radionuclide***	***Estimate [a] (curies)***
Tritium	Not reported	Uranium-235	0.00599
Carbon-14	0.000548	Neptunium-237	0.0000326
Strontium-90	4.48	Uranium-238	0.000719
Technetium-99	0.00211	Plutonium-238	0.0464
Iodine-129	4.41×10^{-6}	Plutonium-239	0.0425
Cesium-137	4.76	Plutonium-241	1.61
Uranium-233	0.00233	Americium-241	0.124
Uranium-234	0.00185	Curium-244	0.00224

[a] Decayed to 2011.
Source: WVNS 1995, DOE 1996a.

C.2.2.4 Neutralization Pit and Interceptors

The Neutralization Pit is a 2.7- by 2.1- by 1.7-meter (9- by 7- by 5.5-foot) below-grade tank constructed with 15.2-centimeter-thick (6-inch-thick) concrete walls and floor. The tank initially had an acid-resistant coating that failed and was replaced with a stainless steel liner. The pit is radiologically contaminated and may contain chemical constituents derived from the management of low-level radioactive wastewater. The Neutralization Pit receives liquid low-level radioactive waste from floor drains in the Main Plant Process Building. Sodium hydroxide or potassium hydroxide is added to the wastewater through floor drains in the Utility Room to maintain a pH of greater than 10 for insect larvae control. The liquid is subsequently transferred to Lagoon 2.

The Old Interceptor is a 12- by 7.6- by 3.5-meter (40- by 25- by 11.5-foot) unlined concrete liquid waste storage tank located below-grade. The floor was initially 30.5 centimeters (12 inches) thick, but in 1967 an additional 30.5 centimeters (12 inches) of concrete were added to provide radiation shielding after some wastewater with higher than normal levels of contamination was inadvertently sent to it. The walls are 30.5 centimeters (12 inches) thick. The roof is made of steel. The Old Interceptor received low-level liquid waste generated at the Main Plant Process Building from the time of initial operation until the New Interceptors were constructed. The Old Interceptor is currently used for storing radiologically contaminated liquids that exceed the effluent standard of 0.005 microcuries per milliliter gross beta activity. It is radioactively contaminated. After verification of acceptable radiological contamination concentrations, the contents are transferred by steam jet to the New Interceptors.

The New Interceptors were constructed and began operations between July 1, 1967, and September 30, 1967. The interceptors are twin (north and south) below-grade concrete storage tanks with dimensions of 6.7 meters by 6.1 meters by 3.5 meters (22 by 20 by 11.5 feet). The walls and floor are 35.6 centimeters (14 inches) thick and are lined with 14-gauge Type 304L stainless steel. The New Interceptors are open-topped but have a sheltering steel roof several feet above the open tops. The New Interceptors replaced the Old Interceptor and are used as liquid sample points before transfer of the liquid to Lagoon 2. The New Interceptors are radiologically contaminated.

Relatively small amounts of residual radioactivity (less than 0.01 curies) are expected to be present in the Neutralization Pit and the interceptors, except for the Old Interceptor. Fixed contamination is expected in the concrete walls and floor and on the stainless steel liner in the Neutralization Pit. Most of the inventory in the Old Interceptor is encapsulated by concrete poured into the lower portion of the interceptor. There is no estimate for the encapsulated inventory. Most of the contamination in the New Interceptors is expected to be on the stainless steel liner. Strontium-90 and cesium-137 dominate the residual radioactivity in the Neutralization Pit and interceptors. The Neutralization Pit and interceptors are identified as a SWMU subject to corrective action requirements pursuant to the RCRA 3008(h) Consent Order. A Corrective Measures Study is being prepared.

C.2.2.5 Solvent Dike

The Solvent Dike is located about 90 meters (300 feet) east of the Main Plant Process Building. It was a 9- by 9-meter (30- by 30-foot) unlined basin, excavated in the sand and gravel layer. It received rainwater runoff from the Solvent Storage Terrace, which formerly housed an acid storage tank and three storage tanks containing a mixture of used n-dodecane and tributyl phosphate. Because of elevated radiation fields measured during a 1986 field gamma radiation survey, the solvent dike was excavated. Soil sampling and analysis detected elevated radionuclide concentrations, including strontium-90, cesium-137, americium-241, and uranium and plutonium isotopes. Contaminated soil, which also contained n-dodecane and tributyl phosphate, was removed from the dike and placed in appropriate drums with sorbent material and moved to Lag Storage. The excavation was backfilled with clean topsoil, graded, and seeded; however, the Solvent Dike still contains radiologically contaminated soil. The Solvent Dike is identified as a SWMU; however, it has been determined that no further action is required.

C.2.2.6 Maintenance Shop Leach Field

The Maintenance Shop Leach Field occupies an area of 140 square meters (1,500 square feet) and consists of three septic tanks, a distribution box, a tile drain field, and associated piping. The leach field served the Maintenance Shop and the Test and Storage Building before these buildings were connected to the sanitary sewer system in 1988. RCRA hazardous constituents were detected in the sediment of one septic tank, but none of the concentrations exceeds RCRA hazardous waste criteria or action levels prescribed by New York State Department of Environmental Conservation (NYSDEC). All three tanks are out of service and have been filled with sand. The Maintenance Shop Leach Field is identified as a SWMU; however, it has been determined that no further action is required.

C.2.2.7 Fire Brigade Training Area

The Fire Brigade Training Area is a 6.1- by 6.1-meter (20- by 20-foot) area north of Lagoon 4 that was used two to four times a year between 1982 and 1993 for several types of firefighting training exercises. Piles of wood coated with kerosene or diesel fuel were ignited and then extinguished with water and/or foam. Other exercises involved diesel fuel and water mixtures placed in a shallow metal pan that were ignited and extinguished using a steady stream of water and/or foam. These training exercises were conducted pursuant to the Restricted Burning Permits issued for the training area. Wastes managed in the Fire Brigade Training Area would have included wood ash, residual kerosene or diesel fuel, and water and/or foam used to extinguish the fires. The training area is identified as a SWMU; however, it has been determined that no further action is required.

C.2.2.8 Underground Pipelines

At the starting point of this EIS, the underground pipelines within WMA 2 will still be in place. Of these, 47 wastewater pipelines are known to be radioactively contaminated. Other pipes contain insignificant amounts of residual radioactivity.

C.2.3 Waste Management Area 3: Waste Tank Farm Area

WMA 3, the Waste Tank Farm Area, shown on **Figure C–4**, encompasses approximately 0.8 hectare (2 acres). It includes the waste storage tanks (8D-1, 8D-2, 8D-3, and 8D-4) and associated vaults, High-Level Waste Transfer Trench, Permanent Ventilation System Building, STS, STS Support Building, Equipment Shelter and Condensers, Con-Ed Building, and underground pipelines. A Tank and Vault Drying System will be installed to dry the remaining liquid heels in the tanks prior to the starting point of this EIS. Included in WMA 3 is a portion of the North Plateau Groundwater Plume, which also extends through WMAs 1, 2, 4, 5, and 6.

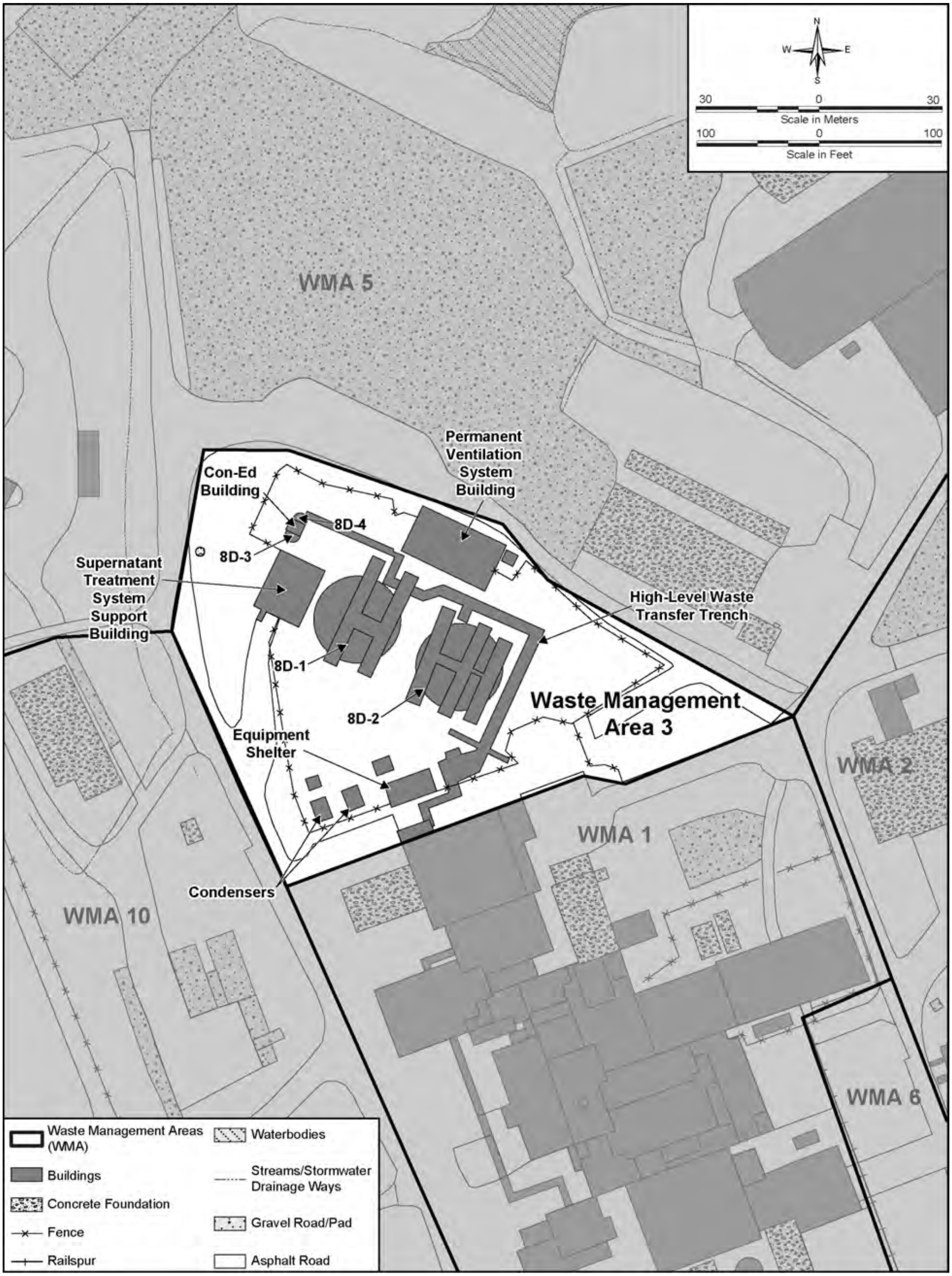

Figure C–4 Waste Management Area 3 – Waste Tank Farm Area

C.2.3.1 Waste Storage Tanks and Vaults

Waste Storage Tanks 8D-1, 8D-2, 8D-3, and 8D-4 were built to store liquid high-level radioactive waste generated during spent nuclear fuel reprocessing operations. Tanks 8D-2 and 8D-4 were used to store plutonium-uranium extraction (PUREX) and thorium extraction (THOREX) wastes, respectively, from reprocessing operations. Tanks 8D-1 and 8D-3 were maintained as companion spare tanks. These tanks were subsequently modified to support treatment of high-level radioactive waste during implementation of WVDP. Modifications included constructing a fabricated steel truss system over the tanks to carry the weight of sludge mobilization and transfer pumps and installing treatment equipment in Tank 8D-1. The Waste Storage Tanks are RCRA interim status units and are subject to RCRA closure.

The estimated residual radioactivity and hazardous chemical inventories in the tanks at the starting point of this EIS are shown in **Table C–8** and **C–9**. A large number of radioactive isotopes have been identified as present at the site. In order to facilitate presentation of data and conduct of the analysis, a dose-based screening analysis was performed to generate a more concise list of radionuclides for detailed analysis. Radionuclides identified for detailed analysis accounted for greater than 99 percent of dose on the screening analysis. Data are presented in this appendix for radionuclides identified for detailed analysis rather than for all radionuclides that may be present on the site.

Table C–8 Radionuclide Inventory in the Waste Tank Farm – Conservative Case [a]

Radionuclide [b]	*Tank 8D-1 (curies)*	*Tank 8D-2 (curies)*	*Tank 8D-3 (curies)*	*Tank 8D-4 (curies)*	*Total (curies)*
Carbon-14	0.020	0.00546	0.0000147	0.00999	0.0355
Strontium-90 [c]	1,950	29,000	0.691	4,440	35,400
Technetium-99	5.40	5.85	0.0156	0.240	11.5
Iodine-129	0.0068	0.00768	0.0000196	0.0032	0.0177
Cesium-137 [c]	213,000	85,900	0.176	1,690	301,000
Uranium-233	0.260	0.0873	0.00214	0.044	0.393
Uranium-234	0.100	0.0361	0.000770	0.00328	0.140
Uranium-235	0.00340	0.00134	0.0000211	0.000140	0.0049
Uranium-238	0.0310	0.00815	0.000206	0.0000560	0.0394
Neptunium-237	0.0230	0.517	0.000258	0.0120	0.552
Plutonium-238	5.30	139	0.0100	19.2	164
Plutonium-239	1.50	36.8	0.00267	0.630	38.9
Plutonium-240	1.10	26.8	0.00192	0.310	28.2
Plutonium-241	31.4	535	0.0709	11.8	578
Americium-241	0.793	387	0.0197	2.70	391

[a] In the first of the two references cited below (the primary reference), three estimates are provided for the curie content as follows: Best Estimate Case (typically presents the lowest values); Worst Estimate Case (highest values); and Conservative Case (values somewhere in between). The latter case was assumed. Inventory estimates include the Supernatant Treatment System.
[b] Decayed to 2011.
[c] Activity excludes progeny.
Sources: WVNSCO 2005, WVES 2008c.

Table C–9 Estimated Hazardous Chemical Inventory in the Waste Tank Farm

Chemical	*Tank 8D-1 (kilograms)*	*Tank 8D-2 (kilograms)*	*Tank 8D-3 (kilograms)*	*Tank 8D-4 (kilograms)*	*Lines (kilograms)*	*Total (kilograms)*
Silver	1.98	1.13	0.00318	0.287	0.000398	3.40
Arsenic	3.92	2.21	0.00795	0.354	0.000795	6.49
Barium	17.5	9.73	0.00636	0.287	0.00360	27.5
Beryllium	0.608	0.372	0.00757 *	0.332 *	0.000115	1.32
Cadmium	1.66	0.884	0.00159	0.0710	0.000324	2.62
Chromium	85.6	47.8	0.0401	0.934	0.0172	134
Mercury	1.15	0.640	0.000320	0.0210	0.000241	1.81
Nickel	85.9	47.7	0.0300 *	2.79 *	0.0177	136
Lead	14.2	7.97	0.0159	0.708	0.00291	22.9
Antimony	9.76	5.47	0.0151 *	0.890 *	0.00199	16.1
Selenium	4.87	2.73	0.00636	0.261	0.000993	7.87
Thallium	9.68	5.38	0.00379 *	0.415 *	0.00199	15.5

Note: Inventory estimates include the Supernatant Treatment System. To convert kilograms to pounds, multiply by 2.2046.
Source: WVES 2008c, 2008d for all values given in the table except for those with a *. The values with the * were taken from URS 2005 because no data were given in the other references.

Tanks 8D-1 and 8D-2

Tanks 8D-1 and 8D-2 are similar in size and construction, and each tank is housed within its own cylindrical concrete vault. Each tank is 8.2 meters (27 feet) high by 21.3 meters (70 feet) in diameter, with a storage capacity of 2,840,000 liters (750,000 gallons). The tanks were constructed from a reinforced carbon steel plate. The roof of each tank is supported internally by 45 20.3-centimeter-diameter (8-inch-diameter) vertical pipe columns that rest on a horizontal gridwork of wide flange beams and cross members in the bottom 0.6 meters (2 feet) of each tank. Each tank rests on two 15.2-centimeter-thick (6-inch-thick) layers of perlite blocks that rest on a 7.6-centimeter (3-inch) layer of pea gravel. The tank, perlite blocks, and pea gravel are contained within a carbon steel pan that rests on a 7.6-centimeter (3-inch) layer of pea gravel that separates the pan from the floor of the vault.

Each tank and its associated pan are housed within a cylindrical reinforced concrete vault that has an outside diameter of 23.9 meters (78.6 feet). The walls of each vault are 45.7 centimeters (18 inches) thick and extend nearly 11 meters (36 feet) above the floor of the vaults. The floor of the vault is 68.6 centimeters (27 inches) thick, except under the six 76.2-centimeter-diameter (30-inch-diameter) vertical concrete columns that support the vault roof, where the floor is thicker. These columns pass upward from the floor of the vault through the tanks and are encased in steel pipes that are welded to the top and bottom of each tank. The columns are located approximately 4.9 meters (16 feet) from the center of the tank. The floor of each vault is underlain by a 1.2-meter-thick (4-foot-thick) bed of gravel. The concrete vault roof is 0.6 meters (2 feet) thick and is supported by six concrete columns. The top of the vault is 1.8 to 2.4 meters (6 to 8 feet) below-grade. Tanks 8D-1 and 8D-2 will be emptied of any residual liquids by accelerated evaporation prior to the starting point of the EIS (WVES 2008c).

Tanks 8D-3 and 8D-4

Tanks 8D-3 and 8D-4 are identical in size and construction, and both are housed within a single concrete vault. Each tank is constructed from Type 304L stainless steel, is 3.6 meters (12 feet) in diameter and 4.8 meters (15.67 feet) high, and has a nominal volume of 56,800 liters (15,000 gallons). The shell of each tank and its associated piping were constructed from 304L stainless steel. The associated concrete vault is 9.75 meters

(32 feet) long, 5.8 meters (19 feet) wide, and 7.6 meters (25 feet) tall. The walls, floor, and roof of the vault are 0.53 meters (1.75 feet) thick. The bottom of the vault is lined with stainless steel to a height of 46 centimeters (18 inches) above the floor. The floor contains a stainless steel–lined sump that was designed to collect any liquid that could leak from the tanks and piping. The top of the vault is 1.8 to 2.4 meters (6 to 8 feet) below-grade.

In achieving the starting point of the EIS, the radiologically contaminated residual liquids in Tanks 8D-3 and 8D-4 will be processed by drying and treatment. Titanium-treated zeolite will be used to adsorb cesium-137 in the Tank 8D-4 liquid and trap a portion of the plutonium content. The titanium-treated zeolite will be packaged and shipped for offsite disposal before the starting point of this EIS (WVES 2008c).

Hazardous chemical inventories have been estimated for the Waste Tank Farm, including the four waste storage tanks and underground process lines (URS 2005, WVES 2008d). These inventories are summarized in Table C–9.

Waste Tank Pumps

Tank 8D-1 contains five waste mobilization pumps and Tank 8D-2 contains four. Tanks 8D-1 and 8D-2 each contain an STS suction pump. Each pump is approximately 2.4 meters (8 feet) long and is supported by a 25.4-centimeter (10-inch) stainless steel pipe column that is 15 meters (50 feet) long. Each pump was operated by a 150-horsepower electric motor located at the top of the pipe column. Tanks 8D-1, 8D-2, 8D-3, and 8D-4 also each contain a waste transfer pump. These centrifugal multistage turbine-type pumps are each supported by a 36-centimeter (14-inch) pipe column. The pipe columns for Tanks 8D-1 and 8D-2 have an overall length of more than 15 meters (50 feet); for Tanks 8D-3 and 8D-4, the length of the pipe column is approximately 6 to 8 meters (20 to 25 feet). Similar to the mobilization pumps, the transfer pumps were driven by 150-horsepower electric motors.

The pumps contain radioactive contamination. An order-of-magnitude estimate of the residual radioactivity in a removed pump in 1998 was approximately 220 curies, with about 90 percent of this amount in the lower 2.4-meter (8-foot) section, that is, the pump itself.

The mobilization pumps remaining in the tanks will likely be similarly contaminated. The transfer pumps will likely have more contamination because high-level radioactive waste passed through the entire length of the pump rather than only the lower portion.

Tank and Vault Drying System

The Tank and Vault Drying System will be installed to dry the liquid heels remaining in the waste tanks prior to the starting point of this EIS. Equipment for the system will include a dehumidifier and heater for air forced into the vaults. The exhaust air leaving the vaults will pass through HEPA filters. An additional enhancement to reduce corrosion inside the tanks would be to reconfigure the Tank and Vault Drying System to dry both inside the vaults and inside the tanks.

Dewatering Well

A dewatering well was installed during construction of the waste tanks and has been used on a nearly continual basis to maintain the static groundwater levels in the Waste Tank Farm Area in a depressed condition. The location of the dewatering well is approximately between Tanks 8D-1 and 8D-2, adjacent to the Permanent Ventilation System Building. Low levels of radiological contamination are present, and the water that is removed is sent to the Low-Level Waste Treatment Facility.

C.2.3.2 High-Level Waste Transfer Trench

The High-Level Waste Transfer Trench is a long concrete vault containing double-walled piping that was designed to convey waste between the Waste Tank Farm and the Vitrification Facility in WMA 1. It is approximately 152 meters (500 feet) long, extending from the Tank 8D-3/8D-4 vault along the north side of Tanks 8D-1 and 8D-2, before turning to the southwest and entering the north side of the Vitrification Facility. The trench is 1.8 to 6.1 meters (6 to 20 feet) wide, and its height ranges from 1.8 to 2.7 meters (6 to 9 feet). The High-Level Waste Transfer Trench was constructed of reinforced concrete walls and precast concrete covers. The walls of the trench are 45.7 to 61 centimeters (18 to 24 inches) thick, and the precast roof is 0.6 meters (2 feet) thick. The floor slab of the trench is 0.3-meter-thick (1-foot-thick) concrete. The transfer trench contains between two and six stainless steel lines, comprising approximately 915 linear meters (3,000 linear feet) of piping. These process lines are either 5.1 or 7.6 centimeters (2 or 3 inches) in nominal diameter and are encased within an outer containment pipe. The containment pipe is either 10.2 or 15.2 centimeters (4 or 6 inches) in diameter depending on the location and the size of the enclosed pipe.

Stainless steel–lined concrete pump pits that house the upper sections of the waste transfer pumps are located on top of each of the tank vaults. The walls of the pump pits are constructed of 0.6-meter-thick (2-foot-thick) reinforced concrete, the floors are constructed with 0.3-meter-thick (1-foot-thick) concrete, and the roofs are precast concrete covers.

The High-Level Waste Transfer Trench is not expected to be radiologically contaminated because high-level radioactive waste was conveyed in double-walled piping that did not leak during operations. Precipitation that infiltrates the transfer trench is collected at two low points along the trench and is sampled and analyzed. Contamination has not been detected in any of the water collected. A leak detection system is located between the walls of the double-walled high-level radioactive waste transfer piping. This system has not detected any releases of high-level radioactive waste from the piping. However, the pump pits and piping used to convey high-level radioactive waste are radiologically contaminated. It was estimated in 2004 that the piping within the trench contained approximately 235 curies of residual radioactivity, with the pump pits containing approximately twice that amount (WSMS 2009a). The trench is a RCRA interim status unit and is subject to RCRA closure.

C.2.3.3 Permanent Ventilation System Building

The Permanent Ventilation System Building is located approximately 15.3 meters (50 feet) north of Tank 8D-2. This steel-framed and -sided building is 12.2 meters (40 feet) wide, 23 meters (75 feet) long, and 4.9 meters (16 feet) tall and is supported by a concrete foundation and slab. The concrete floor slab is 0.3 meters (1 foot) thick. It contains four rooms: the Permanent Ventilation System Room, Electrical Room, Mechanical Room, and Control Room. The Permanent Ventilation System Building has a sheet metal roof that supports the Permanent Ventilation System Discharge Stack. The Permanent Ventilation System is designed to provide ventilation to the STS Support Building; STS Valve Aisle; STS Pipeway; and Tanks 8D-1, 8D-2, 8D-3, and 8D-4. Airflow from these facilities is directed to the Permanent Ventilation System, where it passes through a mist eliminator, heater, roughing filter, and two sets of HEPA filters before being discharged through the Permanent Ventilation System Stack to the atmosphere.

A small, recently built, skid-mounted Permanent Ventilation System Stack Monitoring Building is located near the east end of the Permanent Ventilation System Building. Insulated sampling lines lead to and from the Permanent Ventilation System Stack.

The Permanent Ventilation System Building contains an aboveground and a belowground petroleum storage tank, both of which would require closure under 6 NYCRR Part 613 regulations.

The Permanent Ventilation System Building is divided into four main rooms, none of which contain surface contamination. Most of the residual contamination in this building is in the two HEPA filters, which could contain as much as 7.5 curies of cesium-137 and much smaller amounts of other radionuclides. No hazardous contamination is expected.

C.2.3.4 Supernatant Treatment System and Supernatant Treatment System Support Building

The STS was installed to support the solidification of the liquid high-level radioactive wastes stored in Tanks 8D-2 and 8D-4. The STS was installed in and adjacent to Tank 8D-1. The STS was a zeolite molecular sieve system designed to strip cesium, the principal radioactive species, from the PUREX/THOREX supernatant and sludge-wash solutions and highly radioactive wastewaters from the Liquid Waste Treatment System. It also removed lesser quantities of strontium and plutonium. During 2003, the STS was also used to process sodium-bearing wastewater from Tanks 8D-1 and 8D-2. The STS equipment installed in Tank 8D-1 (and the only STS equipment coming in contact with high-level radioactive waste) includes an STS prefilter, supernatant feed tank, supernatant cooler, four zeolite columns, STS sand post filter, sluice lift tank, and associated transfer piping.

At the starting point of this EIS, the STS Support Building will be operational. The STS Support Building is located adjacent to Tank 8D-1. It is a two-story structure that contains equipment and auxiliary support systems needed to operate the STS. The upper level of the STS Support Building, extending from a site reference elevation of 32.6 meters (107 feet) to the roof peak at 39.3 meters (129 feet), is a steel-framed work structure covered with steel siding. The lower level of the STS Support Building, extending from 28 to 32.6 meters (92 to 107 feet), was constructed with reinforced concrete walls, floor, and ceiling. This building, with the exception of the Valve Aisle, is a radiologically clean structure that contains a Control Room; heating, ventilation, and air conditioning equipment; utilities; and storage tanks for freshwater and fresh zeolite to support STS operations. The STS Support Building was built on 68 cast-in-place concrete piles. Each pile was installed to a minimum depth of 4.6 meters (15 feet) into the Lavery till unit. These piles were installed to provide additional structural support to the STS Support Building because the backfill soil around Tanks 8D-1 and 8D-2 was not compacted after the tanks were built.

A shielded Valve Aisle is located on the first floor of the STS Support Building adjacent to Tank 8D-1. This Valve Aisle contains remotely operated valves and instrumentation used to control operation of the STS. The shield walls of the Valve Aisle were constructed of 30.5-centimeter-thick (12-inch-thick) carbon steel, and the ceiling was made from 35.6-centimeter-thick (14-inch-thick) carbon steel. The shield walls and ceiling are composed of three individual steel plates that are bolted together. The Valve Aisle is radiologically contaminated. Removable hatches above the Valve Aisle provide access to the aisle for removal of large items.

The STS Pipeway is located on top of the Tank 8D-1 Vault. This concrete and steel structure contains STS piping and structural members that support the STS equipment in Tank 8D-1.

The STS and support building are RCRA interim status units and are subject to RCRA closure.

C.2.3.5 Equipment Shelter and Condensers

The Equipment Shelter is a one-story, concrete block building located immediately north of the Vitrification Facility. The Equipment Shelter is 12.2 meters (40 feet) long, 5.5 meters (18 feet) wide, and 3.6 meters (12 feet) high, and has a concrete floor that is 15.3 centimeters (6 inches) thick. A small extension on the west side of the Equipment Shelter is approximately 2.7 meters (9 feet) long, 2.1 meters (7 feet) wide, and 1.5 meters (5 feet) high, with a 0.3-meter-thick (1-foot-thick) concrete floor. The roof decking covering this structure is 10.2 centimeters (4 inches) thick.

The Equipment Shelter houses the Waste Tank Farm Ventilation System that was formerly used to ventilate the four waste storage tanks (8D-1, 8D-2, 8D-3, and 8D-4) and the STS Vessels in Tank 8D-1 before the Permanent Ventilation System Building began operations. Air from these tanks formerly passed through one of two condensers, a knockout drum, a heater, and two sets of HEPA filters before being discharged through the Main Stack of the Main Plant Process Building. Most of the radiological inventory in the Equipment Shelter is expected to be present in the ventilation system equipment.

Airflow from Tanks 8D-3 and 8D-4 is currently piped to the Equipment Shelter, where it passes through the Waste Tank Farm Caustic Scrubber and the Waste Tank Farm Condensate Tank and is then directed back through the condensers to a line, where it continues to the Permanent Ventilation System Building for treatment.

The condensers are located west of the Equipment Shelter and were originally designed to condense the overheads from Tanks 8D-1 and 8D-2, which were designed to be in a self-boiling condition during operations. The condensed overheads were directed to the Waste Tank Farm Condensate Tank and to an ion-exchange unit in the Low-Level Waste Treatment Facility for additional treatment before discharge to Erdman Brook. The condensers are contaminated with small amounts of radioactivity, and are identified as SWMUs; however, it has been determined that no further action is required.

C.2.3.6 Con-Ed Building

The Con-Ed Building is a concrete block building located on top of the concrete vault containing Tanks 8D-3 and 8D-4. This building, which is 3 meters (10 feet) wide, 4 meters (13 feet) long, and 3.4 meters (11 feet) high, houses the instrumentation and valves used to monitor and control the operation of Tanks 8D-3 and 8D-4. The Con-Ed Building is radiologically contaminated. The majority of the radiological inventory is believed to be contained in the piping and equipment inside the building. The Con-Ed Building is identified as a SWMU; however, it has been determined that no further action is required.

C.2.3.7 Underground Pipelines

At the starting point of this EIS, the underground pipelines within WMA 3 will still be in place. The pipes were used to carry radioactive liquids, PUREX and THOREX wastes, and ventilation exhaust air. Most of the pipes are expected to be radioactively contaminated.

C.2.4 Waste Management Area 4: Construction and Demolition Debris Landfill

WMA 4, shown on **Figure C–5**, is a 4-hectare (10-acre) area in the northeast portion of the North Plateau of WVDP. It includes the Construction and Demolition Debris Landfill (CDDL), which is the only waste management unit in WMA 4. WMA 4 is located in the path of the North Plateau Groundwater Plume, which also extends through WMAs 1, 2, 3, 5, and 6. The plume is described in Section C.2.13. The western part of WMA 4 was impacted by the stack releases that produced the Cesium Prong, which is discussed in Section C.2.14.

The CDDL covers a 0.6-hectare (1.5-acre) area approximately 305 meters (1,000 feet) northeast of the Main Plant Process Building. The CDDL was initially used by Bechtel Engineering from 1963 to 1965 to dispose of nonradioactive waste generated during Bechtel's construction of the Main Plant Process Building. NFS used the CDDL from 1965 to 1981 to dispose of nonradioactive construction-, office-, and facility-generated debris, including ash from the NFS incinerator. The CDDL was used by DOE from 1982 to 1984 to dispose of nonradioactive waste. Typically, the wastes were placed on existing grade in 0.9- to 1.5-meter-thick (3- to 5-foot-thick) lifts, covered with soil, and compacted with bulldozers or trucks. The CDDL is estimated to contain a total volume of 12,000 cubic meters (425,000 cubic feet) of waste material and soil.

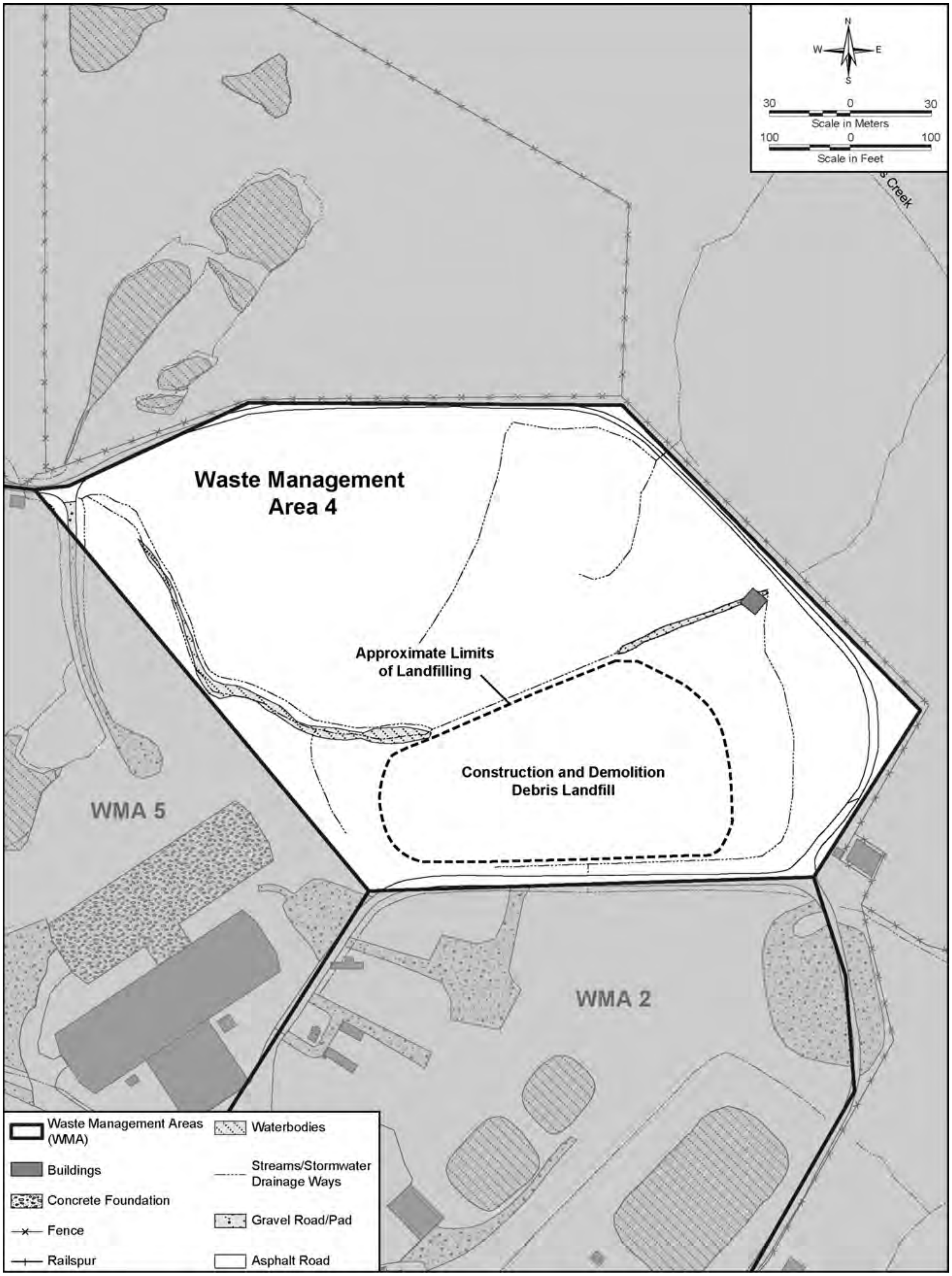

Figure C–5 Waste Management Area 4 – Construction and Demolition Debris Landfill

Disposal operations in the CDDL were terminated in December 1984, and the landfill was closed in accordance with New York State regulations in effect at the time of closure. The final cover on the CDDL consists of a minimum of 45.7 centimeters (18 inches) of compacted soil, which was covered with at least 15.2 centimeters (6 inches) of topsoil capable of sustaining plant growth. The entire cover was graded to achieve a minimum slope of two percent. During October 1986, NYSDEC approved and certified the closure of the CDDL. The CDDL is identified as a SWMU subject to corrective action requirements pursuant to the RCRA 3008(h) Consent Order. A Corrective Measures Study is being prepared.

The CDDL is located in the flow path of the North Plateau Groundwater Plume, described in Section C.2.13. Because radioactively contaminated groundwater in the plume is assumed to have come in contact with the waste buried in the CDDL, the buried wastes are assumed to require handling as radioactive wastes. In addition, volatile organic compounds have been detected in groundwater downgradient of the CDDL.

C.2.5 Waste Management Area 5: Waste Storage Area

WMA 5, the Waste Storage Area, is shown on **Figure C–6**. It encompasses approximately 7.6 hectares (19 acres). Facilities in WMA 5 that will be operational or standing at the starting point of this EIS are the Remote-Handled Waste Facility, Lag Storage Area 4 with the associated Shipping Depot, and the Construction and Demolition Area. Included in WMA 5 is a portion of the North Plateau Groundwater Plume, which also extends through WMAs 1, 2, 3, 4, and 6. It is described in Section C.2.13

At the starting point of this EIS, the Lag Storage Building; Lag Storage Areas 1, 2, and 3; Hazardous Waste Storage Lockers; and Chemical Process Cell Waste Storage Area will have been removed to grade. The disposition of the remaining concrete foundations and slabs is analyzed in this EIS. In addition, the Cold Hardstand near the CDDL, Vitrification Vault and Empty Container Hardstand, Old/New Hardstand Area, Waste Packaging Area, Lag Hardstand, High-Level Waste Tanks Pump Storage Vaults, and Container Sorting and Packaging Facility will have been completely removed. However, the ground underneath these facilities could be radioactively contaminated and would be subject to decommissioning activities.

C.2.5.1 Remote-Handled Waste Facility

At the starting point of this EIS, the Remote-Handled Waste Facility will have been decontaminated to a point where it could be demolished without containment.

The Remote-Handled Waste Facility was included as a containment building in the RCRA Part A permit application for WVDP (Revision 3, June 29, 2001). In accordance with 6 NYCRR Subpart 373-1.5, this updated interim status permit application was transmitted to NYSDEC for review. NYSDEC subsequently approved this permit revision in a November 13, 2001, correspondence. In June 2004, the Remote-Handled Waste Facility became operational as a containment building subject to the operational requirements specified in 6 NYCRR Subpart 373-3.30. The Remote-Handled Waste Facility comprises a Receiving Area, Buffer Cell, Work Cell, Waste Packaging Area, Operating Aisle, Batch Transfer Tank, and Load-Out/Truck Bay. The Receiving Area includes an 18-metric ton (20-ton) bridge crane that also provides access into the adjacent Buffer Cell.

The Buffer Cell is an air lock between the Receiving Area and the contaminated Work Cell. The floor in the Buffer Cell is at the same height as the floor in the Work Cell. Power rollers move waste containers from the Buffer Cell into the Work Cell. A shield window is located in the wall, allowing direct observation into the Buffer Cell. Both ends of the Buffer Cell have sliding shield doors and horizontal swinging contamination control doors.

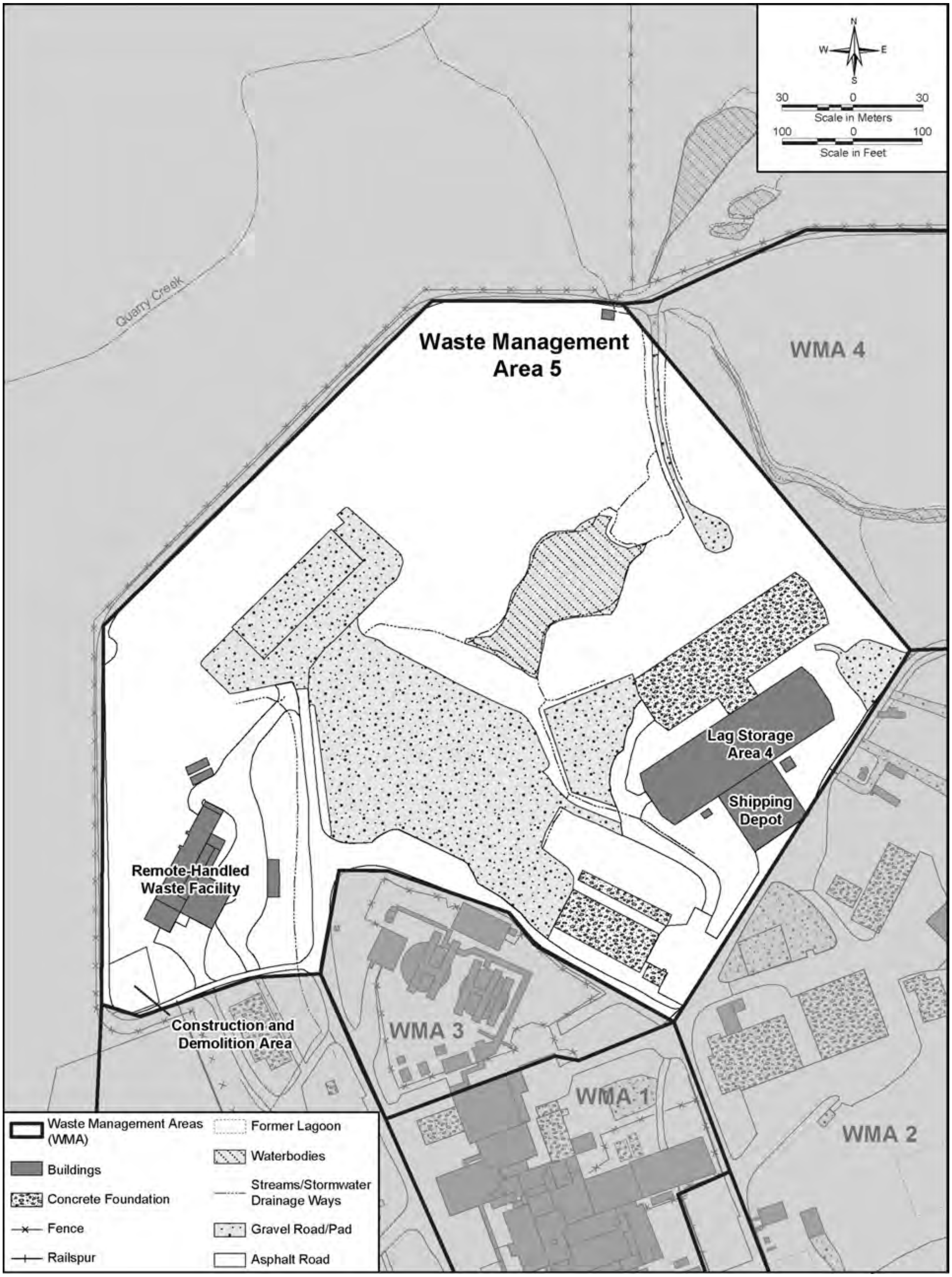

Figure C–6 Waste Management Area 5 – Waste Storage Area

The Work Cell is the primary work zone within the Remote-Handled Waste Facility, with provisions for remote-handling, surveying, segmenting, decontaminating, and repackaging operations. The shielded space is 16.8 meters (55 feet) by 6.7 meters (22 feet) by 7.9 meters (26 feet) high and is served by a 27-metric ton (30-ton) bridge crane. Two powered dexterous manipulator arms are supported by bridge crane trolleys. One jib crane with powered dexterous manipulators is mounted on rails along the long wall over the shield windows. Below-grade wastewater storage tanks could receive spent decontamination solutions containing radiological and chemical contamination prior to the starting point of the EIS. Workstations are located at each shield window. The Work Cell, equipment within it, and the wastewater tanks are expected to be radiologically and chemically contaminated from operations performed within the cell.

The Waste Packaging Area includes the capability to load both waste drums and boxes. The area is expected to be kept radiologically clean, but due to the fact that filled waste containers are handled in this area, low levels of radioactive contamination are possible.

The Operating Aisle houses two waste processing and packaging workstations and one waste sampling transfer workstation. Each workstation includes a 55.9-centimeter-thick (22-inch-thick) oil-filled shield window in the shield wall and controllers for remote operation of facility equipment. The Operating Aisle is expected to be kept radiologically clean, but because filled waste containers are handled in this area, low-level contamination is possible.

The Batch Transfer Tank located in the tank vault is a 5,680 liter (1,500 gallon) tank installed to transfer wash down water batches to the on-site Liquid Waste Treatment Facility via Tank 8D-3. Double walled piping connects the Batch Transfer Tank to Tank 8D-3.

The Remote-Handled Waste Facility is a RCRA interim status unit and is subject to RCRA closure.

C.2.5.2 Lag Storage Area 4

Lag Storage Area 4 is used for storing, sorting, and repackaging low-level radioactive waste and mixed low-level radioactive waste. Lag Storage Area 4 includes a Shipping Depot and a covered passageway that leads to Lag Storage Area 3. The Shipping Depot, a 28- by 26-meter (91- by 85-foot) metal-framed structure, is connected to Lag Storage Area 4. Lag Storage Area 4 is potentially contaminated: low levels of radioactive contamination are expected in soil beneath the building from historical activities and the North Plateau Groundwater Plume. If contamination is encountered in Lag Storage Area 4, it is expected to be minimal due to packaging requirements and storage practices. Lag Storage Area 4 is a RCRA interim status unit and is subject to RCRA closure.

C.2.5.3 Construction and Demolition Area

The Construction and Demolition Area is a 7.6- by 7.6-meter (25- by 25-foot) shallow ground depression located southwest of the Remote-Handled Waste Facility, approximately 91 meters (300 feet) west of the STS Support Building. This area is also known as the Concrete Washdown Area. From 1990 to June 1994, waste concrete was deposited in this area during the cleanout of concrete mixing trucks that transported concrete from offsite sources to support WVDP construction projects such as the Vitrification Facility. The waste concrete generated during truck washing was staged in this area until it hardened, after which it was placed in a dumpster for offsite disposal. Residual concrete is the only waste that was managed in this area, as the Construction and Demolition Area was not used for any other type of waste treatment or management. The Construction and Demolition Area is identified as a SWMU; however, it has been determined that no further action is required.

C.2.6 Waste Management Area 6: Central Project Premises

WMA 6, the Central Project Premises, is shown on **Figure C–7**. It encompasses approximately 5.7 hectares (14 acres). Facilities that will be standing, operable, or operational at the starting point of this EIS in WMA 6 include two Demineralizer Sludge Ponds and the Rail Spur, Equalization Basin, Equalization Tank, Low-Level Radioactive Waste Rail Packaging and Staging Area, Sewage Treatment Plant, and South Waste Tank Farm Test Tower. Included in WMA 6 is a portion of the North Plateau Groundwater Plume, which also extends through WMAs 1 through 5.

At the starting point of this EIS, the Old Warehouse, Cooling Tower, North Waste Tank Farm Test Tower, Road Salt and Sand Storage Shed, Vitrification Test Facility Waste Storage Area, and Product Storage Area will have been removed to grade. The disposition of the remaining concrete foundations and slabs is analyzed in this EIS. Any radioactively contaminated ground underneath these facilities would be subject to decommissioning.

C.2.6.1 Rail Spur

The Rail Spur runs about 2,440 meters (8,000 feet) from the south side of the Main Plant Process Building to where it connects to the main line of the railroad. The southernmost portion of the spur is located in WMA 12. The rails are hot-rolled steel and the ties are creosote pressure-treated wood. Low-level radiological soil contamination, measuring 13 picocuries of cesium-137 per gram, has been detected in a 9.1- by 30.5-meter (30- by 100-foot) area along a section of dual track east of the Old Warehouse. The volume of the contaminated soil has been estimated at about 105 cubic meters (3,700 cubic feet).

C.2.6.2 Demineralizer Sludge Ponds

The Demineralizer Sludge Ponds were built between 1964 and 1965 during construction of the Main Plant Process Building on the North Plateau. The sludge ponds are two unlined rectangular basins located southeast of the Main Plant Process Building. Each pond is 15 by 30 meters (50 by 100 feet) and approximately 1.5 meters (5 feet) deep. The ponds were designed to discharge through a weir box and underground piping to an SPDES-permitted outfall.

The Demineralizer Sludge Ponds were designed to receive discharge solutions backflushed from the process water demineralizer and water softener and sludge from the raw water clarifier. During 1971, radioactive solutions backflowed into the demineralizer. Although the demineralizer units were replaced and effluent routed to the Low-Level Waste Treatment Facility, this episode contaminated sediments in the sludge ponds. Until 1985, only the North Pond was used when the effluent mixing basin was brought on line. From 1985 to 1994, only the South Pond was used to receive water softener regeneration and clarifier blowdown. The Demineralizer Sludge Ponds have remained inactive since June 1994 (WVNS 1993, WVNSCO 2004).

Both ponds are radiologically contaminated. Cesium-137 has been detected in the top 0.9 meters (3 feet) of sediment in the North Pond and in the top 0.6 meters (2 feet) of the South Pond. Nine semivolatile chemicals were detected in sediment in the North Demineralizer Sludge Pond at concentrations below regulatory levels. The Demineralizer Sludge Ponds are identified as a SWMU subject to corrective action requirements pursuant to the RCRA 3008(h) Consent Order. A Corrective Measures Study is being prepared.

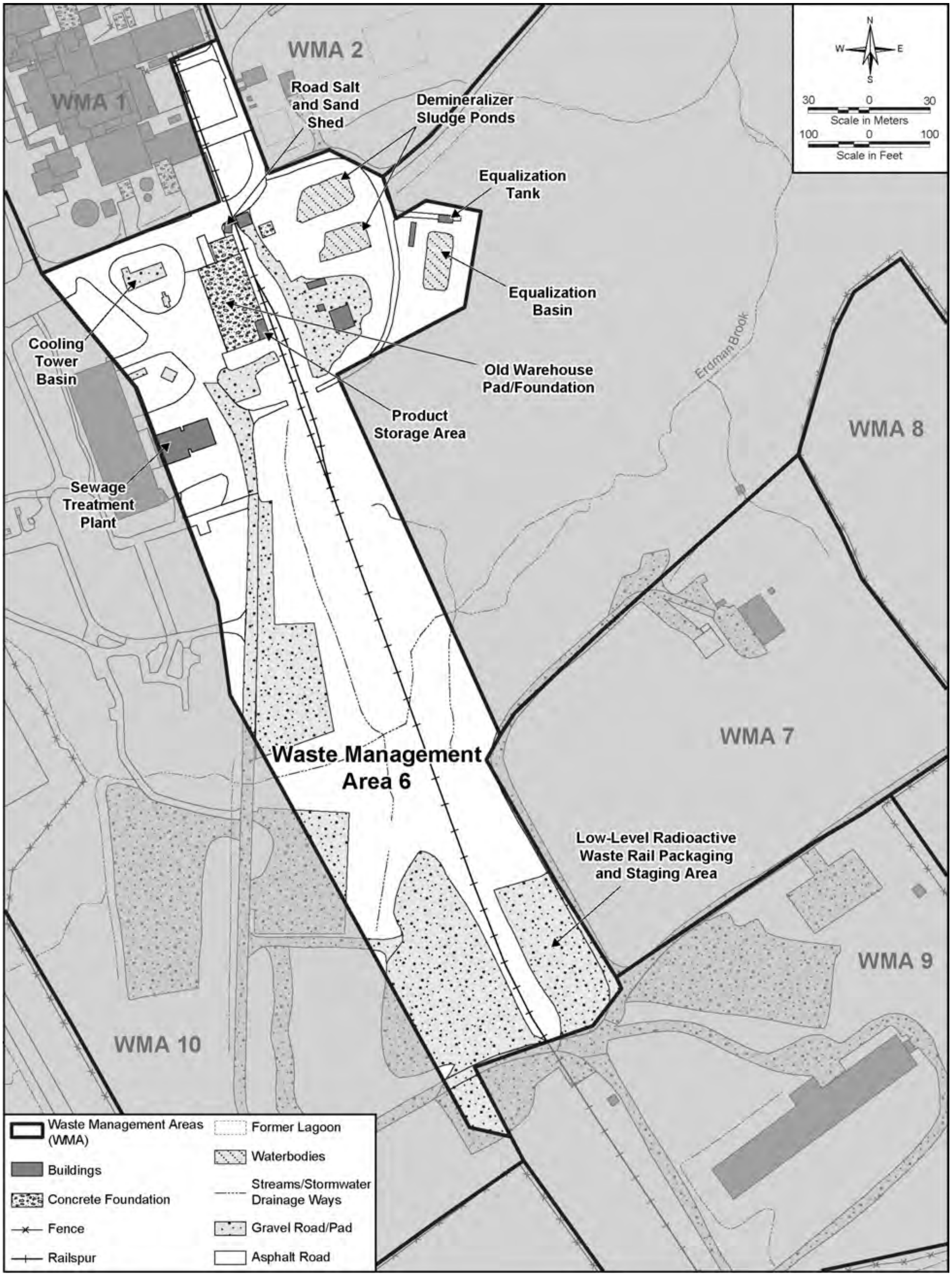

Figure C–7 Waste Management Area 6 – Central Project Premises

C.2.6.3 Equalization Basin

The Equalization Basin is a lined basin that is 22.9 meters (75 feet) wide, 38.1 meters (125 feet) long, and 3 meters (10 feet) deep. The basin is excavated into the sand and gravel layer and underlain with a sand drain. Originally, the basin was called the Effluent Mixing Basin; it received effluents from the Sanitary Sewage Treatment Plant, some discharge from the Utility Room, and cooling water blowdown. Later it received effluents from the Demineralizer Sludge Ponds. The basin currently is used as an excess capacity settling pond for discharges from the Utility Room. Based on sludge sampling, no hazardous or radiological contamination is present in the Equalization Basin. The Equalization Basin is identified as a SWMU and is subject to Clean Water Act corrective action and closure requirements.

C.2.6.4 Equalization Tank

The Equalization Tank was installed in 1997 to work in parallel with the Equalization Basin. The Equalization Tank is an inground concrete tank that was designed with a total capacity of 75,700 liters (20,000 gallons) and a maximum working capacity of 56,800 liters (15,000 gallons). The tank is sloped to the east to allow gravity to affect flow through it. The function of the tank is identical to the Equalization Basin, except that the Equalization Tank would be less affected by the rapid cooling of wastewaters during rapid temperature drops.

C.2.6.5 Low-Level Radioactive Waste Rail Packaging and Staging Area

The Low-Level Radioactive Waste Rail Packaging and Staging Area covers approximately 2,510 square meters (27,000 square feet) east of and adjacent to the railroad tracks at the south end of WMA 6. The area contains two 20-centimeter-thick (8-inch-thick) reinforced concrete pads. The concrete loading dock measures 7.3 by 27.4 meters (24 by 90 feet), and the concrete preparation area measures 7.3 by 18.3 meters (24 by 60 feet). The remaining area is covered with upwards of 0.9 meters (3 feet) of crushed limestone. The Low-Level Radioactive Waste Rail Packaging and Staging Area was used to package and ship contaminated soil stored in roll-off containers and to stage and ship Drum Cell waste drums. This area is not expected to be radiologically contaminated based on its operational history. Waste materials were not typically removed from waste packages.

C.2.6.6 Sewage Treatment Plant

The Sewage Treatment Plant is a wood-framed structure that is 12.5 meters (41 feet) wide by 13.4 meters (44 feet) long by 4.7 meters (15 feet) high, with metal siding and roofing. The base of the facility is concrete and crushed stone. Eight tanks are associated with the plant: six inground concrete tanks, one aboveground polyethylene tank, and one aboveground stainless steel tank. The Sewage Treatment Plant is used to treat sanitary and nonradiological, nonhazardous industrial wastewater generated by WVDP. Water treatment chemicals, such as sulfuric acid, sodium hypochlorite, sodium bisulfite, and sodium bicarbonate, have been used at the plant. The Sewage Treatment Plant also previously contained a satellite accumulation area that stored mercury-bearing RCRA hazardous waste from the Main Plant Process Building. No hazardous or radiological contamination is known to exist there. Treated wastewater from the Sewage Treatment Plant is discharged to Erdman Brook through an SPDES-permitted outfall. The Sewage Treatment Plant is identified as a SWMU and is subject to Clean Water Act corrective action and closure requirements.

C.2.6.7 Waste Tank Farm Test Towers

The Waste Tank Farm Test Towers, also known as training platforms, consist of two test towers. The Waste Tank Farm Test Towers were used to train workers in preparation for removal of pumps from the high-level waste tanks. The North Test Tower will have been removed at the starting point of this EIS. The South Test Tower is the decant pump and heat exchanger platform. It is a pre-engineered structure erected as a stack of six modules, including ladders, handrails, and grating. Structural shapes and plates are carbon steel. The exterior "skin" is fabric. The South Test Tower is not radiologically or chemically contaminated.

C.2.7 Waste Management Area 7: NRC-Licensed Disposal Area and Associated Facilities

WMA 7, which includes the NDA, is shown on **Figure C–8**; the locations of NDA burial areas are shown on Figure C–21. WMA 7 encompasses approximately 3.3 hectares (8 acres) and includes the radioactive waste disposal area and ancillary structures. The NDA is about 122 meters (400 feet) wide and 183 meters (600 feet) long within WMA 7. The NDA is divisible into three distinct areas: the NFS disposal area, known as special holes and deep burial holes; the WVDP disposal trenches and caissons; and the area occupied by the Interceptor Trench and the associated Liquid Pretreatment System structures. Other ancillary structures in the NDA include a Leachate Transfer Line, a former lagoon, and the NDA Hardstand Staging Area.

At the starting point of this EIS, the NDA Hardstand Staging Area will have been removed to grade. It is assumed for this EIS that radiological contamination is present based on past usage. The removal of the remaining gravel foundation is analyzed in this EIS.

In late 2008, infiltration mitigation measures consisting of an upgradient barrier wall and a geomembrane cover over the NDA were installed as an Interim Measure under the 3008(h) Consent Order. The design is similar to that installed over the State-Licensed Disposal Area (SDA) in 1995. The decommissioning of the barrier wall and the geomembrane cover is analyzed in this EIS.

The NDA was operated by NFS, under license from the NRC (formerly the U.S. Atomic Energy Commission), for disposal of solid radioactive waste generated from fuel reprocessing operations. Beginning in 1966, solid radioactive waste materials from the nearby Main Plant Process Building exceeding 200 millirad per hour and other materials not allowable in the SDA were buried in holes and filled with appropriate clean backfill material.

Between 1966 and 1981, NFS disposed of a variety of wastes in a U-shaped area along the eastern, western, and northern boundaries of the NDA. A total of approximately 4,620 cubic meters (163,000 cubic feet) of wastes were disposed of in the NDA by NFS (URS 2000). After establishment of WVDP, approximately 5,660 cubic meters (200,000 cubic feet) of low-level radioactive waste generated from decontamination and decommissioning activities were disposed of in the NDA between 1982 and 1986 (URS 2000). Most of these wastes were placed in trenches located in the unused parcel of land located interior to the U-shaped disposal area used by NFS. Contaminated wastes were confined to the NFS and WVDP disposal area and the Interim Waste Storage Facility. That facility and the associated pad have been clean closed and removed. No waste has been buried at the NDA since 1986.

The NFS deep holes and special holes, and the WVDP trenches and caissons, NDA Interceptor Trench, Liquid Pretreatment System, Leachate Transfer Line, and former NDA lagoon are all SWMUs and are subject to corrective action requirements pursuant to the RCRA 3008(h) Consent Order. A Corrective Measures Study is being prepared.

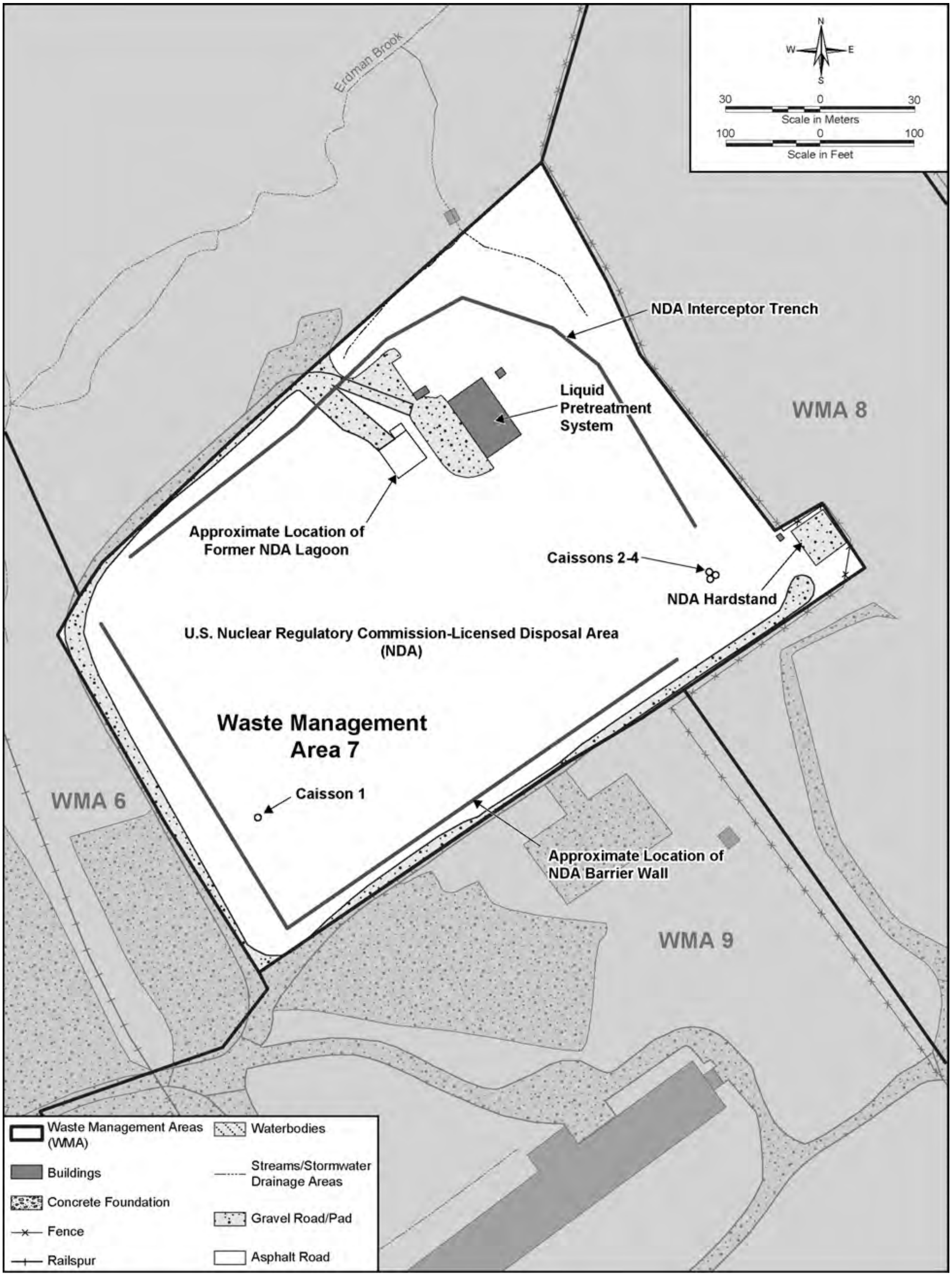

Figure C–8 Waste Management Area 7 – NRC-Licensed Disposal Area and Associated Facilities

Several aspects of the NDA would need to be addressed during decommissioning: NFS and WVDP buried wastes in the disposal area; leachate in the disposal areas; contaminated soil within the NDA; and contaminated groundwater under the NDA. Leachate is known to exist in the NDA disposal holes and trenches. It would consist of water contaminated with both radiological and chemical constituents leached from the buried wastes. It is estimated that approximately 3.8 million liters (1 million gallons) of leachate would require treatment for the NDA buried waste to be either exhumed or stabilized (WSMS 2009e). A Corrective Measures Study is being prepared for the NDA (see Chapter 3, Section 3.3.2).

C.2.7.1 Disposal Areas Within the NRC-Licensed Disposal Area

Nuclear Fuel Services Deep Holes

About 187 cubic meters (6,600 cubic feet) of leached cladding, also known as hulls, from reprocessed fuel are in approximately 100 deep disposal holes located in the eastern portion of the U-shaped area. Many of these holes are 0.8 by 2 meters (2.7 by 6.5 feet) in area and 15 to 21 meters (50 to 70 feet) deep. Generally, the hulls are in 113-liter (30-gallon) steel drums and are stacked three abreast in deep narrow holes. Three of the 113-liter (30-gallon) drums contain irradiated unreprocessed New Production Reactor fuel with damaged cladding. The three drums containing this fuel are in concrete at the bottom of one of the deep holes.

Because the NDA was licensed to permit burial of all waste generated as a result of the operation and maintenance of the reprocessing plant, other plant wastes, including low-level solid wastes, were disposed of in the leached hull disposal area.

The NRC imposed a requirement that the top of each stack of hull cans be limited to a height of 1.2 meters (4 feet) below the top of the weathered Lavery till.

The waste inventory in the NFS deep holes consists of approximately 1,840 cubic meters (65,000 cubic feet) of waste (URS 2000).

Nuclear Fuel Services Special Holes

Approximately 230 NFS special holes are located in the northern and western portions of the U-shaped NFS burial area. The special holes are typically about 6 meters (20 feet) deep, but have various lengths and widths. Most of the special holes are about 3.6 meters (12 feet) wide and 6 to 9 meters (20 to 30 feet) long. The lengths and widths of each special hole were varied according to the quantity of waste requiring disposal at each disposal event and the dimensions of large waste items, such as failed equipment. Miscellaneous wastes, other than leached hulls or related spent nuclear fuel debris, are in several types of containers, including steel drums, wooden crates, and cardboard boxes.

During 1983, a mixture of n-dodecane and tributyl phosphate was observed in a monitoring well at the perimeter of the NDA. It contained slight amounts of radioactivity, indicating that it was spent extractant from the fuel reprocessing operations conducted by NFS. An investigation revealed that the contamination source was eight 3,790-liter (1,000-gallon) tanks containing an absorbed mixture of n-dodecane and tributyl phosphate previously disposed of in NDA Special Holes 10 and 11. During 1986, Special Holes 10 and 11 were excavated, the eight tanks were dismantled and either disposed of off site or stored awaiting offsite disposal, and the holes were backfilled.

The waste inventory in the NFS special holes consists of approximately 2,750 cubic meters (97,000 cubic feet) of waste (URS 2000).

West Valley Demonstration Project Trenches

The 12 WVDP trenches contain approximately 5,660 cubic meters (200,000 cubic feet) of low-level radioactive waste resulting from decontamination activities performed between 1982 and 1986. Most of these wastes are in the parcel of land located interior to the U-shaped disposal area used by NFS.

The WVDP trenches are typically about 9 meters (30 feet) deep and about 4.6 meters (15 feet) wide. The lengths vary from 9 to 76 meters (30 to 250 feet). Trenches 9 and 11 have composite liners and caps. All other WVDP trenches are capped with clay.

West Valley Demonstration Project Caissons

Four steel-lined concrete caissons (cylindrical concrete vaults), 2.1 meters (7 feet) in diameter and 18.3 meters (60 feet) deep, were constructed near the eastern and southern corners of the NDA. WVDP disposal records indicate approximately 23.3 cubic meters (823 cubic feet) of waste in drums were placed in Caisson 1 (URS 2000). However, WVDP disposal records do not indicate that any waste was placed in the other three caissons. The caissons are plugged with concrete for shielding and covered with a plastic shield to prevent rainwater infiltration.

Radionuclide and Chemical Inventories in the Entire NRC-Licensed Disposal Area

The estimated radionuclide inventory of the buried waste associated with NFS and WVDP disposal operations at the starting point of this EIS is provided in **Table C–10**.

Table C–10 Estimated Radionuclide Inventory of the Buried Waste at the NRC-Licensed Disposal Area

Radionuclide	*Estimate [a] (curies)*	*Radionuclide*	*Estimate [a] (curies)*	*Radionuclide*	*Estimate [a] (curies)*
Tritium	35.1	Cesium-137	28,500	Plutonium-238	347
Carbon-14	516	Radium-226	0.00000420	Plutonium-239	579
Cobalt-60	6,990	Uranium-233	11.3	Plutonium-240	398
Nickel-63	107,000	Uranium-234	0.588	Plutonium-241	9,010
Strontium-90	22,200	Uranium-235	0.120	Americium-241	1,960
Technetium-99	10.3	Uranium-238	1.46		
Iodine-129	0.0215	Neptunium-237	0.167		

NRC = U.S. Nuclear Regulatory Commission.
[a] Decayed to 2011.
Source: URS 2000.

An estimate of the hazardous chemical inventory associated with NFS and WVDP disposal operations was prepared (SAIC 2005a), with emphasis on the chemicals that are important for estimating risk to receptors downgradient of the NDA. **Table C–11** presents the estimated inventories of the organic chemicals and metals in the wastes.

C.2.7.2 Interceptor Trench and Liquid Pretreatment System

The Interceptor Trench and associated Liquid Pretreatment System were installed after groundwater contaminated with tributyl phosphate, n-dodecane, and several radionuclides was detected in a well downgradient of the NDA. The Interceptor Trench was designed to intercept potentially contaminated groundwater migrating from the NDA.

Table C–11 Estimated Hazardous Chemical Inventory of the Buried Waste at the NRC-Licensed Disposal Area

Chemical	*Contamination (kilograms)*	*Chemical*	*Contamination (kilograms)*
Phenol	0.030	2-methylnaphthalene	6.7
1,4 dioxane	1.6	Isobutyl alcohol	1.7
Bis (2-ethylexyl) phthalate	110	1,2-dibromo-3-chloropropane	3.2
Di-n-butyl phthalate	0.015	Lead	980
1-butanol	150	Mercury	8.6
Acetone	1.1	Arsenic	160
2-hexanone	1.6	Cadmium	1.8

NRC = U.S. Nuclear Regulatory Commission.
Note: To convert kilograms to pounds, multiply by 2.2046.
Source: SAIC 2005a.

The trench is located on the northeast and northwest boundaries of the disposal area. The depth of the trench is approximately 3.3 to 4.3 meters (11 to 14 feet) below ground surface over its entire length. The base of the trench extends to a minimum of 0.3 meters (1 foot) below the interface of the weathered till with the unweathered till. The trench is drained by a pipe that directs accumulated water to a collection sump. The collection sump has a submersible pump to transfer groundwater to the Liquid Pretreatment System. Liquid that collects in the sump is routinely sampled, analyzed, and transferred to the Low-Level Waste Treatment Facility in WMA 2 for treatment and release. Treated wastewater is discharged from Lagoon 3 in WMA 2 to Erdman Brook through an SPDES-permitted outfall.

The Liquid Pretreatment System consists of seven tanks made of carbon steel: one 18,900-liter (5,000-gallon) holding tank, two 3,790-liter (1,000-gallon) prefiltration holding tanks, two 2,650-liter (700-gallon) tanks containing granular activated carbon, and two 3,790-liter (1,000-gallon) post-filtration holding tanks. The granular activated carbon tanks are housed in a wooden shed 3.7 meters (12 feet) long by 3 meters (10 feet) wide. The other five tanks are in a Quonset-style building. The Liquid Pretreatment System has not been used for its intended purpose (i.e., the collection and treatment of chemically impacted groundwater) and is not radioactively contaminated.

C.2.7.3 Leachate Transfer Line

The Leachate Transfer Line, which—based on its function—could be called the Leachate and Interceptor Trench Line, is a 5.1-centimeter-diameter (2-inch-diameter) black polyvinyl chloride (PVC) pipeline that runs along the northeast and northwest sides of the NDA, continues northward across WMA 6, and terminates at Lagoon 2 in WMA 2. The line converts from PVC to galvanized steel east of the Equalization Basin. The transfer line was originally used to transfer liquids from the SDA lagoons via a pumphouse next to the NDA Hardstand to Lagoon 1. The total length of the line is 1,220 meters (4,000 feet). It is radiologically contaminated and may be chemically contaminated.

The section of the Leachate Transfer Line from the SDA to the Interceptor Trench sump is inactive, and the two ends are capped. The section of line from the northeast corner of the NDA to Lagoon 2 is currently used to transfer groundwater from the NDA Interceptor Trench sump.

C.2.7.4 Former NRC-Licensed Disposal Area Lagoon

A lagoon used for collecting surface water runoff was located in the northeastern portion of the NDA. Around 1972, it was filled with radiologically contaminated soil from cleanup after a HEPA filter was dropped at the NDA during disposal operations. The lagoon could have contributed to surface runoff contamination, but other nearby disposal holes and shallow disturbed soils within the disposal area could have contributed as well.

C.2.8 Waste Management Area 8: State-Licensed Disposal Area and Associated Facilities

Facilities in WMA 8, shown on **Figure C–9**, include the North Disposal Area, the South Disposal Area, the Mixed Waste Storage Facility, and three filled lagoons. The SDA is approximately 6.1 hectares (15 acres) in size and is covered with an impermeable geomembrane to prevent infiltration of precipitation.

From 1963 to 1975, approximately 68,000 cubic meters (2.4 million cubic feet) of wastes were received at the SDA for burial from special purpose reactors, commercial power reactors, nuclear fuel cycle facilities, institutions, isotope production, and industries. The wastes were disposed of in their shipping containers including 18.9-liter (5-gallon) steel drums, 114-liter (30-gallon) steel drums, 208-liter (55-gallon) steel drums, wooden crates, cardboard boxes, fiber drums, and plastic bags. Leachate is known to exist in the disposal holes and trenches; up to 7.9 million liters (2.1 million gallons) are estimated to be present. It consists of infiltration water contaminated with both radiological and hazardous chemical materials leached from the buried wastes.

Efforts to manage infiltration were undertaken to stem accumulation of water in the trenches following cessation of disposal operations. Initially, the northern trenches (1 through 5) were capped with a single, minimum 1.2-meter (4-foot) lift of silty till soil. Based on experience gained from the initial trenching and capping activities, each southern trench (8 through 14) was capped with a single, minimum 2.4-meter (8-foot) lift of silty clay soil. The compaction of the silty clay trench caps was performed using multiple passes by a bulldozer over each cap. In 1978, an additional 1.2-meter (4-foot) lift of silty clay soil was placed and compacted upon each individual northern trench to minimize the infiltration of water. In 1980, the caps associated with Trenches 11 through 14 were addressed in a corrective action plan. This plan detailed the removal of 0.6 meters (2 feet) of silty till and 0.15 meters (0.5 feet) of topsoil followed by replacement with 0.7 meters (2.3 feet) of compacted till and 0.3 meters (1 foot) of topsoil, which was then graded, seeded, and mulched. In response to increasing leachate levels in Trench 14, a concrete barrier was installed upgradient of this trench. The barrier wall was 1.2 meters (4 feet) thick and 40 meters (130 feet) long, and the depth was variable. After installation, sand and gravel west of this barrier was removed and replaced with compacted silt and clay from WNYNSC.

As leachate levels continued to increase within Trenches 13 and 14, New York State Energy Research and Development Authority (NYSERDA) planned a series of interim measures that included the subsurface installation of an upgradient vertical barrier (i.e., slurry wall) followed by the placement of a low-density polyethylene membrane cover to divert precipitation. In September 1992, NYSERDA installed a soil-bentonite slurry wall along the western side of Trench 14 to divert groundwater flow away from the southern trenches (8 through 14). The membrane cover, which extended from the centerline of Trench 12 across Trenches 13 and 14, was completed in June 1993. These barriers have effectively minimized the infiltration of groundwater and precipitation into Trenches 13 and 14. In September 1993, NYSERDA installed a bioengineered cover on Trench 9 as a pilot test. This cover was composed of an impermeable ground cover (i.e., fiberglass panels) over most of the trench in combination with junipers. The fiberglass panels provided for minimal infiltration of precipitation, and the junipers provided for a high rate of evapotranspiration. Upon evaluation of the leachate levels, soil moisture data, and vegetative data, it was determined that a low-density polyethylene geomembrane cover would provide comparable control of infiltration. In 1995, NYSERDA installed a reinforced geomembrane cover over Trenches 1 through 8, 10, 11, and the remainder of 12. A stormwater management system consisting of five reinforced geomembrane-lined stormwater basins was designed and installed to detain precipitation and release it in a controlled manner that would not increase peak runoff. The geomembrane has effectively minimized the infiltration of precipitation into these trenches. In the fall of 1999, an additional low-density polyethylene membrane cover was placed over Trench 9, completing the interim measure to limit infiltration into the SDA trenches.

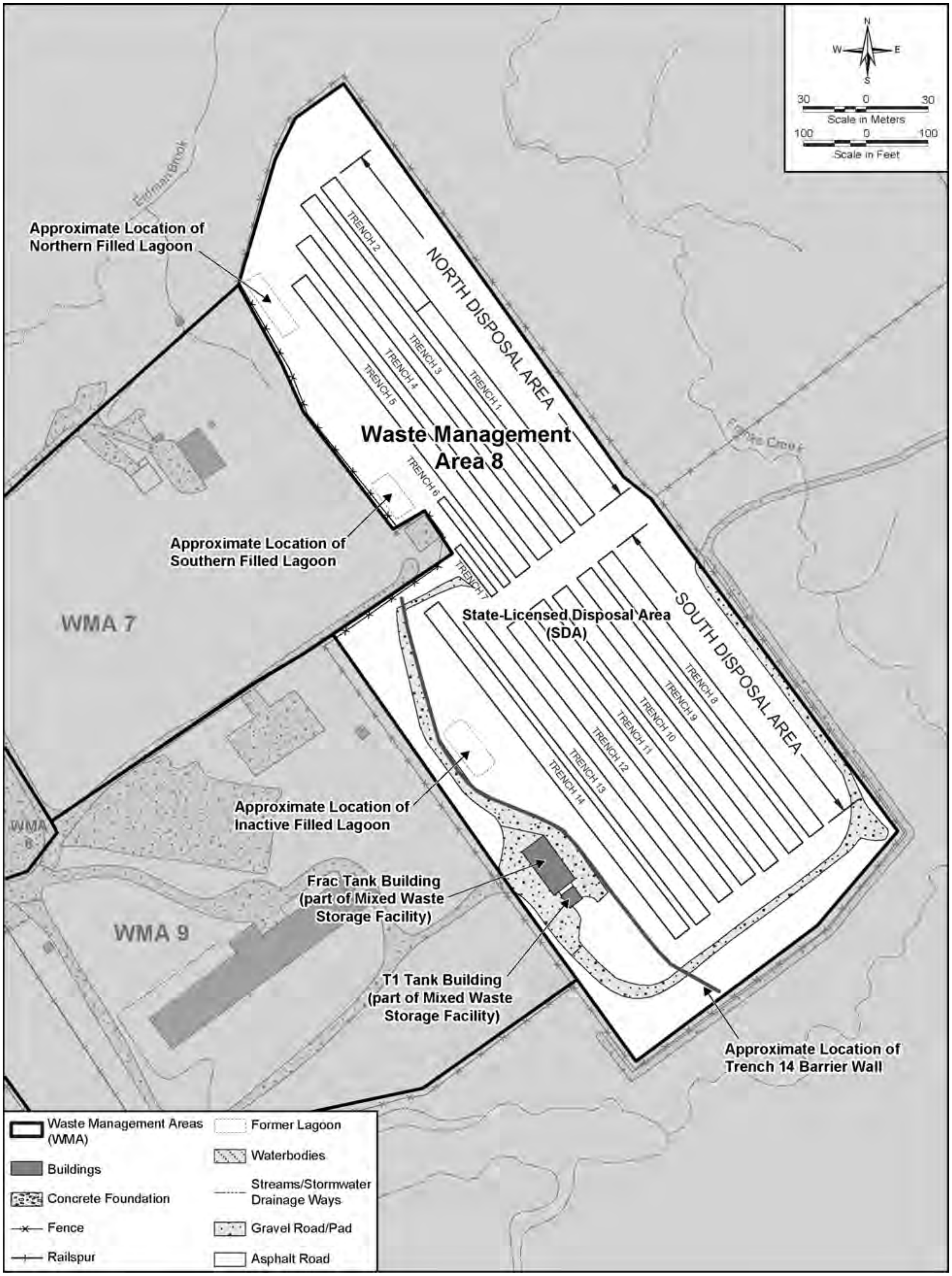

Figure C–9 Waste Management Area 8 – State-Licensed Disposal Area and Associated Facilities

The disposal areas and filled lagoons are identified as SWMUs subject to corrective action requirements pursuant to the RCRA 3008(h) Consent Order. A Corrective Measures Study is being prepared. The Mixed Waste Storage Facility is a RCRA interim status unit and is subject to RCRA closure.

C.2.8.1 Disposal Areas

North Disposal Area

The North Disposal Area includes Trenches 1 through 7. Trenches 1 through 5 were about 10.7 meters (35 feet) across and were excavated to a depth of 6.1 meters (20 feet). These trenches were used to dispose of solid wastes having contact surface readings of 200 millirad per hour or less. The wastes were disposed of in the same packages that were used to contain and transport them.

Trench 6 is actually a series of 19 special purpose holes that were used to dispose of wastes having contact surface readings of more than 200 millirad per hour. These holes were 0.6 to 1.8 meters (2 to 6 feet) wide, 1.2 to 3.6 meters (4 to 12 feet) long, and 2.4 to 3.6 meters (8 to 12 feet) deep. The wastes disposed of in these holes consisted primarily of irradiated reactor parts.

Trench 7 consists of a concrete slab with wastes placed on top of the slab and concrete poured over the wastes to encase them. The wastes were similar to those placed in Trenches 1 through 5.

The unweathered till below Trenches 4 and 5 is contaminated with tritium to a depth of 3 meters (10 feet) and other radionuclides to a depth of 0.9 meters (3 feet) or less (Prudic 1986). It is assumed that Trenches 1, 2, and 3 in the North Disposal Area exhibit a similar vertical contamination profile. The waste inventory in the North Disposal Area trenches, based on available burial records, consists of approximately 26,400 cubic meters (932,000 cubic feet) (URS 2002).

South Disposal Area

The South Disposal Area includes Trenches 8 through 14. These trenches were about 10.7 meters (35 feet) across and were excavated to a depth of about 6.1 meters (20 feet). They were used to dispose of solid wastes having contact surface readings of 200 millirad per hour or less. The wastes were disposed of in the same packages that were used to contain and transport them.

Unweathered till below Trench 8 is contaminated with tritium to a depth of 3 meters (10 feet) and other radionuclides to a depth of 0.9 meters (3 feet) or less (Prudic 1986). It is assumed that the other trenches in the South Disposal Area exhibit a similar vertical contamination profile.

The waste inventory in the South Disposal Area trenches, based on available burial records, consists of 40,500 cubic meters (1,430,000 cubic feet) (URS 2002).

Radionuclide and Chemical Inventories in the Entire State-Licensed Disposal Area

The estimated radionuclide inventory of the buried waste at the North and South Disposal Areas of the SDA at the starting point of this EIS is provided in **Table C–12**.

Table C–12 Estimated Radionuclide Inventory of the Buried Waste at the State-Licensed Disposal Area

Radionuclide	*Estimate [a] (curies)*	*Radionuclide*	*Estimate [a] (curies)*
Tritium	22,300	Uranium-235	3.53
Carbon-14	306	Uranium-238	192
Cobalt-60	1,250	Neptunium-237	0.00165
Nickel-63	19,100	Plutonium-238	24,300
Strontium-90	135	Plutonium-239	184
Technetium-99	1.49	Plutonium-240	109
Iodine-129	3.32	Plutonium-241	2,290
Cesium-137	11,300	Americium-241	484
Uranium-233	2.46	Radium-226	27.2
Uranium-234	98.3		

[a] Decayed to 2011.
Source: URS 2002.

An estimate of the hazardous chemical inventory of the buried waste for the entire SDA was prepared (SAIC 2005b), with emphasis on the chemicals that are important for estimating risk to receptors downgradient of the SDA. **Table C–13** presents the inventories of the organic chemicals and metals.

Table C–13 Estimated Hazardous Chemical Inventory of the Buried Waste at the State-Licensed Disposal Area

Chemical [a]	*Contamination (kilograms)*
Toluene	2,500
Xylene	170
Arsenic	650
Cadmium	90
1,1-dichloroethane	20
1,4-dioxane	5,900
2-chlorophenol	72
2,4-dichlorophenol	91
Benzene	41
Chloroform	13
Cresol (3&4-methylphenol)	90
Methylene chloride	100

[a] Additional chemical contaminants were identified but are not listed in this table because they would add relatively small contributions to the risk to downgradient receptors.
Note: To convert kilograms to pounds, multiply by 2.2046.
Source: SAIC 2005b.

Below-Grade Walls

A subsurface concrete wall was installed during 1987 immediately west of Trench 14. The concrete wall supported NYSERDA's efforts to remove the sand and gravel unit adjacent to Trench 14 and replace it with compacted till. It is a minimum of 1.2 meters (4 feet) thick and 39.6 meters (130 feet) long and contains approximately 320 cubic meters (11,300 cubic feet) of concrete.

A slurry wall located along the west side of Trench 14 was installed during 1992 to control groundwater infiltration into the SDA. It is 9.1 meters (30 feet) deep, 0.76 meters (2.5 feet) wide and

259 meters (850 feet) long; it was made from a mixture of native clay and at least one percent bentonite clay. No radioactive or hazardous chemical contamination of the slurry wall is expected.

C.2.8.2 Mixed Waste Storage Facility

The Mixed Waste Storage Facility consisting of two aboveground buildings near the southern end of the SDA, houses four leachate storage tanks. These structures, the T-1 Tank Building and the Frac Tank Building, are also used to store some solid, radioactive, and potentially mixed low-level radioactive wastes. Residual radioactive and chemical contamination are expected to be found in this facility.

The T-1 Tank Building is the smaller of the two buildings. It is a heated, weatherproof building that houses Tank T-1, a 34,800-liter (9,200-gallon) leachate collection tank made of fiberglass-reinforced plastic. The lower portion of the building is built of concrete to provide secondary containment for a tank that was used to store approximately 28,400 liters (7,500 gallons) of untreated leachate that was pumped from Trench 14 during 1991.

The Frac Tank Building is the larger of the two buildings. It is a nonheated, weatherproof building that houses two 79,500-liter (21,000-gallon) stainless steel frac tanks, T-2 and T-3. The tanks are installed in a steel-supported synthetic berm. These tanks have never been used; they were built to provide contingency storage capacity for SDA leachate.

C.2.8.3 Filled Lagoons

A total of three lagoons were built in the SDA and all three have since been filled. The Northern Lagoon and Southern Lagoon were associated with the North Disposal Area. The third lagoon, called the Inactive Lagoon, was associated with the South Disposal Area. Based on samples collected and analyzed as part of the RCRA facility investigation, these three lagoons contain RCRA hazardous constituents, including, but not limited to, benzene, ethylbenzene, toluene, and xylene. All were found to be below NYSDEC recommended cleanup goals (Ecology and Environment 1994); however, a Corrective Measures Study is being prepared.

The Northern Lagoon is 10.7 meters (35 feet) wide and 31.7 meters (104 feet) long, is unlined, and was used to store water pumped from the North Disposal Area trenches. The accumulated water was either treated or discharged, depending on its chemical and radiological characteristics. During 1971, it was connected by a pipeline to the Low-Level Waste Treatment Facility in WMA 2. The unweathered till beneath the lagoon is radiologically contaminated.

The Southern Lagoon is also unlined. It was used to store water pumped from the North Disposal Area trenches and from the NDA Hardstand. The accumulated water was either treated or discharged, depending on its chemical and radiological characteristics. During 1971, it was also connected by a pipeline to the Low-Level Waste Treatment Facility in WMA 2. About 170 cubic meters (6,000 cubic feet) of weathered till beneath the Southern Lagoon became contaminated with tritium. The unweathered till beneath the Southern Lagoon is also believed to be radiologically contaminated from past operations.

The Inactive Lagoon is located approximately 15.2 meters (50 feet) west of Trench 14. The unweathered till beneath the Inactive Lagoon is believed to be radiologically contaminated from past operations.

The Inactive Lagoon was closed by removing liquids and installing a vinyl liner. Native till soil was placed above the vinyl liner and compacted, followed by a cap layer of compacted clay till. The Northern and Southern Lagoons were closed by removing accumulated liquids and placing adsorbent material and compacted native soil over the contaminated soil.

C.2.9 Waste Management Area 9: Radwaste Treatment System Drum Cell

WMA 9, shown on **Figure C–10**, includes 5 hectares (12.4 acres) on the South Plateau adjacent to the NDA and SDA. The Drum Cell is the primary facility in WMA 9; it will be standing at the starting point of this EIS. WMA 9 includes the Subcontractor Maintenance Area and the NDA Trench Soil Container Area.

The Drum Cell was built during 1986 and 1987 (Landau et al. 1989) to receive and store radioactive waste solidified in cement and packaged in square 270-liter (71-gallon) drums. The drums of the cement-solidified waste were removed in 2007 and shipped to offsite low-level radioactive waste facilities. The Drum Cell is enclosed by a temporary weather structure, which is a pre-engineered metal building 114 meters (375 feet) long, 18.3 meters (60 feet) wide, and 7.9 meters (26 feet) high. The facility consists of a base pad, shield walls, remote waste handling equipment, container storage areas, and a Control Room within the weather structure. The shield walls at the Drum Cell perimeter are 4.6 meters (15 feet) high and 51 centimeters (20 inches) thick. The base pad consists of concrete blocks set on a layer of compacted crushed stone, underlain by geotextile fabric and compacted clay, which is designed to enhance water drainage. Concrete curbs to support the drum stacks are on top of the base pad. The Drum Cell can hold up to 21,000 drums but is currently empty and is not expected to be contaminated. The Drum Cell is identified as a SWMU; however, it has been determined that no further action is required.

The Subcontractor Maintenance Area is an area that is approximately 6 meters (20 feet) wide by 9 meters (30 feet) long, located on the South Plateau portion of WVDP. The area is flat, covered with compacted stone, and is adjacent to a paved highway. Prior to 1991, a WVDP construction contractor had used this area to clean asphalt paving equipment by spraying the equipment with diesel fuel. During this operation, some of the diesel fuel and asphalt material dripped off the equipment and fell onto the ground surface. Following remediation of the area in 1991, it has been used as a staging area for heavy equipment and inert construction materials, including stone and gravel. The Subcontractor Maintenance Area is identified as a SWMU; however, it has been determined that no further action is required.

The NDA Trench Soil Container Pad is a crushed stone pad approximately 46 meters (150 feet) by 92 meters (300 feet) in size and 30 centimeters (12 inches) in thickness. This pad was used to store roll-off containers full of soil excavated from the NDA Interceptor construction. At the starting point of this EIS, the Trench Soil Container Pad will be left in place. The pad is expected to be slightly radiologically contaminated due to past operations.

C.2.10 Waste Management Area 10: Support and Services Area

WMA 10, the Support and Services Area, is shown on **Figure C–11**. WMA 10 encompasses approximately 12.3 hectares (30 acres) extending from the North Plateau to the South Plateau. Facilities in WMA 10 subject to decommissioning include the New Warehouse, Meteorological Tower, and Security Gatehouse and fences. Parking lots located in WMA 10 are discussed in Section C.2.12.2.

At the starting point of this EIS, the Administration Building, Expanded Environmental Laboratory, Construction Fabrication Shop, and Vitrification Diesel Fuel Oil Storage Tank and Building will have been removed to grade. The disposition of the remaining concrete foundations and slabs is analyzed in this EIS.

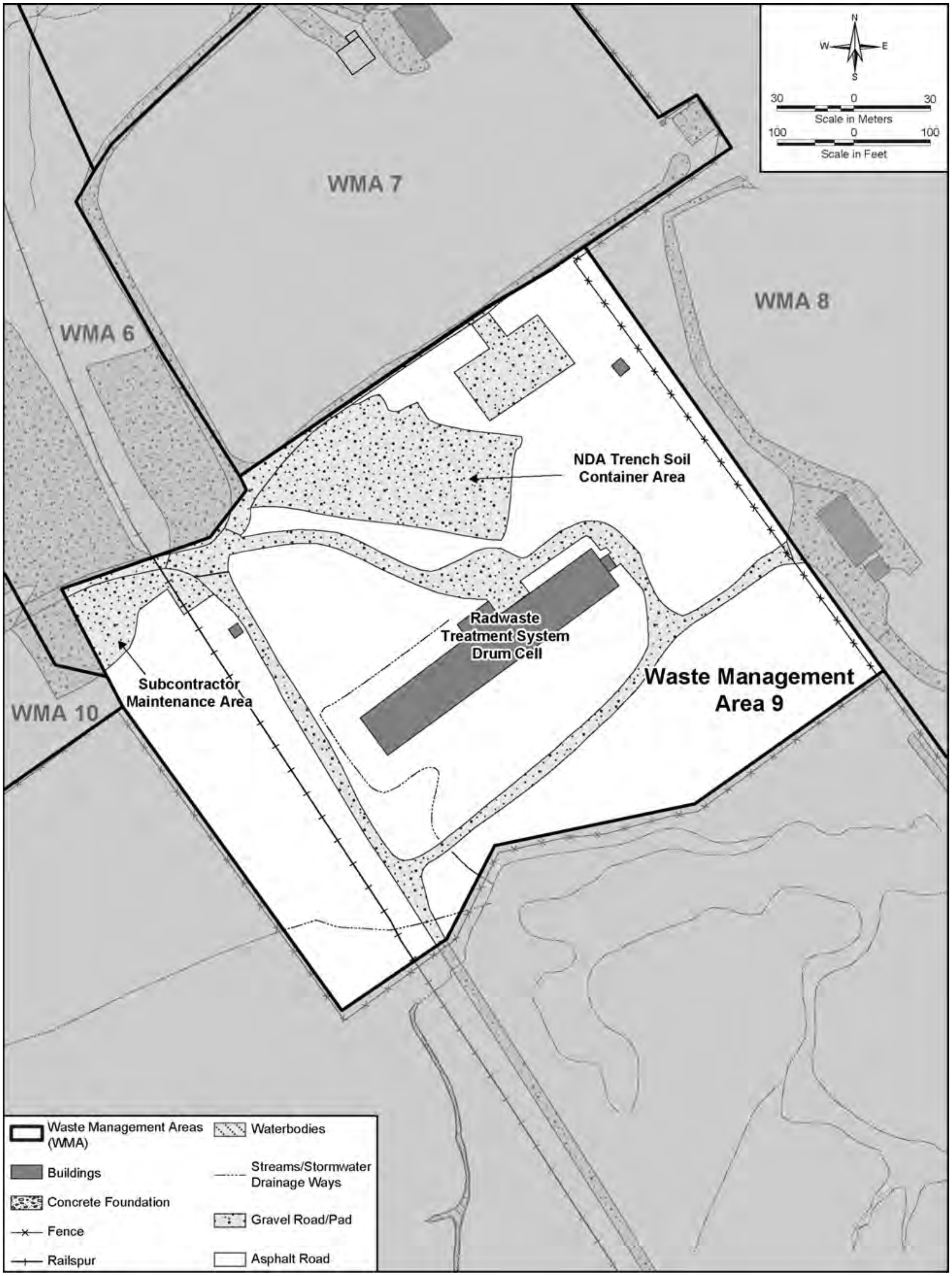

Figure C–10 Waste Management Area 9 – Radwaste Treatment System Drum Cell

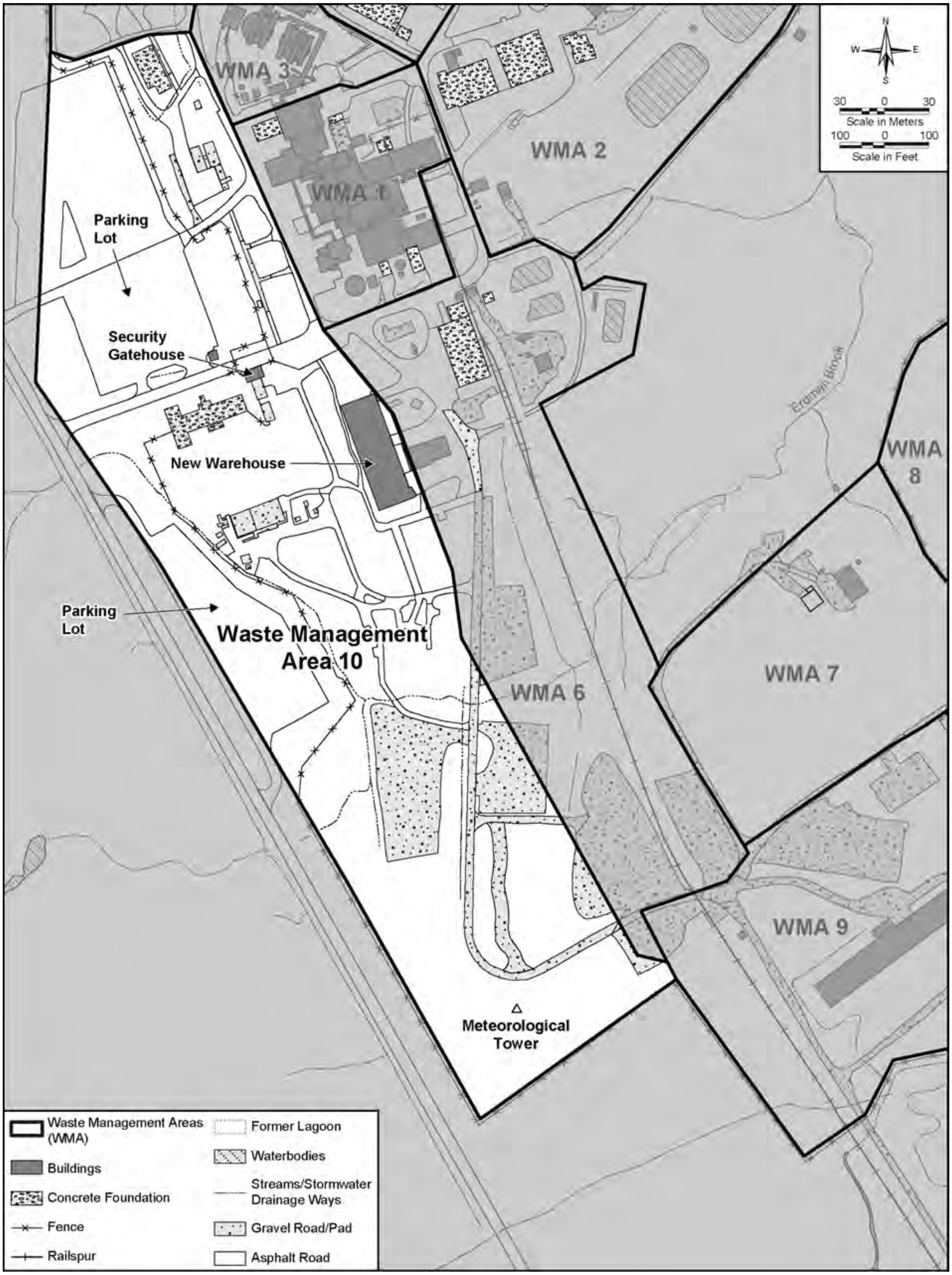

Figure C–11 Waste Management Area 10 – Support and Services Area

C.2.10.1 New Warehouse

The New Warehouse was built during the 1980s and is located east of the Administration Building. It is a pre-engineered steel building that is 24.4 meters (80 feet) wide, 76.2 meters (250 feet) long, and 6.6 meters (21.5 feet) high at the roof peak, resting on about 40 concrete piers and a poured concrete foundation wall. The concrete piers are 0.76 meters (2.5 feet) square and 0.9 meters (3 feet) high; they rest on concrete footings that are 1.5 meters (5 feet) square and 0.4 meters (1.3 feet) thick. The concrete floor is underlain with a gravel base. The average thickness of the concrete floor is 15.2 centimeters (6 inches). The foundation wall is 20.3 centimeters (8 inches) wide and 1.8 meters (6 feet) high. A concrete block firewall divides the warehouse into two sections, separating the Former Waste Management Staging Area from the general storage/warehouse section.

C.2.10.2 Meteorological Tower

The Meteorological Tower is located at the south end of WMA 10. It is constructed from steel, is approximately 60.9 meters (200 feet) high, and is supported by a concrete foundation. It has three 3.3-centimeter-diameter (1.25-inch-diameter) main support columns with interior trusses. It is anchored down at three deadman locations with five support cables attached to each deadman. Monitoring equipment is located on the tower at 9.7 meters (32 feet), 60.4 meters (198 feet), and 60.9 meters (200 feet) above the ground. A standby generator and electrical boxes rest on a concrete pad that is 1.5 meters (5 feet) wide, 1.8 meters (6 feet) long, and 15.2 centimeters (6 inches) thick.

C.2.10.3 Security Gatehouse and Fences

The Main Security Gatehouse is located adjacent to the Administration Building. This gatehouse was constructed when the Main Plant Process Building was built in 1963. During the early 1980s, the Main Gatehouse was renovated, and a large addition was added. The gatehouse is 10.4 meters (34 feet) long, 6.1 meters (20 feet) wide, and 2.7 meters (9 feet) high at the edge of the roof. Construction materials include a concrete foundation, concrete block walls, a concrete slab floor that is 15.2 centimeters (6 inches) thick, and a built-up roof with metal deck.

A barbed-wire security fence runs along the perimeter of the WNYNSC property line. This fence consists of three strands of barbed wire supported by metal posts; the posts are spaced 6.1 meters (20 feet) apart. The fencing has a total running length of approximately 38,100 meters (125,000 linear feet).

A steel security fence surrounds WVDP, the SDA, and miscellaneous other locations. It is made of galvanized chain link with galvanized steel pipe posts spaced 3 meters (10 feet) apart. The fence is 2.1 meters (7 feet) high with a total length of 7,620 meters (25,000 feet). Three strands of barbed wire are stretched across the top of the fence. The posts are set in concrete footings that are 15.2 centimeters (6 inches) in diameter and 1.5 meters (5 feet) deep.

C.2.11 Waste Management Area 11: Bulk Storage Warehouse and Hydrofracture Test Well Area

WMA 11, located in the southeast corner of WNYNSC outside the Project Premises and the SDA, is shown on **Figure C–12**. The only facility in this WMA analyzed in this EIS is the Scrap Material Landfill. The Bulk Storage Warehouse and the Hydrofracture Test Well Area will be decommissioned before the starting point of this EIS.

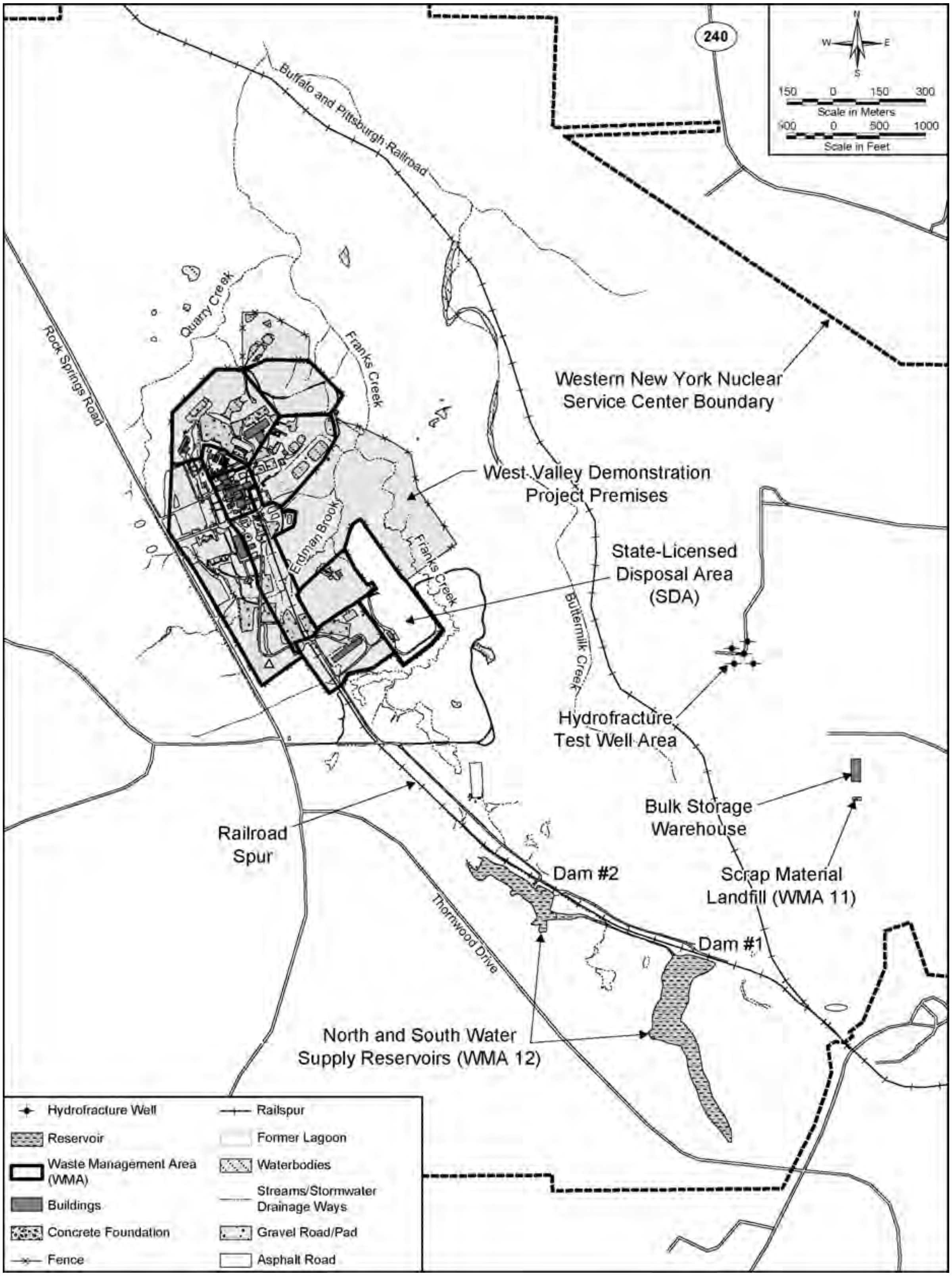

Figure C–12 Waste Management Areas 11 and 12 – Bulk Storage Warehouse and Hydrofracture Test Well Area (Waste Management Area 11) and also Balance of Site (Waste Management Area 12)

The Scrap Material Landfill is located approximately 30 meters (100 feet) south of the Bulk Storage Warehouse. The surface expression of the Scrap Material Landfill is a noticeable low mound that rises 1.2 to 1.5 meters (4 to 5 feet) above the surrounding natural grade. During 1982, NYSERDA removed scrap equipment, consisting of an aluminum transfer hood and 326 empty steel and concrete containers, from the Bulk Storage Warehouse and buried them in a 3-meter-wide (10-foot-wide), 36.6-meter-long (120-foot-long), 4.3-meter-deep (14-foot-deep) trench in the Scrap Material Landfill. This waste material was radiologically surveyed; decontaminated, as necessary; and released for unrestricted use before it was buried in the trench. No radioactive or hazardous waste was buried in the Scrap Material Landfill. The trench was backfilled with soil and capped with a 12.2-meter-wide (40-foot-wide), 39.6-meter-long (130-foot-long), 1.5-meter-high (5-foot-high) soil cover. Two concrete markers identify the ends of the burial trench. The Scrap Material Landfill is identified as a SWMU; however, it has been determined that no further action is required.

C.2.12 Waste Management Area 12: Balance of Site

WMA 12, Balance of Site, is shown on Figure C–12. Facilities analyzed in this EIS consist of the two earthen dams and reservoirs, parking lots (actually located in WMA 10), and miscellaneous (roped-off) areas of surface contamination (located throughout the Project Premises). WMA 12 also includes Buttermilk Creek, Erdman Brook, and Franks Creek, some of which contain radiologically contaminated sediments resulting from regulated releases of treated process wastewater from the Low-Level Waste Treatment Facility by way of Lagoon 3.

C.2.12.1 Dams and Reservoirs

The two water supply reservoirs, the South Reservoir and the North Reservoir, were constructed during 1963 about 2.4 kilometers (1.5 miles) southeast of the Main Plant Process Building. The South Reservoir has an earthen dam that is 23 meters (75 feet) high with pilings to prevent seepage. The South Reservoir drains through a short canal to the North Reservoir. The North Reservoir has an earthen dam that is 15.2 meters (50 feet) high. It also has a control structure and pumphouse to regulate water level. This reservoir drains into Buttermilk Creek.

The control structure has reinforced concrete walls that are 38.1 centimeters (15 inches) thick and an 88.9-centimeter-thick (35-inch-thick) concrete slab floor supported by pilings. Two pumps in the control building discharge into a 20-centimeter (8-inch) cast iron line that directs water to a storage tank near the Main Plant Process Building. The pumphouse has a 20-centimeter-thick (8-inch-thick) floor. The outflow barrel is a 91.4-centimeter (36-inch) corrugated metal pipe.

C.2.12.2 Parking Lots and Roadways

Two parking lots are located off Rock Springs Road in WMA 10. They are designated as the Main Parking Lot and the South Parking Lot.

The original Main Parking Lot was constructed during the mid-1960s. Two extensions were added during the 1980s. It has a total paved surface area of 16,700 square meters (180,000 square feet). The south driveway into the lot is 7.3 meters (24 feet) wide and 64.6 meters (212 feet) long. The north driveway is 7.3 meters (24 feet) wide and 69.5 meters (228 feet) long. Two aluminum utility poles, 15–25 centimeters (6–10 inches) in diameter and 9 meters (30 feet) tall, rest on concrete foundations that are 0.6 meters (2 feet) square and 0.8 meters (2.5 feet) thick. Six wooden utility poles, 30.5 centimeters (12 inches) in diameter and 9 meters (30 feet) tall, are also there.

The South Parking Lot is an irregularly shaped area constructed during 1991. It has approximately 7,430 square meters (80,000 square feet) of parking area and approximately 595 square meters (6,400 square feet) of driveways; both are covered with 20.3 centimeters (8 inches) of asphalt. A guardrail approximately 366 meters (1,200 feet) long borders the lot along its southern, eastern, and western sides. The guardrail is one rail high with 120 posts. Eight wooden poles run through the western side of the lot. Each pole is approximately 9.1 meters (30 feet) high.

Roadways are constructed of a stone sub-base that is approximately 20.3 centimeters (8 inches) thick, covered with asphalt that is approximately 10.2 centimeters (4 inches) thick. The total area of pavement is approximately 120,000 square meters (1,300,000 square feet). Although paved roadways are located in most of the designated WMAs, they are addressed here collectively for convenience.

C.2.12.3 Railroad Spur

The Railroad Spur runs from the Fuel Receiving and Storage Building to a rail line junction, northeast of Riceville Station. It serviced the Project Premises site. The portion of the spur within WMA 12 is south of the Project Premises.

C.2.12.4 Soils and Stream Sediments

Available radiological sampling and survey data provide information to estimate areas of surface soil contamination. Additional data from subsequent characterization programs will supplement the currently available information.

Contaminated stream sediments in WMA 12 include sediments in Erdman Brook and in Franks Creek between the Lagoon 3 outfall and the confluence of Franks Creek and Quarry Creek inside the Project Premises fence.

C.2.12.5 Other Potentially Contaminated Areas

Several other areas (“roped-off areas”) are known or believed to contain radiological contamination. These areas consist of the Lag Storage Area 2 Hardstand, a limited area adjacent to Lag Storage Area 3, an overgrown area south of the Solvent Dike, an area east of Lagoons 2 and 3, the railroad track area by the old warehouse, the old Sewage Treatment Plant ditch south of the old warehouse, and several areas near but outside the NDA.

C.2.13 North Plateau Groundwater Plume

Groundwater in portions of the sand and gravel unit in the North Plateau of WNYNSC is radiologically contaminated as a result of past NFS operations. The most significant area of groundwater contamination is associated with the North Plateau Groundwater Plume, which extends from WMA 1 into WMAs 2 through 6, as shown on **Figure C–13**. The plume boundary shown on Figure C–13 represents the boundary of the 10-picocuries-per-liter gross beta concentration in groundwater, as found in 2007. The plume discharges from groundwater to surface water in WMA 4. This contaminated surface water then flows from WMA 4 to WMA 12 to Cattaraugus Creek, where it leaves WNYNSC.

The North Plateau Groundwater Plume is a 200-meter-wide (650-foot-wide) by 500-meter-long (1,640-foot-long) zone of groundwater contamination that extends northeastward from the Main Plant Process Building in WMA 1 to the CDDL in WMA 4. Strontium-90 is the principal radionuclide in this plume, with it and its daughter radionuclide, yttrium-90, contributing equal amounts of beta activity. An estimate of the amount of residual radioactivity present in the North Plateau Groundwater Plume at the start of the decommissioning is given in **Table C–14.**

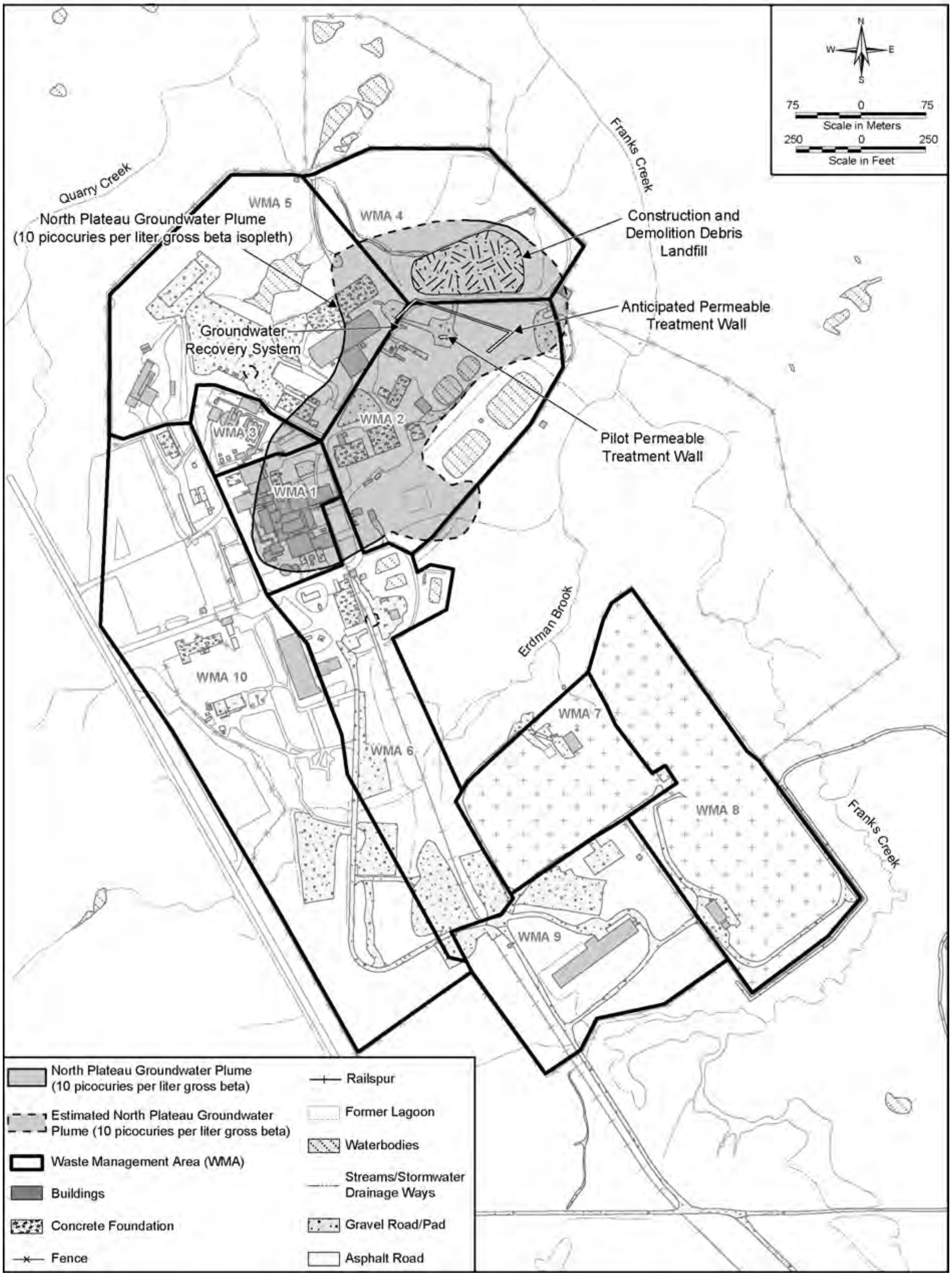

Figure C–13 North Plateau Groundwater Plume

Table C–14 Estimated Radionuclide Inventory in the North Plateau Groundwater Plume

Radionuclide	*Estimate* [a] *(curies)*	*Radionuclide*	*Estimate* [a] *(curies)*
Carbon-14	0.00127	Uranium-235	8.89×10^{-7}
Strontium-90	36.7	Uranium-238	7.88×10^{-6}
Yttrium-90	36.7	Neptunium-237	0.00025
Technetium-99	0.015	Plutonium-238	0.051
Iodine-129	1.95×10^{-6}	Plutonium-239	0.016
Cesium-137	39.7	Plutonium-240	0.013
Uranium-233	0.0000688	Plutonium-241	0.253
Uranium-234	0.0000465	Americium-241	0.662

[a] Decayed to 2011.
Source: Westcott 1998.

The source of the plume is generally considered to be an acid recovery line that leaked in the southwest corner of the Main Plant Process Building. During the late 1960s, the NFS Acid Recovery System, which was housed in the southwest corner of the Main Plant Process Building, leaked an unknown volume of radioactive nitric acid that contained various radioactive fission products. The leaking acid flowed down the walls of the off-gas cell and the adjacent southwest stairwell and migrated into the sand and gravel unit underlying the Main Plant Process Building through an expansion joint in the floor of the off-gas cell. After entering the sand and gravel unit, the radiologically contaminated acid was able to mix with groundwater. To varying degrees, mobile radionuclides such as tritium, strontium-90, and technetium-99 were able to migrate with the groundwater along the northeast groundwater flow path in the North Plateau. Currently, the highest strontium-90 activities in groundwater are estimated to exist 46 meters (150 feet) downgradient from the original release point under the Main Plant Process Building. Less-mobile radionuclides, such as cesium-137, are expected to have remained beneath the immediate source area because of the high cesium sorptive capacity of the minerals in the sand and gravel unit. The eastern edge of the smaller southeastern lobe shown on Figure C–12 is generally considered to have originated from Lagoon 1.

For the purpose of analysis in this EIS, the North Plateau Groundwater Plume is divided into two areas: the source area directly underneath the Main Plant Process Building and the nonsource area that encompasses the rest of the plume.

C.2.13.1 Groundwater Recovery System

During 1995, a pump and treat system (Groundwater Recovery System) was established in WMA 2 to control the western lobe of the plume. Groundwater is pumped from three wells to the Low-Level Waste Treatment Facility, where strontium-90 is removed by ion-exchange. The treated groundwater is transferred to Lagoons 4 or 5 and then to Lagoon 3, from which it is eventually discharged through an SPDES-regulated discharge point to Erdman Brook. Through calendar year 2007, approximately 186 million liters (49 million gallons) of groundwater had been treated, and approximately 8 curies of strontium-90 had been removed (WVES and URS 2008, WVES 2007). Although the Groundwater Recovery System has been effective in limiting the seepage of impacted groundwater to the ground surface, it has not completely mitigated the advance of the western lobe of the plume (Geomatrix 2007). Further, it has no impact on the eastern lobe of the plume, leading to the consideration of additional technologies and construction of a pilot-scale permeable treatment wall, which is discussed in the following section.

C.2.13.2 Permeable Treatment Walls

During 1999, a pilot-scale permeable treatment wall was installed in WMA 2 within the leading edge of the eastern lobe of the plume to evaluate the effectiveness of this type of system in treating groundwater contaminated with strontium-90. The bottom of the pilot-scale permeable treatment wall is in the Lavery till, and the wall extends above the water table level. The wall is about 9.1 meters (30 feet) wide, 1.8 meters (6 feet) thick, and 8.5 meters (28 feet) deep; it is filled with a natural zeolite ion-exchange material, known as clinoptilolite. A 0.3-meter-thick (1-foot-thick) vertical layer of pea gravel was placed on the upgradient side of the wall to reduce clogging and provide a porous inlet for groundwater to enter the 1.5-meter-thick (5-foot-thick) vertical layer of natural zeolite. Soil was placed over the permeable treatment wall, and it was seeded with vegetation to prevent erosion. As groundwater flows through the permeable treatment wall, the strontium-90 is removed from groundwater onto the natural zeolite by ion-exchange. Wells were installed upgradient of and downgradient from the permeable treatment wall for the purpose of sampling the groundwater to monitor the effectiveness of the permeable wall for capturing strontium-90 in this application. Concentration reductions exceeding three orders of magnitude have been indicated by groundwater monitoring data. While some groundwater passes through the permeable treatment wall, test results indicate that groundwater also flows around the permeable treatment wall due to subsurface heterogeneity in the immediate vicinity.

An evaluation of monitoring data indicates that the permeable treatment wall is effective in removing strontium-90 from groundwater inside the permeable treatment wall through ion-exchange although the pilot system is too short in length to mitigate the advance of strontium-90 in the east lobe. Evaluations also indicate some operational and construction improvements can be made to increase the effectiveness of the technology application at WVDP when applied at full scale. Because the pilot program successfully showed that strontium-90 can be removed in situ using a permeable treatment wall and also provided information on construction and design issues that can be overcome (Geomatrix 2007), this technology is seen as a potential full-scale remedy for managing groundwater affected by strontium-90 at the site. Therefore, a full-scale system that is approximately 150 meters (500 feet) wide, is assumed to be implemented in WMA 2 before the EIS starting point.

C.2.14 Cesium Prong

The Cesium Prong, shown on **Figure C–14**, is the result of emissions of cesium in 1968 that contaminated land inside and outside of the WNYNSC boundary. The primary contaminant is cesium-137.

Studies have shown that contaminant concentrations decrease with depth. Seventy-five percent of the activity is in the upper 5 centimeters (2 inches) of soil, and 20 percent is in the layer between 5 centimeters (2 inches) deep and 10 centimeters (4 inches) deep. In other words, 95 percent of the activity may occur in the upper 10.2 centimeters (4 inches) of soil.

C.3 Decommissioning Activities

This section provides detailed descriptions of the decommissioning activities proposed under each action alternative for each WMA. The descriptions include methods of demolition or closure, proposed area remediation as applicable, and discussions on the type and quantity of waste that is estimated to be generated. The various types of waste that would be potentially generated are defined in Chapter 2, Section 2.1, of this EIS. The section is structured on an alternative basis. Section C.3.1 describes the proposed activities under the Sitewide Removal Alternative; Section C.3.2, the Sitewide Close-In-Place Alternative; and Section C.3.3, Phase 1 of the Phased Decisionmaking Alternative. Summaries of the decommissioning activities are presented in Sections 2.4.1, 2.4.2, and 2.4.3 of this EIS.

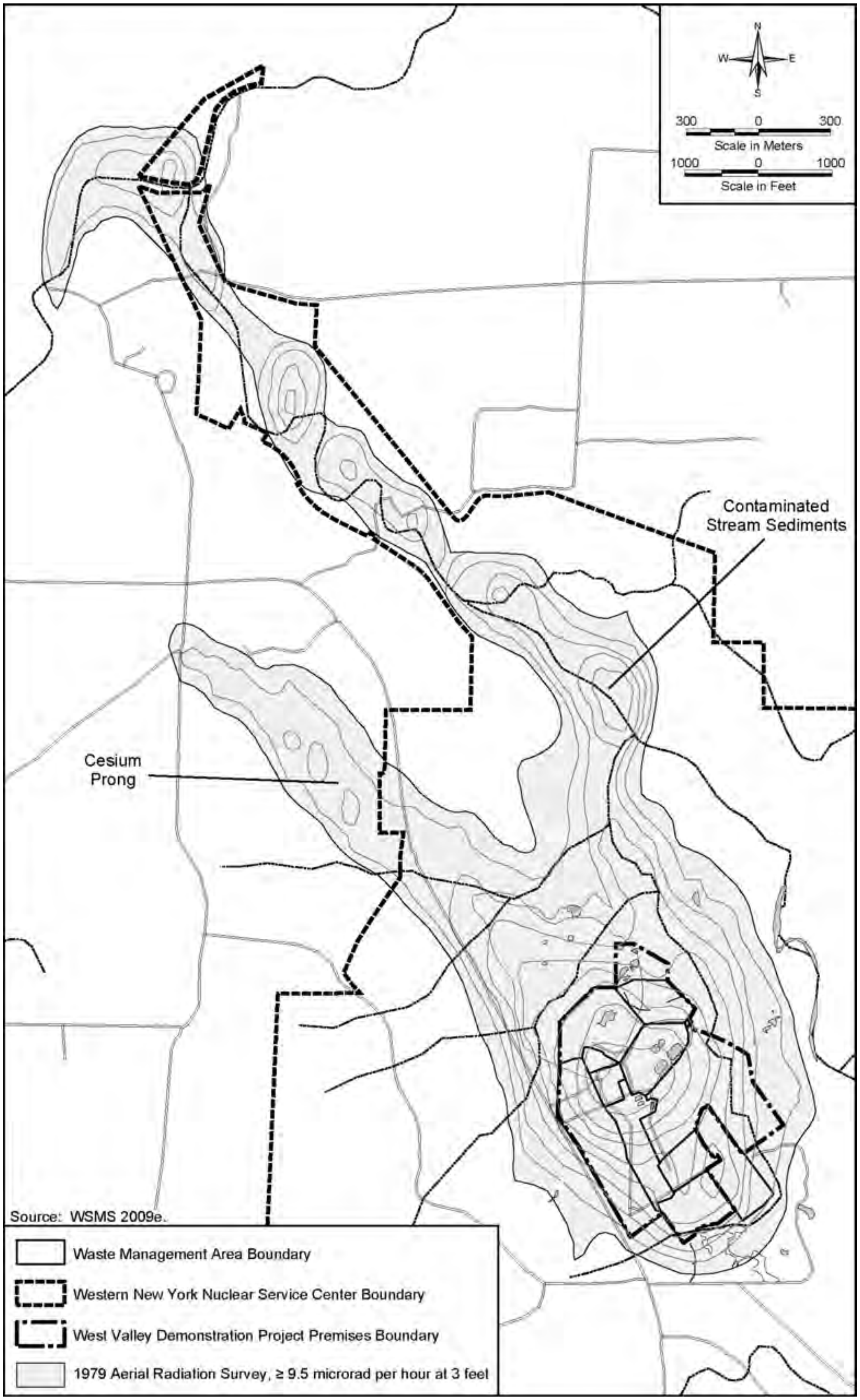

Figure C–14 1979 Aerial Radiation Survey

C.3.1 Sitewide Removal Alternative

Under the Sitewide Removal Alternative, all site facilities would be removed, environmental media would be decontaminated, and all radioactive, hazardous, and mixed low-level radioactive waste would be characterized; packaged, as necessary; and shipped off site for disposal.

This alternative also involves the use of storage facilities to provide for interim storage of orphan waste having no currently permitted disposal site. The new Container Management Facility, which would be constructed primarily for the processing of the waste removed from the NDA and SDA, would be used for this purpose. The Container Management Facility is discussed in Section C.4.4.

Unless otherwise noted, information presented in Section C.3.1 is from the *Sitewide Removal Alternative Technical Report* (WSMS 2009b).

C.3.1.1 Waste Management Area 1: Main Plant Process Building and Vitrification Facility Area

Under the Sitewide Removal Alternative, the high-level radioactive waste canisters stored in the Main Plant Process Building would be relocated. All facilities, including underground structures and remaining floor slabs and foundations, would be removed, including the Main Plant Process Building; Vitrification Facility; 01-14 Building; Load-In/Load-Out Facility; Utility Room and Utility Room Expansion; Plant Office Building; Fire Pumphouse and Storage Tank; Electrical Substation; Off-Gas Trench; underground tanks (7D-13, 15D-6, 35104); and underground process, wastewater, and utility lines. The source area of the North Plateau Groundwater Plume would also be removed.

C.3.1.1.1 Relocation of the High-Level Radioactive Waste Canisters

Preparations to move the vitrified high-level radioactive waste canisters from the Main Plant Process Building to the new onsite Interim Storage Facility (Dry Cask Storage Area) would include modifying the Equipment Decontamination Room to handle the high-level radioactive waste canisters; modifying the Load-In/Load-Out Facility for this purpose, that is, converting it into a Load-Out Facility; and establishing the new Interim Storage Facility (Dry Cask Storage Area), which would be located on the South Plateau near the Rail Spur. The new onsite Interim Storage Facility (Dry Cask Storage Area) to be constructed is discussed in Section C.4.1.

Modifications to the Equipment Decontamination Room would include installation of new equipment such as a crane to remove the canisters from the transfer cart and to position them for transfer into the Load-Out Facility, along with a storage rack and a canister tilting fixture to be used to prepare the canisters for horizontal transfer into the Load-Out Facility. Equipment to weigh the canisters and verify their dimensions would also be installed.

Modifications would also include installation of equipment such as a shielded transfer cell, a canister handling system, and a high-capacity crane. The transfer cell would provide the capability to remotely decontaminate and survey the outside surfaces of the canisters and include features such as a shielded viewing window(s) and a remotely operated manipulator. The cell walls and roof would be constructed of carbon steel to provide radiation shielding. A HEPA-filtered ventilation exhaust system would also be installed. The Load-Out Facility design concept is based on use of a truck-mounted transportation and storage cask that would hold up to seven vitrified high-level radioactive waste canisters.

The new onsite Interim Storage Facility (Dry Cask Storage Area), which would be located in WMA 6, would be patterned on spent nuclear fuel dry storage installations currently licensed by the NRC. It would consist of a reinforced concrete pad where casks containing the high-level radioactive waste canisters would be temporarily stored inside individual concrete storage modules that would provide radiation shielding and mechanical protection.

After the preparations to move the high-level radioactive waste canisters, including the appropriate readiness reviews, are completed, the canisters would be decontaminated, loaded in their storage casks, and transported to the new Interim Storage Facility (Dry Cask Storage Area). They would remain in this facility until disposition decisions are made and implemented.

C.3.1.1.2 Demolition of the Main Plant Process Building

For demolition purposes, portions of the Main Plant Process Building would be divided into five categories, based upon design, construction, and location: (1) the plant stack and remaining equipment, (2) framework cells, (3) reinforced concrete framework cells, (4) tower cells, and (5) below-grade cells. Demolition of the Main Plant Process Building would also follow this general sequence.

The Main Plant Process Building contains 32 lead glass viewing windows, which together contain approximately 10,000 kilograms (22,000 pounds) of lead in their frames. These viewing windows would be removed before demolition of the building begins, and some portion would likely be managed as hazardous waste.

Removal of the Plant Stack and Remaining Equipment

The plant stack, which is 41 meters (160 feet) tall and 1.4 to 3 meters (4.5 to 10 feet) in diameter and is made of Type 304L stainless steel, is located on the roof of the Main Plant Process Building. It would be removed before demolition of the building itself is started. Because the stack was originally assembled in five sections, to facilitate demolition, it would similarly be removed in sections. The pieces would be lowered to the ground by crane, where they would then be wrapped to prevent the spread of contamination. The pieces would be reduced in size and packaged and would likely be disposed of as Class A low-level radioactive waste.

Prior to demolition, remaining equipment, including piping and vessels, would be removed. Some of this material may be transuranic waste.

Demolition of the Framework Cells

The framework cells were designed and constructed with masonry or concrete walls, floors, and ceilings that are supported by a structural steel framework. The walls of the framework cells are constructed from concrete block. Floors are concrete on steel decking. In demolishing the framework cells, asphalt roofing material, some of which contains asbestos, would be removed first using skid steer loaders and handheld equipment. The debris would be removed and placed in containers for disposal. Asbestos-containing material would be managed separately.

The steel roof decking underlying the asphalt roofing would be removed and reduced in size with a mobile shear attached to a small, track-mounted, electric powered, hydraulic demolition machine. The shear attachment could cut through the roof decking, reduce the size of this material, and place it into boxes.

The masonry and concrete walls in the framework cells would be demolished with a demolition machine equipped with either a demolition hammer operated under a fog spray or shear. The hammer would break through the concrete, and the shear would be used to cut through the steel reinforcement in the concrete, as well as the steel members comprising the skeleton of these cells. A skid steer loader would be used to place rubble into the transfer boxes, which would be lowered to ground level with a crane. The demolition debris is assumed to be managed as low-specific-activity waste and disposed of off site at a low-level radioactive waste disposal facility.

Demolition of the Reinforced Concrete Framework Cells

The reinforced concrete framework cells were constructed using reinforced high-density concrete up to 1 meter (3 feet) thick to provide radiation shielding while highly radioactive samples were being analyzed within them. These cells are situated within and above the framework cells of the Main Plant Process Building, and they would be demolished in conjunction with those cells.

The reinforced concrete framework cells include Analytical Cells 1 through 5, the Sample Cell, and the Sample Storage Cell, which are located at a plant elevation of 40 meters (131 feet). These cells would be demolished with demolition machines. A skid steer loader would place the demolition debris into transfer boxes, which would be lowered to ground level using a crane. This debris is assumed to be managed as low-specific-activity waste and disposed of off site at a low-level radioactive waste disposal facility.

Demolition of the Tower Cells

The tower cells are constructed entirely of reinforced concrete. Their construction would allow these cells to be free-standing structures if they were physically segregated from other portions of the Main Plant Process Building. The walls, floors, and ceilings of these cells typically consist of either high-density (3,800 kilograms per cubic meter [235 pounds per cubic foot]) or standard density (2,400 kilograms per cubic meter [150 pounds per cubic foot]) reinforced concrete that is up to 1.7 meters (5.5 feet) thick. The tower cells would be demolished in a controlled manner by segmenting the walls and ceilings with diamond-wire saws.

The first step in the demolition of the tower cells would be segmentation and removal of the ceilings. A series of holes would be drilled through the ceiling through which the diamond wire would be passed and to which lifting bales would be attached. The diamond wire would cut through the concrete and any rebar or penetrations. The ceiling segment would be supported from above by a crane that would remove the ceiling segment when cut.

The walls would be segmented in a similar fashion using diamond-wire cutting. The ceiling and wall segments would be sized to fit into waste packages. Conventional demolition equipment would be used to remove the floor slabs once the walls are removed. The demolition debris from the tower cells is assumed to be classified as low-specific-activity waste and would be disposed of off site at a low-level radioactive waste disposal facility.

Demolition of Below-Grade Cells

The demolition of the below-grade cells is addressed in Section C.3.1.1.8 of this EIS with the discussion of the removal of underground structures.

C.3.1.1.3 Demolition of the Vitrification Facility

The Vitrification Facility contains nine lead glass viewing windows having approximately 1,360 kilograms (3,000 pounds) of lead in their frames. These windows would be removed from the building before demolition of the structure and managed separately.

The Vitrification Facility would be demolished to grade level using methods such as those described for the Main Plant Process Building. Considering the construction of the building, the steel frame and sheet metal part of the structure would be demolished first and then the reinforced concrete Vitrification Cell. The thick reinforced concrete walls and roof components would be segmented, as necessary, using a technique such as diamond-wire cutting. The steel shield doors would also be segmented, as necessary, for disposal.

Demolition waste would be removed from the area and disposed of off site. The debris from the Vitrification Cell would be managed as Class A low-level radioactive waste and the rubble from the rest of the structure as low-specific-activity waste.

Demolition of this building would be coordinated with demolition of the Main Plant Process Building because the two structures are connected.

C.3.1.1.4 Demolition of the 01-14 Building

The 01-14 Building contains a single lead glass viewing window with approximately 225 kilograms (500 pounds) of lead in the frame. This window would be removed from the building before demolition of the structure and managed separately.

In demolishing the structure, the corrugated steel structure would be removed first. It is not expected to be radioactively contaminated, and it is assumed that the materials would be disposed of as construction and demolition debris.

Removal of the concrete building structure would involve use of methods similar to those used with the Main Plant Process Building. It is assumed that the building debris would be handled as low-specific-activity waste.

C.3.1.1.5 Demolition of the Load-Out Facility

The Load-Out Facility (converted from Load-In/Load-Out Facility) would be demolished once all of the high-level radioactive waste canisters have been removed from the Main Plant Process Building. The shielded transfer cell, canister handling system, and high-capacity crane would be dismantled, packaged, and disposed of as Class A low-level radioactive waste at an offsite disposal facility.

A characterization survey would be performed to quantify the contamination and radiation fields in various parts of the building, and a spray fixative would be applied to the interior surfaces of the building. All of the utilities would be isolated. Any equipment remaining in the Load-Out Facility would be removed, including electrical equipment such as generators and pump motors. All the drains and sumps would be sealed.

Standard construction equipment would be used to demolish the Load-Out Facility, as the internal wall surfaces of the structure are not expected to be contaminated. All waste would be characterized, packaged, and disposed of as uncontaminated construction and demolition debris at appropriate offsite disposal facilities.

Using an excavator equipped with a shear, a grapple, and a hammer, the building and slab would be demolished. The equipment and debris would be reduced in size, as necessary, and disposed of off site.

Soils beneath the building and slab would be surveyed to determine if established Derived Concentration Guideline Levels (DCGLs) have been exceeded. Soil with radioactivity concentrations exceeding the DCGLs would be removed. Any contaminated soil would be shipped to an offsite disposal facility as low-level radioactive waste.

The excavation would be backfilled with appropriate clean backfill material.

C.3.1.1.6 Demolition of Other Waste Management Area 1 Facilities

The Utility Room, Utility Room Expansion, Fire Pumphouse, Water Storage Tank, Electrical Substation, and Plant Office Building are relatively simple structures that would be demolished to grade using conventional demolition equipment at an appropriate point in the Main Plant Process Building demolition. The rubble from the Utility Room and Utility Room Expansion would be managed as low-specific-activity waste and the Plant Office rubble as uncontaminated construction and demolition debris.

Equipment and piping in the Fire Pumphouse would be removed and disposed of off site as uncontaminated construction and demolition debris. The pumphouse would be demolished by conventional methods and the rubble managed as uncontaminated construction and demolition debris. The Water Storage Tank would be drained and the water released to the storm sewer in accordance with the existing SPDES permit. The steel tank would be segmented using conventional steel cutting equipment. The tank segments would be disposed of off site as uncontaminated construction and demolition debris.

C.3.1.1.7 Excavation and Hydraulic Barrier Wall Installation

To facilitate removal of the underground structures of the Main Plant Process Building and Vitrification Facility, along with the source area of the North Plateau Groundwater Plume, an area larger than the footprint of both buildings would be excavated. This area is shown on **Figure C–15**.

As can be seen on Figure C–15, the western edge of the excavation would lie near the road in front of the Plant Office Building. Reference should also be made to Figure C–1. The northern edge of the excavation would follow the walkway between the Vitrification Facility and the Waste Tank Farm. The eastern edge would follow the road between the Main Plant Process Building area and the Interceptors. The southern edge would correspond with a line running immediately south of the 01-14 Building, the Utility Room, and the Utility Room Expansion. The footprint of the excavation would comprise approximately 1.2 hectares (3 acres).

To control groundwater, a vertical hydraulic barrier would be installed around the area to be excavated, as shown on Figure C–15. The upgradient portion would be constructed of sheet pile. The downgradient portion would consist of a soil-cement-bentonite slurry wall. Both would extend approximately 0.6 meters (2 feet) into the Lavery till, and the slurry wall would remain in place after the excavation is backfilled.

The total length of the slurry wall would be approximately 230 meters (750 feet), with approximately 160 meters (525 feet) of this length directly adjacent to the WMA 1 area to be excavated. The 160-meter (525-foot) portion of the slurry wall adjacent to the area to be excavated would be 4 meters (13 feet) wide, with the remainder a more typical 0.6 meters (2 feet) wide. The extra width of the main portion of the slurry wall and the inclusion of cement in the mixture would provide the stability necessary to accommodate the nearby excavation.

Construction of the soil-cement-bentonite slurry wall would involve activities such as the following:

- Preparations would be made to handle the approximately 5,600 cubic meters (7,300 cubic yards) of soil to be excavated, 5,000 cubic meters (6,500 cubic yards) of which would be assumed to be radioactively contaminated, with approximately half of that assumed to be saturated.
- A hydraulic excavator would be used to dig the trench for installation of the slurry wall.
- The slurry and backfill mixtures would be prepared in contained areas that would be constructed near the slurry wall.
- During the excavation process, the trench would be kept filled with slurry to help support its walls.

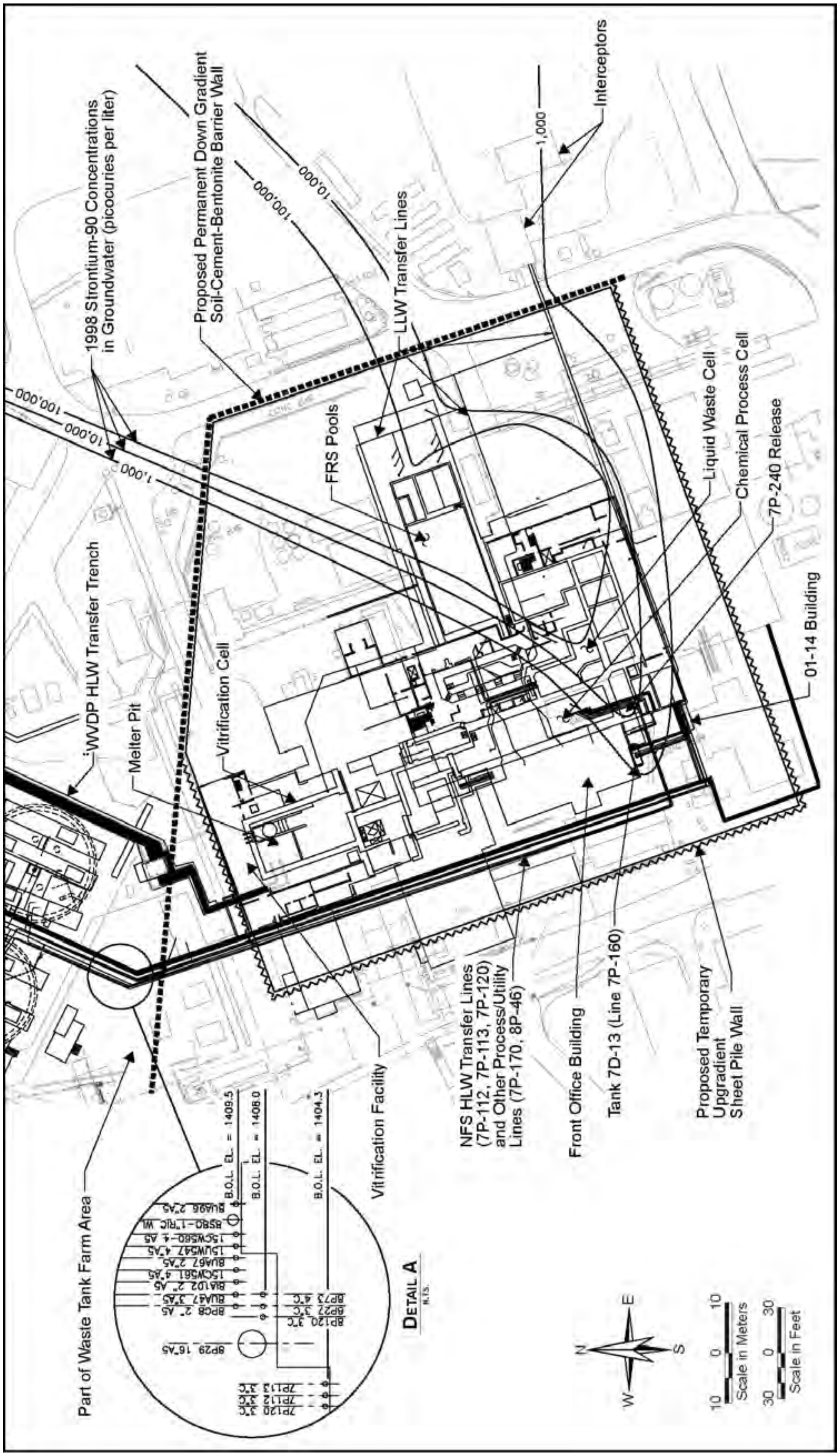

Figure C–15 Conceptual Layout of Waste Management Area 1 Excavation

C.3.1.1.8 Removal of the Plume Source Area, Underground Structures, and Equipment

Removal of the underground structures and equipment would be coordinated with soil removal because the North Plateau Groundwater Plume source area lies beneath the Main Plant Process Building.

Removal of Contaminated Soil and Groundwater

In addition to installation of the hydraulic barrier wall, preparations would include installation of fifteen 15-centimeter-diameter (6-inch-diameter) extraction wells, design and fabrication of a skid-mounted groundwater treatment system, and design and erection of a pre-engineered confinement structure.

The extraction wells would be similar to the extraction wells currently in use in the North Plateau Groundwater Recovery System. This system would include two skid-mounted treatment units having a combined capacity for treating contaminated water of 379 liters (100 gallons) per minute.

The conceptual design of the confinement structure to be used during excavation of the higher-activity materials near the original release is described in Section C.4.6.7. This single-span structure would extend over the portion of the excavation near the release in the southwest corner of the Main Plant Process Building to provide for weather protection and control of airborne radioactivity.

Before excavation would begin, the hydraulic barrier wall would be installed, the groundwater pretreatment system set up, the dewatering wells installed and placed in operation, and the confinement structure installed. The excavation process would be accomplished in two phases using conventional excavation equipment.

The first phase would involve removal of soil in the vadose zone and offsite shipment as low-specific-activity waste. Excavation of soil in the saturated zone would begin after the dewatering wells have removed groundwater in the confined area to the extent practical. The groundwater would be treated using ion-exchange and discharged directly to Erdman Brook through an SPDES-permitted outfall after confirmation that radioactivity concentrations are acceptably low. As the excavation progresses deeper into saturated soils, the excavation crew would construct common sumps to remove free liquid.

The excavation would extend at least 0.3 meters (1 foot) into the Lavery till. Additional soil would be excavated, as necessary, to remove essentially all the soil impacted by radioactivity. The extent of soil removed beyond the proposed limits would be determined by the use of DCGLs. Remedial action surveys would be performed during the course of the work to identify those areas that contain contaminated soil above the DCGLs and those that do not. Soil with radioactivity concentrations exceeding the DCGLs would be removed.

For estimating purposes, the following assumptions have been made:

- The excavation is assumed to extend 0.3 meters (1 foot) into the Lavery till or more in those cases where the underground structure extends into the Lavery till.
- All of the soil to be excavated would be radioactive and processed through a Soil Drying Facility (see Section C.4.3) and disposed of off site.
- Soil in the North Plateau Groundwater Plume source area and immediately downgradient would be disposed of as Class A low-level radioactive waste.
- The remainder of the soil would be disposed of as low-specific-activity waste and placed in containers for transportation to the disposal facility.

Removal of Underground Structures

The design and construction of the below-grade cells are similar to the tower cells (see Section C.3.1.1.2); they would also be freestanding structures if they were physically segregated from the remainder of the Main Plant Process Building. The walls, floors, and ceilings of these cells are composed of either high-density (2,400 kilograms per cubic meter [235 pounds per cubic foot]) or standard density (3,800 kilograms per cubic meter [150 pounds per cubic foot]) reinforced concrete that is up to 1 meter (3 feet) thick.

The demolition of below-grade cells and structures would be coordinated with the removal of the three underground tanks, the underground piping, and contaminated soil associated with the source area of the North Plateau Groundwater Plume. After soil is excavated to expose their structures, the below-grade cells would be demolished with conventional demolition equipment operating under a fog spray, as necessary, and with diamond-wire saws.

The ceilings and walls would be segmented and removed using diamond-wire saws and cranes. The cut segments would be sized to fit into appropriate containers. Once the walls have been removed, conventional demolition equipment would be used to remove the floor slabs and foundations.

All remaining concrete floor slabs and foundations in the area, including those outside of the excavation, would also be removed. The nearly 500 foundation pilings supporting the Main Plant Process Building would be cut just below the limit of excavation. Additional piling removal would be considered if contaminants are found to have migrated further down the pilings. Assumptions have been made regarding the pile removal that involve potentially numerous work crews working together in a small space (excavation and concrete demolition would be proceeding at the same time as the pile removal). This working arrangement might cause reductions in work productivity to occur, increasing cost and decreasing the level of safety against worker injury. The work involved in this effort is relatively common; however, coordination among the work crews would need close attention.

All demolition debris would be managed as low-specific-activity waste and disposed of off site at a low-level radioactive waste disposal facility.

Removal of Underground Tanks and Piping

The three underground tanks and underground piping within the excavated area would be removed and disposed of as radioactive waste, as appropriate. Planning for underground line removal would take into account two lines of particular interest: Waste Transfer Line 7P-120 and the off-gas line running between the Vitrification Facility and the 01-14 Building. Waste Transfer Line 7P-120, which is shown on Figure C–15, has been estimated to contain more than 90 percent of the radioactivity in the underground lines in the Main Plant Process Building area.

Waste Transfer Line 7P-120, as well as 7P-112 and 7P-113, would be isolated and completely filled with grout. These pipes would be removed from the point of origin within the Main Plant Process Building, to beyond the proposed downgradient barrier wall (see Section C.3.1.1.7), and into WMA 3. Pipes left in the ground would be properly plugged and sealed.

The off-gas line, which runs in the Off-Gas Trench just below-grade with other lines, is also expected to contain high levels of residual radioactivity. The Off-Gas Trench would be removed along with the pipelines it contains. Rubble from the Trench is expected to be disposed of off site as construction and demolition debris. Soil beneath the underground structures would be excavated 0.3 meters (1 foot) into the Lavery till.

The wastewater piping under the Main Plant Process Building would be removed and disposed of as Class A low-level radioactive waste and the surrounding soils as low-specific-activity waste. All contaminated piping running into other WMAs would be removed. This process would apply to radioactive lines only. Nonradioactive sanitary lines and utility lines would remain in place in cases where this is practicable because removal would involve extensive excavation and these lines would not need to be maintained. Parking lots and roadways would be removed because they would otherwise need to be maintained.

C.3.1.1.9 Site Restoration

Once the below-grade structures of the Main Plant Process Building and Vitrification Facility, the three wastewater tanks, the underground piping, the remaining concrete floor slabs and foundations, and the underlying contaminated soils associated with the source area of the North Plateau Groundwater Plume have been removed, a final status survey would be performed in the excavation to verify that residual radioactivity levels do not exceed DCGLs. Arrangements would also be made for an independent verification survey. Confirmatory sampling for RCRA constituents of concern would be performed, and remedial actions would be based on the results.

After the verification survey is completed, the area would be filled with appropriate clean backfill material and then graded, as necessary, to restore it to a near natural appearance. It is assumed in the estimates that the backfill would be composed entirely of clean earth brought in for this purpose.

C.3.1.1.10 Disposition of Support Facility Materials

The sheet pilings installed on the upgradient sides of the excavation would be removed as the excavation is backfilled and disposed of as low-specific-activity waste, as would the groundwater extraction wells. It is assumed that the components of the groundwater treatment system would be disposed of as low-specific-activity waste, with the ion-exchange media disposed of as Class A low-level radioactive waste. It is assumed that the ventilation exhaust equipment associated with the confinement structure would be disposed of as low-specific-activity waste, with the confinement structure itself being disposed of as uncontaminated construction and demolition debris.

C.3.1.1.11 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 1 are presented in **Table C–15**. The estimate includes the modification of the Load-In/Load-Out Facility and the operation and demolition of the Interim Storage Facility (Dry Cask Storage Area) associated with the high-level waste canister removal.

Table C–15 Estimated Waste to be Generated: Waste Management Area 1

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	440,000
Hazardous Waste	83
Low-level Radioactive Waste	
Low Specific Activity	3,500,000
Class A	280,000
Class B	3,100
Class C	9,000
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	1,400
Transuranic Waste	24,000

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.2 Waste Management Area 2: Low-Level Waste Treatment Facility Area

The Sitewide Removal Alternative approach to closing WMA 2 is removal of all remaining surface structures and concrete floor slabs, removal of all below-grade piping, removal of the contaminated waste and sediment contained in Lagoon 1, excavation of all contaminated sediment from Lagoons 2 and 3, removal of liners from Lagoons 4 and 5 and excavation of any underlying contaminated soil, and restoration of the surface to a natural contour.

C.3.1.2.1 Removal of Structures/Facilities

Low-Level Waste Treatment Facility

The contents of skid-mounted wastewater processing modules, ion-exchange media, and activated carbon would be flushed to the waste packaging area, where they would be packaged for transport off site and disposal as low-specific-activity waste. The wastewater processing equipment and piping from the building would be removed and reduced in size, as appropriate; packaged; placed into containers; and transported off site for disposal as low-specific-activity waste.

The waste packaging area would be demolished using appropriate controls such as fog spray, with the debris, including the sump liner, being placed into containers for disposal off site as low-specific-activity waste. The remainder of the Low-Level Waste Treatment Facility and its floor slab would then be demolished by conventional methods without confinement and the surrounding soils excavated, as needed, to satisfy the DCGLs. The debris and excavated soil would be handled as low-specific-activity waste, placed into containers, and transported off site for disposal.

A final radiological status survey would be performed in the area and arrangements made for an independent verification survey. After the surveys have been completed and any necessary confirmatory sampling of RCRA constituents of concern has been performed, the excavation would be filled with appropriate clean backfill material and contoured to grade.

Neutralization Pit

The liner, concrete walls, and floor of the Neutralization Pit and the underground lines in the immediate area would be demolished and removed with the debris being disposed of as low-specific-activity waste.

After completion of this work, a larger excavation would be performed as part of the WMA 2 remediation. Following that, a final status survey would be performed to include the Neutralization Pit excavated area and arrangements made for an independent verification survey. After the surveys have been completed and any necessary confirmatory sampling of RCRA constituents of concern has been performed, the excavation would be filled with appropriate clean backfill material and contoured to grade.

Old Interceptor

The Old Interceptor would be demolished using a process similar to that used for the Neutralization Pit, with appropriate radiological controls. The concrete rubble would be managed as low-specific-activity waste and placed in lift liners for offsite disposal. The valve pit and underground lines in the immediate area would be removed and disposed of as low-specific-activity waste.

After completion of this work, a larger excavation would be performed as part of the WMA 2 remediation. Following that, a final status survey would be performed to include the Old Interceptor excavated area and arrangements made for an independent verification survey. After the surveys have been completed and any necessary confirmatory sampling of RCRA constituents of concern has been performed, the excavation would be filled with appropriate clean backfill material and contoured to grade.

New Interceptors

The New Interceptors and the valve pit would be demolished using a process similar to that used for the Neutralization Pit, with the rubble being disposed of as low-specific-activity waste. Underground lines in the immediate area would also be removed and disposed of as low-specific-activity waste.

After completion of this work, a larger excavation would be performed as part of the WMA 2 remediation. Following that, a final status survey would be performed to include the New Interceptors' excavated area and arrangements made for an independent verification survey. After the surveys have been completed and any necessary confirmatory sampling of RCRA constituents of concern has been performed, the excavation would be filled with appropriate clean backfill material and contoured to grade.

Fire Brigade Training Area

Surface and subsurface soils that have been impacted by past operations at the Fire Brigade Training Area would be excavated and disposed of off site. The excavated material would be packaged and characterized for disposal; it is assumed to be classified as low-specific-activity waste.

Sometime after completion of the excavation of impacted soils, a larger excavation would be performed as part of the WMA 2 remediation. Following that, a final status survey would be performed to include the Fire Brigade excavated area, and arrangements would be made for an independent verification survey. A RCRA confirmatory status survey would also be performed. After the surveys have been performed and any necessary sampling and analysis for constituents of concern have been completed, the excavation would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.2.2 Concrete Floor Slabs and Foundations

The concrete floor slabs of the 02 Building, Test and Storage Building, Vitrification Test Facility, Maintenance Shop, Maintenance Storage Area, Vehicle Maintenance Shop, and Industrial Waste Storage Area would be demolished by conventional means and the surrounding soils excavated, as needed, to satisfy the DCGLs. The demolition debris is assumed to be disposed of as uncontaminated construction and demolition debris.

A final status survey would be performed in the excavated areas and arrangements made for an independent verification survey. After the surveys have been completed and any necessary confirmatory sampling of RCRA constituents of concern has been performed, the excavations would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.2.3 Decommissioning of the Lagoons

Lagoon 1

Preparation for decommissioning of Lagoon 1 would include fabrication of a confinement structure. Section C.4.6.6 describes the conceptual design of this structure, which would consist of a single-span metal building large enough to cover the lagoon area excavation and accommodate heavy equipment.

The confinement structure would be erected over the Lagoon 1 area to prevent any airborne releases during excavation. The topsoil and clay cap, hardstand waste, and contaminated sand and gravel underlying Lagoon 1 would be excavated and evaluated for waste characterization.

The excavation is expected to encompass a 30.4- by 30.4-meter (100- by 100-foot) area and extend approximately 0.6 meters (2 feet) into the Lavery till, with a total depth of approximately 4.3 meters (14 feet). Sheet piling would be installed around the excavation to limit groundwater intrusion. As with removal of the North Plateau Groundwater Plume source area in WMA 1, DCGLs would be used to determine the extent of contaminated sediment and soil removal.

The excavated hardstand waste is assumed to be disposed of as Class A low-level radioactive waste. It is assumed that the underlying sand and gravel would be disposed of as Class C low-level radioactive waste.

Following removal of Lagoon 1 within the confinement structure, additional surrounding soils would also be removed. This area extends from about the interceptors to Lagoon 2 and is approximately 5,800 square meters (64,000 square feet) in size. Soils would be excavated down to about 4.3 meters (14 feet) and disposed of off site as low-specific-activity waste. By removing the larger area around Lagoon 1 all the way from Lagoon 2 to the interceptors, any potential areas of secondary contamination would be effectively remediated.

After completion of this work, a final status survey would be performed in the excavated area and arrangements made for an independent verification survey. After the surveys have been completed and any necessary confirmatory sampling of RCRA constituents of concern has been performed, the excavation would be filled with appropriate clean backfill material.

It is assumed that the ventilation exhaust equipment associated with the confinement structure would be disposed of as low-specific-activity waste, with much of the confinement structure itself being disposed of as uncontaminated construction and demolition debris.

Lagoon 2

Lagoon 2 was excavated through the sand and gravel unit into the underlying Lavery till. There is little to no groundwater flow from the sand and gravel unit into the lagoon. Groundwater flow in the Lavery till is vertically downward toward the underling Kent Recessional Unit. Before excavation activities associated with decommissioning would begin, aqueous waste remaining in Lagoon 2 would be pumped to the Low-Level Waste Treatment Facility for treatment.

As part of the decommissioning process, equipment and piping would be removed from the pump shed, the shed would be demolished, and buried piping and conduit would be removed using appropriate radiological controls. The resulting equipment and building debris would be disposed of as low-specific-activity waste. The buried piping would be managed as Class A low-level radioactive waste. The stairways would be removed, cut into manageable sizes, and disposed of as low-specific-activity waste.

Using appropriate radiological controls and conventional excavation methods, contaminated lagoon sediment and a limited thickness of the underlying Lavery till would be removed. As with Lagoon 1, DCGLs would be used to determine the extent of contaminated sediment and soil removal. It is expected that a total of 1 meter (4 feet) of soil/sediment would be removed, including the upper 0.3 meters (1 foot) of the underlying Lavery till. It is assumed that the removed sediment and soil would be disposed of as Class A low-level radioactive waste.

After completion of this work, a final status survey would be performed in the excavated area and arrangements made for an independent verification survey. After the surveys and any necessary confirmatory sampling of RCRA constituents of concern have been completed, the excavation would be filled with appropriate clean backfill material.

Lagoon 3

Similar to Lagoon 2, Lagoon 3 was excavated through the sand and gravel unit into the underlying Lavery till. There is little to no groundwater flow from the sand and gravel unit into the lagoon. Groundwater flow in the Lavery till is vertically downward toward the underlying Kent Recessional Unit. Before excavation activities associated with decommissioning would begin, aqueous waste remaining in Lagoon 3 would be discharged to Erdman Brook through the SPDES-permitted discharge.

The Lagoon 3 decommissioning process would be similar to the Lagoon 2 process. The stainless steel liner would be removed from the discharge weir and would be disposed of as low-level radioactive waste. Using appropriate radiological controls and conventional excavation methods, contaminated lagoon sediment and a limited thickness of the underlying Lavery till would be removed. DCGLs would be used to determine the extent of contaminated sediment and soil removal. It is expected that a total of 0.6 meters (2 feet) of soil/sediment would be removed, including a thin layer of the underlying Lavery till. It is assumed that the removed sediment and soil would be disposed of as Class A low-level radioactive waste.

After completion of this work, a final status survey would be performed in the excavated area and arrangements made for an independent verification survey. After the surveys and any necessary confirmatory sampling of RCRA constituents of concern have been completed, the excavation would be filled with compacted clay.

Lagoons 4 and 5

Lagoons 4 and 5 were excavated into the vadose zone of the sand and gravel unit, and an impermeable liner was installed after their construction to limit releases to the sand and gravel unit.

During decommissioning, the liners in Lagoons 4 and 5 would be removed. Radioactively contaminated soil beneath the liners would be removed to meet DCGLs. For estimating purposes, it is assumed that approximately 0.3 meters (1 foot) of underlying soil is contaminated above the DCGLs and that the removed sediment, soil, and liners would be disposed of as Class A low-level radioactive waste. Because Lagoons 4 and 5 and their liners are in the vadose zone of the sand and gravel unit, interaction with the groundwater would be successfully managed.

After completion of this work, a final status survey would be performed in the area and arrangements made for an independent verification survey. After the surveys and any necessary confirmatory sampling of RCRA constituents of concern have been completed, the excavation would be filled with compacted clay.

C.3.1.2.4 Solvent Dike

The Solvent Dike would be excavated. The excavated material is assumed to be disposed of off site as low-specific-activity waste.

After completion of this work, a larger excavation would be performed as part of the WMA 2 remediation. Following that, a final status survey would be performed in the excavated area and arrangements made for an independent verification survey. After the surveys and any necessary confirmatory sampling of RCRA constituents of concern have been completed, the excavation would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.2.5 Maintenance Shop Leach Field

The leach field components would be removed by conventional means without confinement. This material would be disposed of as low-level radioactive waste because it is assumed that this area has been impacted by the North Plateau Groundwater Plume, although it is unclear whether the depth to be excavated would encounter the saturated zone. This work would likely be performed concurrently with the North Plateau Groundwater Plume excavation.

After completion of this work, a final status survey would be performed in the excavated area and arrangements made for an independent verification survey. After the surveys and any confirmatory sampling of RCRA constituents of concern have been completed, the excavation would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.2.6 Remaining Underground Piping

All underground wastewater lines within WMA 2 that remain after facility removal and lagoon excavations would be removed and disposed of as Class A low-level radioactive waste. A final status survey would be performed in each excavated area and arrangements made for an independent verification survey. After the surveys have been completed and any necessary confirmatory sampling of RCRA constituents of concern has been performed, the excavated areas would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.2.7 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 2 are presented in **Table C–16**.

Table C–16 Estimated Waste to be Generated: Waste Management Area 2

Waste Type	***Waste Volume (cubic feet)***
Construction and Demolition Debris	50,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	1,400,000
Class A	340,000
Class B	0
Class C	33,000
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Note: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.3 Waste Management Area 3: Waste Tank Farm Area

The Sitewide Removal Alternative closure approach for WMA 3 includes the removal of all facilities, including Tanks 8D-1, 8D-2, 8D-3, and 8D-4 and their associated vaults; the high-level radioactive waste mobilization and transfer pumps; the High-Level Waste Transfer Trench; the Permanent Ventilation System Building; the STS and STS Support Building; the Equipment Shelter and Condensers; the Con-Ed Building; the underground process and STS wastewater and utility lines; and all remaining concrete slabs and foundations. All contaminated soil and groundwater would be remediated to levels supporting unrestricted release.

C.3.1.3.1 Demolition of the Supernatant Treatment System Support Building and Tanks 8D-1, 8D-2, 8D-3, and 8D-4 and Associated Vaults

The closure of the Waste Tank Farm Area in WMA 3 would be performed within the confines of the Waste Tank Farm Waste Processing Facility, which is described in Section C.4.2. Closure activities would include a number of separate tasks including, but not limited to, removal and processing of any mobile radionuclide inventory from the tanks, demolition of the tanks and associated vaults and the processing and packaging of this waste, decontamination and characterization of waste packages, and loading and offsite shipment of packaged waste.

Supernatant Treatment System Support Building

The STS Support Building would be demolished under the Waste Tank Farm Waste Processing Facility enclosure. Most of the second floor of the STS Support Building is uncontaminated and would be demolished in a hands-on manner. The equipment and structural components of the second floor of the STS Support Building would be surveyed and a spray fixative applied, if necessary. The equipment would be removed, characterized, packaged, and disposed of at appropriate offsite disposal facilities. After the equipment has been removed, the second floor of the structure would be demolished using a demolition machine equipped with a demolition hammer and shear. The sheet metal and structural steel would be removed, reduced in size, packaged, and disposed of at appropriate offsite disposal facilities.

The first floor of the STS Support Building includes the STS Valve Aisle, which was contaminated during STS operations. The uncontaminated portions of the first floor outside of the STS Valve Aisle would be demolished using manned demolition machines. The STS Valve Aisle would be demolished remotely. All equipment located outside of the STS Valve Aisle would be removed, packaged, and disposed of as low-specific-activity waste at an offsite disposal facility.

A spray fixative would be applied to the interior of the STS Valve Aisle. The steel shield walls and roof of the STS Valve Aisle would be removed remotely using a telescoping mast equipped with cutting, grappling, and lifting tools. The telescoping mast works mainly in the vertical direction; it employs a series of tubes that fit inside each other, and, when extended, form a mast longer than any of the individual tubes. The mast is operated hydraulically (remotely if necessary) and would be able to operate the various end attachments discussed previously. The steel shielding would be transferred to the Remote-Handled Work Cell of the Waste Tank Farm Waste Processing Facility for size reduction and packaging before being disposed of at an offsite low-level radioactive waste disposal facility. The concrete floor of the STS Valve Aisle would be demolished using the remotely operated demolition hammer attached to a telescoping mast. All demolition debris would be packaged in containers and disposed of as low-specific-activity waste at an offsite disposal facility.

Removal of Supernatant Treatment System Equipment in Tank 8D-1

An estimated 2.5 meters (8 feet) of soil overlies the vaults of Tanks 8D-1 and 8D-2, which would be removed using both manned and remotely operated excavation equipment. The soil would be packaged and disposed of as low-specific-activity waste at an offsite disposal facility. Once the soil has been removed from above the Tank 8D-1 vault, the STS equipment in Tank 8D-1 would be removed, processed, and packaged for disposal.

The four ion-exchange columns contain radioactively contaminated zeolite. The zeolite in the ion-exchange columns would be backflushed through the column J nozzles to the Liquid Waste Process Cell of the Waste Tank Farm Waste Processing Facility for processing and stabilization with grout. The zeolite/grout mixture would be placed into 208-liter (55-gallon) drums for curing. Once the mixture has cured, the drums would be transferred to the decontamination station in the Remote-Handled Work Cell. It is assumed that the stabilized zeolite will be disposed of as transuranic waste.

The STS equipment in Tank 8D-1 would be removed using a telescoping mast system. A 27-metric ton (30-ton) hoist and trolley would transport the equipment to the Remote-Handled Work Cell, where the telescoping work arm platforms equipped with cutting torches would reduce the size of the equipment for waste packaging. The packaged waste would be decontaminated in the Waste Package Decontamination Area, after which it would be transferred to the Nondestructive Assay Cell for waste characterization, as required by the waste acceptance criteria of the disposal facility. After the packages have been characterized, they would be transferred from the Nondestructive Assay Cell to the Remote-Handled Cask Loading Cell and packaged into appropriate transportation casks as required. The loaded casks would be transferred to the Transport Loading Area, where they would be loaded onto an appropriate transport trailer for shipping to a waste disposal facility.

It is assumed that the processed STS equipment would be disposed of as Class C low-level radioactive waste. Residual ion-exchange and filter media in the equipment would be transferred into waste containers for disposal.

Removal of Residual Waste from Tank 8D-1

The vault roofs and tops of Tanks 8D-1 and 8D-2 would be removed remotely before the residual inventory is removed from these tanks. The tanks would be accessed by remotely demolishing the vault roofs with the telescoping mast equipped with a demolition hammer. Grapples would be used to remove the vault debris, after which it would be packaged for offsite disposal as low-specific-activity waste. The risers would be segmented, packaged, and characterized for offsite disposal. The waste class of the riser segments is expected to range from Class A low-level radioactive to transuranic waste, depending on its location.

The carbon steel tank tops would be cut away by rigging sections of the tank tops to the Z-mast crane and cutting the sections using a torch to free the rigged section. The cut section would be transferred to the Remote-Handled Work Cell for additional size reduction and packaging using the two telescoping work arm platforms equipped with grappling equipment, torch, and saw attachments.

Any residual mobile radionuclide inventory in Tanks 8D-1 and 8D-2 would be removed using a Waste Dislodging and Conveyance System. The zeolite and solids in the bottom of Tank 8D-1 would be transferred to the liquid waste storage tanks in the Liquid Waste Process Cell using the transfer pumps and associated piping. This waste would be pumped from the storage tanks to the centrifugal dewatering system, where the solids would be separated. The solids would be transferred to the Container Fill Area of the Liquid Waste Process Cell, where they would be mixed with grout produced in the Grout Batch Plant. The solids/grout mixture would be placed into 208-liter (55-gallon) drums for curing. Once the mixture has cured, the drums would be transferred to the decontamination station in the Remote-Handled Work Cell. It is assumed that the stabilized solids would be disposed of as transuranic waste.

Tanks 8D-1 and 8D-2

Once the STS equipment and mobile waste have been removed from Tanks 8D-1 and 8D-2, the tanks would be segmented using a telescoping mast system and dual-arm work platform equipped with torch-cutting attachments. The residual radionuclide inventory associated with the tank shells of Tanks 8D-1, 8D-2, and 8D-4 would require this waste to be packaged in 208-liter (55-gallon) drums. This would require initial segmentation within the tanks, followed by additional size reduction to allow placement within the

208-liter (55-gallon) drums. After initial cutting, the tank segments would be transferred to the Remote-Handled Work Cell using the hoist and trolley system.

The tank walls, supporting columns, horizontal gridwork, and floor would be segmented and processed in a similar manner to the tops of the tanks, as described previously. The tank segments would be transferred to the Remote-Handled Work Cell for size reduction and packaging using the two telescoping work arm platforms equipped with grappling equipment, torch, and saw attachments to segment and package the waste. The waste packages would be decontaminated in the Waste Package Decontamination Area and then characterized for waste disposal in the Nondestructive Assay Cell. The waste class of the tank segments would range from Class C low-level radioactive waste (Tank 8D-1) to transuranic waste (Tank 8D-2). The waste packages would be transferred to the Remote-Handled Cask Loading Cell for loading into shipping casks followed by transfer to the Transport Loading Area, where the casks would be loaded onto trailers for shipment.

Tanks 8D-3 and 8D-4

The soil overlying the vault would be removed using the Waste Tank Farm Waste Processing Facility telescoping mast system with appropriate tools. The soil would be packaged and disposed of as low-specific-activity waste. The Waste Tank Farm Waste Processing Facility telescoping mast system would then be used to demolish the valve pit, the pump pit, and the 0.6-meter-thick (2-foot-thick) vault roof using demolition hammers or similar types of equipment. The debris would be packaged and disposed of as low-specific-activity waste. The top of Tanks 8D-3 and 8D-4 would be removed using the Waste Tank Farm Waste Processing Facility telescoping mast system with a work arm equipped with a torch. The tank tops would be transferred into the Remote-Handled Work Cell for additional segmentation, as necessary, for packaging.

The telescoping vertical mast would be used to deploy the Waste Dislodging and Conveyance System inside Tanks 8D-3 and 8D-4 to remove the mobile waste in the tanks and transfer it to the Liquid Waste Process Cell for processing and stabilization with grout. The cooling coils contained in Tanks 8D-3 and 8D-4 would then be removed using grapples and/or mechanical shear tools as required. The tank shells would be segmented with the telescoping vertical mast and dual-arm work platform equipped with torch- and shear-cutting tools. The tank segments would be transferred into the Remote-Handled Work Cell for additional size reduction and packaging. Tank 8D-3 is assumed to be Class B low-level radioactive waste based on its current estimated radionuclide inventory. Tank 8D-4 is assumed to be transuranic waste based on its current estimated radionuclide inventory.

Vaults of Tanks 8D-1, 8D-2, 8D-3, and 8D-4

After Tanks 8D-1, 8D-2, 8D-3, and 8D-4 have been removed, radiological surveys would be conducted to evaluate dose rates and levels of contamination remaining in the vaults. Depending upon the results, it may be possible to demolish the vaults using manned demolition equipment.

The perlite blocks and gravel underlying Tanks 8D-1 and 8D-2 are assumed to be removed with manned equipment such as long reach hydraulic excavators, packaged, and disposed of as low-specific-activity waste at an offsite disposal facility. The telescoping arm and dual-arm work platform equipped with a torch would be used to segment the pans in the vaults in Tanks 8D-1 and 8D-2. The pan segments would be transferred to the Remote-Handled Work Cell for additional size reduction and packaging. The tank pans are expected to be disposed of as Class A low-level radioactive waste.

Sheet piling would be driven around the tank vaults to stabilize the surrounding soil before the tank vaults are removed. The tank vaults would be demolished using either manned hydraulic excavators or a remotely telescoping arm and dual-arm work platform equipped with a demolition hammer. The vault debris would be packaged and disposed of as low-specific-activity waste at an offsite disposal facility. The soil beneath the vaults would be surveyed, and any contaminated soil with radioactivity concentrations exceeding the established DCGLs or other applicable criteria would be removed.

C.3.1.3.2 Removal of Waste Tank Pumps and Pump Support Structures

Tank 8D-1 contains five high-level radioactive waste mobilization pumps, and Tank 8D-2 contains four of these centrifugal pumps. Each pump is approximately 2.4 meters (8 feet) long and is supported by a 25.4-centimeter (10-inch) stainless steel pipe column that is 15.2 meters (50 feet) long.

Tanks 8D-1, 8D-2, and 8D-4 each contain a high-level radioactive waste transfer pump. These centrifugal multistage turbine type pumps are each supported by a 35.6-centimeter (14-inch) pipe column, with an overall length of more than 15.2 meters (50 feet) for tanks 8D-1 and 8D-2 and approximately 6 to 8 meters (20 to 25 feet) in length for Tanks 8D-3 and 8D-4. Like the mobilization pumps, the transfer pumps were driven by 150-horsepower electric motors. Tanks 8D-1 and 8D-2 also contain an STS suction pump, which is assumed to be the same size as the transfer pumps.

The mobilization, transfer, and STS suction pumps are radiologically contaminated. The transfer and suction pumps will likely have more contamination that the mobilization pumps because high-level radioactive waste passed through the entire length of these pumps, rather than impacting only the lower portions of the latter.

Each one of the pumps would be removed using appropriate radiological controls. The pumps would be cut into sections during removal and packaged for disposal in the field. It is assumed that some portions of the pumps would be classified as low-level radioactive waste and others as transuranic waste.

The methods and controls needed for safe removal of the pumps have been demonstrated with the previous pump removals; however, the segmenting methods and controls have not been demonstrated. The pumps would have to be segmented to fit inside of waste containers for eventual offsite disposal.

The pump support structures would be removed in connection with removal of the pumps and the material disposed of off site as construction and demolition debris.

C.3.1.3.3 Removal of High-Level Waste Transfer Trench Piping

The High-Level Waste Transfer Trench itself is not expected to be radiologically contaminated because the piping did not leak and contamination has not been detected in water collected in the trench.

Using appropriate radiological controls, the piping would be cut into sections, packaged, and transported to an offsite low-level radioactive waste disposal facility for disposal as Class A low-level radioactive waste. The piping and other equipment in the pits would also be cut into sections and disposed of in this manner, coordinated with removal of the waste tank pumps.

After the piping has been removed, radiological surveys would be performed in the empty transfer trench and it would be demolished and disposed of off site as uncontaminated construction and demolition debris.

C.3.1.3.4 Demolition of the Permanent Ventilation System Building

The equipment inside the Permanent Ventilation System Building would be removed, packaged, and disposed of, and the building would be demolished through the use of a front-end loader and other concrete demolition equipment. Demolition would include both the superstructure and all concrete slabs and foundations associated with it. All demolished equipment would be disposed of as low-specific-activity waste, with the exception of the ventilation system media, which would be packaged and disposed of as Class A low-level radioactive waste.

Upon completion of the foundation demolition and removal of any remaining waste materials, a final status survey would be performed over the footprint of the building, and arrangements would be made for any necessary independent verification surveys. After the surveys have been performed and any necessary sampling and analysis of constituents of concern have been completed, the disturbed area would be graded and filled with appropriate clean backfill material, as needed.

C.3.1.3.5 Demolition of the Equipment Shelter and Condensers

Any remaining liquid would be drained from the system. The equipment would be removed, packaged, and disposed of off site as Class A low-level radioactive waste. The structure would be demolished without containment using conventional methods, with the floor slab and impacted soil removed, as needed. As with other remediation areas, DCGLs would be used to determine the extent of contaminated soil removal. The demolition debris would be disposed of off site as uncontaminated construction and demolition debris.

Arrangements would be made for any necessary independent verification surveys. After the surveys have been performed and any necessary sampling and analysis of constituents of concern have been completed, the excavation would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.3.6 Demolition of the Con-Ed Building

The structure would be demolished without containment using conventional methods, with the floor slab and impacted soil removed, as needed. As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal. The demolition debris would be disposed of off site as uncontaminated construction and demolition debris.

Arrangements would be made for any necessary independent verification surveys. After the surveys have been performed and any necessary sampling and analysis of constituents of concern have been completed, the excavation would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.3.7 Decontamination and Demolition of the Waste Tank Farm Waste Processing Facility

Portions of the Waste Tank Farm Waste Processing Facility and its associated equipment would become contaminated while supporting the closure of the Waste Tank Farm Area. The interior of the Waste Tank Farm Waste Processing Facility would be surveyed to assess contamination levels associated with building surfaces and equipment. A spray fixative would be applied to the external surfaces of equipment and the internal surfaces of the walls and ceiling of the Waste Tank Farm Waste Processing Facility. Equipment and stainless steel liners would be dismantled, reduced in size, packaged, and disposed of at an offsite radioactive waste disposal facility.

The Waste Tank Farm Waste Processing Facility would be demolished after the post-excavation survey has been completed, with the resulting excavation filled with appropriate clean backfill material. The enclosure would be demolished using conventional demolition equipment, such as hydraulic excavators equipped with demolition hammers and shears. The demolition debris would be packaged as low-specific-activity waste and transported to an offsite radioactive waste disposal facility.

Once the facility has been removed, any contaminated soil generated during demolition would be removed and disposed of as low-specific-activity waste. A final status survey would be performed in the area impacted by demolition of the enclosure to establish that residual radioactivity levels do not exceed the established DCGLs.

After the survey is complete, additional appropriate clean backfill material would be placed and the area graded to a near natural appearance.

C.3.1.3.8 Site Restoration

Removal of Tanks 8D-1, 8D-2, 8D-3, and 8D-4 and their associated vaults would result in a large excavation under the Waste Tank Farm Waste Processing Facility. Post-excavation surveys would be performed before the Waste Tank Farm Waste Processing Facility is demolished to verify that residual radioactivity levels do not exceed the established DCGLs and that concentrations of RCRA hazardous constituents are below guidance limits. After the surveys are complete, the excavation would be filled with appropriate clean backfill material under the confinement provided by the Waste Tank Farm Waste Processing Facility.

C.3.1.3.9 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 3 are presented in **Table C–17**. The estimate includes the Waste Tank Farm Waste Processing Facility construction, operation, and demolition.

Table C–17 Estimated Waste to be Generated: Waste Management Area 3 [a]

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	120,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	2,100,000
Class A	66,000
Class B	870
Class C	8,500
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	11,000

[a] If the waste incidental to reprocessing process is not applied to the high-level radioactive waste storage tanks and waste residuals in the tanks, under the Sitewide Removal Alternative approximately 500 cubic meters (18,000 cubic feet) of waste would be added to the inventory of high-level radioactive waste already stored on site, and the amount of low-level radioactive waste and transuranic waste shown in this table would be reduced by about 210 cubic meters (7,500 cubic feet) and 280 cubic meters (10,000 cubic feet), respectively. For Phase 1 of the Phased Decisionmaking Alternative, approximately 51 cubic meters (1,800 cubic feet) of waste would be added to the inventory of high-level radioactive waste, and the amount of low-level radioactive waste and transuranic waste would be reduced by about 32 cubic meters (1,100 cubic feet) and 19 cubic meters (670 cubic feet), respectively.

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.

Source: WSMS 2009a.

C.3.1.4 Waste Management Area 4: Construction and Demolition Debris Landfill

The Sitewide Removal Alternative closure approach for WMA 4 is exhumation of the CDDL and restoration of the surface to a natural contour.

C.3.1.4.1 Exhumation of the Construction and Demolition Debris Landfill

The overburden of the CDDL would be excavated and the wastes exhumed with a hydraulic excavator. Soil would be transported to a new Soil Drying Facility, described in Section C.4.3, for processing before being sampled for characterization, packaged into containers, and transported as low-specific-activity waste to an offsite disposal facility.

Buried wastes would be exhumed in a slow, deliberate manner, paying close attention to the characteristics of the wastes being unearthed. Wastes deemed to be free of hazardous constituents, such as construction debris, typically would be placed into appropriate containers, sampled, and transported as low-specific-activity waste for disposal. When oversized materials are encountered, a hydraulic excavator equipped with a shear would be used within the excavation to cut them into pieces, as necessary, to prepare them for packaging.

Wastes that could contain hazardous waste, such as paint cans and batteries, would be segregated from the other wastes, characterized, and packaged in 208-liter (55-gallon) drums for disposal. Some of this waste is assumed to be disposed of as mixed low-level radioactive waste.

Site restoration work would occur after the North Plateau Groundwater Plume has been excavated. After the waste and any contamination have been removed from WMA 4, a final status survey would be performed to verify that residual radioactivity levels do not exceed the established DCGLs. An independent verification survey may be required. After the verification survey is complete and any necessary confirmatory sampling of RCRA constituents of concern has been performed, the area would be filled with appropriate clean backfill material and then contoured to grade.

C.3.1.4.2 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 4 are presented in **Table C–18**.

Table C–18 Estimated Waste to be Generated: Waste Management Area 4

Waste Type	***Waste Volume (cubic feet)***
Construction and Demolition Debris	0
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	800,000
Class A	2,900
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	2,000
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.5 Waste Management Area 5: Waste Storage Area

The Sitewide Removal Alternative approach to closing WMA 5 includes demolition of Lag Storage Area 4 and the associated Shipping Depot, the Remote-Handled Waste Facility, and the Construction and Demolition Area; removal of all remaining concrete floor slabs; and disposal of demolition debris, waste, and contaminated soils at appropriate offsite disposal facilities.

C.3.1.5.1 Demolition of Lag Storage Area 4

The structures would be demolished without confinement, and the floor slabs and foundations and impacted surrounding soil would be removed, as needed. As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal. The demolition debris and soil would be disposed of off site as construction and demolition debris. After completion of this work, a final status survey would be performed in the excavated area. After completion of removal of any contaminated soil found and the associated surveys of the area are performed, arrangements would be made for an independent verification survey. After the surveys have been completed and any necessary confirmatory sampling of RCRA constituents of concern has been performed, the excavations would be filled with appropriate clean backfill material and then contoured to grade.

C.3.1.5.2 Demolition of the Remote-Handled Waste Facility

Closure of the facility under an NYSDEC-approved RCRA closure plan would be coordinated with other demolition requirements. The Remote-Handled Waste Facility would be demolished by conventional methods without confinement after it has completed processing all equipment and waste requiring remote handling and characterization. Demolition of the structure would include removal of the underground tank vault; the rest of the building would be taken down, including subgrade structures and foundations.

The majority of the Remote-Handled Waste Facility would be classified as low-specific-activity waste. The office structure would be characterized as construction and demolition debris. The underground Waste Transfer Lines to Tank 8D-3 in WMA 3 would be grouted, removed, and disposed of as Class A low-level radioactive waste.

As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal. After completion of this work, a final status survey would be performed in the excavated area and arrangements made for any necessary independent verification surveys. RCRA confirmatory sampling would also be performed. After completion of the surveys and sampling, the excavated area would be filled with appropriate clean backfill material and contoured to grade.

Removal of the Construction and Demolition Area

Surface soils, as well as any remaining concrete debris, would be excavated and removed from the construction and demolition area and disposed of off site. The excavated material would be packaged and characterized for disposal. It is assumed to be classified as construction and demolition debris and would be disposed of at a local sanitary landfill or construction and demolition debris landfill.

Upon completion of the excavation, a final status survey would be performed in the excavated area, and arrangements would be made for any necessary independent verification surveys. After the surveys have been performed and any necessary sampling and analysis of RCRA constituents of concern have been completed, the excavation would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.5.3 Removal of Remaining Floor Slabs, Foundations, and Gravel Pads

All remaining concrete floor slabs and foundations would be removed, including those associated with the Lag Storage Building, Lag Storage Area 1, and Lag Storage Area 3. The Lag Storage Area 2 Hardstand would also be removed, along with the gravel pads associated with the Chemical Process Cell Waste Storage Area, hazardous waste storage lockers, the Cold Hardstand Area, Vitrification Vault and Empty Container Hardstand, Old/New Hardstand Area, and Lag Hardstand.

The floor slabs, foundations, hardstands, and gravel pads would be demolished by conventional means. As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal. The demolition debris would be disposed of as uncontaminated construction and demolition debris.

A final status survey would be performed in the excavated areas. Soil with radioactivity concentrations exceeding the DCGLs would be removed and disposed of as low-specific-activity waste and the areas resurveyed. Arrangements would be made for independent verification surveys. After all of the surveys have been completed and any necessary confirmatory sampling of RCRA constituents of concern has been performed, the excavations would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.5.4 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 5 are presented in **Table C–19**.

Table C–19 Estimated Waste to be Generated: Waste Management Area 5

Waste Type	***Waste Volume (cubic feet)***
Construction and Demolition Debris	190,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	100,000
Class A	32,000
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.6 Waste Management Area 6: Central Project Premises

Under the Sitewide Removal Alternative, the Rail Spur, Demineralizer Sludge Ponds, Equalization Basin, Equalization Tank, Low-Level Waste Rail Packaging and Staging Area, Sewage Treatment Plant, and South Waste Tank Farm Area Test Tower would be removed, along with the remaining concrete floor slabs and foundations, asphalt pads, and gravel pads. Any contaminated soil, sediment, and groundwater in the area would be remediated to levels supporting unrestricted release.

C.3.1.6.1 Removal of Structures/Facilities

Rail Spur

The Rail Spur rail and ties would be removed and disposed of as construction and demolition debris. A small portion, about 700 square meters (7,500 square feet), of the Rail Spur ballast would be disposed of as low-specific-activity waste. The remaining uncontaminated ballast (approximately 92 cubic meters [3,290 cubic feet]) would be disposed of as construction and demolition debris.

Demineralizer Sludge Ponds

The ponds would be excavated to a total depth of approximately 1.6 meters (5 feet), with the material removed being disposed of off site as low-specific-activity waste. After completion of this work, a final status survey would be performed in the excavated areas. Soil with radioactivity concentrations exceeding DCGLs would be removed and the areas resurveyed. Arrangements would be made for any necessary independent verification surveys. RCRA confirmatory sampling would also be performed. After completion of the surveys and sampling, the excavated areas would be filled with appropriate clean backfill material and contoured to grade.

Equalization Basin

The Equalization Basin liner, as well as any impacted subgrade soil, would be removed and disposed of off site. As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal. After completion of this work, a final status survey would be performed in the area and arrangements made for any necessary independent verification surveys. RCRA confirmatory sampling would also be performed. After completion of the surveys and sampling, the area would be filled with appropriate clean backfill material and contoured to grade.

Equalization Tank

The Equalization Tank would be demolished using conventional methods, and the resulting material would be disposed of off site as construction and demolition debris. As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal. After completion of this work, a final status survey would be performed in the area and arrangements would be made for an independent verification survey. RCRA confirmatory sampling would also be performed. After completion of the surveys and sampling, the excavated area would be filled with appropriate clean backfill material and contoured to grade.

Low-Level Waste Rail Packaging and Staging Area

The Low-Level Waste Rail Packaging and Staging Area would be removed, and the demolition debris would be disposed of off site or staged on site for beneficial use. The concrete pads of the loading dock and preparation area would be demolished, and the demolition debris would be directly packaged for offsite transport and disposal. Although radioactive materials were managed in these areas, the concrete debris is not expected to be radiologically contaminated. It is assumed that the debris would be classified as construction and demolition debris and would be disposed of at a construction and demolition debris landfill or sanitary landfill.

The stone base below the concrete is also not expected to be contaminated and would be staged on site to be used for beneficial purposes (e.g., temporary haul road construction) or used as backfill for nearby excavation areas.

Upon completion of the pad demolition and excavation and removal of the stone base, a final status survey would be performed in the excavated area, and arrangements would be made for any necessary independent verification surveys. After the surveys have been performed and any necessary sampling of RCRA constituents of concern have been completed, the disturbed area would be filled with appropriate clean backfill material and contoured to grade, as needed.

Sewage Treatment Plant

This facility and the underground concrete tanks would be completely removed using conventional demolition methods. The concrete foundation would be removed, as well as impacted subgrade soils. As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal. It is assumed that the demolition debris would be disposed of off site as construction and demolition debris. Any removed soil with radioactivity concentrations that exceed the DCGLs would be disposed of as low-specific-activity waste.

After completion of this work, a final status survey would be performed in the excavated area and arrangements made for any necessary independent verification surveys. After completion of the surveys and any necessary confirmatory sampling of RCRA constituents of concern, the excavated area would be filled with appropriate clean backfill material and contoured to grade.

South Waste Tank Farm Test Tower

This test tower would be removed using conventional demolition methods, and the debris would be disposed of off site as construction and demolition debris. After completion of this work, a final status survey would be performed in the excavated area and arrangements made for any necessary independent verification surveys. RCRA confirmatory sampling would also be performed. After completion of the surveys and sampling, the excavated area would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.6.2 Removal of Remaining Floor Slabs and Foundations

The remaining floor slabs and foundations in the area, including the underground structure of the Cooling Tower, would be removed and disposed of as low-specific-activity waste, and impacted surrounding soils would be removed, as needed. As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal. After completion of this work, a final status survey would be performed in each excavated area and arrangements made for any necessary independent verification surveys. RCRA confirmatory sampling would also be performed. After completion of the surveys and sampling, the excavated areas would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.6.3 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 6 are presented in **Table C–20**.

Table C–20 Estimated Waste to be Generated: Waste Management Area 6

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	76,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	42,000
Class A	100
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.7 Waste Management Area 7: NRC-Licensed Disposal Area and Associated Facilities

The Sitewide Removal Alternative closure approach for WMA 7 would include exhumation of all buried wastes in the NDA and removal of the Liquid Pretreatment System and the Interceptor Trench, along with the buried leachate transfer line, the former lagoon, and the remaining concrete slabs and gravel pads associated with the NDA Hardstand Staging Area. All contaminated soil, sediment, and groundwater in the area would be remediated to levels supporting unrestricted release.

A new Leachate Treatment Facility, as described in Section C.4.5, would be designed and constructed on the South Plateau near SDA Trench 14 to process the aqueous leachate in the holes and trenches in the NDA and in the trenches in the SDA. It would be capable of accepting the leachate, removing organic chemicals that might be present by biological degradation and adsorption, removing entrained solids by filtration, and removing dissolved radionuclides by ion-exchange before transferring the treated water to the Low-Level Waste Treatment Facility for final treatment and discharge.

A new Container Management Facility, as described in Section C.4.4, would be designed and constructed to process the wastes excavated from the NDA and the SDA. It would be capable of receiving the wastes in an "as excavated" form, drying them, sorting them, reducing the size of larger items, recompacting wastes that were "bulked-up" during excavation, packaging them, decontaminating the packages, classifying them, and temporarily storing them. This facility may require an RCRA treatment and storage permit because some of the excavated wastes may be mixed low-level radioactive waste.

C.3.1.7.1 Removal of Structures/Facilities

The NDA Interceptor Trench would be excavated; the excavated soil and stone would be packaged for transport off site for disposal as low-specific-activity waste.

The Leachate Transfer Line could be excavated any time after a decision is made that the Liquid Pretreatment System of the Interceptor Trench Project is not needed or would no longer be needed to support treatment of leachate from the NDA. The debris would be characterized and shipped off site for disposal as low-specific-activity waste. The filled lagoon would be excavated when the special holes surrounding it are excavated.

C.3.1.7.2 Exhumation of Nuclear Fuel Services Deep Holes

The NDA deep holes and special holes contain highly radioactive waste that would be classified as Class C low-level radioactive waste or Greater-Than-Class C waste. A confinement structure, called the NDA Environmental Enclosure, would be constructed over all waste burial holes in WMA 7 suspected of containing wastes classifiable as being greater than Class A low-level radioactive waste. Therefore, it would be constructed over the NFS deep holes, the NFS special holes, and WVDP Trenches 1 through 7. The conceptual NDA Environmental Enclosure is discussed in Section C.4.6.1.

The upper layer of weathered overburden, approximately 1.2 meters (4 feet), would be excavated. This soil would be stockpiled to be used as temporary backfill material for the excavated deep holes.

As each deep hole is being prepared for excavation, sheet piling would be driven around it to a depth of approximately 3 meters (10 feet) below the base of the planned excavation. The sheet piling would provide structural support for the surrounding till during the excavation process. A crane would then be used to position the specially designed Modular Shielded Environmental Enclosure over the sheet piling. The Modular Shielded Environmental Enclosure is further described in Section C.4.6.8.

The Modular Shielded Environmental Enclosure would be equipped with a HEPA-filtered ventilation system operated at a slight vacuum compared with the ambient atmosphere within the NDA Environmental Enclosure and serve as the primary confinement structure for excavation work. The Modular Shielded Environmental Enclosure would provide secondary confinement against airborne emissions and shield against high-radiation fields.

Excavation of the deep holes and removal of the wastes would be accomplished using a telescoping Z-mast crane system. Visibility would be provided by closed-circuit television cameras. Hoisting equipment, independent from the remotely operated crane system, would be used within the Modular Shielded Environmental Enclosure. This equipment would include a bridge, trolley, and hoist to provide three-dimensional movement of materials within the Modular Shielded Environmental Enclosure and the hole over which it is located. Using the remotely operated crane system and the Modular Shielded Environmental Enclosure hoist, all the material bounded within the sheet piling would be systematically excavated.

Soil that was backfilled over the waste would be removed, to the extent possible, using an excavation bucket. Loose soil would be removed, whenever possible, by use of a vacuuming system. As the soil is brought to the surface, it would be placed into appropriate containers. Contaminated overburden soil would be placed into lift liners and sealand containers or railcars and managed as low-specific-activity waste. Interstitial soil and soil removed from the sides of the holes would be placed into 208-liter (55-gallon) drums because subsequent assay work could determine that they are Greater-Than-Class C wastes. To prevent accumulation of any liquid water in the drums, an absorbent or cementitious material, such as calcium oxide, would be placed into the bottoms of the drums and would be intermingled with the wastes as they are placed into the drums. The drums would be remotely closed, wiped down using the master-slave manipulators, and removed from the Modular Shielded Environmental Enclosure through a sealed load-in/load-out system. The loaded drum would then be transported to the Container Management Facility for characterization, interim storage, and shipment off site for disposal.

Leachate encountered during the exhumation process would be pumped to the Leachate Treatment Facility for treatment.

Buried waste would be removed using a manipulator or grapple on the Z-mast, together with a bucket and hook on the chain hoist. The retrieved wastes would be packaged in 208-liter (55-gallon) drums before being removed from the Modular Shielded Environmental Enclosure.

Whenever exposure levels immediately outside the Modular Shielded Environmental Enclosure become greater than 50 millirem per hour, operations would be performed remotely. To keep radiation exposures as low as is reasonably achievable (ALARA), remote operation could be performed until less-intense radiation fields are encountered. Conceptually, the Control Room for the remote operations would be located in the Container Management Facility, with observation capabilities provided by closed-circuit television cameras inside the Modular Shielded Environmental Enclosure and on excavation equipment lowered into the hole or trench.

After all the waste has been retrieved from a hole, contamination on the interior surfaces of the Modular Shielded Environmental Enclosure would be removed by remote wiping or immobilized with a spray-on fixative. The Modular Shielded Environmental Enclosure would then be removed from over the hole and positioned over the next hole to be excavated. After the Modular Shielded Environmental Enclosure has been removed, the sheet piling would be extracted for reuse and some of the stockpiled weathered till would be used to temporarily backfill the hole.

C.3.1.7.3 Exhumation of Nuclear Fuel Services Special Holes

Exhumation of the NFS special holes would be done under confinement provided by the NDA Environmental Enclosure. Each special hole would be excavated under a HEPA-filter ventilated confinement structure within the NDA Environmental Enclosure. This temporary confinement structure would provide the primary confinement for the excavation work. The NDA Environmental Enclosure would provide secondary confinement. Special holes containing Greater-Than-Class C wastes would be excavated under a Modular Shielded Environmental Enclosure, as described in the preceding section for the deep holes. For those special holes that do not contain Greater-Than-Class C wastes, a tent-like containment structure would be erected over the hole or group of holes.

The upper layer of weathered overburden, approximately 1.2 meters (4 feet) in thickness, would be excavated. This soil would be placed into appropriate containers, sampled for characterization purposes, and transported to a low-level radioactive waste disposal facility for disposal as low-specific-activity waste.

The first special hole would be opened by excavating a vehicle access ramp at the end of the special hole down to the floor level of the hole. Leachate, as encountered, would be transferred to the Leachate Treatment Facility for treatment and discharge.

The first special hole or trench under the temporary confinement structure would then be excavated from the side using appropriate excavation equipment. Whenever exposure levels greater than 50 millirem per hour are encountered, remotely operated excavation equipment would be used.

Depending upon moisture content, the bucket loads of soil would be transported to the Container Management Facility to be dried or would be sampled and placed directly into appropriate containers.

The bucket loads of waste or waste commingled with soil would be placed into covered transfer boxes. The boxes would be wiped down and transported to the Container Management Facility. At the Container Management Facility, the waste would be unloaded, dried, sorted, reduced in size and volume, and packaged. The packages would be decontaminated, characterized, and prepared for shipment.

Items of waste that are too large to be handled using an excavator bucket would be unearthed as much as possible and segmented with an oxygen lance-style cutting torch. During cutting operations, a localized roughing filter and HEPA filter ventilation system would be applied to prevent spread of airborne contamination. Should the exposure levels be greater than 50 millirem per hour, segmenting would be performed remotely using an oxygen lance-style cutting torch mounted on a roving robot.

For items expected to be classified as Greater-Than-Class C waste that cannot be processed within a Modular Shielded Environmental Enclosure, the segments would be placed into 208-liter (55-gallon) drums, which would be closed, remotely wiped down using the roving robots, then transferred to the Container Management Facility, where the drums would be characterized and stored until disposition decisions are made and implemented. For other large items, such as the railroad car in Special Hole 72, the segments would be placed into appropriate containers, which would subsequently be closed, wiped down, and transferred to the Container Management Facility, where the containers would be characterized and prepared for shipment.

Leachate encountered during the excavation process would be pumped to the Leachate Treatment Facility for treatment, followed by transfer to the Low-Level Waste Treatment Facility for final treatment and discharge.

After each special hole or trench has been excavated, the wall between it and an adjacent special hole or trench would be excavated—this soil would be handled as contaminated or potentially contaminated soil. The same access ramp would therefore be used for all special holes and trenches excavated within the temporary confinement structure.

After all the special holes under the temporary confinement structure have been excavated, the temporary confinement structure would be dismantled and then re-erected over the next series of special holes to be excavated.

C.3.1.7.4 Exhumation of West Valley Demonstration Project Burial Trenches

Because WVDP Trenches 1 through 5 contain wastes classifiable as being greater than Class A low-level radioactive waste, these trenches would be excavated under the NDA Environmental Enclosure. The configuration of the NDA Environmental Enclosure would also cover WVDP Trenches 6 and 7, which are in close proximity to Trenches 1 through 5. WVDP Trenches 8 through 12 would be excavated under a less-robust structure called the WVDP Disposal Area Environmental Enclosure, which is discussed in Section C.4.6.2.

The wastes in WVDP Trenches 1 through 7 would be exhumed in the same manner as the NFS special holes, as described in the preceding section.

After all the trenches have been excavated, the remaining surrounding till would be excavated. Anticipating that this soil would be classified as low-specific-activity waste, it was assumed to be sampled and placed into appropriate containers. The samples would be analyzed to verify and document the waste classification. All waste generated would be disposed of as described in Chapter 4, Section 4.1.11. Transuranic and Greater-Than-Class C waste volumes are shown in Table C–21.

After all the adjacent trenches have been excavated, one large excavation cavity would remain. A final status survey would be performed in this excavation before it is filled with appropriate clean backfill material. The WVDP Disposal Area Environmental Enclosure would be decontaminated and dismantled, the foundations would be demolished, and the debris would be disposed of as low-level radioactive waste.

C.3.1.7.5 Exhumation of West Valley Demonstration Project Caissons

Any leachate present in the WVDP caissons would be pumped to the Leachate Treatment Facility for treatment and discharge before any waste removal activities begin.

WVDP disposal records indicate that approximately 23 cubic meters (823 cubic feet) of waste in drums is present in Caisson 1. The disposal records do not indicate that waste was placed in Caissons 2 through 4. If possible, the drums would be removed intact using a crane and associated grappling attachment. If necessary, the waste would be removed from the caisson using a crane and an excavation bucket. As the waste is brought to the surface, the drums would be inspected. If intact, they would be overpacked and transported to the Container Management Facility for classification and shipment for disposal. If not intact, the debris and waste soil would be placed into appropriate containers, which would be closed, decontaminated, and transported to the Container Management Facility for classification and shipment for disposal. After the waste has been removed from a caisson, the floor of the caisson would be inspected using a closed-circuit television camera lowered by a crane. If waste is found to be present in Caissons 2 through 4, it would be removed and managed in a similar manner. After all the waste has been retrieved from a caisson, it would be demolished and disposed of off site as low-specific-activity waste.

C.3.1.7.6 Site Restoration

Large excavations would remain after the deep holes, special holes, trenches, and caissons have been exhumed. As a final step, all of the contaminated soil from the vicinity of the holes, as well as the cap material used for the temporary barrier, would be excavated and disposed of as low-specific-activity waste. The resulting "crater" would then be surveyed and filled. A final status survey would be performed in these excavations to verify that residual radioactivity levels do not exceed the established DCGLs. Similarly, chemical sampling would be performed to verify that all hazardous constituents are below acceptable regulatory guidance values. An independent verification survey may also be performed. After the verification survey is complete, the area would be backfilled with appropriate clean backfill material and contoured to grade.

C.3.1.7.7 Closure of Environmental Enclosures and Hydraulic Barriers

Demolition of NRC-Licensed Disposal Area Environmental Enclosure and West Valley Demonstration Project Disposal Area Environmental Enclosure

The HEPA filters from the ventilation systems of the NDA Environmental Enclosure and the WVDP Disposal Area Environmental Enclosure would be removed by bag-out procedures, wrapped in polyethylene or equivalent material, and loaded into a container as radioactive waste. The ventilation system equipment would then be selectively demolished, loaded into appropriate containers, and transferred to the Container Management Facility for characterization and shipment for disposal as low-specific-activity waste.

The interior surfaces of the NDA Environmental Enclosure and the WVDP Disposal Area Environmental Enclosure are expected to be slightly contaminated. Therefore, they would be thoroughly surveyed and a spray fixative applied, as necessary, to allow demolition of the structure without confinement. The enclosure would be manually demolished with conventional equipment such as hydraulic hammers and backhoes. The debris would be surveyed and sampled for characterization purposes, placed into appropriate containers, and then shipped off site for disposal as low-specific-activity waste.

Verification Surveys, Backfilling, and Landscaping

Once the enclosures and below-grade hydraulic barriers have been removed, any contaminated soil generated during demolition would be removed and disposed of as low-specific-activity waste. A final status survey would be performed in the area impacted by demolition of the enclosure and excavation of the NDA barrier wall to establish that residual radioactivity levels do not exceed the established DCGLs. Because there is a possibility of removing mixed low-level radioactive waste from the NDA burial areas, confirmatory soil samples would likely be collected and analyzed for constituents of concern. RCRA confirmatory sampling would also be performed. Once all the required surveys and sampling have been completed, clean soil backfill would be placed and the area graded to a near natural appearance.

C.3.1.7.8 Disposal of Equipment

The used equipment would include, among other items, the Modular Shielded Environmental Enclosures; manually and remotely operated excavators; two or more remotely operated roving robots with closed-circuit television cameras, a cutting torch, or both; and multiple overhead crane systems. This equipment would be reduced in size, boxed, and disposed of at an offsite low-level radioactive waste disposal facility.

C.3.1.7.9 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 7 are presented in **Table C–21**. The estimate includes the construction and demolition of all structures other than the Leachate Treatment Facility and the Container Management Facility supporting the exhumation activities in WMA 7. **Table C–22** provides the estimated waste to be generated from the construction, operation, and demolition of the Leachate Treatment Facility and the Container Management Facility, which would be constructed to support the waste processing activities in the NDA and SDA.

Table C–21 Estimated Waste to be Generated: Waste Management Area 7

Waste Type	***Waste Volume (cubic feet)***
Construction and Demolition Debris	200,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	7,300,000
Class A	340,000
Class B	55,000
Class C	23,000
Greater-Than-Class C Waste	75,000
Mixed Low-level Radioactive Waste	310
Transuranic Waste	1,100

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

Table C–22 Estimated Waste to be Generated: Leachate Treatment Facility and Container Management Facility

Waste Type	***Waste Volume (cubic feet)***
Construction and Demolition Debris	150,000
Hazardous Waste	0
Low-Level Radioactive Waste	
Low Specific Activity	370,000
Class A	200,000
Class B	0
Class C	1,100
Greater Than Class C Waste	0
Mixed Low-Level Radioactive Waste	14,000
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.8 Waste Management Area 8: State-Licensed Disposal Area and Associated Facilities

Removal of WMA 8 would be performed under a negotiated closure plan approved by the NYSDEC Hazardous Waste and Radiation Programs. This closure plan would satisfy RCRA closure and corrective action requirements and Radiation Program requirements under 6 NYCRR Part 380. Preparatory characterization and design work would be performed and applications would be made for the necessary regulatory approvals.

The Sitewide Removal Alternative closure approach for WMA 8 would be similar to that for the NDA. The buried waste in the SDA would be removed; the Mixed Waste Storage Facility would be removed; and all contaminated soil, sediment, and groundwater in the area would be remediated to levels supporting unrestricted release.

A new Leachate Treatment Facility, as described in Section C.4.5, would be constructed on the South Plateau near SDA Trench 14 to process the aqueous leachate in the trenches in the SDA and in the holes and trenches in the NDA. A new Container Management Facility would be constructed, as described in Section C.4.4, on the South Plateau near the Rail Spur to process the wastes excavated from the SDA and NDA.

C.3.1.8.1 Removal of Structures/Facilities

Mixed Waste Storage Facility

Tanks T-1, T-2, and T-3 and associated equipment in the Mixed Waste Storage Facility would be reduced in size and disposed of offsite. Tank T-1 could be disposed of as either Class A low-level radioactive waste or mixed low-level radioactive waste.[1] It is assumed that Tanks T-2 and T-3 would be disposed of as construction and demolition debris because they were never used. However, these tanks may be sold or recycled. The Mixed Waste Storage Facility would be demolished with the debris packaged, characterized, and shipped offsite for disposal.

C.3.1.8.2 Exhumation of State-Licensed Disposal Area Trenches in the South Disposal Area

Removal of the SDA trenches in the South Disposal Area would include the following activities: (1) construction of an environmental enclosure over the southern SDA trenches; (2) leachate management and treatment using the Leachate Treatment Facility; (3) management, treatment, packaging, and characterization of excavated waste in the Container Management Facility; and (4) demolition and disposal of support facilities used during the removal. These activities are discussed in greater detail in the following paragraphs.

The South SDA Environmental Enclosure would be constructed over Trenches 8 through 14, which are known to contain wastes classifiable as greater than Class A low-level radioactive waste. This structure is discussed in Section C.4.6.3.

The existing fabric geomembrane, approximately 1.2 meters (4 feet) of earthen cap material, and approximately 1.2 meters (4 feet) of adjacent weathered till, would be excavated. This soil would be placed into appropriate containers, sampled for characterization purposes, and transported to a commercial low-level radioactive waste disposal facility. Generally, this material is expected to be classified as low-specific-activity waste.

A Modular Shielded Environmental Enclosure would be constructed inside the South SDA Environmental Enclosure. As each trench is being prepared for excavation, sheet piling would be driven around it to a depth of approximately 3 meters (10 feet) below the base of the planned excavation, using a drop hammer or single-acting diesel hammer. A crane would then be used to position each of the panels of the specially designed Modular Shielded Environmental Enclosure onto the sheet piling and over the trench to create the enclosure, as described in Section C.4.6.8.2.

Excavation of the trenches and removal of the wastes would be accomplished using a remotely operated Z-mast crane system. Visibility would be provided using closed-circuit television cameras. A tool appropriate for the work to be performed would be attached remotely to the excavator arm. The tools available for use would include, but would not necessarily be limited to, a standard bucket, proclain bucket, grapple, parallel jaw

[1] Tank T–1 may be removed prior to the starting point of this EIS. For purposes of analysis in this EIS, Tank T-1 is included in the inventory of low-level radioactive waste.

grippers, and shear. The standard bucket would be used, as appropriate, to remove cap and overburden material from over the trenches. The standard bucket would be used to remove loose materials from the trenches. The grapple would be used to remove objects from the trenches. The shear would be used to reduce the size of objects within the trenches to facilitate removal. The Z-mast crane would be able to extend to the bottom of the 6-meter-deep (20-foot-deep) trenches and would be able to operate effectively when the arm is fully extended.

Using the Z-mast crane, all the material bounded within the sheet piling would be systematically excavated. Material brought to the surface would be placed into appropriate containers and transferred to the Container Management Facility for processing, packaging, characterization, and transport off site.

Leachate encountered during the excavation process would be pumped to the Leachate Treatment Facility. The treated leachate would be directed to the existing Low-Level Waste Treatment Facility for final treatment and discharge at the permitted outfall from Lagoon 3 to Erdman Brook.

Because leachate is expected to have transferred some contaminants into the surrounding till, the excavations would extend both laterally to the sheet piling placed around the trench and down a short distance below the original bottom of the trench.

Whenever exposure levels immediately outside the Modular Shielded Environmental Enclosure become greater than 50 millirem per hour, operations would be performed remotely. To keep radiation exposures ALARA, remote operation would be performed until less-intense radiation fields are encountered. Conceptually, the Control Room for the remote operations would be located in the Container Management Facility, with observation capabilities provided by closed-circuit television cameras inside the Modular Shielded Environmental Enclosure and on excavation equipment lowered into the trench.

After all the waste has been retrieved from a trench, the interior surfaces of the Modular Shielded Environmental Enclosure would be decontaminated to the maximum reasonable extent by remote wiping. The Modular Shielded Environmental Enclosure would be removed from over the trench and positioned over the next trench to be excavated. After the Modular Shielded Environmental Enclosure has been removed, the sheet piling would be extracted and retained for reuse.

The soil between the trenches would be excavated and disposed of as low-specific-activity waste at a commercial low-level radioactive waste disposal facility.

The South SDA Environmental Enclosure would remain until all excavation work in the South Disposal Area has been completed.

A large excavation would exist after the waste and contaminated soil is removed from the trenches in the South Disposal Area. A final status survey would be performed in the excavation to verify that residual radioactivity levels do not exceed the established DCGLs. RCRA confirmatory sampling would also be performed. An independent verification survey may be required. Once all the required surveys and sampling have been completed, the area would be backfilled with appropriate clean backfill material and contoured to grade.

C.3.1.8.3 Exhumation of State-Licensed Disposal Area Trenches in the North Disposal Area

Similar to the process described for the SDA trenches in the South Disposal Area, a confinement structure called the North SDA Environmental Enclosure would be constructed over Trenches 1 through 7, which are known to contain wastes classifiable as greater than Class A low-level radioactive waste. The North SDA Environmental Enclosure is discussed in Section C.4.6.4.

Wastes disposed of in the northern SDA trenches would be removed in the same manner as those in the southern SDA trenches. A final status survey would be performed in the excavation. RCRA confirmatory sampling would also be performed.

The North SDA Environmental Enclosure would remain until all excavation work in the North Disposal Area has been completed.

C.3.1.8.4 Exhumation of Filled Lagoons

A pre-engineered, sheet metal confinement structure called the SDA Lagoon Environmental Enclosure would be constructed over each of the three filled lagoons, as described in Section C.4.6.5. Once the lagoons have been excavated and confirmed to be in compliance with applicable regulatory requirements, the confinement structures, which are expected to become slightly contaminated during excavation, would be dismantled and disposed of as low-specific-activity waste in a commercial low-level radioactive waste disposal facility.

The upper layer of weathered overburden over each of the three lagoons, approximately 1.2 meters (4 feet) thick, would be excavated. This soil would be placed into appropriate containers and sampled for characterization purposes. This material is expected to be low-specific-activity waste.

The fill within the filled lagoons would be excavated using a hydraulic excavator. High radiation fields are not anticipated and, for purposes of this EIS, an assumption was made that remotely operated equipment would not be needed for excavation of the filled lagoons.

After the lagoons have been excavated, the lagoon confinement structures would be sprayed with fixative and demolished. The demolition debris would be disposed of as low-specific-activity waste at a commercial low-level radioactive waste disposal facility.

After the waste material has been removed from the lagoons, any impacted material surrounding the lagoons would be removed. Additionally, once the waste material has been removed and the enclosures are deemed to be no longer necessary, demolition of the enclosures would begin. Removal of the enclosures would allow the excavation to expand beyond the limits of the enclosures if necessary. A water mist would be applied, as necessary, to prevent the generation of airborne dust. Because this soil is expected to be contaminated and classified as low-specific-activity waste, it would be placed into appropriate containers or railcars. The material would be transported to a commercial low-level radioactive waste disposal facility. As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal.

C.3.1.8.5 Site Restoration

Demolition of State-Licensed Disposal Area Environmental Enclosures

The North SDA Environmental Enclosure and the South SDA Environmental Enclosure could be demolished at different times, but both would be demolished in the manner described in the following paragraphs.

The HEPA filters from the ventilation systems of the SDA Environmental Enclosures would be removed by bag-out procedures, wrapped in polyethylene or equivalent material, and loaded into an appropriate container as radioactive waste. The ventilation system equipment would then be selectively demolished, loaded into the containers, and transferred to the Container Management Facility for characterization and shipment for disposal as low-specific-activity waste at a commercial radioactive waste disposal facility.

The interior surfaces of the SDA Environmental Enclosures are expected to be slightly contaminated. Therefore, they would be thoroughly surveyed, and contamination would be spray fixed, as necessary, to allow demolition of the structure without confinement. The environmental enclosures would be manually demolished using hydraulic excavators equipped with demolition hammers, grapples, and shear attachments. The debris would be surveyed and sampled for characterization purposes, placed into lift liners, and then shipped off site for disposal as low-specific-activity waste at a commercial low-level radioactive waste disposal facility.

Removal of the Below-Grade Walls

To restore natural groundwater flow, the below-grade concrete wall and the below-grade slurry wall would be excavated, and the excavated material would be appropriately packaged for shipment. For estimating purposes, the excavated material was assumed to be managed as low-specific-activity waste and disposed of at a commercial low-level radioactive waste disposal facility.

Once the enclosures and below-grade hydraulic barriers have been removed, any contaminated soil generated during demolition would be removed and disposed of as low-specific-activity waste. A final status survey would be performed in the area impacted by demolition of the enclosures and excavation of below-grade hydraulic barriers to establish that residual radioactivity levels do not exceed the established DCGLs. A chemical survey would also be performed to verify that all hazardous constituents are below appropriate regulatory guidance values. After the surveys are completed, additional appropriate clean backfill material would be placed and the area graded to a near natural appearance.

C.3.1.8.6 Disposal of Equipment

The used equipment would include, among other items, the Modular Shielded Environmental Enclosures, a manually operated excavator, Z-mast crane and other overhead crane systems. Items would be reduced in size, as necessary; packaged; and shipped to a commercial low-level radioactive waste disposal facility.

C.3.1.8.7 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 8 are presented in **Table C–23**. The estimate includes the construction and demolition of all structures supporting the decommissioning activities in WMA 8 except the Leachate Treatment Facility and the Container Management Facility, which were included in the discussion of WMA 7 activities and presented in Table C–21.

Table C–23 Estimated Waste to be Generated: Waste Management Area 8

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	480,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	14,000,000
Class A	2,700,000
Class B	31,000
Class C	65,000
Greater-Than-Class C Waste	74,000
Mixed Low-level Radioactive Waste	2,500
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.9 Waste Management Area 9: Radwaste Treatment System Drum Cell

C.3.1.9.1 Removal of the Radwaste Treatment System Drum Cell

The Drum Cell would be demolished by conventional means and the floor slab and foundation removed, along with the underlying gravel base. It is assumed that the demolition debris would be disposed of off site as construction and demolition debris.

After completion of this work, a final status survey would be performed in the excavated area and arrangements made for any necessary independent verification surveys. RCRA confirmatory sampling would also be performed. After completion of the surveys and sampling, the excavated area would be filled with appropriate clean backfill material, and contoured to grade.

C.3.1.9.2 Removal of the Subcontractor Maintenance Area and Gravel Pads

The subcontractor trailers would be demolished using standard means and methods. The demolition debris and gravel pad would be managed as construction and demolition debris.

In addition, the NDA Trench Soil Container Area’s gravel pad would be removed. This pad is assumed to have been contaminated during its operational period and would be processed as low-specific-activity waste. As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal.

C.3.1.9.3 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 9 are presented in **Table C–24**.

Table C–24 Estimated Waste to be Generated: Waste Management Area 9

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	250,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	56,000
Class A	100
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.10 Waste Management Area 10: Support and Services Area

The Sitewide Removal Alternative closure approach for WMA 10 is demolition and removal of existing facilities, along with the remaining concrete floor slabs and foundations. Any contaminated soil, sediment, and groundwater in the area would be remediated to levels supporting unrestricted release.

C.3.1.10.1 Removal of Structures/Facilities

The New Warehouse (including the former Waste Management Staging Area), Meteorological Tower, Security Gatehouse and security fences would be demolished and the debris would be disposed of off site as uncontaminated construction and demolition debris.

The remaining floor slabs and foundations in the area, including those for the Administration Building, Expanded Environmental Laboratory, Construction and Fabrication Shop, and Vitrification Diesel Fuel Oil Storage Tank and Building would be removed. After completion of this work, a final status survey would be performed in each excavated area and arrangements made for any necessary independent verification surveys. RCRA confirmatory sampling would also be performed. After completion of the surveys and sampling, the excavated areas would be filled with appropriate clean backfill material and contoured to grade.

C.3.1.10.2 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 10 are presented in **Table C–25**.

Table C–25 Estimated Waste to be Generated: Waste Management Area 10

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	96,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	0
Class A	0
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.11 Waste Management Area 11: Bulk Storage Warehouse and Hydrofracture Test Well Area

Under the Sitewide Removal Alternative, the Scrap Material Landfill would be excavated. Any contaminated soil, sediment, and groundwater would be remediated to levels supporting unrestricted release.

C.3.1.11.1 Removal of Structures/Facilities

Scrap Material Landfill

The overburden above the Scrap Material Landfill would be excavated and staged nearby. The contents of the Scrap Material Landfill would be exhumed and disposed of as construction and demolition debris at an offsite disposal facility. The excavation would be filled with appropriate clean backfill material, after which the overburden material that had been removed would be replaced over the top.

Although no radioactive contamination is expected, once closure activities have been completed, a final status survey would be performed to verify that residual radioactivity levels do not exceed the established DCGLs.

An independent verification survey may also be required. After the verification survey is complete, the area would be filled with appropriate clean backfill material and graded, as necessary, to restore it to a near natural appearance.

C.3.1.11.2 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 11 are presented in **Table C–26**.

Table C–26 Estimated Waste to be Generated: Waste Management Area 11

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	33,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	0
Class A	0
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.12 Waste Management Area 12: Balance of Site

Under the Sitewide Removal Alternative, the dams and reservoirs and parking lots and roadways would be removed. Contaminated soil across the Project Premises would be removed, as necessary, to achieve levels supporting unrestricted release. In addition, contaminated stream sediments would be removed to levels supporting unrestricted release.

C.3.1.12.1 Dams and Reservoirs

The dams and reservoirs would be removed in accordance with applicable Federal and state regulations and approvals from NYSDEC, the New York State Department of Health, and the U.S. Environmental Protection Agency. The North and South Reservoirs would be drained slowly to prevent unnecessary disturbance of sediment downstream. After the water level has been lowered, the control building, pumphouse, and pipe would be demolished, and the resulting debris would be sent to an offsite disposal facility.

Dam 1 would be excavated first. An excavator would be used to excavate the soil and load it into dump trucks for transport over Dam 2 to a nearby laydown location. Dam 2 would then be excavated, and the soil would be transported to the same laydown location. The soil may be made available for use as appropriate clean backfill material in support of closure of other WMAs, but it is assumed that it will be managed as construction and demolition debris.

The steel bridge that spans across Reservoir 2 and the bridge crossing the South Reservoir would be removed. The bridges would be sectioned using a cutting torch, and the sections would be collected and disposed of as construction and demolition debris.

C.3.1.12.2 Parking Lots and Roadways

The parking lots and roadways associated with the Project Premises would be removed.

Because the parking lots and roadways were never suspected of radiological or chemical contamination, and no such materials were handled in these areas, final status surveys would not be necessary. Visual inspections to confirm the removal of all areas would serve as the primary confirmation that decommissioning requirements have been met.

C.3.1.12.3 Railroad Spurs

The Railroad Spur would be dismantled and removed. The length of the spur to be removed is approximately 2,000 meters (6,500 feet). The removed rail ties, tracks and track ballast would be disposed of as construction and demolition debris in accordance with Article 27, Title 25 of New York State Law.

C.3.1.12.4 Remediation of Surface Soil and Sediment

Surface soil and sediment with radionuclide concentrations in excess of DCGLs would be remediated during closure activities.

Available data on radioactive contamination in surface soil and sediment and additional data from the characterization program would be evaluated, considering DCGLs for surface soil and sediment. Soil and sediment with radioactivity concentrations exceeding DCGLs would be removed and disposed of off site as low-specific-activity waste. Final status surveys would be performed in areas where impacted soil or sediment was removed. RCRA confirmatory sampling would also be performed.

Because the available data on surface soil contamination are limited, estimates of the amounts of contaminated soil to be removed in different WMAs are based on the size of the posted soil radiation areas within those WMAs. Estimates for the volume of contaminated sediment to be removed are based on available radiation levels and radioactivity concentration data.

C.3.1.12.5 Remediation of Streambed Sediments

Streambed sediment in Erdman Brook and in Franks Creek between the Lagoon 3 outfall and the confluence of Franks Creek and Quarry Creek inside and outside the Project Premises fence would be remediated to DCGLs. Planning for removal of contaminated sediment would be based on consideration of available sediment data and additional data collected during the characterization program.

A process such as the following would be used:

- An access route for heavy excavation equipment would be established by removing selected trees between the road that passes Lagoon 3 and Erdman Brook; removing vegetation, as necessary; and placing gravel to provide support for the equipment.
- Streamflow would be temporarily diverted to bypass sections of streambeds to be excavated.
- Runoff controls would be installed to prevent the migration of disturbed sediment downstream of the excavation.
- An excavator would be used to remove contaminated sediment. If necessary, cranes would be used to move the material from the streambed to the plateau surface.

- Sediments would be transferred to the Soil Drying Facility (see Section C.4.3).
- The sediment would be placed in appropriate containers, which would be shipped off site for disposal as low-specific-activity waste.
- Subsequent to excavation, radiological remedial action surveys would be performed in the streambeds; additional sediment would be removed, as necessary; and a final status survey would be performed. A RCRA confirmatory status survey would also be performed.

For estimating purposes, it was assumed that streambed sediment would be removed from Erdman Brook and Franks Creek between the Lagoon 3 outfall and the confluence of Franks Creek and Quarry Creek.

C.3.1.12.6 Other Potentially Contaminated Areas

The areas identified in Section C.2.12.5 are known or believed to contain low levels of contamination. They would also be excavated and processed. As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal.

C.3.1.12.7 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative in WMA 12 are presented in **Table C–27**. The estimate includes existing facility maintenance.

Table C–27 Estimated Waste to be Generated: Waste Management Area 12

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	2,600,000
Hazardous Waste	450
Low-level Radioactive Waste	
Low Specific Activity	250,000
Class A	180,000
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.13 North Plateau Groundwater Plume

C.3.1.13.1 Excavation of North Plateau Groundwater Plume

Decommissioning activities associated with the source area of the North Plateau Groundwater Plume are described in Section C.3.1.1.8. Soil and water within the nonsource area of the North Plateau Groundwater Plume would be removed to levels allowing for unrestricted use of the North Plateau area. To achieve this, the 10-picocuries-per-liter gross beta isopleth has been used to define the area of excavation. The vertical boundary is based on the depth of the Lavery till. The excavation would include the following steps: (1) install a curtain of sheet pilings around the perimeter of the plume beyond the 10-picocurie-per-liter isopleth; (2) remove and treat the contaminated groundwater to the extent feasible; (3) place a cover over the area not being actively excavated to minimize infiltration; (4) excavate the soil down to a depth of at least

0.3 meters (1 foot) into the Lavery till; and (5) process the soil, as needed, in the Soil Drying Facility and package it for disposal as low-level radioactive waste. As with other surface remediation areas, DCGLs would be used to determine the extent of contaminated soil removal.

After the source(s) of contamination are removed, the Groundwater Recovery System, pilot-scale permeable treatment wall, and full scale permeable treatment wall would be removed and a final status survey would be performed to verify that residual radioactivity levels do not exceed the established DCGLs. A RCRA confirmatory status survey would also be performed. An independent verification survey may be required. After the surveys are complete, the area would be filled with appropriate clean backfill material and graded, as necessary, to restore it to a near natural appearance.

The Soil Drying Facility would be demolished and removed after all site soil is processed. Additional remediation and closeout activities include (1) the demolition by conventional methods of the paved waste and railcar/staging areas, with the resulting debris managed as low-specific-activity waste; (2) decontamination of the skid-mounted treatment system, as necessary, and return of the system to the vendor for recycling or reuse; (3) packaging of spent ion-exchange media to be sent off site for disposal as Class B low-level radioactive waste; and (4) removal of the perimeter fencing (used to control access to the remediation site) and disposal off site as construction debris.

C.3.1.13.2 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative for the management of the nonsource area of the North Plateau Groundwater Plume are presented in **Table C–28**. The estimate also includes waste from the construction, operation, and demolition of the Soil Drying Facility. The estimated waste to be generated from the source area of the North Plateau Groundwater Plume is included within the estimate for the closure of WMA 1, shown in Table C–15.

Table C–28 Estimated Waste to be Generated: North Plateau Groundwater Plume (nonsource area)

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	73,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	15,000,000
Class A	26,000
Class B	820
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.14 Cesium Prong

Areas of the Cesium Prong within and outside of WNYNSC exceeding DCGLs for unrestricted release would be excavated typically to a depth of about 15.2 centimeters (6 inches). The excavated material would be packaged into appropriate containers and transported as low-specific-activity waste to an offsite low-level radioactive waste disposal facility. Based on the shallow excavation depth, it is assumed that the excavated soil would meet the soil moisture requirements of the designated waste disposal facility. In the unlikely event that some of the soil exceeds soil moisture requirements, it would be left to dry or sorbent material would be added.

After the source(s) of contamination are removed, a final status survey would be performed in the Cesium Prong to verify that residual radioactivity levels do not exceed the established DCGLs. RCRA confirmatory sampling would also be performed. An independent verification survey may be required. After the surveys and sampling are complete, the area would be filled with appropriate clean backfill material and graded, as necessary, to restore it to a near natural appearance.

The estimated waste volumes expected to be generated under the Sitewide Removal Alternative for the management of the Cesium Prong are presented in **Table C–29**.

Table C–29 Estimated Waste to be Generated: Cesium Prong

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	0
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	2,100,000
Class A	7,000
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009a.

C.3.1.15 Removal of Environmental Monitoring Equipment

Preparation and planning for removal of the onsite and offsite environmental monitoring equipment and groundwater monitoring wells would include the following activities:

- Obtain regulator approval, as appropriate.
- Secure the required work permits, land access agreements, transportation and disposal manifests, and other documentation.
- Conduct radiological screening of the structures to ensure that the workers and the environment are appropriately protected.
- Notify the appropriate utility companies (e.g., electric, telephone/instrumentation) of discontinued power needs.

C.3.1.15.1 Demolition of Monitoring Structures

The air and surface water monitoring stations are all assumed to consist of a prefabricated fiberglass or plastic shelter that contains sampling equipment, electrical service, instrumentation systems, and other ancillary items. The equipment shelters sit on a concrete pad.

Demolition would begin with removal of the electrical service and instrument wiring. All aboveground structures and equipment remaining would then be removed and reduced in size by hand using hand tools and portable demolition saws. Crew productivity is estimated to be approximately one structure per day. The demolished monitoring equipment would be disposed of as construction and demolition debris. Concrete pads would be removed and disposed of as construction and demolition debris. The estimated waste volumes to be generated from these activities are included in the estimate for WMA 12, shown in Table C–27.

C.3.1.15.2 Groundwater Well Removal

Following excavation of the North Plateau Groundwater Plume, NDA, and SDA and the remainder of the excavation projects involved with the Sitewide Removal Alternative, all remaining groundwater monitoring wells would be removed using overdrilling and borehole grouting techniques. The overdrilling would be done using a hollow-stem auger drill rig. Once the wells are removed, the boreholes would be filled with a nonshrink, cement-bentonite grout.

C.3.2 Sitewide Close-In-Place Alternative

Under the Sitewide Close-In-Place Alternative, the major facilities would be closed in place. The residual radioactivity in facilities involving long-lived radionuclides would be isolated using specially designed closure structures and engineered barriers (e.g., an engineered rubble pile that would contain rubble from demolition of the Main Plant Process Building). A small number of aboveground structures, such as the Lag Storage Area 4 and the Remote-Handled Waste Facility in WMA 5 and the Low-Level Waste Treatment Facility in WMA 2, would be torn down to the concrete pads to eliminate maintenance costs, and the demolition debris would be shipped off site. The waste classification and disposal facilities anticipated for final disposition of these materials would be the same as those described for the Sitewide Removal Alternative, discussed in Section C.3.1. Nearly all of the debris in WMAs 1, 3, 7, and 8 would remain on site and be covered by several caps. Activities affecting each WMA are discussed in further detail in the following subsections.

This decommissioning approach would allow large portions of WNYNSC to be released for unrestricted use. The remaining portions of WNYNSC could remain under long-term license or permit. It is also conceivable that the NRC-regulated portion of WNYNSC could have its license terminated under restricted conditions.

Unless otherwise noted, information presented in Section C.3.2 is from the *Sitewide Close-In-Place Alternative Technical Report* (WSMS 2009b).

C.3.2.1 Waste Management Area 1: Main Plant Process Building and Vitrification Facility Area

Under the Sitewide Close-In-Place Alternative, the high-level radioactive waste canisters stored in the Main Plant Process Building would be relocated. All structures within WMA 1 would be demolished to grade level. The demolition debris of the above-grade portions of the structures would be used as backfill for the underground portions of the Main Plant Process Building and the Vitrification Facility. The backfilled below-grade portions of the Main Plant Process Building, Vitrification Facility, and North Plateau Groundwater Plume source area would all be closed in an integrated manner with the Waste Tank Farm (WMA 3) within a common hydraulic barrier and beneath a common multi-layer cap. The underground storage tanks, underground lines, and Off-Gas Trench would remain in place.

C.3.2.1.1 Relocation of the High-Level Radioactive Waste Canisters

The high-level radioactive waste canisters would be relocated from the Main Plant Process Building to a new Interim Storage Facility (Dry Cask Storage Area). The activities associated with the high-level waste canister removal are the same as those that would occur under the Sitewide Removal Alternative, discussed in Section C.3.1.1.1.

C.3.2.1.2 Approach to Facility Demolition

All structures within WMA 1 would be removed to grade level. The general approach to demolition would be as follows:

- Tanks 35104, 15D-6, and 7D-13 would be filled with grout.
- Underground process lines would be filled with grout or flowable fill and left in place, contained within the circumferential hydraulic barrier wall around WMA 1 and WMA 3 (see Section C.4.8).
- Removal of the equipment and piping from the Fire Pumphouse and demolition of the superstructure itself would be accomplished by conventional methods. The Water Storage Tank would be drained, segmented using conventional cutting equipment, and placed within the area to be covered by the multi-layered, engineered cap.
- The transformer within the electrical substation would be disconnected and removed by the electrical utility company, and the remaining structure and foundation would be demolished. The demolition debris would be placed within the area to be covered by the multi-layered, engineered cap. Waste oil removed from the transformers would be characterized as hazardous waste and would be disposed of at an appropriately licensed facility. In addition, the bulk oil storage tank would be disposed of off site as construction and demolition debris.
- The Main Plant Process Building, 01-14 Building, Utility Room, Utility Room Expansion, and Plant Office Building would be demolished down to their concrete floor slabs, and the debris and pieces of remaining equipment would be placed within the subgrade portions of cells of the Main Plant Process Building or retained for the engineered rubble pile. Because the roof over the Main Plant Process Building is expected to be classified as asbestos-containing material, the waste generated from roof removal would be disposed of off site at a disposal facility licensed to accept asbestos-containing material. It is likely that the waste would be disposed of at a local sanitary landfill.
- The Vitrification Facility and the Load-In/Load-Out Facility would be demolished to their concrete floor slabs in conjunction with demolition of the Main Plant Process Building, and the debris would be placed within the melter pit or subgrade portions of the building or retained for the engineered rubble pile.
- A concrete crusher would be employed to reduce the size of large pieces of concrete rubble to make them suitable for filling subgrade portions of the Main Plant Process Building and Vitrification Facility and for creating the engineered rubble pile. Diamond-wire saw cutting would also be employed, and the blocks of concrete debris would be prescriptively placed into the subgrade facilities.
- A vertical subsurface circumferential hydraulic barrier wall would be constructed around WMA 1 and WMA 3. The structure would be a soil-bentonite barrier wall extending to sufficient depth to position it at least 1 meter (3 feet) into the unweathered Lavery till. This barrier wall would be constructed to channel groundwater around the closed facilities and help minimize the possibility of an excessive hydraulic head developing within the closed facilities. A second chevron-shaped hydraulic barrier wall would be located upgradient of the closed facilities to prevent mounding of groundwater against the circumferential barrier wall.
- A multi-layer closure cap would be constructed over the closed facilities to minimize infiltration of precipitation into the stabilized facilities. The lateral limits of the closure cap would extend over both the chevron-shaped and circumferential barrier walls. The edge of the cap would be bounded by a rock apron and a circumferential ring of large boulders.

The same hydraulic barriers and engineered cap would also enclose and cover the Waste Tank Farm in WMA 3. The hydraulic barriers and engineered cap are discussed in Section C.4.8.

C.3.2.1.3 Demolition of Main Plant Process Building

For demolition purposes, portions of the aboveground Main Plant Process Building would be divided into four categories based upon design, construction, and location: (1) the plant stack, (2) framework cells, (3) reinforced concrete framework cells, and (4) tower cells. Demolition of the Main Plant Process Building would also follow this general sequence. The general arrangement of the building was discussed in Section C.3.1.1.2.

The Main Plant Process Building contains 32 lead glass viewing windows, which together contain approximately 10,000 kilograms (22,000 pounds) of lead in their frames. These viewing windows would be removed before demolition of the building begins and would likely be managed as hazardous waste.

Removal of the Plant Stack and Remaining Equipment

The plant stack is located on the roof of the Main Plant Process Building. It would be removed before demolition of the building itself is started. The stack would be removed in sections, and the pieces would be lowered to the ground by crane, where they would be segmented, as necessary, for handling purposes and placed within an underground building cavity such as the Fuel Storage Pool.

Prior to demolition, the remaining equipment, including piping and vessels, would be removed. Some of this material has the potential for being transuranic waste.

Demolition of the Framework Cells

The framework cells were designed and constructed with masonry or concrete walls, floors, and ceilings that are supported by a structural steel framework. The walls of the framework cells are constructed from concrete block, and the floors are concrete on steel decking.

During demolition of the framework cells, asphalt roofing material, some of which contains asbestos, would be removed first using small skid steer loaders and handheld equipment. Asbestos-containing material would be identified and disposed of offsite as asbestos-containing waste.

The steel roof decking underlying the asphalt roofing would be removed and reduced in size with a mobile shear attached to a hydraulic demolition machine. The shear attachment could cut through the roof decking and reduce the size of this material, which would be disposed of off site as low-specific-activity waste.

The masonry and concrete walls in the framework cells would be demolished using the demolition machine equipped with either a shear or a demolition hammer operated under a fog spray. The hammer would break through the concrete, and the shear would be used to cut through the steel reinforcement in the concrete, as well as the steel members comprising the skeleton of these cells. A skid steer loader would be used to place rubble into the transfer boxes, which would be lowered to ground level using a crane. The demolition debris would be placed within a building cavity or staged for incorporation into the engineered rubble pile.

Demolition of the Reinforced Concrete Framework Cells

The reinforced concrete framework cells were constructed using reinforced high-density concrete up to 1 meter (3 feet) thick to provide radiation shielding while highly radioactive samples were being analyzed within them.

These cells are situated within and above framework cells of the Main Plant Process Building, and they would be demolished in conjunction with those cells.

The reinforced concrete framework cells include Analytical Cells 1 through 5, the Sample Cell, and the Sample Storage Cell, which are located at a plant elevation of 40 meters (131 feet). These cells would be demolished using demolition machines. A skid steer loader would place the demolition debris into transfer boxes, which would be lowered to ground level with a crane. This demolition debris would also be placed within a building cavity or staged for incorporation into the engineered rubble pile.

Demolition of the Tower Cells

The tower cells are constructed entirely of reinforced concrete. Their construction would allow these cells to be freestanding structures if they were physically segregated from other portions of the Main Plant Process Building. The walls, floors, and ceilings of these cells typically consist of either high-density or standard density reinforced concrete that is up to 1.7 meters (5.5 feet) thick.

The tower cells would be demolished in a controlled manner by segmenting the walls and ceilings using diamond-wire saws. The first step in the demolition of the tower cells would be segmentation and removal of the ceilings.

A series of holes would be drilled through the ceiling through which the diamond wire would be passed and to which lifting bales would be attached. The diamond wire would cut through the concrete and any rebar or pipe penetrations. The ceiling segments would be supported from above by a crane that would lift and remove the ceiling segment when cut.

The walls would be segmented in a similar fashion using diamond-wire cutting. The ceiling and wall segments would be placed directly into the subgrade facilities, reduced into small pieces and placed within a building cavity, or staged for incorporation into the engineered rubble pile.

C.3.2.1.4 Demolition of the Vitrification Facility

The Vitrification Facility would be demolished to grade level using methods such as those described for the Main Plant Process Building. Considering the construction of the building, the steel frame and sheet metal part of the structure would be demolished first, followed by the reinforced concrete Vitrification Cell.

The thick reinforced concrete walls and roof components would be segmented, as necessary, using a technique such as diamond-wire cutting. The steel shield doors would also be segmented, as necessary, for disposal, after removing them from the building if that would be more efficient.

All demolition waste would be placed in the melter pit or staged in the area for incorporation into the engineered rubble pile.

Removal of the concrete building structure would involve use of methods similar to those used with the Main Plant Process Building. This demolition debris would be placed within a Main Plant Process Building cavity or staged for incorporation into the engineered rubble pile.

C.3.2.1.5 Demolition of 01-14 Building

Demolition of the 01-14 Building would occur as described in Section C.3.1.1.4 except that the debris would be included in the rubble pile under the cover.

C.3.2.1.6 Demolition of the Load-Out Facility

The Load-Out Facility (converted from Load-In/Load-Out Facility) would be demolished once all of the high-level radioactive waste canisters have been removed from the Main Plant Process Building. The shielded transfer cell, canister handling system, high-capacity crane, and other equipment would be dismantled, removed, and included in the rubble pile under the cover.

A characterization survey would be performed to quantify the contamination and radiation fields in various parts of the building, and a spray fixative would be applied to the interior surfaces of the building. All of the identified utilities would be isolated, and all the drains and sumps would be sealed.

Standard construction equipment would be used to demolish the Load-Out Facility because the internal wall surfaces of the structure are not expected to be contaminated. The building and slab would be demolished using an excavator equipped with shear, grapple, and hammer attachments. All demolition debris would be included in the rubble pile under the cover.

C.3.2.1.7 Demolition of the Other Waste Management Area 1 Structures

The Utility Room, Utility Room Expansion, and Plant Office Building are relatively simple structures that would be demolished to grade using conventional demolition equipment at an appropriate point in the Main Plant Process Building demolition sequence. The rubble would be placed in an underground part of the building or staged for incorporation into the engineered rubble pile.

Equipment and piping in the Fire Pumphouse would be removed if deemed valuable in terms of reuse or recycling. Then the Fire Pumphouse would be demolished by conventional methods, and the demolition debris would be incorporated into the engineered rubble pile.

The Water Storage Tank would be drained and the water released to the storm sewer in accordance with appropriate SPDES permits. The steel tank would then be segmented using conventional steel cutting equipment, such as acetylene torches. Although the tank segments might be recycled, they are conservatively assumed to be added to the engineered rubble pile and thus disposed of on site.

The Electrical Substation and the bulk oil storage tank would be both drained of oil, and the oils would be handled according to applicable regulations. The transformer oils are assumed to be characterized as hazardous waste due to PCB concentrations. The fuel oil from the tank is expected to be recycled or reused without disposal costs.

Once the bulk oil storage tanks are empty, they would be segmented, as appropriate, and removed from the site for offsite disposal. The tanks are assumed to be classified as clean construction and demolition debris and would be disposed of at a local sanitary landfill or construction and demolition debris landfill.

C.3.2.1.8 Placement of Building Rubble

The debris from demolition of the aboveground portions of the Main Plant Process Building and other WMA 1 structures would be placed within the underground areas of the building to the extent practicable. These areas would be completely filled with debris.

The total volume of the underground portions of the Main Plant Process Building and the Vitrification Facility available for demolition debris is approximately 5,000 cubic meters (175,000 cubic feet), with approximately 3,400 cubic meters (120,000 cubic feet) of this amount in the Fuel Receiving and Storage Area. The estimated volume of rubble from demolition of the above-grade portions of the Main Plant Process Building and Vitrification Facility is approximately 14,000 cubic meters (500,000 cubic feet).

Some underground areas, such as the three areas in the Fuel Receiving and Storage Area, melter pit, soaking pit, and Liquid Waste Cell, have the advantage of being readily accessible. Others have thick reinforced concrete ceilings that form part of the ground floor of the Main Plant Process Building.

The general process for establishing a building rubble pile would include steps such as the following:

- Placing rubble into the Fuel Storage Pool, Cask Unloading Pool, and Water Treatment Area until these spaces are filled to grade level
- Placing rubble into other areas that do not have grade-level ceilings such as the melter pit, soaking pit, and Liquid Waste Cell until these spaces are filled to grade level
- Demolishing the ceilings (the grade-level floor slabs) above areas such as the General Purpose Cell, General Purpose Cell Crane Room, the Miniature Cell, and the General Purpose Cell Crane Room Extension and filling these spaces with rubble
- Spreading the remaining rubble, approximately 9,000 cubic meters (325,000 cubic feet) evenly over the WMA 1 area, which would produce an average pile height of approximately 1 meter (3 feet)

C.3.2.1.9 Installation of the Circumferential Hydraulic Barrier Wall and the Closure Cap

The WMA 1 and WMA 3 hydraulic barrier wall and the closure cap would be installed after completing preparations to close the Waste Tank Farm and after receiving regulatory approval. The hydraulic barrier wall and multi-layer cap are discussed in Sections C.3.2.3.8 and C.4.8.

C.3.2.1.10 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Close-In-Place Alternative in WMA 1 are presented in **Table C–30**. The estimate includes the modification of the Load-In/Load-Out Facility and the operation and demolition of the Interim Storage Facility (Dry Cask Storage Area) associated with the high-level waste canister removal.

Table C–30 Estimated Waste to be Generated: Waste Management Area 1

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	210,000
Hazardous Waste	83
Low-level Radioactive Waste	
Low Specific Activity	39,000
Class A	46,000
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	1,400
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

C.3.2.2 Waste Management Area 2: Low-Level Waste Treatment Facility Area

The approach to closing WMA 2 under the Sitewide Close-In-Place Alternative involves stabilization and enclosing Lagoon 1 within a vertical hydraulic barrier wall; stabilizing and then filling Lagoons 2 and 3 with compacted earth; removing the membrane liners and underlying berms from Lagoons 4 and 5; regrading the area so that no perched water can form, and then covering the area of all five lagoons with a multi-layer cover. The permeable treatment wall installed across the nonsource area of the North Plateau Groundwater Plume for the starting point of the EIS would be periodically replaced. Other activities in WMA 2 include backfilling the Neutralization Pit and the interceptors after breaking up their bottoms and removing the Low-Level Waste Treatment Facility to grade.

C.3.2.2.1 Removal of Structures/Facilities

The closure of WMA 2 facilities would be coordinated to facilitate removal of the water in the Neutralization Pit and the interceptors and transfer of the water to the Low-Level Waste Treatment Facility for processing before the Low-Level Waste Treatment Facility and the lagoons would be taken out of service. The lagoons would be closed in a sequence that would permit discharge of the water through the permitted outfall to Erdman Brook. Decommissioning activities associated with the Low-Level Waste Treatment Facility, Neutralization Pit, and Old and New Interceptors are described in the following paragraphs. No action would be taken on the Solvent Dike, Maintenance Shop Leach Field, Fire Brigade Training Area, or the remaining floor slabs and foundations.

Low-Level Waste Treatment Facility

The contents of skid-mounted wastewater processing modules (ion-exchange media and activated carbon) would be flushed to the waste packaging area, where they would be packaged for transport off site and disposal as low-specific-activity waste. The wastewater processing equipment and piping from the building would be removed and reduced in size, as appropriate; packaged; placed into appropriate containers; and transported off site for disposal as low-specific-activity waste.

The waste packaging area would be demolished to its floor slab using appropriate controls such as fog spray, and the sump liner would be removed. The resulting debris would be packaged for disposal off site as low-specific-activity waste. The remainder of the Low-Level Waste Treatment Facility would then be demolished to its floor slab by conventional methods without confinement, and the resulting debris would be handled as low-specific-activity waste, placed into appropriate containers, and transported off site for disposal.

A final status survey would be performed on the remaining floor slab and in the sump cavity, and arrangements would be made for any necessary independent verification surveys. After the surveys have been completed, the sump cavity would be filled with appropriate clean backfill material.

Neutralization Pit

The water in the pit would be pumped out. A final status survey of the pit would be performed, and arrangements would be made for any necessary independent verification surveys. After the surveys have been completed, the bottom of the pit would be broken up to prevent water retention, and it would be backfilled with appropriate clean backfill material.

New and Old Interceptors

The New and Old Interceptor roofs would be removed from the subsurface structures, demolished, and packed in containers for disposal. The roof debris is expected to be managed as low-specific-activity waste. The subsurface structures would be demolished in place by using an excavator with a hydraulic hammer to punch holes in the liner (if present) and concrete walls/base, minimizing the potential for water to become trapped within the subsurface structure. Because the Old Interceptor concrete floor is expected to have high levels of residual contamination between layers of concrete, the floor would not be demolished. Rather, the concrete walls above the floor surface would be penetrated to ensure trapped water is minimized. The vaults would then be filled with appropriate clean backfill material. During backfilling, other remaining depressions, such as the Neutralization Pit, would also be filled with appropriate clean backfill material.

Wastewater pipelines in the vicinity of the interceptors would be excavated, severed, and plugged with grout. The excavations would be performed immediately outside of the interceptors, and no waste would be generated. Grouting of the pipelines is intended to minimize the preferential groundwater flow through inactive sewers, pipes, and other conduits.

C.3.2.2.2 Decommissioning of the Lagoons

A common engineered multi-layer cover would be installed over Lagoons 1, 2, 3, 4, and 5 as part of the Sitewide Close-In-Place Alternative. The cover is discussed in Section C.4.9. It is assumed that the lagoons would be dewatered prior to the start of work. As part of the cover installation, the sediments of Lagoons 1 and 2 would be stabilized, and a circumferential barrier wall would be placed around Lagoon 1.

Lagoon 1 Sediment Stabilization

It is assumed that approximately 1.5 meters (5 feet) of sediment and debris would be stabilized in Lagoon 1 using a shallow-soil mixing method, such as a hollow stem mixing/drilling tool. This usually consists of fixed rotating large-diameter blades, with injection ports located along the base of the tool. As the tool is pushed into the ground, a slurry mixture is injected. Once the final depth is reached, the tool is raised and lowered in a predetermined mixing pattern to ensure a homogenous mix over the entire area. For this case, a 6 percent Portland cement mixture was selected as the grouting material.

Lagoon 1 Barrier Wall

A soil-bentonite barrier wall would be installed to divert groundwater around the portion of Lagoon 1 that is below the groundwater table. The wall would be keyed into the underlying till and would be installed such that water would be directed around the Lagoon 1 area.

A 0.6-meter-wide (2-foot-wide) by approximately 125-meter-long (408-feet-long) trench would be excavated around the perimeter of Lagoon 1. The trench would be approximately 5.2 meters (17 feet) deep and would extend 1 meter (3 feet) into the Lavery Till. A hydraulic excavator would be used to excavate the slurry trench for eventual installation of the soil-bentonite backfill material.

Once the wall is complete and begins to set up, the upper 1-meter (3-foot) section would be backfilled. Traffic areas would be backfilled with stone to allow heavy equipment to bridge the wall. The resulting barrier wall would have an in-place saturated hydraulic conductivity of approximately 1.0×10^{-8} centimeters (4.0×10^{-9} inches) per second. The Lagoon 1 barrier wall is discussed in detail in Section 4.10.

Lagoons 2 and 3

Lagoons 2 and 3 would be solidified with Portland cement using standard excavation equipment. The sediment solidification task would be accomplished using standard equipment (i.e., a hydraulic excavator). Once the sediment in the vicinity of the excavator is solidified, the working platform would be extended, and solidification would continue into a nearby area. Backfilling of the lagoon would be performed after sediment solidification is complete. The transfer pump shed would be demolished and disposed of as construction and demolition debris.

Lagoons 4 and 5

Lagoons 4 and 5 are lined lagoons with little or no accumulated sediments. Demolition of the liners in these lagoons would involve using heavy equipment to destroy the integrity of the liners and mixing the liner fragments with solidified sediments, ensuring that there will be no future likelihood of perched water in the lagoon area.

C.3.2.2.3 Completion of Final Status Surveys in Waste Management Area 2

After completion of decommissioning activities within WMA 2, a final status survey of the area would be performed in accordance with a final status survey plan. RCRA confirmatory sampling would also be performed. Arrangements would also be made, as needed, for independent verification surveys.

The results of the final status survey, combined with information such as groundwater monitoring data, historical subsurface soil sample data, the results of the initial surface soil and sediment characterization surveys, and data from the final status surveys of those facilities closed in place, would describe the radiological and hazardous chemical conditions within WMA 2 at the completion of all decommissioning activities. This information would be used to confirm that decommissioning requirements have been met.

C.3.2.2.4 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Close-In-Place Alternative in WMA 2 are presented in **Table C–31**.

Table C–31 Estimated Waste to be Generated: Waste Management Area 2

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	550
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	33,000
Class A	720
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

C.3.2.3 Waste Management Area 3: Waste Tank Farm Area

The following closure activities would be implemented in WMA 3 under the Sitewide Close-In-Place Alternative.

- Tanks 8D-1, 8D-2, 8D-3, and 8D-4 and their associated vaults would be backfilled with controlled low strength material and strong grout. Controlled low strength material is a self-compacting, cementitious material used primarily as a backfill in lieu of compacted backfill. It is defined as a material that has a compressive strength of 84 kilograms per square centimeter (1,200 pounds per square inch) or less, although most controlled low strength material applications require unconfined compressive strengths of 14 kilograms per square centimeter (200 pounds per square inch) or less. This lower strength requirement is necessary to allow for future excavation of the controlled low strength material. The sorbent capabilities of controlled low strength material would significantly retard the mobilization and migration of residual radionuclides in groundwater. The controlled low strength material would also serve to structurally stabilize the tanks by replacing the void space with a structurally stable material. The strong grout would serve as an intruder barrier.

- The STS equipment would remain and be closed within Tank 8D-1. The spent zeolite would remain in the columns and the isotope exchange unit columns. The supernatant feed tank and the sluice feed tank would be filled with grout.

- The underground lines within WMA 3 would remain in place, including lines running from the Tank 8D-2 pump pit to the STS Support Building; the dewatering well would also remain in place.

- The high-level radioactive waste mobilization and transfer pumps would be removed, sectioned, packaged, and disposed of off site as low-level radioactive waste or transuranic waste.

- The high-level radioactive waste pump support structures would be removed and incorporated into an engineered rubble pile beneath a multi-layer cap that would be constructed.

- The High-Level Waste Transfer Trench piping would be grouted and left in place within the transfer trench. The transfer trench would be filled with demolition debris and concrete rubble.

- The Equipment Shelter and Condensers; Con-Ed Building; Permanent Ventilation System Building; and STS Support Building, including the STS Valve Aisle; would be demolished down to their concrete floor slabs after all equipment has been removed. The slabs would remain in place. All demolition debris would be incorporated into the rubble pile.

- The Tank and Vault Drying System equipment installed as part of the starting point of the EIS (see Section C.2.3.1) would be removed.

- A vertical circumferential hydraulic barrier would be constructed around WMA 1 and WMA 3. The barrier would be a soil-bentonite wall extending to sufficient depth to position it at least 1 meter (3 feet) into the unweathered Lavery till. This barrier wall would be constructed to channel groundwater around the closed facilities and help minimize the possibility of an excessive hydraulic head developing within the closed facilities. A second chevron-shaped barrier wall would be located upgradient of the closed facilities to prevent mounding of groundwater against the circumferential barrier wall. The circumferential barrier wall is discussed in Section C.4.8.

- A multi-layer closure cap would be constructed over the closed facilities to minimize infiltration of precipitation into the stabilized facilities. The lateral limits of the closure cap would extend over both the upgradient and circumferential barrier walls. The selected closure cap slope is consistent with the maximum slope allowed for in-place closure of uranium mill tailing piles. This criterion was developed to provide an optimal balance between the objectives of promoting drainage, minimizing erosion, and assuring slope stability. The multi-layer closure cap is described in Section C.4.8.

- A final status survey would be performed in the area to be covered by the cap.

These activities would be accomplished in an appropriate sequence to maintain operations of the Tank and Vault Drying System as long as practicable. These activities are described in more detail in the sections that follow.

C.3.2.3.1 Stabilization of Tanks 8D-1, 8D-2, 8D-3, and 8D-4 and Associated Vaults

Tanks 8D-1, 8D-2, 8D-3, and 8D-4 and their associated vaults would be closed in place. The tanks would first be filled with controlled low strength material containing sorbents and reducing materials to retard radionuclide migration. The tank vaults would be filled with controlled low strength material to a level coincident with the top of the tanks. The headspace between the top of the tank and the vault roof and any tank and vault penetrations would be filled with strong grout that has a compressive strength in excess of 141 kilograms per square centimeter (2,000 pounds per square inch) to serve as an intruder barrier.

The controlled low strength material mixture would consist of Portland cement, fly ash, ground granulated blast furnace slag, phosphatic ore, and water, and would have a compressive strength ranging from approximately 4 to 14 kilograms per square centimeter (50 to 200 pounds per square inch). The blast furnace slag and phosphatic ore, which contains the mineral apatite, would improve the ability of the controlled low strength material to limit the mobilization and migration of long-lived radioactive isotopes.

C.3.2.3.2 Removal of Waste Tank Pumps and Pump Support Structures

Removal of the waste tank pumps is described in Section C.3.1.3.2. Each pump would be removed using appropriate radiological controls. The pumps would be cut into sections during removal and packaged for offsite disposal. It is assumed that the pumps would be classified as either transuranic waste or low-level radioactive waste.

The pump support structures would be removed in connection with removal of the pumps, and the resulting material would be incorporated into the engineered rubble pile beneath the WMA 3 cap.

C.3.2.3.3 High-Level Waste Transfer Trench Piping

The transfer trench itself is not expected to be radiologically contaminated because the piping did not leak and contamination has not been detected in water collected in the trench.

Using appropriate radiological controls, the piping would be filled with grout and left in place. The piping and other equipment in the pits would also be managed in this manner; this effort would be coordinated with removal of the waste tank pumps and grouting of the tanks and vaults. The transfer trench would subsequently be filled with demolition debris and concrete rubble.

C.3.2.3.4 Demolition of the Permanent Ventilation System Building

The Permanent Ventilation System Building would remain in operation until no longer needed for Waste Tank Farm closure work, such as filling the underground waste tanks with controlled low strength material.

The ventilation system equipment in the Permanent Ventilation System Building, which contains the majority of the radionuclide inventory in the structure, would be incorporated into the rubble pile beneath the WMA 3 cover after the tanks in the Waste Tank Farm have been stabilized. Once the ventilation system equipment is removed, the Permanent Ventilation System Building would be demolished by conventional methods without the need of confinement using a demolition machine equipped with a demolition hammer and shear. A spray fixative would be applied to the interior surfaces of the structure, including the Permanent Ventilation System stack, before demolition.

The Permanent Ventilation System stack would be removed and sectioned using the shear attachment of the demolition machine. The shear would be used to section, remove, and reduce the size of the metal walls and roof of the building. After the metal walls have been removed, the demolition machine, equipped with a demolition hammer, would be used to demolish and remove the concrete walls to the floor slab. The demolition debris would be incorporated into the WMA 3 engineered rubble pile.

C.3.2.3.5 Demolition of the Supernatant Treatment System Support Building

An approach similar to the following would be used to remove this building to the floor slab and foundation:

- Perform characterization surveys.
- Install suitable radiological containment with HEPA-filtered ventilation exhaust for removal of the Valve Aisle.
- Remove equipment and waste from the Valve Aisle.
- Decontaminate the interior of the Valve Aisle, as appropriate, to facilitate dismantlement, and apply a suitable fixative to interior surfaces.
- Cut the structure of the Valve Aisle into sections suitable for handling and disposal using equipment appropriate for cutting thick, contaminated steel plates, such as a diamond-wire saw operated inside a containment tent with HEPA-filtered ventilation exhaust.
- Complete removal of the Valve Aisle.
- Decontaminate the building structure, and apply fixatives to contaminated areas, as appropriate, prior to demolition.
- Perform characterization surveys of contaminated embedded piping that will remain in the floor slab so the results can be considered in the refined performance assessment, and cap this embedded piping.
- Dismantle the structure to the floor slab using conventional demolition methods without confinement.

All of the waste and demolition debris would be incorporated into the WMA 3 engineered rubble pile.

C.3.2.3.6 Demolition of the Equipment Shelter and Condensers

The demolition of the Equipment Shelter and Condensers would be performed the same way as under the Sitewide Removal Alternative, described in Section C.3.1.3.5. All of the waste and demolition debris would be incorporated into the WMA 3 engineered rubble pile.

C.3.2.3.7 Demolition of the Con-Ed Building

The demolition of the Con-Ed Building would be performed the same way as under the Sitewide Removal Alternative, discussed in Section C.3.1.3.6. All of the waste and demolition debris would be incorporated into the WMA 3 engineered rubble pile.

C.3.2.3.8 Installation of the Waste Management Area 1 and Waste Management Area 3 Circumferential Hydraulic Barrier Walls and Multi-layer Cap

A single subsurface circumferential barrier wall would be constructed around the partially demolished and stabilized facilities in WMA 1 and WMA 3. In addition to this circumferential barrier wall, a separate, chevron-shaped subsurface barrier wall would be constructed hydraulically upgradient of the circumferential barrier wall. This upgradient barrier wall would be oriented transverse to the direction of groundwater flow to divert groundwater flow and to help prevent groundwater mounding from occurring against the upgradient side of the circumferential barrier wall.

A multi-layer cover system would be constructed over these facilities and the subsurface barrier walls. The top-slope portion of the multi-layer cover system would extend laterally to just beyond the top of the barrier walls, and the side-slope portions of the cover system would be located outside the limits of the barrier walls.

The hydraulic barrier wall and the multi-layer cap are discussed in Section C.4.8.

C.3.2.3.9 Site Restoration

After completion of barrier wall and final cap installation, a final status survey of the area would be performed in accordance with a final status survey plan. RCRA confirmatory sampling would also be performed. Arrangements would also be made for independent verification surveys.

The results of the surveys, combined with information such as groundwater monitoring data, historical subsurface soil sample data, the results of the initial surface soil and sediment characterization surveys, and the estimated radioactivity inventories of the underground waste tanks and their associated vaults, would describe the radiological and hazardous chemical conditions within WMA 1 and WMA 3 at the time of the installation of the multi-layer cap. This information would be used to confirm that decommissioning requirements have been met.

C.3.2.3.10 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Close-In-Place Alternative in WMA 3 are presented in **Table C–32**. The estimate includes the removal of surface structures, grouting operations, and the construction of the barrier walls and multi-layer cap.

Table C–32 Estimated Waste to be Generated: Waste Management Area 3

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	0
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	56,000
Class A	4,300
Class B	110
Class C	1,300
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	1,200

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

These activities are described in more detail in the sections that follow.

C.3.2.4 Waste Management Area 4: Construction and Demolition Debris Landfill

The CDDL would continue to be monitored and maintained under the Sitewide Close-In-Place Alternative. However, characterization surveys of surface soil and sediment in the area would be performed. The results of these surveys would establish the baseline conditions for surface soil and sediment in WMA 4 as decommissioning work begins elsewhere on the Project Premises.

After completion of decommissioning activities in other WMAs, a final status survey of WMA 4 would be performed in accordance with a final status survey plan. RCRA confirmatory sampling would also be performed. Arrangements would also be made for independent verification surveys.

The results of the surveys, combined with other information such as groundwater monitoring data, historical subsurface soil sample data, and the results of the initial surface soil and sediment characterization surveys, would describe the radiological and hazardous chemical conditions within WMA 4 at the completion of all decommissioning activities.

C.3.2.5 Waste Management Area 5: Waste Storage Area

Under the Sitewide Close-In-Place Alternative, Lag Storage Area 4 and the associated Shipping Depot and Remote-Handled Waste Facility would be demolished to grade. The underground portion of the Remote-Handled Waste Facility would be filled with appropriate clean backfill material, and the remaining concrete floor slabs and foundations would remain in place.

C.3.2.5.1 Demolition of the Lag Storage Area 4 and Shipping Depot

The structures would be demolished without confinement to their floor slabs and foundations, with the demolition debris disposed of off site as construction and demolition debris. The disposal facilities assumed for final disposition of these types of wastes are local construction and demolition debris landfills or sanitary landfills.

C.3.2.5.2 Demolition of the Remote-Handled Waste Facility

Closure of this facility under a NYSDEC-approved RCRA closure plan would be coordinated with other demolition requirements. The Remote-Handled Waste Facility would be demolished to grade level by conventional methods without confinement.

Equipment would be disposed of as Class A low-level radioactive waste. The office building demolition debris would be disposed of as construction and demolition debris. The underground decontamination Waste Transfer Lines from the Batch Transfer Tank to Tank 8D-3 in WMA 3 would be grouted and remain in place. The majority of the debris generated from the facility demolition would be classified as low-specific-activity waste.

After completion of this work, a final status survey would be performed in the underground vault, and arrangements would be made for any necessary independent verification surveys. After completion of these surveys, the vault would be covered with appropriate clean backfill material.

C.3.2.5.3 Completion of Final Status Surveys in Waste Management Area 5

After completion of decommissioning activities within WMA 5, a final status survey of the area would be performed in accordance with a final status survey plan. RCRA confirmatory sampling would also be performed. Arrangements would also be made for independent verification surveys.

The results of the surveys, combined with information such as groundwater monitoring data, historical subsurface soil sample data, the results of the initial surface soil and sediment characterization surveys, and data from the final status survey of the Remote-Handled Waste Facility vault, would describe the radiological and hazardous chemical conditions within WMA 5 at the completion of all decommissioning activities. This information would be used to confirm that decommissioning requirements have been met.

C.3.2.5.4 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Close-In-Place Alternative in WMA 5 are presented in **Table C–33**.

Table C–33 Estimated Waste to be Generated: Waste Management Area 5

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	24,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	51,000
Class A	33,000
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

C.3.2.6 Waste Management Area 6: Central Project Premises

Under the Sitewide Close-In-Place Alternative, the Rail Spur and Low-Level Waste Rail Packaging and Staging Area would remain in place. The Demineralizer Sludge Ponds, Equalization Basin, and Equalization Tank would be covered with appropriate fill. The Sewage Treatment Plant and South Waste Tank Farm Test Tower would be demolished to ground level, and remaining subsurface facilities would be filled with appropriate clean backfill material.

C.3.2.6.1 Removal of Structures/Facilities

Demineralizer Sludge Ponds

A final status survey would be performed in both ponds. Arrangements would be made for independent verification surveys. After completion of the surveys, the ponds would be filled with appropriate clean backfill material.

Equalization Basin

To eliminate the future potential for perched water in the Equalization Basin, the liner would be removed and disposed of off site as construction and demolition debris, and the influent line would be filled with concrete. After completion of this work, a final status survey would be performed in the area, and arrangements would be made, as needed, for independent verification surveys. After completion of the surveys, the area would be filled with compacted soil.

Equalization Tank

The Equalization Tank would be partially demolished using conventional methods to prevent accumulation of water. A final status survey would be performed in the area, and arrangements would be made, as needed, for independent verification surveys. After completion of the surveys, the tank would be filled with appropriate clean backfill material.

Sewage Treatment Plant

The facility would be removed to its concrete slab using conventional demolition methods. It is assumed that the demolition debris would be disposed of off site as construction and demolition debris. The underground concrete tanks associated with the plant would remain in place. However, they would be partially demolished to prevent accumulation of water and filled with appropriate clean backfill material.

South Waste Tank Farm Test Tower

This test tower would be removed to its concrete foundation using conventional demolition methods, and the debris would be disposed of off site as construction and demolition debris.

C.3.2.6.2 Completion of Final Status Surveys

After completion of decommissioning activities within WMA 6, a final status survey of the area would be performed in accordance with a final status survey plan. RCRA confirmatory sampling would also be performed. Arrangements would also be made, as needed, for independent verification surveys.

The results of the surveys, combined with information such as groundwater monitoring data, historical subsurface soil sample data, the results of the initial surface soil and sediment characterization surveys, and data from the final status surveys of the Equalization Basin, Equalization Tank, and Demineralizer Sludge Ponds, would describe the radiological and hazardous chemical conditions within WMA 6 at the completion of all decommissioning activities. This information would be used to confirm decommissioning requirements have been met.

C.3.2.6.3 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Close-In-Place Alternative in WMA 6 are presented in **Table C–34**.

Table C–34 Estimated Waste to be Generated: Waste Management Area 6

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	7,300
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	1,200
Class A	100
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

C.3.2.7 Waste Management Area 7: NRC-Licensed Disposal Area and Associated Facilities

Under the Sitewide Close-In-Place Alternative, the existing NDA geomembrane cover would be replaced with a robust multi-layer cap similar in design to the WMA 1 and WMA 3 multi-layer cap. Leachate would be removed from some of the disposal holes and trenches, and grout would be injected to stabilize them. A new standalone Leachate Treatment Facility, discussed in Section C.4.5, would be constructed for this purpose. This facility would also be used to support decommissioning activities at the SDA. The Liquid Pretreatment System would be removed. The Interceptor Trench would be emptied of leachate and filled with material such as cement grout. The buried Leachate Transfer Line, existing outside of the WMA 2 excavations, would be abandoned in place. The former lagoon and upgradient NDA barrier wall would also remain in place.

C.3.2.7.1 Removal of Structures/Facilities

Liquid Pretreatment System

The equipment in the Liquid Pretreatment System would be reduced in size, as necessary, and transported off site for disposal as construction and demolition debris. The structures would be demolished by conventional means, and the rubble would be disposed of off site as construction and demolition debris.

Interceptor Trench

Water would be drained from the trench and the sump. The trench would then be grouted using either a dilute Portland cement-sand slurry or a silicate grout mixture that would be introduced into the trench backfill through a series of injection lances either driven vertically into, or excavated directly alongside, the trench. A surface-based pressure grouting apparatus would be used for injecting grout into the injection lances. The seven associated manholes and connecting drain pipes would also be filled with grout.

C.3.2.7.2 Leachate Removal and Grouting of Holes, Trenches, and Caissons

Prior to constructing the multi-layer cover system, selected disposal holes and trenches within the NDA would be grouted to mitigate the potential effects of future long-term subsidence. An area-based criterion would be used for selecting disposal holes and trenches to be grouted. Leachate would be removed, as necessary, from these areas as they are grouted.

Portions of the geomembrane cover would be removed, as necessary, to support leachate removal and grouting work. These portions would be reinstalled after the work is completed so the geomembrane would remain essentially intact until installation of the multi-layer cap begins.

Disposal holes and trenches that have any surface dimension greater than 6.1 meters (20 feet) in length would be grouted based on the area-based criterion. For conceptual design purposes, it has been assumed that the disposal trenches and holes selected for grouting would be grouted from approximately 1.2 meters (4 feet) below the ground surface to their bottoms.

Removal and Treatment of Leachate

Before initiating grouting, leachate may need to be extracted from disposal holes or trenches that contain significant amounts of leachate. The leachate would be treated in the Leachate Treatment Facility, and the treated effluent would be released though an SPDES-permitted outfall. Leachate management would continue in parallel with trench grouting.

Installation of Grout

Grout injection pipes would be driven into the NDA disposal holes and trenches selected for grouting; the intent of this action would be to inject grout to fill void spaces present within the disposal holes and trenches. The pipes would be installed in an appropriate pattern at a grid spacing designed to be sufficient to promote a very high percentage of void space infilling. An estimated 6,700 cubic meters (235,000 cubic feet) of grout would be injected to fill the void spaces within these holes and trenches. It is also assumed that an equal quantity of leachate would be displaced.

Caissons

The caissons would be covered by the multi-layer caps. Based on their small surface dimensions, grout is not assumed to be necessary.

C.3.2.7.3 Installation of Engineered Multi-layer Cover System

The design and installation of the NDA multi-layer cap would be similar to the WMA 1 and WMA 3 multi-layer cap. It is discussed in Section C.4.11.

C.3.2.7.4 Erosion Control Features

Installation of the erosion control features discussed in Section C.4.13 would be coordinated with construction of the NDA (and SDA) caps so the features that support surface water drainage in the cap area would be in place when cap installation is completed.

C.3.2.7.5 Final Conditions

After the NDA closure system is in place and as other decommissioning work associated with this alternative is being completed, the NDA area would be monitored and maintained. A perimeter of large boulders would be installed around the NDA to eliminate the potential for future vehicular access to the cap. The environmental monitoring program would include monitoring the effectiveness of the cover system and barrier wall in limiting infiltration of precipitation and groundwater into the burial area.

C.3.2.7.6 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Close-In-Place Alternative in WMA 7 are presented in **Table C–35**. The estimates include the construction and operation of all structures, other than the Leachate Treatment Facility, supporting the exhumation activities in WMA 7. The estimated waste volumes expected to be generated during the construction, operation, and closure of the Leachate Treatment Facility, which would be built to support the waste processing activities in the NDA and SDA, are presented in **Table C–36**. Sitewide erosion controls are not included in these tables.

Table C–35 Estimated Waste to be Generated: Waste Management Area 7

Waste Type	*Waste Volume (cubic feet)* [a]
Construction and Demolition Debris	15,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	0
Class A	0
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

[a] The waste volumes do not include those associated with the Leachate Treatment Facility.
Note: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

Table C–36 Estimated Waste to be Generated: Leachate Treatment Facility

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	2,200
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	12,000
Class A	35,000
Class B	0
Class C	980
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	13,000
Transuranic Waste	0

Note: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

C.3.2.8 Waste Management Area 8: State-Licensed Disposal Area and Associated Facilities

The following activities would take place under the Sitewide Close-In-Place Alternative:

- The three tanks and associated equipment in the Mixed Waste Storage Facility would be removed, and the facility would be demolished to grade.
- The Leachate Treatment Facility, described in Section C.4.5, would be used to pump out and treat leachate from the SDA trenches.
- The SDA burial trenches would be grouted to mitigate potential subsidence.
- An engineered multi-layer cap similar to those used for the NDA and WMAs 1 and 3 would be installed over the SDA.
- The SDA lagoons would be left in place.

The SDA would be closed in accordance with a closure plan approved by the NYSDEC Hazardous Waste and Radiation Programs.

C.3.2.8.1 Removal of Structures/Facilities

Mixed Waste Storage Facility

Characterization surveys would be performed in the facility. Any remaining leachate in the tanks would be removed and processed in the Leachate Treatment Facility. The tanks and other equipment would be removed and reduced in size, as necessary. Tank T-1 could be disposed of as either Class A low-level radioactive waste or mixed low-level radioactive waste.[2] It is assumed that Tanks T-2 and T-3 would be disposed of as construction and demolition debris because they were never used. However, these tanks may be sold or recycled. The structures would be demolished by conventional means.

C.3.2.8.2 Leachate Removal and Trench Grouting

Prior to constructing the multi-layer cover system, burial trenches within the SDA would be grouted to mitigate the potential effects of long-term subsidence within these trenches on the cover system. Portions of the geomembrane cover would be removed, as necessary, to facilitate this work.

Leachate would be pumped from the SDA trenches and treated at the Leachate Treatment Facility before and during the trench grouting activities. It is assumed that approximately 40,000 cubic meters (1.4 million cubic feet) of grout would be used to properly stabilize the SDA trenches and that an equal volume of leachate would be processed.

C.3.2.8.3 Installation of Engineered Multi-layer Cover System

The design and installation of the SDA multi-layer cap would be similar to the NDA cap. It is discussed in Section C.4.11.

C.3.2.8.4 Erosion Control Features

Installation of the erosion control features described in Section C.4.13 would be coordinated with construction of the SDA cap (and NDA cap) so the features that support surface water drainage in the cap area would be in place when cap installation is completed.

C.3.2.8.5 Final Conditions

After the SDA closure system is in place, and as other decommissioning work associated with this alternative is being completed, the SDA area would be monitored and maintained. A perimeter of large boulders would be installed around the SDA to deter vehicular access to the capped area. The environmental monitoring program would include monitoring the effectiveness of the cover system, the barrier wall, and the French drain in limiting infiltration of precipitation and groundwater into the burial area.

C.3.2.8.6 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Close-In-Place Alternative in WMA 8 are presented in **Table C–37**. The estimated waste to be generated from the construction, operation, and demolition of the Leachate Treatment Facility is given in Table C–36.

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[2] *Tank T–1 may be removed prior to the starting point of this EIS. For purposes of analysis in this EIS, Tank T-1 is included in the inventory of low-level radioactive waste.*

Table C–37 Estimated Waste to be Generated: Waste Management Area 8

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	70,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	10,000
Class A	1,400
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Note: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

C.3.2.9 Waste Management Area 9: Radwaste Treatment System Drum Cell

Under the Sitewide Close-In-Place Alternative, the Drum Cell would be removed, along with its associated monitoring shed. There are no planned activities for the Subcontractor Maintenance Area. The NDA Trench Soil Container Area (pad) would also be left in place.

C.3.2.9.1 Removal of the Radwaste Treatment System Drum Cell

Before decommissioning activities begin in WMA 9, characterization surveys of surface soil and sediment in the area and inside the Drum Cell would be performed. The Drum Cell would be demolished using conventional means to its gravel pad and foundation. It is assumed that the demolition debris would be disposed of off site as construction and demolition debris. The disposal facilities assumed for final disposition of these types of waste are local construction and demolition debris landfills or sanitary landfills.

After completion of this work, final status surveys of the area would be performed. RCRA confirmatory sampling would also be performed. Arrangements would also be made for independent verification surveys. The results of the surveys, combined with information such as groundwater monitoring data, historical subsurface soil sample data, and the results of the initial surface soil and sediment characterization surveys, would describe the radiological and hazardous chemical conditions within WMA 9 at the completion of all decommissioning activities. This information would be used to confirm that decommissioning requirements have been met.

C.3.2.9.2 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Close-In-Place Alternative in WMA 9 are presented in **Table C–38**.

Table C–38 Estimated Waste to be Generated: Waste Management Area 9

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	89,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	0
Class A	0
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

C.3.2.10 Waste Management Area 10: Support and Services Area

Under the Sitewide Close-In-Place Alternative, the New Warehouse would be demolished to grade. The Meteorological Tower and the Security Gatehouse and fences would remain in place. The remaining floor slabs and foundations would also remain in place.

C.3.2.10.1 Removal of Structures/Facilities

New Warehouse

The New Warehouse would be demolished using conventional means to its concrete slab, and the demolition debris would be disposed of off site as construction and demolition debris.

After completion of this work, final status surveys of the area would be performed. RCRA confirmatory sampling would also be performed. Arrangements would also be made for independent verification surveys. The results of the surveys, combined with information such as groundwater monitoring data, historical subsurface soil sample data, and the results of the initial surface soil and sediment characterization surveys, would completely describe the radiological and hazardous chemical conditions within WMA 10 at the completion of all decommissioning activities. This information would be used to confirm that decommissioning requirements have been met.

C.3.2.10.2 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Close-In-Place Alternative in WMA 10 are presented in **Table C–39**.

Table C–39 Estimated Waste to be Generated: Waste Management Area 10

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	23,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	0
Class A	0
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

C.3.2.11 Waste Management Area 11: Bulk Storage Warehouse and Hydrofracture Test Well Area

No decommissioning activities would take place in WMA 11 under the Sitewide Close-In-Place Alternative. As a result, no waste would be generated. The results of the final status survey, and RCRA confirmatory sampling, combined with information such as groundwater monitoring data, historical subsurface soil sample data, and the results of the initial surface soil and sediment characterization surveys would describe the radiological and hazardous chemical conditions within WMA 11 at the completion of all decommissioning activities. This information would be used to confirm that decommissioning requirements have been met.

C.3.2.12 Waste Management Area 12: Balance of Site

Under the Sitewide Close-In-Place Alternative, the dams and reservoirs would be taken out of service in accordance with applicable Federal and state regulations. The streambeds of Erdman Brook, Franks Creek, and Buttermilk Creek downstream of its confluence with Franks Creek, which have been impacted by releases of treated radioactive effluent or unintentional releases, would be subject to characterization surveys. These surveys would focus primarily on the known impacted areas. Parking lots and roadways would remain in place. The removal of the dams and reservoirs would proceed in the same manner as under the Sitewide Removal Alternative, discussed in Section C.3.1.12.1, except that only the middle third of the dams would be removed. Removal of a steel bridge spanning a reservoir and the reservoirs would not occur until after the high-level waste canisters have been removed from the site.

Much of the data collected during characterization surveys would be intended to serve final status survey purposes as well, because remediation of any areas exceeding DCGLs would not be undertaken for this alternative. Given this situation, arrangements would be made for any necessary independent verification surveys to be performed in conjunction with or following the characterization surveys.

At the conclusion of all site decommissioning activities, final status surveys of WMA 12 would be performed. These surveys would focus on areas that may have been impacted during decommissioning activities, taking into account the scope and results of the characterization surveys. RCRA confirmatory sampling would also be performed. Arrangements would also be made, as needed, for independent verification surveys. The results of these surveys, combined with information such as the results of the initial surface soil and sediment characterization surveys and the results of the site environmental monitoring program, would be used to confirm that decommissioning requirements have been met.

Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Sitewide Close-In-Place Alternative in WMA 12 are presented in **Table C–40**. The estimate includes miscellaneous sitewide generation of waste from activities including maintenance of existing facilities, security, environmental monitoring installations, security installations, erosion control installations, and long-term monitoring and maintenance. Although portions of these wastes could be generated in other areas of the site, they are included in the WMA 12 totals.

Table C–40 Estimated Waste to be Generated: Waste Management Area 12

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	99,000
Hazardous Waste	36
Low-level Radioactive Waste	
Low Specific Activity	4,800
Class A	26,000
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Note: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

C.3.2.13 North Plateau Groundwater Plume

As discussed in Section C.2.13, a pump and treat system (Groundwater Recovery System), a pilot-scale permeable treatment wall, and a full-scale permeable treatment wall would have been installed at the starting point of this EIS for groundwater mitigation and remediation of the North Plateau Groundwater Plume.

Under the Sitewide Close-In-Place Alternative, the Groundwater Recovery System would be decommissioned. The permeable treatment wall would be periodically replaced approximately every 20 years.

The circumferential hydraulic barrier wall that would be installed around WMAs 1 and 3 under this alternative would provide containment of the upgradient portions of the North Plateau Groundwater Plume, where the source of the plume would remain in place. The plume would be allowed to decay in place.

The estimated waste volumes to be generated under the Sitewide Close-In-Place Alternative from the maintenance of the nonsource area of the North Plateau Groundwater Plume are presented in **Table C–41**. The waste volumes are entirely due to the periodic replacement of the permeable treatment wall.

C.3.2.14 Cesium Prong

The Cesium Prong would be managed by implementing restrictions on use for a nominal period of 100 years until in-place decay results in levels allowing for unrestricted use. As a result, no waste would be generated.

Table C–41 Estimated Waste to be Generated: North Plateau Groundwater Plume (nonsource area)

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	0
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	217,000
Class A	1,000
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009b.

C.3.3 Phased Decisionmaking Alternative

Under the Phased Decisionmaking Alternative, decommissioning would be carried out in two phases:

Phase 1

- Phase 1 would include removal of all WMA 1, 2, 5, and 9 facilities, the WMA 2 lagoons, the source area of the North Plateau Groundwater Plume, and all facilities other than the Rail Spur in WMA 6. No WMA 4, 8, or 11 facilities or areas would be removed.

  In WMA 3, mobilization and transfer pumps associated with Tanks 8D-1 through 8D-4 and the piping associated with the High-Level Waste Transfer Trench would be removed, as would the Waste Tank Farm Equipment Shelter and Condensers, the Permanent Ventilation System Building, and the Con-Ed Building. The NDA HardStand Staging Area would be removed in WMA 7, and the New Warehouse would be removed in WMA 10. The permeable treatment wall in the North Plateau Groundwater Plume area would be periodically replaced.

  Various floor slabs, gravel pads, and foundations in WMAs 1, 2, 5, 6, 9, and 10 would be removed during Phase 1. Parts or all of WMAs 3, 4, 6, 7, 8, 10, and 12; the North Plateau Groundwater Plume area; and the Cesium Prong would be monitored and maintained. Section C.3.3.5.3 contains more detailed information about these activities.

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

Phase 2

- Phase 2 would complete decommissioning, following the approach determined through evaluations from the site characterization and studies to be conducted during and subsequent to Phase 1.

During Phase 1, the site would undergo an operations, monitoring, and maintenance program that is similar in concept but lesser in magnitude to what is currently in place at the site. Because the Main Plant Process

Building and lagoons would have been removed, these facilities would no longer require operations support, and monitoring and maintenance requirements would be significantly reduced. However, the environmental monitoring program, modified as needed to better fit the remaining WMAs, would continue at a magnitude similar to the current program. Environmental monitoring, modified as necessary, would ensure that unforeseen adverse impacts resulting from Phase 1 remedial activities or recontamination of Phase 1 sources are evaluated. Additionally, inspections and subsequent maintenance activities that are undertaken currently (e.g., erosion inspections, monitoring and maintenance, stormwater monitoring, cap maintenance) to safely operate the site would be continued until final disposition of the remaining WMAs is selected and implemented.

The following sections discuss in more detail the decommissioning activities that would take place during Phase 1 of the Phased Decisionmaking Alternative for each WMA.

Unless otherwise noted, information presented in Section C.3.3 is from the *Phased Decisionmaking Alternative Technical Report* (WSMS 2009c).

C.3.3.1 Waste Management Area 1: Main Plant Process Building and Vitrification Facility Area

During Phase 1 of the Phased Decisionmaking Alternative, the high-level radioactive waste canisters stored in the Main Plant Process Building would be relocated. All facilities, including underground structures and remaining floor slabs and foundations of WMA 1, would be removed. These facilities include the Main Plant Process Building; Vitrification Facility; 01-14 Building; Load-In/Load-Out Facility; Utility Room and Utility Room Expansion; Plant Office Building; Fire Pumphouse; Water Storage Tank; Electrical Substation; Off-Gas Trench; underground tanks (7D-13, 15D-6, 35104); and underground process, wastewater, and utility lines. The source area of the North Plateau Groundwater Plume would also be removed.

C.3.3.1.1 Relocation of the High-Level Radioactive Waste Canisters

Activities associated with relocation of the high-level radioactive waste canisters during Phase 1 of the Phased Decisionmaking Alternative are the same as those that would occur under the Sitewide Removal Alternative. They are discussed in Section C.3.1.1.1.

C.3.3.1.2 Demolition of the Main Plant Process Building

The process for demolition of the Main Plant Process Building under this alternative would be the same as the process under the Sitewide Removal Alternative, discussed in Section C.3.1.1.2.

C.3.3.1.3 Demolition of Other Waste Management Area 1 Structures

The process for demolition of all the remaining structures under this alternative would be the same as the process under the Sitewide Removal Alternative, discussed in Sections C.3.1.1.2 through C.3.1.1.6.

C.3.3.1.4 Excavation and Hydraulic Barrier Wall Installation

To facilitate removal of the underground structures of the Main Plant Process Building and Vitrification Facility, along with the source area of the North Plateau Groundwater Plume, an area larger than the footprint of both buildings would be excavated, as under the Sitewide Removal Alternative. The discussion of the excavation and the hydraulic barrier wall installation is included in Section C.3.1.1.7 and in the following sections.

C.3.3.1.5 Removal of the Plume Source Area, Underground Structures, and Equipment

The process for the removal of the North Plateau Groundwater Plume source area and the underground structures and equipment under this alternative would be the same as that for the Sitewide Removal Alternative, discussed in Section C.3.1.1.8, with some minor exceptions. In the same manner as the Sitewide Removal Alternative, soil would be excavated to a depth of at least 0.3 meters (1 foot) into the Lavery till; the extent of additional soil removal would be determined by the use of cleanup goals specified in the *Phase 1 Decommissioning Plan for the West Valley Demonstration Project (Decommissioning Plan).* Remedial action surveys would be performed during the course of the work, and soil on the bottom of the excavation with radioactivity concentrations exceeding the cleanup goals would be removed and disposed of off site as radioactive waste. Soil would be excavated up to the barrier wall. The other sides of the WMA 1 excavation would have a side slope of approximately 45 degrees.

The horizontal limits of the excavation would be based primarily on physical considerations, although consideration would also be given to analytical data on subsurface soil contamination at the planned excavation boundary acquired early during Phase 1.

C.3.3.1.6 Site Restoration

The process for the site restoration of WMA 1 would be the same as that discussed for the Sitewide Removal Alternative in Section C.3.1.1.9.

C.3.3.1.7 Disposition of Support Facility Materials

The disposition of support facility material would be the same as that for the Sitewide Removal Alternative, discussed in Section C.3.1.1.10.

C.3.3.1.8 Estimated Waste to be Generated

The estimated waste volumes expected to be generated under the Phased Decisionmaking Alternative in WMA 1 are presented in **Table C–42**. The estimate includes the modification of the Load-In/Load-Out Facility and the operation and demolition of the Interim Storage Facility (Dry Cask Storage Area) associated with the high-level waste canister removal.

Table C–42 Estimated Waste to be Generated: Waste Management Area 1

Waste Type	***Waste Volume (cubic feet)***
Construction and Demolition Debris	440,000
Hazardous Waste	83
Low-level Radioactive Waste	
Low Specific Activity	3,500,000
Class A	280,000
Class B	3,100
Class C	9,000
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	1,400
Transuranic Waste	24,000

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009c.

C.3.3.2 Waste Management Area 2: Low-Level Waste Treatment Facility Area

The Phased Decisionmaking Alternative approach to closing WMA 2 is removal of all remaining surface structures and concrete floor slabs, exhumation of the contaminated waste and sediment contained in Lagoon 1, excavation of all contaminated sediment from Lagoons 2 and 3, removal of liners from Lagoons 4 and 5 and underlying contaminated soil, and restoration of the surface to a natural contour. The permeable treatment wall installed for the starting point of the EIS would be periodically replaced.

The difference between the Phased Decisionmaking Alternative and the Sitewide Removal Alternative for WMA 2 is the construction of a subsurface soil-cement-bentonite barrier wall. This barrier wall would be installed under the Phased Decisionmaking Alternative to prevent migration of the North Plateau Groundwater Plume back into the remediated source area and Main Plant Process Building excavation. Other than this difference, the decommissioning activities in WMA 2 for Phase 1 of the Phased Decisionmaking Alternative are the same as those discussed in Section C.3.1.2 for the Sitewide Removal Alternative. The barrier wall would be installed as discussed previously in Section C.3.1.1.7.

Estimated Waste to be Generated

The estimated waste volumes expected to be generated during Phase 1 of the Phased Decisionmaking Alternative in WMA 2 are presented in **Table C–43**.

Table C–43 Estimated Waste to be Generated: Waste Management Area 2

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	50,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	1,500,000
Class A	340,000
Class B	0
Class C	33,000
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009c.

C.3.3.3 Waste Management Area 3: Waste Tank Farm Area

During Phase 1 of the Phased Decisionmaking Alternative, Tanks 8D-1, 8D-2, 8D-3, and 8D-4 would remain in place, as would the Permanent Ventilation System Building, STS Support Building, and underground piping in the area. The tanks would continue to be monitored and maintained with the Tank and Vault Drying System, as necessary. However, the high-level waste mobilization and transfer pumps would be removed from the tanks. The Equipment Shelter and Condensers, the Con-Ed Building, and piping in the High-Level Waste Transfer Trench would be removed.

C.3.3.3.1 Removal of Waste Tank Pumps and Pump Support Structures

The process of removing the waste tank pumps and the pump support structures would be the same as that for the Sitewide Removal Alternative; however, the Phased Decisionmaking Alternative does not include construction of the Waste Tank Farm Waste Processing Facility. Instead, temporary shelters and confinements would be erected to support this work. Descriptions of the pumps, support structures, and removal process are included in Section C.3.1.3.2.

C.3.3.3.2 Removal of High-Level Waste Transfer Trench Piping

The process of removing the High-Level Waste Transfer Trench piping would be the same as that for the Sitewide Removal Alternative, described in Section C.3.1.3.3.

C.3.3.3.3 Removal of the Permanent Ventilation System Building

The process for removing the Permanent Ventilation System Building would be the same as that for the Sitewide Removal Alternative, described in Section C.3.1.3.4.

C.3.3.3.4 Demolition of Equipment Shelter and Condensers

The demolition of the Equipment Shelter and Condensers would be performed the same way as under the Sitewide Removal Alternative, discussed in Section C.3.1.3.5.

C.3.3.3.5 Demolition of the Con-Ed Building

The demolition of the Con-Ed Building would be performed the same way as under the Sitewide Removal Alternative, discussed in Section C.3.1.3.6.

C.3.3.3.6 Monitoring and Maintenance

Monitoring and maintenance of the Waste Tank Farm would continue during Phase 1 of the Phased Decisionmaking Alternative. The Tank and Vault Drying System installed in achieving the starting point of the EIS would remain in operation. Decommissioning of the Waste Tank Farm would be conducted during Phase 2.

A dewatering well was installed during the construction of the waste tanks and has been used on a nearly continual basis to maintain the static water levels in the Waste Tank Farm Area in a depressed condition. The location of the dewatering well is approximately between Tanks 8D-1 and 8D-2, adjacent to the Permanent Ventilation System Building.

The dewatering well would continue to be used to lower the water table to minimize inleakage of groundwater into the tank vaults. After the Low-Level Waste Treatment Facility is taken out of operation, it is assumed that the water would be collected, sampled, and released to Erdman Brook through a new SPDES-permitted outfall. Once the Low-Level Waste Treatment Facility is taken out of service and remediation is undertaken in this area, a groundwater holding tank would be required to complement the dewatering well process. It is estimated that a 76,000-liter (20,000-gallon) tank would be required for this purpose.

C.3.3.3.7 Estimated Waste to be Generated

The estimated waste volumes expected to be generated during Phase 1 of the Phased Decisionmaking Alternative in WMA 3 are presented in **Table C–44**.

Table C–44 Estimated Waste to be Generated: Waste Management Area 3

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	88,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	3,500
Class A	5,300
Class B	720
Class C	1,300
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	1,200

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009c.

C.3.3.4 Waste Management Area 4: Construction and Demolition Debris Landfill

The CDDL would continue to be monitored and maintained during Phase 1 of the Phased Decisionmaking Alternative. No waste would be generated.

C.3.3.5 Waste Management Area 5: Waste Storage Area

During Phase 1 of the Phased Decisionmaking Alternative, Lag Storage Area 4 and the associated Shipping Depot and Remote-Handled Waste Facility would be removed. The remaining concrete floor slabs and foundations would also be removed. The work to be performed in WMA 5 under this alternative is the same as that under the Sitewide Removal Alternative, described in Section C.3.1.5.

C.3.3.5.1 Demolition of Lag Storage Area 4

The structures would be demolished without confinement and the floor slabs and foundations would be removed; resulting demolition debris would be disposed of off site as construction and demolition debris. Detailed discussion of this work is included in Section C.3.1.5.1.

Following removal of the structure and floor slab, up to 0.6 meters (2 feet) of soil would also be removed. Following this excavation, radiological surveys and RCRA confirmatory sampling would be performed to document conditions, and then backfilling would occur.

C.3.3.5.2 Demolition of the Remote-Handled Waste Facility

Closure of this facility under an NYSDEC-approved RCRA closure plan would be coordinated with its demolition under the *Decommissioning Plan*. The Remote-Handled Waste Facility would be demolished by conventional methods without confinement after it has completed processing of all equipment and waste requiring remote handling and characterization. Demolition of the structure would include removal of the underground tank vault; the rest of the building would be taken down entirely.

The demolition debris would be handled as low-specific-activity waste except the office building debris would be handled as construction and demolition debris and disposed of off site. The underground decontamination Waste Transfer Lines from the Batch Transfer Tank to Tank 8D-3 in WMA 3 would be cut off, characterized, and disposed of as Class A low-level radioactive waste.

Following removal of the structure and floor slab, up to 0.6 meters (2 feet) of soil would also be removed. Following this excavation, radiological surveys and RCRA confirmatory sampling would be performed collected to document conditions, and then backfilling would occur.

C.3.3.5.3 Removal of Remaining Floor Slabs, Foundations, and Gravel Pads

All remaining concrete floor slabs and foundations would be removed, including those associated with the Lag Storage Building, Lag Storage Area 1, and Lag Storage Area 3. The Lag Storage Area 2 Hardstand would also be removed, along with the gravel pads associated with the Chemical Process Cell Waste Storage Area, Hazardous Waste Storage Lockers, Cold Hardstand Area, Vitrification Vault and Empty Container Hardstand, Old/New Hardstand Area, and Lag Hardstand.

The floor slabs, foundations, hardstands, and gravel pads would be demolished by conventional means. The demolition debris would be disposed of as uncontaminated construction and demolition debris.

Following removal of the structure and floor slab, up to 0.6 meters (2 feet) of soil would also be removed. Following this excavation, radiological surveys and RCRA confirmatory sampling would be performed to document conditions, and then backfilling would occur.

C.3.3.5.4 Estimated Waste to be Generated

The estimated waste volumes expected to be generated during Phase 1 of the Phased Decisionmaking Alternative in WMA 5 are presented in **Table C–45**.

Table C–45 Estimated Waste to be Generated: Waste Management Area 5

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	190,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	100,000
Class A	32,000
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009c.

C.3.3.6 Waste Management Area 6: Central Project Premises

During Phase 1 of the Phased Decisionmaking Alternative, the Rail Spur would remain in place. The Demineralizer Sludge Ponds, Equalization Basin, Equalization Tank, Sewage Treatment Plant, South Waste Tank Farm Test Tower, and Low-Level Waste Rail Packaging and Staging Area would be removed, along with the remaining pads and concrete floor slabs and foundations.

C.3.3.6.1 Removal of Structures/Facilities

During Phase 1 of the Phased Decisionmaking Alternative, the removal of structures, other than the Rail Spur, would be the same as that for the Sitewide Removal Alternative. The process of removing the structures in WMA 6 is described in Section C.3.1.6.1.

C.3.3.6.2 Removal of Remaining Floor Slabs and Foundations

The remaining floor slabs and foundations in the area, including underground structures of the Cooling Tower, would be removed along with up to 0.6 meters (2 feet) of underlying soil. Radiological and RCRA confirmatory sampling surveys would then be performed to document the conditions of the base of the excavation. After completion of the surveys, the excavated areas would be filled with appropriate clean backfill material.

C.3.3.6.3 Estimated Waste to be Generated

The estimated waste volumes expected to be generated during Phase 1 of the Phased Decisionmaking Alternative in WMA 6 are presented in **Table C–46**.

Table C–46 Estimated Waste to be Generated: Waste Management Area 6

Waste Type	***Waste Volume (cubic feet)***
Construction and Demolition Debris	51,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	37,000
Class A	310
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009c.

C.3.3.7 Waste Management Area 7: NRC-Licensed Disposal Area and Associated Facilities

The NDA would continue to be monitored and maintained during Phase 1 of the Phased Decisionmaking Alternative. No decommissioning actions related to the NDA itself would take place in this phase of the alternative. The only Phase 1 decommissioning actions would involve removal of the remaining concrete slab and gravel pad associated with the NDA Hardstand. This work is discussed as part of WMA 9 activities in Section C.3.3.9, which also includes the removal of the pad at the NDA Trench Soil Container Area.

The disposition of the NDA and any related decommissioning actions would be reflected in the Phase 2 decommissioning plan.

Estimated Waste to be Generated

The estimated waste volumes expected to be generated during Phase 1 of the Phased Decisionmaking Alternative in WMA 7 are presented in **Table C–47**. The estimate includes wastes generated from maintenance activities only.

Table C–47 Estimated Waste to be Generated: Waste Management Area 7

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	2,100
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	0
Class A	22,000
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009c.

C.3.3.8 Waste Management Area 8: State-Licensed Disposal Area and Associated Facilities

Under this alternative, active management of the SDA would continue in accordance with applicable Federal and state regulations. The associated Mixed Waste Storage Facility would remain operational. The performance of the SDA would also be assessed annually to confirm that management activities would continue to protect public health and safety and the environment. Like the NDA, the SDA would continue to be monitored and maintained during Phase 1. No action would be taken for the Waste Storage Facility.

Estimated Waste to be Generated

The estimated waste volumes expected to be generated during Phase 1 of the Phased Decisionmaking Alternative in WMA 8 are presented in **Table C–48**. The estimate includes waste generated from maintenance activities and geomembrane replacement.

Table C–48 Estimated Waste to be Generated: Waste Management Area 8

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	900
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	7,300
Class A	1,000
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009c.

C.3.3.9 Waste Management Area 9: Radwaste Treatment System Drum Cell

C.3.3.9.1 Removal of the Radwaste Treatment System Drum Cell

The Drum Cell would be demolished by conventional means and the floor slab and foundation removed. It is assumed that the majority of demolition debris would be disposed of off site as construction and demolition debris. The work involved in this task is described in detail in Section C.3.1.9.

The gravel pad associated with the NDA Trench Soil Container Area would be removed to its 0.3-meter (1-foot) depth. Also, the footprint of the NDA Hardstand Area would be excavated to 0.3 meters (1 foot) below-grade, and the excavated materials would be disposed of off site as low-specific-activity waste. Surveys would be performed in the excavated areas to document conditions. After completion of the surveys, the area would be filled with appropriate clean backfill material. Sampling would also be performed to verify that hazardous constituents are below appropriate regulatory guidance levels.

The trailers in the Subcontractor Maintenance Area would be demolished by conventional means and the debris managed as construction and demolition debris waste. The gravel pad in the area would also be managed as this type of waste.

C.3.3.9.2 Estimated Waste to be Generated

The estimated waste volumes expected to be generated during Phase 1 of the Phased Decisionmaking Alternative in WMA 9 are presented in **Table C–49**.

Table C–49 Estimated Waste to be Generated: Waste Management Area 9

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	250,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	56,000
Class A	100
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009c.

C.3.3.10 Waste Management Area 10: Support and Services Area

The Phased Decisionmaking Alternative closure approach for WMA 10 is demolition and removal of the New Warehouse, along with the remaining concrete floor slabs and foundations, during Phase 1. The Meteorological Tower, Security Gatehouse, and security fence would remain in place and operational.

C.3.3.10.1 Removal of Structures/Facilities

The New Warehouse and former Waste Management Staging Area, including the floor slabs, would be demolished, and the debris would be disposed of off site as uncontaminated construction and demolition debris.

The remaining floor slabs and foundations in the area, including those for the Administration Building, the Expanded Environmental Laboratory, the Vitrification Diesel Fuel Storage Building, and the Construction Fabrication Shop, would be removed. After completion of this work, radiological surveys and RCRA confirmatory sampling would be performed in each excavated area to document conditions. After completion of the surveys, the excavated areas would be filled with appropriate clean backfill material and contoured to grade.

C.3.3.10.2 Estimated Waste to be Generated

The estimated waste volumes expected to be generated during Phase 1 of the Phased Decisionmaking Alternative in WMA 10 are presented in **Table C–50**.

Table C–50 Estimated Waste to be Generated: Waste Management Area 10

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	59,000
Hazardous Waste	0
Low-level Radioactive Waste	
Low Specific Activity	0
Class A	0
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009c.

C.3.3.11 Waste Management Area 11: Bulk Storage Warehouse and Hydrofracture Test Well Area

No decommissioning activities would take place in WMA 11 during Phase 1 of the Phased Decisionmaking Alternative. As a result, no waste would be generated.

C.3.3.12 Waste Management Area 12: Balance of Site

During Phase 1 of the Phased Decisionmaking Alternative, the dams and reservoirs would continue to be monitored and maintained. Parking lots and roadways would remain in place. Surface soils and sediments would be characterized and evaluated for remediation.

C.3.3.12.1 Remediation of Surface Soils and Sediments

Surface soil and sediment having radioactivity concentrations in excess of the DCGLs specified in the *Decommissioning Plan* may be remediated during Phase 1 decommissioning work. This includes soils and sediments outside those areas being removed or maintained during Phase 1 decommissioning (e.g., Main Plant

Process Building, Waste Tank Farm, North Plateau Groundwater Plume, Low-Level Waste Treatment Facility, NDA, and SDA). An initial action during Phase 1 of the Phased Decisionmaking Alternative would be additional radiological characterization of soil contamination. The characterization data would allow more precise decisionmaking regarding the location of contaminated soils and the extent of removal.

During Phase 1, surface soils and stream sediment to be addressed may be remediated to meet criteria for unrestricted release either immediately or after a period of decay. The determinations would be consistent with NRC License Termination Rule criteria and Federal and state cleanup criteria, as applicable. For analysis purposes, an estimate of soil volume to be removed has been made, but the estimate is based on limited characterization data and is considered to be conservative. The estimate was based on a removal depth of 0.6 meters (2 feet).

C.3.3.12.2 Estimated Waste to be Generated

The estimated waste volumes expected to be generated during Phase 1 of the Phased Decisionmaking Alternative in WMA 12 are presented in **Table C–51**. The estimate includes waste that would be generated from miscellaneous sitewide activities, including environmental monitoring installations, security installations, annual environmental monitoring, and existing facility maintenance. Although portions of these wastes could be generated in other areas of the site, they are included in the WMA 12 totals.

Table C–51 Estimated Waste to be Generated: Waste Management Area 12

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	29,000
Hazardous Waste	180
Low-level Radioactive Waste	
Low Specific Activity	240,000
Class A	75,000
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Notes: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009c.

C.3.3.13 North Plateau Groundwater Plume

Decommissioning activities associated with the source area of the North Plateau Groundwater Plume would be the same as those described for the Sitewide Removal Alternative. They are described in Section C.3.1.1.8. The existing North Plateau Groundwater Recovery System and related equipment would be left in place in a standby condition. The nonsource area of the plume would be contained by the permeable treatment wall installed for the starting point of the EIS. The estimate of the waste that would be generated from the source area of the North Plateau Groundwater Plume is included in the estimate for WMA 1. The estimated waste volumes to be generated from the maintenance of the nonsource area of the North Plateau Groundwater Plume are presented in **Table C–52**. The waste volumes are entirely due to the periodic replacement of the permeable treatment wall.

Table C–52 Estimated Waste to be Generated: North Plateau Groundwater Plume (nonsource area)

Waste Type	*Waste Volume (cubic feet)*
Construction and Demolition Debris	0
Hazardous Waste	0
Low-Level Radioactive Waste	
Low Specific Activity	71,000
Class A	310
Class B	0
Class C	0
Greater-Than-Class C Waste	0
Mixed Low-level Radioactive Waste	0
Transuranic Waste	0

Note: The estimated waste volumes are based on commercial disposal and are presented with two significant figures. To convert cubic feet to cubic meters, multiply by 0.028317.
Source: WSMS 2009c.

C.3.3.14 Cesium Prong

The Cesium Prong would be managed in place during Phase 1 of the Phased Decisionmaking Alternative. As a result, no waste would be generated from the management of the Cesium Prong.

C.4 Construction of New Facilities/Structures

Section C.4 provides detailed descriptions of facilities and structures that would need to be constructed or installed and to support decommissioning activities under various EIS alternatives. An overview of the facilities and structures needed to support each alternative is provided in **Table C–53**.

The modification of existing facilities was considered in lieu of new construction for the Interim Storage Facility (Dry Cask Storage Area), the Waste Tank Farm Waste Processing Facility, the Soil Drying Facility, the Container Management Facility, and the Leachate Treatment Facility. The rationale for each new facility is provided in the following paragraphs. Detailed descriptions of the proposed new facilities and other construction necessary to support the implementation of the alternatives are presented in Sections C.4.1 through C.4.13.

Interim Storage Facility (Dry Cask Storage Area) in Waste Management Area 6

The Interim Storage Facility would be constructed to safely and securely store the high-level radioactive waste canisters until disposition decisions are made and implemented. The facility would be constructed under the Sitewide Removal, Sitewide Close-In-Place, and the Phased Decisionmaking Alternatives. To tear down the Main Plant Process Building and the Vitrification Facility, the canisters need to be removed and placed elsewhere on site. The storage concept is patterned on spent nuclear fuel dry storage installations licensed by the NRC. To provide the necessary space, a concrete pad just under 0.4 hectare (1 acre) in size would be needed.

One existing facility that appeared to be a candidate for long-term storage of the vitrified high-level radioactive waste canisters was the Vitrification Facility Cell. However, it was not used to provide flexibility for decommissioning that portion of the site and to provide access to the North Plateau Groundwater Plume source area. Use of the Drum Cell was also considered, but it would require major work on the pad, and the layout and dimensions are not the most efficient.

Table C–53 Proposed New Construction Under Each Action Alternative

Facility/Structure	*Section*	*Sitewide Removal Alternative*	*Sitewide Close-In-Place Alternative*	*Phased Decisionmaking Alternative (Phase 1)*
Interim Storage Facility (Dry Cask Storage Area) in WMA 6	C.4.1	x	x	x
Waste Tank Farm Waste Processing Facility in WMA 3	C.4.2	x		
Soil Drying Facility in WMA 6	C.4.3	x		
Container Management Facility in WMA 9	C.4.4	x		
Leachate Treatment Facility in WMA 9	C.4.5	x	x	
Environmental Enclosures and Confinement Structures for Exhumation of NDA, SDA, Lagoon 1 in WMA 2, and the North Plateau Groundwater Plume Source Area	C.4.6	x		
Main Plant Process Building Excavation Downgradient Barrier Wall in WMA 1	C.4.7	x		x
Circumferential Hydraulic Barrier around WMA 1 and WMA 3 and Multi-layer Cap	C.4.8		x	
Multi-layer Cover over WMA 2 lagoons	C.4.9		x	
Barrier Wall in WMA 2	C.4.10			x
Multi-layer Covers over NDA and SDA	C.4.11		x	
Circumferential Barrier Wall in WMA 2 for Lagoon 1	C.4.12		x	
Erosion Control Structures	C.4.13		x	

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area; SDA = State-Licensed Disposal Area; WMA = Waste Management Area.
Sources: WSMS 2009a, 2009b, 2009c, 2009e.

The facility would be placed on the South Plateau within WMA 6 to be closer to the rail line and away from the facilities and decommissioning activities on the North Plateau. There are no existing facilities that could be used without significant upgrades or additions, so it is believed that building a new storage area is the most efficient means of providing the most cost-effective solution.

Waste Tank Farm Waste Processing Facility in Waste Management Area 3

A facility would be constructed under the Sitewide Removal Alternative to be used for the treatment, stabilization, packaging, and characterization of the residual radionuclide inventory in the Waste Tank Farm.

The Waste Tank Farm Waste Processing Facility would be a robust shielded structure built over the Waste Tank Farm in WMA 3 equipped with all the required components to complete the removal of the highly radioactive waste tanks. Based on the form and amount of radioactive material that would be handled, processed, and packaged for disposal and the potential impacts on workers and the public, a single robust structure within which all the closure processes would be performed in an integrated manner would be most efficient in protecting the health and safety of the workers and the public.

Estimates have shown that removing the surface soil and the top of the vaults from above the tanks would result in unacceptably high exposure rates in the Waste Tank Farm Area. The thickness of the concrete walls and roof of the Waste Tank Farm Waste Processing Facility have been selected to reduce the Waste Tank Farm Area exposure rate, due to the residual tank activity, to unrestricted access levels (e.g., less than 5 millirem per hour). In addition to providing shielding, the Waste Tank Farm Waste Processing Facility must function as a confinement structure to contain airborne material expected to be generated during the cutting of the tanks.

Consideration was also given to using an existing facility like the Remote-Handled Waste Facility for the packaging portion of the Waste Tank Farm mission. Usage of the Remote-Handled Waste Facility for this partial mission would still require the construction of a processing facility at the tank disassembly site, as well as transportation considerations between the facilities. Performing the entire mission, including packaging, at the tank site is considered to be more cost-effective and safer than using separate facilities for tank removal and waste packaging.

Soil Drying Facility in Waste Management Area 6

A facility would be constructed under the Sitewide Removal Alternative to support dewatering/drying and packaging of contaminated soil and sediment to be excavated from the North Plateau Groundwater Plume, the CDDL, and WMA 12 (stream sediment removal). This facility is not required under the Phased Decisionmaking Alternative due to the lower volume of excavated soils; high-capacity absorbent materials would be added to the disposal containers instead.

Due to the large volume of contaminated soils that would be generated during excavation of the entire North Plateau Groundwater Plume and other miscellaneous areas on the North Plateau, there is an advantage in locating the new Soil Drying Facility near the Rail Spur. The area selected is located just south of the southern portion of the plume, thereby providing a single area for staging, processing, and loading soils that is outside of contaminated areas and adjacent to the Rail Spur. Using an existing facility like the Remote-Handled Waste Facility would require transporting soils to several areas for processing and loading or extending the Rail Spur. Therefore, no existing facility was given further consideration as it is considered more efficient to construct a new facility where all the functions can be performed at a single location.

Container Management Facility in Waste Management Area 9

A facility would be constructed under the Sitewide Removal Alternative to provide the processes needed to support the excavation of the NDA and SDA. The facility would also be used for storage of potential orphan wastes.

The Drum Cell is not large enough to house all the functional needs of the Container Management Facility and would require significant modification and upgrades to the already 20-year old facility to use it to support the functions of the Container Management Facility. Under the Sitewide Removal Alternative, it would be advantageous to have a single location to consolidate all wastes that might require interim storage. This would make monitoring and maintenance activities the most efficient. Because the greatest quantities of such wastes would come from the NDA and the SDA, and because a single location on the South Plateau would allow all facilities and operations to be removed from the North Plateau, using a single new facility on the South Plateau would be the most efficient approach.

Leachate Treatment Facility in Waste Management Area 9

A facility would be constructed to treat the leachate that would be pumped from the NDA and SDA disposal areas to support both the Sitewide Removal and Sitewide Close-In-Place Alternatives. Available information indicates that the facility would need to provide treatment for both radiological and hazardous constituents before the effluent could be discharged. To minimize transfer distances and the potential for environmental impacts, a new facility located between the NDA and SDA is the preferred option. No existing facility has all the components needed for performing the treatment that would be required. The Low-Level Radioactive Waste Treatment Facility on the North Plateau is designed to treat certain radionuclides but is not large enough to house all the components needed to treat leachate from the disposal areas. Use of this facility to support SDA and NDA removal would require transferring the highly contaminated liquids a much greater distance. It is conceivable that some components of the NDA liquid pretreatment system could be used; however, these components are nearly 30 years old and may not be easily compatible with the currently envisioned leachate treatment system.

C.4.1 Interim Storage Facility (Dry Cask Storage Area) in Waste Management Area 6

The Interim Storage Facility would be used to temporarily store the 275 vitrified high-level radioactive waste canisters from WMA 1 until disposition decisions are made and implemented. The Load-In/Load-Out Facility in WMA 1 would be converted to a Load-Out Facility to support the removal of the vitrified high-level radioactive waste canisters from the Main Plant Process Building and transfer them to the Interim Storage Facility. The equipment to be installed in the facility would include a shielded transfer cell, a canister handling system to extract the canisters from the shielded transfer cell and to place them into storage casks, and a high-capacity crane. The Load-Out Facility would be demolished once all the vitrified high-level radioactive waste canisters have been removed from the Main Plant Process Building (WSMS 2009e).

The design of the Interim Storage Facility would be patterned on spent nuclear fuel dry storage installations currently licensed by the NRC, which are designed to meet 10 CFR 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-level Radioactive Waste, and Reactor Related Greater-Than-Class C Waste." The Interim Storage Facility will be designed to withstand events such as seismic activity or atmospheric phenomena. The design life of the dry cask storage system proposed for the site is 50 years. The storage area would measure approximately 113 meters by 33.5 meters (370 feet by 110 feet). The vitrified high-level radioactive waste canisters would be transferred into casks, which would be placed into horizontal storage modules, ensuring adequate shielding and mechanical protection. The Interim Storage Facility would be located in WMA 6 on the South Plateau adjacent to the southwest edge of the NDA, as shown on **Figure C–16**.

Up to seven canisters would be moved within a single cask; each cask would be moved completely within a period of approximately 40 hours of work. This estimate is based on experience gained during the removal and placement of material with high and very high dose rates (greater than 100 milliroentgen per hour) contained in lead-shielded containers at Brookhaven National Laboratory and Oak Ridge National Laboratory and compares favorably with the *Diablo Canyon Independent Spent Fuel Storage Installation Safety Analysis Report* (PG&E 2002) estimate of time required for similar activities (17 hours for transferring a loaded cask to the Independent Spent Fuel Storage Installation). While these events are similar to those proposed for the high-level radioactive waste canister transfer, there are differences in loading configuration and waste disposition that could affect duration and cost estimates.

For security purposes, two fences, one of chain link and one of razor wire, would be constructed around the perimeter of the area. Additional lighting and remote monitoring equipment would be installed as necessary. The Interim Storage Facility would be decontaminated and demolished after the high-level radioactive waste canisters have been removed for disposition.

C.4.2 Waste Tank Farm Waste Processing Facility in WMA 3

Under the Sitewide Removal Alternative, decommissioning of WMA 3 would require the removal of a residual radionuclide inventory from the tanks, followed by the demolition and removal of the contaminated tank shells and their associated vaults. The removed inventory would need to be treated, stabilized, packaged, and characterized before disposal. The tank shells would need to be reduced in size, packaged, and characterized before disposal. These operations would be performed in the Waste Tank Farm Waste Processing Facility, a 104- by 84-meter (340- by 275-foot) robust, shielded structure built over the Waste Tank Farm Area (WMA 3) that would be equipped with the required infrastructure to complete the proposed closure activities. The location of the Waste Tank Farm within WMA 3 is shown on Figure C–3.

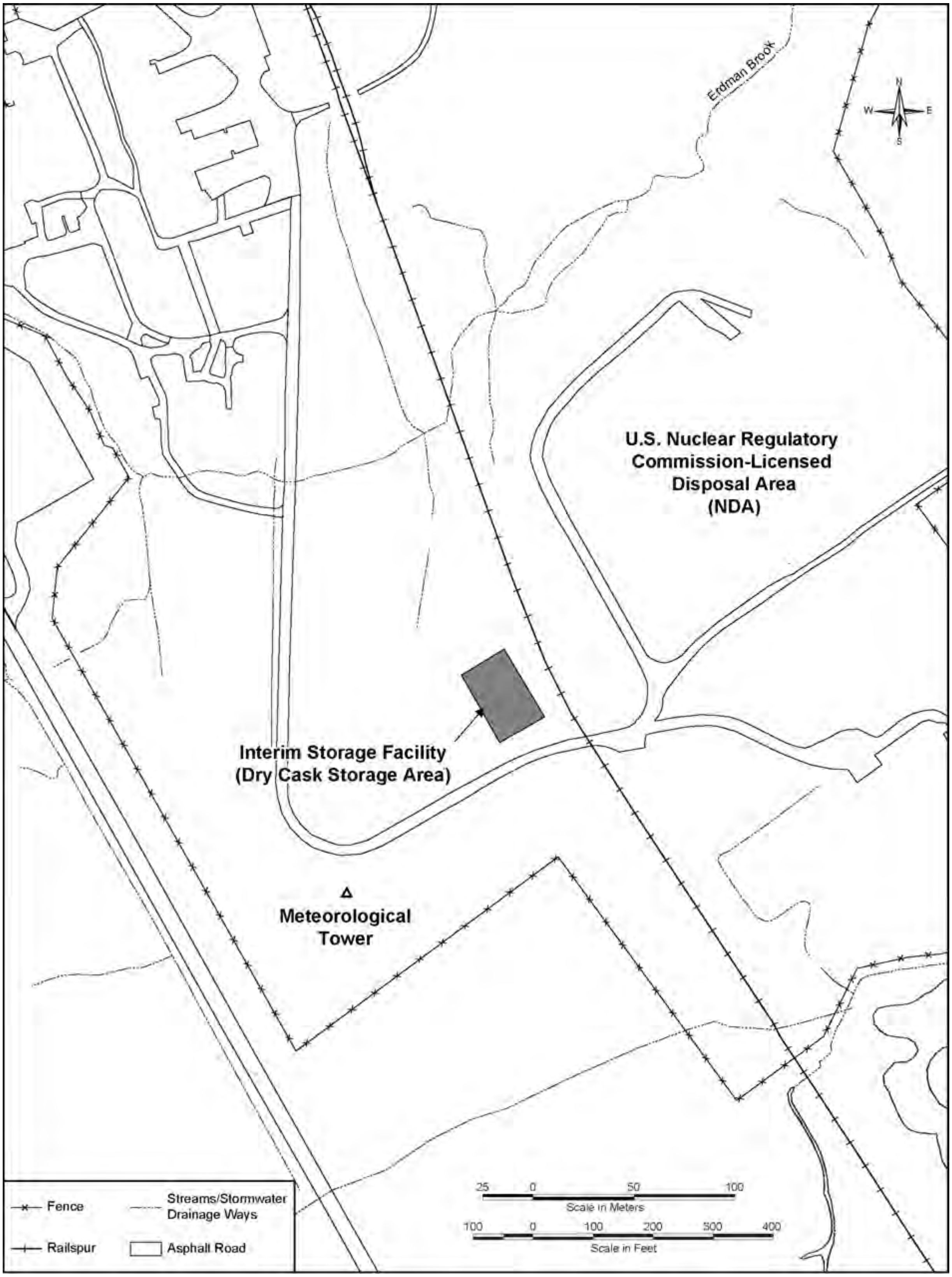

Figure C–16 Location of the Interim Storage Facility (Dry Cask Storage Area) in Waste Management Area 6

Guidance for the design of facilities used to process radioactive materials is provided in DOE Standard 1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components* (DOE 1996b). Based on the form and amount of radioactive material to be processed in the Waste Tank Farm Waste Processing Facility and on the likely consequences to workers and members of the public in the event of an accident in the facility, it is expected that the Waste Tank Farm Waste Processing Facility would be categorized as a Performance Category 2 facility using the guidance in Standard 1021-93. In general, Performance Category 2 facilities are designed to conform to the requirements of the International Building Code. However, certain elements of facility design may be enhanced to provide a greater degree of hazard protection. Enhancements, where necessary, are discussed in the rest of this section.

Pressure differentials would be maintained between each confinement zone so that airflow travels from zones of lesser contamination potential to zones of greater contamination potential. The Waste Tank Farm Waste Processing Facility ventilation system would ensure positive confinement of airborne radioactive material.

The air from all spaces would be filtered using a minimum of two fire-resistant HEPA filters in series before discharge to the environment. Redundant exhaust blower capability would be provided, and additional HEPA filter train(s) would be provided to allow for the maintenance and testing of a given HEPA filter train. The Waste Tank Farm Waste Processing Facility would be equipped with diesel generators housed in the warehouse to provide emergency standby electrical power to the appropriate motor control center(s) to ensure that power to Waste Tank Farm Waste Processing Facility ventilation system components could be provided in the event of a loss of offsite power.

The Waste Tank Farm Waste Processing Facility would be a freestanding reinforced concrete and steel structure enclosed within an exterior sheet metal weather structure providing approximately 4,650 square meters (50,000 square feet) of confinement over Tanks 8D-1, 8D-2, 8D-3, and 8D-4 and their associated structures. The Waste Tank Farm Waste Processing Facility also includes 1,100 square meters (12,000 square feet) of office/project support space and a 3,070-square-meter (33,000-square-foot) loading and transport wing. The maximum overall dimensions would be approximately 104 meters (340 feet) in length and 84 meters (275 feet) in width. The facility would be 26 meters (87 feet) high at its roof peak. The facility would be constructed primarily of cast-in-place reinforced concrete up to 1.5 meters (5 feet) in thickness for radiological shielding purposes and would be supported by a foundation on H-piles driven to a depth of at least 15.2 meters (50 feet) into the underlying geologic material.

Demolition and waste processing, packaging, and shipping activities would be performed or supported in the following areas within the Waste Tank Farm Waste Processing Facility:

- Waste Tank Farm Confinement Area
- Liquid Waste Process Cell
- Remote-Handled Work Cell
- Sampling and Observation Aisle
- Waste Package Decontamination Area
- Nondestructive Assay Cell
- Remote-Handled Cask Loading Cell
- Transport Loading Area
- Shipping Depot
- Control Room
- Facility Support Areas

The Waste Tank Farm Waste Processing Facility would be demolished after the post-excavation survey is completed, and the excavation would be filled with appropriate clean backfill material. The enclosure would be demolished by conventional demolition equipment such as hydraulic excavators equipped with demolition hammers and shears. The demolition debris would be packaged as low-specific-activity waste and transported to an offsite low-level radioactive waste disposal facility. The equipment would be packaged as Class A low-level radioactive waste and also would be disposed of off site.

Once the facility has been removed, any contaminated soil generated during demolition would be removed and disposed of as low-specific-activity waste. A final status survey would be performed in the area impacted by demolition of the enclosure to establish that residual radioactivity levels do not exceed the established DCGLs. RCRA confirmatory sampling would also be performed. Additional clean soil backfill would be placed and the area graded to a near natural appearance.

C.4.3 Soil Drying Facility in Waste Management Area 6

The Soil Drying Facility would support packaging of contaminated soil and sediment excavated from the North Plateau Groundwater Plume. It would be a new facility located just south of the southern portion of the North Plateau Groundwater Plume, near the Rail Spur. The Soil Drying Facility would consist of a 4,600-square-meter (50,000-square-foot) pad housing the process equipment, an 8,200-square-meter (88,000-square-foot) Dry Soil Shelter Building, and 1,800 linear meters (6,000 linear feet) of Rail Spur tracks and gondola car storage.

The major items of process equipment in the Soil Drying Facility would include a feed bin, conveyor, rotary dryer, soil cooler, radial soil stacker, off-gas baghouse, HEPA filters, thermal oxidizer, and stack.

The Soil Drying Facility would be demolished and removed after the North Plateau Groundwater Plume (including the source area), the CDDL, the Main Plant Process Building, and the WMA 2 areas have been excavated. The debris generated from the demolition would be packaged as low-specific-activity waste and disposed of off site at a low-level radioactive waste disposal facility.

C.4.4 Container Management Facility in Waste Management Area 9

The Container Management Facility would be a new facility, as shown on **Figure C–17**, and would be located along the Rail Spur on the South Plateau, as shown on **Figure C–18**. It would be capable of receiving the wastes in an "as excavated" form, drying them, sorting them, reducing the size of larger items, recompacting wastes that were "bulked-up" during excavation, packaging them, decontaminating the packages, classifying them, temporarily storing them, and loading them onto trucks or railcars for offsite transport. It would also be capable of receiving wastes in packaged form; decontaminating the packages, if necessary; classifying them; temporarily storing them; and loading them onto trucks or railcars for offsite transport. The Container Management Facility would also contain an area for the storage of potential orphan waste, including Greater-Than-Class C waste, pre-project Class B and C low-level radioactive waste, and transuranic waste generated under the Sitewide Removal Alternative. Pre-project waste is waste that was buried before DOE assumed control of a portion of the site and would, therefore, not be disposed of at a DOE disposal facility such as the Nevada Test Site.

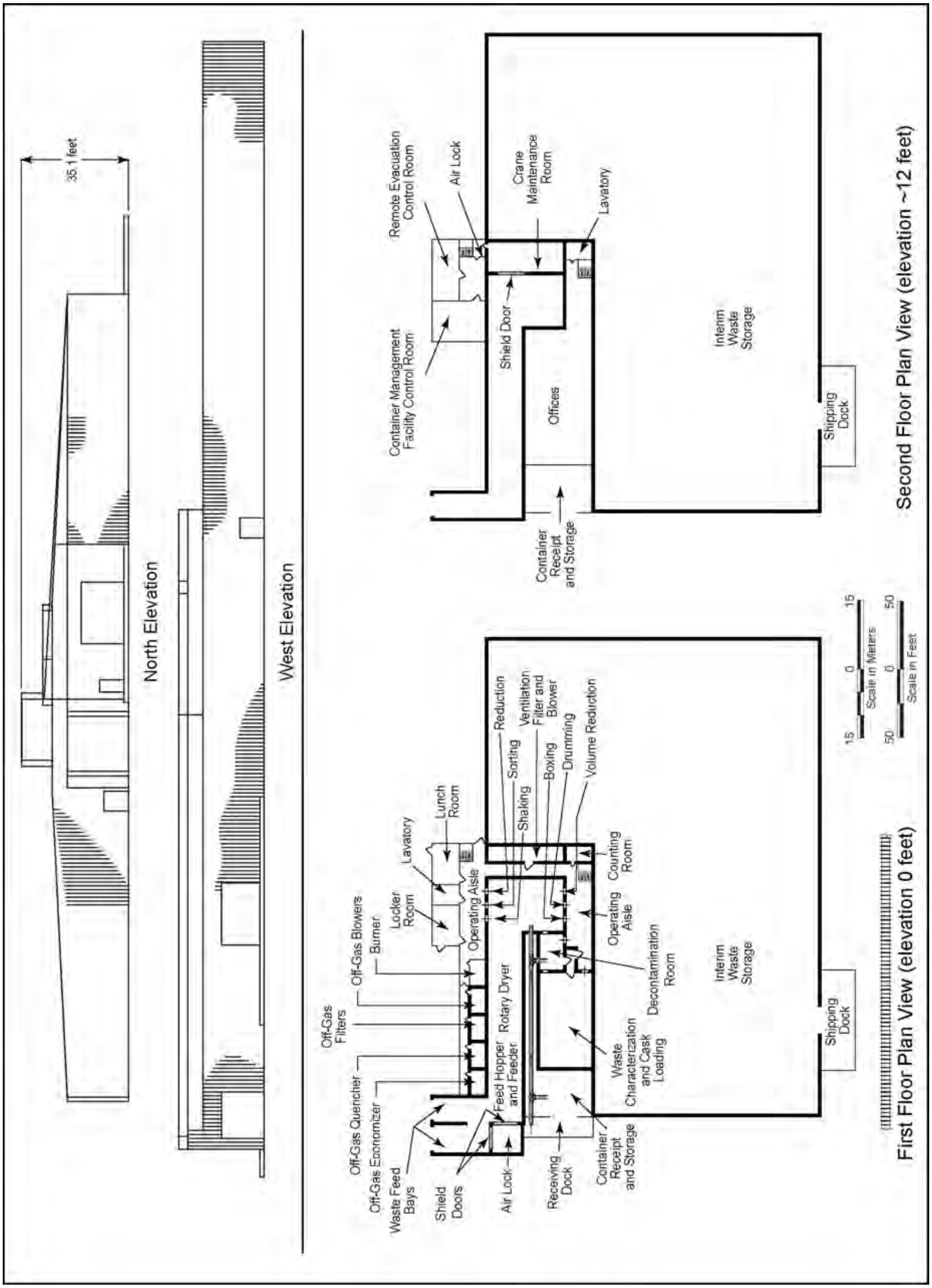

Figure C–17 Conceptual Container Management Facility in Waste Management Area 9 – Elevation and Plan View

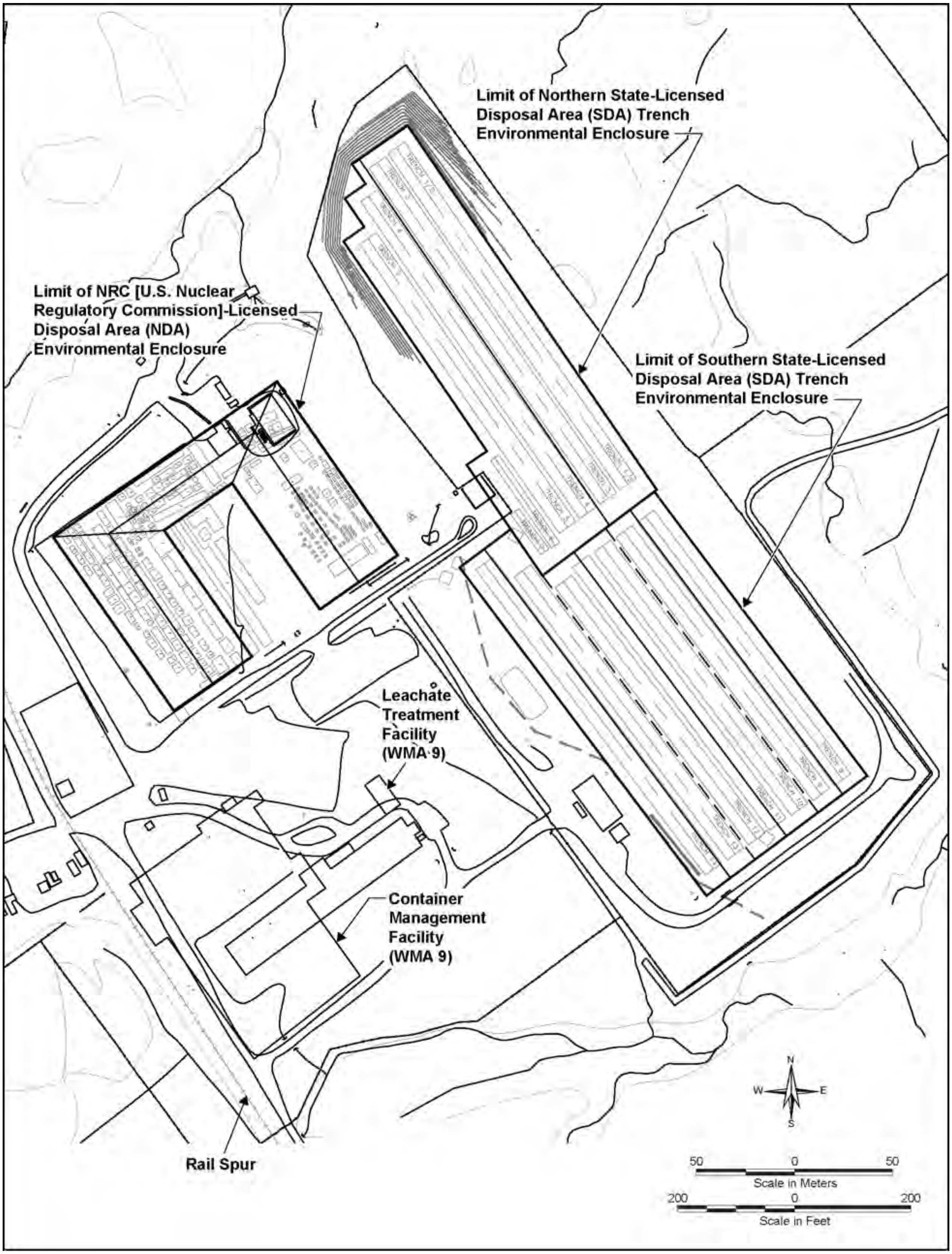

Figure C–18 Locations of Container Management and Leachate Treatment Facilities in Waste Management Area 9

The Container Management Facility is a conceptual structure with dimensions designed according to the space needed for processing and potentially storing large volumes of waste. The geometry of the Container Management Facility is flexible, with the most critical features of the design being the relatively small process area and the space required for the process equipment. The location of the Container Management Facility is also flexible, provided that it is sited in relative proximity to the NDA and SDA and allows for the efficient movement of wastes from the burial areas to the facility. The footprint of the Container Management Facility is anticipated to occupy some of the space that is currently occupied by the Drum Cell building, because the Sitewide Removal Alternative implementation schedule has the Drum Cell being removed prior to construction of the Container Management Facility. However, there is a potential for the Drum Cell to be used for decommissioning purposes (i.e., storage area, laydown area) during the course of the Sitewide Removal Alternative for which the timing might overlap with the schedule for construction and operation of the Container Management Facility. In this case, the Container Management Facility storage area configuration might be revised to allow for construction and operation of the facility prior to demolition of the Drum Cell. The variations that are envisioned as a result of the reconfiguration would have negligible effect on the overall costs and impacts.

The Container Management Facility considered in the Sitewide Removal Alternative was designed with sufficient open storage space to adequately store all Greater-Than-Class C waste and commercial Class B and C low-level radioactive waste generated from the NDA and SDA. The conceptual Container Management Facility is also adequately sized to allow temporary storage of the transuranic wastes generated during removal of WMA 3 and dismantlement of the high-level radioactive waste tanks.

The Container Management Facility would be a radiological facility with reinforced concrete shield walls around processing and storage areas and a steel frame and steel cladding in other areas. The floors and foundations would be constructed of reinforced concrete, and the roofs would be constructed of concrete with asphalt roofing. The conceptual layout of the facility was created with a portion of the building in a two-story configuration: the processing, containerizing, and characterization areas on the first floor and office space on the second floor. The footprint of this section of the building was designed to be approximately 1,560 square meters (20,000 square feet).

The remainder of the conceptual facility was designated for interim storage of commercial Class B and C low-level radioactive waste, Greater-Than-Class C waste, and transuranic waste. This portion of the building was designed as a single-story, warehouse-type structure that contains a floor area of 6,500 square meters (70,000 square feet).

The inside surfaces of the shielded work area would be lined to facilitate decontamination. The floor and lower levels of the walls subject to impact from crane-carried loads would be lined with stainless steel. The upper levels of the walls and the ceilings would be covered with a strippable paint.

The building would be equipped with a HEPA-filtered ventilation system, independent from the process off-gas system. This ventilation system would be designed for heating, ventilation, air conditioning, and contamination control. The ventilation system would discharge to the same stack as the off-gas treatment system.

Because the Container Management Facility would be used to process waste that would contain fission products and transuranic radionuclides, the facility would be designed and built to meet the requirements of a Performance Category 3 structure (as defined by DOE Standard 1020-2002). It would be capable of withstanding design-basis natural hazards, such as earthquakes, high winds, and snow loading (DOE 1996b).

The facility would contain a waste dryer, off-gas treatment equipment, dry waste processing equipment, decontamination room, waste characterization equipment, and waste loading and transport equipment. An

Interim Waste Storage Area would be sized to provide temporary storage for all Greater-Than-Class C wastes expected to be exhumed from the NDA and SDA. The facility would also contain adequate storage space for the pre-project Class B and Class C low-level radioactive waste removed from the NDA and SDA. These wastes would be stored in this facility until a disposal facility becomes available to accept them. The building would be demolished after all wastes have been removed from the Interim Waste Storage Area.

Demolition of the Container Management Facility would result in the generation of a variety of waste streams ranging from construction and demolition debris waste through Class A low-level radioactive waste. The demolition process would include appropriate measures for facility areas and components based on their respective operational histories.

Decommissioning activities would include surveying and characterizing contaminants, conducting mechanical decontamination, removing and segmenting stainless steel liner systems and process equipment, and using spray fixatives. Foundations are assumed to be uncontaminated. The waste generated from decommissioning activities is assumed to be managed as construction and demolition debris waste.

The exterior surfaces of the waste handling equipment and the interior surfaces of the rotary drum dryer would be decontaminated using mechanical decontamination methods, such as carbon dioxide pellet decontamination. A spray fixative would be applied after decontamination. The equipment would be dismantled and reduced in size, as necessary. The dryer, shaker table, and sorting tables would be reduced in size in place using cutting equipment, such as plasma arc torches. The resulting equipment segments and the stainless steel liner would be packaged and transported off site for disposal as Class A low-level radioactive waste.

The interior surfaces of the building would be sprayed with fixative to allow for demolition without confinement. The structure would be demolished by conventional methods. The debris would be packaged as low-specific-activity waste and transported off site for disposal.

The conceptual Container Management Facility proposed for NDA and SDA remediation is considered first of its kind. There are no full-scale field examples of waste retrieval and processing operations of this magnitude and involving the waste classes that would be dealt with under the Sitewide Removal Alternative. The anticipated wastes have been listed based on historic documentation. However, there exists a significant potential to discover wastes and types that are unexpected or unplanned. The costs of construction of the facilities would be fairly reliable (within the contingency specified in the estimates), as the structural and equipment components are readily available and have been used in some capacity in the past. However, the project productivity and safety are items of uncertainty that cannot be easily estimated.

One component of the waste retrieval process that involves a high level of uncertainty is the retrieval of wastes from the NFS deep holes, using primarily a telescoping boom with various tools. Conceptually, this equipment would be able to work vertically at depth, using different end attachments to scan, excavate, cut, and vacuum the waste materials and bring the wastes to the surface. However, this process has not been demonstrated in a full-scale field environment.

C.4.5 Leachate Treatment Facility in Waste Management Area 9

A Leachate Treatment Facility would be designed and constructed to treat leachate generated during the NDA and SDA waste removal activities and the 28,390 liters (7,500 gallons) of leachate stored in the Mixed Waste Storage Facility. The Leachate Treatment Facility is expected to include a 37-square-meter (400-square-foot) leachate storage building, a 176-square-meter (1,900-square-foot) Shielded Treatment Building, and a 209-square-meter (2,250-square-foot) treated water storage building/laboratory.

The facility would be constructed near the new Container Management Facility to house the treatment equipment (see Figure C–18). The facility would be able to treat organic chemicals and dissolved radionuclides in the leachate. However, it would not be able to remove or treat tritium in the leachate. A plan view of the Shielded Treatment Building, the operational component of the Leachate Treatment Facility, is shown on **Figure C–19**. The water storage facilities are not shown.

The facility would be operated on demand and, based on the limiting productivity of the waste removal process, would be expected to process an average of 3,800 liters (1,000 gallons) of leachate per day. It is assumed to be operated 8 hours per day during the waste removal work. The treatment process would consist of a leachate hold tank, a bioreactor, a mechanical filter, an activated carbon polisher, and ion-exchange columns. The components of the facility that are used to manage raw leachate, including the raw leachate storage tank and the primary process equipment, would be constructed inside of a building intended to provide appropriate shielding between these components and the environment.

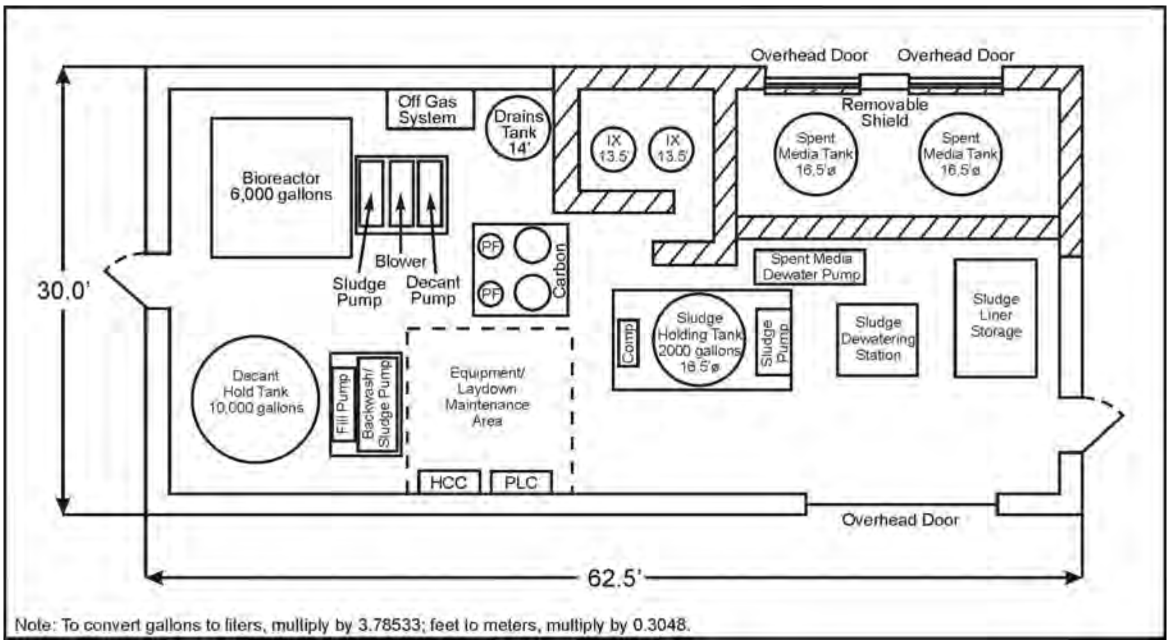

Figure C–19 Conceptual Leachate Treatment Facility in Waste Management Area 9 – Plan View

The principal components of the Leachate Treatment Facility are:

- The 34,000-liter (9,000-gallon) raw (untreated) leachate hold tank – The leachate hold tank would be installed in a shielded enclosure, separate from the treatment process as well as the treated leachate storage tanks. Leachate pumped from the hold tank would be filtered using mechanical filtration prior to introduction to the treatment train;

- The bioreactor – This component would be used to treat the organic chemicals in the leachate. The reactor would be operated on a batch basis and would employ aeration with agitation, settling, and decanting. The sludge from the bioreactor would be transferred to a sludge hold tank for processing, packaging, and disposal;

- The ion-exchange columns – This component would be used to remove most of the dissolved radionuclides from the leachate, and would employ an inorganic ion-exchange material to remove the two principal radionuclides of concern, cesium-137 and strontium-90;

- Mechanical Filter and Carbon Beds – The decanted leachate in the hold tank would be passed through fine filters to remove entrained solids prior to introduction of the leachate into the activated carbon polisher beds, thereby preventing plugging of the beds. The activated carbon polisher would be used to remove any remaining organic material that was not removed by operation of the bioreactor;

- The effluent from the carbon beds would be directed to the treated water storage tanks. The treated leachate in these tanks would be sampled and analyzed before being directed either to the Low-Level Waste Treatment Facility lagoons for final treatment and/or discharge through a SPDES-permitted discharge, or back into the Leachate Treatment System to be "reworked"; and

- Off-Gas Treatment – Off-gases from the bioreactor would be treated by (1) mist elimination to remove entrained droplets, (2) heating to reduce the relative humidity for purposes of protecting downstream equipment, (3) HEPA filtration to remove radiologically contaminated particulate matter, and (4) carbon adsorption to remove organic vapors. An off-gas blower would keep the process under negative pressure for contamination control.

The Leachate Treatment Facility would be decommissioned and demolished upon completion of the WMA 7, WMA 8, and/or other potential emergent site activities that require its support. The treatment system would be flushed to purge residual leachate and wastewater. The zeolite ion-exchange media would be removed from the vessels and managed as Class C low-level radioactive waste. The treatment equipment would be removed, segmented, and managed as Class A low-level radioactive waste. The Leachate Treatment Facility Building would be demolished using typical site protocols, and the structural components of the building, including concrete, would be managed as low-specific-activity waste.

C.4.6 Environmental Enclosures and Confinement Structures

Environmental enclosures and confinement structures would be constructed over the NDA and SDA, Lagoon 1 in WMA 2, SDA lagoons, and the North Plateau Groundwater Plume source area to support removal of buried waste or contaminated soils for the Sitewide Removal Alternative. Some of these structures would not be movable while others would be modular with the capability of being deconstructed and moved to different disposal locations. These structures are described in the following subsections.

The analysis in this EIS assumes that these structures would eventually be demolished with all resulting debris characterized and appropriately disposed of. However, waste minimization practices would be used to minimize disposal volumes as much as practical. By using modular structures as much as possible, secondary waste would be avoided. At the end of the exhumation projects, all enclosures would be surveyed, and if feasible, section of the enclosures would be released and available for reuse consistent with DOE requirements. If it is not technically or economically feasible to release sections of the enclosures, waste volumes would be minimized through size reduction techniques including cutting, compaction, or pulverizing (e.g., concrete).

C.4.6.1 NRC-Licensed Disposal Area Environmental Enclosure

A confinement structure, called the NDA Environmental Enclosure, would be constructed over all waste burial holes in WMA 7 suspected of containing wastes classifiable as being greater than Class A low-level radioactive waste. It would be constructed over the NFS deep holes, NFS special holes, and WVDP Trenches 1 through 7. It would be designed as a Performance Category 3 structure (as defined by DOE Standard 1020-2002) and would withstand design-basis natural hazards, such as earthquakes, high winds, and snow loading (DOE 1996b). A Performance Category 3 structure is designed to include such elements as a "Tornado Missile Barrier," involving substantial walls and roof. The conceptual NDA Environmental Enclosure is shown on **Figure C–20**. WVDP Trenches 8 through 12 would be excavated under a less robust structure called the WVDP Disposal Area Environmental Enclosure, discussed in the next section.

The conceptual NDA Environmental Enclosure would be a single-span, steel-framed building with 0.3-meter-thick (1-foot-thick) reinforced concrete exterior walls and a metal roof with gutters. The foundations would be placed outside the perimeter of known waste burials. A perimeter barrier wall and French drain are proposed to provide groundwater control during the project. These features, in addition to the burial locations, are shown on **Figure C–21**. The enclosure would be large enough to allow use of heavy equipment and erection of localized confinement structures within it. It would be well ventilated to prevent accumulation of exhaust fumes from operation of heavy equipment. The ventilation air discharge would be HEPA-filtered to limit the release of airborne radionuclides to the atmosphere and permitted to meet appropriate Federal and/or state requirements. Fire protection equipment would be included. A heating system and insulation would also be included to provide freeze protection for the fire protection system and other items inside the structure. Electrical lighting, a closed-circuit television system, and a gantry crane system would be included to support the work to be performed inside.

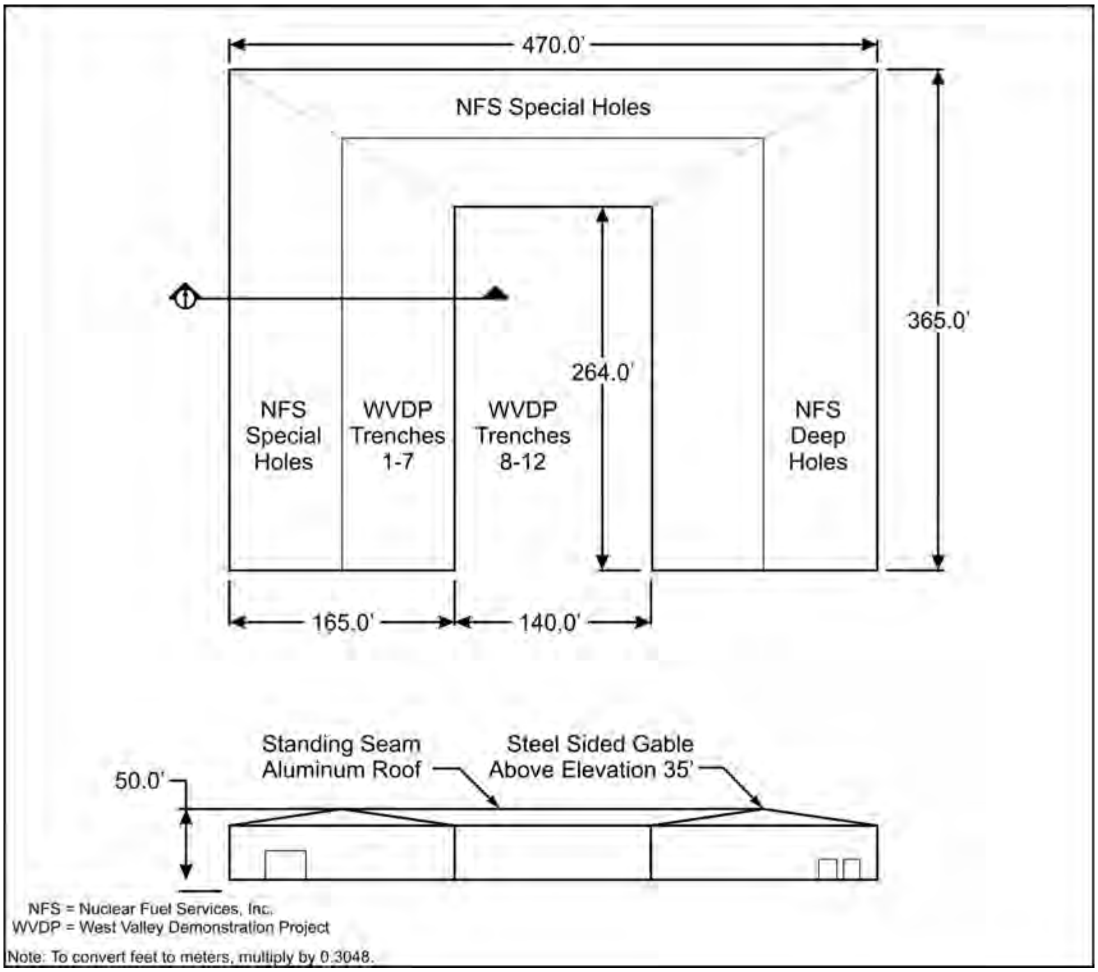

Figure C–20 Conceptual NRC-Licensed Disposal Area Environmental Enclosure – Plan and Elevation

Excavation of wastes within the NDA Environmental Enclosure would primarily be performed remotely using a combination of techniques, including Z-mast cranes, masts with various tools, and remotely operated excavators. Factors determining the excavation technique include the depth to the waste type, size of waste, and estimated activity associated with the waste. Secondary containment within the NDA Environmental Enclosure would be used for exhumation of higher-activity wastes to prevent unnecessary spread of contamination within the enclosure.

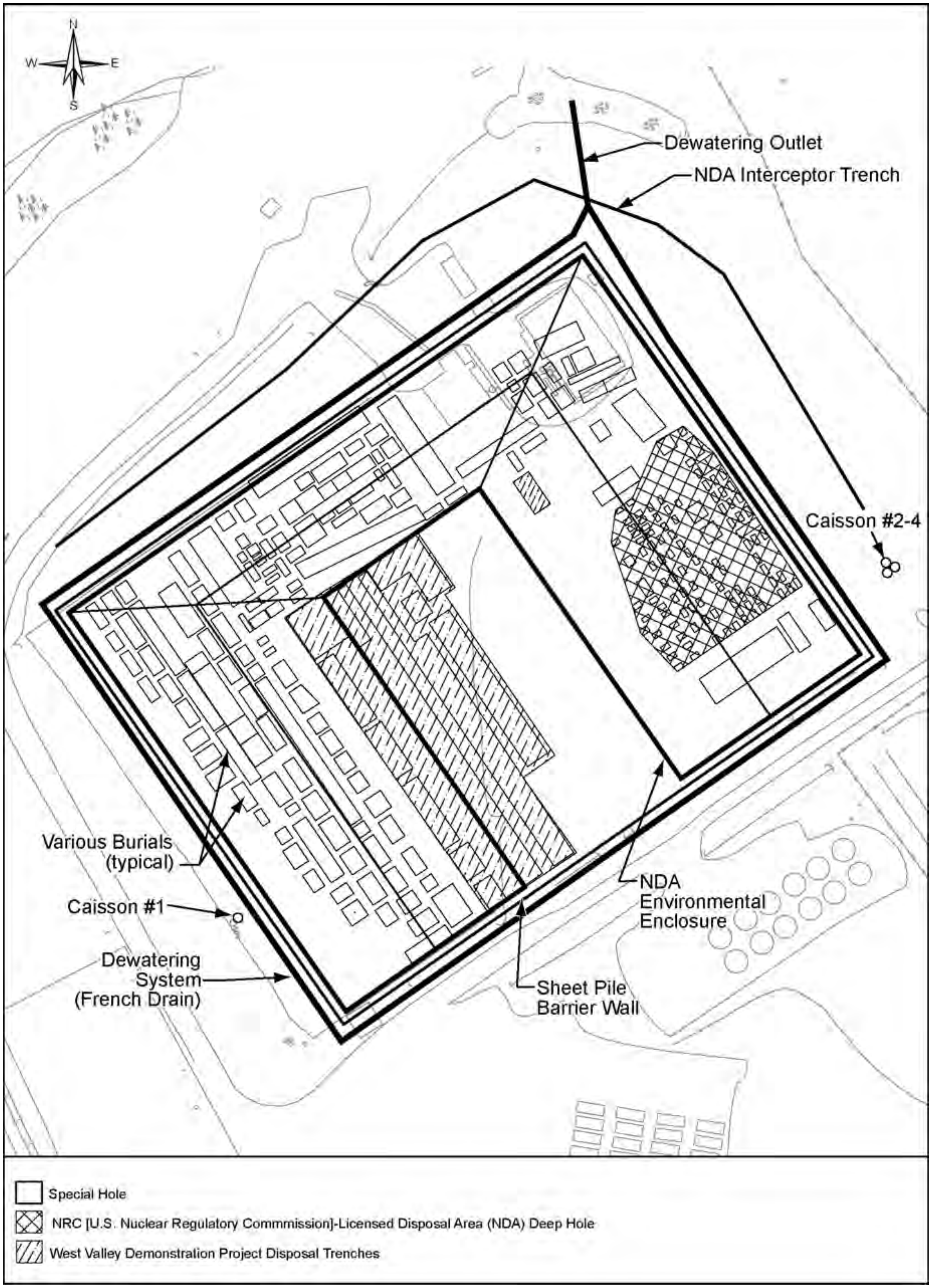

Figure C–21 Conceptual NRC-Licensed Disposal Area Barrier Wall and French Drain Layout

The HEPA filters from the ventilation system of the NDA Environmental Enclosure would be removed by bag-out procedures, wrapped in polyethylene or equivalent material, and loaded into containers as radioactive waste. The ventilation system equipment would then be selectively demolished, loaded into containers, and transferred to the Container Management Facility for characterization and shipment for offsite disposal as low-specific-activity radioactive waste.

The interior surfaces of the NDA Environmental Enclosure are expected to be slightly contaminated. Therefore, it would be thoroughly surveyed and a spray fixative applied, as necessary, to allow demolition of the structure without confinement. The enclosure would be manually demolished using conventional equipment such as hydraulic hammers and backhoes. The debris would be surveyed and sampled for characterization purposes and placed into containers for offsite disposal as a mixture of Class A low-level radioactive waste and low-specific-activity waste.

C.4.6.2 West Valley Demonstration Project Disposal Area Environmental Enclosure

A pre-engineered sheet metal confinement structure, called the WVDP Disposal Area Environmental Enclosure, would be constructed over WVDP Trenches 8 through 12, known to contain Class A low-level radioactive waste. It would be located in the "courtyard" area of the NDA Environmental Enclosure.

The conceptual WVDP Disposal Area Environmental Enclosure would be a single-span, steel-framed building with sheet metal walls and a roof with gutters. The foundations would be placed outside the perimeter of known waste burials. The structure would be about 79 meters (260 feet) by about 61 meters (200 feet), with an eave height of about 10.6 meters (35 feet), large enough to allow use of heavy equipment inside. It would be well ventilated to prevent accumulation of exhaust fumes from operation of heavy equipment. The ventilation air discharge would be HEPA-filtered to prevent migration of any airborne radionuclides to the atmosphere and permitted to meet appropriate Federal and/or state requirements. Electrical lighting would be included to support the work to be performed inside.

C.4.6.3 South State-Licensed Disposal Area Environmental Enclosure

Under the Sitewide Removal Alternative, a confinement structure, called the South SDA Environmental Enclosure, would be constructed over Trenches 8 through 14 of the SDA, which are known to contain wastes classifiable as greater than Class A low-level radioactive waste. This structure would be designed to withstand design-basis natural hazards, such as earthquakes, high winds, and snow loading (DOE 1996b). The footprint of the conceptual South SDA Environmental Enclosure is shown on **Figure C–22**.

The conceptual South SDA Environmental Enclosure would be a tri-span, steel-framed building with 0.3-meter-thick (1-foot-thick) reinforced concrete exterior walls and a metal roof with gutters. The perimeter foundations would be placed outside the perimeter of known waste burials. Pile foundations would be required to support the interior column lines. The pile foundations would be located between Trenches 9 and 10 and between Trenches 12 and 13. The piles would be driven to approximately 9 meters (30 feet) below-grade. The structure would be about 216 meters (710 feet) long by about 105 meters (345 feet) wide, with an eave height of about 10.7 meters (35 feet), large enough to allow use of heavy equipment and erection of confinement structures within it.

Similar to the NDA Environmental Enclosure, this enclosure would include a ventilation system with HEPA filtration, a fire protection system, a heating system, electrical lighting, a closed-circuit television system, and a gantry crane system.

The demolition of the South SDA Environmental Enclosure would be performed in the same manner as the demolition of the NDA Environmental Enclosure, described in Section 4.6.1.

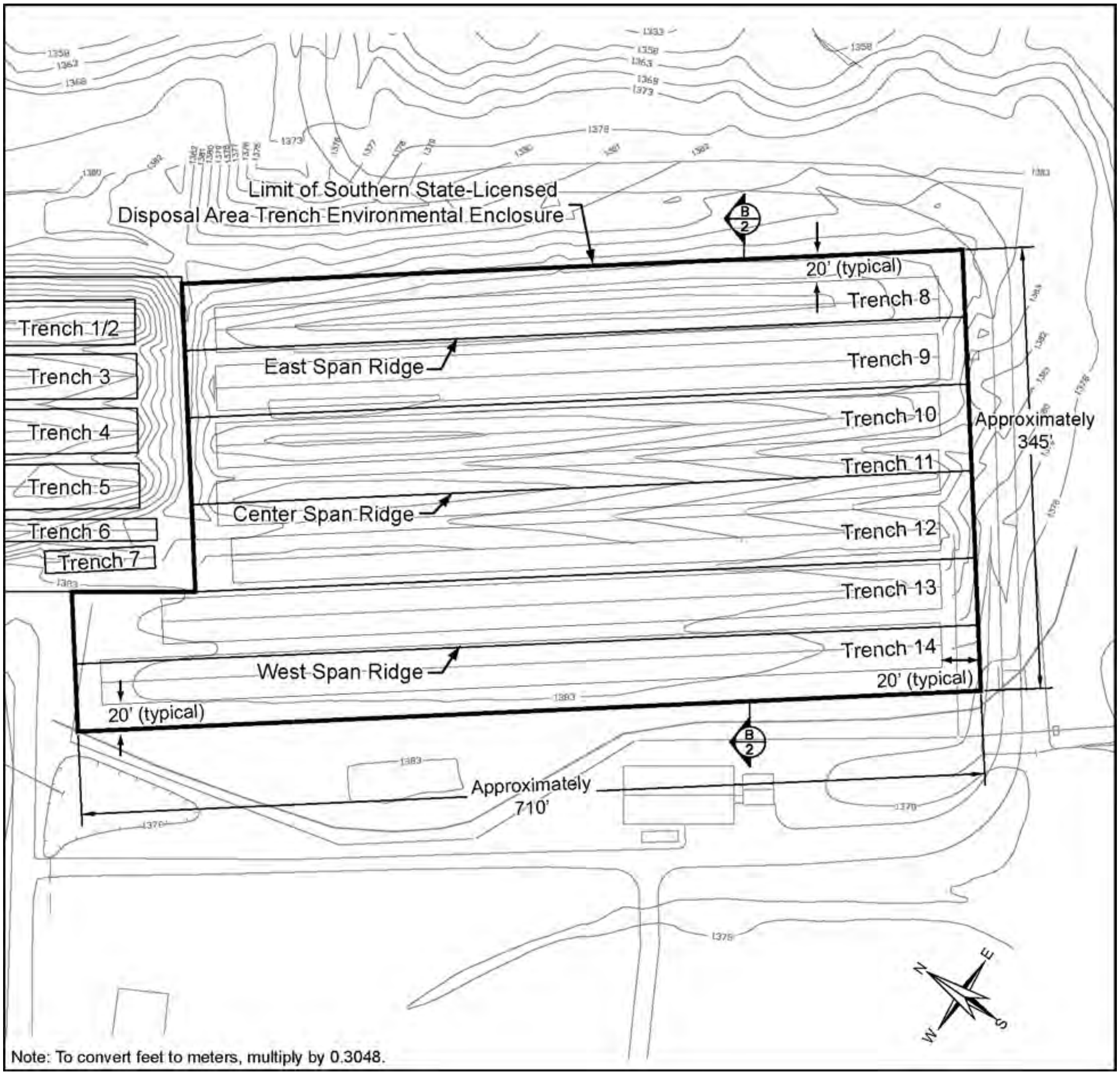

Figure C–22 Conceptual South State-Licensed Disposal Area Environmental Enclosure Footprint

C.4.6.4 North State-Licensed Disposal Area Environmental Enclosure

A confinement structure, called the North SDA Environmental Enclosure, would be constructed over Trenches 1 through 7 of the SDA, which are known to contain wastes classifiable as greater than Class A low-level radioactive waste. It would be designed to withstand design-basis natural hazards, such as earthquakes, high winds, and snow loading (DOE 1996b). The footprint of the conceptual North SDA Environmental Enclosure is shown on **Figure C–23**.

The conceptual North SDA Environmental Enclosure would be a single-span, steel-framed building with 0.3-meter-thick (1-foot-thick) reinforced concrete exterior walls and a metal roof with gutters. The foundations would be placed outside the perimeter of known waste burials. The structure would be about 232 meters (760 feet) long by about 62.5 meters (205 feet) wide, with an eave height of about 10.7 meters (35 feet), large enough to allow use of heavy equipment inside.

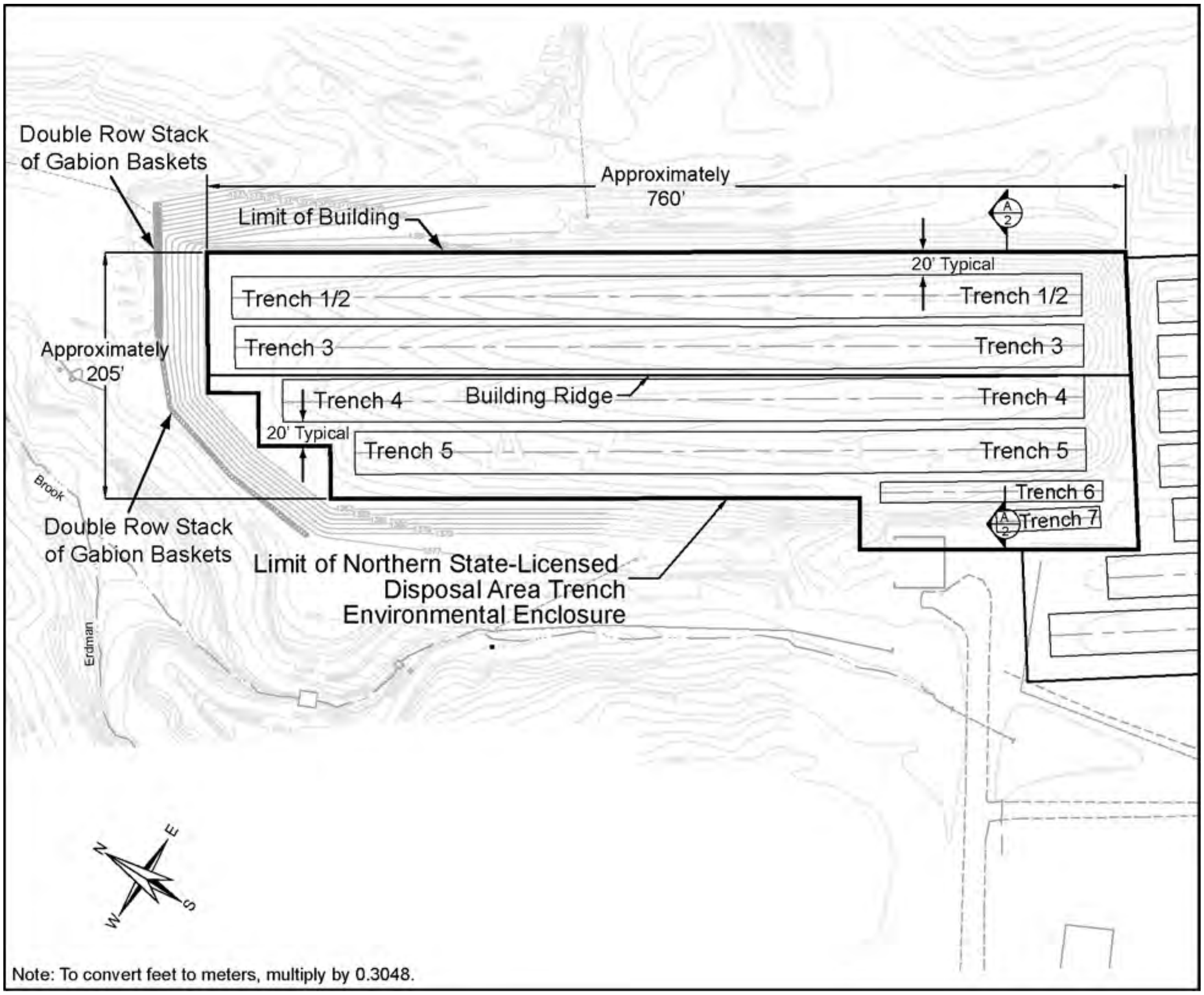

Figure C–23 Conceptual North State-Licensed Disposal Area Environmental Enclosure Footprint

Similar again to the NDA Environmental Enclosure, this enclosure would include a ventilation system with HEPA filtration, a fire protection system, a heating system, electrical lighting, a closed-circuit television system, and a gantry crane system.

The demolition of the North SDA Environmental Enclosure would be performed in the same manner as the demolition of the NDA Environmental Enclosure, described in Section 4.6.1.

C.4.6.5 State-Licensed Disposal Area Lagoon Confinement Structures

Three pre-engineered sheet metal confinement structures, called the SDA Lagoon Confinement Structures, would be constructed over each of the three filled lagoons in WMA 8. The confinement structures would be single-span, steel-framed buildings having sheet metal interior walls, concrete exterior walls, and steel roof with gutters. They would each be approximately 1,580 square meters (17,000 square feet) in size, and high enough to allow use of heavy equipment inside.

C.4.6.6 Lagoon 1 (Waste Management Area 2) Confinement Structure

A pre-engineered sheet metal confinement structure, called the Lagoon 1 Confinement Structure, would be constructed over Lagoon 1 in WMA 2 before excavation of the closed lagoon. The Confinement Structure would be a single-span, steel-framed building with sheet metal interior walls, concrete exterior walls, and a steel roof with gutters. It would be approximately 2,090 square meters (22,500 square feet) in size and high enough to allow use of heavy equipment inside.

C.4.6.7 North Plateau Groundwater Plume Source Confinement Structure

A pre-engineered sheet metal confinement structure, called the North Plateau Groundwater Plume Source Confinement Structure, would be constructed over the North Plateau Groundwater Plume source area in WMA 1, where the Main Plant Process Building previously stood. The confinement structure would be a single-span, steel-framed building with sheet metal walls and a steel roof with gutters. It would be approximately 930 square meters (10,000 square feet) in size and high enough to allow use of heavy equipment inside.

C.4.6.8 Modular Shielded Environmental Enclosure

These enclosures would be used to support exhumation of wastes from the NDA and the SDA that are expected to have characteristics that would exceed those of Class C low-level radioactive waste. The Modular Shielded Environmental Enclosures proposed for NDA and SDA remediation are considered first of their kind. There are no full-scale field examples of waste retrieval and processing operations of this magnitude and involving the waste classes that would be dealt with under the Sitewide Removal Alternative. The anticipated wastes have been listed based on historic documentation. However, there exists a significant potential to discover wastes and types that are unexpected or unplanned. The costs of construction of the facilities would be fairly reliable (within the contingency specified in the estimates), as the structural and equipment components are readily available and have been used in some capacity in the past. However, the project productivity and safety are items of uncertainty that cannot be easily estimated.

C.4.6.8.1 NRC-Licensed Disposal Area Modular Shielded Environmental Enclosure

The NDA Modular Shielded Environmental Enclosure would be designed and procured to support exhumation of wastes from the NDA that are expected to have characteristics that would exceed those of Class C low-level radioactive waste. This enclosure would control airborne emissions, shield against high-radiation fields, and permit exhumation of wastes from holes up to 16.8 meters (55 feet) deep.

The NDA Modular Shielded Environmental Enclosure would provide secondary confinement for the radiological and hazardous material releases that are expected during the excavation and retrieval activities to be performed. The enclosure would be designed to accommodate remote excavation, retrieval, and maintenance operations. It would be of modular design so that it could be customized to accommodate holes and trenches of various sizes. Individual modular panels would lock together to provide an airtight enclosure. It would be maintained under negative pressure using a HEPA-filtered ventilation system. It would be equipped with a carbon dioxide fire suppression system for conventional fires and a metal-halide fire suppression system for pyrophoric metal fires.

Because of its modular design, the NDA Modular Shielded Environmental Enclosure would enable the user to increase the overall length by adding either a roof panel or a wall panel. Several of the modules would have apparatus attached for ventilation systems, shield window atriums, and glovebox panels or equipment and waste container passages.

The wall panels of the structure would be approximately 3 meters (10 feet) wide and 6 meters (20 feet) high and would be constructed with a steel frame. A core of lead brick shielding (5 centimeters [2 inches] thick) would be installed from the bottom of the wall (ground level) to a height of 2 meters (8 feet) to provide shielding for the workers on the ground around the perimeter of the enclosure. The lead core would be held in place by steel sheeting on the inner and outer surfaces of the lead brick core. The roof panels would not be shielded.

The wall panels would fit side by side around the perimeter of the excavation (on top of the sheet pile). The roof panels would be approximately 3 meters (10 feet) wide by 3 meters (10 feet), 6 meters (20 feet), or 12 meters (40 feet) long. These different lengths would be suitable for spans of 3 meters (10 feet), 6 meters (20 feet), or 12 meters (40 feet) and could cover holes or trenches of 9 to 90 square meters (100 to 1,000 square feet), 20 to 260 square meters (200 to 2,800 square feet), or 37 to 300 square meters (400 to 3,200 square feet) in size, respectively.

The length of any of these NDA enclosure configurations could be adjusted by removing a number of wall and roof panels, the smallest configuration would be 9 square meters (100 square feet) and the largest, 300 square meters (3,200 square feet). The conceptual design included in the Sitewide Removal Alternative contains a quantity of materials sufficient to construct six structures, two of each size (span).

The NDA Modular Shielded Environmental Enclosure modules would vary in size due to hole sizes at the NDA and would employ a Z-mast crane system operating from the outside of the enclosure. The crane mast would penetrate through a boot in the top of the NDA Modular Shielded Environmental Enclosure and would perform necessary operations using remote video. This configuration was selected based on the small size of the NDA special and deep holes. It is estimated that two of these remote-operated cranes would be needed for the NDA work.

The NDA Modular Shielded Environmental Enclosure would be equipped with a soil handling workstation. This station would include a soil vacuum system that would be used to remove loose soil and collect it in appropriate containers, depending upon known characteristics of the hole or trench from which the waste was being exhumed. This station would include shielding, a shield window, master-slave manipulators, and a waste container transfer system.

The NDA Modular Shielded Environmental Enclosure would also be equipped with a material handling workstation. This station would include shielding, a shield window, a console for operating the chain hoist system, master-slave manipulators, and a waste container transfer system.

C.4.6.8.2 State-Licensed Disposal Area Modular Shielded Environmental Enclosure

The SDA Modular Shielded Environmental Enclosure would be designed and procured to support exhumation of wastes from the SDA, some of which are expected to have characteristics that would exceed those of Class C low-level radioactive waste. This enclosure would be similar in construction to the system described previously for NDA excavation.

The SDA Modular Shielded Environmental Enclosure would provide the primary confinement for the radiological and hazardous material releases that are expected during the excavation and retrieval activities to be performed. The enclosure would be designed to accommodate remote excavation, retrieval, and maintenance operations. It would be of modular design so that it could be customized to accommodate trenches of various sizes. Individual modular panels would lock together to provide an airtight enclosure. It would be maintained under negative pressure by a HEPA-filtered ventilation system. It would be equipped with a carbon dioxide fire suppression system for conventional fires and a metal-halide fire suppression system for pyrophoric metal fires.

The SDA Modular Shielded Environmental Enclosure would house a Z-mast system. The crane would be mounted on rails within the enclosure and would be able to reach to the bottom of the trenches. After lifting a load from a trench, the system would be able to move the load to the side and place it in front of an appropriate workstation. The crane system would include crane rails, side supports, an overhead bridge, a carriage, an excavating arm, and other attachments.

The SDA Modular Shielded Environmental Enclosure soil handling workstation would include shielding, a shield window, master-slave manipulators, and a waste container transfer system. The material handling workstation would include shielding, a shield window, a console for operating a chain hoist system, master-slave manipulators, and a waste container transfer system.

The roof and wall panels would be constructed similar again to the NDA panels, however the SDA roof panels would be a standard 12 meters (40 feet) in length. Because the cranes would be installed on the inside of these enclosures, the roof penetrations would not be necessary.

The SDA structures would be configured to fit the SDA trenches based on the perimeter of each trench. For example, Trench 3, with a length of approximately 210 meters (700 feet) and a width of approximately 10 meters (33 feet), would have a perimeter of almost 460 meters (1,500 feet). Based on this perimeter, a total of 76 shielded wall panels (20 feet each) and 36 roof panels (6 meters by 12 meters [20 feet by 40 feet]) would be needed. This enclosure would be approximately 220 meters (720 feet) in length and would be used for Trenches 1, 2, and 3.

A 210-meter-long (700-foot-long) enclosure would be used for Trench 4 and reused for Trench 14; a 200-meter-long (640-foot-long) enclosure for Trench 13, then 5; a 180-meter-long (600-foot-long) enclosure for Trench 8, then 9; a 180-meter-long (600-foot-long) enclosure for Trench 10, then 11; a 61-meter-long (200-foot-long) enclosure for Trench 12 only; and a 61-meter-long (200-foot-long) enclosure for Trench 6, then 7.

In summary, the Sitewide Removal Alternative concept contains a quantity of materials sufficient to construct Modular Shielded Environmental Enclosures over half (seven) of the SDA trenches and Z-mast cranes for each (seven total) of these structures. The enclosures and cranes would subsequently be used a second time to complete the remainder of the trenches.

C.4.7 Waste Management Area 1 Main Plant Process Building Excavation Downgradient Barrier Wall

To facilitate removal of WMA 1 underground structures and the contaminated soil beneath the Main Plant Process Building (i.e., North Plateau Groundwater Plume source area), a barrier wall would be installed around the footprint of the WMA 1 buildings. The wall would extend approximately 0.6 meters (2 feet) into the underlying Lavery till to isolate the subsurface structures and contamination from groundwater outside the source area. The upgradient and crossgradient portions of the barrier wall would be constructed of sheet pile, while the downgradient section would consist of a soil-cement-bentonite backfill mixture that would remain in place after remediation of WMA 1 is completed. On the upgradient side of the wall, a subsurface drain would be installed during backfilling to mitigate mounding of groundwater.

The total length of the barrier wall would be approximately 690 meters (2,250 feet), 230 meters (750 feet) of which would be soil-cement-bentonite and 460 meters (1,500 feet) of which would consist of sheet pile. The section of soil-cement bentonite wall adjacent to the excavation (approximately 150 meters [500 feet]) would be approximately 4 meters (13 feet) wide, while the remainder would be a typical three feet in width. The thicker wall with cement, adjacent to the excavation, would provide the stability necessary to accommodate excavation up to the wall. The designed maximum hydraulic conductivity of the barrier wall would be 1×10^{-7} centimeters per second (3.9×10^{-8} inches per second).

Construction of the barrier wall would involve use of a conventional pile driver for the sheet pile section and a hydraulic excavator for the soil-cement-bentonite wall section. Approximately 5,600 cubic meters (7,300 cubic yards) of soil would be excavated for the soil-cement-bentonite wall, 5,000 cubic meters (6,500 cubic yards) of which is assumed to be contaminated and half of that volume is assumed to be saturated. The slurry and backfill mixtures for the soil-cement-bentonite wall would be prepared in contained areas, and the trench would be kept filled with slurry to support its walls during excavation. The bentonite used to support the walls of the excavation would be evaporated. Any residual material would be disposed of with the excavated soil.

C.4.8 Installation of the Waste Management Area 1 and Waste Management Area 3 Circumferential Hydraulic Barrier Walls and Multi-layer Cap

This section includes a description of the general concept for the WMA 1 and WMA 3 closure system, as well as the design features of the multi-layer cap. The last subsection presents the approach that would be used to construct the hydraulic barrier wall and the multi-layer cap.

C.4.8.1 Conceptual Design of the Closure System

A single subsurface circumferential barrier wall would be constructed around the partially demolished and stabilized facilities in WMA 1 and WMA 3. In addition to this circumferential barrier wall, a separate, chevron-shaped subsurface barrier wall would be constructed hydraulically upgradient of the circumferential barrier wall. This upgradient barrier wall would be oriented transverse to the direction of groundwater flow to divert groundwater flow and to help prevent mounding from occurring against the upgradient side of the circumferential barrier wall.

A multi-layer cover system would be constructed over the demolished and closed WMA 1 and WMA 3 facilities and the subsurface barrier walls. The top-slope portion of the multi-layer cover system would extend laterally to just beyond the top of the barrier walls, and the side-slope portions of the cover system would be located outside the limits of the barrier walls.

The actual configuration of the cover system would be based on the surrounding topography; the final height of the closed-in-place facilities; and the surface slopes required for providing adequate lateral drainage, limiting infiltration, and satisfying slope stability and erosion control requirements. The final cover configuration would be designed to preclude subsequent surface water ponding, minimize infiltration, exhibit stability under normal and stressed conditions, and protect the closure cap from excessive erosion.

The conceptual cover system and the subsurface barrier walls incorporate features that are designed to minimize degradation due to long-term exposure to environmental and geomechanical processes. Potential degradation processes include wind and/or water erosion, biological disruption by plants and animals, geochemical processes, seismic events, and inadvertent human intrusion. The cover design therefore includes redundant barrier components to help preserve long-term effectiveness. The barrier walls and low-permeability hydraulic barrier components of the multi-layer cover system are designed to meet the following objectives:

- Resist degradation due to erosional forces from wind and water, damage due to frost penetration, and potential damage by geochemical processes.
- Limit infiltration of precipitation into the stabilized structures by restricting the rate of infiltration through the closure cap and limiting the rate of lateral inflow of groundwater through the barrier wall.

- Withstand intrusion by plants, animals, and humans.
- Exhibit slope stability under static, seismic, and seepage conditions.
- Be cost-effective to construct, and require a minimum of maintenance.

A conceptual plan view drawing depicting the approximate areal extent of the multi-layer cover system is shown on **Figure C–24**.

The entire multi-layer cover system would occupy a total area of approximately 41,000 square meters (441,000 square feet), or approximately 4 hectares (10 acres). The cover would extend up to 4 to 6 meters (15 to 20 feet) above the existing ground surface. The flatter top-slope of the cover system would have a true surface area of approximately 23,000 square meters (246,000 square feet), or approximately 2.3 hectares (5.7 acres). The steeper, rip-rap-covered side-slopes would have a true surface area of approximately 18,000 square meters (195,000 square feet), or approximately 1.8 hectares (4.5 acres).

C.4.8.2 Construction of the Hydraulic Barrier Walls

The subsurface barrier walls would be constructed using the slurry trench technology. This technology was selected because it has been used extensively and successfully elsewhere and has the longest history of use of any of the barrier technologies considered for the project.

The barrier walls are designed to divert groundwater flow around the stabilized facilities. The upgradient chevron-shaped barrier wall would be a low-permeability soil-bentonite barrier wall that would reduce groundwater flow into the closed facilities area by laterally diverting groundwater flow around the circumferential wall surrounding WMA 1 and WMA 3. The circumferential barrier wall would be bimodal in its composition and hydraulic properties, consisting of two distinct portions:

- The upgradient segment of the wall would be a soil-bentonite barrier wall of similar composition and hydraulic properties as the chevron-shaped barrier wall.
- The portion of the wall downgradient of the closed facilities would be a mixture of soil, bentonite, and a sorbent material such as a granular apatite.

The soil-bentonite-sorbent material mixture incorporated into the downgradient segment of the circumferential wall would provide sorptive capability for sequestering selected radionuclides that might be dissolved in groundwater. This portion of this barrier wall would be designed to be slightly more permeable than the very-low-permeability layer of the closure cap to minimize the possibility of groundwater mounding within the circumferential wall. The downgradient segment of the wall would be constructed to achieve a hydraulic conductivity of 1.0×10^{-7} centimeters (4.0×10^{-8} inches) per second; the upgradient segment, of 1.0×10^{-8} centimeters (4.0×10^{-9} inches) per second.

The chevron-shaped and circumferential barrier walls would be constructed in the sand and gravel unit and underlying Lavery till; the base of each wall would be keyed at least 1 meter (3 feet) into the underlying unweathered Lavery till to minimize leakage of groundwater through the bottom of the walls.

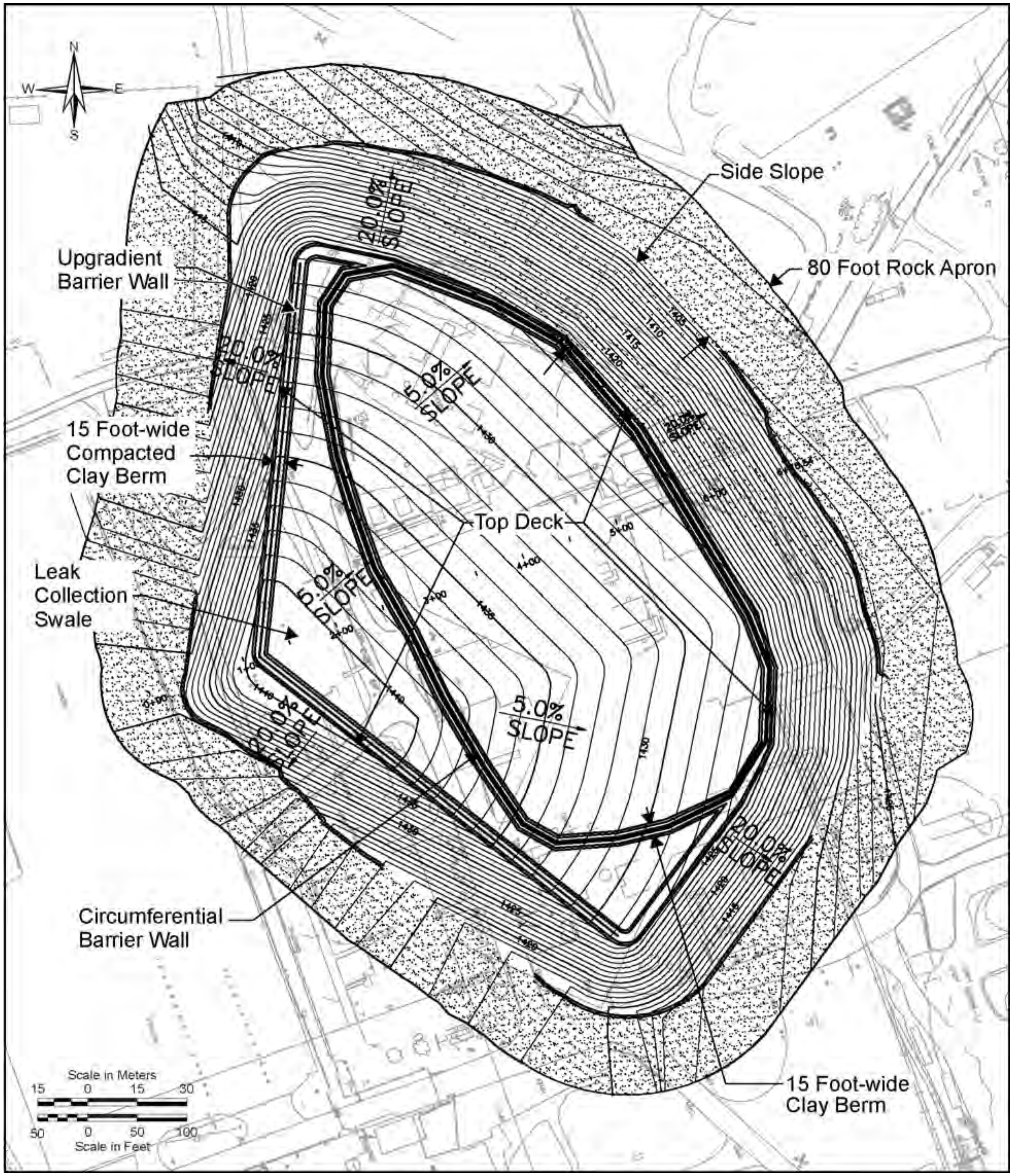

Figure C–24 North Plateau Closure Cap Conceptual Plan View

C.4.8.3 Multi-layer Closure Cap Design

The multi-layer closure cap cover system would include top-slope and side-slope portions of differing construction. Notable design features include the following:

- Thirteen separate layers in the top-slope portion, with a total thickness of approximately 3.7 meters (12.3 feet) and a 5-degree slope eastward
- Two layers in the side-slope portion, which would have a 20-percent slope, along with a 5.2-meter-wide (19-foot-wide) rock apron to provide added protection against gullying and erosion
- A perimeter barrier formed of large boulders intended to prevent access by vehicles or construction equipment

The top-slope portion of the cover would consist of the following components, from top to bottom:

- Rip-rap – 0.77 meters (2.5 feet) thick with an average stone size (D_{50}) of approximately 7.6 centimeters (3 inches) – to provide erosion protection and function as a barrier from bio-intrusion
- Rock Filter/Bedding – 0.38 meters (1.3 feet) thick with a D_{50} of approximately 3.8 centimeters (1.5 inches) – to function as bedding to rip-rap and a filter to underlying layers and to provide additional erosion protection
- Coarse Sand Filter – 15 centimeters (6 inches) thick – to serve as granular filter to prevent degradation of underlying loam layer
- Compacted Loam – 0.6 meters (2 feet) thick sandy clay soil – to provide water storage and freeze/thaw protection
- Coarse Sand Filter – 15 centimeters (6 inches) thick – to prevent clogging of underlying drainage layer
- Clean Gravel Drainage Layer – 0.3 meters (1 foot) thick with a hydraulic conductivity of approximately 0.001 centimeters per second (0.00039 inches per second) – to serve as the primary drain for removing water that percolates into the cap
- Geotextile – marginal thickness, non-woven cushion – to protect the underlying geomembrane from puncture and excessive wear from drainage gravel
- Geomembrane Liner – 60 mils (0.060 inches) of linear low- or high-density polyethylene – to serve as an infiltration barrier in the short term
- Bentonite/Additive Mixture – a 0.6 meter-thick (2 foot-thick) bentonite sand mixture with a hydraulic conductivity of approximately 5.0×10^{-9} centimeters per second (2.0×10^{-9} inches per second) – to function as a low-permeability barrier layer in the long term
- Sandy Clay Loam – a 0.3 meter-thick (1 foot-thick) compacted layer – to provide structural support for the bentonite layer and to function as secondary water storage and freeze/thaw protection
- Geocomposite – a marginal-thickness geonet with geotextile fabric to serve as a leak detection layer in the short term
- Geomembrane Liner – to function as a secondary infiltration barrier
- Compacted Clay – 0.45 meters (1.5 feet) thick with a hydraulic conductivity of approximately 7.0×10^{-7} centimeters per second (2.8×10^{-7} inches per second) – to provide foundational and structural support in addition to redundant infiltration protection

Because the side-slope portion of the closure cap would be located outside the limits of the slurry wall, it would overlie the ground located outside of the WMA 3 area. The side-slopes of the cover would be graded at approximately 20 percent, and would consist of the following components, from top to bottom:

- A rock rip-rap layer – approximately 0.6 meters (2 feet) thick with a D_{50} size of approximately 25.4 centimeters (10 inches) – to provide erosion protection and minimize animal and human intrusion
- A granular bedding/filter layer – approximately 0.3 meters (1 foot) thick with a D_{50} size of approximately 3.8 centimeters (1.5 inches) – to provide a uniform, competent layer for rip-rap placement and to mitigate internal soil erosion

The proposed closure cover has been evaluated for veneer (layer) stability under static, seepage, and seismic conditions. Evaluation results indicate that the proposed materials would provide the necessary sheer strength to maintain stability under static conditions with a safety factor of at least 1.5 and to survive an earthquake inducing a theoretical maximum horizontal ground acceleration equal to 0.20 *g*, with a safety factor of at least 1.1 (URS 2004).

The closure cover would be designed in accordance with criteria established by the NRC to protect cover systems from damage due to long-term erosion (NRC 2002) and RCRA requirements. The top-slope and side-slope portions of the cover would be sloped at approximately 5 percent and 20 percent or less, respectively. The top-slope and side slope rip-rap layers are designed to withstand the erosive effects expected from a probable maximum precipitation event at the site. The height of the cap would be approximately 5 to 6 meters (15 to 20 feet) above the existing grade.

C.4.8.4 Performance of Permeable Treatment Walls, Hydraulic Barrier Walls, and Covers

Engineered hydraulic barriers and covers are described in various locations throughout Sections C.3.2 and C.3.3 for the Sitewide Close-In-Place and Phased Decisionmaking Alternatives, respectively, as well as previously in this section. Performance of the permeable treatment wall would be predicated on how effective the zeolite material is on contaminant removal and how long it lasts. To reduce uncertainties associated with the performance of the permeable treatment wall, a study was conducted that evaluated the performance of the pilot-scale permeable treatment wall (WVNSCO 2002). While the study showed where constructional and operational improvements could be made in a full-scale system, other factors could influence the performance of the technology. These include both hydraulic factors, such as groundwater bypass around the system and dispersal of "treated" groundwater, and operational factors, such as the logistics and practicality of replacing the zeolite approximately every 20 years.

There is uncertainty about the long-term performance of other engineered barriers, including multi-layered covers, waste grout, and barrier walls. Hydraulic factors, such as mounding and groundwater bypass, and other aspects, such as long-term durability, could potentially impact the long-term performance of barrier walls designed to keep subsurface contaminants from migrating off the site. Long-term performance of closure caps could be affected by erosion and differential settlement that increases the permeability of the engineered covers. These hydraulic factors are mitigated in the analysis by use of conservative assumptions. The performance of the hydraulic barriers is incorporated into the sensitivity analysis presented in Appendix H of this EIS.

C.4.9 Waste Management Area 2 Lagoons Engineered Multi-layer Cover

An engineered multi-layer cover would be installed over Lagoons 1 through 5 in WMA 2 as part of the Sitewide Close-In-Place Alternative. The cover would consist of the following layers:

Sand and Gravel Backfill: Backfill would be placed in all of the lagoons to fill them to the surrounding ground surface. The sand and gravel backfill would be filled using a bulldozer. As the lagoons are being filled, the backfill would be watered and compacted by a sheepsfoot roller.

Compacted Clay Layer: A minimum of a 1-meter-thick (3-foot-thick) clay liner would be spread over the entire proposed multi-layer cap by a bulldozer (see **Figure C–25**). As the liner is being spread, water would be applied, and the laid liner would be compacted with a sheepsfoot roller. The liner would also be tested to ensure it meets the required placement specifications.

Geosynthetic Liner: A 60-mils (0.060-inch) low-density polyethylene membrane would be installed over the entire compacted clay layer.

Drainage Layer: A 0.6-meter-thick (2-foot-thick) drainage layer would be installed over the geosynthetic liner. The drainage layer would consist of screened and clean, washed gravel. This layer would be placed by a bulldozer and compacted by a sheepsfoot roller.

Intruder Barrier: A 1-meter-thick (3-foot-thick) intruder barrier would be installed over the drainage layer. This barrier would consist of cobbles and would be placed over the drainage layer by a front-end loader.

Vegetation Layer: A 46-centimeter (18-inch) layer of topsoil would be placed on top of the entire landfill cover. Seed and mulch would be applied over the topsoil to provide erosion protection.

C.4.10 Barrier Wall in Waste Management Area 2

To facilitate the long-term performance of the remedial work at WMA 2 under the Phased Decisionmaking Alternative, a subsurface soil-cement-bentonite barrier wall would be installed. The assumed location of the barrier is shown on Figure C–25. The wall would extend approximately 0.6 meters (2 feet) into the underlying Lavery till to create a vertical hydraulic barrier, reducing the likelihood of the North Plateau Groundwater Plume cross-contaminating the backfilled lagoons. The barrier wall would consist of a soil-cement-bentonite backfill mixture that would remain in place after remediation of WMA 2 is completed. The designed maximum hydraulic conductivity of the barrier wall would be 1×10^{-7} centimeters per second (4×10^{-8} inches per second). Construction of this wall would be similar to the process described in Section C.4.7 for WMA 1.

The soil-cement-bentonite barrier wall would be approximately 320 meters (1,050 feet) in length and approximately 4 meters (13 feet) in width to permit the nearby excavation to occur up to the base of the wall.

Liquid bentonite slurry would be prepared using a shear mixer and would be contained in earthen containment berms until such time that it is needed for trench construction. During the excavation process, the trench would be kept filled with bentonite slurry to provide the necessary stability of the trench walls.

The soil-cement-bentonite backfill material would be mixed using heavy equipment (excavator, bulldozer, or loader) on a concrete mixing pad. During the mixing process, the dry ingredients and dry bentonite would be mixed together, and then the hydrated bentonite slurry would be pumped in and mixed to create a thick mud-like consistency. Prepared backfill material would then be loaded into dump trucks or moved directly to the trench site using loaders or cranes and finally would be placed in the trench. The backfill would displace the slurry, which would then be used to continue the trench excavation.

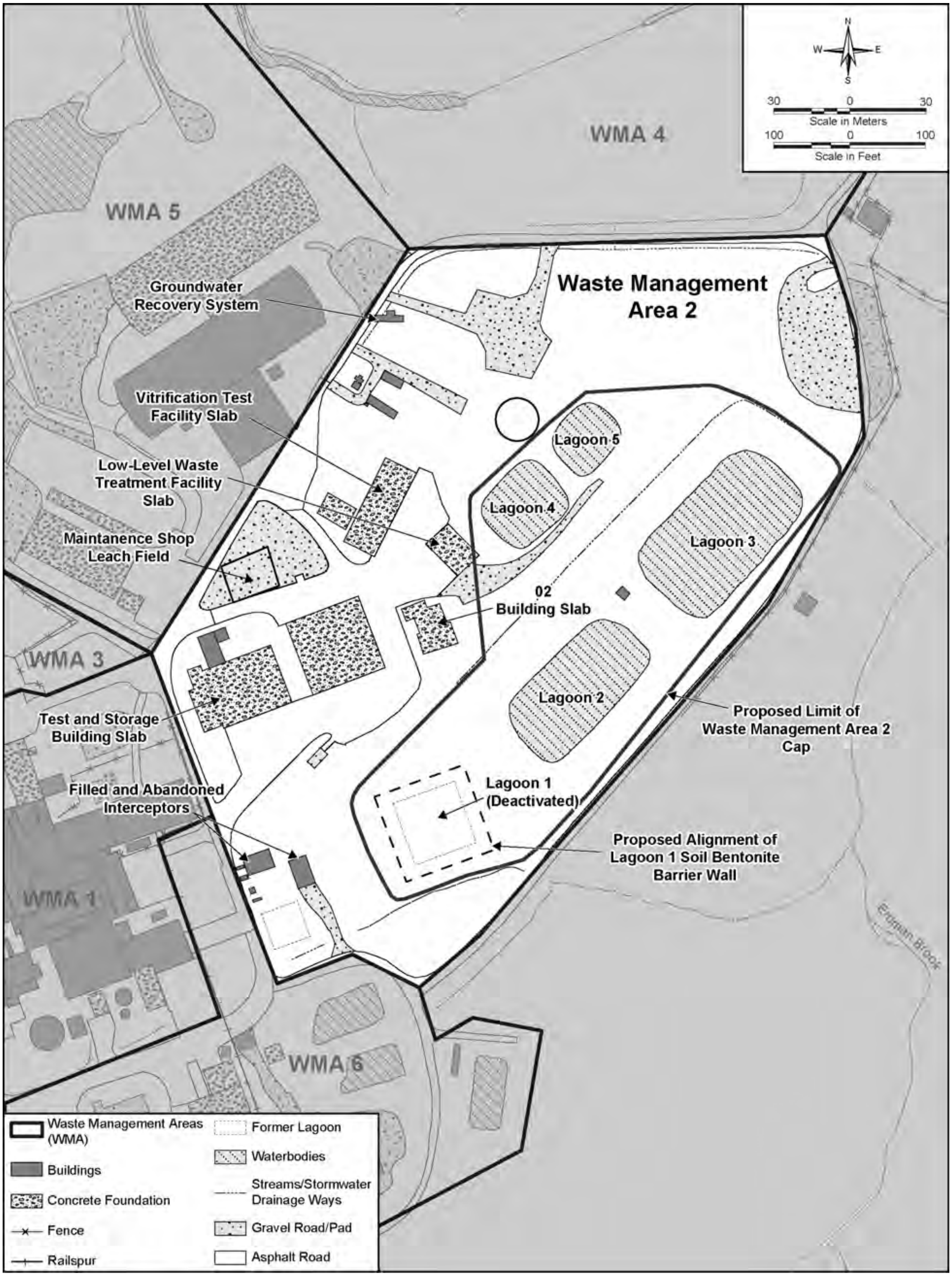

Figure C–25 Plan View of Cap and Barrier Wall in Waste Management Area 2

C.4.11 NRC-Licensed Disposal Area and State-Licensed Disposal Area Engineered Multi-layer Covers

Engineered multi-layer covers would be used to replace the geomembranes and isolate buried wastes at the NDA and SDA under the Sitewide Close-In-Place Alternative.

The conceptual design and construction methodology of the engineered multi-layer covers over the NDA and SDA are the same as those described for the engineered multi-layer cover proposed for the isolation of WMA 1 and WMA 3, described in Section C.4.8. However, due to the limited groundwater flow in the South Plateau, it was determined that downgradient barrier walls would serve no purpose. For this reason, the barriers designed for the South Plateau disposal areas would be constructed on the upgradient side of the NDA and SDA.

The NDA cover's footprint would be approximately 4 hectares (10 acres).

The SDA cover's footprint would be approximately 11 hectares (28 acres).

C.4.12 Circumferential Barrier Wall in Waste Management Area 2

Under the Sitewide Close-In-Place Alternative, a subsurface soil-bentonite barrier wall would be used to divert groundwater around the portion of Lagoon 1 that is below the groundwater table. The wall would extend around the perimeter of the lagoon. In-place soil mixing would be used to help stabilize and encapsulate the remaining contaminated sediments, soils, and debris in Lagoon 1. The barrier wall would be keyed approximately 0.9 meters (3 feet) into the underlying till and would extend vertically at least above the seasonal high groundwater table elevation in that area.

C.4.13 Erosion Control Structures

Under the Sitewide Close-In-Place Alternative, long-term erosion without mitigation may negatively impact several WMAs. Successful in-place closure and long-term management of these WMAs would therefore depend on methods to control erosion over time.

The strategy for controlling erosion would include use of the following measures:

- Diversion berms and ditches
- Water control structures
- Streambed armoring

The location of these features and the general conceptual design for long-term erosion control are shown on **Figure C–26**. The primary objectives of these measures would be to control surface water runoff to mitigate gully erosion progress and to reduce streambed erosion. The conceptual design provides an integrated approach to controlling erosion on both the North Plateau and the South Plateau, especially around the closed in-place facilities.

Erosion controls would be designed to accommodate the probable maximum flood consistent with guidance in NUREG-1623, *Design of Erosion Protection for Long-Term Stabilization* (NRC 2002). Designs would be intended to function without long-term maintenance, although it is assumed that periodic inspections and maintenance would be performed. The strategy for controlling erosion at the site would be implemented in three general terrain areas: flat-sloped plateaus where unconcentrated sheet flow occurs; steeper-sloped areas where sheet flow becomes concentrated; and streambed areas where concentrated flows are fully developed.

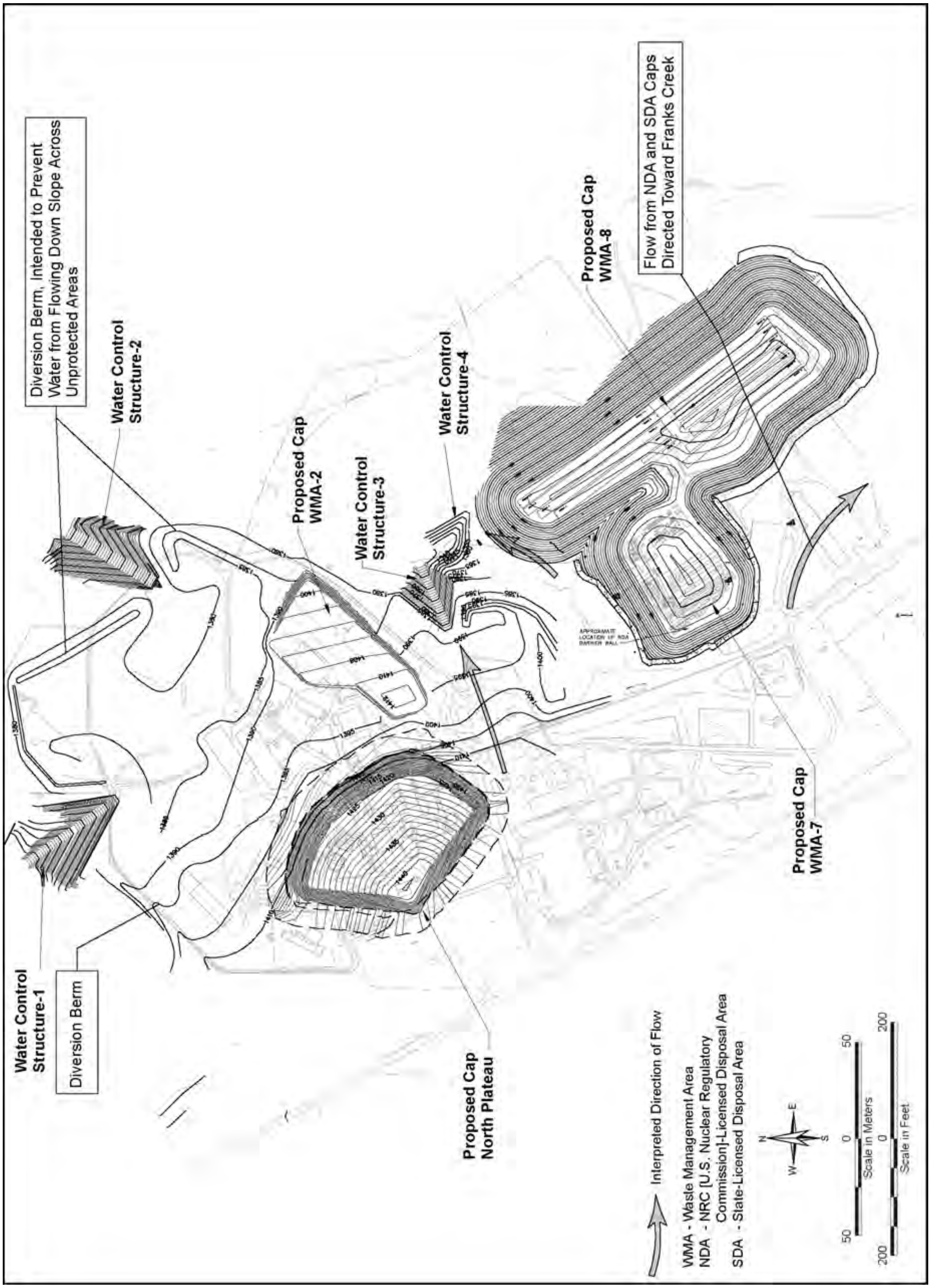

Figure C–26 Location and Conceptual Design for Long-term Erosion Control

Conventional construction methods would be used; bulldozers and excavators would remove soil for installation of the erosion control structures. Some of the removed soil would be used as fill to establish the preliminary grade for the closure cap installations.

Diversion Berms and Ditches

Diversion berms and ditches would be provided on the North Plateau to direct stormwater and sheet flow to water control structures located at strategic points, thereby preventing runoff from flowing down unprotected slopes and deepening existing gullies or cutting new ones. The diversions would consist of trapezoidal-shaped channels with a supporting ridge on the lower side, as shown on **Figure C–27**. The tops of the ridges would be approximately 3–6 meters (10–20 feet) wide, as shown on the figure.

To minimize long-term erosion of the berms and ditches themselves, they would be armored with three layers of aggregate. Coarse sand at the base would serve as a filter layer to create stability between the base soil and the bedding layer. The sand would be covered with a layer of rock bedding, which would be topped with a layer of rip-rap.

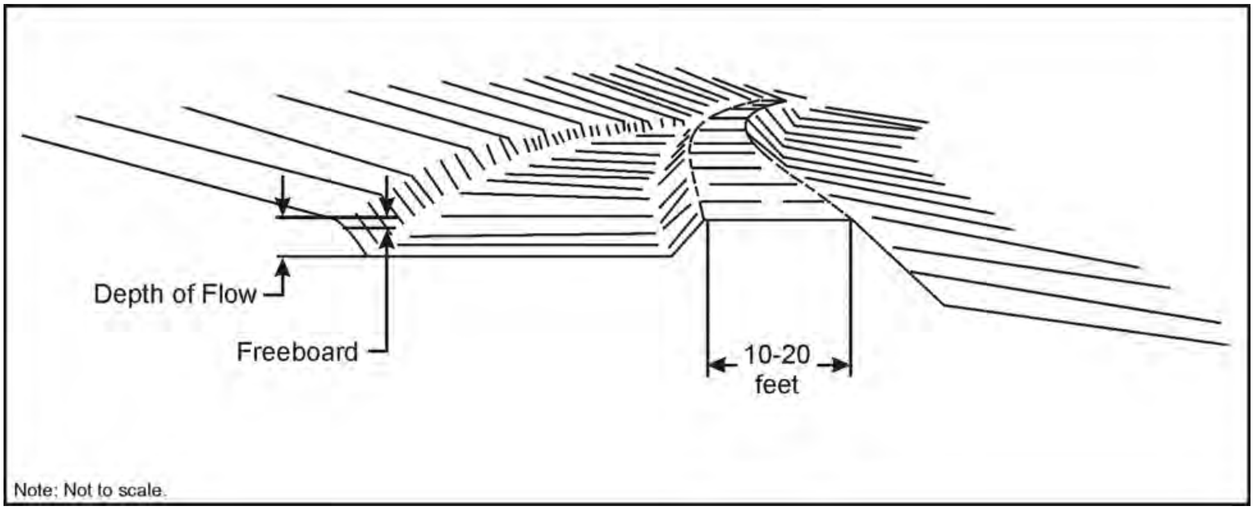

Figure C–27 Typical Diversion Berm

Water Control Structures

Water control structures would be provided at the locations shown on Figure C–26. The construction of each structure would be similar to that shown on **Figure C–28**.

These water control structures would channel flow from the plateau surface down to the creek bottom in a manner that would dissipate energy and minimize erosive impacts, being designed so that surface water runoff from events up to the 100-year rainfall would pass though concrete piping instead of running down the slope. Concrete fill would be poured around the piping to promote long-term durability.

A broad-crested weir and an armored overflow spillway would be provided to accommodate the probable maximum flood. Both the spillway and pipe discharges would be protected using discharge aprons. These structures would be reinforced with rip-rap/rock armoring.

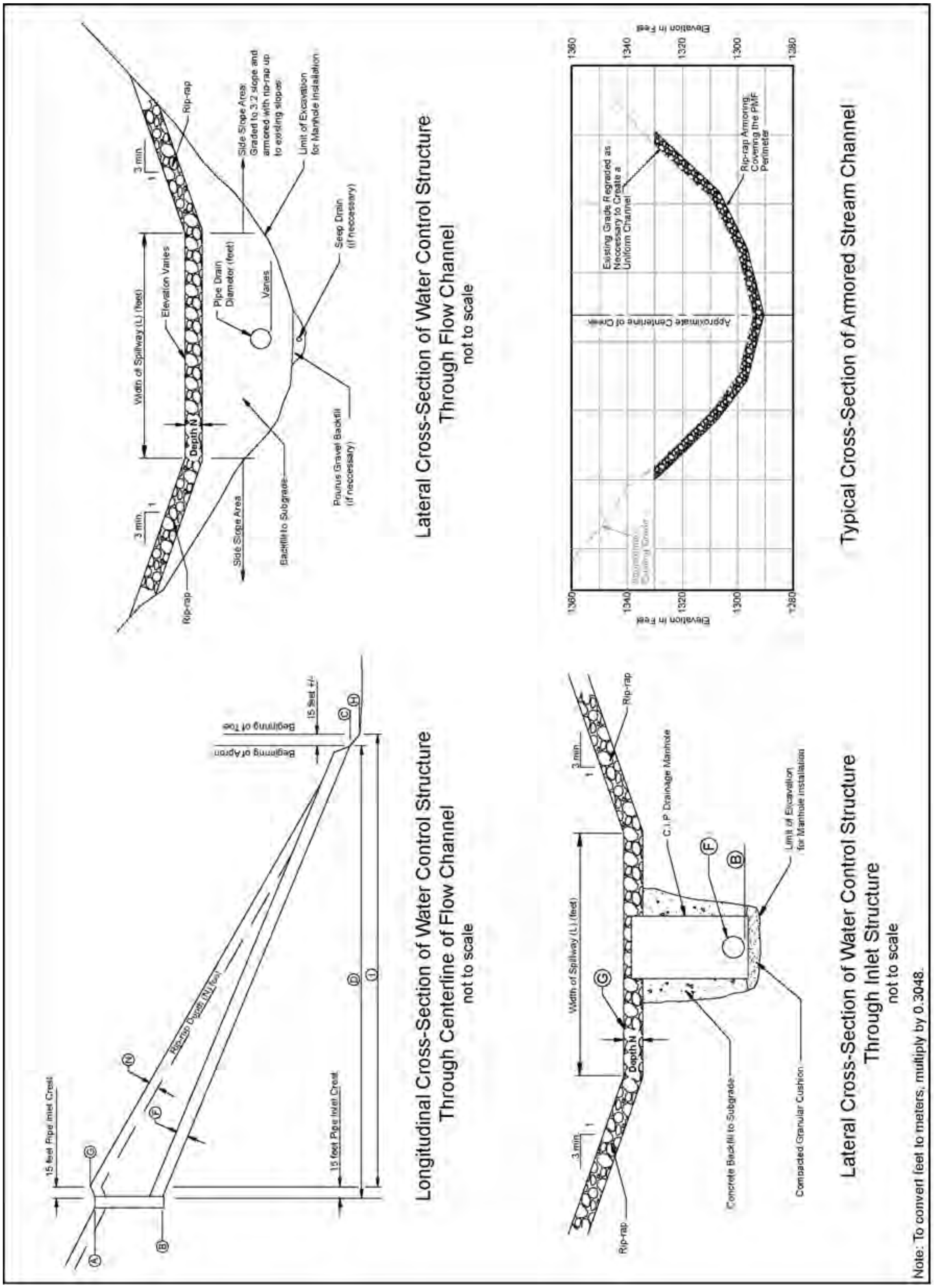

Figure C–28 Typical Water Control Structure

Streambed Armoring

Stone armoring would be installed in the beds of Quarry Creek, Erdman Brook, and Franks Creek from upstream of the SDA to its confluence with Buttermilk Creek to provide protection again the erosive forces of water flowing downstream. This armoring would ensure that erosive forces do not continue to lower the streambed elevation. Figure C–28 illustrates the typical cross-section of an armored stream channel.

The total armored length of these streams would be approximately 3,970 meters (12,900 feet).

Planning for excavation of streambed material for installation of the rip-rap armor would take into account the results of the streambed characterization surveys. Excavation necessary to install the rip-rap armor would include removal of contaminated streambed sediment along with other uncontaminated material.

The process to be used for each stream would begin with clearing trees and undergrowth from both sides of the stream and establishing temporary haul roads. Although construction would be purposely planned during dry months, a bypass pumping system would be placed in operation to remove the baseline stream flow. Construction would likely proceed from Buttermilk Creek, in an upstream direction, with relatively short sections of stream being reconstructed at a time. Bypass pumping would move upstream with construction, pumping only that necessary for construction. Excavation would be accomplished using conventional equipment such as excavators and bulldozers to provide uniform streambed geometry and slope. The streambed may be straightened in some cases as the new bed is shaped.

After flow diversion, clearing, and excavation, a filter layer consisting of coarse sand would be laid in the excavated streambed. A layer of rock bedding would be laid on top of the sand. Then a layer of rip-rap would be placed over the rock bedding to form a dense, well-graded mass of stone with minimum voids. Finally, the streamflow would be rediverted back to the armored streambed.

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APPENDIX D
OVERVIEW OF PERFORMANCE ASSESSMENT APPROACH

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Estimating future impacts on human health and the environment is an important aspect of the alternatives analysis for this environmental impact statement (EIS). Impacts would occur both during the short-term decommissioning period due to planned activities and accidents, and in the long-term future under the influence of natural processes. Potentially affected individuals include workers and the public at both on- and offsite locations. Constituents of concern include radionuclides and hazardous chemicals.

Because potential impacts would occur in the future and involve new actions at the site, direct measurement of impacts or projections based on current releases is not possible. Thus, the estimation of impacts is based on exposure scenario analysis using mathematical models. The scenarios comprise combinations of releases from a facility, transport through the environment, and exposure of individuals. In principle, scenarios may be constructed to cover the range of all possible impacts from small to large. In practice, a set of scenarios intended to represent the upper range of potential impacts was selected for analysis. Scenario analysis models predict contaminant release rates from facilities, contaminant movement rates through the environment, exposure point concentrations, and human receptor exposure and risk levels. The analysis considers both radionuclides and hazardous chemicals and addresses: (1) short-term impacts due to accidents and planned releases to the atmosphere and local surface waters during the decommissioning period of each alternative, and (2) longer-term impacts resulting from future slow or episodic releases of any remaining contamination.

The performance assessment objectives of this EIS are to:

- Obtain estimates of potential impacts on human health and the environment that provide valid insight into the comparative impacts of the EIS alternatives, and
- Understand the interdependence of facility designs and environmental processes on human health and the environment.

This appendix presents an introductory overview of the approach for estimating impacts on human health due to (1) releases during decommissioning actions, and (2) long-term releases resulting from natural processes or human intrusion. The introductory discussion on the approach to estimating long-term impacts addresses the general approach to long-term assessment modeling, the site conceptual model, the considerations that went into identification of receptor scenarios, and the types of modules and integrated models used for the long-term analysis.

More-detailed information on the methods used for analysis of impacts during decommissioning, along with results, are presented in Appendix I of this EIS. More-detailed information on the specific release, transport, or dose modules that are used in the long-term performance assessment is presented in Appendix G. More-detailed information on the hydrology modeling and erosion modeling that support the long-term performance assessment is presented in Appendices E and F, respectively. Finally, more-detailed information on long-term performance assessment scenarios, model input parameters, and results for specific scenarios for the Sitewide Close-In-Place Alternative and the No Action Alternative is presented in Appendix H.

D.1 Summary of Performance Assessment Approach

The initial effort in the development of the performance assessment involves identification of site characteristics relevant to the estimation of impacts. These characteristics, collectively identified as the site conceptual model, are those that determine movement and dilution rates in the atmosphere, groundwater, and surface waters. Once a site conceptual model has been developed, the performance assessment process may be described as comprising three major steps. The first step involves combining information on site conditions, facility designs and release mechanisms, and regulatory guidance to identify exposure scenarios for analysis. The scenario development process considered a complete range of contributing processes and conditions, but only a limited set of scenarios, intended to represent the upper range of potential impacts, was selected for analysis. The following information sources were used to identify exposure scenarios:

- Site physical characteristics, such as meteorology and hydrology
- Estimates of contaminant release rates
- Local and regional activity and land use plan information that provides a basis for estimating future human activities and their locations
- Regulatory requirements or guidance that identify relevant performance objectives or requirements

An element of the scenario development process is identification of environmental pathways appropriate to each facility under consideration. In the case of the Western New York Nuclear Service Center (WNYNSC), multiple facilities, three areas of existing environmental contamination (North Plateau Groundwater Plume, Cesium Prong, and creek/stream sediment contamination) are present, and the set of scenarios includes one that analyzes impacts from single facilities and other scenarios (downstream water users) that analyze impacts from multiple facilities. Analyses that only include a single facility can be combined to estimate the consequences of situations where a single receptor may come in contact with contamination from multiple facilities or areas. Specific examples of such combination are presented in Appendix H of this EIS. The exposure point location for the scenarios evaluating impacts from multiple facilities was selected based on conservative evaluation of the intersection of environmental pathways for individual facilities (i.e., nearby plume centerlines were assumed to overlap even when there is some actual separation). Cumulative impacts estimated in this manner included all onsite facilities and sources associated with WNYNSC. No sources outside WNYNSC having measurable potential human health impacts on WNYNSC receptors have been identified.

The second step was establishment of a method for performing calculations consistent with the integrated conceptual model developed in the first step. This step required review of existing models or analytical methods to determine if the basic requirements could be met using existing models or whether site- or project-specific models needed to be developed. Three requirements were used for selection, development, and use of models. The first requirement was to select and use models that strike a reasonable balance between analytic complexity and realistic modeling of site- and design-specific features. The second requirement was to be consistent in modeling processes across the site so that any variability in estimated impacts would be primarily due to differences in waste, barrier, or site properties, rather than differences in model features. The third requirement was to evaluate realistic, likely exposure scenarios that accurately reflected impacts of the alternatives.

The third step of the performance assessment process was the actual calculation of release and transport rates and impact estimates using the selected models and appropriate input parameters. Input data were selected in a systematic procedure that considers the available site characterization data, surrogate data from similar sites, and regulatory guidance. Calculation results were examined to determine reasonableness of predicted release rates, transport, and impacts. The computer codes and models used in the long-term performance assessment were verified through a process that included the development of test cases and comparison of the results of model calculations with the results developed using alternate models and hand calculations. (See Appendix G, Section G.1, of the EIS.) Sensitivity analyses were conducted to determine more-important model and input parameters.

The performance assessment process is summarized on **Figure D–1**. The large text boxes aligned downward along the center of the figure represent the three major steps of the performance assessment process. The figure also shows the use of information about regulatory requirements, local human activity, site characteristics, and waste release or containment design during both the scenario development step (Step 1) and calculation step (Step 3).

Application of the first two steps of this process (identify scenarios and select calculation methods) for estimating short-term (decommissioning period) impacts is discussed in Section D.2.

Section D.3 discusses application of the first two steps of this process for estimating long-term impacts, as well as the approach to sensitivity analyses, which are particularly important to long-term performance assessments.

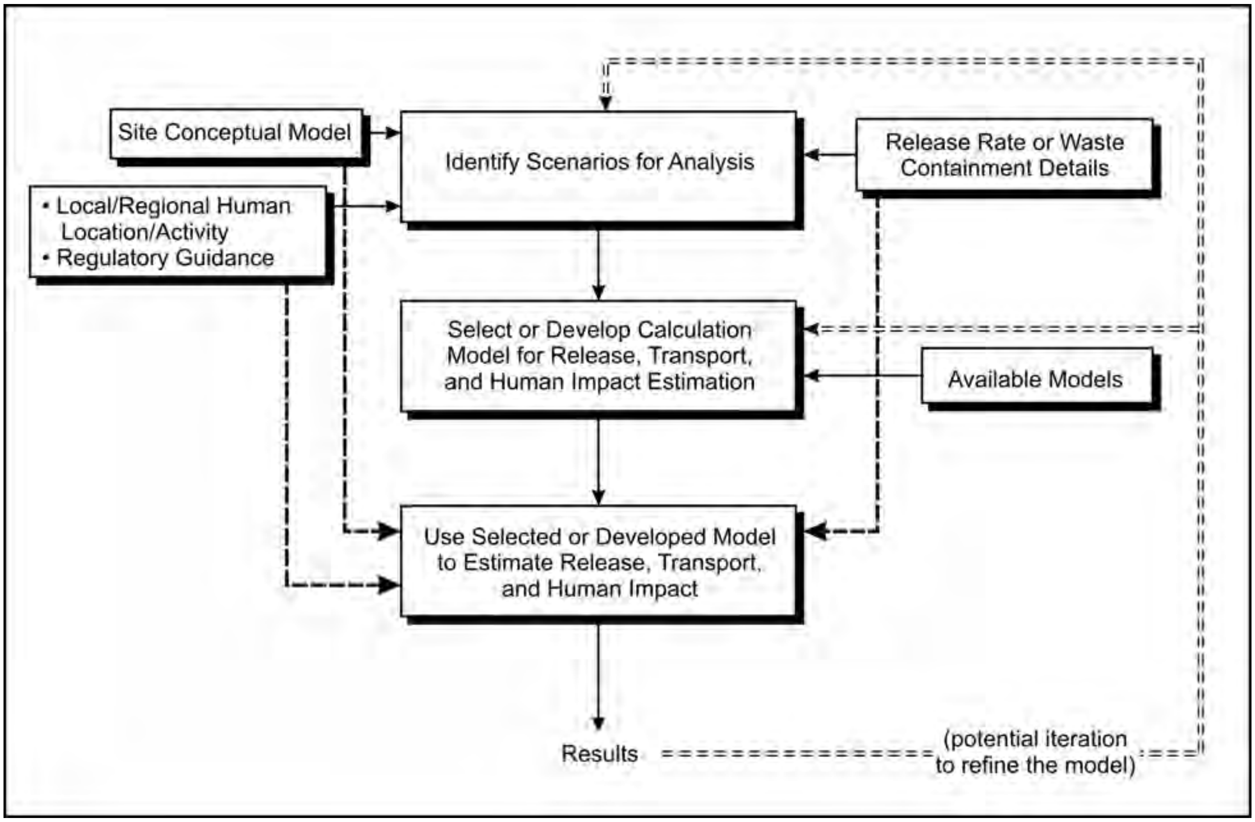

Figure D–1 Performance Assessment Flow Diagram

D.2 Short-term Performance Assessment

The decommissioning period is the approximately 5- to-60-year period during which remediation, stabilization, and closure activities would be performed. During this time, workers would be present on site, public access to the site would be limited, and contaminant releases to the environment would be controlled. This section describes development of exposure scenarios for the public and selection of models for the short-term period under alternatives evaluated in this EIS.

D.2.1 Short-term Performance Assessment Exposure Scenarios

During the decommissioning period, planned releases to the atmosphere and surface water would impact offsite individuals. Estimates of the impacts due to these releases were developed based on consideration of the nature of proposed activities and on the release rate, rates of movement through and dilution in the environment, and potential receptor locations and activities. This section describes these analysis elements and summarizes their combination into scenarios selected for analysis.

D.2.1.1 Site Conceptual Model

Site characteristics relevant to estimation of decommissioning-period impacts are those that determine movement through, and dilution that would occur over, the relatively short decommissioning period. Potential pathways considered for analysis include atmospheric dispersion, dispersion via groundwater and surface water, and dispersion resulting from erosion leading to exposure of waste to potential dispersion by means of the atmosphere or water. Dispersion in the short term was determined to be by means of movement and dilution in the atmosphere and surface waters. Details are presented in Chapter 3 and Appendix I of this EIS.

The approach for characterizing surface water hydrology involved review of annual maximum, minimum, and average flow rate conditions and selection of conditions representative of average flows. This information is used in predicting downstream concentration of contaminants released from the site and is part of the information used in evaluation of erosion and erosion impacts. The information collected on surface hydrology is presented in Chapter 3.

Meteorological characteristics were monitored at an onsite weather station, as well as at weather stations located in the site vicinity. Windspeed frequency, direction and stability class, precipitation rates, and extreme wind occurrences were recorded as reported in Chapter 3. Site topography was measured and recorded on the West Valley Demonstration Project (WVDP) and U.S. Geological Survey maps. This information, in conjunction with the atmospheric dispersion calculation model described in Appendix I, constitutes the site model for dispersion in the atmosphere. Useful information derived from the model included released material concentrations, their locations, and the highest contaminant concentration.

The configuration of watersheds and the network of gullies and creeks draining the site and their paths to Lake Erie were mapped. Topography, rates of precipitation, and groundwater flow were characterized. Flow rates of on- and offsite creeks were measured at important site locations (WVNS 1993). For the decommissioning period, releases to Erdman Brook would be controlled. The flow path and recorded rates through Erdman Brook, Franks Creek, Buttermilk Creek, and Cattaraugus Creek to Lake Erie, in conjunction with the assumed complete dilution of contaminants in the creeks, constitute the surface water flow conceptual model. Useful information derived from the model included released material concentrations at locations in the creeks and Lake Erie.

Other possible transport processes involving groundwater or erosion would occur over longer periods of time. Historical measurements, as well as the groundwater flow analysis discussed in Appendix E indicate that, because of decay and geochemical retardation, the groundwater flow path would not contribute significantly to decommissioning-period impacts. Similar erosion measurements and the erosion analysis discussed in Appendix F show that erosion would not contribute to decommissioning-period impacts. Groundwater and erosion would, however, be considered as part of the long-term performance assessment.

D.2.1.2 Short-term Performance Assessment Release Rates

Contaminant release rates to the atmosphere and surface waters were directly estimated in engineering design studies for each alternative. This information is presented in the referenced technical reports and summarized in Appendix I. Releases can be radiological in nature (e.g., hydrogen-3 [tritium] and cesium-137) or involve nonradiological materials. Estimation of ionizing radiation flux during radioactive material transportation was based on material and package physical and radiological characteristics using standard methods (Chen et al. 2002).

D.2.1.3 Short-term Performance Assessment Human Receptors

Receptors that must be considered in the short-term impact analysis are those outside the WNYNSC boundary. The U.S. Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA) would maintain access controls during the decommissioning period so there is no potential for a recurring onsite receptor. The locations and activities of receptors were selected considering the proposed activities, conceptual model of the site, current demography, and regulatory guidance.

For the atmospheric pathway, application of dispersion analysis and comparison with known residences indicate that the point of maximum concentration occurs in the north-northeast direction near WNYNSC. Thus, receptors for the atmospheric pathway are an individual at the north-northeast boundary; a member of the Seneca Nation of Indians (a potentially sensitive population) located near Gowanda, New York; and the general population out to a distance of 80 kilometers (50 miles) from the site.

For the surface water pathway, a set of three offsite locations was selected to evaluate potential impacts. The first location, near the confluence of Buttermilk and Cattaraugus Creeks, is the location of highest contaminant concentration in surface water outside the WNYNSC boundary. The second location, in Cattaraugus Creek near Gowanda, New York, is the location of the Seneca Nation of Indians, a potentially sensitive population. The final location, the Lake Erie water source for the surrounding population out to a distance of 80 kilometers (50 miles), combines the impact of water intake points located near Sturgeon Point and in the Niagara River. For transportation activities, populations were selected on a transportation-route-specific basis using routing models (Johnson and Michelhaugh 2000) and incorporating current census data.

Consistent with past practice in EIS analyses and regulatory guidance[1] (ICRP 1984, NRC 2006), receptor characteristics are those of the general population, a hypothetical individual located so as to receive the maximum calculated dose, and the average member of the critical group (AMCG). The AMCG is one of a group of individuals reasonably expected to receive the greatest exposure for the set of applicable circumstances. For these individuals, inhalation, drinking water intake, and fish consumption rates and gardening practices are selected to produce an estimate that is expected to reasonably bound potential impacts, but not represent an overly conservative worst-case estimate.

D.2.1.4 Summary of Short-term Performance Assessment Exposure Scenarios

For the decommissioning period, two environmental pathways (air and surface water combinations of release and transport mechanisms) have been identified. Eight scenarios are analyzed for each alternative (see Appendix I of this EIS).

D.2.2 Selection of Short-term Performance Assessment Calculation Model

For estimation of impacts during the short-term period (decommissioning period), standard models incorporating past practice for EIS analyses were selected. For releases of chemical (nonradiological) constituents to the atmosphere, meteorological dispersion modeling procedures described in Appendix K of this EIS were used to generate concentrations per unit source and deposition per unit source values and, therefore, contaminant concentrations as a function of distance and direction. The Industrial Source Complex atmospheric dispersion model was used for these calculations. For hydrologic releases, concentrations of nonradiological constituents in Cattaraugus Creek were calculated by assuming the total quantity released would be mixed into the total flow of Cattaraugus Creek without any allowances for absorption or deposition.

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[1] *While regulatory guidance was used to help inform the selection of potential receptors, this analysis is intended to meet National Environmental Policy Act (NEPA) requirements and is not a regulatory compliance analysis.*

For estimation of impacts due to radioactive material releases, the GENII computer code (PNNL 2007), an integrated dose-estimation model incorporating the most recent developments in dose assessment methods and exposure modes, was selected. The GENII code uses physiologic models and procedures recommended in *1990 Recommendations of the International Commission on Radiological Protection* (ICRP 1991) and Federal Guidance Reports 12 and 13 (EPA 1993, 1999) to estimate internal and external dose conversion factors. GENII estimates impacts of atmospheric and surface water releases on individuals and populations. Exposure through a spectrum of pathways, including inhalation; direct external; and ingestion of crops, animal products, and soil, may be evaluated in the analysis. For estimation of impacts due to transportation activities, the RADTRAN 5 computer code (Neuhauser et al. 2000), a dose estimation model that considers normal operation and accident conditions, was selected.

D.3 Long-term Performance Assessment

The long-term period is the time extending from the end of the decommissioning period out to the distant future. The following sections describe the approach for estimation of long-term impacts, including scenario development, model selection, and the approach to understanding uncertainty.

D.3.1 Long-term Performance Assessment Exposure Scenarios

Scenario development and analysis for long-term performance assessment is more complex than for short-term performance assessment because more physical processes are involved and transport pathways are more complicated for post-closure conditions. These long-term processes include a variety of mechanisms for contaminant release to groundwater, as well as erosion that can release buried materials. In addition, there is a wider range of potential receptors that could come into contact with released contaminants. While most of the receptors are located outside the boundaries of any area where control is retained, it is also necessary to consider intrusion within the boundaries when considering long periods of time. Addressing additional contaminant transport mechanisms and additional receptors is an integral part of scenarios for long-term performance assessment. The analysis period for long-term performance assessment for decommissioning activities cited as a regulatory requirement (DOE 1999, NRC 2006) is 1,000 years. However, the U.S. Nuclear Regulatory Commission (NRC) WVDP Decommissioning Policy Statement (67 *Federal Register* [FR] 5003) states that an evaluation of reasonably foreseeable impacts requires that an analysis of impacts beyond 1,000 years should be provided. Additionally, DOE recommends (DOE 1999) that the magnitude of peak impacts be identified, even if the peak impact is projected to occur after tens of thousands of years. Analysis in this EIS identifies the magnitude and time of peak impact.

D.3.1.1 Site Conceptual Model

Site conceptual model characteristics include consideration of physical conditions and natural processes, both current and evolving, including long-term disruptive processes that serve as a basis for quantifying contaminant release and transportation processes that could lead to human health impacts. In development of the site conceptual model, consideration was given to processes occurring at the regional and local scales. Consistent with NRC guidance (NRC 2000), site conditions arising from extreme global-scale climatic changes (including human-induced climate change), whose adverse effects would invalidate the scenarios and receptors of the performance assessment and greatly exceed site-specific effects resulting from residual contamination, are not considered in the long-term performance assessment. The impact of natural cycling (periods of wetter or dryer conditions) is addressed through sensitivity analyses. The conceptual model serves to identify site-specific natural processes and human-related activities that can lead to contaminant release, transport, and human exposure and thus play an important role in scenario development. To facilitate model development, conditions were categorized as: (1) currently occurring or (2) disruptive processes occurring gradually or in specific episodes over a long-term period. Disruptive processes include earthquakes, tornadoes, floods, and erosion.

The conceptual model development approach for both current and disruptive conditions included environmental data collection and documentation, data review, development of a representation of contributing environmental processes, and development of mathematical descriptions of the processes to allow quantitative analysis.

Current Site Conditions

Description of current conditions includes characterization of existing contamination and consideration of geologic, hydrologic, and atmospheric processes. The two important existing sources of environmental contamination involve groundwater and surface soil. A plume of contaminated groundwater, termed the "North Plateau Plume," extends in a northeasterly direction from a historical source below the Main Plant Process Building. An area of soil contamination, termed the "Cesium Prong," extends in a northwesterly direction from a historical source at the main plant stack.

The approach for geologic conditions included review of structures and stratigraphy at regional and local scales and development of a model view of site stratigraphy and of site strata interfacing with larger-scale features. The results of this activity are useful in understanding current groundwater flow paths and in evaluating potential future paths. The information collected and analyzed is documented in Chapter 3 and Appendix E of this EIS.

The approach for characterizing surface water hydrology involved review of annual maximum, minimum, and average flow rate conditions and selection of conditions representative of average flows. This information was used in predicting downstream concentration of contaminants released from the site and was part of the information used in evaluation of erosion and erosion impacts. The information collected on surface hydrology is presented in Chapter 3.

The approach for developing an understanding of groundwater hydrology was to review existing geohydrologic characterizations and available data, develop a three-dimensional model of site conditions calibrated to observed pressure levels, and use the results of three-dimensional modeling about groundwater flow direction and velocity as input conditions for one-dimensional models appropriate for long-term impact analysis. The results of the three-dimensional groundwater analysis and characterization are presented in Appendix E.

The approach for meteorological transport was to summarize data in a joint frequency distribution and use a Gaussian plume model to estimate dispersion factors used to predict downwind concentrations of released contaminants at various distances and directions from the site. The results of this information are presented in Chapter 3 and Appendix K of this EIS.

Potential Disruptive Processes

Disruptive events occurring at the site include earthquakes, tornadoes, floods, and erosion. The approach adopted for characterization of both earthquakes and tornadoes was development of a hazard curve depicting exceedance probability as a function of event severity.

The most recent estimate of site seismic hazard risk was conducted by the URS Corporation (URS 2004) using the U.S. Geological Survey National Seismic Hazard Maps (USGS 2002). This information is presented in Chapter 3.

For tornadoes, the damage area per unit-path-length method was applied to an area within 160 kilometers (100 miles) of the site (Fujita 1979). Detailed results are presented in this EIS and summarized in the form of a plot of windspeed against that windspeed's exceedance frequency.

The flood and erosion analysis was based on rainfall data collected over the past 30 years, including estimation of probable maximum precipitation and precipitation for storms with return periods of 2, 10, and 100 years (WVNS 1993), and on statistically generated daily precipitation histories covering periods up to 100 years (USDA 1995). For floods, stream levels were estimated for each of these storm magnitudes and compared with present stream channels configurations.

For erosion, site-specific, long-term unmitigated erosion rates were estimated using a landscape evolution model calibrated to reproduce historical long-term erosion at the site and a simplified single gully model intended to place an upper bound on potential local-scale impacts not captured by the landscape evolution model. Where gullies are postulated to impact a specific waste management area, area-specific gully erosion rates were used to estimate human health impacts. The erosion site model results are presented in Appendix F of this EIS, and the gully model is discussed in Appendix G.

D.3.1.2 Long-term Performance Assessment Release Rates and Environmental Transport Pathways

The approach to identification of long-term release mechanisms includes characterization of the waste inventory and facility-engineered barriers, review of the site physical characteristics, and development of a list of processes that could transport contaminants from the facility into the surrounding environment. The approach was applied for each of the EIS alternatives. The procedure was applied both for conditions where institutional controls are assumed to be in place and for disruptive processes, including those that would occur in the absence of institutional control (e.g., effects on intruders and unmitigated erosion effects).

Estimation of contamination release rates and identification of environmental transport pathways involve cataloguing of the processes that remove contamination from the source and the mechanisms that move contamination through the environment to the receptor. Potential release mechanisms from the source include direct contact by humans, plants, or animals; evaporation to the atmosphere; dissolution in surface water or groundwater; and entrainment in wind, surface water, or groundwater. Following release from the source, primary transport pathways include dispersion in the atmosphere, surface water, or groundwater; transfer to plants or animals; and, finally, transfer to humans.

The role of engineered barriers was evaluated for residual contamination and below-grade structures. For the site, descriptions of radionuclide inventories and facility closure designs are presented in waste characterization reports and technical reports, respectively. Release mechanisms and environmental transport pathways have been identified and evaluated (Case and Otis 1988; NRC 2000, 2006; Shipers and Harlan 1989). Due to the nature of previous fuel reprocessing operations and waste management practices at the site and the time since reprocessing, radionuclides are present in the waste in chemical forms that are both soluble and insoluble in water, but with negligible quantities of volatile forms. Thus, evaporative release through the unsaturated zone to the atmosphere would be negligible. For the Sitewide Close-In-Place Alternative, the residual contamination in the Main Plant Process Building, the Vitrification Facility, the Waste Tank Farm, the NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area (NDA), and the State-Licensed Disposal Area (SDA) would be located at depths greater than 3 meters (10 feet) below the current ground surface and under a rock and vegetation-covered tumulus with a maximum height of 9 meters (30 feet). Residual contamination at these depths is unlikely to be mobilized by human intrusion, burrowing animals, or vegetation or roots. Thus, assuming institutional control, transport by groundwater is the only mechanism for transport of contaminants from the waste form to the surrounding environment, and releases via diffusion and convective flow are the release mechanisms of concern. As discussed in Section D.3.1.3, forms of human intrusion are considered to provide additional perspective on potential impacts. Contaminants dissolved in groundwater may be transported to onsite wells or discharged to onsite surface water (Erdman Brook, Franks Creek, and Buttermilk Creek) that flows to Cattaraugus Creek and Lake Erie. Once the potentially contaminated water has been pumped from the ground or creek, it may be consumed as drinking water or used for crop irrigation. In the case of crop irrigation, all the contributing pathways of the residential farmer scenario were applied. In addition, contamination in surface water is transferred to fish harvested and consumed by the surface water user. Hydraulic and chemical properties of engineered barriers were considered in the release rate estimation. Consistent with regulatory guidance (NRC 2000), hydraulic property values of barriers subject to degradation mechanisms, such as subsidence, cracking, or clogging, were assumed to degrade over time. Chemical properties, such as adsorptive capacity, were assumed to remain constant consistent with past practice (Kennedy and Strenge 1992, Yu et al. 1993) and the stability of sand and clay formations over geologic times (Rowe et al. 2004).

Disruptive processes that may occur at WNYNSC include earthquakes, tornadoes, floods, and erosion. The maximum historical earthquake observed at the site had a Modified Mercalli Intensity of V, which would produce minor damage to glassware and have no effects on waste-isolating engineered structures that would remain across the site under the Sitewide Close-in-Place Alternative. Any waste located below grade would not be affected by tornadoes. Site-specific analysis of flooding potential indicated that water levels for storms up to the probable maximum precipitation would not affect existing site facilities. Erosion is occurring at the site and could release radionuclides to the environment. Erosion processes are addressed in this EIS as an aspect of long-term performance assessment.

D.3.1.3 Long-term Performance Assessment Human Receptors and Exposure Modes

A two-step process was used to identify site-specific receptors. The first step involved establishment and use of a set of principles to select generic receptors. The second step was the application of site-specific information to the generic receptors to develop site-specific receptors. Both of these steps are discussed in the following paragraphs.

Principles established for the first step were based primarily on review of regulations, past practice, and guidance. Some of the referenced regulations or guidance are relevant but not directly applicable to the site and Project Premises. Receptors both inside and outside the current WNYNSC boundary were identified. Receptors outside the current WNYNSC boundary correspond to individuals who could actually be exposed to contamination released from the site, assuming the existing boundaries and institutional controls remain in place. Receptors inside the current WNYNSC boundary correspond to hypothetical individuals, whose location and activities are assumed for analytical purposes, including investigation of the upper bound of impacts. Site-specific information includes directions and velocities of groundwater and surface water flow, population distribution around the site, and physical conditions associated with the residual contamination or disposed waste. These physical conditions could include location of the waste in relation to environmental pathways and available land area or facility designs that limit accessibility of the waste.

The set of principles that guided identification of generic and site-specific receptors is consistent with the practice and conditions present at the site. These principles are:

- Provide a realistic to reasonably conservative evaluation of the long-term impact on the health of the general public.

- Provide estimation of the impact on individuals indirectly contacting radioactive waste at some time after closure of the site following the assumption of institutional control failure.

- Identify receptors based on review and interpretation of prior analysis performed by the NRC, U.S. Environmental Protection Agency, and DOE, and on principles applied in environmental and safety analyses.

The first and second principles have their bases in generally applicable environmental regulations. The third principle is based on the need to comply with regulations and guidance of Federal agencies charged with environmental analysis and the desire to conduct an analysis that provides insight into compliance with decommissioning dose criteria.

Guidance and past practice relevant to identification of receptors for the WNYNSC performance assessment include information related to facilities operating under normal conditions, facilities undergoing decommissioning, low-level radioactive waste disposal facilities, and facilities contaminated with hazardous waste (EPA 1991, 1995). The following paragraphs summarize guidance and practice for each of these cases.

NEPA directs that Federal plans shall be coordinated to protect human health and the environment, but does not identify specific human populations or limits to the analysis. Guidance promulgated by the Council on Environmental Quality (CEQ 1986) created under NEPA also does not identify specific populations, but does specify that data and analysis should be commensurate with the impacts of the action. Early guidance issued by the NRC (NRC 1977) for assessment of impacts of normal operations of nuclear reactors provides methods for estimation of doses to maximally exposed individuals and to the population out to 80 kilometers (50 miles). Guidance for assessment of impacts of fuel reprocessing plant operations (NRC 1975) also directs consideration of doses to populations out to 80 kilometers (50 miles). More recent guidance for controlling normal operations impacts (DOE 1995, NRC 2006) focuses on limiting doses to the AMCG. The AMCG is a member of the group reasonably expected to receive the greatest exposure to releases from the site. The range of activities of an exposed individual includes inhalation of contaminated air, ingestion of contaminated drinking water, establishment of a residence on or near contaminated material, and establishment of a garden on contaminated soil. In addition to these general considerations, Executive Order 12898 (February 11, 1994) directs Federal decisionmakers to identify and address high and adverse environmental impacts that disproportionately affect minority and low-income populations.

Standards for termination of NRC licenses (NRC 2006) address exposure to residual contamination for an AMCG where this individual is representative of the group reasonably expected to receive the greatest dose. Supporting guidance, which provides methods and additional details for generic screening scenarios and procedures for development of site-specific scenarios (NRC 2006), is useful when determining the scope of the long-term performance assessment for this EIS. For screening scenarios, the AMCG occupies the site and is in direct contact with residual contamination (NRC 2006). For site-specific scenarios, the AMCG and scenarios may be developed in light of planned future land use, physical characteristics that constrain site use, and realistic processes for contaminant transport (NRC 2006). Guidance developed for analysis of impacts of residual contamination at DOE sites (Yu et al. 1993) provides dose-limit criteria and methods for analysis of residential receptor exposure scenarios. For situations involving contamination of surface soil, the receptor is in direct contact with contaminated material. For situations involving subsurface contamination, the receptor contacts contaminated material indirectly through use of well water contaminated by percolation of precipitation through the waste material. Both NRC and DOE guidance discuss the range of activities of an exposed individual, including inhalation of contaminated material, use of contaminated drinking water, establishment of a residence on or near contaminated material, and establishment of a garden in contaminated soil.

The NRC's analysis of generic disposal sites is presented in the *Environmental Impact Statement on 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste"* (NRC 1981, 1982). Information supporting this analysis proves useful in identifying receptors and receptor habits. NRC guidance (NRC 2000) for sites where institutional controls are in effect identifies the offsite receptor as the AMCG located at the disposal site boundary. For unrestricted release of a site, the public receptor is not necessarily located at the disposal site boundary, but rather at a point determined to be the location of maximum exposure. Onsite intruders do not deliberately intrude into disposed waste, but do have contact with contaminated water in a well scenario and direct contact with disposed material in home construction, discovery, and residential agriculture scenarios (NRC 1982). Waste stability and layering are assumed to be effective in reducing contact with waste for only a limited period of time (NRC 1982). A range of intrusion scenarios was considered prior to selection of the home construction, discovery, and residential agriculture scenarios. In the construction scenario, a worker excavated a foundation to a depth of 3 meters (10 feet) (NRC 1981). As long as a 1- to 2-meter (3- to 6-foot) cap was maintained over the waste, direct contact with the waste was considered very unlikely (NRC 1981). The residential agriculture scenario was initiated when a portion of the soil excavated in the construction scenario was distributed around the home and assumed available for cultivation of crops (NRC 1981). An alternative scenario was considered in which the waste cover was stripped away and the intruder lived directly on the waste. This scenario was judged unreasonable, as a commercial operation would be required to perform the work (NRC 1981). In the well water exposure scenario, the well was located at the boundary of the disposal facility at a distance of 40 meters (130 feet) from the release point of the contaminated water (NRC 1981). An additional intrusion scenario (Oztunali and Roles 1986) involves short-term exposure related to drilling a well through the waste disposal facility. For alternatives involving control of the site, initiation of intrusion scenarios is assumed to occur after 100 years (DOE 1999), following loss of institutional control. To provide perspective for regulatory analysis, impacts for intrusion scenarios were also estimated for the case of immediate loss of institutional controls.

Given that the receptor is not capable of large-scale site disruption, credit for function of passive elements of engineered barriers under the Sitewide Close-In-Place Alternative is reasonable and consistent with NEPA guidance that arbitrary elements of analysis be avoided. This credit would include physical separation enforced by presence of thick caps; inability to move drilling equipment over the large, irregular rip rap comprising the apron and deck of engineered caps; and effectiveness of subsurface flow diversion structures. These principles also imply that physical processes, such as desiccation, cracking, and erosion, are considered in determining the degree of credit for function of passive barriers. Thus, the hydraulic conductivity of cements and grout increases with time, approaching that of soil, and hydraulic conductivity of surface layers of caps increases with time, approaching that of native soil. Consistent with material property evaluation (Atkinson and Hearne 1984), the stability of sand and clay formations over geologic times (Rowe et al. 2004), and regulatory guidance (NRC 2000), lifetimes of cement-based engineered barriers are less than 500 years. For this analysis, existence of the tank vault and placement of strong grout in the tank supports selection of a 500-year lifetime for the intruder barrier at the Waste Tank Farm (WSMS 2009). For other subsurface engineered barriers, including grouts, slurry walls, and tumulus drainage layers, a 100-year life is assumed. Specific engineered barrier parameters used for specific analyses are identified in Appendix H, Section H.2.2, of this EIS. Chemical properties of natural materials, such as adsorptive capacity, are, however, not expected to decrease with time, consistent with the long lifetimes observed for sand and clay formations in the environment (NRC 2000). Engineered disposal facilities include infiltration drainage layers and subsurface groundwater diversion structures that decrease productivity of wells inside the facility relative to wells located outside the facility. Because of the cap design incorporating large rock, it is reasonable to propose that wells under the Sitewide Close-In-Place Alternative be located outside the engineered barrier system for the Main Plant Process Building, the Vitrification Facility, the Waste Tank Farm, the NDA, and the SDA. The premise that properly selected, quarried, and placed rock can have long service life is supported by reference to analog sites for chemical weathering of rock and adherence to design and construction principles described in regulatory guidance (NRC 2002). The design thickness of the rock layers of the cap is approximately 1.14 meters (3.75 feet). Data from natural analogs include reported rates of weathering for the foreland boundary of a glacier of 1.6 millimeters per 1,000 years for gneiss surfaces and negligible weathering for quartz layers over approximately 9,700 years (Owen et al. 2007). The cap design is expected to consider both normal conditions and extreme events, and incorporate defense in depth of flow control and diversion structures to produce a robust design. In the case of well water use for domestic purposes, past practice has located the well away from the release point (NRC 1981) and has provided realistic representation of dilution in infiltration and mixing in an aquifer serving the well (NRC 1981, Yu et al. 1993).

Guidance provided for performance assessment of DOE low-level radioactive waste disposal facilities (Case and Otis 1988) specifies that impacts should be evaluated for the surrounding population out to a distance of 80 kilometers (50 miles), a maximally exposed individual located at the boundary of the site, and an intruder located at the disposal facility. More-detailed guidance related to intruder scenarios has also been provided (Kennedy and Peloquin 1988). The guidance directs evaluation of the home construction, discovery, and residential agriculture scenarios developed by the NRC and supplements these scenarios with well-drilling and post-drilling residential agriculture scenarios (Kennedy and Peloquin 1988). In the post-drilling scenario, contaminated cuttings from the borehole are distributed onto soil on which a home and garden are located (Kennedy and Peloquin 1988).

For evaluation of risk of exposure to hazardous chemicals, regulatory guidance (EPA 1995) recommends that analysis should reflect reasonably anticipated future land use. Thus, for free release of site areas, receptors would be residential farmer receptors located on site. For agency control of site areas, receptors would be residential farmer receptors located off site.

Receptors Outside the Current Western New York Nuclear Service Center Boundary

Site-specific receptors outside the current WNYNSC boundary would be either actual individuals currently living near the site or individuals whose locations and activities could reasonably be extrapolated from current conditions. At the site, these receptors correspond to the AMCG living at offsite locations. These receptors include individuals living near the confluence of Buttermilk and Cattaraugus Creeks, a member of the Seneca Nation of Indians living on Cattaraugus Creek near Gowanda, and the general population out to a distance of 80 kilometers (50 miles) using water from eastern Lake Erie. Five municipal water intakes are located in Lake Erie and the Niagara River, and the dose to individuals in the general population is characterized by two receptors: one with no dilution of Cattaraugus Creek water (e.g., Sturgeon Point water user) and one with dilution due to the east channel of the Niagara River (e.g., North Tonawanda water user). The five water intakes serve a population extending beyond the 80-kilometer (50-mile) limit generally applied in NEPA analysis. Water use characteristics of these four individual receptors used for dose analysis are summarized in **Table D–1**. For each of the receptors, drinking water consumption corresponds to the 95th percentile of the national distribution of drinking water consumption rates (EPA 1999). For the Cattaraugus Creek and Seneca Nation receptors, fish consumption corresponds to the 95th percentile of national and subsistence fish consumption rates (EPA 1999), respectively. The subsistence consumption rate is consistent with results of American Indian subsistence fishing on Lake Ontario (Forti et al. 1993). For the general population, fish consumption rates correspond to the average of fish yields for eastern Lake Erie (NYSDEC 1998). Each individual is assumed to cultivate a garden irrigated with potentially contaminated lake water and consume crop and animal products at rates recommended in regulatory guidance (Beyeler et al. 1998). The fish consumption rates for the four individual receptors are also presented in Table D–1.

Table D–1 Intake Parameter Values for Drinking Water and Fish Consumption by Receptors Outside Current Western New York Nuclear Service Center Boundary

Location	*Pathway*	
	Drinking Water (liters per day)	***Fish Consumption (kilograms per year)***
Cattaraugus Creek (near Buttermilk Creek)	2.35	9
Cattaraugus Creek (Seneca Indian)	2.35	62
Lake Erie/Niagara River water users [a]	2.35	0.1

[a] The same fish consumption rate is assumed for both undiluted (e.g., Sturgeon Point) and diluted (e.g., North Tonawanda) water users.

Note: To convert liters to gallons, multiply by 0.264; kilograms to pounds, multiply by 2.2046.

Receptors Inside the Current Western New York Nuclear Service Center Boundary

A set of four site receptors inside the current WNYNSC boundary was developed and screened based on the principles and information described above. The general locations and activities of the receptors were selected to span the range of conditions that could occur if site control were lost. Since documentation supporting regulatory guidance was used to influence the selection of receptors, the site receptors have characteristics similar to the residential agriculture receptor used in NRC license termination analysis (NRC 2006), the intruders used in Title 10 of the *Code of Federal Regulations* (CFR), Part 61, analyses, and DOE residual contamination analyses (Yu et al. 1993). These are the home construction, well-drilling, and residential farmer receptors. Additionally, to address direct exposure resulting from erosion, a resident located opposite the exposed waste along one of the creeks within the WNYNSC boundary was selected. The nature of the contamination and environmental transport pathways and receptor behavior combine to produce sets of exposure modes for each receptor. Conditions of these exposure scenarios are consistent with guidance recommendations (EPA 1991, 1999) developed for evaluation of risk of exposure to hazardous chemicals.

Locations of receptors are determined based on receptor selection Principles 1 and 2 discussed earlier in this section and site-specific conditions. Given Principle 2, it is reasonable to propose an onsite receptor whose activities are consistent with the capabilities of an individual who establishes a residence on the site. Each of the individual receptors may be located on site on the plateaus or along Buttermilk Creek, but location and activities are constrained by topography, groundwater availability, and waste form location. In particular, direct intrusion into buried waste is assumed to not occur in the erosion case, because erosion-driven exposure of the waste involves development of steep slopes and concentrated flow as the rim of the creek moves into the contaminated area. These conditions are less favorable to utilization than settling of nearby areas outside of the creek channel. For erosion scenarios, intrusion involves a hiker walking along the contaminated creek bank and coming into direct contact with waste for a limited period of time.

Home Construction Receptor

The ability of the receptor to directly contact radioactive material is related to the excavation capability of the individual and the degree of separation afforded by the nature of the residual contamination or by the disposal facility design. The receptor selection principles and past practice indicate that an individual involved in home construction could directly contact contamination if physical separation is not provided, but is not likely to do so if direct contact requires construction capabilities greater than those required to build a home (NRC 1981). Selection of this type of individual is reasonable in light of the low probabilities that an industrial concern would excavate large quantities of cement, rock, and soil to contact waste; could not recognize the hazard, given industrial-technical capability; and could continue to function, given that institutional control of government agencies had failed (NRC 1981). Thus, the home construction receptor excavates a limited volume of soil to a depth of less than three meters (10 feet), but does not have the capability to remove large quantities of soil or rock. Exposure modes for the home constructor include inhalation of airborne contaminated material and exposure to direct radiation. In the course of excavating the home foundation, contaminated material may be removed from the excavation and serve to initiate residential farmer exposure modes. Occurrence of this scenario is reasonable for the Low-Level Waste Treatment Facility, the NDA, and the SDA for the No Action Alternative but is precluded by placement of a thick cap for these four facilities for the Sitewide Close-In-Place Alternative.

Well-drilling Receptor

Even though contamination may be located in an area having little available water due to natural conditions or placement of engineered barriers, it is reasonable to consider the transient effects of construction of a well inside the barrier system. In this case, an individual has direct contact with waste in a drilling operation located at the facility, but does not consume water from the well. Exposure modes for the well driller include inhalation of fugitive dust and external exposure to material deposited in a well cuttings pond. Subsequent to drilling activity completion, contaminated material may be removed from the cuttings pond and distributed on the ground surface to initiate residential exposure modes. Occurrence of this scenario is possible for all facilities for the No Action Alternative and for the Low-Level Waste Treatment Facility for the Sitewide Close-In-Place Alternative.

Residential Farmer Receptor

In the case of a residential farmer receptor, past practice (Yu et al. 1993, NRC 1981) indicates that presence of a 3-meter-thick (10-foot-thick) cap prevents direct contact with radioactive material. The residential agriculture receptor may contact near-surface soil with residual contamination, or have access to soil, groundwater, or surface water contaminated by releases from a site facility. For facilities stabilized in place, direct contact with contamination derived from that waste is unlikely due to depth of cover of the waste form, and exposure via residential agriculture would require contact with potentially contaminated groundwater or surface water. Drinking and irrigation water wells with adequate productivity could be located on the North Plateau between the individual waste management areas and groundwater discharge to Erdman Brook. Site data and the three-dimensional site-wide groundwater model indicate that the Kent recessional sequence is unsaturated below the North and South Plateaus, indicating that this unit is not a reasonable source of domestic or irrigation water. The degree of saturation and directions of flow in the Kent recessional sequence are discussed in Appendix E, Section E.3.7.1. Due to size and flow regularity, surface water used by onsite receptors would likely come from Buttermilk Creek. Based on past practice (EPA 1991, 1999; NRC 1981, 2006; Yu et al. 1993), exposure modes related to residential agriculture activities include inhalation of contaminated air; ingestion of contaminated groundwater, surface water, crops, animal products, and soil; and exposure to direct radiation. For this EIS analysis of onsite receptors, these exposure modes have been extended to include hiking in an area contaminated by groundwater discharge to a creek and consumption of deer (selected to represent exposure resulting from hunting activities in the area) contaminated by consumption of vegetation growing in the contaminated groundwater discharge area.

Residential Receptor (Erosion)

Although establishment of a residence or farm immediately in an area of active erosion is unlikely, establishment of a residence adjacent to such an area is possible. The primary exposure mode related to such a residence is exposure to direct radiation from areas exposed as a result of erosion along creekbeds. This receptor does not grow crops on the actively eroding area. For this EIS analysis, this exposure mode has been extended to include hiking in the area of exposed waste.

The assumed contaminated drinking water and fish consumption rates for receptors inside the current WNYNSC boundary (the receptors discussed in the previous paragraphs) are presented in **Table D–2**.

Table D–2 Intake Parameter Values for Drinking Water and Fish Consumption by Receptors Inside the Western New York Nuclear Service Center Boundary

Receptor	*Pathway*	
	Drinking Water [a] (liters per day)	*Fish Consumption (kilograms per year)*
North Plateau resident farmer	2.35	0
North/South Plateau well driller/worker	0	0
Buttermilk Creek resident farmer	2.35	9

[a] Drinking water rates are 95th percentile rates.
Note: To convert liters to gallons, multiply by 0.264; kilograms to pounds, multiply by 2.2046.

D.3.1.4 Summary of Long-term Performance Assessment Exposure Scenarios

Based on combinations of release mechanism, environmental transport pathway, and receptor location and behavior, three types of exposure scenarios have been developed. These are groundwater release, erosion release, and direct intrusion scenarios. The types of contamination initiating these scenarios are residual contamination of near-surface soil and groundwater and residual contamination of below-grade soil and structures.

Residual Contamination of Near-surface Soil

For residual contamination in surface soil, combinations of release mechanisms, environmental transport pathways, and exposure modes have been identified, screened, and developed into standard exposure scenarios (NRC 2006; Yu et al. 1993, 1994). This scenario, termed “residential farmer,” has been adopted for this analysis, but extended to include deer consumption and recreational hiking for onsite receptors. Due to the nature of the alternatives, the residential farmer scenario is widely applied.

Existing Contamination of Groundwater

Due to a historical unplanned release of acidic wastewater from the nuclear fuel reprocessing plant, a plume of contaminated groundwater with activity concentration dominated by strontium-90 has developed to the northeast of the plant. Use of this contaminated water would initiate all of the residential exposure modes described above for the residential farmer receptor.

Residual Contamination of Below-Grade Soil and Structures

For residual contamination of below-grade soil and structures, analysis of site and facility conditions identified three site-specific release mechanisms: partitioning into groundwater, entrainment in surface water runoff (erosion), and direct intrusion. Analysis of environmental conditions identified three primary environmental transport pathways: transport in groundwater to onsite wells, transport in groundwater to surface water, and transport in surface water. For each alternative and each facility, the groundwater release mechanism initiates scenarios affecting an onsite farmer (transport of contaminated groundwater to onsite wells) and five users of surface water (Buttermilk Creek; Cattaraugus Creek near Buttermilk Creek; Cattaraugus Creek near Gowanda, New York [Seneca Nation]; Lake Erie and Niagara River). For each alternative and each facility, erosion initiates an additional five scenarios affecting an onsite resident/recreational hiker and surface water users on Buttermilk Creek; Cattaraugus Creek near Buttermilk Creek; Cattaraugus Creek near Gowanda, New York (Seneca Nation); and Lake Erie/Niagara River (population). Thus, for each alternative and each facility, a basic set of 5 erosion release scenarios is considered. For each alternative and each facility, a set of 2 direct intrusion scenarios (home construction and well drilling) is considered. While a total of 12 basic scenarios are considered, some may be eliminated due to waste depth or other considerations for a specific alternative. The combinations of release mechanism and receptor location are summarized in **Table D–3**.

For groundwater release scenarios, onsite receptors are residential farmer receptors consuming drinking water, garden products, and deer and engaging in recreation at rates consistent with their location. For erosion release scenarios, onsite receptors are residents living near waste exposed by erosion who engage in recreational hiking and are exposed via direct radiation, inhalation, and inadvertent soil ingestion pathways. For direct intrusion scenarios, workers are exposed via direct radiation, and inhalation pathways. For residential farmer scenarios initiated by direct intrusion, receptors are subject to the exposure modes listed above for onsite residential farmer receptors. For both groundwater and erosion release scenarios, offsite receptors consume fish and drinking water and are subject to the balance of residential farmer pathways listed above for onsite receptors. Characterization of the exposure modes for these receptors is summarized in **Table D–4** and described in more detail in Appendix G.

Table D–3 Summary of Exposure Scenarios

Release Mechanism	*Location*
Partitioning to groundwater	North or South Plateau Buttermilk Creek Cattaraugus Creek (near site) Cattaraugus Creek (Seneca Nation of Indians) Lake Erie (population)
Entrainment in surface water (erosion)	North or South Plateau (recreational hiker) Buttermilk Creek Cattaraugus Creek (near site) Cattaraugus Creek (Seneca Nation of Indians) Lake Erie (population)
Direct Intrusion Home construction Well drilling	 North or South Plateau North or South Plateau

Table D–4 Summary of Receptor Exposure Modes [a]

Release and Transport Mode, Receptor Location	*Exposure Mode*						
	Drinking Water Consumption	*Fish Consumption*	*Residential with Agriculture* [b]	*Residential without Agriculture*	*Deer Consumption*	*Recreational Hiking*	*Worker Inhalation & External Exposure*
Groundwater to groundwater							
North Plateau	Y	N	Y	N	Y	Y	N
South Plateau	N	N	Y	N	Y	Y	N
Groundwater to groundwater and surface water							
Buttermilk Creek	Y	Y	Y	N	N	N	N
Cattaraugus Creek	Y	Y	Y	N	N	N	N
Seneca Nation of Indians	Y	Y	Y	N	N	N	N
Sturgeon Point	Y	Y	Y	N	N	N	N
Niagara River	Y	Y	Y	N	N	N	N
Erosion to surface water							
Buttermilk Creek	Y	Y	Y	N	N	N	N
Cattaraugus Creek	Y	Y	Y	N	N	N	N
Seneca Nation of Indians	Y	Y	Y	N	N	N	N
Sturgeon Point	Y	Y	Y	N	N	N	N
Niagara River	Y	Y	Y	N	N	N	N
Erosion with adjacent residence							
North Plateau	N	N	N	Y	N	Y	N
South Plateau	N	N	N	Y	N	Y	N
Intrusion							
Home construction							
worker	N	N	N	N	N	N	Y
resident	Y	N	Y	N	N	N	N
Well-drilling							
worker	N	N	N	N	N	N	Y
resident	Y	N	Y	N	N	N	N

[a] Y = Yes, combination of release, transport, and exposure modes and receptor location occurs.
N = No, combination of release, transport, and exposure modes and receptor location does not occur.
[b] Inhalation and direct exposure are subpaths for the residential agriculture scenario.

In addition to the set of basic scenarios that analyze impacts of releases from individual facilities, combination scenarios were constructed to evaluate cumulative impacts of all facilities for each receptor. Locations of onsite receptors for cumulative impacts were identified by conservative evaluation of intersection of groundwater flow paths for individual facilities. Because groundwater flow paths to surface water for all facilities reach Buttermilk Creek, cumulative impacts on surface water users would be the sum of impacts of each facility.

D.3.2 Selection of Long-term Performance Assessment Calculation Models

Analysis of scenarios involves selection, development, and use of computerized mathematical models applied for radionuclides and hazardous chemicals. The models produce estimates of dose, Hazard Index, and risk to individuals and populations due to releases from individual facilities. The results can be added for multiple facilities to provide a cumulative dose, Hazard Index, and risk. For scenarios involving contact with surface water contaminated by groundwater releases or by erosion collapse, the cumulative impact was calculated as the sum of impacts due to releases from individual facilities. For scenarios involving onsite contact with contaminated groundwater, cumulative dose, Hazard Index, and risk were estimated as the sum of impacts due to intersecting groundwater paths from multiple facilities. Direction of groundwater flow and locations of intersecting groundwater flow paths were identified using hydrologic analysis results, described in Appendix E. The following subsections discuss the approach for selection, development, and some aspects of mathematical model use. Estimates of dose, Hazard Index, and risk developed using mathematical models are presented in Appendix H.

D.3.2.1 Review of Existing Models and Conceptual Alternatives

The primary objectives for estimation of human health impacts (dose, Hazard Index, and risk) are to provide a basis for choice among alternative courses of action. Mathematical models used for these purposes should:

- Have a basis in observable physical processes and standard scientific principles that allows reasonable projection over time
- Use consistent technical approaches that do not introduce bias favoring specific actions
- Provide reasonable representation of site-specific conditions
- Allow for development of demonstrably conservative estimates when used in a deterministic manner
- Allow verification of estimates

The first step in selection of models for release, transport, and human health impact analysis was identification of the site-specific conditions important in estimation of health impacts. This includes specification of environmental conditions, facility designs, and exposure scenarios specific to WNYNSC as described in Section D.3.1. Environmental conditions important to estimation of human health impacts of facilities stabilized in place include groundwater flow directions and velocities and erosion locations and rates. Facility design considerations specific to WNYNSC facilities include layering of engineered barriers, time-dependence of engineered barriers physical properties, and nonuniform vertical and radial distributions of contaminants. The layered design of engineered barriers supports the objective of minimizing early releases to realize reduction in concentration due to decay of radionuclides and degradation of hazardous chemicals. Under these circumstances, diffusive, dispersive, and advective releases are of interest. Nonuniform vertical or radial distribution of concentration introduces the need for distributed parameter representation of transport mechanisms.

The second step in selection of mathematical models was review of the technical literature and regulatory guidance to identify existing models meeting site-specific requirements. Guidance on the approach to human health impact modeling and the appropriate types of performance assessment models has been published (Case and Otis 1988; EPA 1991, 1999; Kozak et al. 1990; Kozak et al. 1993; NRC 2000, 2006). For analysis of low-level radioactive waste facilities, formal analysis of uncertainty was recommended, an iterative approach was anticipated, limits to the required level of detail were recognized, and use of particular models or codes was not endorsed (NRC 2000). Particular models applicable to performance assessment include those addressing facility release rates (Icenhour and Tharp 1995, NRC 1993), groundwater transport (Codell et al. 1982; Pigford et al. 1980; van Genuchten and Alves 1982), and integration of release rate, groundwater transport, and exposure (Kennedy and Strenge 1992, Yu et al. 1993).

The referenced models were evaluated for their ability to simulate the site-specific scenarios and closure designs developed for WNYNSC facilities. In general, no single model for groundwater release scenarios addressed the combination of waste form conditions and engineered barriers specified for site facilities, and no models addressed erosion scenarios. Thus, for groundwater release scenarios, the approach selected for analysis of site facilities was development of site-specific release models combined with referenced groundwater transport (van Genuchten and Alves 1982) and exposure models (Yu et al. 1993, EPA 1991) to produce the integrated codes required for estimation of human health impacts. For erosion scenarios, the approach selected was to couple a site-calibrated landscape evolution model with a site-specific integrated release and exposure model that combined the site-specific release rate with a referenced exposure model (Yu et al. 1993).

D.3.2.2 Site-specific Models

Integrated human health impact estimation models were constructed using modules that addressed: (1) release from the storage/disposal configuration (release module), (2) transport through groundwater and surface water (groundwater transport module), and (3) human health impacts resulting from consumption or use of contaminated water (human health impact module). In addition, each integrated model includes an executive routine that controls data input and output and calculation flow. Flow of groundwater through and around the waste form was estimated using three-dimensional near-field flow models described in Appendix E. A set of eight integrated models (four for radionuclides and four for hazardous chemicals) was developed for the analysis of site facilities. Each set of four uses differing types of release, and groundwater transport modules, but common human health impact modules. Two additional integrated codes (one for radionuclides and one for hazardous chemicals) were developed for analysis of erosion collapse release scenarios. A single integrated code was developed for analysis of radiological impacts of direct intrusion into waste. Only the integrated groundwater release models use the groundwater flow, release, or transport modules. Each of these modules is discussed in the following paragraphs. The five release modules are discussed first, followed by a discussion of the groundwater transport module and then the human health impact module. The discussion of the individual modules is followed by a short discussion of how the modules are assembled into integrated codes for long-term dose prediction. Further details on the equations used in the modules and the nature of integrated codes are presented in Appendix G of this EIS.

Near-field Flow Models

For groundwater release scenarios, a set of models was developed to reflect the site-specific configuration of the aquifer and the engineered barrier system determining groundwater flow around and through the waste system. These three-dimensional near-field flow models simulate performance of the combination of a slurry wall, tumulus, waste form, and aquifer using the STOMP [Subsurface Transport Over Multiple Phases] computer code (White and Oostrom 2000). The tumulus comprises a drainage layer and a central core with a low-permeability upper layer and lower block of backfill soil or grout. More-specific information on the near-field flow models is presented in Appendix E of this EIS.

Site-specific Release Modules

Four modules for releases to groundwater and a single model for erosive release to surface water were developed. In each groundwater case, whether the contamination is in unsaturated or saturated zones, the rate of groundwater movement through the waste is estimated using the near-field flow models described in Appendix E of this EIS. The release modules were developed to address the more complex geometries over short distances and different materials that are part of the waste confinement systems. The release modules are as follows:

- A distributed-parameter, layered cylindrical-geometry release model was developed to predict release of radionuclides or hazardous chemicals in the horizontal, but not vertical, direction from waste solidified in a tank. In this model, a central cylindrical core representing the waste form is encircled by layers representing a grout-filled annulus and a slurry wall. Each system element has adsorptive properties, but the annular grout and slurry wall layers are initially free of contamination. The model allows for advection as well as diffusion as small amounts of the groundwater flow through the waste form and then mix with the majority of the groundwater that flows around the slurry wall. The model allows for variation in the contaminant concentration with radial position and may be used in an iterative manner to represent vertical distribution of contaminants. This model uses finite difference methods to solve mass balances and predict the concentration of a contaminant entering the groundwater downstream of the engineered structure. This particular model is most appropriate for analysis of the Waste Tank Farm when there is a solid waste form within the tank and engineered barriers around the waste.

- A lumped-parameter model with layered, rectangular symmetry was developed to predict rate of release from contaminated soil or stabilized waste located in the saturated zone. The model comprises three layers: the waste form and two adsorptive layers downstream of the waste form. This module predicts releases from the engineered structure, assuming equilibrium partitioning of radionuclides or hazardous chemicals between the solid and pore water phases of the waste form. Contaminant concentration varies in steps within the waste form, and release occurs by advection but not diffusion. The mass balances allow an analytical solution, and this release model is applicable to below-grade portions of the Main Plant Process Building, the NDA, and the SDA.

- A distributed-parameter, layered rectangular-geometry release module was developed to simulate release in the vertical direction from portions of the Main Plant Process Building and Waste Tank Farm. The model represents downward percolation of precipitation through an upper adsorptive barrier, waste form, and lower adsorptive barrier. Water exiting this engineered system flows horizontally through an aquifer. The model represents spatial distribution of concentration of radionuclides or hazardous chemicals, advective and diffusive transport, and time-dependence of physical properties. This module uses finite difference methods to solve the mass balance equations.

- A distributed-parameter rectangular flow tube model was developed to simulate release from contaminated soil and groundwater; that is, future development of a groundwater plume. The model represents spatial distribution of concentration of radionuclides or hazardous chemicals, as well as advective and diffusive transport, and allows simulation of a slurry wall within the contaminated area. This module uses finite difference methods to solve mass balance equations.

- An erosion model was developed that predicts the release of below-grade waste into surface streams. The release rates are based on horizontal and vertical distribution of radionuclides or hazardous chemicals in a rectangular cell. For this EIS, erosion rates are predicted by a simplified gully model that draws its starting point from topography established by the use of the CHILD [Channel-Hillslope Integrated Landscape Development] landscape evolution model. The CHILD model was calibrated by reproducing a close approximation of the current topography from a topography estimated to have been present following the last glacial retreat a little over 15,000 years ago. The simplified single gully release model allows investigation of local-scale features that may not be captured by the landscape evolution model.

Groundwater Transport Module

For releases from localized sources, a single one-dimensional groundwater transport module was developed that predicts changes in soil and groundwater contaminant concentrations at various distances and times using the parameters of groundwater velocity, soil adsorption properties, and contaminant decay rate. This model utilizes an analytic solution to the contaminant transport equation in conjunction with the principle of superposition to represent a time series of releases. This module is linked with one of the groundwater release modules discussed earlier to predict downgradient contaminant concentration as a function of position and time. As described above, for releases from spatially distributed sources such as the North Plateau Groundwater Plume, a finite-difference solution to the one-dimensional contaminant transport equation is applied. Initial concentration of contaminants in the aquifer is specified as model input.

Human Health Impact Module

For both radioactive and hazardous chemical constituents, a human health impact module was developed that calculated dose and risk (radionuclides) or Hazard Index and risk (hazardous chemicals) from contact with and use of contaminated soil and water. The human health impact module allows for the consumption of contaminated water, crops, and livestock as well as fish raised in contaminated water. It also allows for the siting of a house in contaminated soil. Estimation of human health impacts of deer consumption and recreational hiking are included in the model.

Integrated Models

The various modules are combined to develop sets of integrated release, transport, and exposure models. **Table D–5** summarizes the combinations of modules composing the sets of integrated models that represent the capabilities on the integrated long-term performance assessment models. The finite-difference cylindrical, analytic rectangular, and finite-difference rectangular modules all involve release to groundwater and groundwater transport to either a well or surface water. The plume model involves release to either a groundwater well or surface water. The erosion model simulates direct release to surface water, while the intruder model does not involve transport to groundwater or surface water. Further information on the capabilities of specific integrated models is presented in Appendix G of this EIS. Information on which models are used for specific analyses is presented in Appendix H, where the results of specific analyses are presented.

Table D–5 Summary of Integrated Release/Transport/Exposure Models

	Release Module						
Model	***Finite-Difference Cylindrical***	***Analytical Rectangular***	***Finite-Difference Rectangular***	***Erosion***	***Direct Intrusion***	***Groundwater Transport Module***	***Health Impact Module***
Plume			Yes			Yes	Yes
Tank [a]	Yes	Yes	Yes			Yes	Yes
Above-grade monolith [a]		Yes	Yes			Yes	Yes
Below-grade monolith		Yes				Yes	Yes
Erosion				Yes		No	Yes
Intruder					Yes	Yes	Yes

[a] The tank and tumulus models have two versions, one with a distributed-parameter source and one with a lumped-parameter source.

D.3.2.3 Approach to Addressing Long-term Performance Assessment Uncertainty

Evaluation of uncertainty involves consideration of contributions from model structure, model parameters, and scenario elements (Draper et al. 1999). Because probability distributions of model structure (i.e., uncertainty of appropriate model structure), receptor behavior, and some model parameters are not available for both groundwater and erosion scenarios, a comprehensive probabilistic evaluation is not practical. Thus, a combination of conservative assumptions and sensitivity analyses were applied to investigate uncertainty associated with dose estimates. As a first step in the process, the nature of the model was reviewed to identify fidelity to the physical system represented by the model. As a second step, literature of sensitivity and uncertainty analysis was reviewed to survey the current understanding of model sensitivity and uncertainty. The next step comprised review of site-specific environmental conditions, closure designs, and models to select a set of sensitivity cases. Results of deterministic sensitivity analysis are presented in Appendix H of this EIS.

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APPENDIX E
GEOHYDROLOGICAL ANALYSIS

APPENDIX E
GEOHYDROLOGICAL ANALYSIS

E.1 Introduction

A three-dimensional far-field site groundwater flow model has been implemented for the *Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center (Decommissioning and/or Long-Term Stewardship EIS)*. This model extends the model domain beyond that of models previously employed at the site. Both model conceptual development and parameterization incorporated recent data along with those used in prior modeling efforts. The updated model confirms historical understanding of upper layer hydrology with an improved understanding of flows through the slack-water sequence and the Kent recessional sequence (see Chapter 3, Section 3.6, of this EIS). In addition, three-dimensional near-field models for the North and South Plateaus were developed for the evaluation of the environmental impact statement (EIS) alternatives. These models facilitate understanding of near-field flow and the impacts of design decisions for the facilities involved.

This appendix provides descriptions of the groundwater models used in the assessment of the impacts for the EIS decommissioning alternatives under consideration. The objectives of the EIS groundwater modeling activities were:

- To develop an updated three-dimensional groundwater model that utilizes the additional characterization data collected since the last local model was developed in the mid-1990s.
- To extend the model domain beyond that used in previous modeling at the site to investigate the potential flow in the Kent recessional sequence deeper units.
- To establish a methodology for estimating how local hydrology will change as a result of the engineering features proposed under the various decommissioning alternatives.
- To provide a context for contaminant transport methodology used in the assessments of the EIS decommissioning alternative impacts.

The approach taken to meeting these objectives was 1) to develop the site groundwater flow model for determining flow patterns and exploring conceptual issues at the site scale; 2) to develop the near-field three-dimensional numerical models, consistent with the site model, for the evaluation of changes in local hydrology as a result of proposed alternative actions; and 3) to extract from the near-field models key transport parameters needed for the performance assessments of the alternatives. The two near-field models' domains were the North Plateau and South Plateau.

The site model (covering much of the site area and extending into the bedrock) was implemented using the U.S. Department of Energy (DOE) FEHM [Finite Element Heat and Mass Transfer] code developed at Los Alamos National Laboratory (LANL 2003) and the near-field models that were developed using the DOE STOMP [Subsurface Transport Over Multiple Phases] code developed at Pacific Northwest National Laboratory (PNNL 2000). FEHM is a finite element code and STOMP is a finite difference code. Both are capable of modeling partially saturated-saturated systems. The focus of this appendix is on model conceptualization and parameterization, along with the presentation of key results and data analyses.

A significant amount of the effort expended in the development of the groundwater models was directed toward data reduction and evaluation of the large and varied amount of data available. Several notable findings came out of these analyses. Perhaps of most interest, for some geohydrological units, statistically significant differences exist in same-hole hydraulic conductivities, i.e., hydraulic conductivities determined at the same location (well) but at different times, before and after 1999. As might be expected, the amount of available data varies widely from unit to unit with those of more historical interest being better represented. A preliminary geostatistical characterization of the thick-bedded unit hydraulic conductivity was performed.

Section E.2 provides a discussion of the site environs, the geology of the site relevant to the groundwater modeling activities, identification of the geohydrological units on site, flow systems found at the site, and a general discussion of groundwater conditions. Section E.3 provides information on the implementation of the sub-regional FEHM model, calibration and sensitivity analyses, and a summary of results from the base case model. Details of the near-field STOMP models are presented in Section E.4. The discussion is broken down by North and South Plateau and by alternative. In addition to the geohydrological parameters, the discussion includes the identification and characterization of design elements and parameters used in the models. Transport parameters needed for assessment of alternative impacts are derived from the corresponding STOMP results.

E.2 Site Characteristics

This section summarizes available site information used to support the development and testing of the groundwater flow models. General information regarding the site geology and hydrogeology is provided in Chapter 3 of this EIS.

E.2.1 Overview of Geologic and Hydrogeologic Setting

The hydrostratigraphy underlying the North and South Plateaus is summarized in the following sections, including a description of the saturated zone characteristics, delineation of the direction and rate of groundwater flow, and the distribution and nature of groundwater contamination as derived from historical studies and ongoing investigations. Information regarding the hydrostratigraphic units and their properties is provided in Section E.3, in the support analyses for the development of a three-dimensional groundwater flow model and the associated long-term performance assessment in Appendix H of this EIS.

E.2.1.1 Location and Main Features

Figure E–1 shows the general location of the Western New York Nuclear Service Center (WNYNSC) and the West Valley Demonstration Project (WVDP). WNYNSC is located 48 kilometers (30 miles) south of Buffalo, New York. The entire site is located within the Buttermilk Creek drainage basin, which is part of the Cattaraugus Creek watershed. Cattaraugus Creek is located north of the site and flows westward to Lake Erie.

The developed portion of the site is divided geographically by Erdman Brook into the North Plateau and South Plateau and operationally into waste management areas (WMAs). The North Plateau contains the majority of the processing plant facilities. The area covered by the groundwater monitoring network on the North Plateau includes the Main Plant Process Building and Vitrification Facility Area (WMA 1), Low-Level Waste Treatment Facility Area (WMA 2), Waste Tank Farm Area (WMA 3), Waste Storage Area (WMA 5), Construction and Demolition Debris Landfill (CDDL) (WMA 4), Central Project Premises (WMA 6), and Support and Services Area (WMA 10). The monitoring network on the South Plateau includes the Central Project Premises (WMA 6), the inactive NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area (NDA) and Associated Facilities (WMA 7), the inactive SDA and Associated Facilities (WMA 8), Radwaste Treatment System Drum Cell (WMA 9), and Support and Services Area (WMA 10). **Figure E–2** shows the layout of major site features and WMAs across WNYNSC and WVDP.

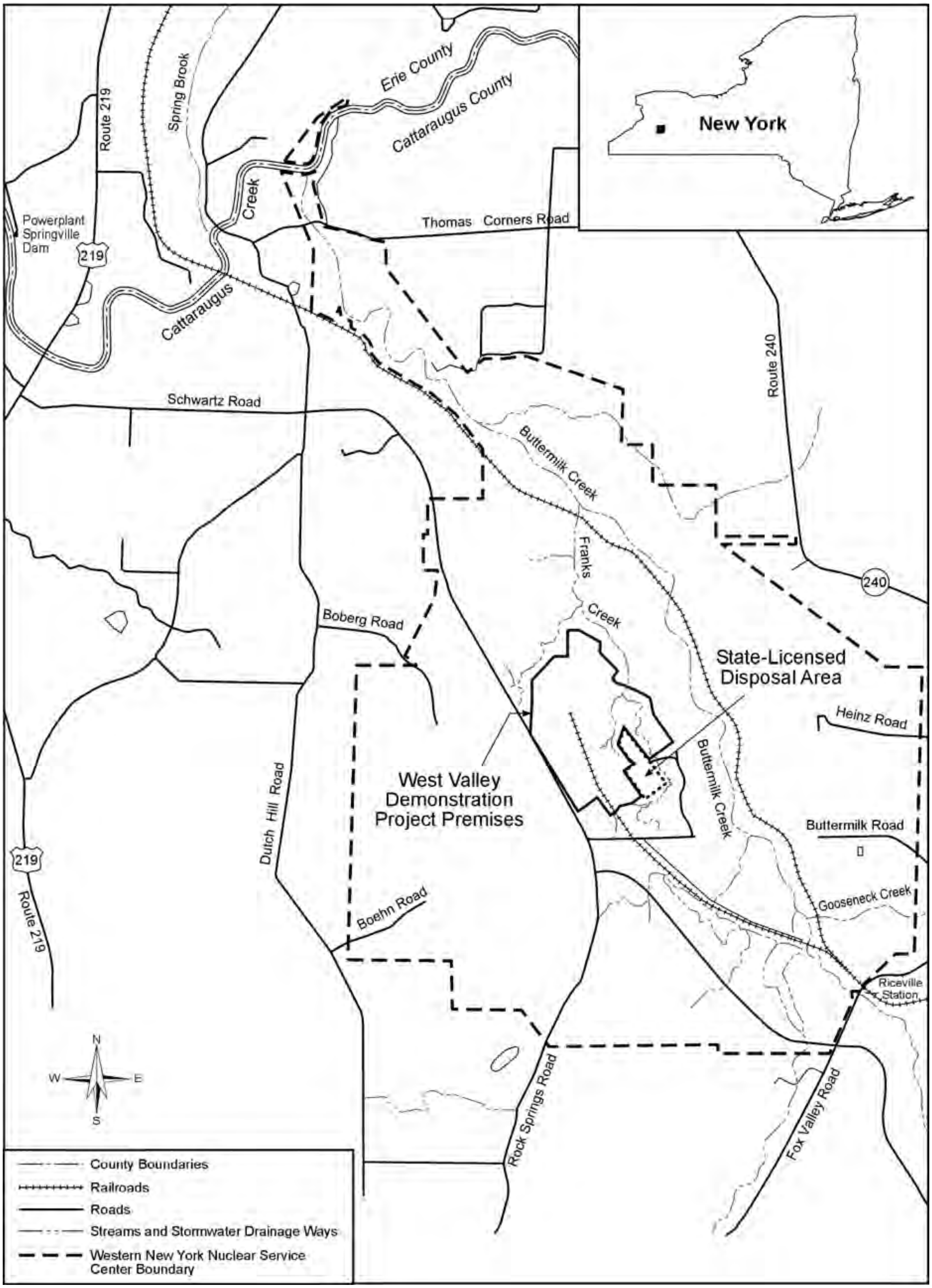


Figure E–1 General Location Map of the Western New York Nuclear Service Center and the West Valley Demonstration Project

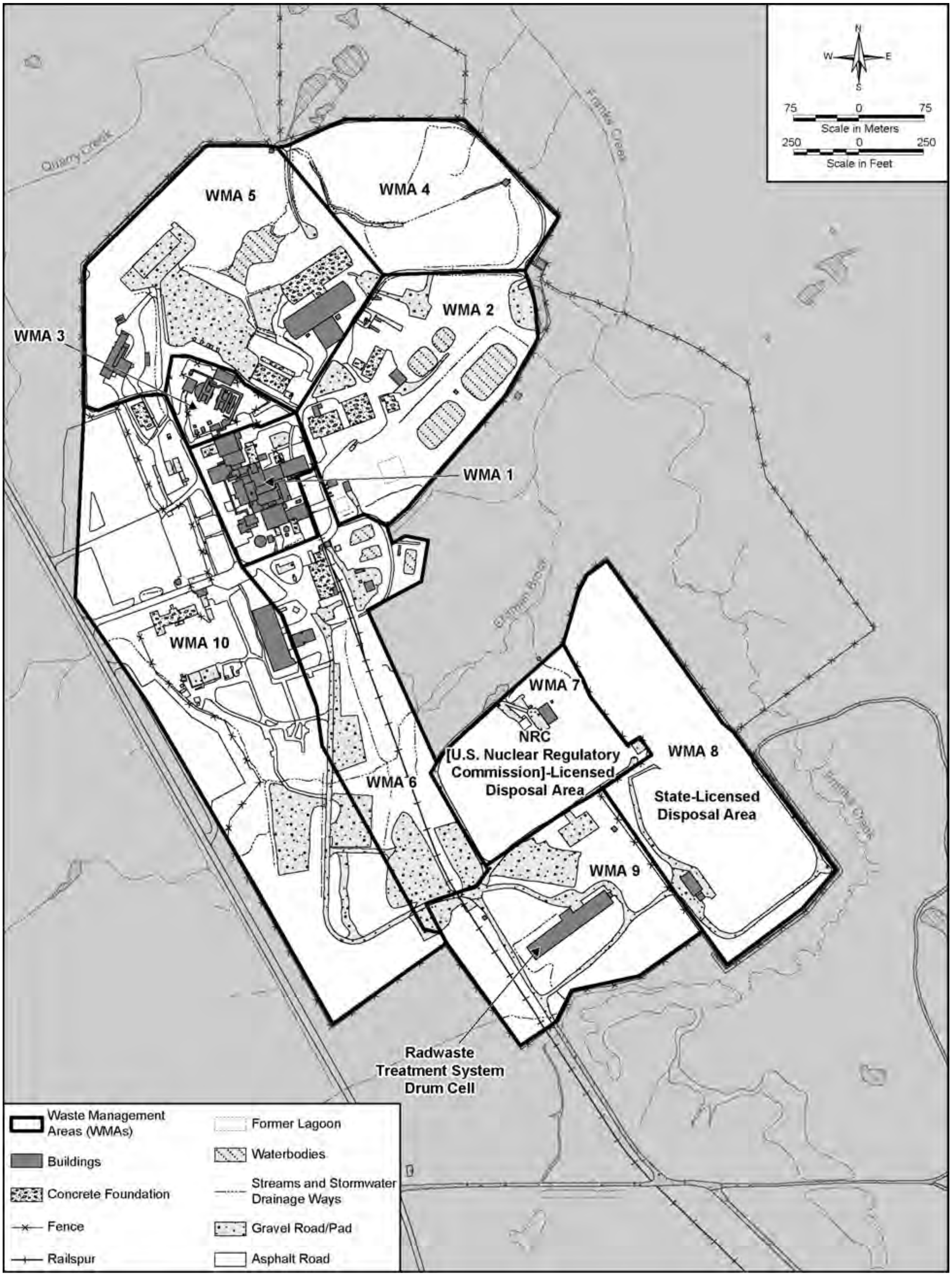


Figure E–2 West Valley Demonstration Project Site and Waste Management Areas

The area between Franks Creek and Buttermilk Creek, referred to as the East Plateau in this appendix, is a third plateau area located east and northeast of the Project Premises (Figure E–1). The East Plateau area is overlain by sand and gravel deposits in the north and weathered till in the south. While part of the same units that underlie the main WVDP facilities, the shallow geologic units on the East Plateau are isolated from WVDP by the Franks Creek Valley. The deeper till units underlying the East plateau are laterally contiguous with the till to the west.

E.2.1.2 Geology

WNYNSC is located within the glaciated northern portion of the Appalachian Plateau physiographic province at an average elevation of 396 meters (1,300 feet) above mean sea level (WVNS 1993a, WVNS and URS 2005). The site is approximately midway between the boundary delineating the southernmost extent of Wisconsin Glaciation and a stream-dissected escarpment to the north that establishes the boundary between the Appalachian Plateau and the Interior Low Plateau Province.

WNYNSC is located in the Buttermilk Creek Valley. The valley is a steep-sided, northwest-trending U-shaped valley that has been incised into the underlying Devonian bedrock. A sequence of Pleistocene-aged deposits and overlying Holocene (recent) sediments up to 150 meters (500 feet) thick occupies the valley. Repeated glaciation of the ancestral bedrock valley occurred between 14,500 and 38,000 years ago, resulting in the deposition of a sequence of three glacial tills (Lavery, Kent, and Olean tills) that comprise the majority of the valley fill deposits (WVNS 1993a, WVNS and URS 2005). The Holocene deposits are principally deposited as alluvial fans and aprons derived from the glacial sediments that cover the uplands surrounding WNYNSC and from floodplain deposits derived from Pleistocene valley-fill sequences (WVNS 1993a, 2007).

Glacial tills of Lavery, Kent, and Olean formations separated by stratified, interstadial, fluvio-lacustrine deposits overlie the bedrock beneath the North, South, and East Plateaus. Repeated glaciation of the Buttermilk Creek Valley occurred between 24,000 and 15,000 years ago, ending with the deposition of approximately 40 meters (130 feet) of Lavery till. Outwash and alluvial fan deposits were deposited on the Lavery till between 15,000 and 14,200 years ago (URS 2002). **Figure E–3** shows the surface geology of the Buttermilk Creek basin in the vicinity of WNYNSC.

The uppermost Lavery till and younger surficial deposits form a till plain covering 25 percent of the Buttermilk Creek basin with elevations ranging from 490 meters to 400 meters (1,600 to 1,300 feet) from south to north. The Project Premises and the SDA are located on this stream-dissected till plain west of Buttermilk Creek at an elevation of 430 meters (1,400 feet). Erdman Brook divides the Project Premises into North and South Plateaus (WVNS 1993a).

E.2.1.3 Site Stratigraphy

Sediments overlying the bedrock consist of glacial tills of the Lavery, Kent, and Olean (WVNS and URS 2005) formations that are separated by stratified fluvio-lacustrine deposits (**Figure E–4** and **Table E–1**). The glacial layers dip to the south at approximately 5 meters (16 feet) per kilometer. The stratigraphic units present at the North and South Plateaus are shown on **Figure E–5** and **Figure E–6**, respectively. The stratigraphy of the North and South Plateau areas is differentiated by sand and gravel deposits that overlie the till on the North Plateau areas and the lack of sand and gravel deposits overlying the till on the South Plateau areas. Unit designations in the vicinity of the site are also indicated on Figure E–4, developed from La Fleur (La Fleur 1979) and Prudic (Prudic 1986). The continuity of the shallow deposits is interrupted by the deeply incised stream valleys occurring between the plateaus. Deposition of the sand and gravel has significantly reduced the depth of weathering in the underlying till on the North Plateau areas while weathered till is exposed at the surface on the southern part of the site (WVNS 1993a).

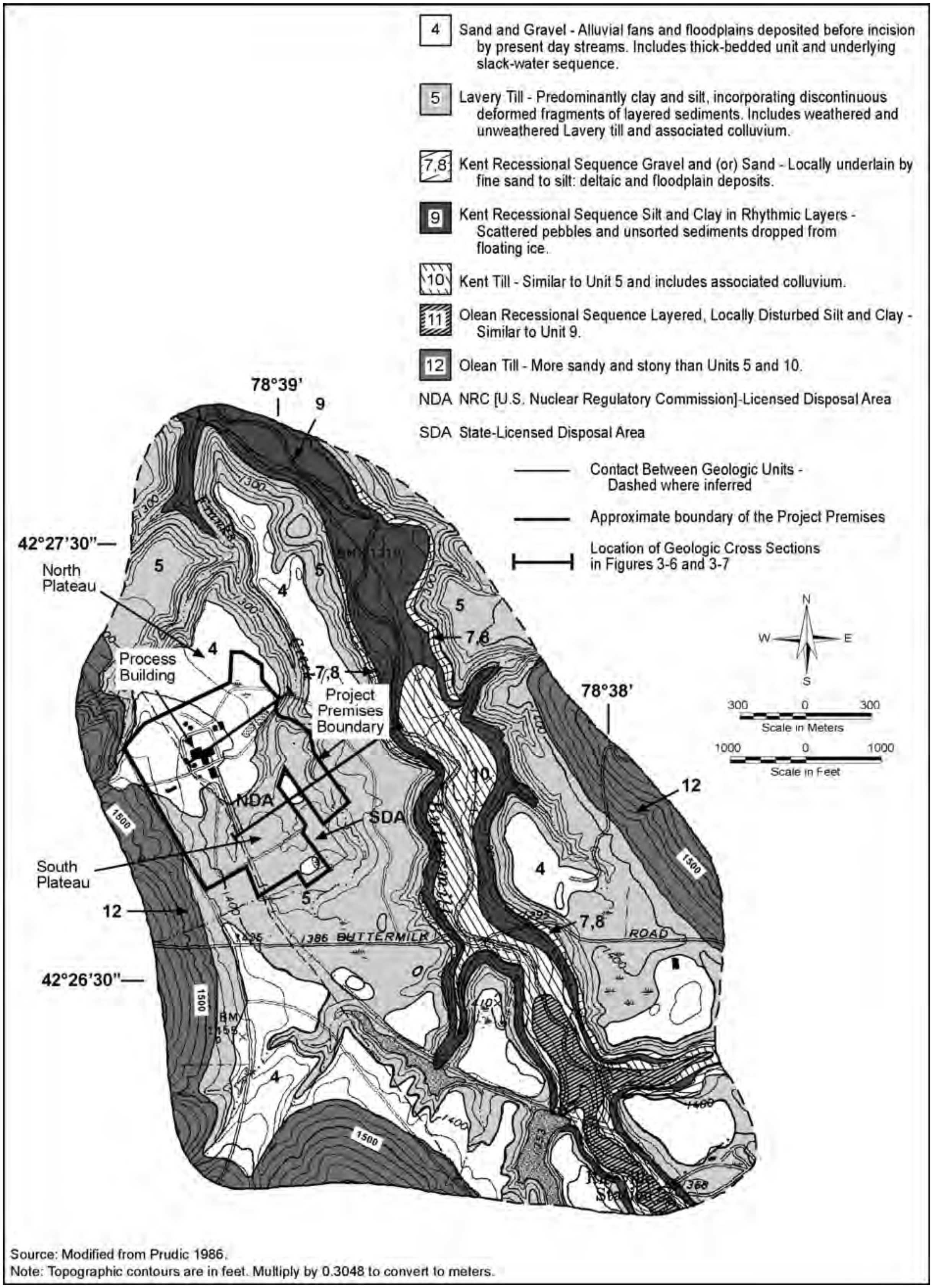


Figure E–3 Surface Geology in the Vicinity of the Western New York Nuclear Service Center

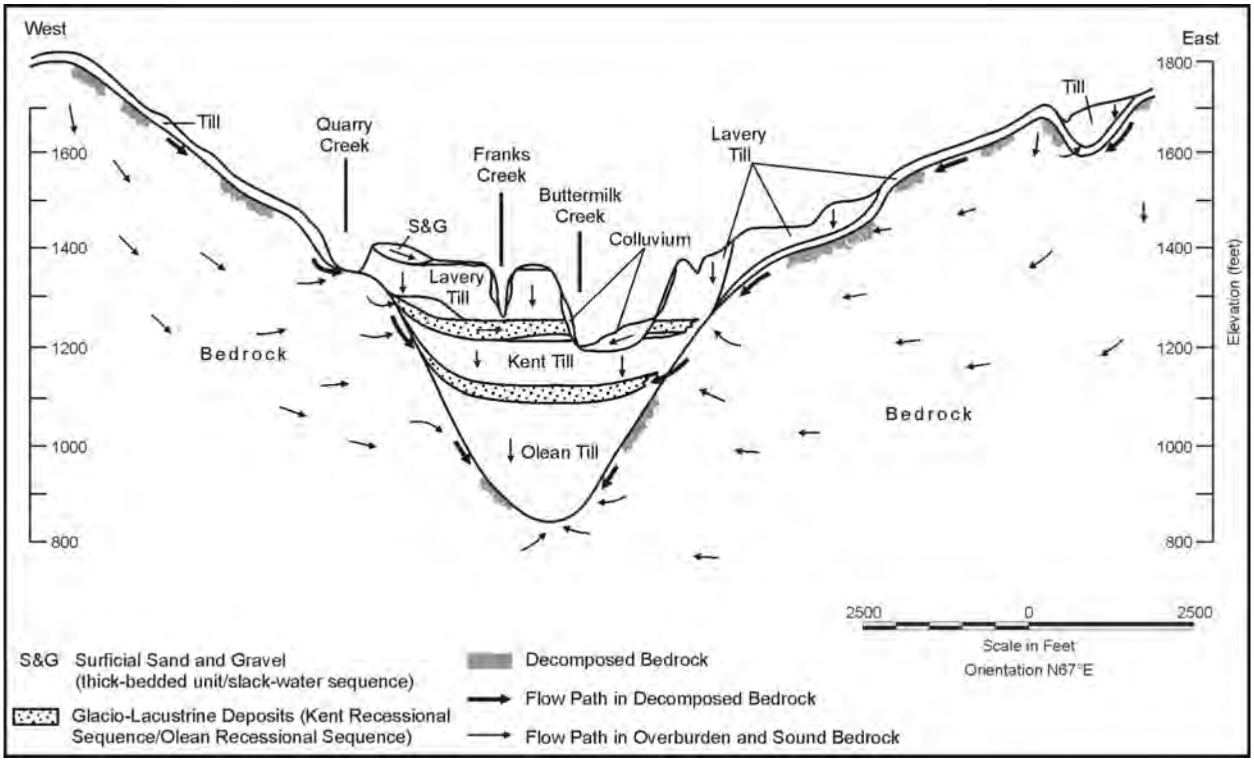


Figure E–4 Geologic Cross-section through the Buttermilk Creek Valley

The clay layer that differentiates the sand and gravel (thick-bedded unit and slack-water sequence) units in the subsurface underlying the North Plateau has previously been interpreted as unweathered Lavery till, resulting in portions of the slack-water sequence being interpreted as Lavery till-sand. However, recent reinterpretation of the sandy interval as slack-water sequence has revised the extent of the Lavery till-sand and the slack-water sequence beneath the North Plateau (WVES 2007). The primary justification for the stratigraphic revision to the model is based on the elevation of the encountered units as delineated from borings. As a result of the reinterpretation, the horizontal extent of the slack-water sequence has been expanded from previous delineations to encompass areas located upgradient of the Main Plant Process Building and has also been extended to conform to the surface of the underlying unweathered Lavery till. As fewer borings are now considered to have encountered Lavery till-sand, the horizontal extent of the Lavery till-sand has been reduced (WVES 2007). The new interpretation is a recent development and is still evolving. Potential impacts on flow at the site are considered in the discussion of the modeling results in Section E.3.7.

E.2.2 Definition of Hydrostratigraphic Units

The stratigraphic units underlying the WVDP area are subdivided into hydrostratigraphic units on the basis of lithology and hydrogeologic properties. In this regard, contiguous layers with similar lithologic and hydrogeologic characteristics may be combined into a single hydrostratigraphic unit. The various hydrostratigraphic units are shown by the generalized geologic cross-sections on Figures E–5 and E–6. **Figure E–7** illustrates a conceptual block model of the groundwater flow systems underlying the North and South Plateaus. This model is conceptual and flows between the units are mostly inferred from the known hydrostratigraphy—with the exception of locations where recharge from or discharge to the surface is clearly observed. Groundwater movement beneath the East Plateau combines elements of both conceptual flow systems.

Table E–1 Stratigraphy of the West Valley Demonstration Project Premises and the State-Licensed Disposal Area

Geologic Unit	Description	Origin	Thickness [a] North Plateau (meters)	Thickness [a] South Plateau (meters)
Colluvium	Soft plastic pebbly silt only on slopes, includes slump blocks several meters thick	Reworked Lavery or Kent till	0.3 to 0.9	0.3 to 0.9
Thick-bedded Unit	Sand and gravel, moderately silty	Alluvial fan and terrace deposits	0 to 12.5	0 to 1.5 at Well 905 [b]; not found at other locations
Slack-water Sequence	Thin-bedded sequence of clays; silts, sands, and fine-grained gravel at base of sand and gravel layer	Lake deposits	0 to 4.6	Not present
Weathered Lavery Till	Fractured and moderately porous till, primarily comprised of clay and silt	Weathered glacial ice deposits	0 to 2.7 (commonly absent)	0.9 to 4.9, average = 3
Unweathered Lavery Till	Dense, compact, and slightly porous clayey and silty till with some discontinuous sand lenses	Glacial ice deposits	1 to 31.1 Lavery till thins west of WVDP	4.3 to 27.4 Lavery till thins west of WVDP
Till-sand Member of Lavery Till	Thick and laterally extensive fine to coarse sand within Lavery till	Possible meltwater or lake deposits	0.1 to 4.9	May be present in one well near northeast corner of the NDA
Kent Recessional Sequence	Gravel composed of pebbles, small cobbles, and sand, and clay and clay-silt rhythmic layers overlying the Kent till	Proglacial lake, deltaic, and alluvial stream deposits	0 to 21.3	0 to 13.4
Kent Till, Olean Recessional Sequence, Olean Till	Kent and Olean tills are clayey and silty till similar to Lavery till; Olean recessional sequence is predominantly clay, clayey silt, and silt in rhythmic layers similar to the Kent recessional sequence overlying the Olean till	Mostly glacial ice deposits	0 to 91.4	0 to 101
Upper Devonian Bedrock	Shale and siltstone, weathered at top	Marine sediments	> 402	> 402

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area.

[a] To convert meters to feet, multiply by 3.2808.

[b] Coarse sandy material was encountered in this well. It is unknown whether this deposit is equivalent to the sand and gravel layer on the North Plateau.

Source: Geologic unit descriptions and origins from Prudic (1986) as modified by WVNS (1993a, 1993b). Thickness from lithologic logs of borings drilled in 1989, 1990, and 1993 (WVNS 1993d); from Well 905 (WVNS 1993b); and from Well 834E (WVNS 1993a). Kent and Olean till thickness from difference between bedrock elevation (based on seismic data) and projected base of Kent recessional sequence (WVNS 1993a); upper Devonian bedrock thickness from Well 69 U.S. Geological Survey 1-5 located in the southwest section of WNYNSC (WVNS 1993a).

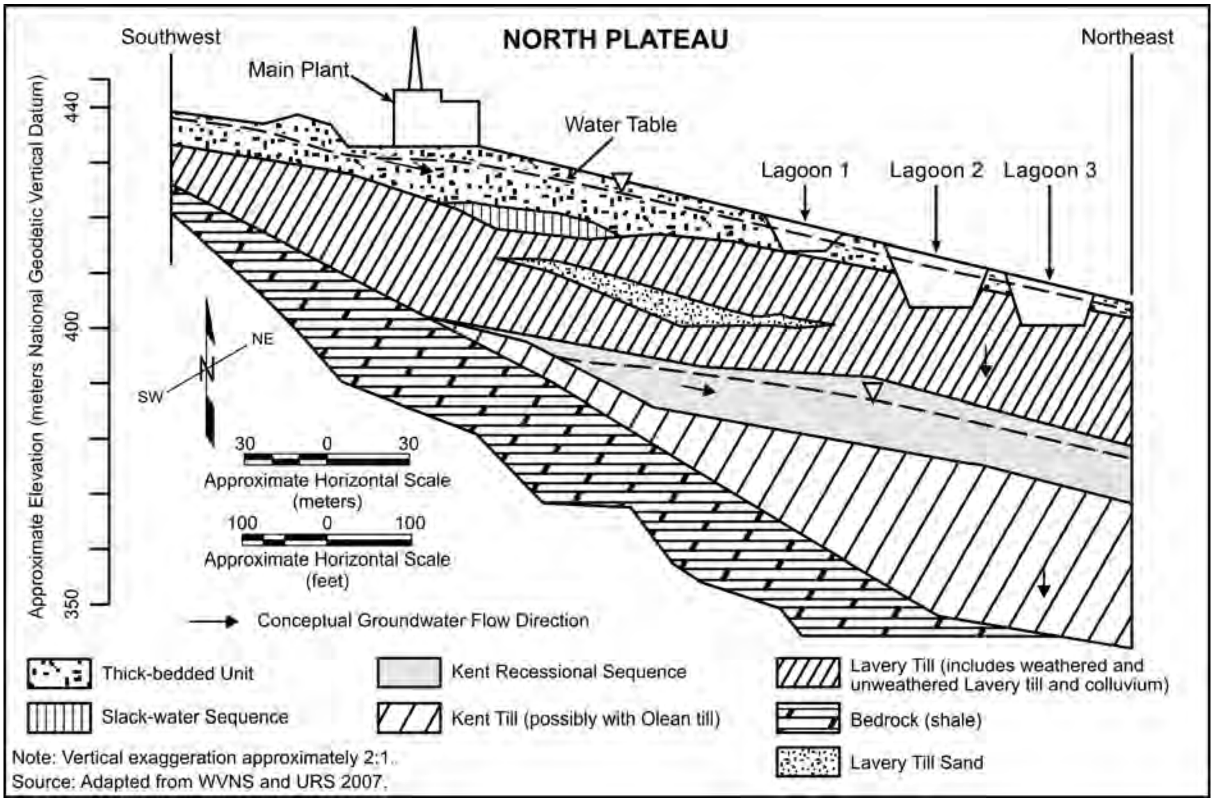


Figure E–5 Geologic Cross-section through the North Plateau

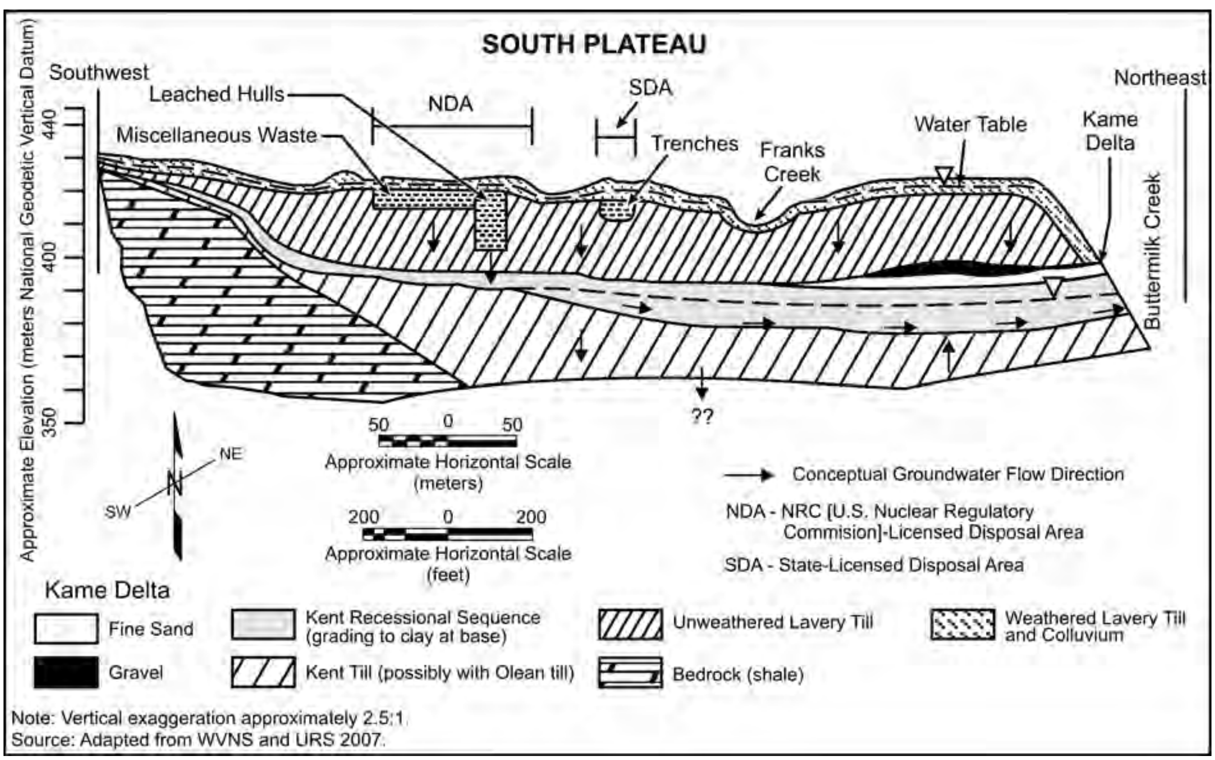


Figure E–6 Geologic Cross-section through the South Plateau

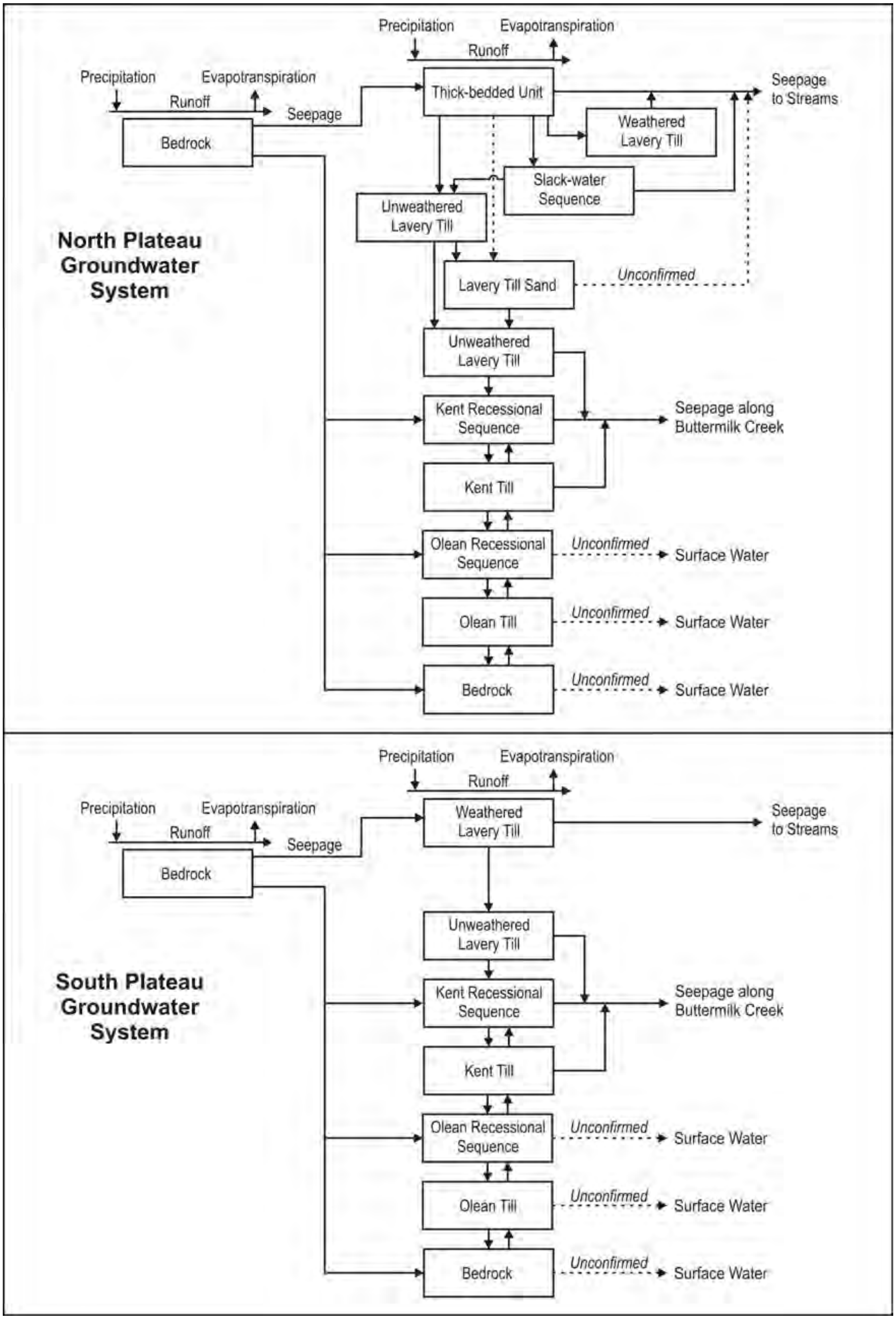


Figure E–7 Conceptual Block Models of the North and South Plateau Groundwater Flow System at the West Valley Demonstration Project Site

E.2.2.1 Thick-bedded Unit Sand and Gravel and Slack-water Sequence

The thick-bedded unit is a Holocene-age alluvial fan that was deposited by streams entering Buttermilk Creek Valley and is the thicker and more extensive of the two deposits. The alluvial fan overlies the Lavery till over most of the North Plateau and directly overlaps the Pleistocene-age glaciofluvial slack-water sequence that occurs in a narrow northeast trending trough in the Lavery till (see **Figure E–8**). On steeper slopes, Holocene-age landslide deposits (colluvium) also blanket or are interspersed with the sand and gravel (WVNS 1993a). Fill material occurs in the developed portions of the North Plateau and mainly consists of recompacted surficial sediment that is mapped as part of the sand and gravel (WVNS 1993b). The slack-water sequence is a Pleistocene-age glaciofluvial gravel deposit that overlies the Lavery till in a narrow northeast-trending trough across the North Plateau (WVNS 1993a, 1993b, 1993d, 2007). The unit contains thin-bedded layers of clay, silt, sand, and fine-grained gravel deposited in a glacial lake environment (WVNS 1993d). These subunits overlie the Lavery till on the North Plateau with localized amalgamation with the Lavery till-sand. Previous studies have treated the thick-bedded unit and slack-water sequence as a single unit, the Sand and Gravel Unit. Investigators have used both the single and the two-subunit representations in past studies, depending on the purpose of the analysis. In this EIS, the two-subunit representation is used to account for the differences in hydraulic conductivity between the units for modeling purposes.

E.2.2.1.1 Thick-bedded Unit Sand and Gravel

The thick-bedded unit underlying the North Plateau has an areal extent of approximately 42 hectares (104 acres) with a thickness of up to 12.5 meters (42 feet) in the vicinity of the process building (WMA 1) and the wastewater treatment facility (WMA 2). The average textural composition of the surficial sand and gravel is 41 percent gravel, 40 percent sand, 11 percent silt, and 8 percent clay, classifying it as a muddy gravel or muddy sandy gravel (WVNS 1993b). The sand and gravel unit is thickest, ranging from 9 meters (30 feet) to 12.5 meters (41 feet), along a trend oriented southwest to northeast across WMA 1. The locally thicker sand and gravel deposits correspond to erosional channels incised into the underlying Lavery till. The sand and gravel thins to the north, east, and south where it is bounded by Quarry Creek, Franks Creek, and Erdman Brook, respectively, and to the west against the slope of the bedrock valley (WVNS 1993a, 1993b; WVNS and URS 2006). At these boundaries, the thick-bedded unit is truncated by the downward erosion of the streams and groundwater discharges to surface water through seepage faces and underflow down stream valley walls through weathered Lavery till or colluvium.

The thick-bedded unit on the North Plateau is recharged by inflow from direct contact with fractured bedrock west of the site and from infiltrating precipitation. Discharge from this unit flows into Erdman Brook, Franks Creek, and Quarry Creek from the North Plateau, and into Franks and Buttermilk Creeks from the East Plateau. Prior studies indicate that a small fraction of the water flows downward from the surficial thick-bedded unit to the Lavery till (Prudic 1986, WVNS 1993b). The thick-bedded unit underlying the East Plateau is physically and hydrologically disconnected from the North Plateau.

Groundwater in the sand and gravel forms the upper aquifer beneath WVDP. The depth to the water table within the sand and gravel ranges from 0 meters (0 feet) where the water table intersects the ground surface and forms swamps and seeps along the periphery of the North Plateau, to as much as 6 meters (20 feet) beneath portions of the central North Plateau where the layer is thickest (WVNS 1993b). Groundwater in the sand and gravel generally flows to the northeast across the North Plateau from the southwestern margin of the unit near Rock Springs Road toward Franks Creek. Flow in the thick-bedded unit is predominantly horizontal (WVNS 1993b, WVNS and Dames and Moore 1997, WVNS and URS 2006).

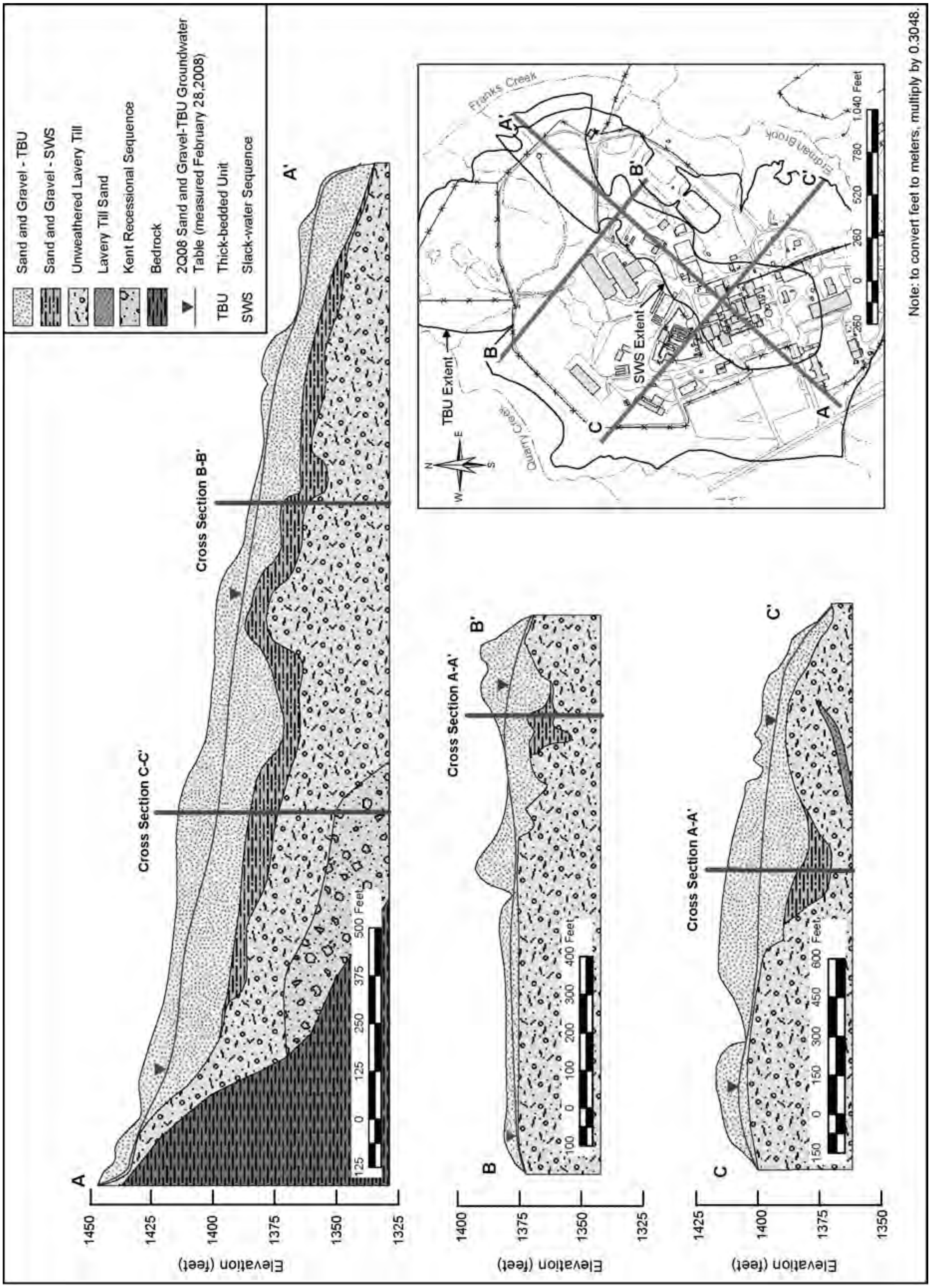


Figure E–8 Surficial Sand and Gravel Showing the Extent of Both the Thick-bedded Unit and the Slack-water Sequence

E.2.2.1.2 Slack-water Sequence

The slack-water sequence, shown on Figure E–8, occurs at the base of the thick-bedded unit from the area of the cooling tower northeast to Franks Creek Valley (WVNS 1993d). The slack-water deposits range in thickness up to 4.6 meters (15 feet). Numerous thin horizontal clay layers occur in the slack-water sequence. This can be seen in estimated slack-water sequence textures ranging from 95 percent clay and silt to 100 percent sand. Although the overlying thick-bedded unit aquifer is considered to be under unconfined conditions, localized confined conditions occur in the slack-water sequence.

The lateral extent of the slack-water sequence is a focus of the new geological interpretation that has evolved at the site. The basic changes in the reinterpretations are that the shallower portion of the Lavery till-sand in the old interpretation is now incorporated into the slack-water sequence and Lavery till-sand is now diminished and completely isolated within the Lavery till (WVES 2007).

Recharge to the slack-water sequence is from the overlying thick-bedded unit. Discharge occurs both at seeps along the slopes above Franks Creek and as downward vertical flow into the Lavery till.

E.2.2.2 Lavery Till

The surficial units and the entire Project Premises are underlain by the Lavery till. The till underlying the North Plateau is predominantly unweathered, owing to the presence of the overlying sand and gravel (WVNS 1993a). Weathered zones in the till are generally less than 0.3 meters (1 foot) thick (WVNS and Dames and Moore 1997). The till consists of dense, pebbly, silty clay to clayey silt. The unweathered Lavery till is typically olive-gray and calcareous (WVNS 1993a) and contains discontinuous and randomly oriented pods or masses of stratified sand, gravel, and rhythmically laminated clay-silt. The average textural composition of the unweathered Lavery till is 50 percent clay, 30 percent silt, 18 percent sand, and 2 percent gravel (WVNS 1993b). Across the site, the thickness of the till ranges from 9 to 12 meters (30 to 40 feet), reaching a maximum thickness of approximately 31 meters beneath the North Plateau and 27 meters beneath the South Plateau.

The weathered Lavery till at the South Plateau is generally exposed at grade or may be overlain by a veneer of fine-grained alluvium (WVNS 1993a). The upper portion of the till beneath the South Plateau has been extensively weathered and is physically distinct from unweathered Lavery till. The weathered till has been oxidized from olive-gray to brown, contains numerous root tubes, and is highly desiccated with intersecting horizontal and vertical fractures (WVNS 1993b, WVNS and URS 2006). Vertical fractures extend from approximately 4 to 8 meters (13 to 26 feet) below ground surface into the underlying unweathered till. The average textural composition of the weathered Lavery till is 47 percent clay, 29 percent silt, 20 percent sand, and 4 percent gravel. The thickness of the weathered Lavery till ranges from 0.9 meters (3 feet) to 4.9 meters (16 feet) across the South Plateau (WVNS 1993b, WVNS and URS 2006).

Groundwater in the unweathered Lavery till generally infiltrates vertically toward the underlying Kent recessional sequence (Prudic 1986, WVNS 1993b, WVNS and Dames and Moore 1997). The till unit is perennially saturated with relatively low hydraulic conductivity in the vertical and horizontal dimensions and functions as an effective aquitard (WVNS and Dames and Moore 1997). The observed hydraulic gradient in the unweathered Lavery till is close to unity (Prudic 1986).

The weathered Lavery till is variably weathered to a depth of 0.9 to 4.9 meters (3 to 16 feet) (see Chapter 3, Section 3.3.1.1). Because of the weathered and fractured nature of the till, both horizontal and vertical components are active in directing groundwater movement (WVNS and URS 2006). Lateral groundwater movement in the weathered till is controlled by the availability of interconnected zones of weathering and fracturing, the prevailing topography on the weathered till/unweathered till interface, and the low permeability of the underlying unweathered Lavery till. The range of hydraulic conductivities and the variation in lateral gradients lead to horizontal velocity estimates on the order of tens of centimeters per year to meters per year. Flow may continue a short distance before slower vertical movement through the underlying unweathered till occurs, or in some circumstances, may continue until the groundwater discharges at the surface in a stream channel or a seep.

Research conducted by the New York State Geological Survey (Dana et al. 1979a, 1979b) studied the shallow till and associated joints and fractures as part of a hydrogeologic assessment of the Lavery till. Intrinsic till joints and fractures were classified as: (1) prismatic and columnar jointing related to hardpan soil formation; (2) long, vertical, parallel joints that traverse the entire altered zone and extend into the parent till, possibly reflecting jointing in the underlying bedrock; (3) small displacements through sand and gravel lenses; and (4) horizontal partings primarily resulting from soil compaction and secondarily from trench excavation. Prismatic and columnar jointing may represent up to 60 percent of all till fractures and were believed to have been formed by alternating wet/dry or freeze/thaw conditions. Fracture density was determined to be a function of the moisture content and weathering of the till, with fracturing being more pervasive in the weathered and drier soil and associated till. Densely spaced, vertical fractures with spacing ranging from 2 to 10 centimeters (0.8 to 3.9 inches) were limited to depths in the soil near the surface. However, vertically persistent fractures were observed to extend from the surface soils into the relatively moist and unweathered till. These long vertical fractures were systematically oriented to the northwest and northeast. Spacing between fractures ranged from 0.65 to 2.0 meters (2 to 6.5 feet) and generally extended to depths of 5 to 7 meters (16 to 23 feet). The fracture spacing increased with depth and the number of fractures were observed to decrease with depth. Trenching found one vertical fracture extending to a depth of 8 meters (26 feet) (Dana et al. 1979a).

Open, or unfilled, fractures in the upper portion of the Lavery till provide pathways for groundwater flow and potential contaminant migration. Tritium was not detected in two groundwater samples collected from a gravel horizon at a depth of 13 meters (43 feet) in New York State Geological Survey Research Trench #3, indicating that modern (post-1952) precipitation has not infiltrated to the discontinuous sand lens in the Lavery till. Analysis of physical test results on Lavery till samples by the New York State Geological Survey concluded that open fractures would not occur at depths of 15 meters (50 feet) below ground surface due to the plasticity characteristics of the till (Dana et al. 1979a, 1979c).

E.2.2.3 Lavery Till-Sand

The Lavery till-sand is a lenticular silty sand deposit found in the southeastern portion of the North Plateau within the unweathered Lavery till. It is distinguished from the isolated pods of stratified sediment in the Lavery till because borehole observations indicate that the till-sand unit is laterally continuous beneath portions of the North Plateau (WVNS 1993b, WVNS and Dames and Moore 1997). The till-sand consists of 19 percent gravel, 46 percent sand, 18 percent silt, and 17 percent clay. The till-sand occurs within the upper 6 meters (20 feet) of the till and ranges in thickness from about 0.1 to 4.9 meters (0.4 to 16 feet).

The Lavery till-sand is the other geohydrological unit substantially modified in the new interpretation of North Plateau geology. In the new picture, it is isolated entirely within the unweathered Lavery till, functioning as a large lens. Groundwater pathways through the till-sand travel to the east-southeast toward Erdman Brook. However, surface seepage locations from the unit into Erdman Brook have not been observed (WVNS and Dames and Moore 1997, WVNS and URS 2006). The lack of seepage suggests that the till-sand is largely surrounded by unweathered Lavery till. Fractures in the Lavery till may allow groundwater in the till-sand to discharge along the north banks of Erdman Brook, but at a slow rate. As a result, recharge to and discharge from the till-sand is likely controlled by the physical and hydraulic properties of the Lavery till (WVNS 1993b). Discharge occurs as seepage to the underlying Lavery till. Recharge occurs as leakage from the Lavery till and from the overlying sand and gravel unit, where the till layer is not present (WVNS 1993b, WVNS and Dames and Moore 1997).

Under the older interpretation, the Lavery till-sand is a water-bearing unit under semi-confined conditions that receives and transmits water to other units through vertical leakage from the thick-bedded unit as well as through the unweathered Lavery till. Hydraulic gradients average 0.01 in the general direction of flow, which indicates that some discharge occurs on the southeast boundary of the Lavery till-sand. No associated seeps have been observed (WVNS and URS 2006). In addition, downward gradients are recorded from the thick-bedded unit and slack-water sequence to the Lavery till-sand in the western upgradient area where recharge to the Lavery till-sand occurs. On the eastern side of the Lavery till-sand unit, piezometric heads exceed those in the thick-bedded unit, indicating possible upward flow. This is due to confined conditions in a portion of the Lavery till-sand and the proximity to thick-bedded unit discharge areas near Erdman Brook.

E.2.2.4 Kent Recessional Sequence

The Kent recessional sequence is a sequence of interlayered, ice-recessional lacustrine and kame-delta deposits consisting of silt and clay that coarsens upward into sand and silt. The unit underlies the Lavery till beneath most of the site area, thinning to the southwest where it is truncated by the walls of the bedrock valley. The sequence receives recharge along a zone of contact with the fractured bedrock to the west, and also from downward seepage through the overlying Lavery till. The unit is not exposed on the Project Premises, but it crops out along Buttermilk Creek east of the site (WVNS 1993a, WVNS and URS 2005). The sequence is comprised of alluvial, deltaic, and lacustrine deposits with interbedded till (WVNS 1993b, 1993c). The upper Kent sequence consists of coarse-grained deposits of sand and gravel that overlie fine-grained lacustrine silt and clay (WVNS 1993b, WVNS and URS 2005). The basal lacustrine sediments were deposited in glacial lakes that formed as glaciers blocked the northward drainage of streams. Beneath the North Plateau, the Kent sequence consists of coarse sediments that either overlie the lacustrine deposits or directly overlie glacial till. The average textural composition of the coarse-grained deposits constituting the sequence is 44 percent sand, 23 percent silt, 21 percent gravel, and 12 percent clay. The average textural composition of the lacustrine deposits is 57 percent silt, 37 percent clay, 5.9 percent sand, and 0.1 percent gravel. The Kent recessional sequence attains a maximum thickness of about approximately 21 meters (69 feet) beneath the North Plateau.

Groundwater flow in the Kent recessional sequence is to the northeast and Buttermilk Creek (WVNS 1993b, WVNS and URS 2006). Recharge to the Kent recessional sequence comes primarily from both the overlying till and the adjacent bedrock valley wall. Based on hydrologic principles, some interaction with units below may be mediated by the low-permeability Kent till with low downward flow occurring near recharge areas in the west and discharge areas in the east along Buttermilk Creek. Discharge occurs at seeps along Buttermilk Creek (see Figure E–6) and downward to part of the underlying Kent till (WVNS 1993b, WVNS and Dames and Moore 1997). However, closer to discharge locations along Buttermilk Creek, some movement of groundwater upward from the Kent till and into the Kent recessional sequence likely occurs.

The upper interval of the Kent recessional sequence, particularly beneath the South Plateau, is unsaturated. However, the deeper lacustrine deposits are saturated and provide an avenue for slow northeast lateral flow to points of discharge (seeps) in the bluffs along Buttermilk Creek. The unsaturated conditions in the upper sequence are the result of very low vertical permeability in the overlying till, and thus there is a low recharge through the till to the Kent recessional sequence (Prudic 1986). As a result, the recessional sequence acts as a drain to the till and causes downward gradients in the till of 0.7 to 1.0, even beneath small valleys adjacent to the SDA (WMA 8) on the South Plateau (WVNS 1993b, WVNS and Dames and Moore 1997).

E.2.2.5 Kent Till, Olean Recessional Sequence, and Olean Till

Older glacial till and periglacial deposits of lacustrine and glaciofluvial origin underlie the Kent recessional sequence beneath the North and South Plateaus, extending to Upper Devonian bedrock (WVNS 1993a, 2007). The combined thickness of these units ranges from 0 feet to more than 300 (see Table E–1). The Kent till and Olean recessional sequence are exposed along Buttermilk Creek southeast of the Project Premises. The Kent till has characteristics similar to the Lavery till. The estimated thickness of the till is 100 feet with thinning to the west where the unit is truncated by the walls of the bedrock valley. Field hydraulic conductivity testing has not been conducted in the Kent till. The horizontal and vertical hydraulic conductivities are assumed to be approximately those of the lower values of the unweathered Lavery till. Groundwater movement through the low-permeability Kent till—sandwiched between the much more transmissive Kent and Olean recessional sequences—is likely vertical. Recharge is from the Kent recessional sequence.

The Olean recessional sequence underlies the Kent till and has characteristics similar to the Kent recessional sequence. The Olean recessional sequence is assumed to be a fully saturated unit and underlies the Kent till throughout most of the site with a thickness of approximately 30 feet, thinning out as it intersects the bedrock wall in the western portion of the site. The geohydrological properties of the Olean recessional sequence are assumed to be similar to those of the lower Kent recessional sequence.

Recharge is assumed to come from the Kent till above and move horizontally within the unit to the north and east toward eventual discharge down the valley from the site. (Note that the unit is exposed in the creek valley southeast of the site—upgradient as a result of placement on the valley head wall.) Some inflow from the west into the Olean recessional sequence is also likely by virtue of presumed contact with the (weathered) bedrock there. Also, some downward discharge from the unit into the Olean till likely occurs and upward discharge back into the Kent till and the Kent recessional sequence near its discharge locations may occur. The details of groundwater flow are uncertain because the configuration of the unit in the Buttermilk Creek Valley is unknown.

The Olean till contains more sand and gravel-sized material than the Lavery and Kent tills. The Olean till is exposed near the sides of the valley overlying bedrock (Prudic 1986). The sequence of older glacial till and recessional deposits ranges up to approximately 91 meters (299 feet) in thickness beneath the North Plateau. The Olean till is a fully saturated unit and underlies the Olean recessional sequence throughout most of the site area. The unit thins as it intersects the bedrock valley wall in the western portion of the site. The Olean till is assumed to be similar to the unweathered Lavery till. The vertical hydraulic conductivity is assumed to be equivalent to the horizontal values. The unit receives recharge from the Olean recessional sequence unit above and the groundwater moves in a vertical direction to the weathered bedrock below.

E.2.2.6 Bedrock

Bedrock underlying the Project Premises consists of Devonian shale and sandstone exposed in the upland stream channels along Quarry Creek northwest of the site, on hilltops west and south of the site, and in the steep-walled gorges cut by Cattaraugus Creek to the north and by Connoissarauley Creek to the west (Bergeron, Kappel, and Yager 1987). The uppermost bedrock unit in the vicinity of the Project Premises and SDA is the Canadaway Group, which consists of shale, siltstone, and sandstone and totals approximately 300 meters (980 feet) in thickness. The regional dip of the bedrock layers is approximately 0.5 to 0.8 degrees to the south (Prudic 1986, WVNS 1993a). Locally, measurements of the apparent dip of various strata and two marker beds in selected outcrops along Cattaraugus Creek recorded a dip of approximately 0.4 degrees to the west near the northern portion of WNYNSC (Vaughan 1993).

Regional groundwater in the bedrock flows downward within the higher elevation recharge zones, laterally beneath lower hillsides and terraces, and upward near major stream discharge zones. The upper 3 meters (10 feet) of bedrock in the shallow subsurface and in outcrop is weathered to regolith with systematically oriented joints and fractures. As observed in outcrop along Quarry Creek, the joints are not restricted to the upper 3 meters (10 feet) of the bedrock (Prudic 1986). They are developed throughout and continue at depth (Engelder and Geiser 1979). Recharge to bedrock is from precipitation on the upland areas west of the Project Premises (outside the model area).Wells completed in this zone yield approximately 40 to 60 liters per minute (10.6 to 15.9 gallons per minute).

Subsurface groundwater flow in the weathered bedrock follows the buried topography to the northwest. This flow is the subject of two reports. In 1994, Vaughan (Vaughan 1994) compiled the available basic geological and geohydrological information, and considered the possibility of hydrological connections between the bedrock aquifer and valley fill aquifer systems used by communities north of Cattaraugus Creek. Zadins (Zadins 1997) subsequently explored the questions raised by Vaughan. Working with available quantitative data, e.g., hydraulic gradients and unit elevations, the 1997 study concluded that such interaction is not very likely. Zadins also discussed the role of source location in the related issue of likely contamination of the bedrock aquifer, noting that the situation of source materials at the site is such that flow from contaminated areas is principally directed toward seeps and streams on site and away from the bedrock aquifer.

E.2.3 Flow Systems

Movement of contaminants in groundwater is largely controlled by the direction and speed of the groundwater. However, the groundwater is part of an interconnected flow system consisting of not only groundwater, but also surface-water bodies, recharge, and seepage. Therefore, to understand groundwater flow patterns, it is important to understand the other mechanisms associated with the flow systems and how they interact at the site.

E.2.3.1 Surface Water and Seepage Faces

WNYNSC lies within the Cattaraugus Creek watershed, which empties into Lake Erie about 43 kilometers (27 miles) southwest of Buffalo, New York. Buttermilk Creek, a tributary to Cattaraugus Creek, drains the site. The creek exists primarily within the Kent recessional sequence geologic layer, with a small portion in the upstream segment flowing through the Kent till. The older materials are exposed along the creek’s bed upstream because they were deposited on the upslope of the bedrock in the vicinity of the valley head, and hence, are tilted. Franks Creek joins Buttermilk Creek from the southwest approximately 3 kilometers (2 miles) upstream of the Cattaraugus-Buttermilk confluence. In this area, Franks Creek flows through the Kent recessional sequence. However, the majority of the creek in the vicinity of WVDP lies within the Lavery till. The drainage area for the site is about 13.7 square kilometers (5.3 square miles) and the total Buttermilk Creek drainage area is 79 square kilometers (29.4 square miles).

Quarry Creek and Erdman Brook are two important tributaries to Franks Creek because of their proximity to WVDP. Quarry Creek drains the largest area north and west of the active site operations, while Franks Creek and Erdman Brook drain the majority of the plant area, NDA and SDA to the south. Both tributaries exist primarily within the Lavery till. However, portions of Quarry Creek do flow through areas of exposed bedrock. In addition to the streams described, there also exist a number of natural swamps and ponds within the site. Manmade water bodies consisting of drainage ditches and holding lagoons also have been constructed at the site. In other areas, facilities eliminate or reduce infiltration, and hence, recharge to the groundwater system. These features, natural and manmade, and the streams shown on **Figure E–9** are the surface hydrological features interacting with the groundwater system at the site.

Figure E–9 Site Surface Hydrology

All the creeks and brooks of interest at WNYNSC have seen very high levels of streambank erosion over the years. This has resulted in very steep slopes in the vicinity of each stream, yielding a set of observable seepage faces on the North Plateau occurring near the interface of the permeable surficial sand and gravel and the low-permeability till underneath. These perimeter seeps occur on three sides of the plateau and have a profound influence on the near-surface groundwater hydrology in that area. The locations of observed seeps are indicated on **Figure E–10**.

There has been some characterization of seeps at the site as a result of a 1983 field investigation by the U.S. Geological Survey. The results of these analyses are presented in **Table E–2**. Kappel and Harding (1987) and others (Yager 1987; Bergeron, Kappel, and Yager 1987) summarize various aspects of the investigation, describing both locations and flows recorded for each face during the investigation. They also report stream-discharge data collected at three continuous record stations (Lagoon Road, NP-1 and NP-3) and one partial record station (NP-2). Locations of the recording stations are also indicated on Figure E–10. Estimates of the discharge from springs and seepage faces along the northeast and northwest sides of the 42 hectare North Plateau, which drain to Quarry and Franks Creeks, indicated a total discharge of 20 cubic meters per day or an average application of 1.8 centimeters per year normalized to the surface area of the thick-bedded unit (Kappel and Harding 1987). Estimating the flow into Erdman Brook from the Main Plant Process Building at 500 cubic meters per day, Yager also indirectly quantified the amount of discharge from the North Plateau into Erdman Brook as 180 to 260 cubic meters per day (16 to 23 centimeters per year) (Yager 1987).

The flows reported for the Erdman Brook seeps by Kappel and Harding (1987) are much lower. These authors estimate the seepage flow into that stream to be 10 cubic meters per day. One possible explanation for the large difference in the two estimates may lie in the indirect approach used by Yager and in particular, the need to subtract one large number (the estimated flow from the plant) from another (flow in Franks Creek).

The flows shown in Table E–2 are used in the calibration of the present groundwater model in Section E.3.5.

Table E–2 Observed Seep and Stream Flows

Location	***Observed Discharge (cubic meters per day)***
NP-1	29
NP-2	6
NP-3	113
NP – Total	148
Quarry Creek and Franks Creek	20
Erdman Brook (Yager estimate)	220 (180-260)
Erdman Brook (Kappel and Harding estimate)	10
French Drain (Kappel and Harding estimate)	23
Total	388 (178[a])

[a] Total using Kappel and Harding flow for Erdman Brook.
Note: To convert cubic meters per day to cubic feet per day, multiply by 35.314.

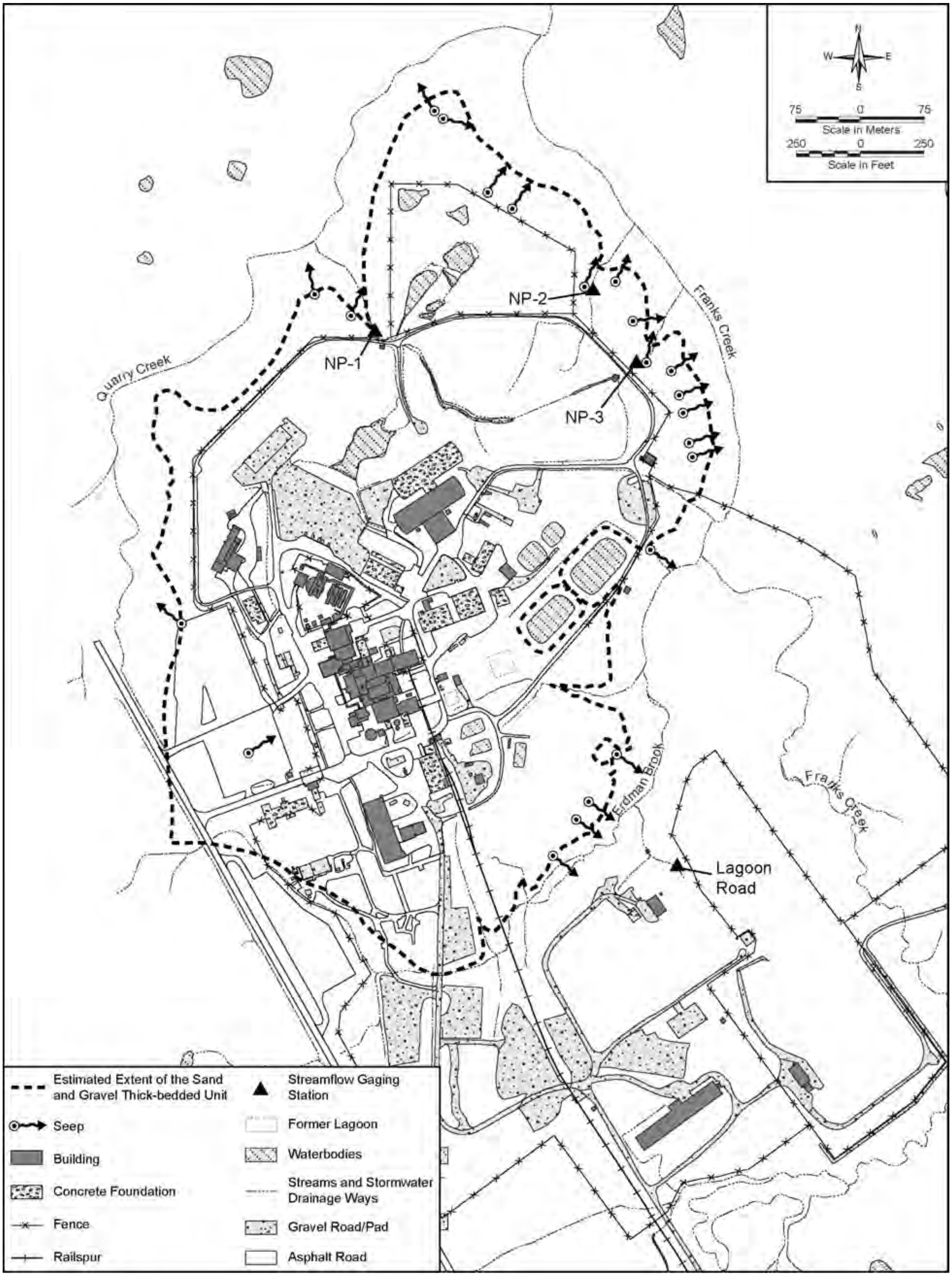


Figure E–10 Locations of Perimeter Seeps and Stream Gauging Stations for the North Plateau

E.2.3.2 Groundwater

Regional and Site Groundwater Flow

The groundwater flow system at the site is part of a larger uplands-valley flow system; the flow of water entering the system is downward in the uplands recharge areas, lateral in the hillsides and terraces, and upward near major streams (Prudic 1986). The hills lying west of the site are the uplands recharge area, and Buttermilk Creek is the major stream. The site model (FEHM) and the area models (STOMP) are situated in lower areas.

The uplands-valley view is an abstraction, and hence, flow is not necessarily vertical or lateral in all locations, highlands or lowlands; discharge does not necessarily occur along the entire reach of the creek; and local geology contributes its own modifications to local flow patterns. This is particularly the case at the site with its composite glacial geology characterized by a juxtaposition of materials with strongly contrasting geohydrological properties.

Considering the valley fill, two broad classes of materials coexist at the site—moderate- to high-permeability sands and gravels, and lower-permeability clay-silt tills. The alignment of groundwater flow through the low-permeability materials tends to be vertical (up or down)—the materials largely serving to conduct flow from one of the more-permeable units to another. As a general rule, flow through the more-permeable units will tend to be horizontal—that material being able to sustain high flow volumes. Thus, even though the site lies in the lower hillside regime, largely vertical flow through the till unit is expected and observed.

The unweathered bedrock occurs throughout the uplands-valley conceptual model. The bedrock consists of horizontal beds of shales and sandstones. Flow in this unit is mostly constrained to shale beds exhibiting horizontal fracturing and to sandstones. Functionally, this unit, along with the weathered bedrock, provides water to the western boundary of the site flow system. In the case of the former, flow is deep inflow from competent bedrock off site to competent bedrock on site. However, the weathered bedrock occurs very close to the surface along the western (hillside) boundary. Inflow at that boundary is to the (shallow) weathered bedrock of the site flow system and to a veneer of valley fill materials—e.g., thick-bedded unit sands and gravels—at the surface of the site flow system. There are three key conceptual points to keep in mind: 1) as formulated, groundwater flow into the site from the west is entirely via bedrock—weathered and unweathered; 2) the boundary between the uplands and the site is imaginary in the sense that there are no differences in the corresponding materials on either side; and 3) significant additional recharge to the site does occur as a result of the infiltration of precipitation.

Groundwater Flow Systems at the Site

The hydrostratigraphic units found at the site were described in Section E.2.2, along with an overview of the groundwater flow in each. In this section, additional discussion of groundwater flow is provided. The paragraphs that follow provide a composite description of flow at the site as extracted from the results and interpretations found in previous modeling studies of groundwater subsystems at the site (Bergeron and Bugliosi 1988, Kool and Wu 1991, Prudic 1986, Yager 1987). The groundwater flow system near the surface in the vicinity of the site consists of two aquifers, separated by an unsaturated zone. Both of these aquifers appear on Figures E–5 and E–6. The upper aquifer exists within the thick-bedded unit/slack-water sequence and Lavery till (weathered and unweathered). The upper aquifer is unconfined and is primarily fed by infiltration coming from precipitation and from surface-water bodies. In addition, some inflow likely occurs into the thick-bedded unit where it interfaces with weathered bedrock at the western edge of the site near Rock Springs Road. The quantity of water coming into the thick-bedded unit from the bedrock has not been well characterized.

Permanent unconfined conditions extend over much of the unit. Groundwater exits the upper aquifer primarily through seeps, discharge into surface water, and some evapotranspiration. The material directly beneath the thick-bedded unit and slack-water sequence is the low-permeability unweathered Lavery till. Vertical flow through the till appears to be limited because of its low hydraulic conductivity, and hence, flow within the saturated zone of the upper aquifer is predominantly horizontal.

The physical basis, and therefore, the behavior of the flow in the southern portion of the upper aquifer is quite different. Here, the aquifer material overlying the unweathered Lavery till is weathered Lavery till. The weathered Lavery till is less permeable and thinner than the thick-bedded unit. Infiltration into the weathered Lavery till is much reduced compared to the thick-bedded unit. In addition, the shallowness of the weathered Lavery till means that the upper aquifer is more susceptible to changes in topography. These factors lead to a picture of a highly variable saturated flow regime sensitive to climatological and hydrological stresses. As such, it is difficult to quantify and is difficult to model in detail. The current model, like previous models (Bergeron and Bugliosi 1988, Kool and Wu 1991, Prudic 1986), reflects this characteristic. While there is some lateral component to the flow in the weathered Lavery till, discharge to surface water is limited to those areas close to the discharge locations, and much of the water entering the system as infiltration will move downward. Wet periods do lead to more potential for lateral flow and discharge at the surface.

Much less is known about the lower aquifer, which is also a water table aquifer. It is situated within the Kent recessional sequence below the unweathered Lavery till. This aquifer has not been previously modeled and its behavior has been inferred from available groundwater monitoring and log data, expert opinion, and analogy with the thick-bedded unit, a unit having similar origins and composed of similar materials. The Kent recessional sequence water table likely exists due to a combination of low infiltration from above through the unweathered Lavery till and a source inflow from the weathered bedrock where the Kent recessional sequence and weathered bedrock interface (Prudic 1986)—a situation analogous to that of the thick-bedded unit in the upper aquifer.

Lying between the bottom of the upper aquifer and the unsaturated top of the lower aquifer, much of the unweathered Lavery till is saturated. Given these circumstances and the low permeability of the unweathered Lavery till, flow through that unit is essentially vertical.

Other, deeper aquifer systems may exist at the site and in the Buttermilk Creek Valley. Little is known about the Olean materials, although the present model does have a recessional unit analogous to the Kent recessional sequence. The possibility of a continuous weathered bedrock aquifer has been considered. In a white paper, Zadins (Zadins 1997) summarizes this work and examines the question of connection with the Springville aquifer further to the north. The physical extent of the present model allows some rudimentary examination of the impacts of the deeper extended geohydrological units through the manipulation of the boundary conditions of those units involved.

Figure E–7 summarizes all of the aquifer systems discussed in the preceding paragraphs, relating known and assumed flows into and out of each system.

Groundwater level data dating from 1990 to the present are available for both WVDP and SDA wells. Since 1995, these data have been collected on a quarterly basis. Additional data are available at other well locations established for special projects. Water-level data are collected and maintained in the site's Laboratory Information Management System for over 220 locations, and provide well elevation information for all of the principal units (thick-bedded unit and slack-water sequence, weathered Lavery till, unweathered Lavery till, Lavery till-sand, and Kent recessional sequence). This number includes locations where monitoring has been discontinued. **Figures E–11** and **E–12** show the fourth quarter 2007 groundwater contours for the upper aquifer at the North Plateau and the WVDP areas of the South Plateau, respectively. Levels for the SDA are monitored and reported annually by New York State independent of WVDP reporting. Contours based on posted water levels in the vicinity of the SDA have been added to Figure E–12.

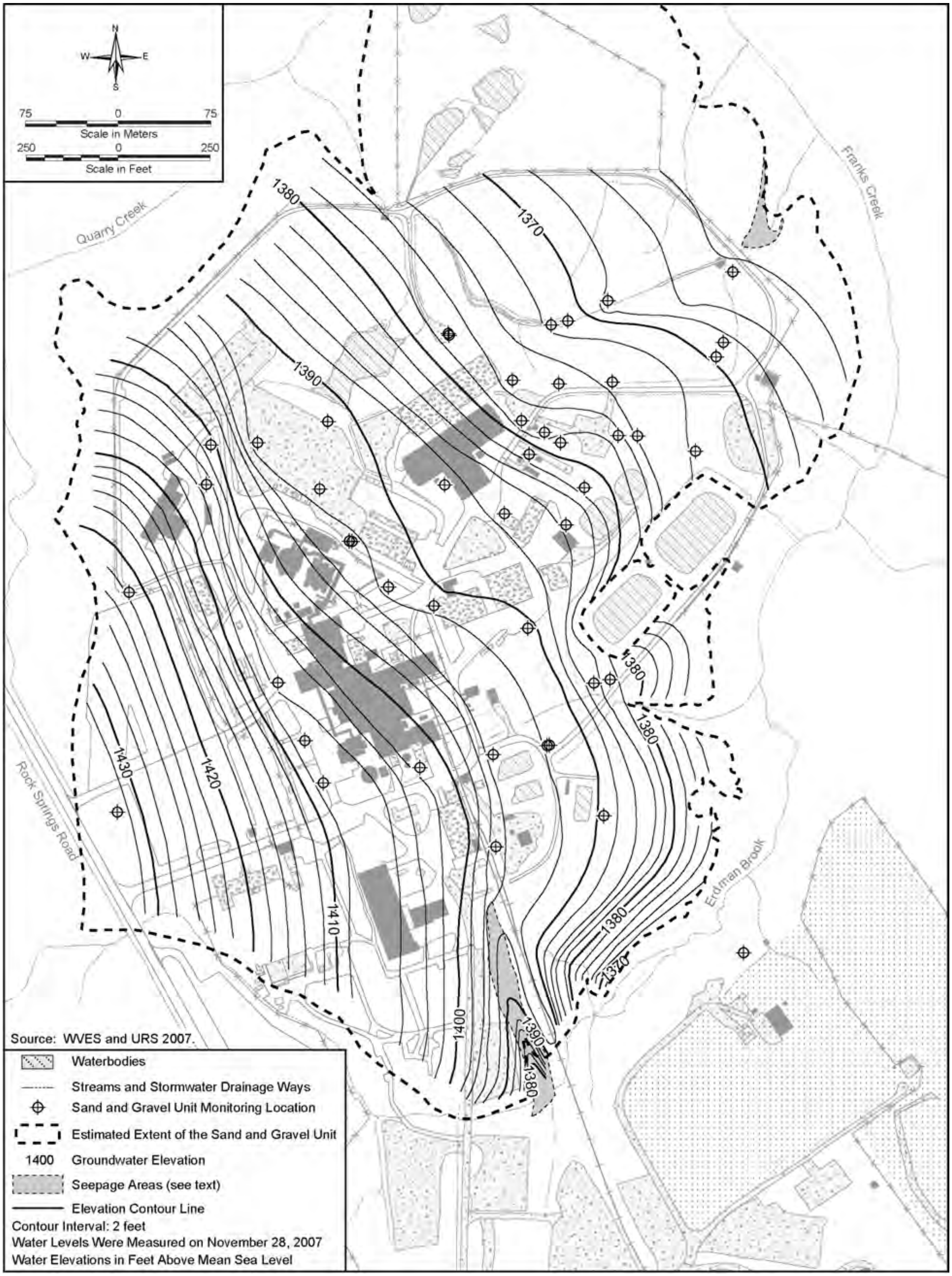


Figure E–11 Fourth Quarter 2007 the Surficial Sand and Gravel Aquifer Groundwater Levels

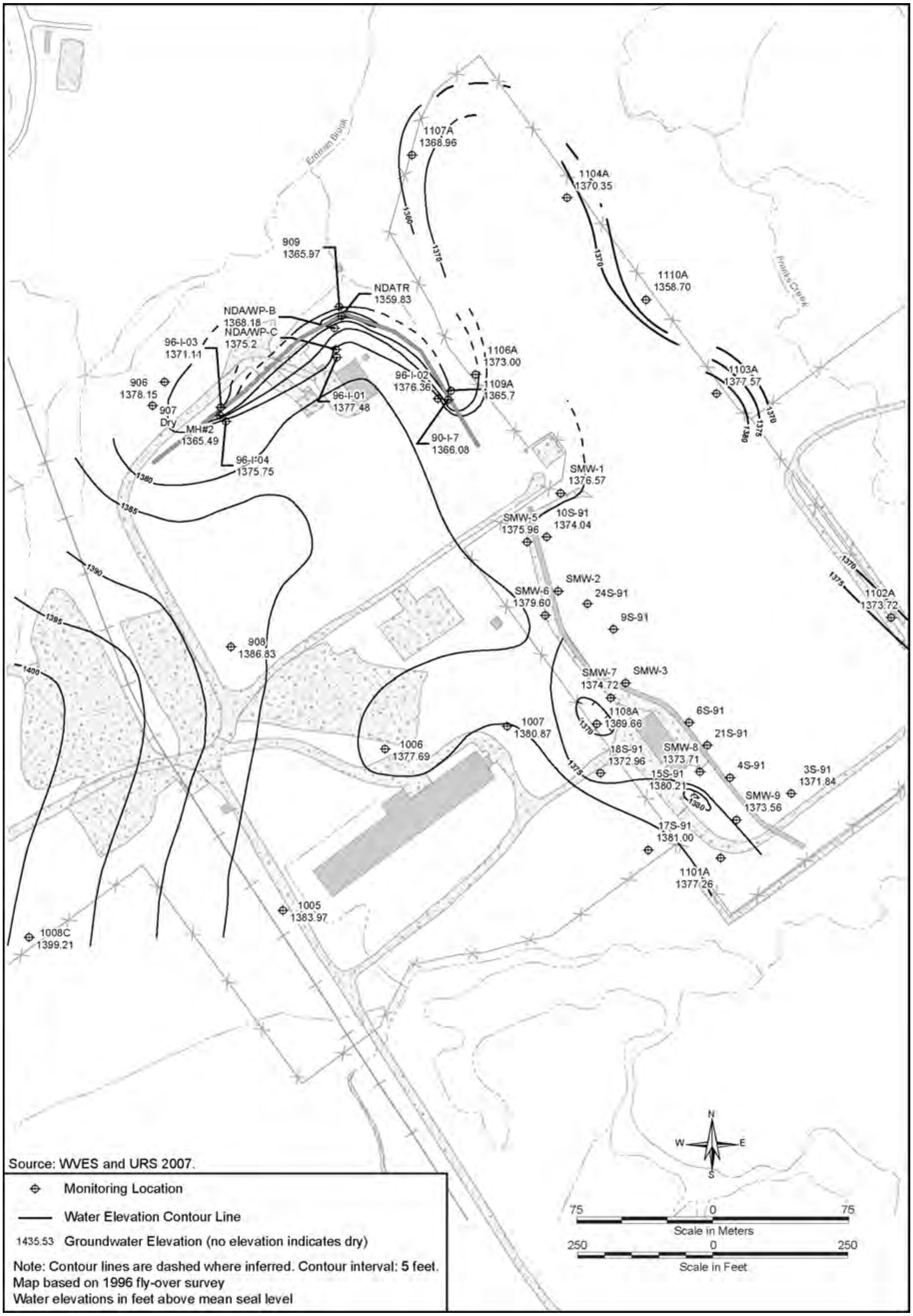


Figure E–12 Fourth Quarter 2007 South Plateau Groundwater Levels

The data were examined using both seasonal trend analyses and hydrographs to identify wells that had a trend over time and those that did not show a trend. Based on these analyses, a set of non-trending or low-trend wells was determined for use in initial model calibration in Section E.3.

E.2.3.3 Water Balances

Water balances have been estimated for the surficial sand and gravel unit. Using data developed by Kappel and Harding (Kappel and Harding 1987), Yager developed a two-dimensional numerical model for the 42-hectare surficial sand and gravel unit on the North Plateau for the year 1983 (Yager 1987). As a part of the study, Yager developed water budgets for the sand and gravel unit—one from the data and one from the model. Using the data of Kappel and Harding, the total annual recharge to the sand and gravel unit was 66 centimeters per year with approximately 50 centimeters per year from precipitation, 12 centimeters per year from inflow from adjacent bedrock near Rock Springs Road, and 4 centimeters per year from leakage from the Main Plant Process Building's outfall channel discharging into Erdman Brook. The estimated total discharge was less at 59 centimeters per year. Discharge to seeps and springs accounted for 21 centimeters per year, streams and channels 13 centimeters per year, discharge to the French drain (now closed off) and low-level radioactive waste treatment system 2 centimeters per year, evapotranspiration 18 centimeters per year, vertical leakage into the Lavery till 1 centimeter per year, and change in storage 4 centimeters per year. This water balance was calculated using the larger estimate, 220 cubic meters per day, for the seepage flow to Erdman Brook discussed in Section E.2.3.1.

Yager's steady-state flow model water budget estimated a total recharge of 60.1 centimeters per year with 46.0 centimeters per year from the infiltration of precipitation, 10.4 centimeters per year from the bedrock inflow, and 3.7 centimeters per year from the outfall leakage. Model-derived discharge estimates from the sand and gravel for evapotranspiration were 20.0 centimeters per year, stream channels 12.2 centimeters per year, French drain and low-level radioactive waste treatment system, 4.3 centimeters per year, and seeps and springs, 23.5 centimeters per year. The net recharge to the water table is the precipitation less the evapotranspiration or 26.0 centimeters per year. Agreement between this water budget and the data-based water budget is good.

In 1993, seasonal fluctuations from 35 wells installed in the sand and gravel unit were used to arrive at a spatially averaged annual recharge to the North Plateau (WVNS 1993b). The estimated recharge was 17.3 centimeters per year. The difference between this value and the recharge derived by Yager was attributed to differences in the hydraulic conductivities used in the calculations—Yager's model hydraulic conductivities (~0.001–0.01 centimeters per second) being greater by approximately an order of magnitude. The differences in saturated hydraulic conductivity are particularly interesting in the present context, where analyses of all of the sand and gravel results collected through 2004 suggest that determinations made for those materials from 1989 to 1999 may be systematically too low—see the discussion in Chapter 3, Section 3.4, of this EIS.

In a review of the 1993 report, Yager notes also that the 1993 calculations do not consider the effects of groundwater discharge from the North Plateau and hence, underestimate the recharge (Yager 1993). Also in 1993, water budget and hydrological analyses for the North Plateau arrived at a total steady-state annual precipitation of 100.1 centimeters per year; runoff, 25.5 centimeters per year; infiltration, 74.7 centimeters per year; drainage below 4 meters (recharge), 15.8 centimeters per year; and evapotranspiration, 56.0 centimeters per year (WVNS 1993c). The estimate, 15.8 centimeters per year, of the recharge from precipitation in this study is also significantly less than those made by Yager—50 centimeters per year and 46 centimeters per year. Yager's 1993 review suggests that the runoff may have been overestimated and recharge underestimated in these calculations (Yager 1993). Other analyses performed in the study produced North Plateau recharge estimates in the range of 5 centimeters per year to 12 centimeters per year (WVNS 1993b).

The 1993 analyses also provided water balances for the South Plateau, i.e., weathered Lavery till surface. In those analyses, infiltration at the surface was estimated to be 7.37 centimeters per year. Of that amount, 1.27 centimeters per year move vertically down into the unweathered Lavery till and 6.1 centimeters per year flow laterally, discharging into nearby streams or seeps.

E.3 Groundwater Flow Model

There were several objectives in the development of the present model:

- Examine how regional flow dynamics directly affect the flow patterns at the site.
- Provide context and guidance in the development of submodels used to evaluate EIS alternatives, e.g., models for groundwater flow in the thick-bedded unit and slack-water sequence.
- Examine the validity of approximations used when developing submodels for specific areas on the site—both in a historical context and for EIS alternatives.
- Consider alternative conceptual models.

There is overlap in the objectives as stated. In the most direct context there is the need to develop models for use in evaluating EIS alternatives. However, review and discussion during the EIS process have also pointed to a need to examine the bases and limitations of models that have been used and are being developed. In addition, groundwater flow and transport modeling has evolved significantly over the past two decades. A significant trend is the move from deterministic models to stochastic models (Yoram Rubin's *Applied Stochastic Hydrogeology* provides a comprehensive overview of stochastic groundwater modeling), the present model is deterministic; thus, the development of such a model in the present case had to be considered. The current view is that the essential need is to reasonably discriminate between alternatives, thereby informing the decision process, and that deterministic models coupled with sensitivity analyses are sufficient.

An important question that must be resolved is whether a single model is sufficient to model flow or even subsystem flow. In some cases, two or more models of a system lead to equally acceptable representations of the system's behavior (known as equifinality). This situation often arises as the complexity of the modeled system increases. In these circumstances, an understanding of all model uncertainties is essential to the assignment of equal behavior. These uncertainties include system conceptualization, structural uncertainty, uncertainties in model parameter values and uncertainties associated with the algorithms and implementations of the model. The geohydrology at the site is complex and the physical extent of the present model allows for some examination of all of these factors short of a full evaluation of uncertainty using formal methodologies such as, for example, the Generalized Likelihood Uncertainty Estimation (Beven 2006).

The current model encompasses a larger area than previous models. The lateral extent of the model at the surface roughly includes both the North and South Plateaus and extends eastward from the vicinity of Rock Springs Road to Buttermilk Creek. In the vertical dimension, the model extends into the bedrock. This model domain was chosen based on the preceeding considerations and based on discussion with professionals working on the project. Natural boundaries were chosen whenever possible.

This model domain incorporates not only the thick-bedded unit/slack-water sequence and unweathered Lavery till used in previous site models, but also adds the Kent recessional sequence, Kent till, Olean recessional sequence, Olean till, weathered bedrock, and bedrock. Choosing a model boundary above the bedrock assumes knowledge of the conditions at the intersection of the model layers, which is an approximation often made to reduce the computational time required to solve the problem. However, in light of present computer capabilities, the increased computational effort is justified by the possibility of insight gained in the larger domain and the need to explore the effects of deeper units, even if demonstrated to be negligible.

The model was setup and run to a steady-state solution. The assumption that the system is in a “steady state” is clearly an approximation that is further addressed in the results. The remainder of this section provides a discussion overview of model implementation and calibration, base case results, and sensitivity analyses.

E.3.1 Model Boundaries

The boundaries are the locations that define the physical extent of the model. Calculations are completed inside the domain, and the boundary supplies the interface with the model calculations and the known or presumed field conditions. In the present model, the project geohydrologist, engineers, and physicists interpreted and fused both the field data and the local geological interpretations into a conceptual site model that supports definition of the numerical model boundaries:

- **Northern Boundary**. The western side of the northern boundary is located along Quarry Creek. As the boundary moves eastward, it intersects and follows Franks Creek after the latter’s confluence with Quarry Creek. The boundary then extends along Franks Creek to where it joins Buttermilk Creek.
- **Western Boundary**. The western boundary roughly follows the 440-meter (1,450-foot) surface contour. It is also near, and runs approximately parallel to, Rock Springs Road, extending from the vicinity of Quarry Creek in the north to the upper Franks Creek drainage.
- **Southern Boundary**. Beginning at the western boundary, the southern boundary follows the west-east-trending reach of Franks Creek immediately south of the South Plateau until that creek bends north into the interior of the model. At that point, the boundary becomes an imaginary line extending east perpendicular to Buttermilk Creek.
- **Eastern Boundary**. The eastern boundary is defined by Buttermilk Creek.
- **Top of Model Domain**. The upper surface of the model domain is the ground surface.
- **Bottom of Model Domain**. The bottom of the model is located at an elevation of 160 meters (525 feet) above sea level. The model bottom is assumed to be a no-flow boundary, i.e., there is no vertical flow across this boundary.

E.3.2 Description of Model Grid

A plane view of the finite-element grid used for the model is shown on **Figure E–13**. The grid blocks are of uniform dimension in the x-y plane with each side having a length of 43 meters (140 feet). The irregular shape of the grid results from the boundaries of the model following the natural boundary lines (such as the creeks) described in the previous section. Each grid block has one node located in the center of the block, resulting in 955 nodes per model layer.

For the vertical discretization of the grid, the topographic surface is the upper boundary and the base of the bedrock is the lower boundary. The domain was broken up into 23 model layers to adequately represent the varying thicknesses of the 10 geologic materials found at the site. To avoid convergence problems in the simulations, the change in vertical discretization in moving from one model layer to an adjacent layer at any location was kept at or below 1.5 feet (0.5 meters). There are a total of 21,965 nodes in the model with 955 nodes in each model layer.

Figure E–14 shows a schematic representation, aligned west to east through the North Plateau of these geologic layers. In the figure, the geologic unit occurs in one or more horizontal regions, delineated by heavy horizontal lines. Each of these regions corresponds to one or more of the model layers, indicated on the far left side of the figure. However, the layers in the model are neither horizontal nor uniform in thickness, but instead change in elevation and thickness to better capture the disposition of the geologic units at the site. In addition, some features shown on Figure E–14 do not occur throughout the entire extent of the site or model.

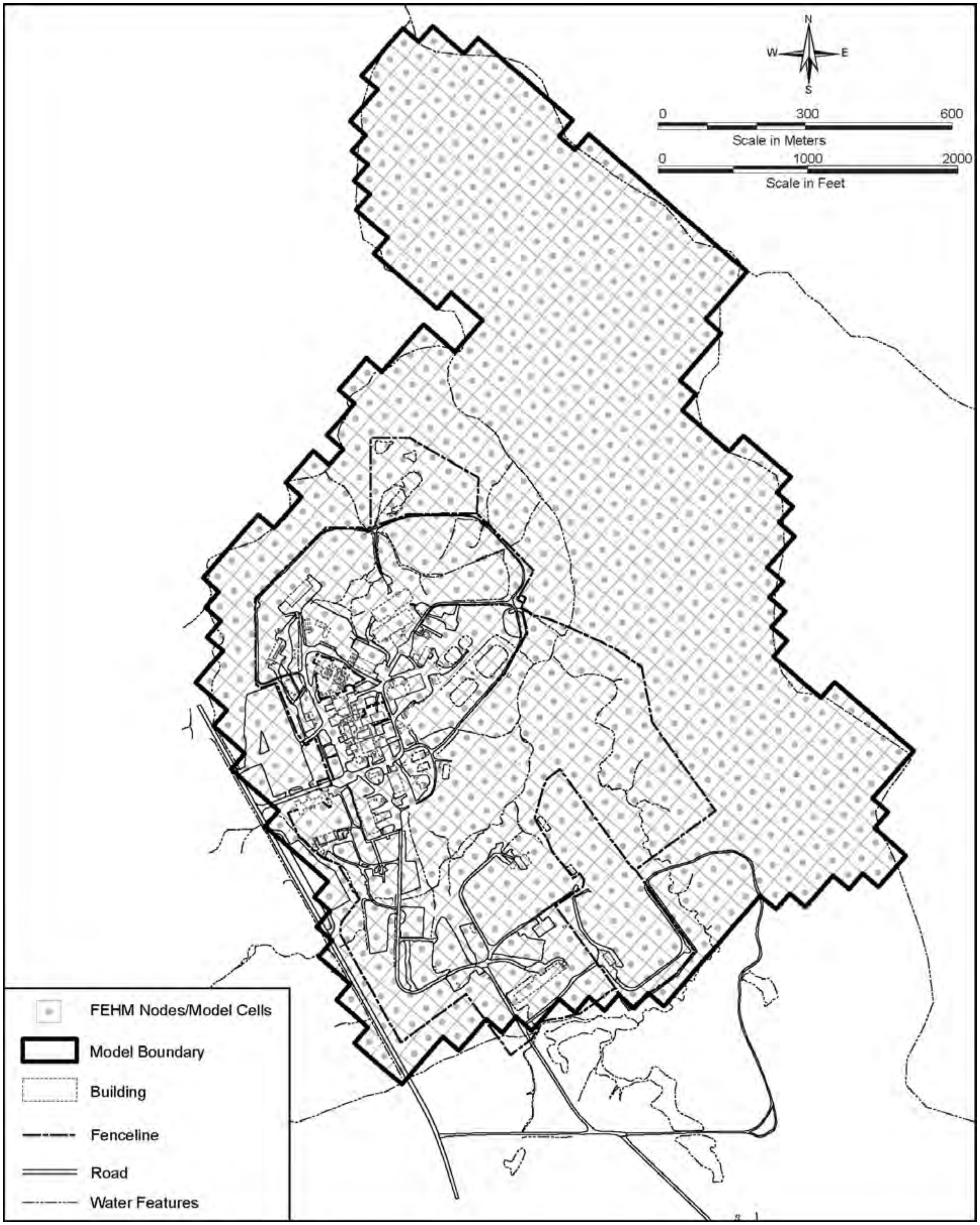


Figure E–13 Plane View of Model Domain and Grid

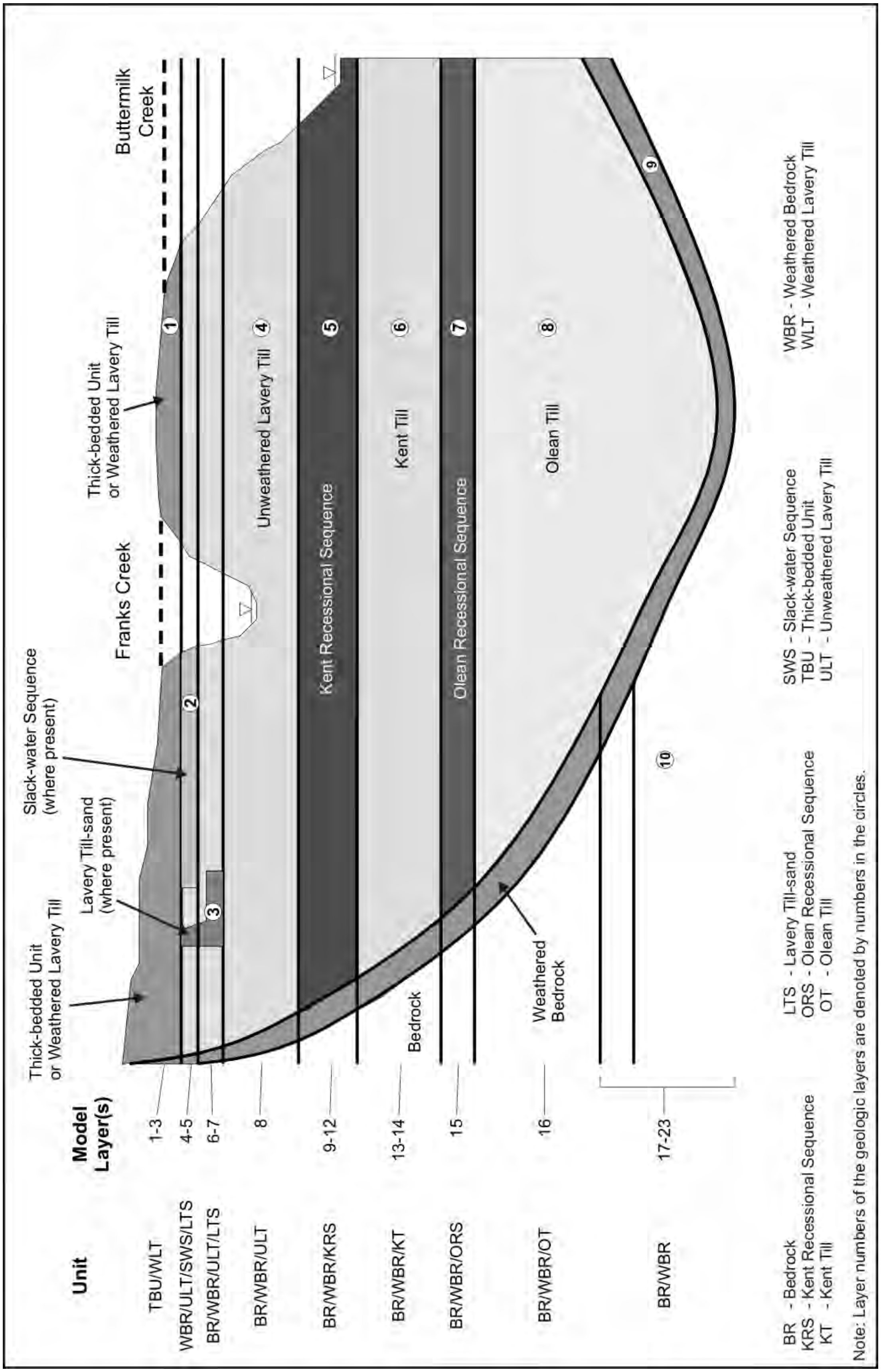


Figure E–14 Schematic Representation of the Geologic Model in the Vicinity of the North Plateau

As examples, the bed of Buttermilk Creek is situated in geologic units other than the Kent till for different reaches along its course, and the Lavery till-sand is limited in extent to a portion of the North Plateau.

The creeks at the site are sharply incised and have very steep stream banks. Because numerical considerations require model layers to be reasonably level, some parts of the upper layers were extended by necessity across these stream banks, creating nodes that are located "in the air." These nodes are effectively inactive and, though not removed from the total node numbering, are not a part of the study area.

E.3.3 Boundary Conditions

To accurately simulate the hydrogeological conditions, the boundary conditions have to be properly defined. The numerical model uses Dirichlet (specified head), Neumann (specified flux), and Cauchy (variable) boundary conditions to simulate groundwater flow into or out of the modeled area. The boundary conditions imposed for the base model are qualitatively described in this section.

The upper surface of the model consists of flux boundary conditions applied over areas receiving a net infiltration, determined by slope and groundcover, in addition to a variety of boundary conditions depicting other hydrologic influences such as surface-water bodies, seeps, and inflow from the weathered bedrock. These boundary conditions are indicated on **Figure E–15**. In this figure, grid cells with a heavy border denote constant head conditions, grid cells with small squares denote seepage faces, and shaded cells denote fluxes into the model. Also, nodes where thick-bedded unit inflow occurs are modeled as flux nodes; crosses are used to denote these nodes. No-flow conditions exist along the boundaries where there are no seep or constant head designations. Seepage nodes exist along much of Erdman Brook, and Franks, Quarry and Buttermilk Creeks consistent with seepage observed along the steep banks of those streams and discussed above. Some nodes along Quarry Creek and Franks Creek are modeled as constant head nodes with the head values approximated by the surface elevations at those locations. The averaged net infiltration for the thick-bedded unit is 27.1 centimeters per year, a value close to the 26.0 centimeters per year used by Yager (Yager 1987). The uniform infiltration into the weathered Lavery till is 2.5 centimeters per year.

The initial estimate of the total inflow into the thick-bedded unit along the western boundary (shown by the x marks on Figure E–15) was the 142 cubic meters per day used by Yager (Yager 1987). Model runs with that value subsequently indicated that this inflow was excessive, with the result that the predicted heads of wells (thick-bedded unit and Lavery till-sand) in the vicinity of the Main Plant Process Building were too high. The inflow was gradually reduced eventually to a value of 20 cubic meters per day, where the impacted heads appeared reasonable. Independent uncertainty calculations used estimated "low-medium-high" distributions for key parameters used by Yager to make his estimate for the inflow (hydraulic conductivity, height and length of the bedrock thick-bedded unit interface, hydraulic gradient, and porosity of the thick-bedded unit) provided an estimated average inflow of 50 cubic meters per day and a median inflow of 37 cubic meters per day. The 5^{th} and 95^{th} quantiles were 12 and 150 cubic meters per day, respectively.

The unweathered Lavery till constitutes model layers 4 through 8 (see Figure E–14). Much of the western and southern boundaries for this layer is considered to be no-flow, predicated on the assumption of vertical movement through this unit. Boundary conditions along Franks and Quarry Creeks vary based on model layer. Areas above the creeks receive seepage conditions. When the creek falls within the model layer, a constant head condition is used. Nodes located within the unweathered Lavery till below Quarry Creek and the lower reach of Franks Creek (after the confluence with Quarry Creek) are considered no-flow to account for the vertical flow up into the creek or the vertical movement downwards described previously. Finally, seepage faces exist along the entire eastern boundary of the till to account for observations of water seen along the Buttermilk Creek Valley.

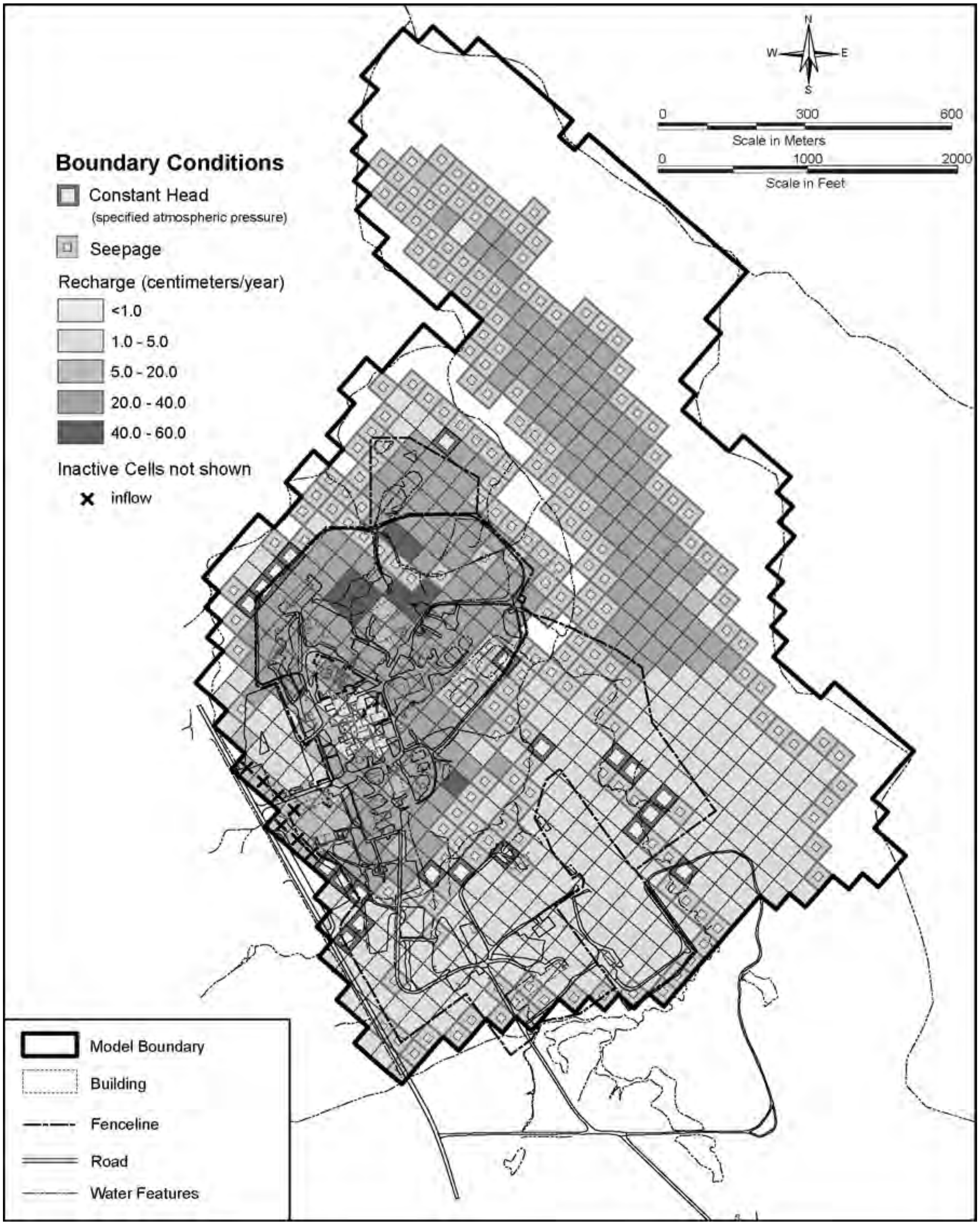


Figure E–15 Surface Boundary Conditions for Model

Model layers 9 through 12 are made up of bedrock along the western boundary and Kent recessional sequence along the remaining boundaries. A no-flow boundary condition is imposed along the western boundary. The southern boundary and portions of the northern boundary (Kent recessional sequence) are also set as no-flow boundaries. The remaining boundaries vary based on model layer. Areas above the creeks receive seepage conditions. When the creek falls within the model layer, a constant head condition is used. Nodes within the Kent recessional sequence that fall below the lower reach of Franks Creek along the boundary are considered no-flow to account for vertical flow up into the creek.

Layers 13 and 14 are composed of bedrock and Kent till. Flow is considered to be vertical through both of these units and hence, a no-flow condition is imposed at most locations along these boundaries. The only exception is the southeast corner of the model, where Buttermilk Creek intersects the unit. There, a constant head boundary condition is imposed in layer 13.

No-flow boundary conditions are applied along the entire perimeter of layer 15, consisting of the Olean recessional sequence and bedrock. The western boundary exists within the bedrock and groundwater flow is presumed to be vertical. The remainder of the boundary lies within the Olean recessional sequence. Little is known about the direction of flow within the Olean recessional sequence. The present base case model assumes that flow in the Olean recessional sequence is mostly vertical and thus, no-flow conditions are imposed for this layer along its perimeter.

Beginning in layer 16 and continuing in layer 17 and below, a constant head condition was applied along the western boundary of the model where those layers consist of bedrock. Formulated as the model evolved, this boundary condition was a key to achieving water levels near observed values in the Kent recessional sequence. The boundary condition is tied to an assumption that the water table existing within the Kent recessional sequence (to the east of the model boundary) occurs approximately 3 meters (10 feet) below the unit's highest and westernmost extent on the bedrock valley upslope. To simulate that condition, a constant head condition was imposed at the model boundary (bedrock) directly west of the elevation of the Kent recessional sequence top less 3 meters (10 feet) (**Figure E–16**). Due to the variation in the Kent recessional sequence top elevation, the constant head boundary condition was applied as appropriate in either layer 16 or 17. Horizontal movement is assumed for the regional aquifer to the west of and outside the site model, and the boundary conditions along that boundary remain constant at the upper elevation for the remaining deeper layers.

In the base case model, groundwater can effectively exit the system only by discharge to streams or seeps at the surface. However, there is some discussion in site literature of the weathered bedrock on site being part of a larger valley-wide weathered bedrock aquifer flowing to the north with discharge to Cattaraugus Creek or locations beyond (Zadins 1997). One of the primary uses of the present model is to examine alternative conceptual formulations. Related to this is a need to examine error in smaller, more-manageable models based on surface and near-surface units and decoupled from the deeper geology on site. Therefore, an important sensitivity case boundary condition exists for layer 17. In an alternative conceptual model, the assumption is made that water flows down through the weathered bedrock until it reaches the bottom of the bedrock valley. It then moves northward in the direction of the bedrock valley trough. This flow is implemented in a sensitivity (or equifinality) case below, as a constant head condition where the trough exits the northern boundary of the model. The constant head at each exit node is set equal to the elevation of the node.

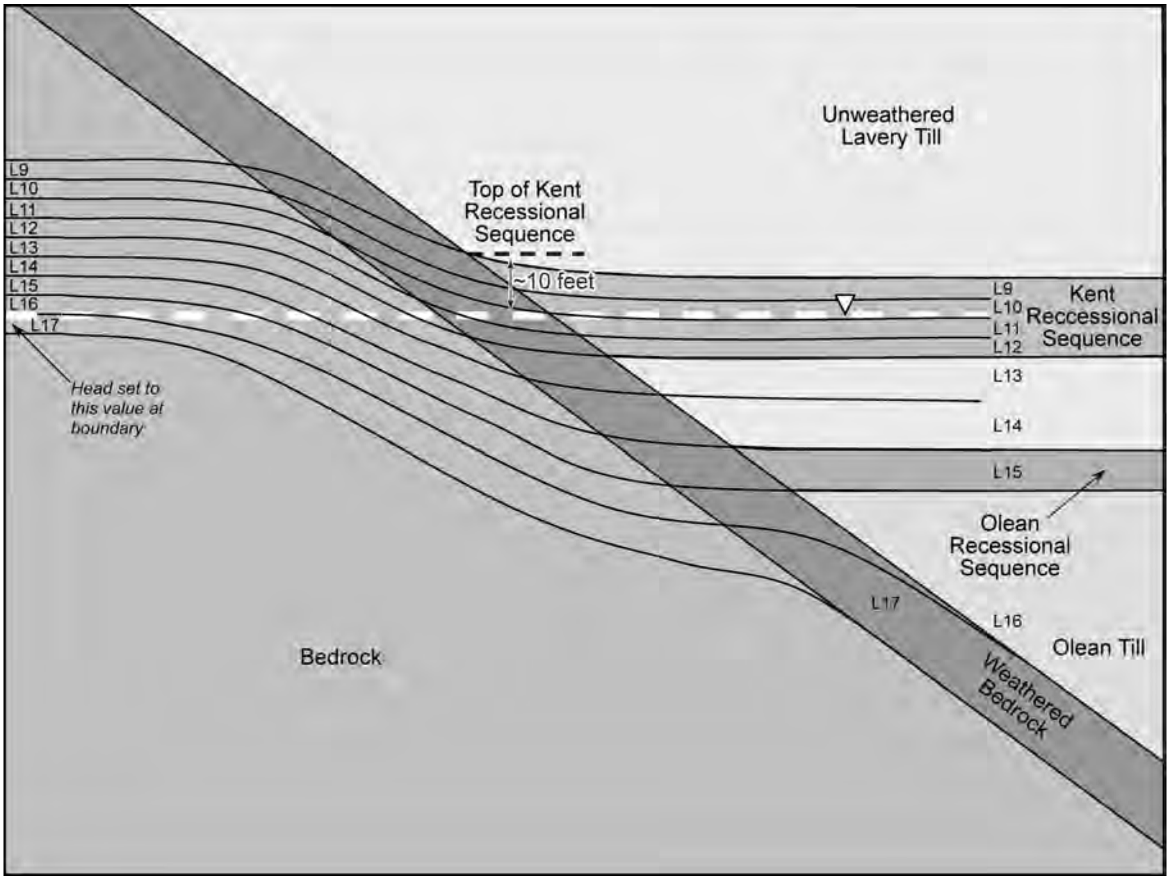


Figure E–16 Boundary Condition Set Relative to Top of the Kent Recessional Sequence

E.3.4 Input Parameters

This section provides a summary characterization of the physical properties of those materials that make up the geohydrological units found at WNYNSC. Estimates of the properties are needed as input for all of the models used in this EIS to quantify the flow of groundwater and transport of contaminants at the site.

By nature, each property described in this section is a distributed property. That is, the property's value varies from one location to another location. In models that approximate natural processes, these properties can be treated as either distributed or lumped (point-value), i.e., characterized by a single value. Statistical characterizations in terms of means, medians, and other statistics, provide lumped parameter estimates, and geostatistical models provide spatially distributed estimates. The ability to develop the latter is at times constrained by the number of observations available, and/or by the distribution in space of those data. Site data are extensive in number but often are 1) the result of focused directed investigations, or 2) the product of routine monitoring at widely separated locations. Such data are informative for characterization but are not complete. Data sources used for the present compilation include both literature sources, typically appearing as document references in this appendix, and electronic data obtained from the site Laboratory Information Management System and provided by site personnel.

Reviews of site stratigraphy data and all well screening interval data came in the early phases of the modeling—before the quantitative characterization of hydraulic conductivities and before the determination of best target water levels for use in model calibration. A rating system was developed in which data from wells screened entirely in a single geohydrological unit were rated high, whereas data from wells screened in more than one unit were rated lower, the exact rating depending on the relative amount of screening in each unit, the relative hydraulic conductivities geologic materials involved, and their situation relative to one another—low hydraulic conductivity over high or high over low. These ratings were used to identify those well data retained for subsequent statistical characterization. The parameter values presented in this appendix are based on those data surviving both the initial stratigraphy-screen interval review and the follow-on statistical analyses.

There were two additional significant findings in the evaluations. First, in the case of the more-permeable units, only hydraulic conductivity data collected after 1999 should be used for characterization. The reason is a distinctive change in conductivity data after 1999, likely due to the introduction of automated data-logging into the site groundwater protocols (**Figure E–17**). On Figure E–17(a), boxplots of the log-transformed data grouped by year clearly show how the hydraulic conductivity determinations are higher after 1999. The plot was constructed so that the horizontal line in each box is the median, and the lower and upper ends of the boxes indicate the 25th percentile and 75th percentile, respectively. On Figure E–17(b), median values for the "before 2000" data and median values for the "2000 and later" data at each well location were first plotted and then a line was drawn connecting the two points for that well location. The results that a single line in the figure presents a visual comparison of the earlier and later hydraulic conductivities at the corresponding well location. A line increasing from left to right indicates that the more-recent determinations of hydraulic conductivity at that location tend to be higher then the earlier determinations. Conversely, a line decreasing from left to right in the figure indicates that the later hydraulic conductivity determinations tend to be lower than those from earlier. Left-to-right increases in the location medians indicated by the gray lines in the figure, occur in 25 of the 27 locations where paired medians exist. That is, the more-recent determinations are (collectively) higher than the earlier determinations at these 25 locations. There are only two locations, indicated with dashed lines for emphasis, where the median decreases, i.e., where post-1999 hydraulic conductivities are lower than the corresponding earlier set (through 1999). This result, combined with the boxplot, suggests that a significant difference exists between those thick-bedded unit hydraulic conductivity determinations made before 2000 and those determinations made during and after 2000.

The second finding for the evaluation of the hydraulic conductivities is that geostatistical characterization is practical only for the thick-bedded unit data. The data for the other units are too few and poorly distributed in space for the development of the statistical models (variograms) needed to estimate hydraulic conductivity in space, i.e., as a function of location and the set of observed values in the unit(s).

E.3.4.1 Hydraulic Conductivity

Thick-bedded Unit

The 27 hydraulic conductivity data of the thick-bedded unit are lognormally distributed with a mean of 4.43×10^{-3} centimeters per second, and a median of 1.11×10^{-3} centimeters per second. The observed minimum and maximum values are 1.25×10^{-4} and 3.78×10^{-2} centimeters per second, respectively.

The thick-bedded unit is the one unit for which geostatistical modeling is feasible. In the case of the geostatistical modeling, those data remaining after screening and statistical evaluation were extended with hydraulic conductivity estimates derived from soil textures. These estimates employed artificial neural network methods. Data from locations with both hydraulic conductivity measurements and soil textures were used to train a Radial Basis Network. Soil texture data from locations without conductivity determinations were then run through the trained network to produce estimates for those locations. The soil textures used to train the network and subsequently predict additional hydraulic conductivities consisted of both laboratory-determined textures and estimates based on boring log descriptions (Cohen 2006).

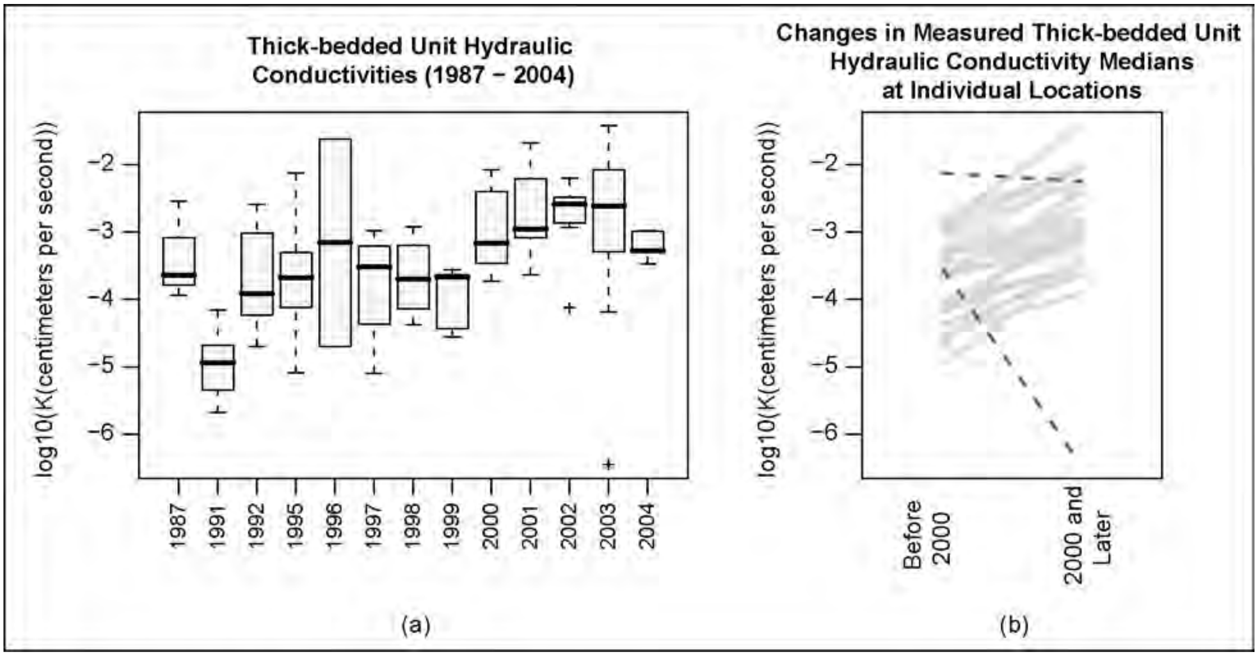


Figure E–17 Changes in the Thick-bedded Unit Hydraulic Conductivity during the Period of 1987 to 2004

A spherical semi-variogram was fit to the log-transformed extended data (EPA 1991a). A kriged (interpolated) log-transformed hydraulic conductivity field was then developed (**Figure E–18**) using the U.S. Environmental Protection Agency (EPA) GEOEAS geostatistical software (EPA 1991a). The kriged field covers a significant fraction of the thick-bedded unit on the North Plateau and hydraulic conductivity estimates are made in areas impacted by previous activities at the site. Locations of observed hydraulic conductivities used in the analyses are indicated by "+" symbols in the figure.

Improvement of the spatial model for the thick-bedded unit is limited by the current data density and distribution. The data support development of (geostatistical) models showing intermediate range (200- to 400-foot) structure. As a part of the analyses, clustered data in the vicinity of the North Plateau Groundwater Recovery System and the permeable treatment wall were removed from the data set during the development of the conductivity field seen in the figure. These clustered data have an average separation of approximately one tenth that of the data on Figure E–18, and semi-variograms indicate some structure with a range on the order of tens of feet. This is suggestive of a hierarchical structure. Such structure in the thick-bedded unit and similar deposits at the site would be consistent with the findings by researchers at other sites with glacio-fluvial deposits in buried bedrock valleys (Ritzi et al. 2003).

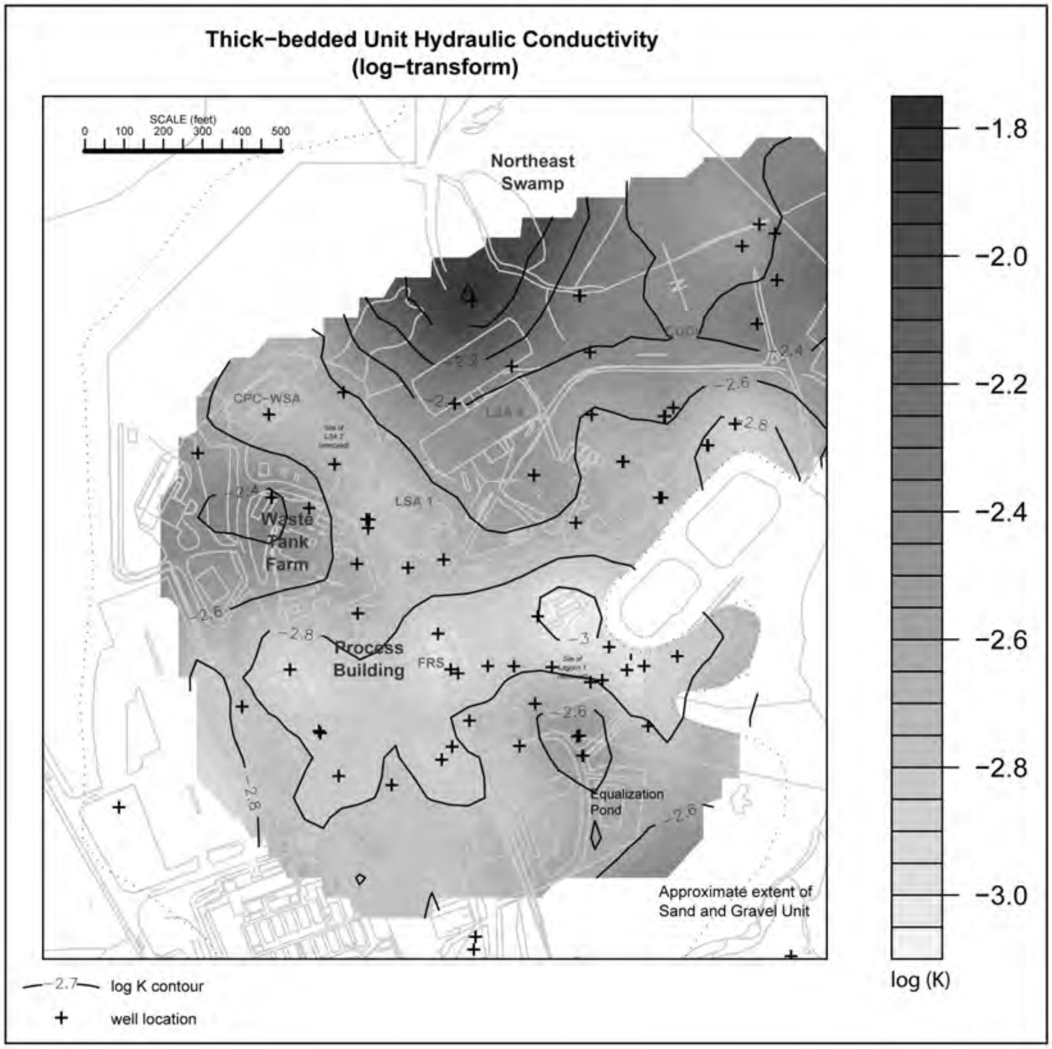


Figure E–18 Kriged Thick-bedded Unit Hydraulic Conductivity (log-transformed)

The kriged field is incorporated into the FEHM mode by back-transforming the log field with bias correction (Weber and Englund 1992), and importing the corrected hydraulic conductivity field into the model cells as block averages. A large area of the thick-bedded unit is not included in the kriged field estimate. Kriging is an interpolation technique and there are no data in these areas. The present FEHM model uses an estimate of the mean hydraulic conductivity for these areas. Because the data are lognormally distributed, the back-transformed estimate of the mean is used. Discussion of lognormal data can be found in the environmental literature, for example, Gilbert's monograph. (See *Statistical Methods for Environmental Pollution Monitoring*.) That value is 2.48×10^{-3} centimeters per second (6.3 feet per day). An anisotropy (horizontal to vertical hydraulic conductivity ratio) of 10 is assumed in the model. **Figure E–19** shows the thick-bedded unit hydraulic conductivity as imported into the model.

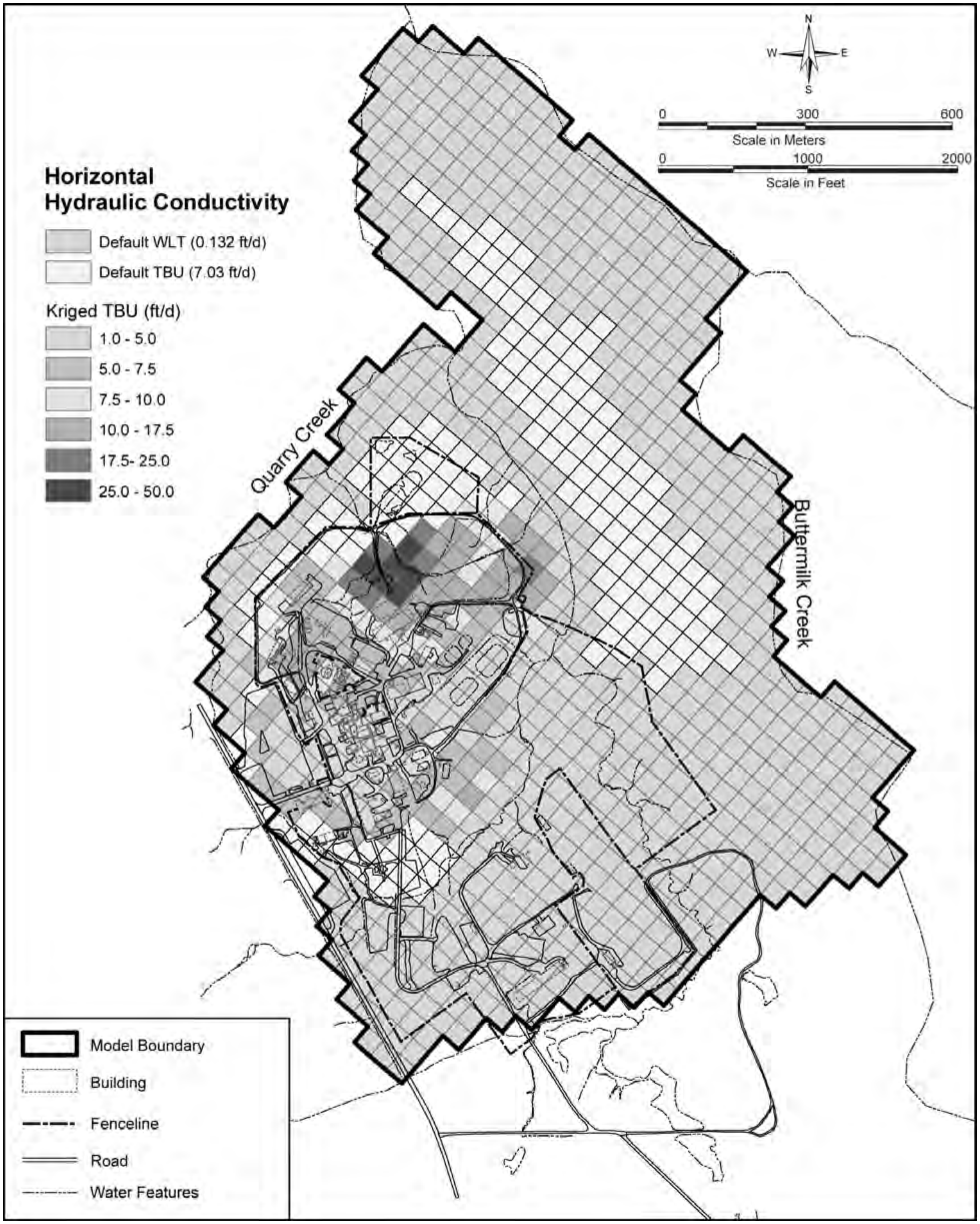


Figure E–19 Horizontal Hydraulic Conductivity of the Thick-bedded Unit in Layers 1, 2, and 3

Unweathered Lavery Till

The predominant feature of the Lavery till hydraulic conductivity is a change with depth. At the shallowest depths, the hydraulic conductivity of the Lavery till is on the order of 10^{-4} centimeters per second (Prudic 1986, Bergeron and Bugliosi 1988, Kool and Wu 1991, WVNS 1993b). In the extreme, this material is distinctly different from the till found deeper, and is even classified as a separate material—the weathered Lavery till—the deep material being known as the unweathered Lavery till. Alteration of the till's chemical and physical properties is the result of the chemical/physical weathering due to infiltration of meteoric water. Fracturing of the till due to relaxation of the materials is also evident, with fracture density decreasing with depth. In addition, the till material itself is subject to desiccation fracturing. At depth, observed field hydraulic conductivities approach laboratory values ranging from 2×10^{-8} to 8×10^{-8} centimeters per second (Prudic 1986).

On **Figure E–20**, hydraulic conductivity for wells screened at different depths in the unweathered Lavery till is plotted as a function of depth. Here, the depth is defined as being from the top of the unweathered Lavery till to the top of the screened interval. In instances where more than one hydraulic conductivity determination has been made, the arithmetic mean at that location is plotted. A decrease in the maximum hydraulic conductivity observed with depth is evident in the figure, particularly when the heavy gray line is included, delineating the envelope of plotted values. This figure suggests that, by the time a depth of 10 meters is reached, the hydraulic conductivity is approaching values less than 1×10^{-7} centimeters per second.

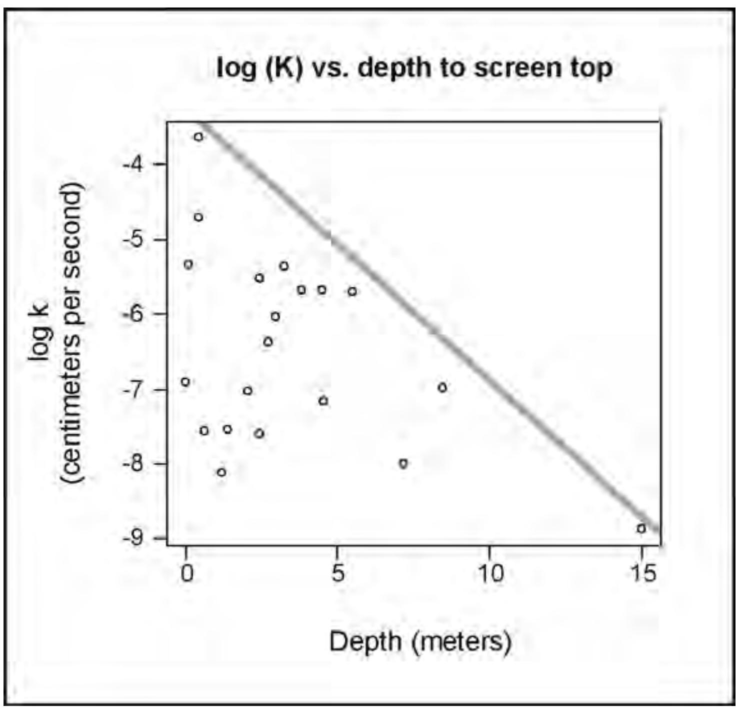


Figure E–20 Unweathered Lavery Till Hydraulic Conductivity as a Function of Depth

In light of the dependence on depth and the low number of data locations after screening, the emphasis in the unweathered Lavery till characterization for the model was on vertical change. A simple rule-based two-layer model for the unweathered Lavery till hydraulic conductivity was implemented:

- At depths of 3 meters or more, $K_h = 6.00 \times 10^{-8}$ centimeters per second.
- At depths of less than 3 meters, $K_h = 1.00 \times 10^{-6}$ centimeters per second.

The first rule is supported by the data. The second number is an interpolation between the weathered Lavery till and the deep unweathered Lavery till.

The spacing of the fractures in the unweathered Lavery till could have an effect on the bulk hydraulic conductivity of the till and the appropriateness of both the laboratory- and field-determined estimates of that parameter. However, Prudic noted that, in the modeling efforts reported alongside the field results, application of these hydraulic conductivities resulted in best-fit-specific storages consistent with their experimentally determined values (Prudic 1986). This finding supports the use of Prudic's reported field and laboratory hydraulic conductivities for the unweathered Lavery till.

No descriptive statistics are presented for the unweathered Lavery till hydraulic conductivity because of the tendency toward lower values with increasing depth.

Weathered Lavery Till

The seven hydraulic conductivity data for the weathered Lavery till are neither normally nor lognormally distributed. The mean is 3.36×10^{-4} centimeters per second and the median is 1.72×10^{-4} centimeters per second. The observed minimum and maximum values are 4.87×10^{-7} and 1.50×10^{-3} centimeters per second, respectively. The geometric mean is 4.95×10^{-5} centimeters per second.

No structure was evident in weathered Lavery till semi-variograms. Well locations are scattered about the site, mostly on the South Plateau and the average distance between locations is hundreds of feet—likely exceeding the spatial scale of any structure in the unit. Observed weathered Lavery till hydraulic conductivities vary over several orders of magnitude. Based on the observed wide range in values, an initial hydraulic conductivity of one-tenth the back-transformed estimate (4.65×10^{-4} centimeters per second), or 4.65×10^{-5} centimeters per second, was used in the FEHM model. Although not completely optimal, sensitivity of model results to changes in the parameter value appears low and therefore, the initial input value has not been changed.

Slack-water Sequence

The slack-water sequence is permeable and the observed hydraulic conductivities appear to change around 1999 in a manner similar to the thick-bedded unit. Twelve '2000 and later' locations remained after the initial screening. However, these data are clustered, and three-quarters of the data locations are in the vicinity of the North Plateau Groundwater Recovery System and the permeable treatment wall. The values at the three locations lying away from the cluster are interquartile values and are not much different than the observations at the cluster locations. The slack-water sequence hydraulic conductivity used in the model was initially set equal to the back-transformed estimate (1.61×10^{-2} centimeters per second), and the anisotropy was set to 10. However, early runs of the model indicated that the slack-water sequence was effectively draining the thick-bedded unit, precluding any reasonable match to observed conditions in that unit. As a result, both the horizontal hydraulic conductivity and the anisotropy were adjusted as part of the calibration. The slack-water sequence hydraulic conductivity from that process was 5.29×10^{-3} centimeters per second. The final anisotropy was 20.

The 12 hole-average hydraulic conductivities data of the slack-water sequence are lognormally distributed with a mean of 2.44×10^{-2} centimeters per second, and a median of 1.11×10^{-3} centimeters per second. The observed minimum and maximum values are 8.19×10^{-4} and 1.13×10^{-1} centimeters per second, respectively.

Lavery Till-Sand

The Lavery till-sand is similar to the thick-bedded unit in that there appear to be differences between the pre-2000 and post-2000 hydraulic conductivity determinations. Only the hydraulic conductivities determined after

1999 were included in the analyses used to estimate the Lavery till-sand hydraulic conductivity. The minimum variance unbiased estimate of those locations, 1.85×10^{-3} centimeters per second, was used for the Lavery till-sand horizontal hydraulic conductivity in the model. An anisotropy of 10 was assumed.

The five hydraulic conductivity data of the Lavery till-sand are lognormally distributed with a mean of 2.04×10^{-3} centimeters per second, and a median of 2.21×10^{-3} centimeters per second. The observed minimum and maximum values are 1.06×10^{-4} and 4.54×10^{-3} centimeters per second, respectively.

Kent Recessional Sequence

The Kent recessional sequence is similar to the thick-bedded unit with differences between the pre-2000 and the 2000 and later hydraulic conductivities. As a result, only those hydraulic conductivities determined after 1999 were included in the analyses. Data from seven locations were used. However, the data are problematic. Their values ranged over three order of magnitudes consistent with the complex structure—lacustrine and kame deposit—and the distances between sample or well locations. The Kent recessional sequence data have a back-transformed estimate of 6.39×10^{-4} centimeters per second and a median of 1.78×10^{-4} centimeters per second. The back-transformed estimate was used for the initial Kent recessional sequence hydraulic conductivity. Calibration and subsequent sensitivity reduced that number by a factor of four and the final hydraulic conductivity for the Kent recessional sequence became 1.60×10^{-4} centimeters per second with an assumed anisotropy of 10.

The seven hydraulic conductivity data of the Kent recessional sequence are lognormally distributed with a mean of 7.03×10^{-4} centimeters per second. The observed minimum and maximum values are 2.98×10^{-6} and 1.62×10^{-3} centimeters per second, respectively.

Kent Till

Little is known about the Kent till. In the present model, it is assumed to be similar to the unfractured unweathered Lavery till.

Olean Till

Little is known about the Olean till. In the present model, it is assumed to be similar to the unfractured unweathered Lavery till.

Olean Recessional Sequence

Little is known about the Olean recessional sequence and it is assumed to be similar to the Kent recessional sequence. An initial Olean recessional sequence hydraulic conductivity estimate of 1.0×10^{-4} centimeters per second was used in the model. Unlike the Kent recessional sequence, that value has not been varied as a part of calibration. An anisotropy of 10 was assumed.

Weathered Bedrock

The weathered bedrock hydraulic conductivity used in the model is 1.0×10^{-5} centimeters per second (Prudic 1986). An anisotropy of 10 was assumed.

Unweathered Bedrock

The unweathered bedrock hydraulic conductivity used in the model is 1.0×10^{-7} centimeters per second (Prudic 1986). An anisotropy of 10 was assumed.

All of the hydraulic conductivities used in the groundwater models are collected in **Table E–3**. The hydraulic conductivities presented in the table are final values from the hand-calibrated model discussed below in Section E.3.5 and take on a variety of forms including statistically derived values from this section, single empirical values, a rule set, and values resulting from the calibration.

Table E–3 Final Hydraulic Conductivities for the West Valley Groundwater Models

<table>
<tr><th colspan="2">Unit</th><th>Nominal K_h (centimeters per second)</th><th>Nominal K_v (centimeters per second)</th><th>Anisotropy (K_h / K_v)</th></tr>
<tr><td colspan="2">Thick-bedded Unit</td><td>Variable [a]</td><td>K_h / 10</td><td>10</td></tr>
<tr><td colspan="2">Thick-bedded Unit-outlying</td><td>2.48×10^{-3} [b]</td><td>2.48×10^{-4} [2]</td><td>10</td></tr>
<tr><td colspan="2">Slack-water Sequence</td><td>5.29×10^{-3}</td><td>2.65×10^{-5}</td><td>20</td></tr>
<tr><td colspan="2">Lavery Till-Sand</td><td>1.85×10^{-3}</td><td>1.85×10^{-4}</td><td>10</td></tr>
<tr><td colspan="2">Kent Recessional Sequence</td><td>1.60×10^{-4}</td><td>1.60×10^{-5}</td><td>10</td></tr>
<tr><td colspan="2">Olean Recessional Sequence</td><td>1.0×10^{-4}</td><td>1.0×10^{-5}</td><td>10</td></tr>
<tr><td colspan="2">Weathered Lavery Till</td><td>4.65×10^{-5}</td><td>4.65×10^{-5}</td><td>1</td></tr>
<tr><td colspan="2">Weathered Bedrock</td><td>1.0×10^{-5}</td><td>1.0×10^{-6}</td><td>10</td></tr>
<tr><td colspan="2">Bedrock</td><td>1.0×10^{-7}</td><td>1.0×10^{-8}</td><td>10</td></tr>
<tr><td colspan="5">Special Cases Unweathered Lavery Till, Kent Till, Olean Till:</td></tr>
<tr><td rowspan="5">Unweathered Lavery Till</td><td colspan="4">A set of rules</td></tr>
<tr><td colspan="4">1.) At depths of 3 meters or more, $K_h = K_v = 6.0 \times 10^{-8}$ (centimeters per second) (anisotropy = 1) – deep</td></tr>
<tr><td colspan="4">2.) At depths of less than 3 meters, $K_h = K_v = 1.0 \times 10^{-6}$ centimeters per second – shallow</td></tr>
<tr><td colspan="4">3.) The depth 3 meters and the shallow</td></tr>
<tr><td colspan="4">Use for Olean Till, Kent Till (lower number, 6.0×10^{-8} centimeters per second, only) and anisotropy = 1 ($K_h = K_v$) [c]</td></tr>
</table>

[a] Kriged field.
[b] For use in areas where no thick-bedded unit hydraulic conductivity determinations have been made and extrapolation would be required.
[c] Depth measured from the top of the unweathered Lavery till.

E.3.4.2 Infiltration

The recharge for the model evolved from a composite developed from a review taken from multiple sources, including the groundwater and vadose zone hydrology environmental information documents (WVNS 1993b, 1993c) and several modeling reports (Bergeron and Bugliosi 1988, Kool and Wu 1991, Prudic 1986, Yager 1987). In the initial phase of the modeling two infiltration rates were applied. Based on the information in these reports, a net recharge of 32 centimeters per year was applied uniformly across the thick-bedded unit, and a rate of 3 centimeters per year was applied across the remainder of the site, where the surficial unit is the weathered Lavery till. For the North Plateau, as calibration proceeded, zones having other recharge rates reflecting differences in surface conditions were added into the model. The number of these zones, however, was kept low to avoid over-calibration. The South Plateau infiltration was adjusted during the calibration but not in zones. The final infiltration used in the base model is shown on Figure E–15 as shaded surface flux cells.

A few porosity data are available for the near-surface units. Estimates for the deeper units are based on similarity of a material to the thick-bedded unit or unweathered Lavery till as appropriate, or adapted from literature values. Effective porosity has been assumed to equal the total porosity. Model porosities are shown in **Table E–4**.

Table E–4 Porosities

Geologic Unit	*Total Porosity (dimensionless)*	*Reference*
Thick-bedded Unit	0.226	WVNS 1993b, Yager 1987 (Specific yield)
Weathered Lavery Till	0.324	Prudic 1986
Slack-water Sequence	0.35	WVNS 1993b
Unweathered Lavery Till	0.324	Prudic 1986
Lavery Till-Sand	0.22	Geology Environmental Information Document
Kent Recessional Sequence	0.22	Kent recessional sequence assumed to be like the thick-bedded unit
Kent Till	0.324	Kent till assumed to be like unweathered Lavery till
Olean Recessional Sequence	0.22	Olean recessional sequence assumed to be like thick-bedded unit
Olean Till	0.324	Olean till assumed to be like unweathered Lavery till
Weathered Bedrock (Shale)	0.4	Assumed
Bedrock (Shale)	0.05	Adapted from Domenico and Schwartz (Domenico and Schwartz 1990)

E.3.4.3 Soil Moisture Characteristics

Soil moisture characteristics were modeled as a function of the hydraulic conductivity, $(K_xK_yK_z)^{1/3}$. In this approach a lookup table (**Table E–5**) is used for setting the van Genuchten soil moisture parameters based on established empirical relationships and keyed to a representative hydraulic conductivity for the material. The establishment of this table (Pantex 2004) stems from earlier statistical characterizations by soil type as documented in the EPA RETC manual and code (EPA 1991b).

Table E–5 Lookup Table for Soil Moisture Characteristics

$(K_xK_yK_z)^{1/3}$ *(feet per day)*	S_r	α (m^{-1})	*N*
<0.0001	0.2	0.6	1.25
0.0001 - 0.001	0.2	1	1.3
0.001 - 0.01	0.2	1.5	1.5
0.01 - 0.10	0.15	1.9	1.6
0.10 - 1.0	0.15	2.2	1.8
1.0 - 5.0	0.15	2.4	1.9
5.0 - 10.0	0.1	3	2
10.0 - 30.0	0.1	3.5	2.2
>30	0.1	3.7	2.5

E.3.5 Model Calibration

The model has been calibrated both manually and using an automated calibration code, Parameter Estimation (PEST) (Doherty 2004). The manual calibration was accomplished by the comparison of model-predicted head with the median of observed groundwater level elevations at each of 56 target well locations, and by the comparison of model-predicted seepage flows with estimated flows from the field. The 56 target locations and median water level values are listed in **Table E–6**. Target well locations did not align with the node locations; therefore, the model-predicted heads at the well locations were estimated by linear interpolation between nodes.

Table E–6 Groundwater Elevation Targets for Model Calibration

Unit	***Well***	***Median (feet amsl)***	***Tier***
Thick-bedded Unit	103	1,391.4	1
	104	1,385.5	1
	111	1,383.0	1
	116	1,380.5	1
	203	1,394.4	1
	205	1,393.1	1
	301	1,410.7	1
	307	1,402.0	2
	401	1,410.3	1
	403	1,408.0	2
	406	1,393.3	1
	601	1,377.3	1
	602	1,387.8	2
	603	1,391.9	1
	604	1,391.6	1
	801	1,376.6	2
	804	1,369.9	2
	8606	1,392.8	1
	8608	1,393.6	2
	8609	1,391.8	1
	8612	1,364.8	2
	EW01	1,377.8	2
	EW04	1,379.2	2
	NB1S	1,435.7	2
	WP04	1,382.2	2
Slack-water Sequence	501	1,391.3	1
	408	1,391.8	1
Sand and Gravel Unit	502	1,388.0	2
	802	1,368.4	1
Kent Recessional Sequence	902	1,283.3	2
	903	1,264.0	2
	1002	1,285.7	1
	1004	1,291.4	1
	8610	1,264.4	1
	8611	1,264.3	1
Lavery Till-sand	202	1,394.6	1
	204	1,394.5	1
	206	1,394.3	1
	208	1,388.0	1
	302	1,400.4	2
	402	1,401.4	1
	404	1,400.6	1

Unit	Well	Median (feet amsl)	Tier
Unweathered Lavery Till	108	1,361.6	2
	109	1,374.7	2
	110	1,375.4	1
	405	1,400.8	1
	701 [a]	1,382.6	2
	702	1,365.0	2
	703	1,382.8	2
	705	1,394.7	1
	904	1,363.9	2
Weathered Lavery Till	907	1,378.2	1
	1007	1,379.7	2
	1008C	1,398.9	1
	96-I-01	1,378.0	2
Bedrock	83-4E	1,242.6	1

[a] Reclassified from Lavery till sand to unweathered Lavery till as this document was being finalized.

With one or two exceptions, the wells on the list are represented by a large number of observed water levels; i.e., they have been tracked over a number of years, exhibit no or little trend, and exhibit no anomalous behavior in their hydrographs. Targets designated as Tier 1 targets were judged to be more reliable in this respect than the Tier 2 targets. Initial calibration used only Tier 1 targets but was later extended to include Tier 2 targets.

Trending in the water levels was evaluated using the U.S. Geological Survey code KENDALL (USGS 2005). Trend testing accounted both for seasonal variation and for external influences, e.g., multi-year climatological variations.

The trend methodology employed was the seasonal Kendall with a LOWESS[1] smooth of precipitation. Four seasons were employed, reflecting the water-level measurement schedules. The precipitation record was daily from January 1990 through February 2006 with some records missing in the first year. The daily data were summed as quarterly based numbers for the LOWESS. The analyses were performed over the maximum period for which data are available. Selection of the target levels was restricted to locations with more than 32 observations and more than 60 observations, in most cases, with a few exceptions, no trending in the observed water level. Exceptions consisted of wells where the total change in the trending water level was very small, on the order of a foot or less, with very little scatter along the trend line.

The occasional spiked or outlying water level occurs in the observed water level data at a number of locations. For this reason, the median water levels at the (Tier 1 or Tier 2) locations were selected as the representative target level values to be used in the calibration. However, the differences between the median and arithmetic mean or average water levels were small, particularly when compared to the observed water level versus predicted water level residuals. **Figure E–21** shows the locations of the target wells used in the calibration.

[1] LOWESS or LOESS, is a locally weighted polynomial regression used here to account for precipitation, an external variable that potentially confounds the trend analysis.

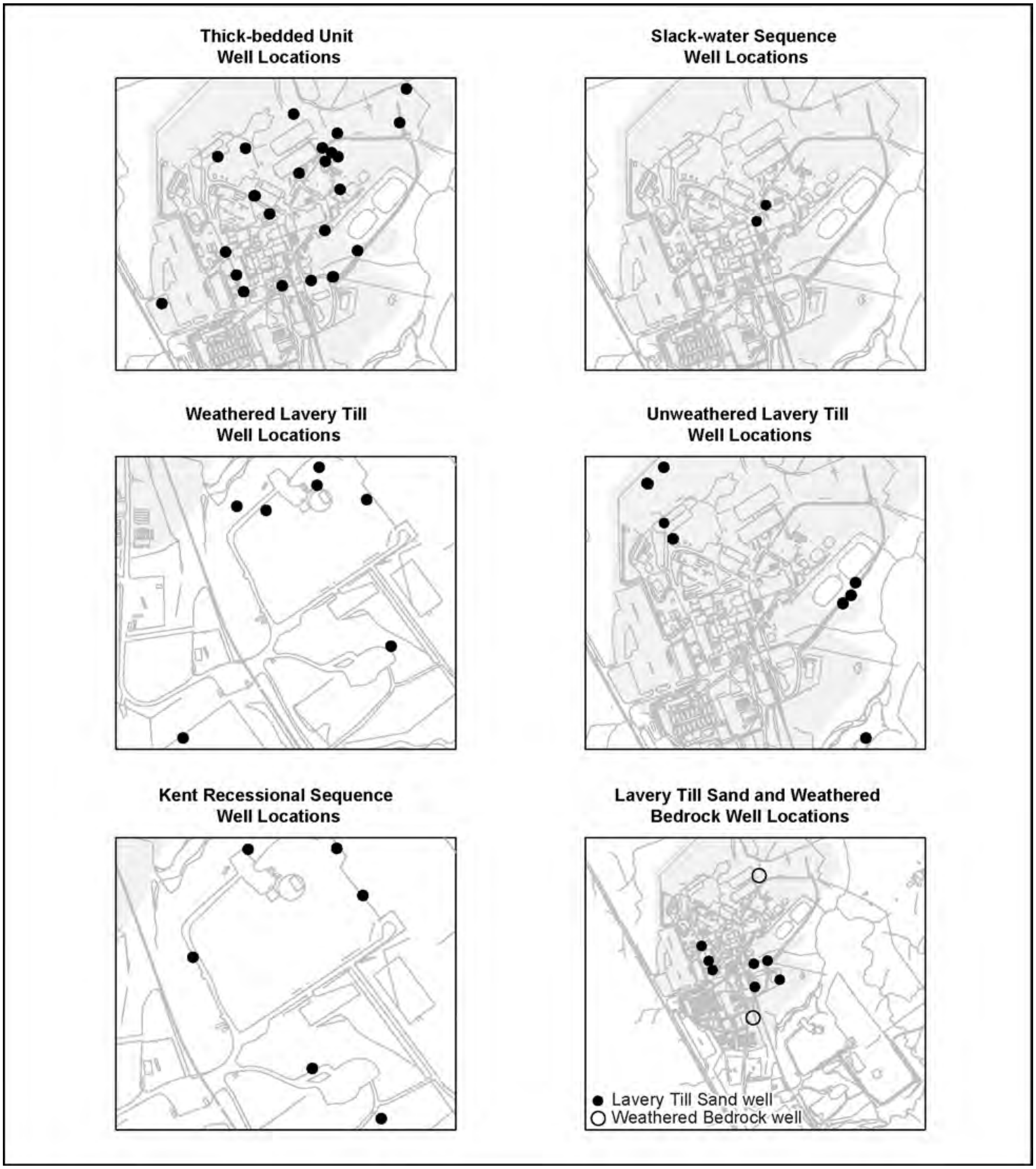


Figure E–21 Locations of Target Wells Used in Calibration of the Site Model

Manual Calibration

Calibration to the target levels was an iterative process using both qualitative and quantitative procedures. It began with a visual fit obtained by iterating modification of one or more parameters, running the model, and visual/quantitative inspection of predicted head versus observed water-level plots. The visual inspection used two criteria to determine the goodness of a run with a given combination of parameters. First, all of the points in the observed versus predicted head scatter-plot should center around the one-to-one line. Second, all of the points should lie within +/- 3 meters (10 feet) of that line. As calibration improved, a quantitative measure was used: regression of observed versus predicted head should result in an adjusted square of the correlation coefficient (R^2) equal to or greater than 0.95.

The seep comparisons used in the calibration were more informal than the head comparisons. Seeps were modeled for nodes in the vicinity of those seep and spring locations identified on Figure E–10 in Section E.2.3.1. The discharges from these nodes were then compared with the tabulated observed values in Table E–2. Comparisons were semi-quantitative, imposing the constraint that modeled discharges reasonably approximate the reported discharges. Model gridding and a significant uncertainty in the observed discharges provide the rationale for this approach.

The manual calibration focused on infiltration, inflow into the thick-bedded unit from the west, and deeper head boundary conditions as the varying model parameters. This tacitly gave preference to the hydraulic conductivity data, which, with one exception, were treated as fixed by observation. That one exception was the hydraulic conductivity for the slack-water sequence. That parameter had to be adjusted in the present calibration, because the slack-water sequence was effectively draining the thick-bedded unit, precluding any fit between observed and predicted heads at a large number of target locations.

Final observed versus predicted head scatter-plots of the manually calibrated model are shown on **Figures E–22** and **E–23**. Figure E–22 presents the results for all target well locations. This figure shows how the target locations fall into two natural groupings, an upper aquifer and a lower aquifer. The upper aquifer system comprises the thick-bedded unit, slack-water sequence, weathered Lavery till, unweathered Lavery till, and Lavery till-sand. The geohydrological units found in the lower units are the Kent recessional sequence, Olean till, Olean recessional sequence, weathered bedrock, and bedrock. The soil and groundwater contamination and source areas are found at or near the surface at the site, and most of the data characterizing groundwater at the site are from units in the upper system. For these reasons, the focus of this calibration was on the upper system, shown on Figure E–23.

The adjusted correlation coefficient for the upper aquifer plot is 0.953. The adjusted correlation coefficient for all target locations, Figure E–22, is 0.992, but the high value reflects the high-low grouping of the data, i.e., predicted-observed pairs, more than goodness of fit. Other useful indications in these figures include the 95 percent confidence band (shaded dark gray), the 95 prediction band (shaded light gray), the one-to-one line (heavy solid line) and the +/- 3-meter (10-foot) band about that line (dotted lines). The confidence and prediction bands are centered about the regression lines (not shown). In both figures, the one-to-one line lies within the confidence band. While no statistical inference can be drawn from this, the fact that the confidence band—an entity constructed to contain the true observed-versus-predicted regression line—also contains the one-to-one line provides a degree of confidence in the calibration with respect to the heads.

The observed (see Section E.2.3.1) and modeled values for the drainage base flows and seep discharges are listed in **Table E–7**. The match between the two sets of values is good in light of the uncertainties in the observed flow estimates as evidenced by the Erdman Brook numbers. The model discharge to Erdman Brook is higher than the Kappel and Harding number but much lower than Yager's indirect estimate.

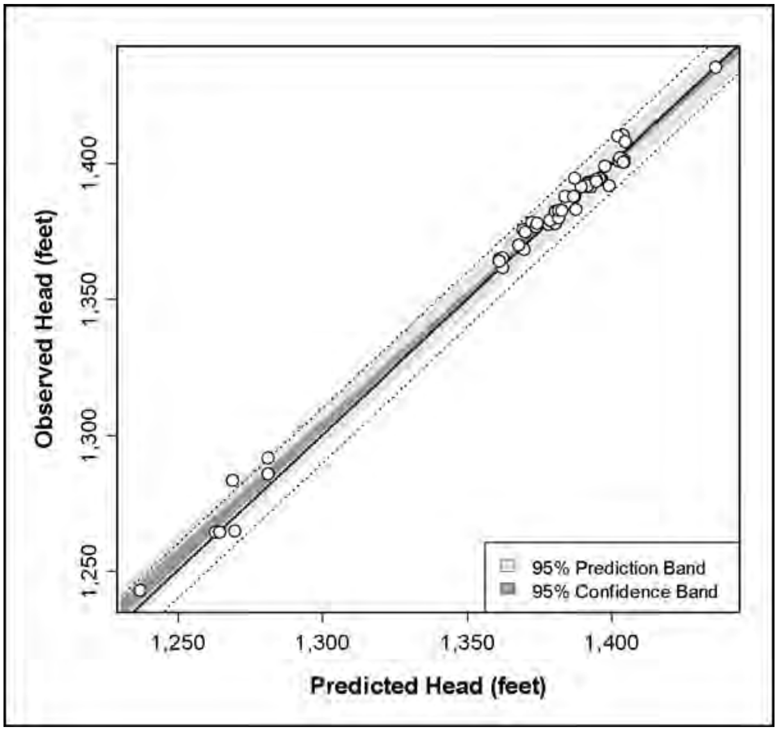


Figure E–22 Observed Versus Predicted Heads in the Base Case Model (all well locations)

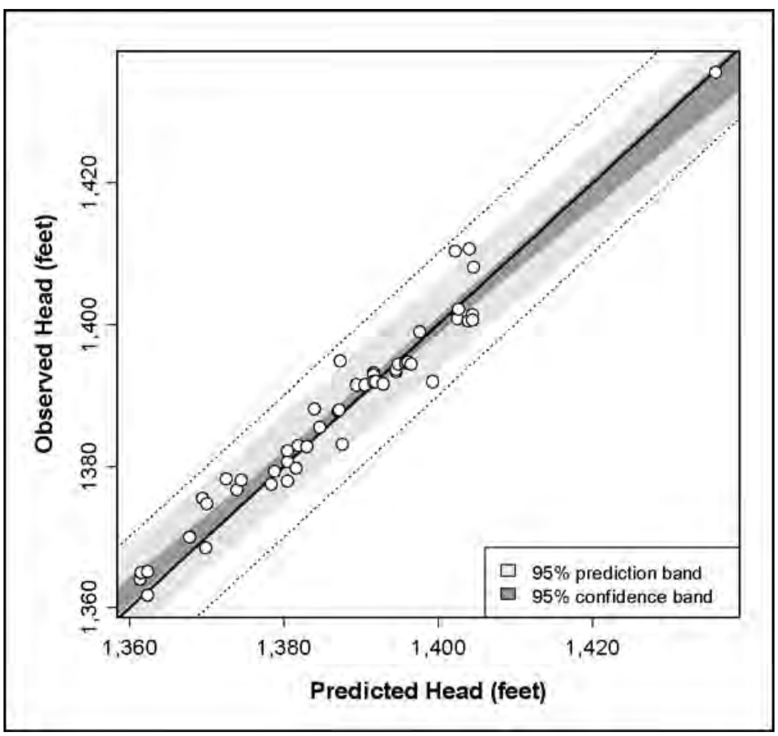


Figure E–23 The Observed Versus Predicted Heads in the Base Case Model (upper aquifer only)

Table E–7 Comparison of Observed and Modeled Seep and Stream Discharges

Location	*Observed Discharge (cubic meters per day)*	*Predicted Discharge (cubic meters per day)*
NP-1 Base Flow	29	8
NP-2 Base Flow	6	20
NP-3 Base Flow	113	86
NP – Total	148	114
Quarry Creek and Franks Creek	20	36
Erdman Brook (Yager/Kappel and Harding)	220/10	61
Total	388/178 [a]	211

[a] Total using Kappel and Harding flow for Erdman Brook.
Note: To convert cubic meters per day to cubic feet per day, multiply by 35.314.

An understanding of the conceptual changes introduced by the new geological interpretations—a realignment of the slack-water sequence and Lavery till-sand—should contribute to a better understanding of the North Plateau seepage faces along Erdman Brook.

The predicted channel base flows (NP-1, NP-2, and NP-3) agree reasonably well with the observed values, but the total predicted flow is low and the observed and predicted distributions of the flow among the three channels differ. The flow at NP-3 is the largest for both the observed and predicted cases, accounting for 76 percent and 75 percent of the total channel base flow in each case, respectively. The split of the remaining 24 percent (25 percent) between the NP-1 and NP-2 channels is approximately reversed in the observed and predicted cases.

Automated Calibration

Sandia National Laboratories (SNL) evaluated the hand-calibrated flow model with respect to the improvement at predicting contaminant transport subject to vis-à-vis automated calibration (Sandia 2008b). SNL reported that the hand-calibrated model achieved a root-mean-square-error (RMSE) for heads of 4.6 meters and for seeps of 0.98 kilograms per second (weighted RMSEs of 5.5 meters and 1.05 kilograms per second, respectively), which are quite reasonable.

This model, combined with the latest utilities available in the PEST software (Doherty 2004), was then used to perform a preliminary uncertainty analysis investigating the ability of the model to match both observed (steady-state) heads and seep flows, and an estimated 330-meter travel-time of 1.6 years for strontium-90 developed in review of data collected in the GeoProbe® sampling program. Results indicated that, given the current estimable parameters and their admissible ranges, the predictive utility of this model would increase after an automated calibration effort.

Because better matches to weighted site data could be achieved, PEST then was used to perform a preliminary automated calibration. The automated-calibrated model yielded a head RMSE of 4.2 meters and a seeps RMSE of 1.04 kilogram per second, but weighted RMSEs were 5.2 meters and 1.11 kilograms per second, respectively. However, the estimated travel time was reduced from 5.7 years for the hand-calibrated model to 1.6 years for the to automated-calibrated model.

The non-trending constraint applied to the hand-calibration was relaxed, increasing the number of observed (median) heads to 162, thus augmenting both the observation data set and calibration parameter set (Sandia 2008a). The calibration was further simplified when multiple median head observations corresponding to a single FEHM node were averaged and the maximum weight from constituent wells applied in the calibration.

Weights for each observation were set inversely proportional to the range of heads measured at that well and a Gaussian distribution was assumed for the measurement error with the range in heads assumed to approximate the 95 percent confidence interval. This yielded weights inversely proportional to the standard deviations. Head observation weights were also evaluated with regard to the confidence to be placed in each (i.e., *excellent*, *good*, *fair*, *poor*, and *eliminate*). Wells rated as *excellent*, *good*, or *fair* did not have their weights adjusted. The two rated as *poor* had their weights cut in half. Wells rated as *eliminate* had zero weight applied. This resulted in 87 non-zero-weighted head observations, a factor of 2.6 increase in the original Tier 1 hand-calibrated observation data set's size.

In this case the automated calibrated model has a higher RMSE and weighted RMSE for heads than the hand-calibrated model. However, incorporation of the seepage flow rates and transport time as calibration targets in the Sandia calibrated model resulted in a model where these "soft" observations are more closely matched than with the hand-calibrated model. The simulated transport time with the Phase II–calibrated model is near the middle of the estimated range of values, whereas the simulated value with the hand-calibrated model is greater than the upper bound (5 years) of the estimated range. In addition, the simulated seepage to Erdman Brook is significantly higher than in the hand-calibrated model, although it is still somewhat lower than the lower bound of the estimated range of values.

SNL concluded that it is reasonable that the match between simulated heads and observed heads be sacrificed to some degree, if the ultimate objective of the flow model is to simulate accurately the migration of contaminants and groundwater flow rates on the North Plateau of the site. Further, there is no strictly objective or rigorous method for the relative weighting of different types of observations, such as heads, seepage rates, and transport times. As a consequence, professional judgment and subjective assessment of the relative importance of various model predictions (e.g., simulated heads versus contaminant transport times) are required to define the objective function used in the automated calibration process in a meaningful way.

The increased RMSE for heads in the PEST-calibrated model relative to the hand-calibrated model highlights structural and/or conceptual uncertainties in the WNYNSC flow model. By adding the constraints of the seepage rates and transport time to the automated calibration process, the flow model is less able to compensate for simplifications associated with these uncertainties and the RMSE for heads is forced to be higher than for the hand-calibrated model, even for an optimized model. These structural or conceptual uncertainties could be related to the zonation of hydraulic conductivity, continuity of hydrogeologic units in the subsurface, zonation of recharge, location of underflow at the lateral boundaries, or zonation of seepage.

E.3.6 Sensitivity and Uncertainty

A series of sensitivity analyses were carried out after the manual calibration. Using the sum of the square of the head residuals as the measure of fit, the values of 14 parameters were varied about their base values in the model one at a time to determine 1) the sensitivity of the model to changes in the parameter value, and 2) the extent to which a locally optimum solution has been achieved.

The sum of the squares of the residuals (SSR) is given by:

$$SSR = \sum (h_i - WL_i)^2$$

where:

i = an index denoting one of the target wells in Table E–6

WL_i = median observed groundwater elevation for target well i (Table E–6)

h_i = model-predicted head at the target well location

The parameters examined include 2 flux boundary condition parameters and 12 material properties, i.e., hydraulic conductivities. The flux parameters are the inflow into the thick-bedded unit along the western boundary (thick-bedded unit inflow) and infiltration at the surface (recharge). The hydraulic conductivities considered are the horizontal and vertical components for the six geohydrological units found in the upper aquifer system: the thick-bedded unit (TBUKxKy, TBUKz), the slack-water sequence (SWSKxKy, SWSKz), the Lavery till-sand (LTSKxKy, LTSKz), the weathered Lavery till (WLTKxKy, WLTKz), the unweathered Lavery till (ULTKxKy, ULTKz), and the Kent recessional sequence (KRSKxKy, KRSKz).

In each case, the parameter is varied about its base case value using a multiplicative factor while the others are kept at their base case values. The multiplicative factors applied to the base value were 0.25, 0.5, 2, and 4. The results are summarized on **Figure E–24** in the form of bar graphs showing the SSR (square feet) versus a multiplicative factor for each of the flux boundary conditions and hydraulic conductivities. The base case is also included in each graph.

The change in a bar graph is indicative of a sensitivity of the model vis-à-vis the SSR to changes in the parameter. A flat appearance suggests little or no sensitivity of the model to a parameter. A large U or V shape indicates sensitivity with the low point representing the approximate best fit. Continuously increasing or decreasing plots indicate situations where the best parameter value lies outside the range considered. If the change across the plot is judged significant, then this sensitivity should be addressed and the parameter's range should be extended and the analysis continued. If the change across the plot is judged not to be significant, no further analysis is performed on that parameter.

Evaluation of the plots on Figure E–24 in this manner pointed to one significant case where the range of analysis was extended—the Kent recessional sequence horizontal hydraulic conductivity (KRSKxKy). Here the SSRs in the original set of analyses continuously increased as the value of the Kent recessional sequence horizontal hydraulic conductivity was increased, suggesting that the best fit lay somewhere below the range used. The range was extended on the low end, showing that the shallow minimum or best fit occurs in the vicinity of the 0.25 case—the lower bound of the original range.

The general conclusions of the sensitivity analyses on the base case model as determined in the head calibration are that the model was reasonably parameterized, although lowering the Kent recessional sequence horizontal hydraulic conductivity is indicated. In addition, the particular set of sensitivities expressed tend to corroborate some of the assumptions regarding flow at the site that are key in decoupling schemes used when smaller domain models are implemented, including horizontal flow and vertical flow.

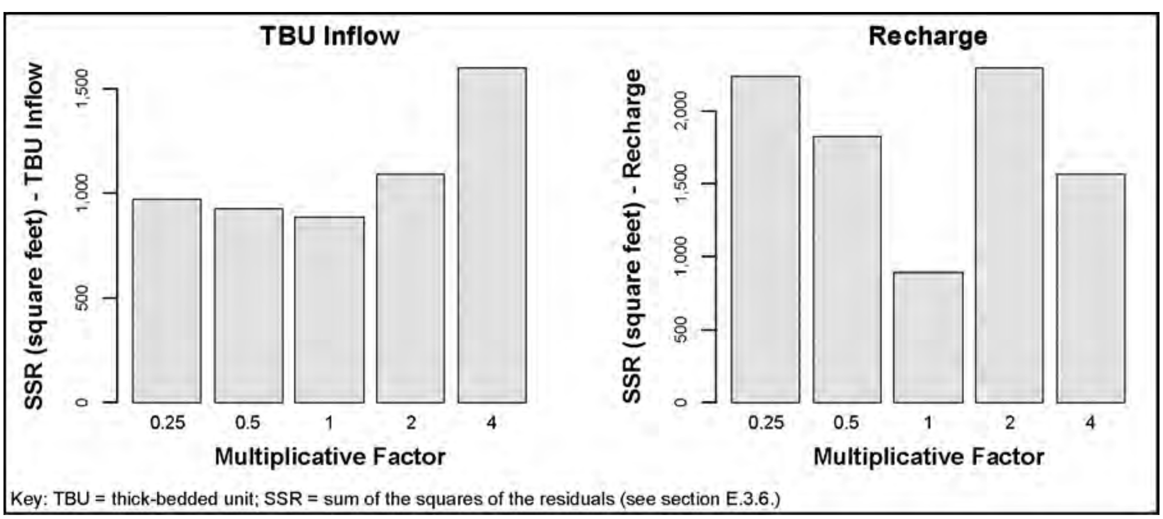
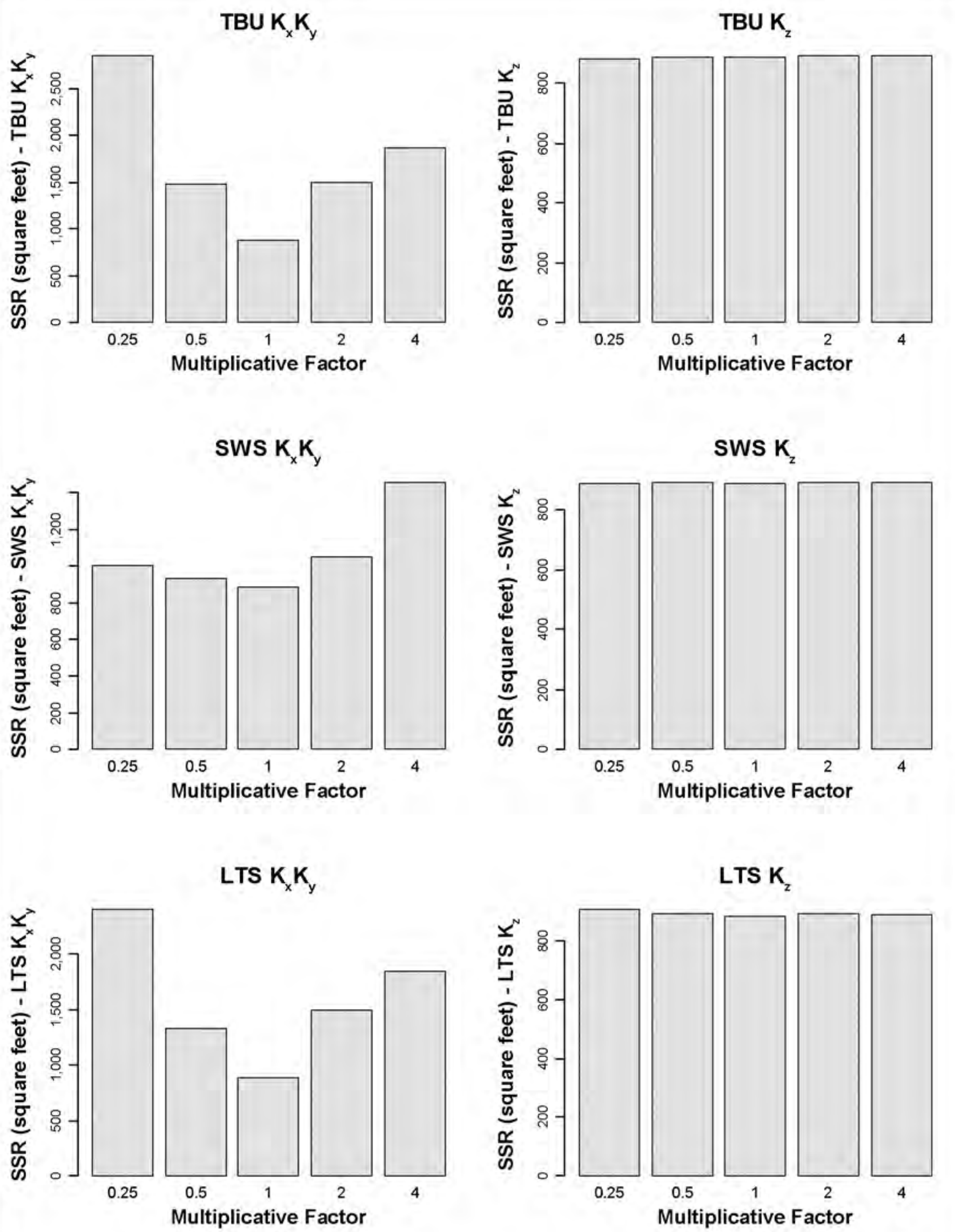


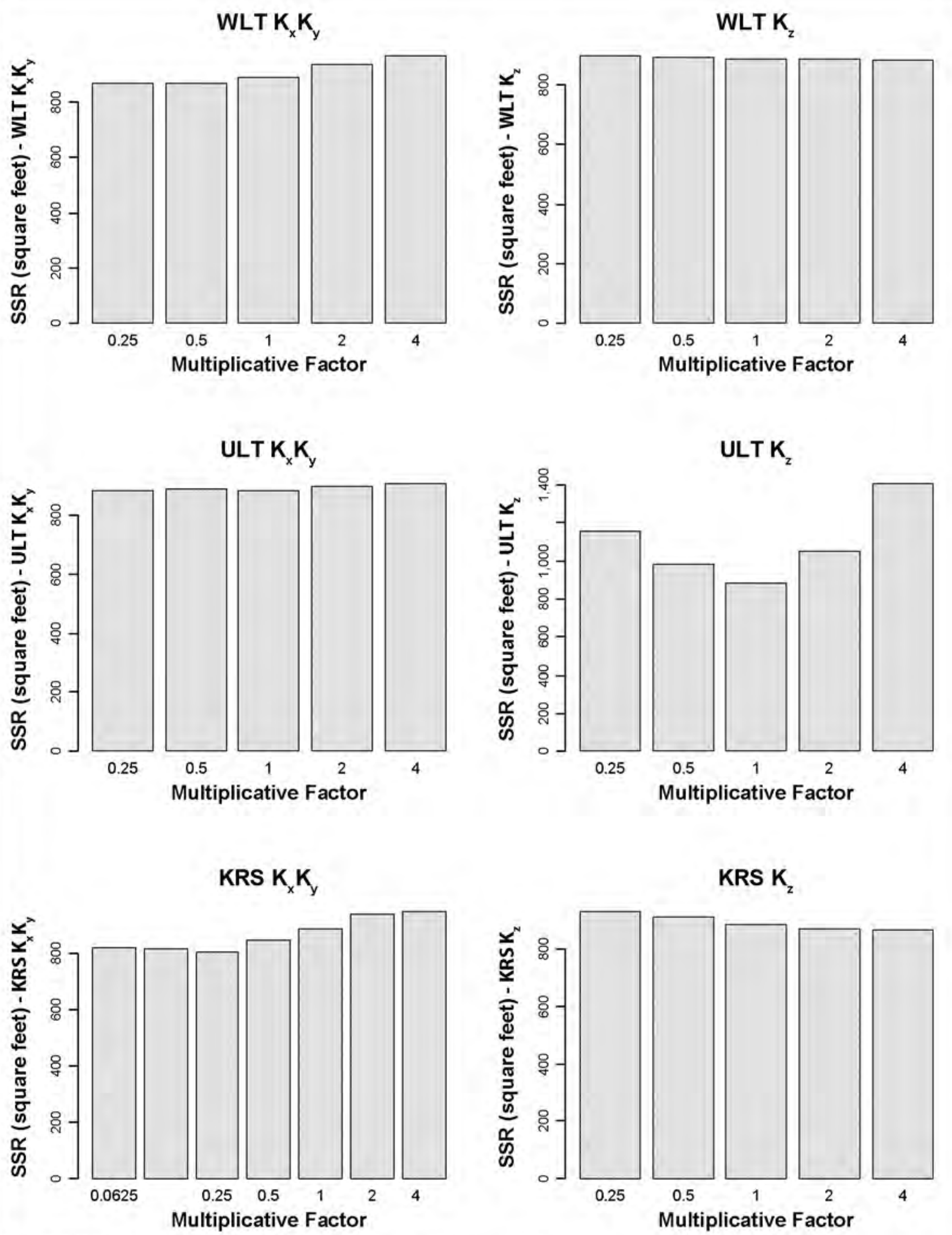
Figure E–24 Results of Sensitivity Analysis of Base Case Model



Note: $K_xK_yK_z$ denote xyz components of the hydraulic conductivity, respectively.

Key: LTS = Lavery till sand; SSR = sum of the squares of the residuals; SWS = slack-water sequence; TBU = thick-bedded unit.

Figure E–24 Results of Sensitivity Analysis of Base Case Model (continued)



Note: $K_xK_yK_z$ denote xyz components of the hydraulic conductivity, respectively.

Key: KRS = Kent Recessional Sequence; SSR = sum of the squares of the residuals; ULT = Unweathered Lavery Till; WLT = Weathered Lavery Till.

Figure E–24 Results of Sensitivity Analysis of Base Case Model (continued)

E.3.7 Results

E.3.7.1 Predicted Water Tables

Automated water table contours for the upper aquifer are presented on **Figure E–25**. These contours are based on the calculated head in model layer 3 of the manually calibrated model. This approximation works well because flow in the upper aquifer is largely horizontal. This layer corresponds to the bottom of the thick-bedded unit at the North Plateau and the bottom of the weathered Lavery till at the South Plateau. Units in the next layer down are the unweathered Lavery till, the slack-water sequence, and the Lavery till-sand.

Comparison of the contours in this figure with the 2007 fourth quarter North Plateau observed water table on Figure E–10 indicates close agreement in most areas of the North Plateau. The comparison is between the results of a steady-state calculation and a single snapshot in time of a dynamic system, the observed water table. Reasonable agreement between the contours in the two figures follows because the aquifer behaves as a steady-state system with small fluctuations over time and space. Exceptions occur, of course, when a major hydrologic stress is added to or removed from the system. An example of this includes tying off the French drain to the northwest of the lagoons in 2002 (WVNS and URS 2007). However, the target water levels (heads) used in the calibration were selected because they exhibit little or no trend over a time period that includes the introduction and removal of stresses. That is, the model was fit to those portions of the aquifer that have been constant over time.

There are several minor differences between the two sets (observed and modeled) of North Plateau contours that can be seen. These include contours in the immediate vicinity of the Main Plant Process Building and contours north of the lagoons. In the first case, differences arise due to limitations inherent in both figures. In the case of Figure E–25, the impact of the building on infiltration has been incorporated into the model, but any restriction of flow due to the subsurface building structure has not been incorporated. This is in part due to the size of the grid. On Figure E–11, only a limited number of locations provide control for contouring, whether done manually or automatically. The difference in the contours north of the lagoons in the two figures is that the predicted contours are as a group slightly lower than the observed contours, suggesting more water is needed in the modeled system in that area. This is also seen in the observed versus predicted heads plot (Figure E–23), where the cluster of locations near the 1,370-foot elevation lies above the one-to-one line.

The contours along the perimeter of the plateau directly across Erdman Brook from the NDA and SDA exhibit features that are the result of the model implementation. Perimeter seeps have been included in the model but the grid spacing is large at 43 meters (140 feet). This part of the North Plateau is also the area where the prediction of water elevations above the actual surface occurred during calibration of the model (Section E.3.5). Yager had a similar result and subsequently refined his model grid in the area (Yager 1987). A physical factor impacting flow in the area is the evolving new hydrostratigraphy. Because the slack-water sequence extends further upslope in the new interpretation, a possible effect of the new slack-water sequence/ Lavery till-sand is more of the flow in the surficial sand and gravel being directed through the slack-water sequence, diverted away from the perimeter seeps along Erdman Brook and Quarry Creek. A more refined interpretation of flow in this area would require further characterization of the Lavery till-sand. However, at present this is not expected to be a critical factor in the prediction of contaminant transport at the site.

A similar comparison can be made between modeled and observed South Plateau water tables. The observed South Plateau water table is on the bottom half of Figure E–12 and the modeled water table is shown on Figure E–25. Like the contours for the North Plateau, the contours in the two figures are similar, but the differences between the two figures are more noticeable. The differences again reflect the absence of some structures in the model and the relatively few data points available for contouring. Undisturbed subsurface

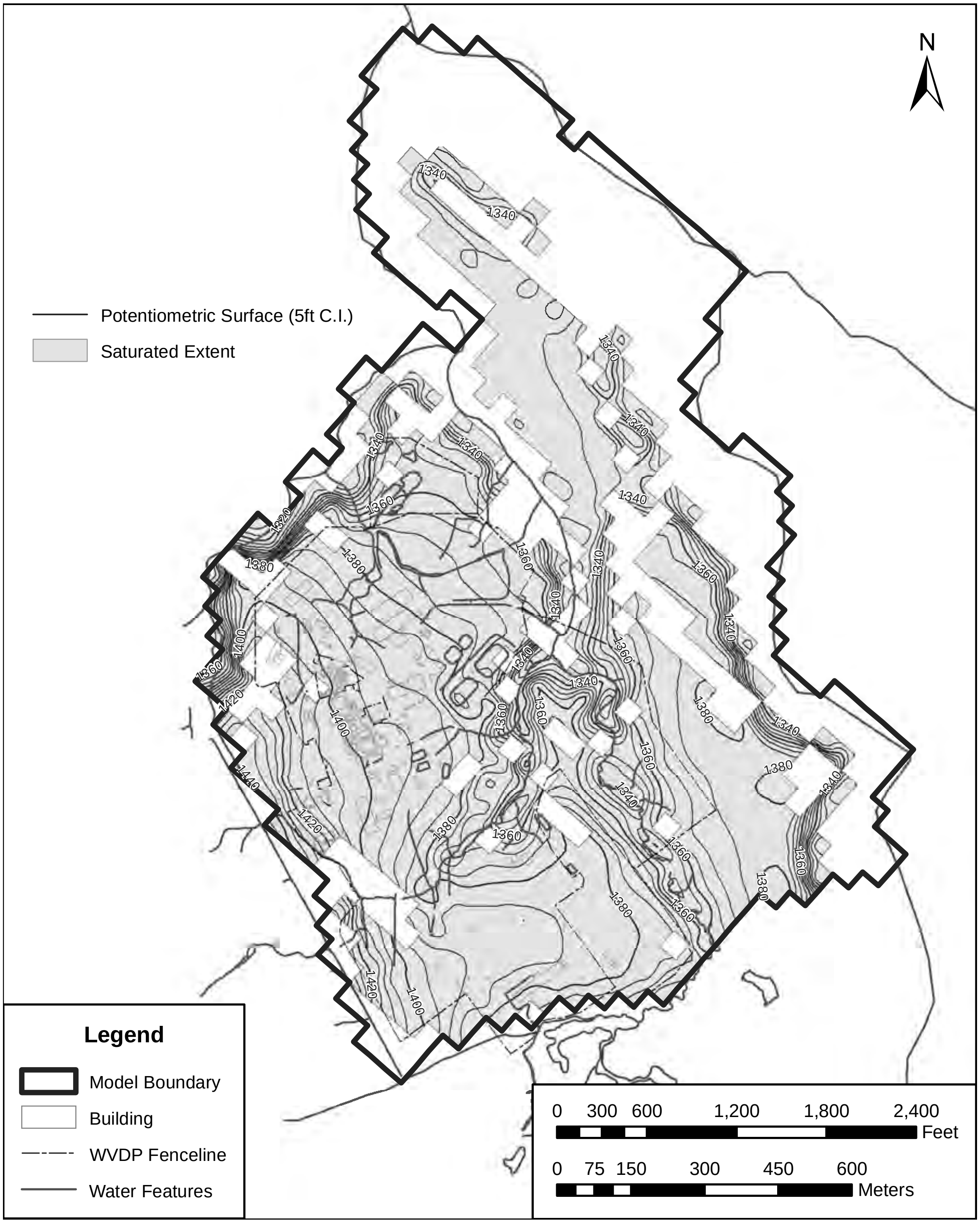


Figure E–25 Simulated Upper Aquifer Water Table in the Thick-bedded Unit and Weathered Lavery Till (Model Layer 3 Head)

conditions are presently modeled. Structures present but not included in the model are the actual disposal facilities. These consist of disposal pits, disposal trenches, the NDA interceptor trench, and the groundwater diversion barrier between the NDA and SDA. These clearly impact the system and any modeled or observed water table contours. The lack of explicit incorporation of these structures into the model may appear to be a limitation of the model but, when considered from the perspective of performance assessment and migration pathways, this limitation may not be too severe.

Two potential groundwater pathways have been identified for the materials disposed of in the NDA and SDA (Prudic 1986). The first pathway is a downward migration through the unweathered Lavery till from the disposal pits and trenches to the Kent recessional sequence and on from there. The second pathway is the result of the bathtub effect. Infiltration and interflow into the trenches and pits eventually raise the water levels in them until the water reaches the interface between the low-permeability unweathered Lavery till and more-permeable weathered Lavery till. From there, the water and any contaminant within it begins to move laterally through the weathered Lavery till saturated zone. That movement continues until the material either reaches a discharge location at a nearby stream or eventually turns down, moving vertically through the unweathered Lavery till. The distance from the release area and the downgradient weathered Lavery till discharge location determines which path is taken.

The first pathway, movement downward through the unweathered Lavery till, is probably not significantly impacted by the exclusion of the pits and trenches from the model. This is because, in their present configuration, these facilities contain standing water. The difference between the top elevation of that water and the top of the unsaturated zone in the Kent recessional sequence provides the driving force for the downward movement. In the case of the undisturbed, i.e., natural or pre-existing conditions model, a very similar driving force is imposed by the water table in the weathered Lavery till and the top of the Kent recessional sequence. Hence, little difference is expected. In analyzing the second pathway, the lateral transport can be approximated in the current model by simply placing the release at the weathered Lavery till/unweathered Lavery till interface, i.e., at the bottom of layer 3 in the weathered Lavery till.

Only a few controls are available for construction of the observed contours seen on Figure E–12 and multiple sets of contours—most similar—could be obtained from the data. Expert and site specific knowledge applied to the task do not appear explicitly in the figure but do shape it. In light of these considerations and the model-side limitations mentioned above, comparison of the figures is valid only up to a point. The two sets of contours are qualitatively and quantitatively similar—both echoing the topography of the South Plateau.

In addition to showing the head contours, Figure E–25 also provides an indication of the extent of the upper aquifer. Shading is included to identify those areas that are fully saturated. The figure shows much of the North Plateau and South Plateau model layer 3 to be saturated. The partially saturated areas occur along or near the steep banks of the stream valleys. The fingerlike East Plateau lying between Franks Creek and Buttermilk Creek is interesting because of the partial saturation along part of its crest. The cause of this effect was not determined, but flow in this area is not considered critical to the estimates of contaminant transport at the site.

Figure E–26 shows the head contours and saturation for model layer 12, which includes the bottom of the Kent recessional sequence. The narrow saturated area running along the western boundary is composed of bedrock and weathered bedrock. The belt of partial saturation to the east of the bedrock and along the southern model boundary is the Kent recessional sequence, as is the large area of saturation over the remainder of the site to the east. The picture of the lower aquifer as it emerges from the present model is one where the zone of saturation does not extend through all of the Kent recessional sequence. In saturated areas, the horizontal flow is in the direction of the Buttermilk Creek Valley, where the aquifer discharges either through seeps along the valley wall or directly into the creek itself.

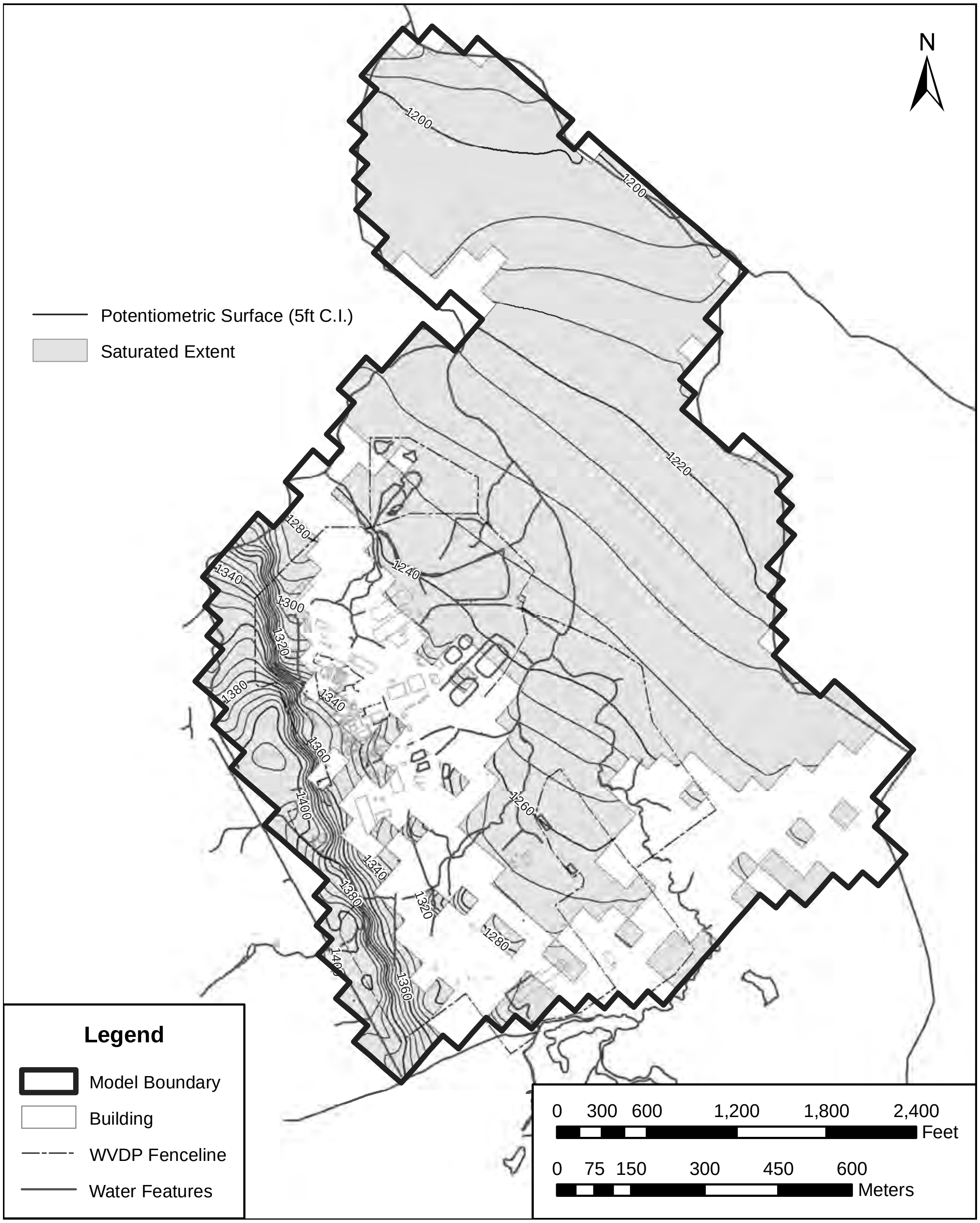


Figure E–26 Simulated Lower Aquifer Water Table in the Kent Recessional Sequence (Model Layer 12)

Figure E–27 is a cross section through the North Plateau showing all of the geohydrologic units found in the model and the water tables for the upper and lower aquifers. Median water level observations for a number of wells screened in the upper system are also shown in the plot. Consistent with the calibration, the observed water levels and the computed water table show good agreement. The profile view on Figure E–27 also aids in understanding the limited extent of the lower aquifer in the Kent recessional sequence. Areas where the aquifer pinches out, becoming partially saturated, correspond to locations where the Kent recessional sequence and the glacial materials (Kent till, Olean recessional sequence, Olean till) underneath it thin out as bedrock rapidly rises to the west.

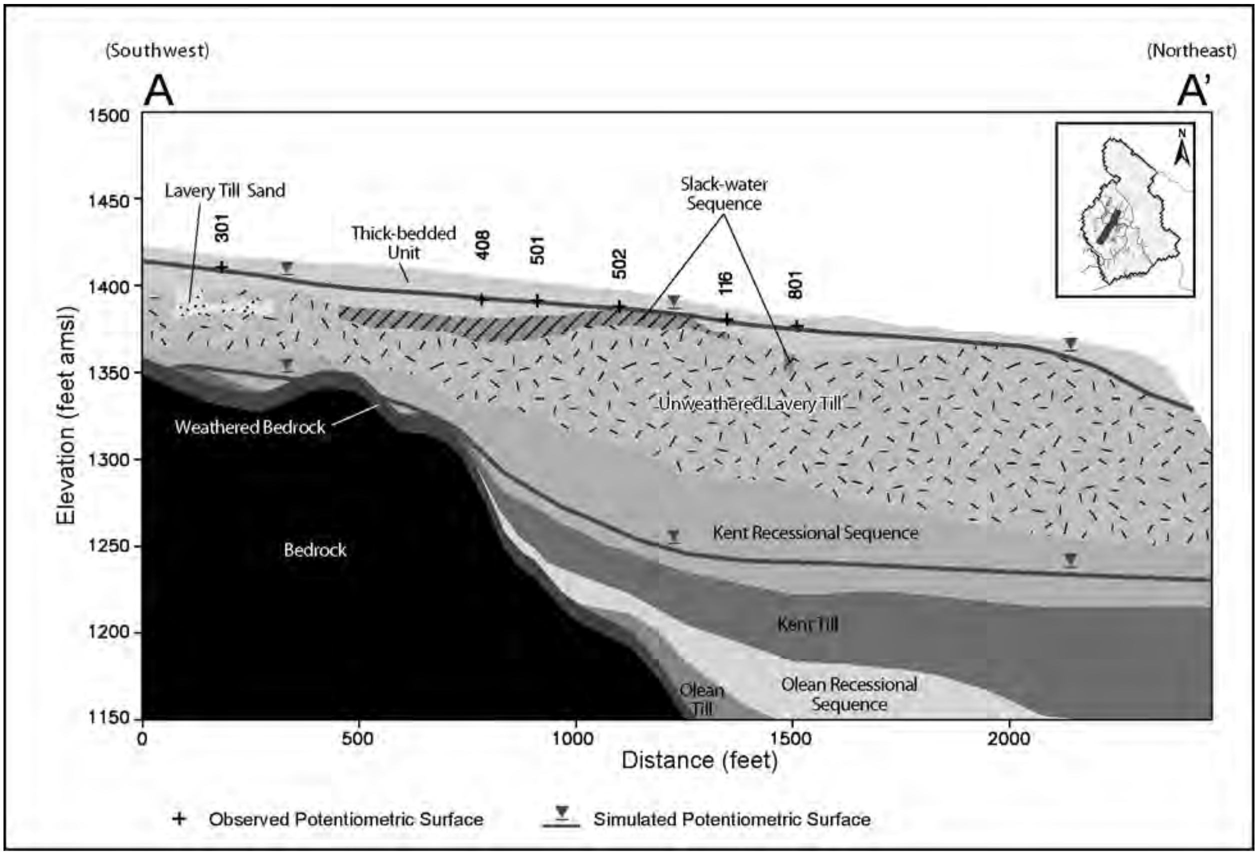


Figure E–27 Upper and Lower Aquifers Tables at the North Plateau

E.3.7.2 Groundwater Flow Directions

Figure E–28 shows the head contours and saturation in model layer 5. This layer consists mostly of unweathered Lavery till and slack-water sequence. The figure shows that most of this layer is saturated, in particular the unweathered Lavery till in the South Plateau. In the model, the saturation is maintained down to the top of the Kent recessional sequence and is consistent with descriptions summarized in previous characterizations and modeling studies of the South Plateau (Bergeron, Kappel, and Yager 1987; Kool and Wu 1991; Prudic 1986; WVNS 1993b). Calculated vertical nodal Darcy velocities in layer 5 beneath the NDA and SDA are on the order of 5×10^{-8} centimeters per second and the estimated linear velocities are about 5 centimeters per year. This is in good agreement with estimates made in the past studies. While this result is expected, it is worth noting because the calculations are made within the much larger model domain and the nodes are located far from any boundary condition nodes.

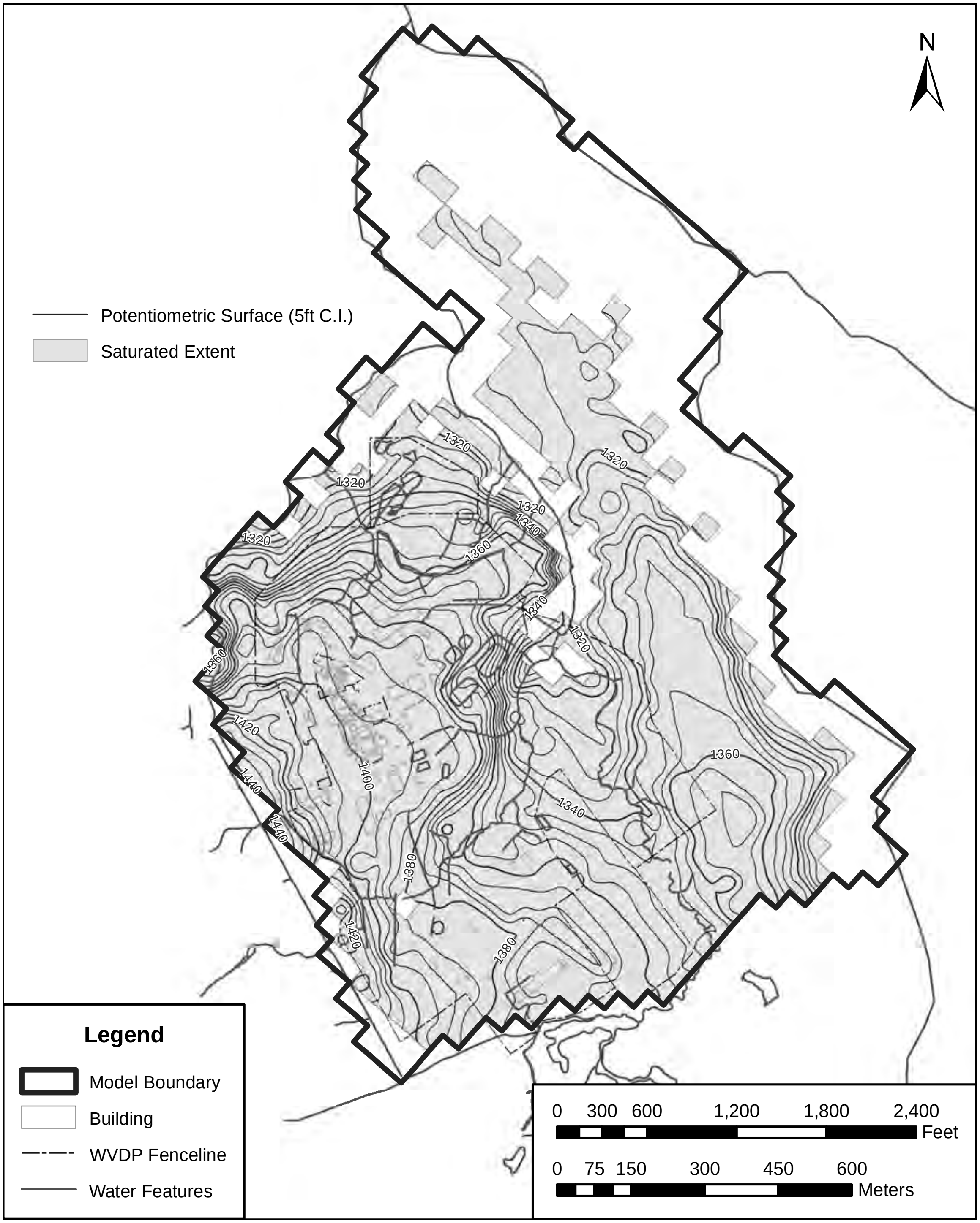
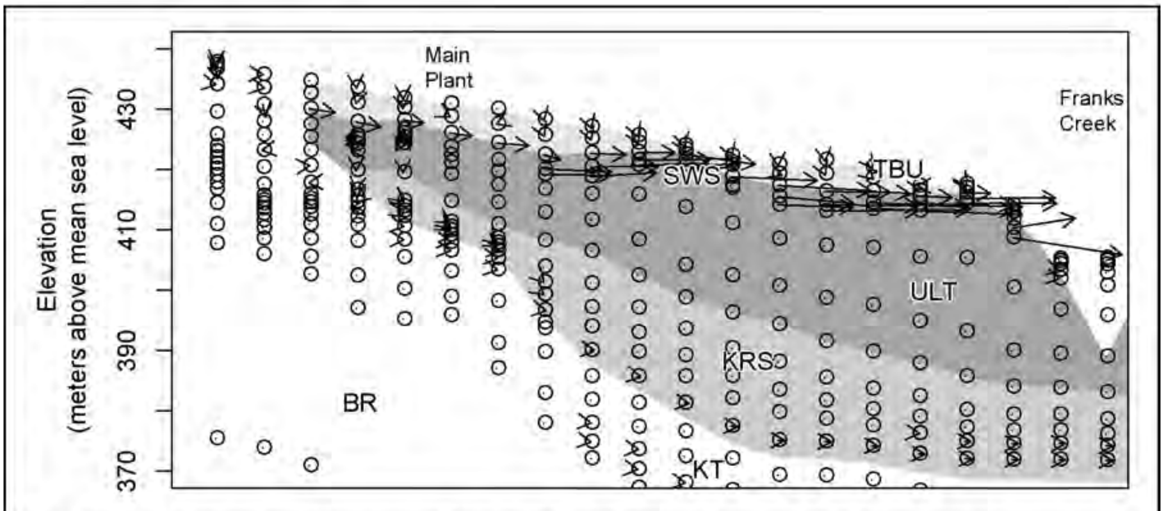


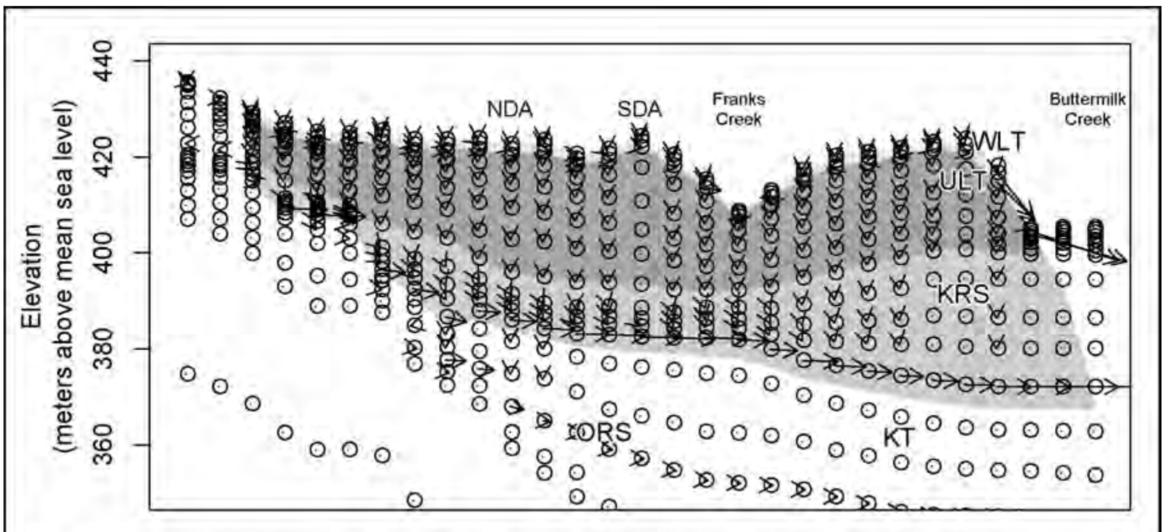
Figure E–28 Saturation in the Unweathered Lavery Till

Figures E–29 and **E–30** show vertical profiles of the velocity field for the North Plateau and the South Plateau, respectively. The arrows or vectors represent the relative magnitude of the flow at a location. The circles indicate the locations where the model provides estimates of the flow. On Figure E–29, the horizontal flow in the surficial sand and gravel is indicated by the mostly horizontal vectors in model layers 3 through 5, the bottom of the thick-bedded unit and the slack-water sequence. The length of each vector is an indication of the flow velocity at that location. The direction of the vector shows the direction of the groundwater flow at that location. The lower downward flow of groundwater through the unweathered Lavery till is indicated by the shortened vectors (heads only) pointing to the bottom of the figure. Horizontal flow in the lower Kent recessional sequence aquifer appears as the "row" of horizontal vectors in the lower mid portion of the figure. Figure E–30 presents similar information, except that the uppermost geohydrologic unit is the weathered Lavery till. Flow through the unweathered Lavery till in the South Plateau profile is vertical and flow along the bottom of the Kent recessional sequence is horizontal.



Key; BR = Bedrock; KRS = Kent Recessional Sequence; KT = Kent Till; SWS = Slack-water Sequence; TBU = Thick-bedded Unit; ULT = Unweathered Lavery Till.

Figure E–29 North Plateau Velocity Field in Profile



Key; KRS = Kent Recessional Sequence; KT = Kent Till; NDA = NRC [U.S. Nuclear Regulatory Commission-licensed Disposal Area; ORS = Olean Recessional Sequence; SDA = State-licensed Dispoasal Area; ULT = Unweathered Lavery Till; WLT = Weathered Lavery Till.

Figure E–30 South Plateau Velocity Field in Profile

The representation of velocity field as shown on Figures E–29 and E–30 is useful in showing how the different components of a groundwater system fit together. The figures, however, do not convey a sense of where individual particles or packets of contamination from a given location might be transported. This information is depicted by streamlines or flowlines that use velocity field information to identify the paths followed as particles (or water) move through the aquifer system. **Figures E–31** and **E–32** show streamlines from several locations of interest on the North and South Plateaus. The streamlines in these two figures are simplified two-dimensional representations illustrating several key concepts distilled from more-complex images produced by post-processing the three-dimensional model results.

For Case A in Figure E–31, a particle released into the flow system in the vadose zone of the thick-bedded unit near the Main Plant Process Building would initially move downward until it enters the saturated zone of the thick-bedded unit where it begins to move downgradient—essentially horizontally—to the northeast. In the vicinity of the slack-water sequence, it moves deeper into the slack-water sequence and, once in that unit, moves horizontally again eventually discharging from a seep on the south valley wall above Franks Creek. In Case B, the particle enters the groundwater system from a surface location uphill from the Main Plant Process Building. It moves downgradient in the direction of the Main Plant Process Building. As it moves horizontally, it slowly moves deeper into the saturated zone and eventually reaches the top of the unweathered Lavery till. Because of the unweathered Lavery till's very low permeability, the hydraulic gradient is vertically downward and the particle moves through the unweathered Lavery till, emerging in the unsaturated portion of the Kent recessional sequence. Movement through the unsaturated zone of the Kent recessional sequence, is also vertical. Once in the lower, saturated part of the Kent recessional sequence, movement is again horizontal to the northeast and discharge occurs along the valley wall of the Buttermilk Creek Valley.

Case C shows what happens when release is near the uphill, or western edge of the model. Here, the valley fill materials are pinching out and the streamline quickly transits through them and into the weathered bedrock. From there the particle moves down-slope in the weathered bedrock adjacent to the glacial materials. From there it may at some point reenter one of the more-permeable fill units such as the Kent recessional sequence or the Olean recessional sequence, or it may continue movement through the weathered bedrock and eventual discharge from that unit. In Case D, the particle enters the system from a surface location downhill from the Main Plant Process Building, approximately halfway to Franks Creek to the northeast. It travels through the thick-bedded unit unsaturated zone, enters the saturated thick-bedded unit, and moves downgradient to the northeast where it discharges to the surface, e.g., a drainage ditch or a swampy area.

The behavior of the South Plateau streamlines in Figure E–32 is similar. One difference from the North Plateau is the surface mantle of weathered Lavery till—a material with lower hydraulic conductivities. In Case A, a particle is released at or near the surface of the weathered Lavery till where it moves down through the unsaturated zone until it hits the shallow saturated zone above the interface with the unweathered Lavery till. There it moves laterally downgradient to discharge at a nearby stream, swampy area, or swale. Because the South Plateau's weathered Lavery till has a lower hydraulic conductivity than the North Plateau's thick-bedded unit, the rate of lateral movement through the former's saturated zone is slower by comparison. As the point of introduction of the particle becomes further away from a discharge area, the particle is more likely to enter the unweathered Lavery till, moving vertically downward—and not discharging locally. This is illustrated in Cases B and C of the figure, where the points of entry are in the NDA and SDA, respectively. Case D, shown for the SDA, but equally applicable to the NDA, shows the fate of a particle introduced into the system deep in the unweathered Lavery till instead of at or near the surface. Under these circumstances, the initial movement is vertically downward through the till and the unsaturated zone of the Kent recessional sequence. Upon reaching the saturated Kent recessional sequence the direction of movement is again horizontal toward the Buttermilk Creek Valley seeps to the northeast. Cases E and F show the result when a particle is released further uphill, admitting a greater possibility for movement down into the deeper units such as the Olean recessional sequence or the weathered bedrock.

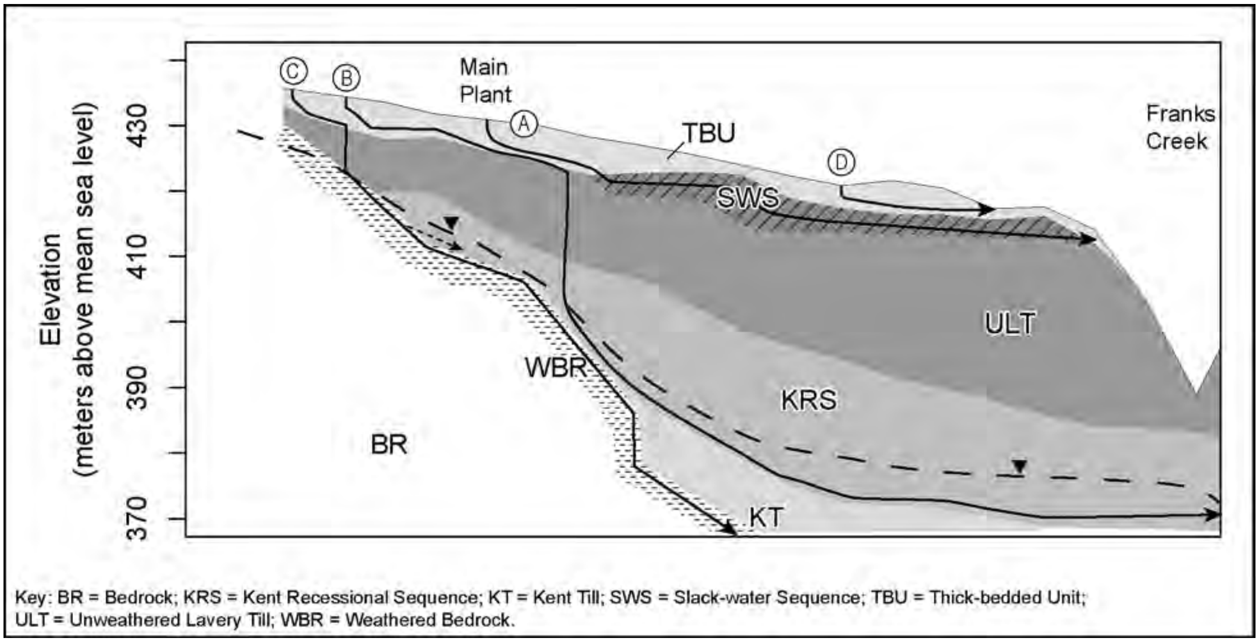


Figure E–31 Streamlines in the North Plateau Flow Field

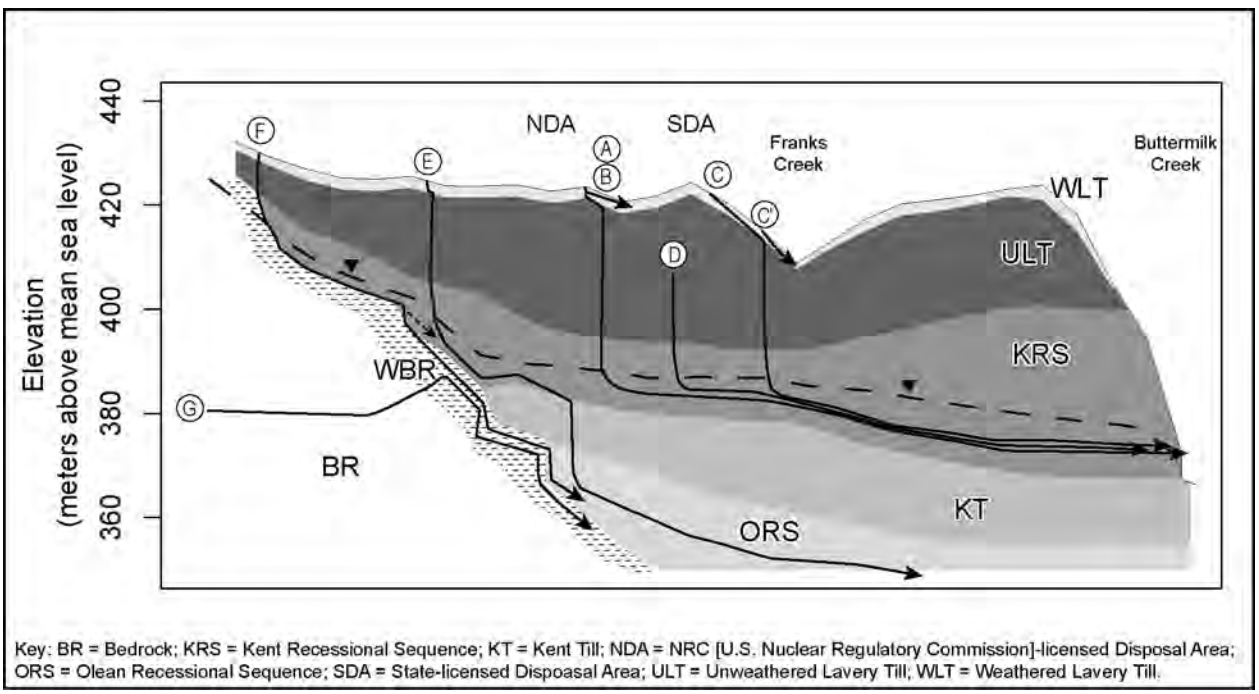


Figure E–32 Streamlines in the South Plateau Flow Field

Streamline G was added to Figure E–32 to indicate the movement of groundwater entering the model from bedrock along the western boundary. This picture is developed from examination of three dimensional streamlines and qualitative hydrological considerations. In the bedrock between the boundary and the weathered bedrock/valley fill, flow is essentially horizontal toward the weathered bedrock.

Upon reaching the weathered bedrock, flow is then directed downhill in that material. Such water entering the weathered bedrock may then continue to move through it or, depending on origin and location, move into one of the more-permeable valley units (the Kent recessional sequence or Olean Recession Sequence). It should be noted that similar paths likely exist for waters originating at or near the ground surface along the western boundary. This possibility is indicated in Figure E–32 by the dash arrow associated with the Case F streamline.

Figure E–33 presents a plan view of the North Plateau with streamlines originating in the vicinity of the Main Plant Process Building and the Waste Tank Farm. A pair of streamlines originate from each location—one for a shallower source in the thick-bedded unit and one for a deeper source in that same unit. Here the streamlines remain in the thick-bedded unit or slack-water sequence until discharge along the banks of the Franks Creek Valley. **Figure E–34** shows a plan view of streamlines originating at two locations in the NDA, three locations in the SDA, and one location in the Radwaste Treatment System Drum Cell Area. With one exception for each location there is a shallow release streamline in which the particle is released into the unsaturated zone of the weathered Lavery till and a deeper release streamline in which the particle is released at depth in the unweathered Lavery till.

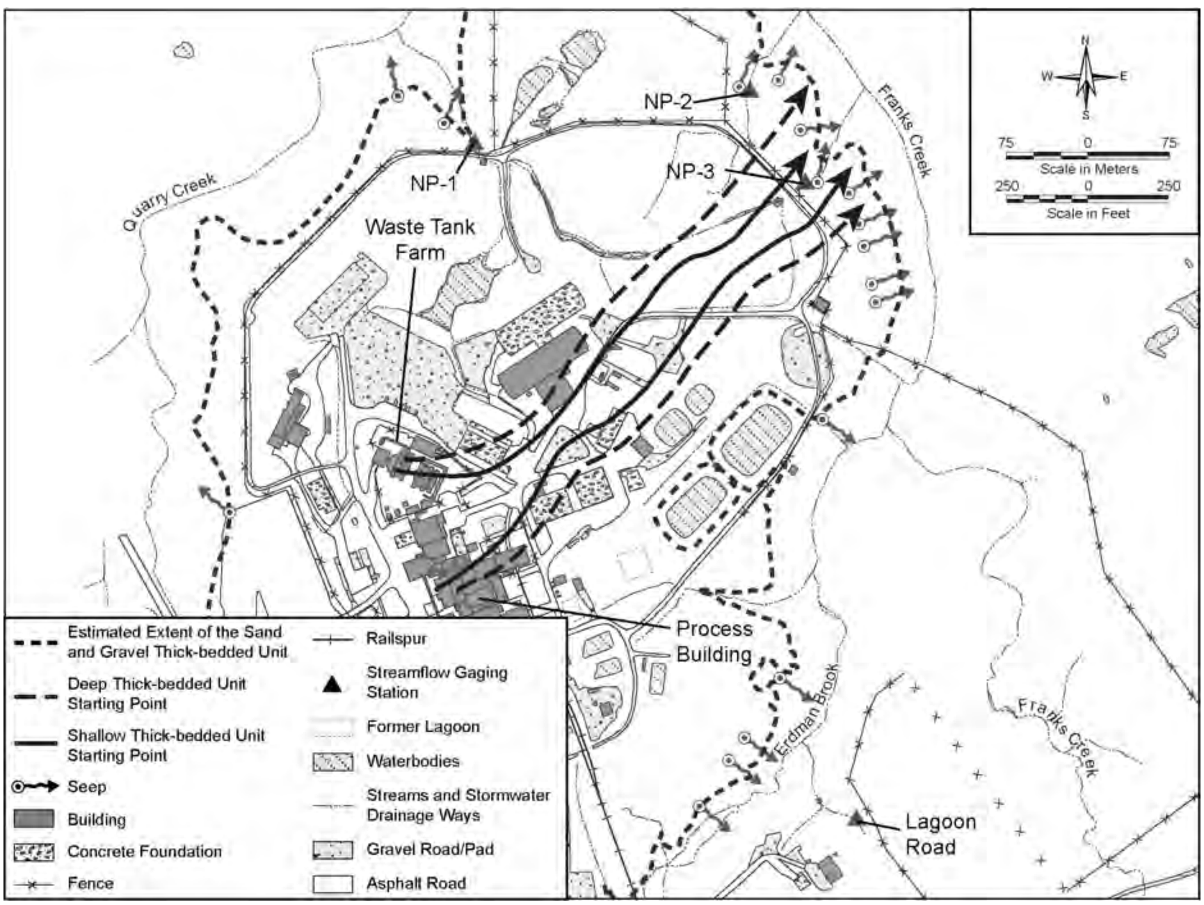


Figure E–33 Modeled Streamlines from the Vicinity of the Main Plant Process Building and the Waste Tank Farm

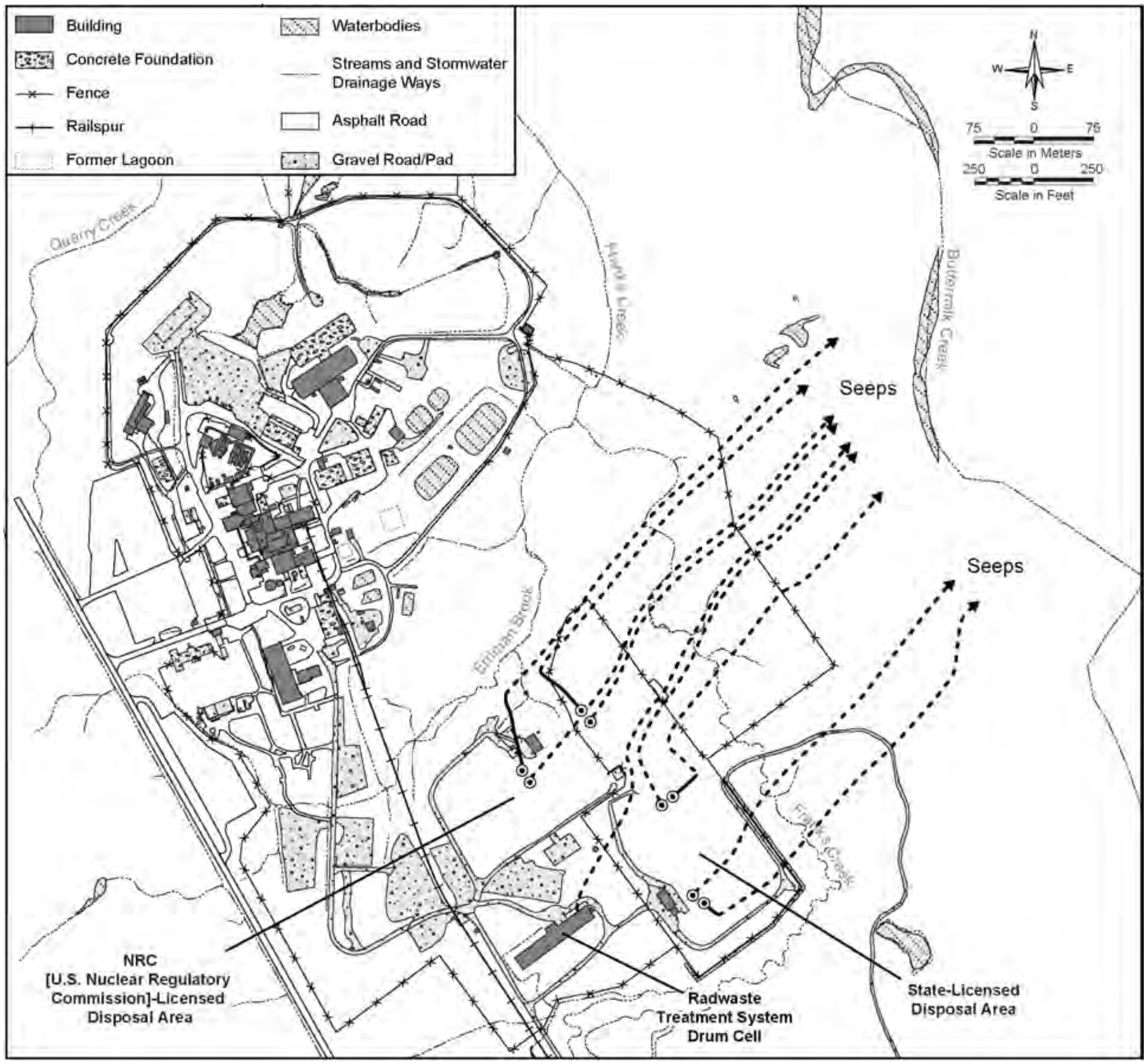


Figure E–34 Modeled Streamlines from the NRC-Licensed Disposal Area and the State-Licensed Disposal Area

Flow in the weathered Lavery till and the direction of flow in the saturated zone is strongly influenced by topography.[2] Thus, at the south end of the SDA, the shallow release streamline initially moves down into the saturated zone of the weathered Lavery till. The streamline moves laterally in the direction of Franks Creek, also, slowly sinking through the saturated zone until it reaches the top of the unweathered Lavery till. At this point it moves vertically down through the unit, into and through the unsaturated zone of the Kent recessional sequence. Upon reaching the Kent recessional sequence saturated zone, movement is once again to the northeast toward eventual discharge along Buttermilk Creek. The deep release from the unweathered upper portion of the Lavery till at the south end of the SDA initially moves vertically through that unit and the unsaturated Kent recessional sequence until it reaches the saturated portion of the Kent recessional sequence and turns toward discharge along Buttermilk Creek.

[2] *The gridding topography in the site model (FEHM model) is coarse. Discussion uses the result of that model here for the purpose of discussion, but actual conditions existing on site will be different in detail.*

Similar patterns are observed for the shallow and deep releases at the other locations too, except that the lateral movement in their respective saturated Lavery till segments are in the directions of other controlling stream valleys or low areas, e.g., Erdman Brook. The deeper release streamline from the center of the SDA does not move toward Buttermilk Creek when it reaches the saturated portion of the Kent recessional sequence. Instead, it initially moves to the northwest before bending back to the northeast and Buttermilk Creek. A clue to this behavior can be found on Figure E–26 where the water table contours indicate local flow to the northeast. This local flow direction also shows up in the streamline originating at the drum cell area as it transits the Kent recessional sequence in the vicinity of the SDA. The drum cell streamline is the exception alluded to above and was included just for this point.

E.3.7.3 Flows

An effort has been made to estimate flows into and out of some of the units of interest. The calculations are approximate because of the geometric complexity and grid configuration of the model. Still, the overall flows look reasonable.

South Plateau – the NDA

A simplified "water balance" calculation for the weathered Lavery till in the NDA was performed. The simplified calculation uses the differences between the nominal net infiltration (precipitation less runoff and evapotranspiration) for several nodes in the NDA and the vertical Darcy velocities of the unweathered Lavery till nodes immediately below in layer 4 to estimate the quantity of groundwater moving laterally through the weathered Lavery till to discharge in neighboring streams, swampy areas, or swales. The average net infiltration per unit area is 2.5 centimeters per year and the model average deep percolation into the unweathered Lavery till is 1.64 centimeters per year. The difference between these two flows, is the estimated discharge to the surface, 0.86 centimeters per year. Thus, approximately one-third of the net infiltration into the weathered till is diverted to the surface.

North Plateau – the Thick-bedded Unit

A water balance for the thick-bedded unit is a little more complex. There are two sources that provide water to the unit. First, the net infiltration for thick-bedded unit cells at the surface in the model is 27.1 centimeters per year—this was determined by summing the model-specified infiltration at each thick-bedded unit location (cell). In addition, there is the specified inflow at the western boundary of the model. This input, when normalized to a unit area for the thick-bedded unit, is 2.03 centimeters per year. The total input to the thick-bedded unit is then 29.1 centimeters per year per unit area.

Flow from the thick-bedded unit includes discharge to seeps and vertical movement down into the units directly below it. Discharge at the major seeps is estimated to be 18.3 centimeter per year—this is the 211 cubic meters per day in Table E–7, normalized to 1 year and a unit area of 1 square meter. The units receiving flow from the thick-bedded unit include the unweathered Lavery till, the Lavery till-sand, the slack-water sequence, and the weathered bedrock. Vertical Darcy velocities in model layer 4—directly beneath the thick-bedded unit—were used to estimate flow into these lower units. The average downward flow from the thick-bedded unit turns out to be 5.6 centimeters per year—again per unit area. The total calculated flow from the thick-bedded unit is then 23.9 centimeters per year per unit area. The calculations indicate that approximately 17 percent of the vertical flow from the thick-bedded unit is to the unweathered Lavery till, 8 percent to the Lavery till-sand, 74 percent to the slack-water sequence, and 0.3 percent to the weathered bedrock.

E.3.7.4 Alternative Conceptual Model – Weathered Bedrock Outlet

One of the modeling questions to be addressed by the current effort is to explore how flow out of the system by way of the weathered bedrock might impact flows in the upper units down to and including the Kent recessional sequence. That is, can the geohydrology below the Kent recessional sequence safely be ignored when modeling the impacts of surface and near-surface facilities at the site? To examine that aspect, the base case model was modified to allow flow out of the system to the north from the weathered bedrock. This was accomplished by setting constant head boundary conditions in a small segment of the boundary weathered bedrock cells near the bedrock valley axis located in that unit approximately beneath the northernmost reach of Buttermilk Creek in the model.

The weathered bedrock constant head used at these locations was varied in several runs, in each case using a single value ranging from 1,160 feet to 1,210 feet. A comparison of predicted target heads and predicted seep values in the different runs and the base case model reveals very little differences for the heads in the upper units (through the Kent recessional sequence). Drawing on these results and on the velocity fields seen for the base case (Figures E–29 and E–30), the implication is that the deeper aquifer systems in the Buttermilk Creek basin can be ignored with little consequence when modeling impacts of near-surface facilities.

E.4 Near-field Groundwater Flow Models

The three-dimensional sitewide groundwater flow model provides a basis for understanding of the rates and directions of groundwater flow for current conditions, but does not provide information for Sitewide Close-In-Place or Phased Decisionmaking Alternative conditions. In addition, the scale of engineered features is small with respect to the scale of the sitewide flow model. For these reasons, three three-dimensional near-field groundwater flow models have been developed to supplement simulation of conditions on the North and South Plateaus. The models have been implemented using the STOMP computer code developed at Pacific Northwest National Laboratory (PNNL 2000). STOMP uses the integrated volume finite difference approach to solve flow and transport equations for unsaturated and saturated conditions. The approach for development of the near-field model is to use the stratigraphy and boundary conditions incorporated into the site-wide model to the extent possible with the STOMP computer code. Flow and transport calculations of the near-field models are used to establish directions and velocities of flow through and away from sources on the North and South Plateaus. To provide understanding of the nature of one-dimensional flow models used in estimation of human health impacts, description of use of a one-dimensional groundwater transport model is presented in the discussion of historical conditions. The following sections describe the near-field models for the North and South Plateaus.

E.4.1 North Plateau

The model developed for the North Plateau has the irregular shape of the lateral extent of the surficial sand and gravel unit and extends from the ground surface to the top of the Kent recessional sequence. The exterior horizontal boundaries of the model are depicted on **Figure E–35**. Geohydrologic units represented in the model are the thick-bedded unit, the slack-water sequence, and the unweathered Lavery till. Together, the thick-bedded unit and the slack-water sequence constitute the surficial sand and gravel unit. As described above, the thick-bedded unit comprises glaciofluvial gravel and alluvial deposits that range from 1 to 6 meters in thickness overlying the unweathered Lavery till. The slack-water sequence is a depositional sequence with layers of gravel, sand, and silt filling a southwest-to-northeast trending channel in the upper portion of the unweathered Lavery till.

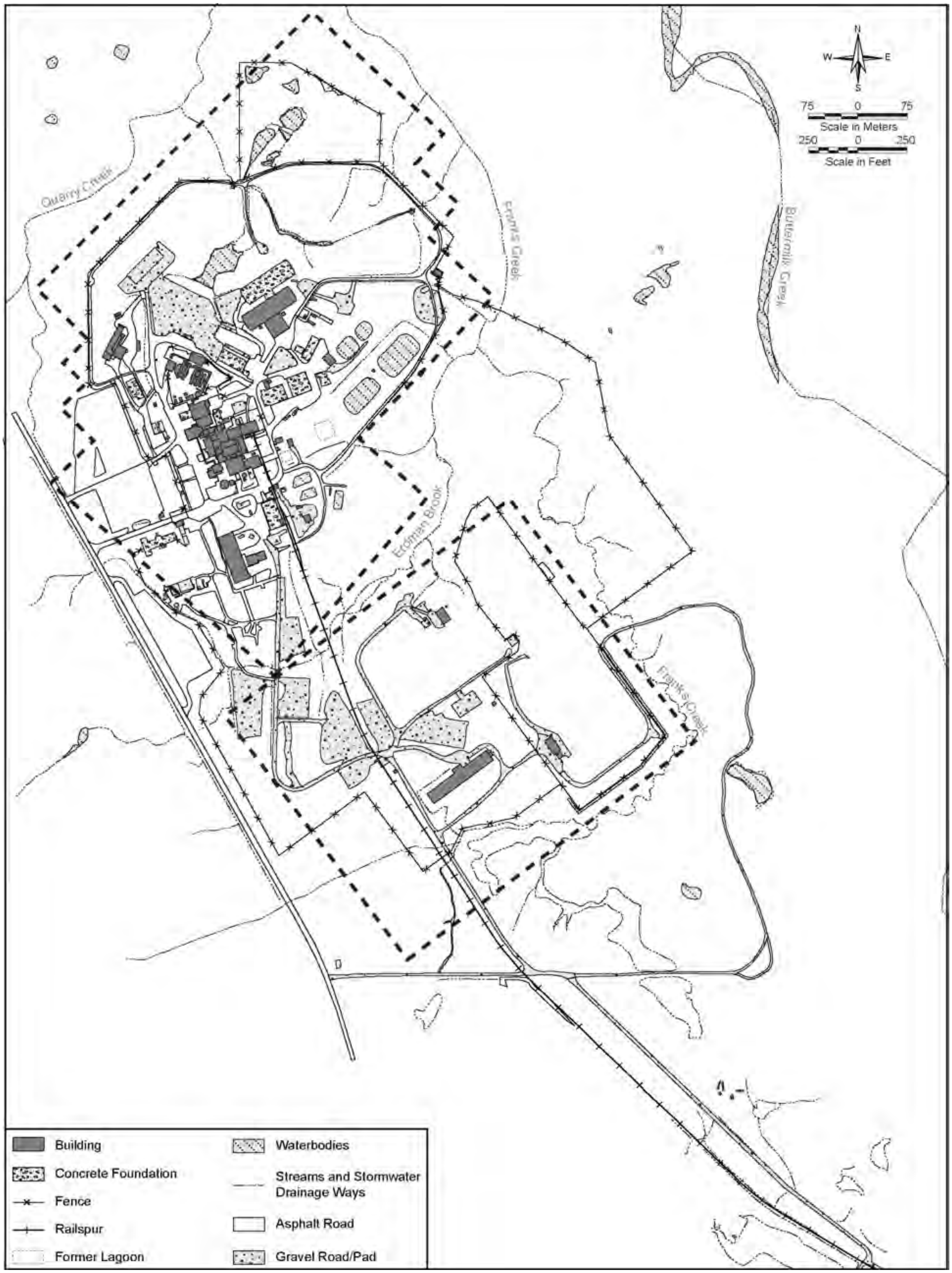


Figure E–35 Boundaries of Model Areas for the North and South Plateau Near-field Groundwater Flow Models

The slack-water sequence varies in thickness from 0 to 5 meters with the thickest portions at the southwest end of the unit below the Main Plant Process Building. The unweathered Lavery till is a glacial till with lenses of silt and sand with a range of thickness of 10 to 17 meters in the model volume. The Waste Tank Farm tanks are located in an excavation of the unweathered Lavery till located at the west side of the model volume. The excavation is simulated as having horizontal dimensions of 90 meters by 60 meters extending vertically 13 meters through the thick-bedded unit into the Lavery till. The two major tanks present in the excavation are represented as rectangular monoliths with horizontal dimensions of 20 meters by 20 meters and height of 10 meters. The cross-sectional structure encoded into the North Plateau near-field flow models is represented on **Figures E–36** through **E–40**. The slack-water sequence appears in the units and northern portions of the model as shown on Figures E–38 through E–40. The Waste Tank Farm excavation appears in the center portion of the model as shown on Figure E–39. Hydraulic conductivities of geohydrologic units are assumed constant over the model domain with values of 2.5×10^{-3}, 5.3×10^{-3}, and 6.0×10^{-8} centimeters per second for the thick-bedded unit, slack-water sequence, and unweathered Lavery till, respectively. For the near-field flow models, the Brooks-Corey relation (Bear 1972) was used to represent the dependence of pressure and hydraulic conductivity on moisture content. Values of the bubbling pressure (h_b) and pore size distribution (λ) parameters of the relation presented in **Table E–8** were selected to match the soil textures of the units and to provide consistency with the relations used in the sitewide groundwater flow model. These general elements of the near-field model were developed further into three variants, the first developed for historical conditions as appropriate for the No Action Alternative, the second incorporated engineered features as appropriate for the Sitewide Close-In-Place Alternative, and the third incorporated the slurry walls present for the Phased Decisionmaking Alternative.

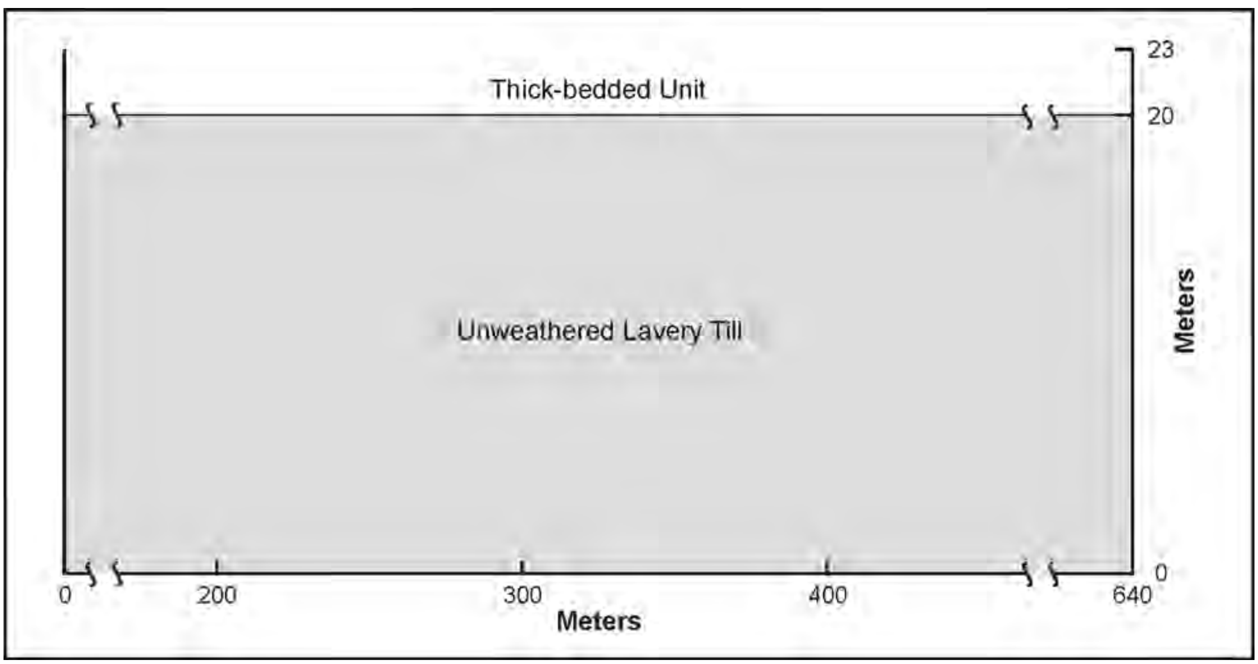


Figure E–36 Cross Section of the Near-field Groundwater Flow Model of the North Plateau: Southwest to Northeast Distance of 0 to 80 Meters

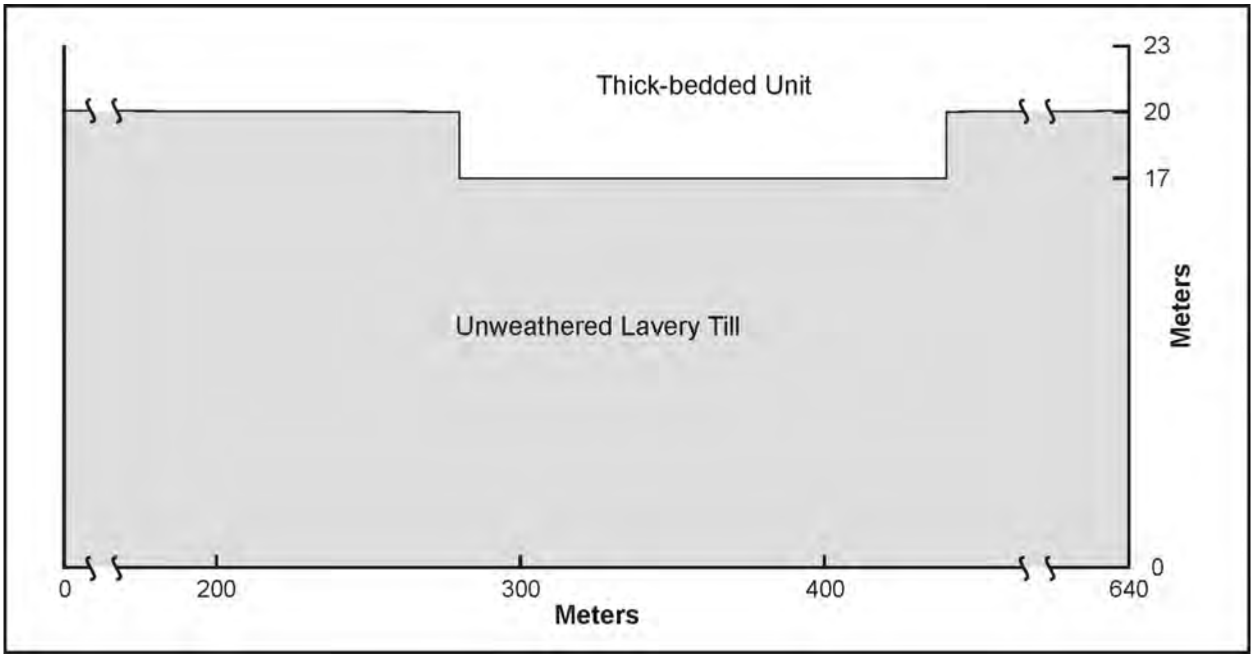


Figure E–37 Cross Section of the Near-field Groundwater Flow Model of the North Plateau: Southwest to Northeast Distance of 80 to 120 Meters

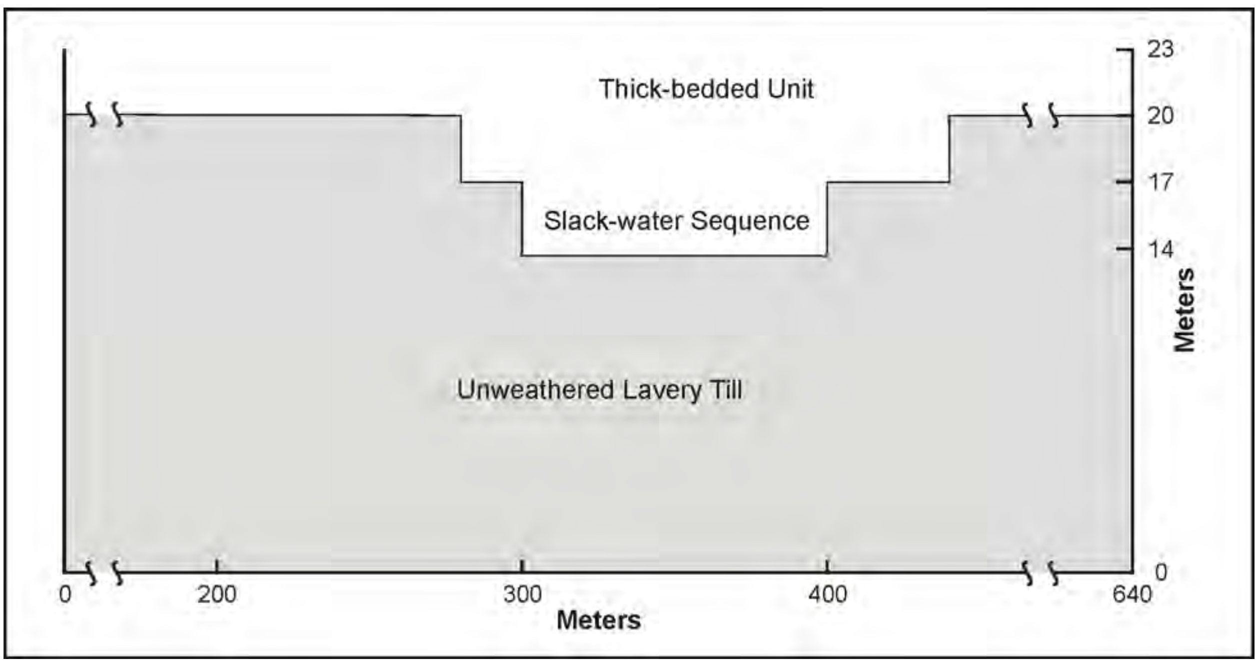


Figure E–38 Cross Section of the Near-field Groundwater Flow Model of the North Plateau: Southwest to Northeast Distance of 120 to 250 Meters

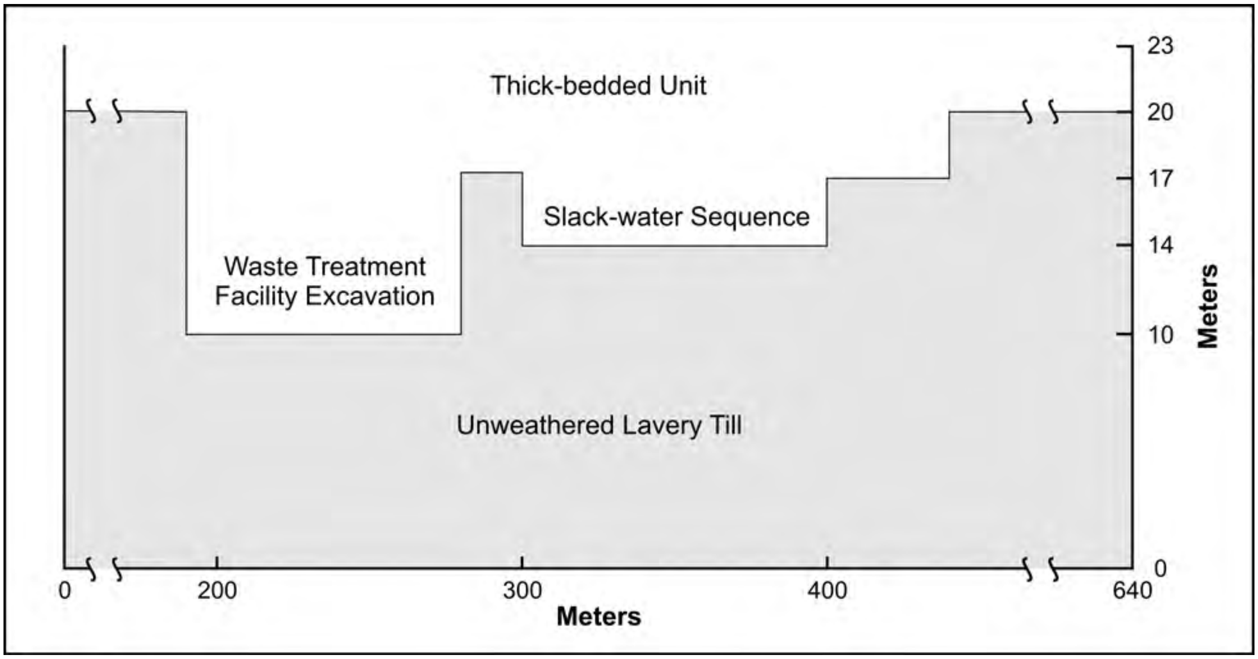


Figure E–39 Cross Section of the Near-field Groundwater Flow Model of the North Plateau: Southwest to Northeast Distance of 250 to 310 Meters

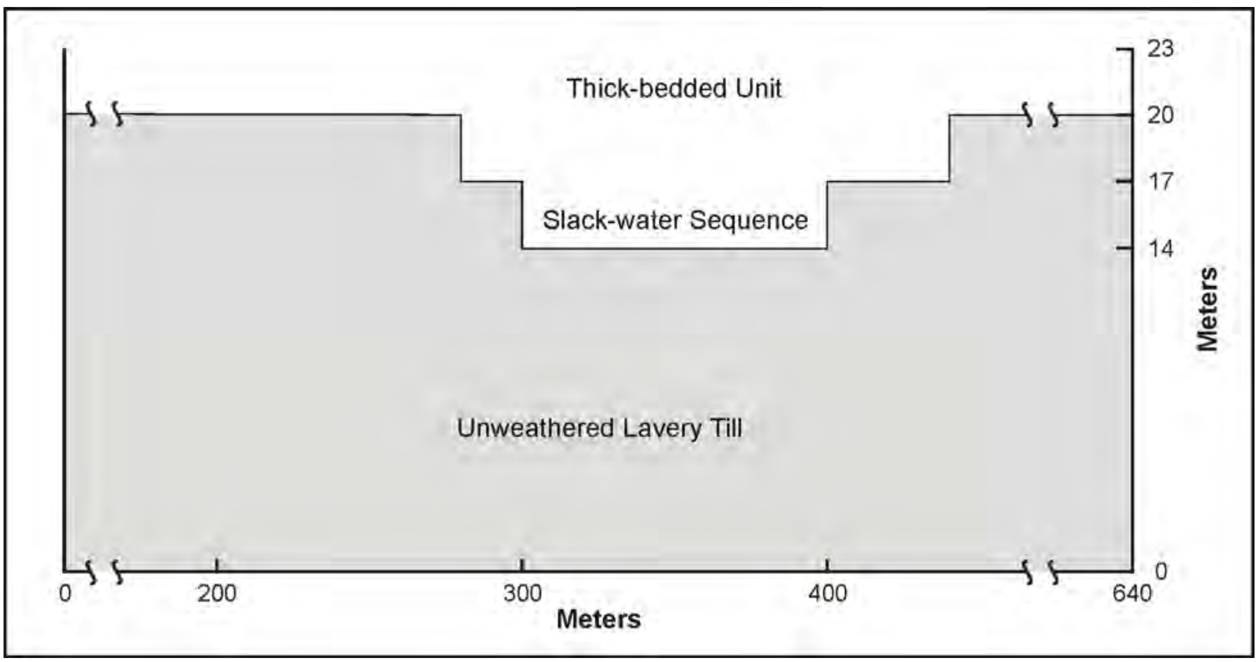


Figure E–40 Cross Section of the Near-field Groundwater Flow Model of the North Plateau: Southwest to Northeast Distance of 310 to 820 Meters

Table E–8 Soil Moisture Characteristics for the Near-field Flow Models [a]

Material Type	*Saturated Moisture Content*	*Residual Saturation*	h_b *(centimeters)*	λ	*Saturated Hydraulic Conductivity (centimeters per second)*
Thick-bedded Unit	0.225	0.10	7	1.67	2.5×10^{-3}
Slack-water Sequence	0.35	0.10	7	1.67	5.3×10^{-3}
Weathered Lavery Till	0.324	0.20	340	0.157	4.65×10^{-5}
Unweathered Lavery Till	0.324	0.20	340	0.157	6.0×10^{-8}

h_b = bubbling pressure; λ = pore size distribution.
[a] Values of the Brooks-Corey moisture characteristic parameters were selected from Meyer and Gee 1999 for sand (thick-bedded unit and slack-water sequence) and silty clay (weathered and unweathered Lavery till).

E.4.1.1 Historical Conditions (No Action Alternative)

To simulate historical conditions, the horizontal portion of the model grid is composed of rectangular blocks with 64 blocks in the southwest-to-southeast direction ranging in size from 1 to 65 meters and 81 blocks in the southwest-to-northwest direction ranging in size from 1 to 50 meters. In the vertical direction, the upper 3 meters were represented using 15 0.2-meter-thick layers, the next 3 meters were represented using 6 0.5-meter-thick layers, and the bottom 17 meters were represented using 17 1.0-meter-thick layers. Thus, this variant of the model utilizes approximately 174,000 grid blocks.

Boundary conditions applied for the near-field model are consistent with site observations and with those applied for the sitewide model. At the bottom of the unweathered Lavery till, atmospheric pressure was applied representing the presence of a water table in the Kent recessional sequence. On each side of the model, no-flow conditions were applied for the unweathered Lavery till. On the southwest side of the model, lateral recharge into the thick-bedded unit of 20 cubic meters per day was applied. On the southeast side of the model, atmospheric pressure conditions were applied for the thick-bedded unit to represent seepage to Erdman Brook. At the northwest and northeast boundaries of the model, atmospheric pressure conditions were specified to represent seepage to Quarry Creek and Franks Creek, respectively.

For recharge at the surface, uniform spatial distribution was applied but varied in a parametric fashion to provide the best match to site conditions. Specification of atmospheric pressure was used to represent seepage to the North Plateau ditch.

Pressures simulated with the North Plateau near-field model are summarized in **Table E–9**, along with measured conditions at target wells. The results indicate that a uniform recharge of 26 centimeters per year produced the closest match to observed conditions. A plot of elevation of the water table in the thick-bedded unit for a recharge of 26 centimeters per year is presented on **Figure E–41**. The results are consistent with both the measured heads and with the predictions of the sitewide model. A summary of the flow balance for the historical conditions model, presented in **Table E–10**, indicates that the majority of groundwater enters the system as recharge at the ground surface and exits the system to creeks at the northeast boundary, primarily Franks Creek. Downward flow into the Kent recessional sequence is 2.2 centimeters per year, approximately 8 percent of recharge at the ground surface.

Table E–9 North Plateau Near-field Flow Model Calibration for Head

Well	*Measured Head (feet)*	*Predicted Head (feet)*		
		Recharge = 18 centimeters per year	*Recharge = 26 centimeters per year*	*Recharge = 34 centimeters per year*
103	1,391.4	1,386.8	1,391.6	1,394.5
104	1,385.5	1,379.6	1,383.1	1,385.7
116	1,380.5	1,372.4	1,376.8	1,379.4
203	1,394.4	1,400.2	1,401.6	1,404.2
205	1,393.1	1,397.9	1,399.2	1,401.2
301	1,410.7	1,401.9	1,406.8	1,410.6
401	1,410.3	1,401.5	1,406.4	1,409.5
406/86-08	1,393.5	1,394.1	1,397.4	1,400.0
601	1,377.3	1,376.9	1,378.9	1,380.9
603	1,391.9	1,395.0	1,397.0	1,399.6
604	1,391.6	1,389.7	1,391.9	1,394.6
86-09	1,391.8	1,391.6	1396.5	1,399.8
408	1,391.8	1,391.0	1,394.8	1,398.4
501	1,391.3	1,386.8	1,391.5	1,394.5
403	1,408.0	1,401.1	1,405.8	1,409.1
801	1,376.6	1,369.3	1,373.1	1,375.7
804	1,369.9	1,356.0	1,359.2	1,360.4
86-12	1,364.8	1,343.6	1,345.2	1,346.8
Sum of Squared Residuals (square feet)		1,111.4	730.1	831.4

Table E–10 Summary of Volumetric Flows for the North Plateau Near-field Model, Historical Conditions

Direction/Unit	*Volumetric Flow Rate (cubic meters per year)*
In	
Recharge at the Ground Surface	107,624
Seepage from Bedrock on the Southwest	7,304
Out	
Down Flow to the Kent Recessional Sequence	9,060
Seepage to Quarry Creek	8,456
Seepage to Franks Creek	66,713
Seepage to Erdman Brook Creek	15,238
Seepage to the North Plateau Ditch	15,445

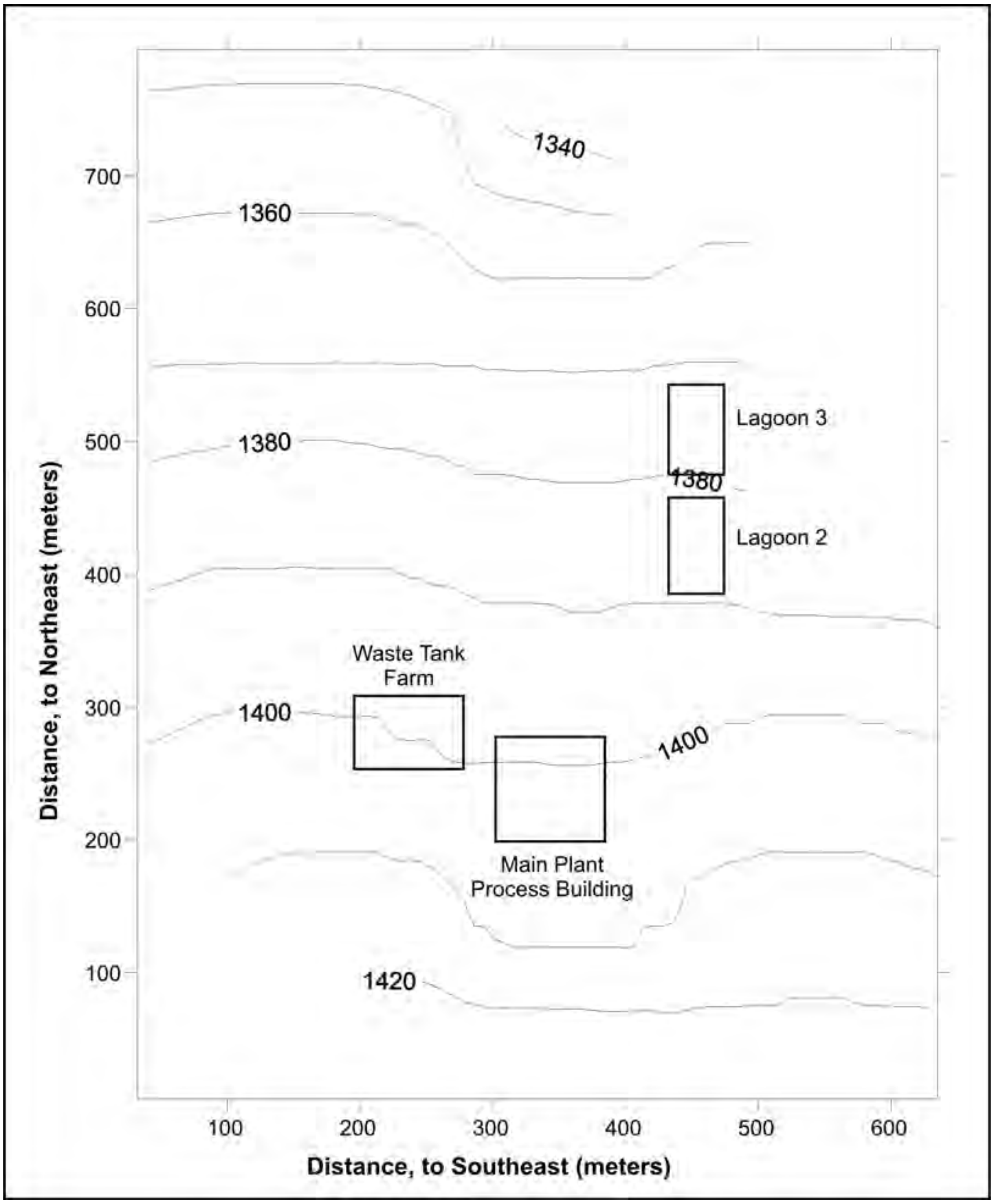


Figure E–41 Water Table Plot for the North Plateau Near-field Flow Model, Historical Conditions

As an additional check of validity of the model, transport calculations were performed for comparison to GeoProbe® measurements of the concentration of strontium-90 in the North Plateau Plume (WVNS 1995). The major source for the plume is believed to be a leak in 1968 from the Main Plant Process Building into the underlying sediments. For this analysis, the leak was represented as an injection of 200 curies of strontium-90 into the central portion of the thick-bedded unit. Two versions of the analysis were performed to evaluate the range of adsorption of strontium onto the sediments of the thick-bedded unit and slack-water sequence. In the first case, the thick-bedded unit and slack-water sequence were assumed to have values of a distribution coefficient of 5.0 milliliters per gram. In the second case, the distribution coefficients for the thick-bedded unit and slack-water sequence were 3.0 and 5.0 milliliters per gram, respectively. These values are within the range observed in site-specific laboratory measurements (Dames and Moore 1995) and using GeoProbe®

measurements (WVNS 1999). The results presented in **Table E–11** indicate that the combination of values of the distribution coefficient (K_d) produces the best match to measured concentrations, and that the model predictions for the center of mass of the plume are consistent with observed conditions.

Table E–11 Comparison of North Plateau Near-field Flow Model Predictions With Observed North Plateau Plume Concentrations of Strontium-90

GeoProbe Number	*Distance from Source (meters)*	*Concentration of Strontium-90 (picocuries per liter)*		
		Observed [a]	*Predicted* [b] *TBU K_d = 5 ml/g SWS K_d = 5 ml/g*	*Predicted* [b] *TBU K_d = 3 ml/g SWS K_d = 5 ml/g*
75	25	1.5×10^5	8.0×10^5	6.0×10^5
30	50	7.8×10^5	8.7×10^5	8.2×10^5
72	65	7.9×10^5	6.7×10^5	8.4×10^5
23	80	2.0×10^5	5.3×10^5	7.7×10^5
66	150	7.5×10^4	2.3×10^4	9.3×10^4
14/67	170	4.6×10^4	6.9×10^3	3.5×10^4
11	270	1.2×10^4	5.1	65
3	330	3.2×10^2	0.1	0.7

ml/g = milliliters per gram, SWS = slack-water sequence, TBU = thick-bedded unit.
[a] The reported observed values are the arithmetic average of Geoprobe® measurements reported (WVNS 1995) for one or more depths below the ground surface at the given location.
[b] The predicted values are the average values estimated for the saturated portion of the thick-bedded unit and slack-water sequence.

The vertical distributions of moisture content and of concentration of strontium-90 for three locations below and downgradient of the source on the centerline of the plume are presented in **Table E–12**. Mass balance analysis of predicted levels of strontium-90 for calendar year 1995, 27 years after the release, indicate that greater than 90 percent of the remaining radionuclide is in a volume with a width of 40 meters in horizontal extent (WVNS 1995).

Table E–12 Near-field Groundwater Flow Model Predictions of Concentration of Strontium-90 in the North Plateau Plume for Calendar Year 1995

Distance Below Ground Surface (meters) (unit)	*Distance from Source (meters)*					
	0 meters		*80 meters*		*150 meters*	
	Aqueous Moisture Content	*Concentration of Strontium-90 (picocuries per liter)*	*Aqueous Moisture Content*	*Concentration of Strontium-90 (picocuries per liter)*	*Aqueous Moisture Content*	*Concentration of Strontium-90 (picocuries per liter)*
2.3 (TBU)	0.066	7.6×10^5	0.225	7.0×10^5	0.225	7.7×10^4
2.7 (TBU)	0.071	5.6×10^5	0.225	7.1×10^5	0.225	8.1×10^4
3.75 (TBU)	0.225	2.4×10^5	0.225	7.5×10^5	0.225	9.0×10^4
5.75 (TBU)	0.225	1.3×10^5	0.225	8.1×10^5	0.225	1.1×10^5
6.5 (SWS)	0.350	1.1×10^5	0.350	8.2×10^5	0.350	1.1×10^5
8.5 (SWS)	0.350	1.0×10^5	0.350	8.3×10^5	0.350	1.1×10^5
13.5 (ULT)	0.324	1.6×10^3	0.324	77	0.324	0.6
18.5 (ULT)	0.324	0	0.324	0	0.324	0

SWS = slack-water sequence, TBU = thick-bedded unit, ULT = unweathered Lavery till.

For sources originating in the saturated portion of the thick-bedded unit below the Main Plant Process Building, transport analysis indicates that the solute reaches the North Plateau ditch and Franks Creek along a southwest-to-northeast path centered on the release point. The entirety of the solute reaching the northeast edge of the model reaches the boundary within 50 meters of the centerline of the source with vertical movement downward into the slack-water sequence. A plot of predicted contours of the plume is presented on **Figure E–42**.

The relation between flow rate in the slack-water sequence and the thick-bedded unit above the slack-water sequence was investigated through tabulation of groundwater velocities along a flow path extending from the northern boundary of the Main Plant Process Building to the North Plateau ditch. Average linear velocities predicted by the near-field model for this path are presented in **Table E–13**. Effective porosity values of 0.225 and 0.35 were used for the thick-bedded unit and slack-water sequence, respectively. For the slack-water sequence and thick-bedded unit above the slack-water sequence, the travel time and average velocity along the flow path are 1.9 years and 161 meters per year and 2.0 years and 157 meters per year, respectively.

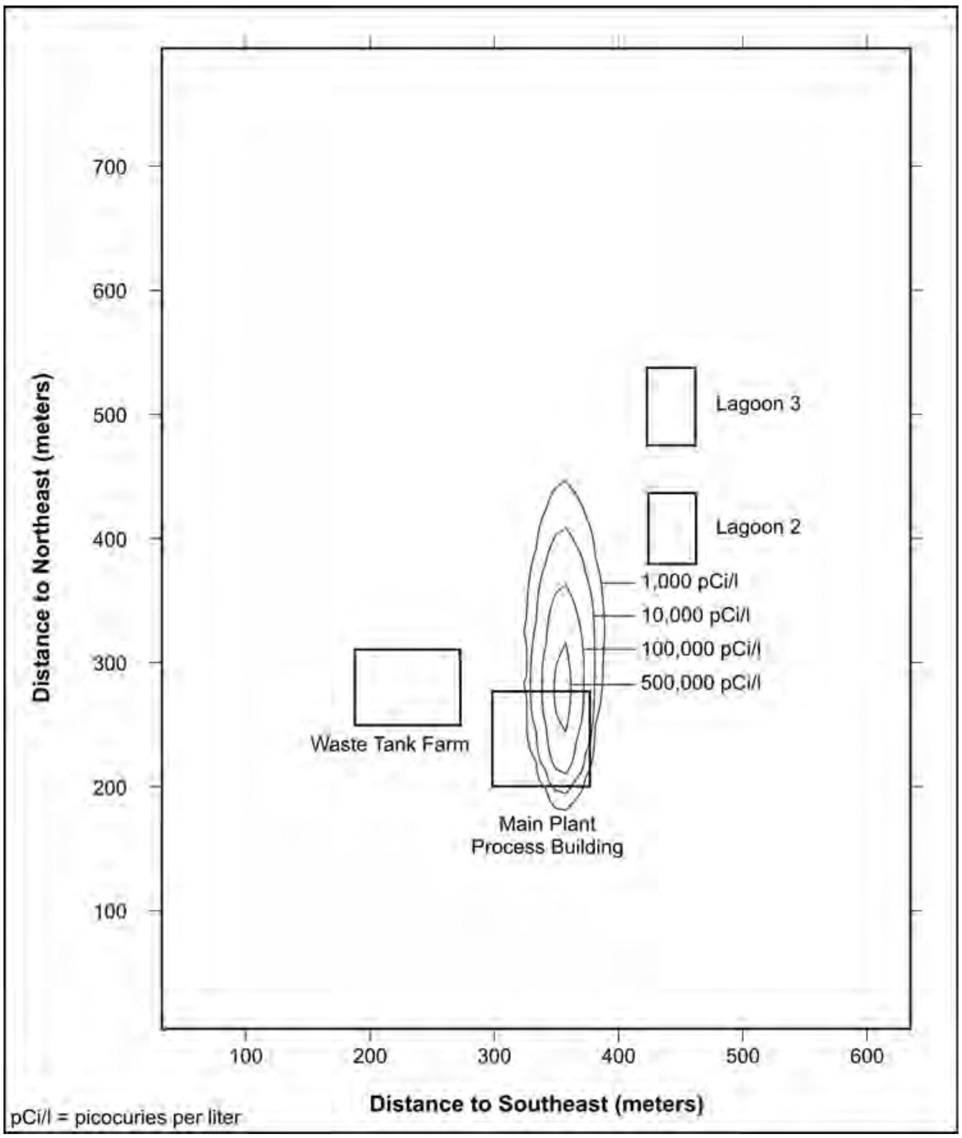


Figure E–42 Near-field Groundwater Flow Model Prediction of Concentration of Strontium-90 in the North Plateau Plume 27 Years After Release

Table E–13 Average Linear Velocity for Flow Path Originating at the Main Plant Process Building

Distance Along Flow Path (meters)	*Average Linear Velocity (meters per year)*	
	Slack-water Sequence	*Thick-bedded Unit*
0 to 10	114	105
10 to 63	130	132
63 to 110	143	147
110 to 160	156	161
160 to 210	171	174
210 to 260	192	180
260 to 310	220	176

Note: To convert meters per year to feet per year, multiply by 3.2803.

The direction of flow through sources at the Main Plant Process Building was investigated using aqueous fluxes produced by the near-field flow model. For sources at the Main Plant Process Building beginning at the ground surface and extending downward into the unsaturated portion of the thick-bedded unit such as the Liquid Waste Cell, the primary direction of flow is downward into the underlying thick-bedded unit and slack-water sequence. For rooms whose floors are at greater depth, such as the General Purpose Cell and the Fuel Receiving and Storage Pool, the primary direction of flow would be in the horizontal direction to the northeast. Flow balances for these cells are presented in **Table E–14**.

Table E–14 Aqueous Flow Balances for Below-grade Cells of the Main Plant Process Building, Historical Conditions

Direction of Flow	*Aqueous Flow (cubic meters per year)*		
	Liquid Waste Cell	*General Purpose Cell*	*Fuel Receiving and Storage Pool*
In			
Top	26.0	26.0	52.0
South	1.6	516.3	590.2
West	0.0	40.2	61.2
Out			
Bottom	26.0	11.7	17.7
North	1.6	542.7	644.6
East	0.0	28.1	41.2

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

Aqueous flux and solute flux were also investigated for sources at the Waste Tank Farm tanks located in an excavation on the west side of the model area slightly north of the Main Plant Process Building.

The direction of flow from the west side of the model volume was investigated for a mobile solute (100 curies of technetium-99 with a distribution coefficient of 0 milliliters per gram) released from a location near the bottom of the Waste Tank Farm tanks. The results indicate that the solute moves eastward from the southwest-to-northeast centerline of the source toward the area of the slack-water sequence. This interpretation is also indicated in the concentration contours plotted on **Figure E–43** for a time of 5 years after release. The rate of arrival of solute at Franks Creek as a function of time is presented on **Figure E–44**. The peak flux occurs at approximately 7 years after traveling approximately 620 meters. The related estimate of average linear velocity of approximately 90 meters per year is consistent with movement primarily through the thick-bedded unit to reach the slack-water sequence and eventually the northeast boundary.

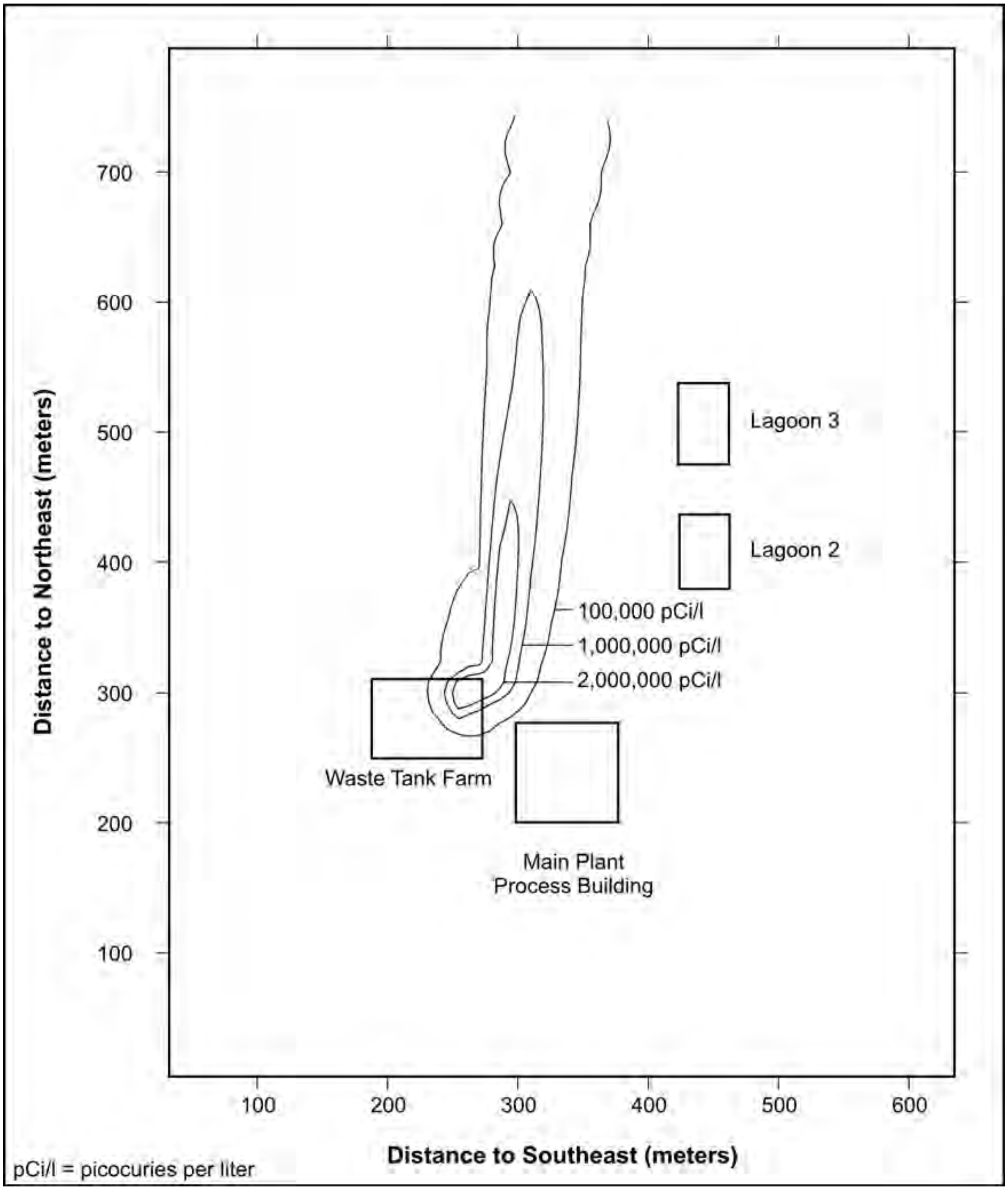


Figure E–43 Near-field Groundwater Flow Model Prediction of Concentration of Technetium-99 for a Release at the Waste Tank Farm 5 Years After Release

The direction of flow through the Waste Tank Farm tanks is indicated by the flow balance for the excavation summarized in **Table E–15**. The results indicate that the primary direction of flow is into the excavation from the southwest, around the tanks, and out of the excavation to the northeast. Flow balances for portions of Tanks 8D-1 and 8D-2, located in the center of the excavation, are summarized in **Table E–16**. As in the case of the excavation, the primary direction of flow is from the southwest to the northeast through each section of the tank volume.

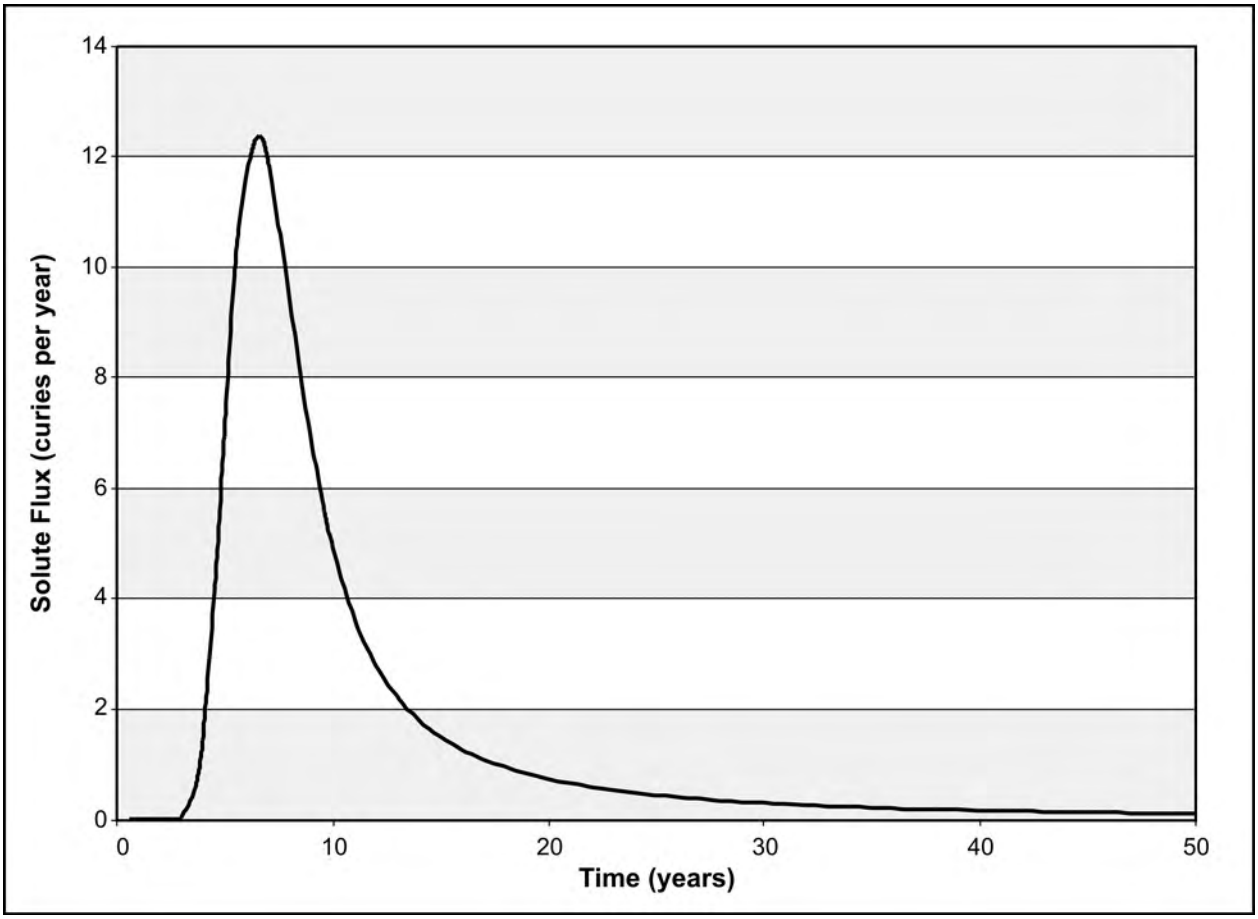


Figure E–44 Rate of Arrival of Technetium-99 at the Model Boundary for a Source at the Waste Tank Farm Tanks

Table E–15 Aqueous Flow Balance for the High-Level Radioactive Waste Tank Excavation, Historical Conditions

Direction of Flow	*Flow Area (square meters)*	*Aqueous Volumetric Flow (cubic meters per year)*
Into Excavation		
Top, South	1,800	3,995.1
Top, West	400	285.5
Top, Center	1,000	109.3
Out of Excavation		
Top, North	2,200	2,738.3
Side, East	180	1,383.7
Bottom	5,400	229.9
Side, South	900	9.5
Side, North	900	12.0
Side, West	600	8.4
Side, East	420	7.4

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

Table E–16 Aqueous Flow Balances for the Sections of the Waste Tank Farm Tanks, Historical Conditions

	Aqueous Volumetric Flow (cubic meters per year)		
	Direction of Flow		
Section	***In***	***Out***	***Flow Area (square meters)***
Tank 8D-1 Grid			
Top	40.60	–	400
Bottom	–	28.53	400
Side, South	61.53	–	20
Side, North	–	58.75	20
Side, West	30.11	–	20
Side, East	–	44.95	20
Tank 8D-2 Grid			
Top	3.93	–	400
Bottom	–	9.70	400
Side, South	63.10	–	20
Side, North	–	63.00	20
Side, West	48.01	–	20
Side, East	–	42.34	20
Tank 8D-2 Ring			
Top	3.88	–	400
Bottom	4.09	–	400
Side, South	158.91	–	40
Side, North	–	157.81	40
Side, West	102.00	–	40
Side, East	–	103.29	40

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

The results of three-dimensional transport modeling of release of strontium-90 from the vicinity of the Main Plant Process Building can be used to investigate the capability of a one-dimensional transport model. The one-dimensional model is a finite difference solution to the transport equation described in Appendix G, Section G.3.3.1. In this case, the values of input parameters and results from the three-dimensional near-field model are used to select conditions for specification of the one-dimensional model. In particular, for the three-dimensional model, the width of 40 meters determined from mass balance considerations and mixing across the approximate 6-meter thickness of the thick-bedded unit and slack-water sequence (Table E–12) is selected as the cross-sectional dimension of the one-dimensional flow system. An average linear velocity of approximately 90 meters per year under the Main Plant Process Building is selected as consistent with the near-field three-dimensional model (Table E–13). An initial inventory of 200 curies of strontium-90, dispersivity of 5 meters, and strontium-90 distribution coefficient of 5 milliliters per gram were also used on the one-dimensional simulation. The one-dimensional model prediction of spatial distribution of concentration of strontium-90 27 years after release is compared with three-dimensional model predictions and measured concentrations on **Figure E–45**. The one-dimensional model result matches the location and magnitude of the peak concentration but does not provide an exact match of the leading edge of the plume where the effect of increase of groundwater velocity in the direction of flow (Table E–13) influences the shape of the concentration profile.

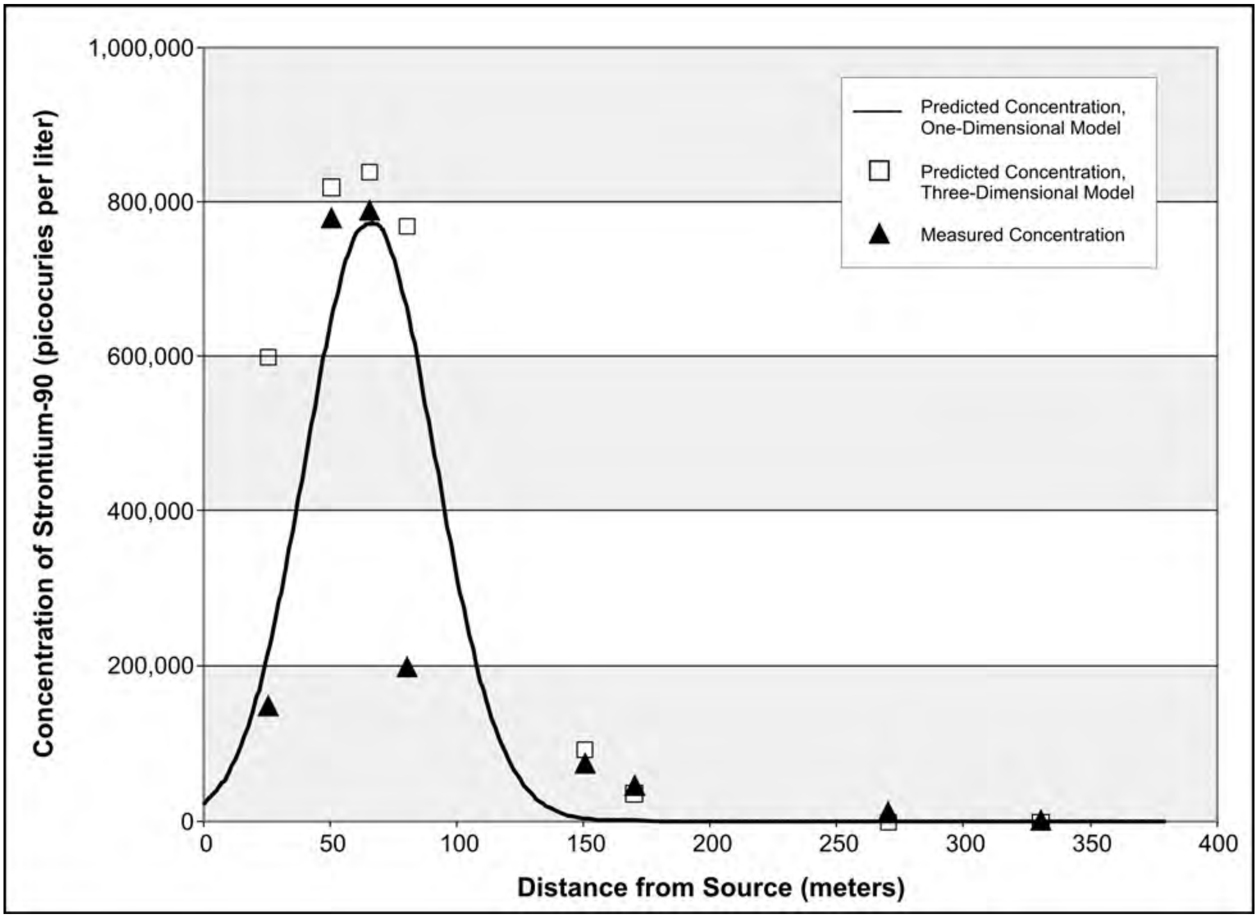


Figure E–45 One-dimensional Groundwater Transport Model Prediction of Concentration of Strontium-90 in the North Plateau Plume 27 Years After Release

E.4.1.2 Engineered Features (Sitewide Close-In-Place Alternative)

The near-field model developed to assess flow conditions with engineered features in place used the same stratigraphy and geohydrologic parameters (see Section E.4.1) and the same model volume (see Figure E–35) as those for historical conditions. For the southwest-to-southeast direction, 50 grid blocks range in size from 1 to 65 meters, while for the southwest-to-northwest direction, 80 grid blocks range in size from 1 to 50 meters. For the vertical direction, the upper 3 meters were represented using 15, 0.2-meter-thick layers, the next 3 meters were represented using 6 0.5-meter-thick layers, and the bottom 17 meters were represented using 17 1.0-meter-thick layers. Thus, this variant of the model utilizes approximately 129,000 grid blocks. The primary differences from the historical conditions model are representation of a 1-meter thick slurry wall and 1-meter thick French Drain placed 30 meters upgradient of the Main Plant Process Building and Waste Tank Farm and specification of reduced infiltration at the Main Plant Process Building, Waste Tank Farm, and Low-Level Waste Treatment Facility to reflect placement of engineered caps over these facilities. This model represents the combination of upgradient slurry wall and circumferential slurry wall of the integrated closure system for the Main Plant Process Building and Waste Tank Farm as a single slurry wall. Other boundary conditions were the same as the historical conditions model, including the background rate of infiltration of 26 centimeters per year. The infiltration estimates through the engineered caps were developed using a separate model described in the following paragraph.

The potential effectiveness of caps was investigated using a simplified model decoupled from the balance of the near-field flow model. Four versions of the cap model are required to simulate performance of engineered caps proposed for the combined Main Plant Process Building and Waste Tank Farm, the Low-Level Waste Treatment Facility, the NDA, and the SDA. The cap model is a two-dimensional rectangular block representing a transect of the cap as shown on **Figure E–46**. The cap comprises four layers: an upper soil layer, a drainage layer, a clay layer, and a backfill layer. The layers were sloped at an angle of 2 degrees from the horizontal position. The Brooks-Corey relationship (Bear 1972) was used to represent unsaturated flow behavior with the design values assumed for simulation purposes summarized in **Table E–17**. Boundary conditions are no flow for the centerline on the left, no flow for layers other than the drainage layer on the right, and atmospheric pressure for the drainage layer on the left and the bottom of the study volume. Infiltration at the top was specified as 100 centimeters per year to represent the likely maximum amount of water to reach the drainage layer. Drainage lengths of the caps for the combined Main Plant Process Building and Waste Tank Farm, the Low-Level Waste Treatment Facility, the NDA, and the SDA were 120, 170, 75, and 30 meters, respectively. Two cases of degraded performance were also evaluated. In the first case, hydraulic conductivity of the drainage layer was decreased by an order of magnitude to reflect clogging and the hydraulic conductivity of the clay layer was increased to reflect desiccation or settling. In the second case, the hydraulic conductivity of the drainage layer was decreased by an additional factor of 10 to reflect additional clogging. Results, expressed as volumetric flows exiting the drainage layer and reaching the lower surface of the cap, are summarized in **Table E–18**. The results indicate that, even under degraded conditions, the cap diverts a high percentage of the initial infiltration. For the combined Main Plant Process Building and Waste Tank Farm cap and the Low-Level Waste Treatment Facility caps, infiltration under degraded conditions is approximately a factor of 10 lower than the North Plateau background infiltration rate of 26 centimeters per year. For the NDA and the SDA caps, infiltration under degraded conditions is approximately equal to the South Plateau background infiltration rate of 2.15 centimeters per year.

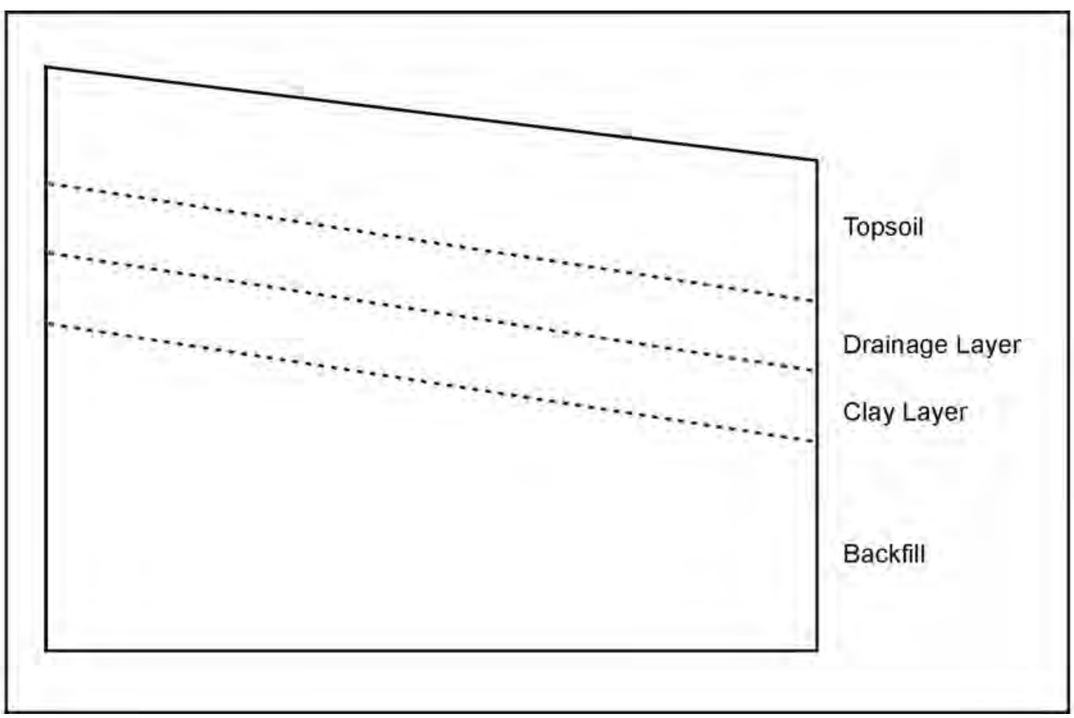


Figure E–46 Schematic of an Engineered Cap

Table E–17 Values of Hydraulic Parameters for an Engineered Cap

Material Type	*Saturated Moisture Content*	*Residual Saturation*	*h_b (centimeters)*	*λ*	*Saturated Hydraulic Conductivity (centimeters per second)*
Topsoil	0.225	0.10	7.0	1.67	1.0×10^{-3}
Drainage Layer	0.40	0.10	7.0	1.67	3.0
Clay Layer	0.324	0.20	353.0	0.127	5.0×10^{-9}
Backfill	0.225	0.15	7.0	1.67	1.0×10^{-3}

h_b = bubbling pressure, λ = pore size distribution.

Table E–18 Distribution of Flows for an Engineered Cap for Design and Degraded Conditions

Recharge at Top of Cap (centimeters per year)	*Flux Out of Drainage Layer (cubic meters per year)*	*Flux Out of Bottom (cubic meters per year)*
Design Case		
MPPB/WTF	119.80	0.19
LLWTF	167.00	2.97
NDA	74.89	0.11
SDA	29.96	0.04
First Degraded Case		
MPPB/WTF	117.34	2.66
LLWTF	165.25	4.75
NDA	73.40	1.60
SDA	29.42	0.58
Second Degraded Case		
MPPB/WTF	116.69	3.31
LLWTF	163.71	6.29
NDA	73.05	1.95
SDA	29.27	0.74

LLWTF = Low-Level Waste Treatment Facility, MPPB = Main Plant Process Building, NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area, WTF = Waste Treatment Facility.

For the Sitewide Close-In-Place Alternative near-field model, the long-term period of time following loss of institutional control and degradation of engineered facilities was simulated. For these conditions, hydraulic conductivity of the slurry wall was taken as 1×10^{-6} centimeters per second, and the recharge through the Main Plant Process Building/Waste Tank Farm and Low-Level Waste Treatment Facility caps were 2.8 and 3.7 centimeters per year, respectively. Design hydraulic conductivity of the slurry wall is less than 1×10^{-7} centimeters per second. In addition, below-grade rooms of the Main Plant Process Building are backfilled with size-reduced materials; the tanks of the Waste Tank Farm are filled with controlled low-strength materials; the sediments of Lagoons 1, 2, and 3 are grouted, and a slurry wall is installed around Lagoon 1. To represent these features, the hydraulic conductivities of below-grade rooms of the Main Plant Process Building, the tanks, and sediments of Lagoons 2 and 3 are assigned values of hydraulic conductivity of 1×10^{-5} centimeters per second, while the combined effects of barriers at Lagoon 1 are represented by assignment of a value of 1×10^{-6} centimeters per second to the material in Lagoon 1. The water table map calculated for these conditions is presented on **Figure E–47**. The results indicate that the slurry wall located at a distance of 200 meters and extending into the center of the model area from the west diverts flow to the east, changing water table conditions relative to historical conditions. The slurry wall decreases thickness of the unsaturated zone upgradient of the wall and in combination with the reduced infiltration due to the caps, increases thickness of the unsaturated zone immediately downgradient of the slurry wall. Average linear velocities for flow paths originating at the Main Plant Process Building and Waste Tank Farm were 161, and 103 meters per year, respectively. A summary of the flow balance for the Sitewide Close-In-Place Alternative near-field model is presented in **Table E–19**. Flow conditions are similar to those of the historical conditions case with the exception mentioned above that the combination of the slurry wall and French drain diverts a portion of the groundwater that would flow northeast to discharge to Franks Creek to the east to discharge to Erdman Brook.

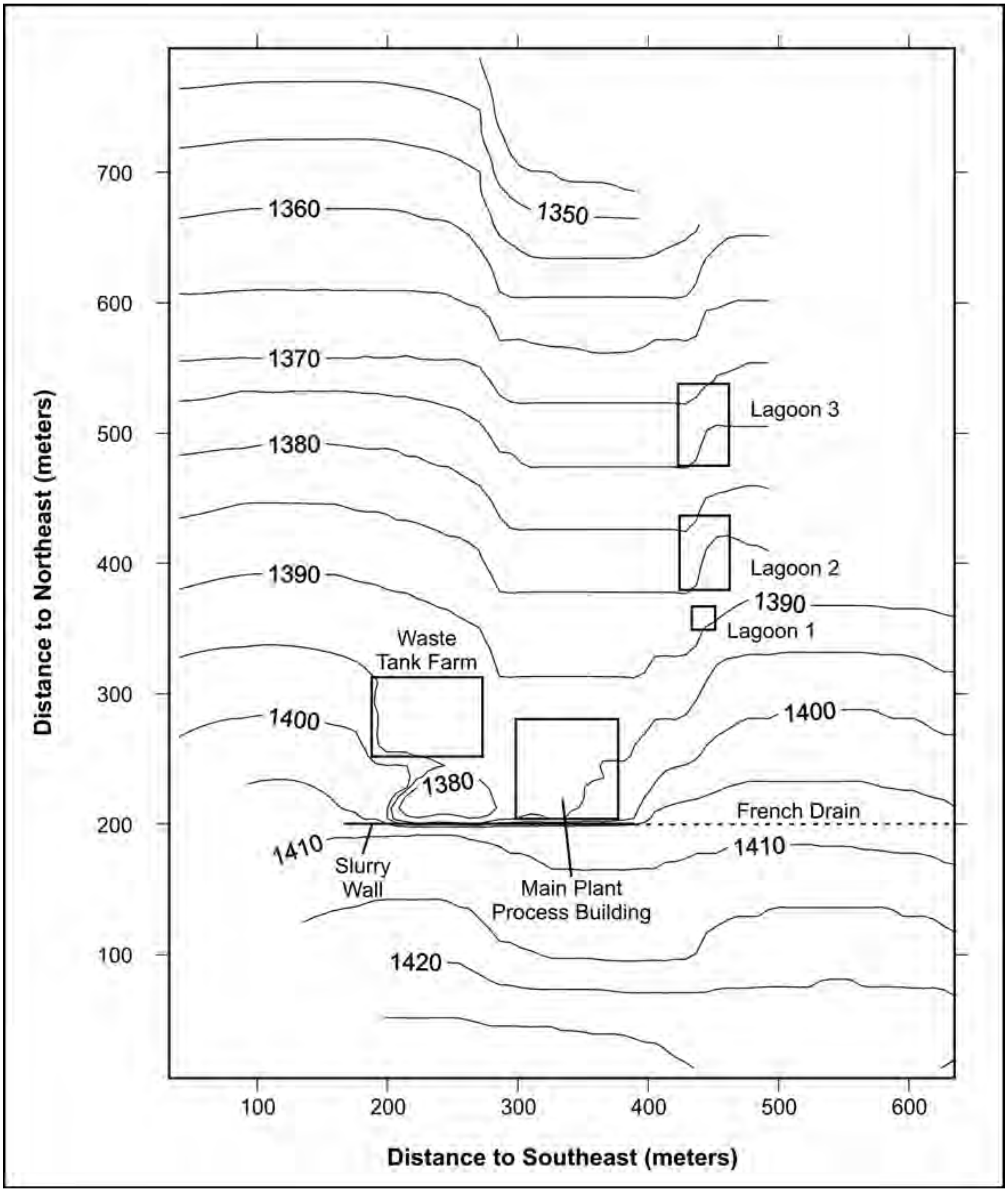


Figure E–47 Water Table Elevation for Sitewide Close-In-Place Alternative Conditions

Table E–19 Summary of Volumetric Flows for the North Plateau Near-field Flow Model, Sitewide Close-In-Place Alternative

Direction/Unit	*Volumetric Flow Rate (cubic meters per year)*
In	
Recharge at the Ground Surface	99,243
Seepage from Bedrock on the Southwest	7,304
Out	
Down Flow to the Kent Recessional Sequence	8,858
Seepage to Quarry Creek	7,575
Seepage to Franks Creek	56,647
Seepage to Erdman Brook	11,317
French drain to Erdman Brook	10,132
Seepage to the North Plateau Ditch	11,999

The direction of flow through sources at the Main Plant Process Building was investigated using aqueous fluxes produced by the near-field flow model. For sources at the Main Plant Process Building, such as the Liquid Waste Cell, General Purpose Cell, and Fuel Receiving and Storage Pool, the primary direction of flow is downward into the underlying thick-bedded unit and slack-water sequence at the specified rate of recharge as indicated by the flow balance presented in **Table E–20**.

Table E–20 Aqueous Flow Balances for Below-grade Cells of the Main Plant Process Building, Sitewide Close-In-Place Alternative Conditions

	Aqueous Flow (cubic meters per year)		
Direction of Flow	*Liquid Waste Cell*	*General Purpose Cell*	*Fuel Receiving and Storage Pool*
In			
Top	2.80	2.80	5.60
South	0.001	0.25	0.95
East	–	0.23	1.26
Out			
Bottom	2.74	2.59	4.53
North	0.04	0.47	2.02
West	0.01	0.23	1.25

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

The direction of flow through the Waste Tank Farm tanks is indicated by the flow balances for the excavation summarized in **Table E–21**. The results indicate that the primary direction of flow is into the excavation from the southwest, around the tanks, and out of the excavation to the northeast and that the combination of the slurry wall and cap reduces flow through the excavation. Flow balances for portions of the tank located in the center of the excavation are summarized in **Table E–22**. As in the case of the excavation, the primary direction of flow is from the southwest to the northeast through each section of the tank volume.

Table E–21 Aqueous Flow Balance for the High Level Waste Tank Excavation, Sitewide Close-In-Place Alternative Conditions

Direction of Flow	*Flow Area (square meters)*	*Aqueous Volumetric Flow (cubic meters per year)*
Into Excavation		
Top	5,400	1,558.6
Out of Excavation		
Side, East	180	1,326.0
Bottom	5,400	204.3
Side, South	900	6.5
Side, North	900	10.8
Side, West	600	5.8
Side, East	420	4.6

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

Table E–22 Aqueous Flow Balances for the Sections of the Waste Tank Farm Tanks, Sitewide Close-In-Place Alternative Conditions

	Aqueous Volumetric Flow (cubic meters per year)		
	Direction of Flow		*Flow Area (square meters)*
Section	*In*	*Out*	
Tank 8D-1 Grid			
Top	6.35	–	800
Bottom	–	6.37	800
Side, South	0.13	–	20
Side, North	–	0.16	20
Side, West	0.57	–	20
Side, East	–	0.52	20
Tank 8D-2 Grid			
Top	3.91	–	800
Bottom	–	3.89	800
Side, South	0.21	–	40
Side, North	-	0.17	40
Side, West	0.53	–	20
Side, East	–	0.60	20
Tank 8D-2 Ring			
Top	6.12	–	800
Bottom	–	4.54	800
Side, South	0.14	–	40
Side, North	–	0.68	40
Side, West	0.69	–	40
Side, East	–	1.73	40

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

The magnitude and direction of flow of groundwater through the sub-surface sediments of the lagoons of the Low-Level Waste Treatment Facility are presented in **Table E–23**.

Table E–23 Magnitude and Direction of Groundwater Flow through Sub-surface Sediments of the Low-Level Waste Treatment Facility [a]

Direction	Volumetric Flow Rate (cubic meters per year)				
	Lagoon 1	*Lagoon 2*	*Lagoon 3*	*Lagoon 4*	*Lagoon 5*
Top	-8.70	-62.05	-63.50	-40.99	-47.84
Bottom	7.69	35.09	46.29	48.14	58.47
South	-0.37	-4.79	-2.32	-493.57	-520.45
North	0.81	9.71	9.01	513.60	540.80
West	0.63	15.82	10.80	-19.27	-18.65
East	-0.04	6.22	-0.28	-7.90	-13.31

[a] Positive value is for flow in the indicated direction, negative value is for flow opposite to the indicated direction.
Note: To convert cubic meters per year to cubic feet per year, multiply by 35.314.

E.4.1.3 Phased Decisionmaking Alternative

For the Phased Decisionmaking Alternative, the Main Plant Process Building, the source area of the North Plateau Plume, and the lagoons of the Low-Level Waste Treatment Facility would have been removed. A slurry wall would be installed to separate the area of the Main Plant Process Building from the Waste Tank Farm and to separate the area of the lagoons from the portion of the plume not recovered by removal of the source area of the plume. A French drain would be installed in front of the slurry wall at the north end of the Main Plant Process Building to divert groundwater to Erdman Brook. The near-field groundwater flow model developed to assess flow conditions for this alternative uses the same model volume as that defined for historical conditions. The cross-sectional structure of the aquifer is represented on Figures E–36 through E–40 with the same vertical discretization as the historical conditions case. A total of approximately 174,000 grid blocks were used: 64 in the southwest-to-southeast, 81 in the southwest-to-northwest and 38 in the vertical directions, respectively. The distribution of hydraulic head predicted for the Phased Decisionmaking Alternative is presented on **Figure E–48**. The results indicate an increase of elevation of the water table in the areas occupied by the Main Plant Process Building and lagoons prior to their removal. Flow balances predict flow from the Main Plant Process Building through the slurry wall to the west, that is, toward the Waste Tank Farm and from the area of the lagoons both to the east toward Erdman Brook and to the west through the slurry wall toward the northern extension of the North Plateau Plume. A summary of the flow balance is presented in **Table E–24**.

Table E–24 Summary of Volumetric Flows for the North Plateau Near-field Flow Model, Phased Decisionmaking Alternative

Direction/Unit	*Volumetric Flow Rate (cubic meters per year)*
In	
Recharge at the Ground Surface	107,624
Seepage from Bedrock on the Southwest	7,304
Out	
Down Flow to the Kent Recessional Sequence	8,909
Seepage to Quarry Creek	8,780
Seepage to Franks Creek	46,791
Seepage to Erdman Brook	14,915
French Drain to Erdman Brook	21,698
Seepage to the North Plateau Ditch	13,783

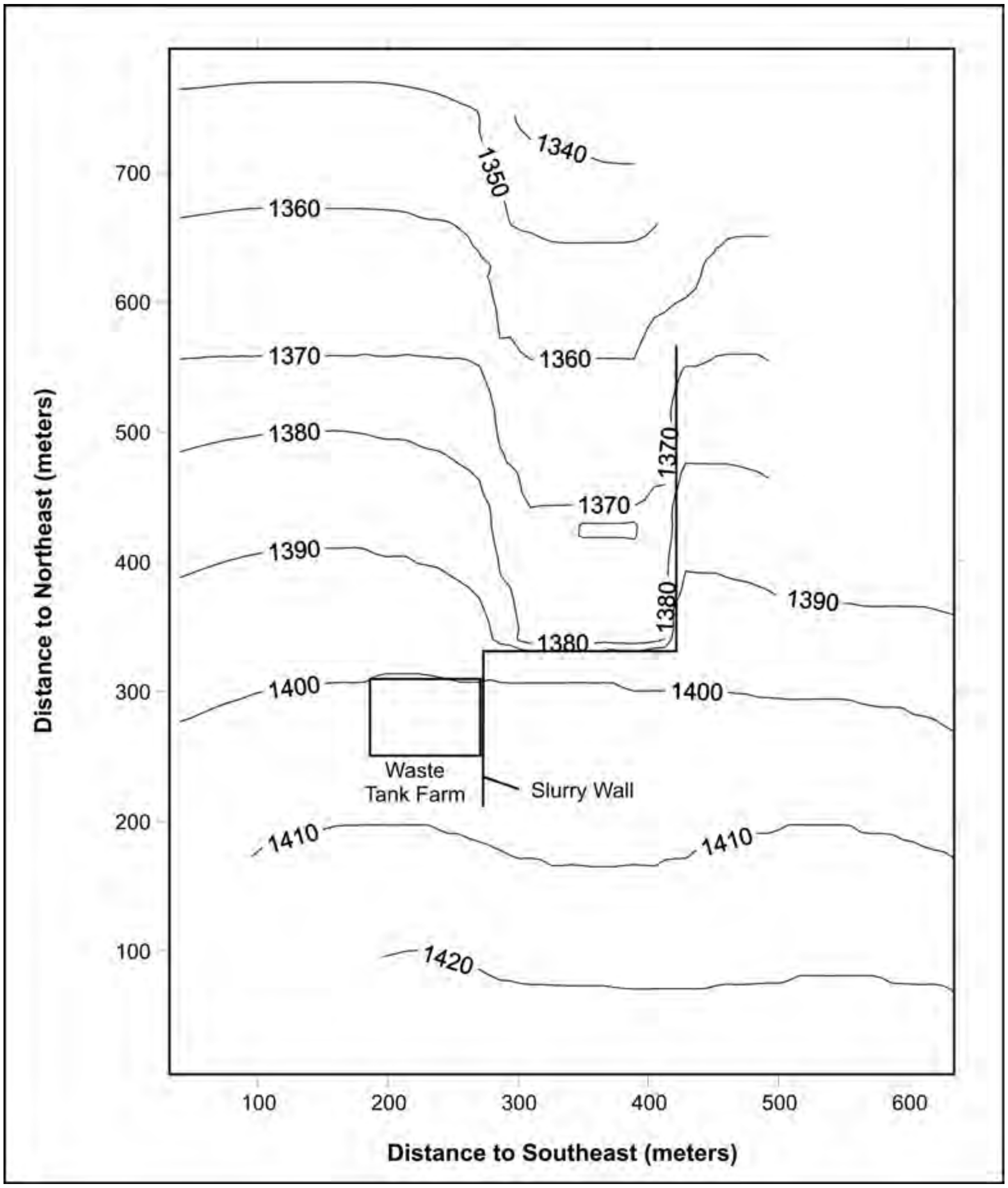


Figure E–48 Elevation of the Water Table on the North Plateau Phased Decisionmaking Alternative, Near-field Flow Model

E.4.2 South Plateau

The model developed for the South Plateau has the shape of a rectangular block oriented from the southwest to the northeast that extends from the ground surface to the top of the Kent recessional sequence. The exterior horizontal boundaries of the model are depicted on Figure E–35. The model boundaries on the northeast, southeast, and northwest sides are along reaches of Franks Creek and Erdman Brook and near contact with bedrock on the south boundary. Geohydrologic units represented in the model are the portions of the Lavery till differentiated into the near-surface weathered Lavery till, the underlying unweathered Lavery till, and portions of till disturbed by holes and trenches excavated for disposal of waste. The hydraulic conductivities of the weathered Lavery till, unweathered Lavery till, and disturbed portions of the till were 4.65×10^{-5}, 6.0×10^{-8}, and 4.65×10^{-5} centimeters per second, respectively. The weathered Lavery till has a thickness of approximately 3 meters across the South Plateau while the unweathered Lavery till is approximately 27 meters thick under the South Plateau. For the southwest-to-southeast direction, grid blocks ranged from 1 to

10 meters in size with a total of 53 grid blocks, while for the southwest-to-northwest direction, grid blocks ranged from one to twenty meters in size with a total of 58 grid blocks. For the vertical direction, the upper 6 meters were represented using 12 0.25-meter-thick layers, while the lower 27 meters were represented using 27 1.0-meter-thick layers. A total of approximately 120,000 grid blocks were used. Boundary conditions applied for the base case model are uniform recharge of 2.15 centimeters per year at the ground surface; atmospheric pressure conditions at the bottom of the unweathered Lavery till to simulate a water table in the underlying Kent recessional sequence; atmospheric pressure in the weathered Lavery till on the northwest, northeast, and southeast to simulate seepage to the creeks; atmospheric pressure in the weathered Lavery till on the southwest to represent seepage from bedrock; and no flow into the unweathered Lavery till on all sides. These general elements of the model were developed further into three variants, the first developed for historical conditions, the second appropriate for the short-term period of the No Action and Phased Decisionmaking Alternatives with engineered barriers at design conditions, and the third appropriate for the long-term period of the No Action and Sitewide Close-In-Place Alternative with degraded function of engineered barriers.

E.4.2.1 Historical Conditions

Due to the low hydraulic conductivity of the till, the water table is generally high on the South Plateau. In addition, only four non-trending target wells are located on the South Plateau. For these reasons, the calibration target for the South Plateau near-field flow model was location of the water table near the ground surface across the model area. A water table map for recharge of 2.15 centimeters per year produced these conditions as represented on **Figure E–49**. A comparison of measured and predicted heads is presented in **Table E–25**. Approximately 91 percent of the incoming recharge exited the model volume at the bottom while approximately 8, 0.5, and 0.7 percent of the recharge exited through seeps on the north, west, and east boundaries of the model area, respectively. A summary of the flow balance is presented in **Table E–26**.

Table E–25 Comparison of Measured and Predicted Heads for the South Plateau Near-field Flow Model

Well	*Measured Head (feet)*	*Predicted Head (feet)*
907	1378.2	1,381.6
1007	1,379.7	1,379.3
1008c	1,398.9	1,396.3
96-I-01	1,378.0	1,375.6

Table E–26 Summary of Volumetric Flows for the South Plateau Near-field Flow Model, Historical Conditions

Direction/Unit	*Volumetric Flow Rate (cubic meters per year)*
In	
Recharge at Ground Surface	5,143
Seepage from Bedrock on South	286
Out	
Down Flow to the Kent Recessional Sequence	4,942
Seepage to Franks Creek on North	422
Seepage to Franks Creek on East	26
Seepage to Erdman Brook on West	39

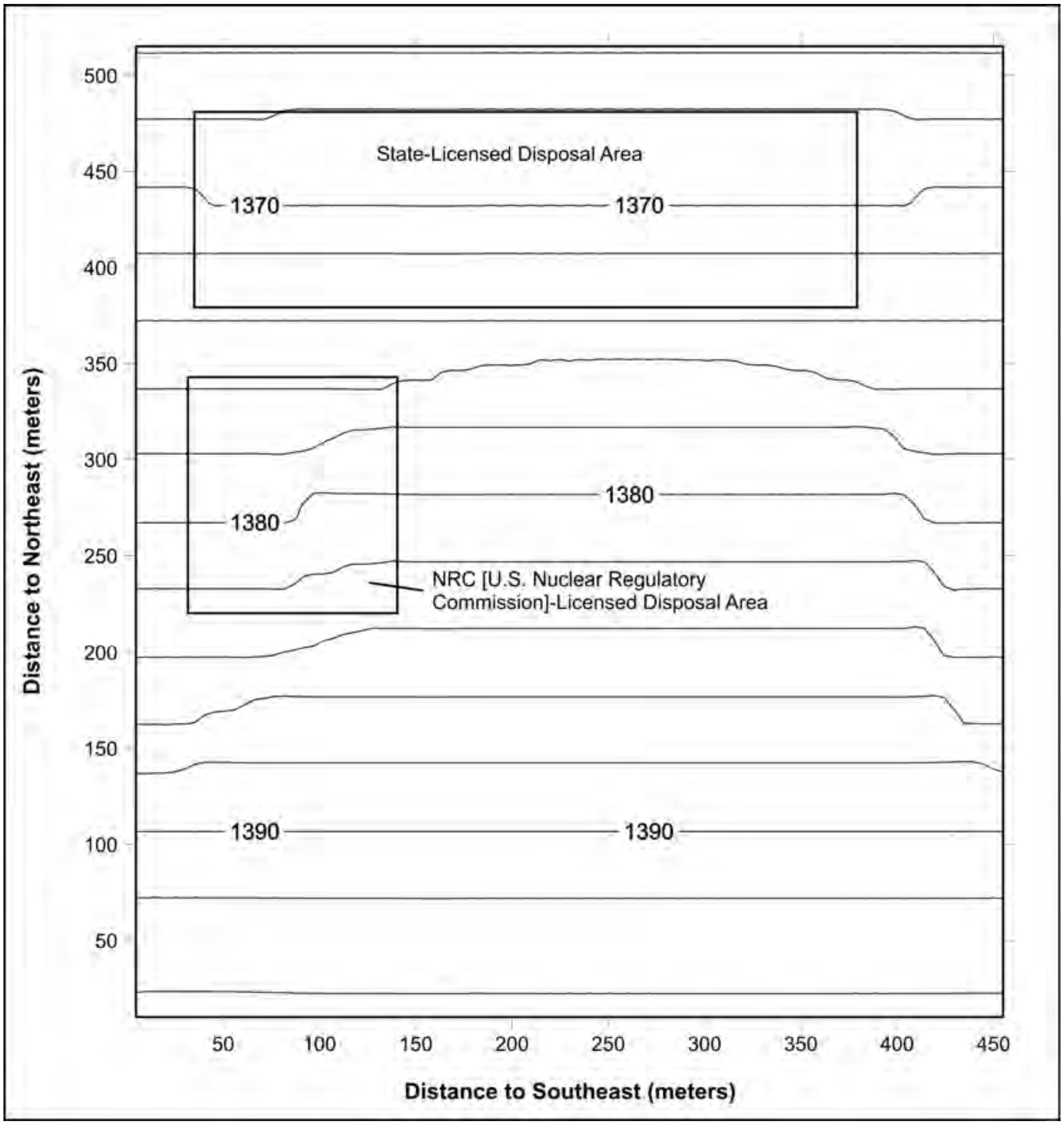


Figure E–49 Elevation of the Water Table on the South Plateau Historical Conditions, Near-field Flow Model

E.4.2.2 Short-term Conditions for the No Action and Phased Decisionmaking Alternatives

In the short-term period, active maintenance of geomembrane covers and subsurface slurry walls will reduce recharge directly into the holes and trenches located on the South Plateau. In order to investigate these conditions, hydraulic conductivity of 1×10^{-6} centimeters per second was specified for slurry walls located south of the disposal facilities and infiltration directly above holes and trenches was specified as 0.1 centimeters per year. Recharge south of the slurry walls was specified as the background value of 2.15 centimeters per year while recharge on the periphery of the holes and trenches was specified as 4.5 centimeters per year to produce seepage to Erdman Brook and Franks Creek. A water table map for these conditions is presented on **Figure E–50**. Water levels in the vicinity of the holes and trenches is reduced relative to the historical conditions case, but due to the general low flow in the horizontal direction, the general pattern of flow is similar to that of the historical conditions case. A summary of the flow balance is presented in **Table E–27**.

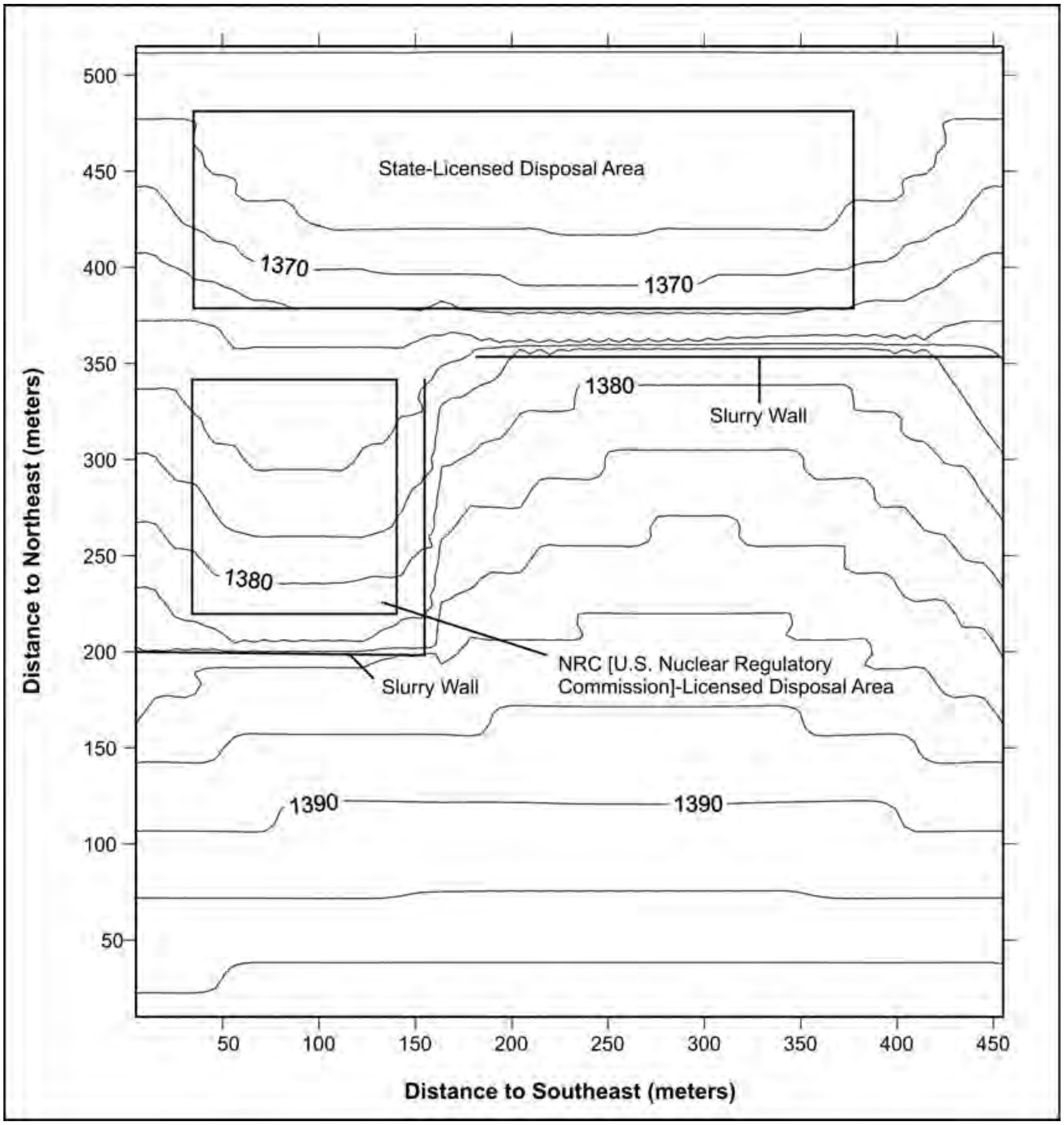


Figure E–50 Elevation of the Water Table for Short-term No Action and Phased Decisionmaking Alternative Conditions, Near-field Flow Model

Table E–27 Summary of Volumetric Flows for the South Plateau Near-field Flow Model, Short-term for No Action and Phased Decisionmaking Alternatives

Direction/Unit	*Volumetric Flow Rate (cubic meters per year)*
In	
Recharge at Ground Surface	5,367
Seepage from Bedrock on South	250
Out	
Down Flow to the Kent Recessional Sequence	4,942
Seepage to Franks Creek on North	436
Seepage to Franks Creek on East	64
Seepage to Erdman Brook on West	176

E.4.2.3 Long-term Conditions for the No Action and Sitewide Close-In-Place Alternatives

Engineered features proposed for South Plateau facilities include installation of a slurry wall upgradient of the disposal areas and placement of caps over these areas. Of most interest is performance over the long-term when loss of institutional control and cessation of maintenance of the engineered facilities may occur. For the purpose of analysis, a value of hydraulic conductivity for a degraded slurry wall was taken to be 1×10^{-6} centimeters per second. As indicated by the cap analysis summarized in Table E–18, long-term performance may provide no reduction of recharge below background conditions on the South Plateau. In this circumstance, flow conditions for the No Action and Sitewide Close-In-Place Alternatives will be similar. A prediction of water table elevation for degraded performance of engineered barriers is presented on **Figure E–51**. Placement of the slurry wall produces an increase in elevation of the water table upgradient of the slurry wall but only minor changes in flow relative to background conditions. Approximately 91 percent of the recharge water exits through the bottom of the model volume with the balance exiting through the weathered Lavery till to the creeks. A summary of the flow balance is presented in **Table E–28**. Estimates of Darcy velocity for the waste disposal areas are presented in **Table E–29**. Because of greater cross-sectional area, the predominant direction of horizontal flow is to the north for sources at the SDA and to the north and west for sources at the NDA.

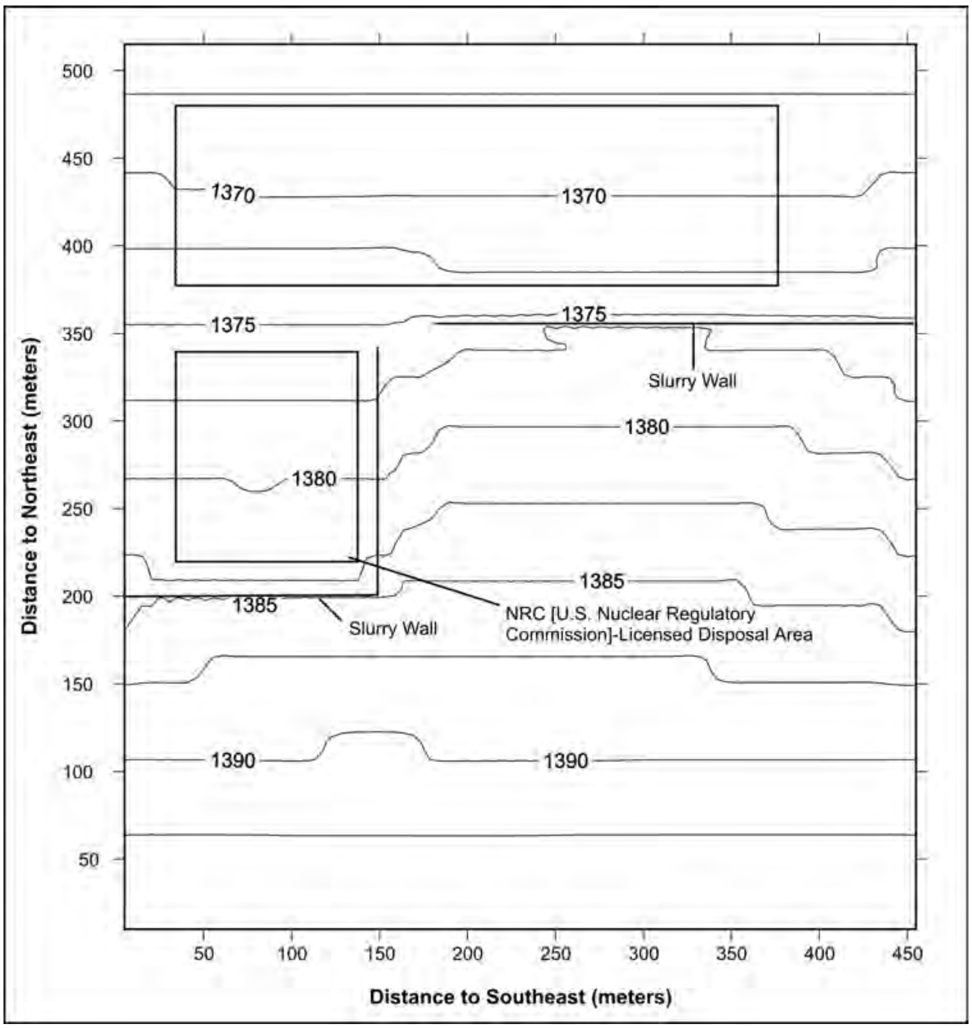


Figure E–51 Elevation of the Water Table for Long-term No Action and Sitewide Close-In-Place Alternative Conditions, Near-field Flow Model

Table E–28 Summary of Volumetric Flows for the South Plateau Near-field Flow Model, Long-term for No Action and Sitewide Close-In-Place Alternatives

Direction/Unit	*Volumetric Flow Rate (cubic meters per year)*
In	
Recharge at Ground Surface	5,143
Seepage from Bedrock on Southwest	268
Out	
Down Flow to the Kent Recessional Sequence	4,948
Seepage to Franks Creek on North	395
Seepage to Franks Creek on East	48
Seepage to Erdman Brook on West	19

Table E–29 Estimates of Darcy Velocity for Waste Disposal Areas on the South Plateau for Long-term No Action and Sitewide Close-In-Place Alternative Conditions

	Darcy Velocity [a] *(meters per year)*				
	Flow Direction				
Disposal Area	*Bottom*	*South*	*North*	*West*	*East*
NFS Process	0.025	-0.23	0.22	-0.06	-0.08
NFS Hulls	0.06	-0.04	0.15	-0.11	-0.13
WVDP	0.031	-0.29	0.22	-0.04	-0.09
SDA	0.020	-0.25	0.30	0.02	0.06

NFS = Nuclear Fuel Services, Inc., SDA = State-Licensed Disposal Area, WVDP = West Valley Demonstration Project.
[a] Positive magnitude indicates flow in the specified direction.
Note: To convert meters to feet, multiply by 3.2808.

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APPENDIX F
EROSION STUDIES

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EROSION STUDIES

Changes in this Appendix Since the Revised Draft Environmental Impact Statement

The basic approach of using site-calibrated landscape evolution models used in the *Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center (Decommissioning and/or Long-Term Stewardship EIS) Revised Draft* has been retained for this Final EIS. The CHILD [Channel-Hillslope Integrated Landscape Development] erosion model was revised for this Final EIS to differentiate regolith, till and bedrock and then recalibrated using Monte Carlo (probabilistic) methods and more detailed calibration criteria. This approach identified five sets of calibration parameters that produced topography predictions that are close to current conditions.

These five sets of best-fit calibration parameters were used to develop topography predictions over 10,000 years for the unmitigated erosion scenario for both the Sitewide Close-In-Place and No Action Alternatives. The predictions considered both current climatology, and wetter climatology conditions to investigate the effects of potential climate change. Predictions in this Final EIS are based on a smaller grid scale around the areas containing waste or contamination than was used in the Revised Draft EIS. These predictions are generally similar to the predictions developed in the Revised Draft EIS analysis, but the use of multiple model calibrations increases the confidence in the predictions.

The material in this Appendix has been reorganized for clarity. The CHILD model calibration and subsequent model projections are now presented earlier in the Appendix and the previous measurements or studies that were useful in evaluating the reasonableness of the CHILD predictions were moved toward the back. A new section has been added about the potential for Buttermilk Creek capture of Franks Creek. Previous studies that were not useful in evaluating the reasonableness of the CHILD predictions were eliminated. Although the SIBERIA predictions from the Revised Draft EIS are generally comparable to predictions from the CHILD model in both the Revised Draft and Final EISs, the SIBERIA discussion and results were eliminated in the interest of simplifying this Appendix.

Erosional processes are actively changing the glacial till landscape at the Western New York Nuclear Service Center (WNYNSC), including the vicinity of the Project Premises and the New York State-Licensed Disposal Area (SDA). The North and South Plateaus are being modified through stream downcutting, slope movement, gully migration, and sheet and rill erosion. The rate at which the plateaus are eroding has been the subject of numerous studies at WNYNSC over the last 30 years (WVNS 1993a, 1993b).

The objective of this appendix is to describe current understanding of the erosion processes affecting WNYNSC and present a scientifically sound estimate of unmitigated erosion at the site (particularly in the areas of the North and South Plateaus) for both the No Action and Sitewide Close-In-Place Alternatives. The erosion predictions are estimated with the CHILD [Channel-Hillslope Integrated Landscape Development] landscape evolution model and verified with the limited amount of available site-specific data and short-term erosion analyses. Section F.1 presents an overview of the processes affecting erosion at WNYNSC and the geologic context in which those processes are acting. Section F.2 discusses observations of environmental conditions related to erosion and summarizes erosion rate estimates based solely on these observations. Section F.3 describes the CHILD landscape evolution modeling approach to predicting long-term erosional impacts on the site and determines the reasonableness of the predicted impacts through comparison to prior erosion rate estimates for both short and long periods of time. Section F.4 presents a summary of these studies.

F.1 Overview of Western New York Nuclear Service Center Erosional Processes and History

F.1.1 Overview of Erosional Processes

Erosion is the loosening and removal of soil by running water, moving ice, wind, or gravity. At WNYNSC, running water is the predominant mechanism that causes erosion. Development of the topography and stream drainage patterns currently observed at WNYNSC began with the glaciation and retreat process that ended approximately 17,000 years ago. Erosion processes have affected the WNYNSC topography due to gravitational forces and water flow within the Buttermilk Creek watershed. A portion of the watershed is represented schematically in the topographic map presented as **Figure F–1**. Buttermilk Creek flows in a northwesterly direction close to the central axis of WNYNSC at an elevation approximately 61 meters (200 feet) below the plateau on which most of the facilities are located. On the plateau, Erdman Brook divides the Project Premises and the SDA into two areas: the North Plateau, containing the industrial area, and the South Plateau, containing the disposal areas. The entire watershed is shown on **Figure F–2**. This figure shows the Project Premises and the SDA as a small area in the central portion of the watershed.

Major erosion processes affecting WNYNSC include stream channel downcutting, stream valley rim widening, gully advance, and, in disturbed areas, sheet and rill erosion. Each of these processes is discussed in the following paragraphs.

During precipitation events, surface water runoff can create sheet and rill flow, which can entrain and transport sediment particles. Sheet flow is a continuous film of water moving over smooth soil surfaces. Rill flow consists of a series of small rivulets connecting one water-filled hollow with another on the rougher terrain. Sheet and rill erosion occurs when the stress exerted by flow is sufficient to entrain and remove soil and sediment particles. This form of erosion is generally rare on well-vegetated surfaces, but can be significant when vegetation is sparse or absent.

The three small stream channels (Erdman Brook, Quarry Creek, and Franks Creek) that drain the Project Premises and the SDA are being eroded by the stream channel downcutting and valley rim–widening processes. The streams appear to be incising rapidly, as suggested by convex-upward longitudinal profiles, steep V-shaped valley-side profiles, and the paucity of floodplains over a major portion of their length. The streams within the plateau areas flow over glacial till material. As channel downcutting progresses, two specific mechanisms contribute to stream rim widening. Streambanks are undercut, causing localized slope failures (i.e., slumps and landslides). This process commonly occurs at the outside of the meander loops and produces a widening of the stream valley rim. Even in locations where there is no bank undercutting, downcutting of the stream will produce a steeper creek bank that is subject to slumping.

Gully advance is the third type of erosion process that results from local runoff and reflects soil characteristics. Gullies are most likely to form in areas along streambanks where slumps and deep fractures are present, seeps are flowing, and the toe of the slope intersects the outside of the meander loop. Gully growth is not a steady-state process; it occurs in response to episodic events, such as thaws and thunderstorms in areas where a concentrated stream of water flows over the side of a plateau, as well as in areas where groundwater pore pressure is high enough for seepage to promote grain-by-grain entrainment and removal of soil particles from the base of the gully scarp (a process sometimes known as "sapping"). Sapping causes small tunnels (or "pipes") to form in the soil at the gully base, which can contribute to gully growth by undermining and weakening the scarp until it collapses. Surface-water runoff into the gully also contributes to gully growth by removing fallen debris at the scarp base, undercutting side walls, and scouring the base of a head scarp. Although human-induced changes to the surface-water drainage pattern can control the growth of some gullies, other natural processes that induce gully formation, such as the development of animal trails or tree falls, cannot be readily controlled.

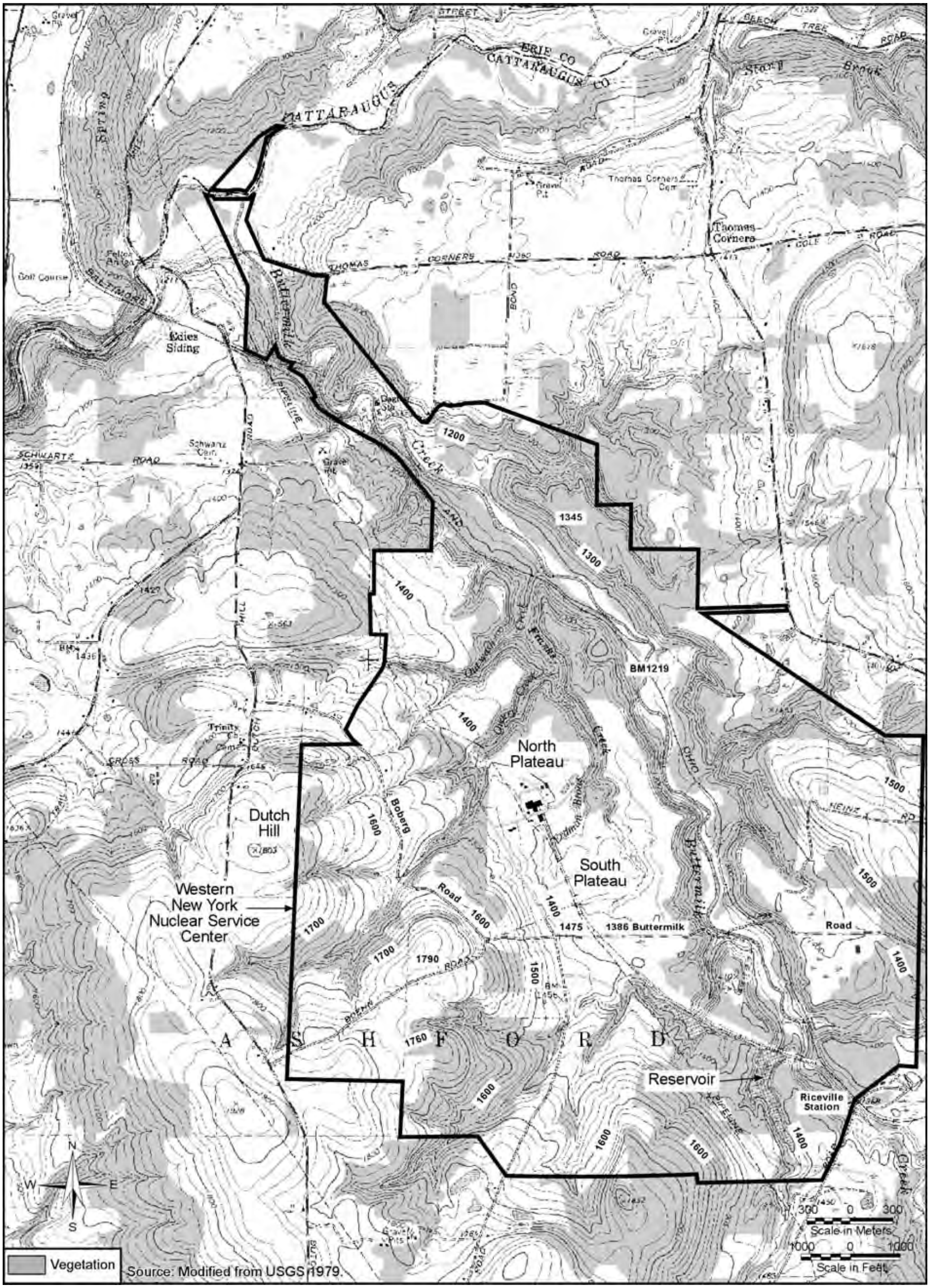


Figure F–1 Western New York Nuclear Service Center Topography

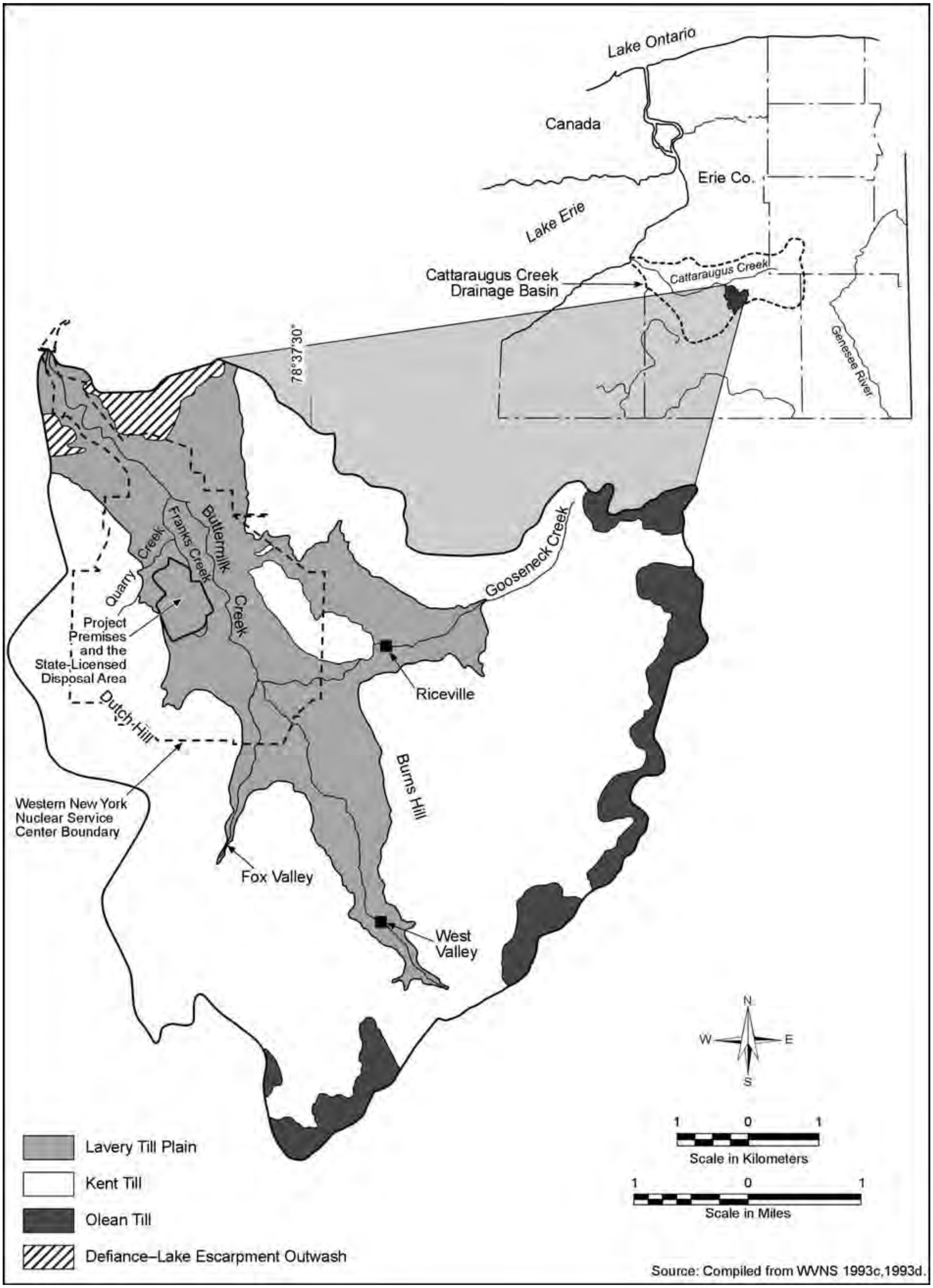


Figure F–2 Buttermilk Creek Drainage Basin

F.1.2 Overview of Geomorphic History

The postglacial geomorphic history of the site is relevant to calibrating long-term erosion models, so it is useful to briefly review what is known about that history. The Cattaraugus Creek drainage basin empties into Lake Erie. The bedrock geology consists of late–Paleozoic sedimentary rocks that dip 0.5 to 0.8 degrees to the south. Within the larger valleys, the bedrock is buried beneath a thick sequence of glacial, lacustrine, and alluvial deposits (LaFleur 1979; Boothroyd et al. 1979, 1982; Fakundiny 1985). These deposits, which are now partly dissected by stream incision, form an extensive set of low-relief, terrace-like surfaces inset into the bedrock topography. Thus, the catchment has three distinct topographic elements: rounded bedrock hills with peak altitudes on the order of 550 meters (1,805 feet), midlevel inset glacial terraces at an altitude of approximately 400 meters (1,312 feet), and modern valley floors etched several tens of meters below the glacial terraces (see **Figure F–3**). The glacial terraces that form the "second floor" in this landscape owe their existence to deposition during repeated advances of the Laurentide ice sheet. Glacial deposits within the Buttermilk Creek Valley are composed of a series of till units representing the Olean, Kent, and Lavery advances, together with interstadial deltaic, lacustrine, and alluvial facies (LaFleur 1979). At its maximum extent, the ice margin reached a position several kilometers south of the Cattaraugus basin (Millar 2005). The ice margin in this area is demarcated in part by the Kent moraine, which has been correlated with the maximum ice advance some time more recently than 24,000 years ago (Muller and Calkin 1993).

The best constraints on the timing of glacial recession in western New York State appear to come from stratigraphic studies in the Finger Lakes region. A seismic stratigraphic study by Mullins et al. (1996) showed that the Finger Lakes were last eroded by a surge of ice at approximately 14,500 radiocarbon (^{14}C) years before present (about 17,000 calendar years ago) that is correlated with Heinrich event H-1 (the most recent of the glacial North Atlantic large iceberg discharges). Radiocarbon-dated cores from Seneca Lake reveal that ice retreated rapidly from the northern end of the lake at about 14,000 ^{14}C years before present (approximately 16,600 calendar years before present) (Anderson and Mullins 1997, Ellis et al. 2004). (Note that the difference between measured ^{14}C years and actual calendar years represents a correction applied to compensate for natural variations through time in both the production rate and concentration of ^{14}C in the earth's atmosphere; see for example, Fairbanks et al. 2005 for details on calibration methods.)

Cattaraugus Creek and many of its tributaries are deeply incised into the complex of unconsolidated, glacially derived sediments that fill the bedrock valleys. The depth of incision varies but is typically on the order of 60 to 70 meters (197 to 230 feet). Near the outlet of Buttermilk Creek, for example, the modern channel lies about 60 meters (197 feet) below the adjacent glacial terrace. The incision is clearly postglacial because it cuts late–Wisconsin valley fills. Although some incision during one of the later interstadials (post–Erie) cannot definitely be ruled out, the geometry of the incised portion of drainage network makes this unlikely. Incision along Cattaraugus Creek extends downstream through the Zoar Valley, a narrow, deep (approximately 150 meters [492 feet]) bedrock canyon just east of Gowanda, New York. Downstream of the Zoar Valley, relief drops markedly as the creek enters a broad, tongue-shaped valley that appears to reflect the position of a former ice lobe. It is hypothesized that incision of the Zoar Valley and the valley fills upstream was triggered by baselevel lowering as the ice margin retreated north from the Gowanda area. Results from optically stimulated luminescence (OSL) dating in and near Buttermilk Creek, discussed in Section F.2.2, are consistent with this hypothesis, though additional dates from terraces along the Cattaraugus Valley upstream and downstream of the Zoar Valley would be necessary to confirm it.

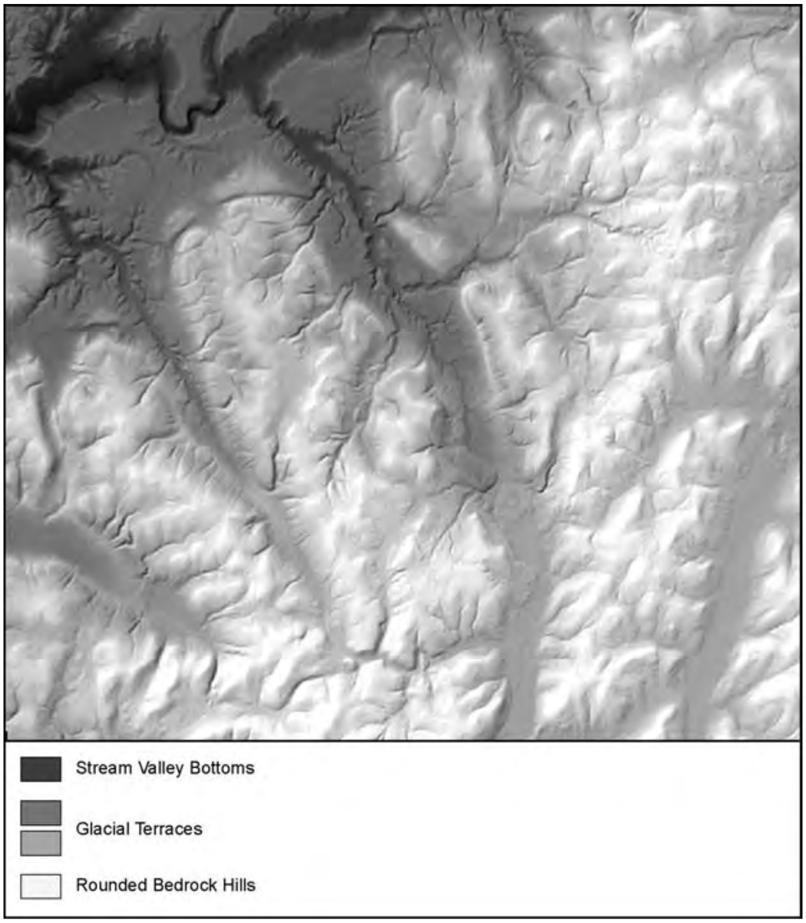


Figure F–3 Shaded Relief Image of Buttermilk Creek and Vicinity, Showing Rounded Bedrock Hills, Glacial Terraces, and Stream Valley Bottoms

F.2 Summary of Site Erosion Measurements

Site-specific historical erosion rates are important for testing the validity of any erosion predictions. Rates for the four dominant erosion processes (sheet and rill erosion, stream channel downcutting, stream valley rim widening, and gully advancement) for the Project Premises and the SDA have previously been estimated from measurements at the site. Sheet and rill erosion rates were directly measured using erosion frames at 23 locations along the stream valley banks adjacent to the Project Premises. Stream downcutting rates were determined from the age dating of terraces using ^{14}C and OSL methods and stream channel longitudinal profile measurements. The downcutting rates were translated into stream valley rim-widening rates using an estimate of the stable slope angle and geometric considerations. Gully migration rates were determined using aerial photographs and the Soil Conservation Service Technical Release 32 Method (USDA 1976). Observation of other geomorphic processes, including meandering and knickpoint advance, provides perspective but no additional quantitative information for erosion rate estimates.

These historical measurements provide perspective by which to judge the reasonableness of current erosion projections. All of these measurements, with the exception of OSL terrace dating, were collected before the current long-term erosion modeling effort was initiated and, therefore, were not designed as calibration measurements with quantifiable uncertainties. Thus, with the exception of the OSL age-dating data, specific measurements reported in this section were not directly used in the long-term modeling projections discussed in Section F.3.2.

F.2.1 Sheet and Rill Erosion Measurement

Field measurements of sheet and rill erosion on overland flow areas were taken at 23 locations along Erdman Brook, Franks Creek, and Quarry Creek using erosion frames (WVNS 1993a) (see **Figure F–4**). Each erosion frame was composed of a triangular steel structure designed to detect changes in surface height at the point of installation. Twenty-one frames were placed on hillslopes that are close to plant facilities and contain a variety of soil types and slope angles. Two frames (EF-5 and EF-9) were placed near the edges of stream valley walls to monitor the potential slumping of large soil blocks. The frames were installed in September 1990 and monitored monthly until 1993, at which point they were monitored at 6-month to 1-year intervals until September 2001. In September 1995, SDA construction activities necessitated removal of frames EF-3, EF-4, and EF-5 to allow for the construction of erosion controls in the SDA gully. Also, EF-12 was removed from the monitoring program in June 1998 because it had been displaced due to a gross slump (block) failure.

The sheet and rill erosion results are shown in **Table F–1**. These results show that soil buildup (aggradation) ranging from 0.003 to 0.16 meters (0.01 to 0.52 feet) was occurring at eight locations along Erdman Brook (EF-1, -2, -7, -8, -9, -21, -22, and -23), three locations along Franks Creek (EF-16, -19, and -20), and one location along Quarry Creek (EF-10) (WVNS 1993a). Soil depletion (degradation) ranging from -0.0003 to -0.015 meters (-0.001 to -0.05 feet) was observed at one location along Quarry Creek (EF-11) and five locations on Franks Creek (EF-6, -13, -15, -17, and -18). The Quarry Creek location (EF-11) is on the slope of the NP-1 gully (see **Figure F–5**), where a stormwater outfall (SO-4) is also located. The management practice of directing runoff to this location likely accelerated the gully development; however, none of the five locations on Franks Creek where degradation occurred are near stormwater outfall locations or appear to have been influenced by stormwater management practices. No soil aggradation or degradation was measured at the EF-14 location. The largest measured erosion rate over the 11-year period was 0.0014 meters (0.0046 feet) per year, which is equivalent to 1,400 millimeters (4.6 feet) per 1,000 years.

F.2.2 Stream Downcutting

Estimates of past rates of channel incision serve three purposes: they give an indication of potential future incision rates, they enable estimates of valley rim widening (using a geometric approach described in Section F.2.3), and they provide data for testing and calibrating long-term erosion models. Rates of stream incision were estimated using two complementary methods. The first method uses dated stream terraces to estimate average incision rates during the time period since terrace abandonment. The second relies on repeated surveys of channel cross sections to assess rates of channel lowering on annual to decadal time scales.

F.2.2.1 Radiocarbon and Luminescence Dating of Fluvial Deposits

LaFleur and Boothroyd calculated an average stream downcutting rate of approximately 6.0 meters (20 feet) per 1,000 years by means of the ^{14}C age dating of one wood fragment sample collected from the highest of 14 terrace levels on the western side of Buttermilk Creek (LaFleur 1979). The sample was extracted from a trench where wood fragments were buried 50 centimeters (20 inches) below the river gravel surface, and was determined to have an age of 9,920 ± 240 years before present (before present uncorrected carbon-14 years, dated by Richard Pardi, Queens College) (Boothroyd et al. 1979). Using the CalPal online radiocarbon calibration curve (http://www.calpal-online.de/), the corresponding calendar age is 11,502 ± 507 before present. This age was assumed to be close to the time of initial incision and downcutting of Buttermilk Creek. Because Buttermilk Creek has eroded to a depth of 55 meters (180 feet) at the Bond Road Bridge near the confluence with Cattaraugus Creek, Boothroyd et al. (1979) calculated a stream downcutting rate of 5.5 meters (18 feet) per 1,000 years as determined by dividing 55 meters by 10,000 years (the approximate uncalibrated age). The equivalent calculation using the calibrated age yields an average downcutting rate of 4.8 meters (15.7 feet) per 1,000 years.

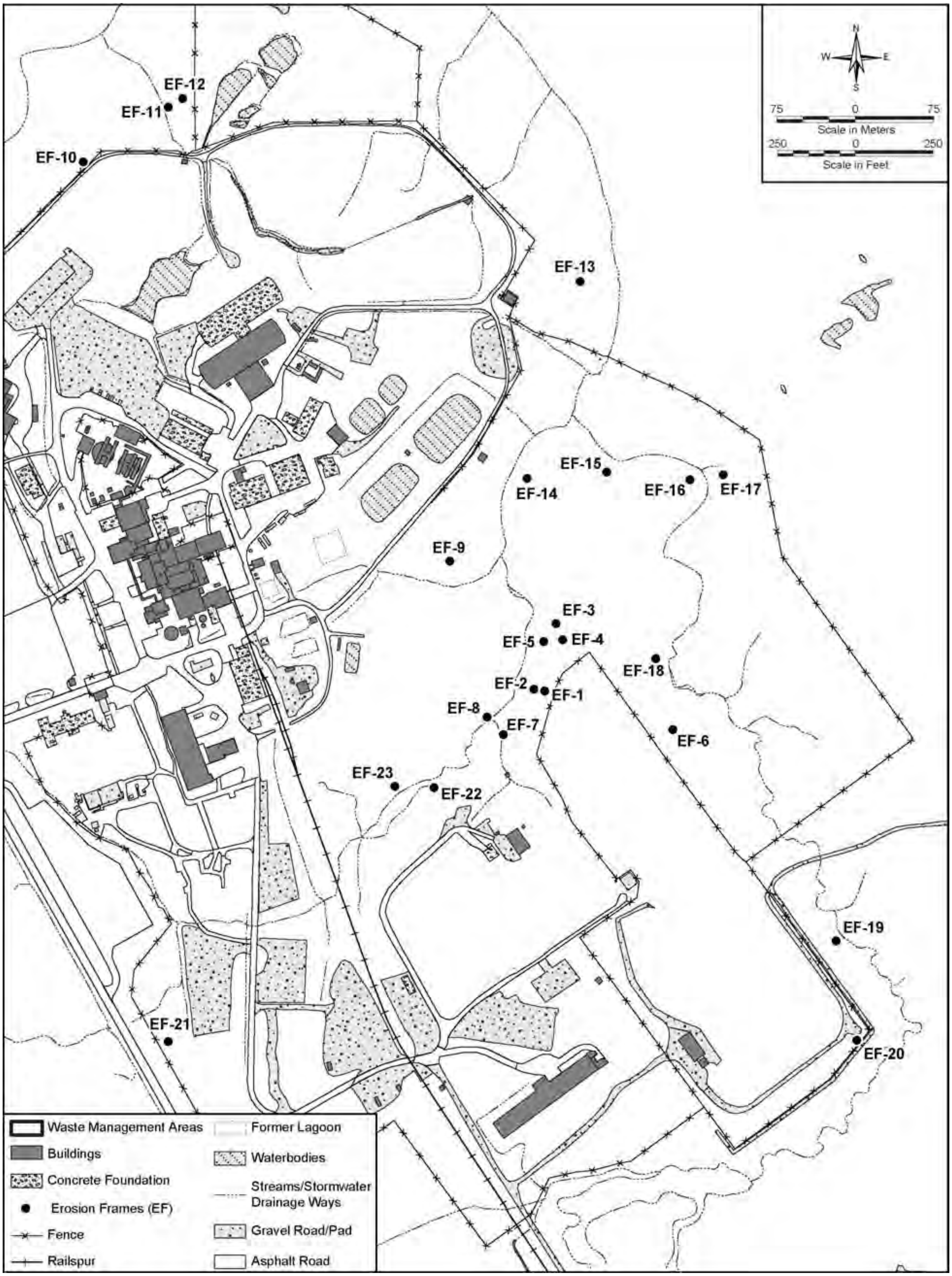


Figure F–4 Sheet and Rill Erosion Frame Measurement Locations

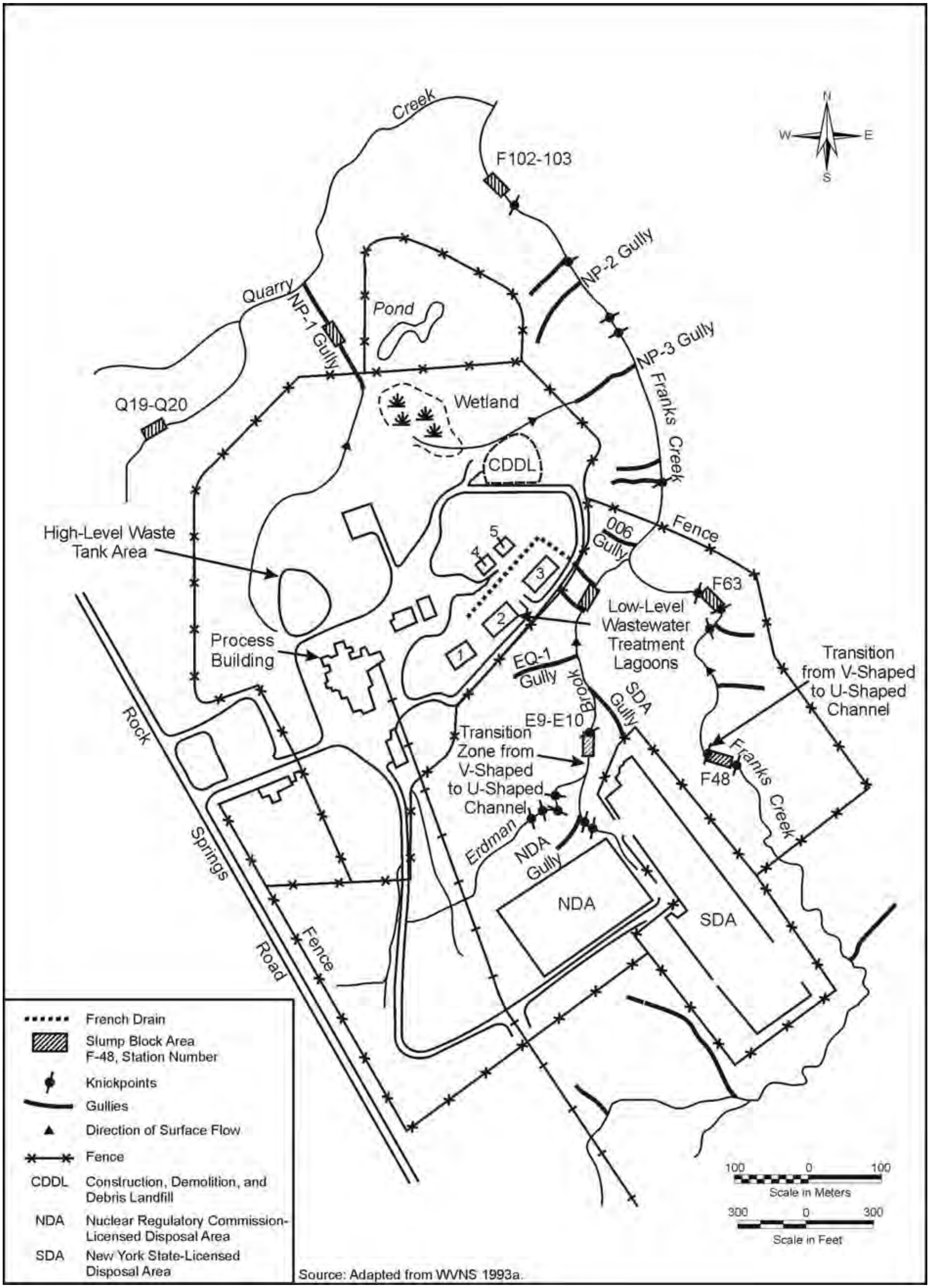


Figure F–5 North and South Plateau Gully Locations

Table F–1 Sheet and Rill Erosion Measurements

Frame Number	*Frame Location*	*Elevation Change between 1990 and 2001 (feet)*
EF-1	At northern end of SDA on slope to Erdman Brook	+0.39
EF-2	On slope to Erdman Brook downgradient of EF-1 location	+0.03
EF-3	Adjacent to gully located northeast of SDA	N/A
EF-4	In stream channel near northeastern corner of SDA	N/A
EF-5	On flat ground near northeastern corner of SDA	N/A
EF-6	At crest of a hillslope on the eastern slope of SDA	-0.02
EF-7	On ridge near northwestern corner of NDA	+0.11
EF-8	On ridge along Erdman Brook	+0.10
EF-9	On flat ground south of lagoon 2	+0.04
EF-10	On plateau at northern end of facilities near Quarry Creek	+0.01
EF-11	On western slope of the NP-1 gully	-0.04
EF-12	In gully NP-1 north of the security fence	N/A
EF-13	On western slope of lower Franks Creek	-0.001
EF-14	South of lagoon 3 on eastern slope of Erdman Brook	-0.000
EF-15	On south slope of Franks Creek	-0.04
EF-16	On western slope of Franks Creek	+0.07
EF-17	On eastern slope of Franks Creek	-0.05
EF-18	On western slope of Franks Creek	-0.004
EF-19	On slope outside the southeastern end of SDA	+0.52
EF-20	On slope outside the southern end of SDA	+0.13
EF-21	At southwestern end of site along Rock Springs Road	+0.06
EF-22	On southern bank of Erdman Brook north of NDA	+0.09
EF-23	On northern bank of Erdman Brook north of NDA	+0.24

+ = aggradation, - = degradation, SDA = State-Licensed Disposal Area, N/A = not applicable, frames removed due to construction activities in SDA and gross slump block failures, NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area.
Note: To convert feet to meters, multiply by 0.3048.

The single sample collected by Boothroyd et al. (1979) provided an indication of the time at which incision of Buttermilk Creek may have begun, but it provided no information about possible changes through time in the incision rate, or of possible variations at different positions in the watershed. It also provided no information about the elevation history near the outlet of Buttermilk Creek, which is important for constraining the catchment's baselevel history. In addition, it is often difficult to judge the reliability of a single sample because there are no other samples with which to compare it. It is generally best (though not always feasible) to collect multiple samples from a study area, so as to ensure that the ages make sense relative to one another given the geologic context. For example, when samples are collected at different levels from within a continuous stratigraphic sequence, the lower ones should be older than the higher ones.

The need for additional dating constraints motivated the collection of dating samples from 10 additional sites in and near the Buttermilk Creek drainage basin during November 2006. The objective of the field campaign was to search at each site for material that could be dated by either the ^{14}C method, the OSL method, or (ideally) both. These two methods are the most common and versatile dating methods for geologic deposits that are on the order of thousands to tens of thousands of years old (Walker 2005). Each method has strengths and weaknesses. An advantage of the ^{14}C method is that accelerator mass spectrometry can be used to obtain very precise dates. As one of the oldest methods in use for relatively young deposits, its application has become routine. However, no dating method is infallible. In the case of ^{14}C, one disadvantage is that it requires an assumption that the once-living material being dated (such as charcoal or bone) died shortly before burial. If the sample material undergoes a prolonged period of transport, or if it goes through multiple cycles of erosion and re-deposition, it will be older than the deposit in which it is found. In addition, bioturbation (mixing of soils or sediments by plants or animals) can transport carbon-bearing material to higher or lower levels in the deposit, though potential presence of such mixing can often be judged on the basis of the sediment texture. As noted above, dates obtained from ^{14}C analysis must be calibrated to account for variations through time in the production rate of ^{14}C in the atmosphere. Finally, the age range for ^{14}C is generally limited to roughly the last 50,000 years.

Quartz-based OSL dating has become an increasingly popular method for dating deposits younger than roughly 100,000 years. In essence, it involves using mineral luminescence as a record of a quartz crystal's exposure to background ionizing radiation in the soil since the last time the crystal was exposed to sunlight (which resets the clock). Unlike the ^{14}C method, OSL dating involves direct dating of the sediments themselves. Because sand- and silt-sized quartz grains are common in sedimentary deposits, it is usually relatively easy to find datable material. One disadvantage of OSL is that grains may not be completely reset (or "bleached") during a deposition event; this may occur, for example, if a sample is deposited at night. (As discussed below, statistical methods have been developed to detect and correct for partial bleaching). The method also generally involves a larger analytical uncertainty than ^{14}C, and therefore is less precise. OSL analysis normally relies on the assumption that the soil radiation dose rate has been constant over the sample's lifetime. Finally, as with ^{14}C, bioturbation can mix together sediments of different ages.

Studies that compare results from the OSL method with independent dating techniques are becoming increasingly common. For example, a recent study by DeLong and Arnold (2007) showed good agreement among ^{14}C, OSL, and cosmogenic-exposure ages at alluvial fan sites in the western Transverse Ranges of California, while Magee and Miller (2004) showed very close agreement between radiocarbon, OSL, and uranium-series dates at a site in Australia. Other studies are reviewed by Rittenour (2008), who notes that "there is no evidence of systematic departure between OSL and independent ages over the last several hundred thousand years."

In November 2006, soil pits were hand-excavated at 10 locations along and near Buttermilk Creek. The sample sites are shown on **Figure F–6**, and their locations and characteristics are summarized in **Table F–2**. No material suitable for ^{14}C dating was identified at any of the locations, but each location yielded sand-bearing sediment suitable for OSL dating. OSL samples were collected in pairs where possible, to provide stored replicates for potential future analysis. Sample collection followed standard procedures for OSL sampling (http://crustal.usgs.gov/laboratories/luminescence_dating/prospective.html).

Three pairs of samples (OSL 4, 8, and 9) were collected from fluvial gravels deposited on or near the plateau surface. Two of the sites (8 and 9) were located near the axis of the Buttermilk Creek Valley, while the third (4) was located in alluvial-fan sediments on the east side of the valley. These sites were chosen to provide evidence of the onset of incision of Buttermilk Creek. One of the sites (location 9) proved particularly valuable, because it contained fluvial deposits overlying Lavery till "bedrock" in an abandoned meander cutoff high above the present valley floor, thus recording the earliest phase of incision along Buttermilk Creek.

Five pairs of samples (OSL 1, 2, 3, 5, and 6) were collected from fluvial terraces mapped by LaFleur (1979) and Boothroyd et al. (1982). These locations were chosen to provide constraints on the elevation history of Buttermilk Creek as it incised. An additional sample pair (OSL 7) was collected from a midlevel strath terrace in the Cattaraugus Valley near the Buttermilk Creek confluence. This location was chosen to provide information about the downcutting rate along Cattaraugus Creek in the vicinity of the Buttermilk Creek outlet, so as to establish Buttermilk Creek's baselevel history. The final sample pair (OSL 10), which is not shown on Figure F–6, was obtained from a high-level strath terrace in the adjacent Connoisarauley Creek Valley, which lies just to the southwest of the Buttermilk Creek watershed. This sample site was intended to provide a preliminary indication of whether the erosion history of Connoisarauley Creek is similar to that of Buttermilk Creek. All primary OSL samples were processed at the U.S. Geological Survey (USGS) Luminescence Laboratory (Mahan 2007), while the replicated samples were stored for potential future analysis.

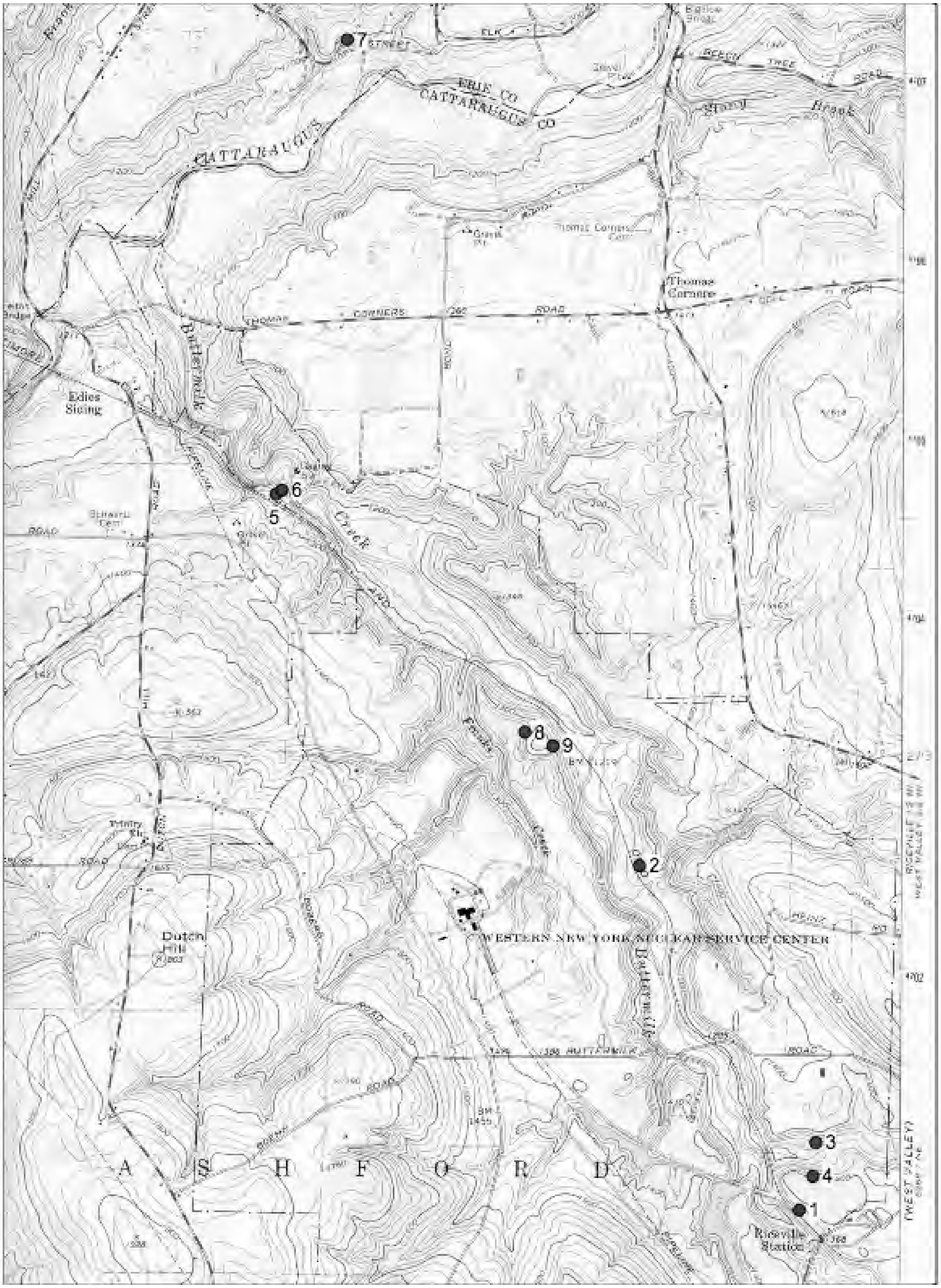


Figure F–6 Contour Map of Buttermilk Creek Showing Optically Stimulated Luminescence Sample Locations

Table F–2 Optically Stimulated Luminescence Sample Locations

Site Number	***Coordinates***	***Altitude (meters)***	***Location Notes***
WV-OSL-1	42.43542 N, 78.63179 W	414	Right-bank strath terrace, upper Buttermilk Creek Valley
WV-OSL-2	42.45270 N, 78.64275 W	382	Right-bank terrace, middle Buttermilk Creek Valley
WV-OSL-3	42.43885 N, 78.63079 W	410	Right-bank terrace in tributary valley
WV-OSL-4	42.43709 N, 78.63091 W	425	Gravel quarry on plateau surface, upper Buttermilk Creek Valley
WV-OSL-5	42.47130 N, 78.66745 W	379	Left-bank terrace, lower Buttermilk Creek Valley
WV-OSL-6	42.47155 N, 78.66703 W	367	Left-bank strath terrace, lower Buttermilk Creek Valley
WV-OSL-7	42.49426 N, 78.66277 W	365	Right-bank terrace, Cattaraugus Valley
WV-OSL-8	42.45938 N, 78.65047 W	408	Plateau-top terrace between Franks and Buttermilk Creeks
WV-OSL-9	42.45874 N, 78.64859 W	394	Fluvial gravel over till, south end of abandoned meander loop
WV-OSL-10	42.42475 N, 78.69410 W	440	Plateau sand/gravel over till, Connoisarauley Creek Valley

[a] Altitude represents terrace tread height rather than sample height.
Note: To convert meters to feet, multiply by 3.281.

F.2.2.2 Analysis and Interpretation of Dating Samples

The OSL sample results shown in **Table F–3** were obtained using a central-age model (CAM), which is most appropriate for well-bleached samples (i.e., those with a narrow equivalent-dose histogram). Three of the samples (OSL 1A, 5A, and 8A) show tight equivalent-dose histograms, indicating that the grains within them are likely to have been well bleached (Mahan 2007). In order to assess and, if necessary, correct for the possibility of partial bleaching, the sample aliquot data were also analyzed using an age-estimation procedure known as the three-parameter minimum-age model (MAM) (Arnold et al. 2009, Galbraith and Laslett 1993). This statistical age-model is designed to detect the presence of a broad tail in the age distribution among aliquots (sub-samples), which is thought to be indicative of partial bleaching, and correct for the resulting error by emphasizing the youngest aliquots. Results from applying the three-parameter MAM are shown in **Table F–4**.

Table F–3 Optically Stimulated Luminescence Sample Ages and Average Incision Rates using a Central-Age Model

Sample Number	***Central-Age Model Date (ky ± 1σ)***	***Depth Below Plateau (meters)***	***Height Above Valley Floor (meters)***	***Pre-terrace Incision Rate (meters per 1,000 years)***	***Post-terrace Incision Rate (meters per 1,000 years)***
1A	14.8 ± 1.33	14	18	6.5	1.2
2A	16.2 ± 1.31	42	9	52	0.56
3A	16.7 ± 0.88	20	10	66	0.60
4A	16.1 ± 2.01	5	25	5.3	1.6
5A	14.5 ± 1.08	32	28	13	1.9
6A	15.0 ± 2.04	44	16	22	1.1
7A	15.2 ± 1.82	40	25	22	1.6
8A	16.8 ± 1.53	7	45	N/A	2.7
9A	17.1 ± 1.39	21	31	N/A	1.8
10A	21.2 ± 1.17	N/A	N/A	N/A	N/A

$1\sigma =$ one standard deviation, ky = 1,000 years, N/A = not applicable.
[a] Depth below plateau and height above valley floor estimated from contour map and/or digital elevation model.
[b] Pre-terrace incision rate based on assumed start time of incision of 17 thousand years before AD 1950.
Note: To convert meters to feet, multiply by 3.281.

Table F–4 Optically Stimulated Luminescence Sample Ages and Average Incision Rates using a Minimum-Age Model

Sample Number	Minimum-Age Model (ky ± 1σ)	Depth Below Plateau (meters)	Height Above Valley Floor (meters)	Pre-terrace Incision Rate (meters per 1,000 years)	Post-terrace Incision Rate (meters per 1,000 years)
1A	10.83 -1.26/+1.33	14	18	2.1	1.7
2A	15.10 -0.34/+0.36	42	9	22	0.60
3A	17.00 -1.36/+1.45	20	10	n/a	0.59
4A	7.91 -3.34/+3.76	5	25	0.55	3.2
5A	13.75 -1.76/+1.86	32	28	9.8	2.0
6A	10.86 -1.14/+1.21	44	16	7.2	1.5
7A	8.39 -1.34/+1.40	40	25	4.6	3.0
8A	17.35 -0.72/+0.75	7	45	N/A	2.6
9A	17.07 -1.07/+1.13	21	31	N/A	1.8
10A	18.92 -2.20/+2.30	N/A	N/A	N/A	N/A

$1\sigma =$ one standard deviation, ky = 1,000 years, N/A = not applicable.
[a] Depth below plateau and height above valley floor estimated from contour map and/or digital elevation model.
[b] Pre-terrace incision rate based on assumed start time of incision of 17 thousand years before AD 1950.
Note: To convert meters to feet, multiply by 3.281.

Samples 8A and 9A originate at and near the top of the plateau, respectively, and are therefore considered to be particularly important because they establish the beginning of incision along Buttermilk Creek. Mahan (2007) noted that sample 8A is among 3 samples that show relatively tight histograms, suggesting that these 3 samples are likely to be the most reliable of the 10 collected. Results from applying the CAM and MAM to samples 8A and 9A overlap within 1-sigma uncertainty bounds. This means that while one can not completely rule out the possibility that these two samples are partially bleached, such partial bleaching is not apparent in the aliquot statistics. Using the 1-sigma uncertainty bounds as a guide, these two samples suggest that Buttermilk Creek began to incise some time between about 16,000 and 18,000 years ago.

The fact that one of the two samples (8A) comes from fluvial deposits atop the plateau, while the other comes from an abandoned meander cutoff incised into the Lavery till, suggests that these two deposits bracket the onset of incision. The overlapping age ranges of the two dates also suggest that early incision was relatively rapid. The implied 16,000 to 18,000-year age range for initial incision is also consistent with the estimate by Ellis et al. (2004) that the Laurentide ice sheet retreated from the Finger Lakes region some time around 16,600 years ago.

Of the Buttermilk Creek terrace samples, numbers 1A and 5A both show relatively narrow single-aliquot distributions, which are generally indicative of good bleaching. The MAM and CAM age estimates for sample 5A overlap within 1-sigma uncertainty, suggesting that the sample is indeed well bleached and can be considered reliable. The MAM age for sample 1A is lower than the CAM age, suggesting that the sample may have been incompletely bleached (despite the narrow range of individual aliquots). Both samples were obtained from terraces with treads lying roughly midway between the plateau surface and the modern valley floor. The age estimates for samples 1A and 5A, respectively, suggest that roughly half of the incision had occurred by 9,000 to 16,000 years before present, and that the remaining incision has occurred since that time. Thus, the incision rate along Buttermilk Creek may have slowed down over time. The post-terrace downcutting rates implied by these two samples are on the order of one to two meters per thousand years. Samples 2A and 3A suggest somewhat lower rates (see Tables F–3 and F–4), but the relatively broad distribution of single-aliquot ages in these samples suggest that they should be interpreted with caution. The MAM analysis of sample 4A, which comes from a coarse alluvial fan exposed in a quarry, shows a very broad dispersion of ages (the 1-sigma uncertainty bounds are greater than 3,000 years) and it is therefore not considered to be a reliable age estimate. Mahan (2007) also noted that sample 4A exhibited a large variation in equivalent-dose measurements.

Sample 7A was collected from a soil pit on a midlevel terrace in the Cattaraugus Valley. The sample showed a large variation in equivalent-dose measurements among its aliquots, suggesting the potential for partial bleaching. The MAM age estimate is considerably younger (about 7,000 to 10,000 years) than the CAM estimate (about 13,000 to 17,000 years). The poor quality of this sample is unfortunate, because at present it provides the only quantitative constraint on the rate of baselevel lowering in the Cattaraugus Valley near the mouth of Buttermilk Creek. The MAM age implies a post-terrace incision rate on the order of a few meters per thousand years.

The origin of the discrepancy between the ^{14}C age and the OSL ages is not known. One possibility is that the radiocarbon was contaminated with younger carbon. Another possibility is that the OSL samples are biased toward older ages by incompletely bleached grains, though if this were the case it would have to apply to those samples for which the MAM analysis revealed no statistical evidence of partial bleaching. Another possibility is that the wood fragments were buried some time after incision had already begun. Resolution of the discrepancy would require additional data collection and/or analysis, such as collection of additional ^{14}C and/or OSL samples. Given the overall consistency among OSL dates, as well as their consistency with the deglacial chronology of the Finger Lakes region, their ages are considered more reliable than the single radiocarbon age reported by Boothroyd et al. (1979).

Collectively, the OSL dating samples obtained from fluvial deposits suggest that Buttermilk Creek has had an average incision rate on the order of one to a few millimeters per year over roughly the last 10,000 to 17,000 years.

F.2.2.3 Estimating Downcutting from Repeated Cross-Section Surveys

The second measurement for downcutting involves comparison of elevation changes in cross sections after 10 years. In 1980, a longitudinal profile survey was conducted by Dames and Moore (WVNS 1993a) on a section of Franks Creek starting at the Quarry Creek confluence and proceeding upstream to a point on the eastern side of the SDA. In 1990, a second survey was completed along the same section of Franks Creek, and a comparison of resulting data indicated a downcutting rate of approximately 0.6 meters (2 feet) per 10-year period, which is equivalent to 60 meters (200 feet) per 1,000 years. This downcutting rate is the result of direct measurement of the change in thalweg, the locus of the lowest points in a stream or valley depth over the 10-year period. Because this rate is based on a short (10-year) projection, it does not take into account the wider range of precipitation values that are likely to occur over the long term, and thus, is not considered to be representative of long-term conditions. The 10-year projection also relies heavily on the current status of land use in the watershed, which is industrial in the vicinity of the Project Premises. The larger percentage of impervious areas associated with the industrial complex results in higher surface-water runoff rates than are anticipated to occur following decommissioning.

F.2.3 Historical Stream Valley Rim Widening

Stream valley rim–widening rates were calculated using estimates of the stream channel downcutting rates and the stream valley stable slope angle. The estimate of stable slope angle was determined from measurements of slope movement rates on several stream valley slopes that are actively slumping. The average downcutting rate, as estimated from dated terraces and the longitudinal profile study, was translated into a rim-widening rate by dividing the downcutting rate by the tangent of the stable slope angle.

F.2.3.1 Rim-Widening Estimates Based on Stream Downcutting Measurements

Dames and Moore studied the angle of ravine slopes within the Buttermilk Creek drainage basin to estimate the angle of stable slopes. They measured 21 cross sections along Quarry Creek, Franks Creek, and Erdman Brook using the 0.61-meter (2-foot) contour interval on a topographic map compiled by stereo-photogrammetric methods from 1:6,000-scale aerial photographs taken on May 17, 1989, and compiled by Tallamy, Van Kuren, Gertis, and Associates of Orchard Park, New York (WVNS 1993a). The cross sections were taken in areas having rather stable stream valley walls (no evidence of active landsliding), and an average slope angle was calculated. The slope angle, approximately 21 degrees, is considered to be representative of an "at-rest" slope condition, meaning the valley walls have reached equilibrium. Slopes with angles greater than 21 degrees are viewed as potentially unstable.

A second method confirmed the estimate of a 21-degree stable-slope angle. In this second study, force balance analysis was applied to estimate the slope angles for eight areas along Erdman Brook and Franks Creek (WVNS 1993a). Five of the areas, with slope angles ranging from 18.4 to 24.9 degrees, were stable. One of the areas, with a slope angle of 27 degrees, was subject to creep. The remaining two areas, with slope angles of 26 and 38 degrees, were unstable.

Using the stable-slope estimate of 21 degrees and an average downcutting rate of 5,500 millimeters (18 feet) per 1,000 years computed from the uncalibrated ^{14}C age of the high-terrace sample, the average rim-widening rate for Buttermilk Creek is 0.0143 meters (0.05 feet) per year. The equivalent figure for the calibrated ^{14}C age is 0.0125 meters (0.04 feet) per year. The same calculation can be made using rates of downcutting estimated from OSL terrace ages. Dividing the height of mid-level Buttermilk Creek terraces (sample locations 1, 2, 3, 5, and 6) by their ages yields average downcutting rates ranging from 0.6 to 1.9 meters (2.0 to 6.2 feet) per 1,000 years (Table F–3). Of these, the most reliable figure is thought to come from the well-bleached sample 5A, with an estimated post-1,000 years ago downcutting rate of 2.0 meters (6.6 feet) per 1,000 years. The corresponding rim-widening rate is 5.8 meters (19.2 feet) per 1,000 years. Note, however, that downcutting estimates based on Buttermilk Creek would likely underestimate the current downcutting rate along Franks Creek, which has a partly convex-upward longitudinal profile that may indicate that it is still in a state of transient response to baselevel lowering in the Buttermilk Creek Valley, and therefore incising faster than Buttermilk Creek.

The rim-widening rate was also estimated using the measured short-term downcutting rate from the longitudinal profile study of approximately 0.6 meters (2 feet) per 10 years in conjunction with an assumed 21-degree stable slope. This approach results in a rim-widening rate of 0.156 meters (0.5 feet) per year for Franks Creek (see **Table F–5**).

Table F–5 Estimates of Stream Valley Rim Widening Based on Stream Downcutting

Location and Method	*Stream Downcutting Rate (meters per 1,000 years)*	*Stream Valley Rim–Widening Rate (meters per year)*
Buttermilk Creek (calibrated radiocarbon age dating of wood fragment)	4.8	0.014
Buttermilk Creek (optically stimulated luminescence dating of terrace alluvium, sample 5A)	2.0 (5A)	0.0058
Franks Creek (longitudinal profile survey)	60	0.175

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

F.2.3.2 Rim-Widening Estimates Based on Slope Movement Measurements

The slope movement rate was measured on active slump areas along Buttermilk Creek and Erdman Brook. A 1978 analysis examined movement of a slump block on the Buttermilk Creek ravine, referred to as the "BC-6" landslide, approximately 426 meters (1,400 feet) east of the Waste Management Area 2 lagoons (Boothroyd et al. 1979). Thirty-five steel posts were surveyed at locations on the slump block complex and adjoining slopes. Resurvey of the posts two years later yielded an estimated average downslope movement rate of 7.9 meters (26 feet) per year. This downslope movement rate corresponds to a stream valley rim–widening rate of 4.9 to 5.8 meters (16 to 19 feet) per year based on the angle of the slope (Boothroyd et al. 1982). This movement rate is believed to represent an upper estimate of the annual mass movement that has occurred on the slope because a moderately severe storm (recurrence interval: 10 to 20 years) was recorded during the measurement period and a sand layer 4.6 meters (15 feet) thick was identified near the top of the landslide. The cohesionless sand layer coupled with the moderately severe storm event likely induced rapid movement, potentially skewing results toward the high end. Also, the high rate is not sustainable over the long term because slope movement slows as the slope angle tends to stabilize and eventually stops as that angle attains equilibrium; movement may be rejuvenated, however, by stream incision at the base of the slope. Over the course of a 1,000-year period, many localized areas throughout the stream valley would develop unstable slopes, causing rapid movement over a short time before stabilizing.

Along the section of Erdman Brook referred to as the "North Slope of the SDA," the New York State Geological Survey installed and surveyed 30 posts in 1982 and resurveyed the post elevations in 1983 to assess slope movement. The downslope till movement rate for the first year (1982 to 1983) was reported to be 0.2 meters (0.66 feet) per year, equivalent to a stream valley rim–widening rate of approximately 0.15 meters (0.49 feet) per year (Albanese et al. 1984). The New York State Energy Research and Development Authority added 4 posts in 1991 and resumed yearly measurements in 1991 and reported a maximum decrease in surface elevation of 0.04 meters (0.12 feet) per year over the last 22 years (1982 to 2004) and a maximum of 0.02 meters (0.07 feet) per year over the last 13 years (1991 to 2004), indicating that the movement rate has slowed down over the last decade (WVNS 1993a). **Table F–6** summarizes these results.

Table F–6 Estimates of Stream Valley Rim Widening Based on Slope Movement

Location	*Slope Movement Rate (meters per year)*	*Stream Valley Rim–Widening Rate (meters per year)*
BC-6 landslide (on Buttermilk Creek 426 meters east of the lagoons)	7.9	4.9 to 5.8
North Slope of the SDA (on Erdman Brook) – first-year rate	0.2	0.15
North Slope of the SDA (on Erdman Brook) – 22-year rate	0.02 to 0.04	0.015 to 0.03

SDA = State-Licensed Disposal Area.
Note: To convert meters to feet, multiply by 3.281.

F.2.3.3 Measurement of Gully Advance Rates

Several existing gullies in the Buttermilk Creek drainage basin are migrating into the edge of the North and South Plateaus. If natural gully advancement proceeds without mitigation, the gully heads could cut into the areas in which residual radioactivity could be closed in place. To address this concern, studies have been initiated to determine the gully migration rate. As shown on Figure F–5, five gullies have been mapped on the North Plateau extending from Quarry Creek (NP-1), Erdman Brook (EQ-1), and Franks Creek (NP-2, NP-3, and 006) toward the industrial area, and two have been mapped on the South Plateau (the SDA and NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area [NDA]) extending from Erdman Brook toward the disposal facilities.

The headward advance rates of three active gullies (SDA, NP-3, and 006) were calculated (WVNS 1993a) using the Soil Conservation Service Technical Release 32 method (USDA 1976). Aerial photographs taken in 1955, 1961, 1968, 1977, 1978, 1980, 1984, and 1989 were reviewed in support of the calculation. As shown in **Table F–7**, this method indicated that the SDA gully was advancing toward SDA Disposal Trench 1 at a rate of 0.4 meters (1.2 feet) per year, implying that, without mitigation, the gully would reach the SDA fence in approximately 25 years and the trench in about 200 years. In 1995, as part of an effort to control infiltration and runoff at the SDA, the gully was filled to mitigate erosion. The NP-3 gully is advancing toward the Construction and Demolition Debris Landfill at a rate of 0.7 meters (2.2 feet) per year; without mitigation, this gully will encroach upon it in about 100 years. The 006 gully is migrating toward the area between the Construction and Demolition Debris Landfill and the wastewater treatment lagoons at a rate of 0.7 meters (2.3 feet) per year. Without mitigation, this gully is predicted to reach the area in approximately 150 years; however, given the present surface-water drainage course, the gully head is not likely to affect the two facilities. Other gullies on the Project Premises have not shown sufficient visible movement of the gully heads to allow for the calculation of migration rates by the Soil Conservation Service Technical Release 32 method.

Table F–7 Gully Advance Rate Measurements

Gully Name	*Gully Location*	*Gully Advance Rate (meters per year)*
SDA	On east bank of Erdman Brook north of SDA	0.4 [a]
NP-3	On west bank of lower Franks Creek, east of Construction and Demolition Debris Landfill	0.7
006	On west bank of Franks Creek, just north of confluence with Erdman Brook	0.7

SDA = State-Licensed Disposal Area.
[a] The SDA gully was reconstructed in 1995 and the 0.4 meters per year rate was measured before mitigation.
Note: To convert meters to feet, multiply by 3.281.

F.3 Erosion Rate Prediction Methods

Mathematical models are used to predict the nature and rates of erosion processes. A survey of the models shows that they fall into two broad categories. Models in the first category make short-term predictions (projections considered valid for decades). These short-term models are generally based on detailed simulation of one or two distinct erosional processes. Models in the second category use upper-level conservation equations representing the combined effect of multiple erosional processes to make long-term projections (thousands of years). The following paragraphs provide a discussion of the long-term erosion modeling study that was used to make the prediction of erosion at the site over the next 10,000-year period. It is followed by a discussion of the short-term modeling analyses that were completed over the last 30 years and are now being used to verify the reasonableness of the long-term modeling assessment.

F.3.1 Long-term Models

The geomorphic history of the site, together with observations of modern processes, dictates the type of model that is required to assess potential erosion rates and patterns over millennial time scales. As discussed earlier, geologic evidence indicates that the topography of the Buttermilk Creek drainage basin has changed substantially since the end of the last ice age. Dating samples imply that rates of stream downcutting have been on the order of 1 meter per 1,000 years or higher, which is relatively rapid for a moderate-relief landscape and suggests the potential for significant topographic change over the next 10,000 years. In addition, observations at and near the facilities indicate ongoing topographic change, in the form of mass movement on hillslopes, gully propagation, and measurable downcutting along creek valleys.

Because topography is expected to continue to evolve in the future, the applicability of standard “fixed terrain” erosion-prediction models, such as the Water Erosion Prediction Project (WEPP) and others like it, is limited. These standard “fixed terrain” models are derived from field-test plot data that was collected over a 20-year period; thus, these models are not intended to be extrapolated for long periods into the future (i.e., thousands of years). Instead, they are useful for estimating erosion rates on an average annual basis or storm-by-storm basis over tens to hundreds of years. Ideally, a model of potential future erosion should be able to incorporate changing topography. Such a model should also be designed, to the extent possible given the state of the science, to represent the types of processes that are occurring today and likely to continue in the future, including sediment transport by streams, erosion of resistant (cohesive) material by streams, mass movement on hillslopes, and the formation of gullies. Thus, the logical tool of choice is a Landscape Evolution Model (LEM). The term, Landscape Evolution Model, is used here to refer to a computer program that calculates the evolution of a topographic surface over time by solving a set of equations and algorithms that represent the geomorphic processes acting on that surface. The development, testing, and refinement of LEMs is the subject of active ongoing research (for recent reviews, see Martin and Church 2004, Willgoose 2005, Codilean et al. 2006, Bishop 2007).

F.3.1.1 Review of Erosion Models

A survey of long-term erosion models was conducted to identify models that could be used for analysis of WNYNSC. Several criteria were used to help identify and evaluate models. These models must have the following capabilities and characteristics:

- Analysis of long-term erosion (thousands of years) with changing topography;
- Modeling of the dominant erosive processes of the site, including hillslope movement (soil creep and landsliding), stream channel downcutting, and gully formation;
- Calibration directly or indirectly using available models or measurements;
- Public availability; and
- Peer review and general verification based on ability to reproduce statistical characteristics of landforms.

Three specific models for predicting landscape evolution were identified. These models, SIBERIA, GOLEM [Geomorphic/Orogenic Landscape Evolution Model], and CHILD, are briefly described in the following paragraphs.

The SIBERIA model was initially developed in the late 1980s to predict landform changes over long periods of time (hundreds to millions of years). It is a physically based model that uses an effective-runoff approach over a specified timeframe and accounts for both fluvial and diffusive (hillslope) processes that move sediment through a drainage system. The fluvial processes include soil detachment and water transport (e.g., sheet and rill erosion, stream downcutting, gully advance), while the diffusional process represents soil creep and landsliding (e.g., slope movement). The central feature of SIBERIA is a sediment balance that is conducted over each rectangular grid element that forms part of the total grid representing the site. The change in sediment thickness within a grid is the basis for prediction of erosion or sedimentation within that grid. The model is one of the earliest of the current generation of landform evolution models. A continuing research program has been under way during the past 10 years to validate SIBERIA predictions against small-scale laboratory experimental and large-scale natural landscapes over a range of different landforms, geologies, and climates.

Studies in this program have demonstrated the following aspects of the SIBERIA model:

- It is able to simulate the statistical form of the Pokolbin catchment in the Hunter Valley in Australia (Willgoose 1994).
- It is able to simulate development of experimental model landscapes (Hancock and Willgoose 2001a).

- It can simulate natural landforms in a tectonically active region of New Zealand (Ibbitt et al. 1999).
- Using parameters derived from a short-term analogue site (i.e., an abandoned uranium mine at Scinto 6 in the South Alligator River Valley, Kakadu National Park, Australia), SIBERIA can accurately model gully development on a manmade postmining landscape over timespans of around 50 years (Hancock and Willgoose 2001b).
- Using parameters derived from a long-term analogue site (i.e., a natural, undisturbed site at Tin Camp Creek within the Myra Falls Inlier, Northern Territory, Australia), SIBERIA can accurately model the geomorphology and hydrology of a natural catchment over the long term (Hancock et al. 2002).

The second model that was identified was GOLEM. This model was developed in the early 1990s to simulate evolution of topography over geologic time scales. Like SIBERIA, it is a physically based model that uses average precipitation over a specified timeframe, accounts for both fluvial and diffusional processes, and conducts sediment balances over the grid elements that represent the site. Its structure is also similar to SIBERIA in that it uses a rectangular, finite-difference grid. It uses a somewhat different method for computing erosion and sedimentation by running water.

The CHILD model was developed in the late 1990s and is a descendant of the GOLEM and SIBERIA models. Like SIBERIA and GOLEM, it simulates the interaction of fluvial processes (slope wash and channel and rill erosion) and diffusive processes (weathering, soil creep, and other slope transport processes). However, this basic capability has been expanded with the addition of several features. It uses an irregular gridding method that makes it possible to represent different parts of the landscape at different spatial resolutions. Instead of using a single effective rainfall or runoff rate that represents a geomorphic average, it provides the option of stochastic rainfall input. Like the GOLEM model (and the related DELIM [Howard 1994]) it allows for detachment-limited, transport-limited, or mixed behavior in calculating runoff erosion. It computes hillslope sediment transport using either a linear or nonlinear diffusion model; the latter is designed to capture rapid mass movement on slopes close to the angle of repose. The ability of the CHILD model to reproduce observed ridge–valley topography and statistical properties such as the slope-area relationship has been demonstrated (Tucker et al. 2001b, Tucker 2004). A recent study (Attal et al. 2008) showed that the model is capable of simulating the topography of a drainage basin in central Italy that is undergoing a transient geomorphic response to accelerated tectonic uplift during the Pleistocene period. The model has also been used to simulate gully development (Istanbulluoglu et al. 2005, Flores-Cervantes et al. 2006), including gully cut-and-fill dynamics in response to stochastic rainfall variation (Tucker et al. 2001b, Arnold et al. 2009). Other published applications of the CHILD model include geomorphic impacts of glacial-interglacial climate variation (Bogaart et al. 2003), valley stratigraphy and geoarchaeology in a meandering river environment (Clevis et al. 2006), the role of vegetation in landscape evolution (Collins et al. 2004; Istanbulluoglu and Bras 2005), grain-size dynamics in drainage networks (Gasparini et al. 2007), karst landform development (Fleurant et al. 2008), and geomorphic effects of rainfall intensity and duration (Tucker and Bras 2000, Sólyom and Tucker 2004).

The CHILD model was selected as the primary analysis tool because (1) it uses a stochastic rainfall module that can be driven by rainfall intensity and duration statistics derived from onsite data, (2) it provides a multi-resolution capability that allows the site to be modeled at a higher resolution than the surrounding catchment, and (3) it allows for fluvial erosion to be limited by either sediment-transport capacity or material detachment capacity.

F.3.1.2 Overview of Approach to Erosion Modeling

Erosion modeling objectives at WNYNSC are to develop an understanding of local erosion processes and the manner in which those processes may develop over a long period of time, and to provide a basis for estimating potential health impacts related to erosion. Major analysis products include the development of future-erosion scenarios at facilities on the North and South Plateaus, evaluation of gully and stream channel development, and assessment of the potential for alteration in drainage patterns.

Application of the CHILD model to the Buttermilk Creek drainage basin is designed to shed light on the nature and magnitude of potential long-term (10,000-year) geomorphic evolution of the area. Modeling over such long periods is based on a simple premise: *if a model, when given a plausible set of parameters and boundary conditions, can adequately reproduce the observed pattern of landscape evolution over the last 10,000 to 20,000 years, then there is increased confidence in the ability of that model to indicate potential erosion trends over a similar timeframe and under similar environmental conditions*. This approach takes advantage of the rather simple and well-constrained postglacial geomorphic history of Buttermilk Creek, which, as noted above, is interpreted to involve postglacial (circa 18,000 years ago) drainage network incision into glacial deposits due to baselevel lowering along Cattaraugus Creek.

In evaluating the output of landscape evolution models like CHILD, it is important to bear in mind that the details of computed drainage network patterns are known to be sensitive to initial conditions. For example, Ijjasz-Vasquez et al. (1992) showed that small perturbations of initial conditions led to notable differences in simulated drainage pathways, though the topography and network geometry were robust in a statistical sense. This instance of the "butterfly effect" means that these models are more useful for indicating general trends, patterns, and parameter sensitivities than for predicting the detailed erosional history at a particular spot in the landscape. The particular geometry of any simulated drainage network should be considered merely one of many possible realizations. Areas with initially very low relief are most prone to this effect. Initializing a model with a pre-existing drainage network (rather than a nearly flat surface) reduces the potential for sensitive dependence on initial conditions but cannot entirely eliminate it. A second consideration concerns the nature of the physical laws ("geomorphic transport laws" [Dietrich et al. 2003]) that go into landscape evolution models like CHILD. For the most part, these are semi-empirical statements about the relationship between sediment transport rates by a particular type of process (e.g., soil creep, channelized flow) and controlling variables such as gradient or fluid friction. For example, the linear and nonlinear soil creep laws rely on empirical rate coefficients that, at present, cannot be determined *a priori* from knowledge of soil type, biota, and climate alone. This means that, like most environmental models, landscape evolution models are provisional; they represent the current state of the science but are subject to continual improvement as the science evolves. In the context of evaluating erosion at WNYNSC, the best available test of these models' reliability is their ability to reproduce past landscape evolution. This is the basis for the testing and calibration strategy used in this study.

Determination of erosion processes and processes influencing erosion requires vastly different scales of space and time. Representative scales for the detachment of soil particles in rills are on the order of millimeters and seconds; those for river meandering or tectonic uplift, from one to thousands of kilometers and from centuries to thousands of years. Within this range of scales, different modeling approaches may be applicable. From the reductionist view, detailed specification of many processes is needed to understand all features of landscape evolution (Rodriguez-Iturbe and Rinaldo 1997). An opposing view holds that, for complex landform systems, a reductionist approach does not provide a self-consistent method (Werner 1999) and that large-scale structure is independent of detailed description of motion at small scales (Goldenfeld and Kadanoff 1999). The CHILD modeling approach is designed to use macroscopic-scale correlation of measured conditions projected over differing space and time scales. The following sections provide the rationale for the selection of the initial postglacial topography, the model boundary conditions, and the input parameters.

F.3.1.3 Overview of CHILD Model Calibration Strategy

Every mathematical-conceptual model has parameters that are the coefficients and exponents in the model equations. These parameters must be estimated for a given watershed and for each computational segment of the model. This requires determining the parameters' inherent relationships with physical characteristics or tuning the parameters so that model response approximates observed response, a process known as calibration. In the calibration process, the modeling results are checked to determine whether they are reasonable for the area and time that was modeled, and for the conditions modeled. The calibration process can be quite complex and time consuming because of the limitations of the input and output data, imperfect knowledge of basin characteristics, the mathematical structure of the models, and limitations in the ability to quantitatively express preferences for how best to fit the models to the data.

Calibration of the CHILD model was accomplished through a forward modeling exercise, which starts with a postglacial (pre-incision) valley topography and attempts to reconstruct the modern topography. Within this framework, a number of different potential strategies, with varying degrees of complexity could be used. These range from Monte Carlo–based, multi-parameter optimization schemes to simple single-parameter tuning exercises. The advantage of complex, multi-parameter schemes such as Monte Carlo methods is that they can achieve the closest possible match to data and can also reveal the potential for model equifinality (multiple solutions providing equivalent matches to the data). They can also be used to place uncertainty bounds on the calibrated parameters. Their main disadvantage is the high cost and long times of computation. Simpler parameter-tuning methods have the advantage of computational efficiency, and are most effective where the majority of parameters can be estimated *a priori* using site-specific data.

The CHILD model was calibrated using a Monte Carlo approach that tested the ability of the model to reproduce the modern landscape, starting from a reconstruction of the ancient landscape. One thousand different runs were computed using randomly generated parameter sets. Parameter ranges, and the values of fixed parameters, were chosen on the basis of available data as described below. For each parameter that was varied at random, five unique values were identified. This “binning” of Monte Carlo parameters is sometimes known as the Latin Hypercube approach, and it has the effect of reducing the parameter space to a finite number of combinations and ensuring that parameter combinations are spread over the full range rather than clustering.

The results from each Monte Carlo run were tested against a set of metrics derived from the modern topography and from age-dating information. Based on these test metrics, a numerical score was assigned to each run. Criteria for an acceptable fit were determined, and those parameter sets fitting these criteria were identified. The overall best-fit run was identified as a “standard” case for developing forward-in-time simulations. Other parameter sets fitting the acceptance criteria were also identified for use in constructing alternative future erosion scenarios.

In calibrating a model in this manner, careful attention must be given to the initial and boundary conditions. The initial conditions for CHILD include the topography just prior to the onset of postglacial valley incision, and the distribution of lithologies within the basin. As noted previously and detailed further below, the postglacial topography was reconstructed on the basis of existing remnants of a once-continuous plateau surface. To represent the varying lithologies across the catchment, a choice must be made as to the degree of complexity in modeling the distribution of rock and sediment types. If strongly contrasting rock or sediment types are lumped together, there is a risk that the model will perform poorly because it fails to account for major differences in erosional resistance. On the other hand, if the landscape and its subsurface are divided into too many individual units, several problems can arise. First and most important, including multiple lithologic categories increases the number of poorly constrained parameters that must be calibrated. Second, the more loosely constrained parameters that are included in a model, the harder it is for an analyst to understand and interpret the model’s behavior. Third, information about the spatial distribution of lithologies, particularly in the subsurface, may be (and usually is) limited or incomplete. To paraphrase Albert Einstein, it is generally best to make a model as simple as possible, but no simpler. In keeping with this philosophy, the approach used in the erosion analysis has been to err on the side of simplicity wherever possible. Thus, the representation of lithologic variability in the CHILD calibration and forward runs has been limited to the three primary and most strongly contrasting lithology classes observed at WNYNSC: (1) Paleozoic bedrock, (2) thick but unlithified glacial sediments, and (3) shallow surface soils/sediments. The choice of parameters to represent these three units, as well as their spatial distribution, is discussed further below.

The boundary conditions for the simulation include the elevation history of the Cattaraugus Valley at the outlet of Buttermilk Creek, which provides the baselevel, and the climate history over time. The elevation history of the Cattaraugus Valley reflects changing baselevels as the Laurentide ice retreated. From the perspective of Buttermilk Creek, what matters is the elevation history of the valley floor in the vicinity of the Buttermilk-Cattaraugus junction, because it is that point that provides the baselevel for Buttermilk Creek. Scenarios for this baselevel history are developed on the basis of topographic features and OSL dating, as described below.

The climate history since ice retreat represents the most difficult set of parameters to constrain. While there are numerous published studies that provide indirect information about the postglacial climate based on proxies such as lake levels and pollen, at present there is no simple method for deriving rainfall or runoff statistics from these proxies. For example, changes in the level of a lake can occur for many different reasons, including changes in rainfall amount or frequency, changes in seasonal temperatures, changes in catchment runoff ratios due to land-cover change, or even changes in atmospheric humidity and wind speed. Thus, interpretation of proxy data in terms of quantitative hydrologic variables such as average storm frequency or intensity would be problematic. In view of this, the logical choice is to err on the side of simplicity and treat the climate as having been essentially constant during the calibration period. This choice inevitably introduces uncertainty into the calibration process. This uncertainty is considered to be no less than the uncertainty that would be introduced by using proxy records to develop educated guesses about the variation in rainfall statistics over the past 17,000 years, while the constant-climate approach has the advantage of parsimony. In addition, as described below, climate uncertainty is addressed to some extent by including among the forward-model scenarios a group of runs that are based on a future doubling of mean rainfall intensity coupled with a very low value for soil infiltration capacity.

F.3.1.4 Parameter Selection for CHILD Model

This section discusses the selection of parameter and parameter-range values for CHILD, as shown in **Table F–8**. A detailed description of the model can be found in Tucker et al. (2001a) and Tucker (2008), while some of the basic data structures and algorithms are presented in Tucker et al. (2001b). Applications of the model to various research problems can be found in a variety of publications (Tucker and Bras 2000, Sloan et al. 2001, Bogaart et al. 2003, Lancaster et al. 2003, Collins et al. 2004, Sólyom and Tucker 2004, Tucker 2004, Istanbulluoglu and Bras 2005, Istanbulluoglu et al. 2005, Clevis et al. 2006, Flores-Cervantes et al. 2006, Crosby et al. 2007, Gasparini et al. 2007, Fleurant et al. 2008).

F.3.1.4.1 Reconstructed Postglacial Topography of Buttermilk Creek

The starting condition for the model was a Digital Elevation Model (DEM), which represented the topography of Buttermilk Creek as it would have existed following the initial retreat of the ice sheet. The last glacial retreat from the area left behind thick accumulations of glacial deposits within the main valleys, including the valleys of the modern Cattaraugus Creek and its tributaries. In the Buttermilk Creek watershed, these glacial deposits, together with a thin mantle created by postglacial fan deposits, formed a low-relief surface sloping gently downward to the north-northwest. Since deglaciation, Cattaraugus Creek and its tributaries have incised these glacial deposits (Fakundiny 1985). Extensive remnants of the incised postglacial valley surface remain throughout the Buttermilk Creek basin, forming a dissected, semicontinuous, low-relief surface with an altitude that ranges roughly from 400 to 430 meters (1,300 to 1,400 feet) within the Buttermilk Creek basin. These remnants appear to be only thinly mantled by postglacial deposits (see, for example, Quaternary geologic map and generalized cross section in LaFleur [1979]), so it is logical to assume that they provide a reasonably accurate representation of the valley topography shortly before stream incision began.

Table F–8 Values of CHILD Input Parameters Selected for Calibration Runs

Parameter	*Symbol*	*Value*
Mean rainfall intensity	$\bar{P}$	1.45 millimeters per hour
Rainfall duration parameter	F_p	0.08
Global time-step length	T_g	0.1 years
Infiltration capacity	I_c	[3.82, 8.29, 16.8, 19.4, 68.7] meters per year
Sediment transport efficiency factor	k_f	[20, 100, 500, 2500, 12500] square meters per year per pascal $^{3/2}$
Sediment transport capacity discharge exponent	m_f	0.667
Sediment transport capacity slope exponent	n_f	0.667
Excess shear stress exponent	p_f	1.5
Bedrock erodibility coefficient (till)	K_{bt}	[1, 10, 100, 1000, 10000] meters per year per pascal
Bedrock erodibility coefficient (bedrock)	K_{br}	[0.001, 0.01, 0.1, 1, 10] meters per year per pascal
Regolith erodibility coefficient	K_r	10,000 meters per year per pascal
Shear stress coefficient (=$\rho\ g^{2/3}\ C_f^{1/3}$; see page F-34)	K_t	[1000, 1250, 1500, 1750, 2000] pascals per (square meter per second) $^{2/3}$
Bedrock erodibility specific discharge exponent	m_b	0.667
Bedrock erodibility slope exponent	n_b	0.667
Exponent on excess erosion capacity	p_b	1
Critical shear stress for bedrock	τ_{cb}	[1, 4, 16, 80, 400] kilograms per meter per second squared
Critical shear stress for regolith	τ_{cr}	[4, 10, 23, 54, 124] kilograms per meter per second squared
Hillslope creep coefficient	k_d or κ	[0.0003, 0.001, 0.003, 0.01, 0.036] square meters per year
Critical slope	S_c	0.3839 meter per meter
Initial regolith thickness	H_{r0}	1.5 meters
Run duration (start of base level lowering)	-	[18.3, 17.5, 16.7, 16.0, 15.24] thousand years
Time at which baselevel reaches terrace 7A	-	[17.04, 14.5, 12.0, 9.5, 7.05] thousand years
At-a-station channel width-discharge exponent	ω_s	½
Downstream channel width exponent	ω_b	½
Channel width coefficient	k_w	4.46 meters per (cubic meters per second) $^{1/2}$

Note: Values in square brackets represent alternative values used in Monte Carlo simulations.

The pre-incision valley topography was reconstructed using the valley slope projection method. This method uses the slope of the existing topographic remnant features within the Cattaraugus Valley. The slope of the initial, pre-incision valley was estimated by projecting the modern-day slopes of the remnant surfaces down the valley toward the outlet of Buttermilk Creek. The resulting pre-incision valley gradient lies between 0.003 and 0.004. Total postglacial incision depth at the Buttermilk Creek outlet was obtained from the difference between the modern creek elevation and the elevation of the surrounding terrace remnants, ranging between 60 and 80 meters (200 and 260 feet) of incision depending on which nearby plateau fragment is selected. The plateau heights in the confluence area appear to reflect the presence of a fill or strath terrace about 20 meters (60 feet) below the original valley surface; this feature is suggested by a gentle east-west-trending scarp that separates two low-relief surfaces above the left bank of lower Buttermilk Creek, in the vicinity of Edies Siding. For purposes of model calibration, we have adopted intermediate values of 0.0035 for the paleo-valley gradient and 405 meters (1,329 feet) for the initial outlet elevation, which implies a total postglacial incision depth of 69 meters (226 feet). The topography of the pre-incision valley was reconstructed by combining two DEMs: one representing the modern topography of the catchment and one representing the postglacial valley-surface topography. The postglacial valley-surface DEM was built using the following algorithm:

- Assignment of a pre-incision elevation (in this case 405 meters [1,329 feet]) to the outlet point.
- Setting the elevation of each remaining DEM cell in the DEM to $z(x,y) = z_0 + L\, S_v$, where z_0 is the outlet elevation, L is the Euclidian distance from the outlet ($= \sqrt{x^2 + y^2}$), S_v is the projected valley slope (in this case 0.0035), and x and y are the east-west and north-south distances, respectively, from the outlet point.

The initial topography DEM was then constructed by assigning to each cell the value of the corresponding cell in either the modern topography DEM or the valley-surface DEM, whichever was greater. This method yielded a smooth, gently sloping central valley whose height corresponds approximately to the present-day height of the plateau remnants, as shown on **Figure F–7**. Finally, the present-day drainage network was lightly etched into the reconstructed plateau surface by reducing by a small amount (2 meters) the elevation of cells containing the mainstem Buttermilk or its larger tributaries. This etching procedure, which has been used in other landscape modeling studies (Anderson 1994), does not substantially alter the marcroscopic erosion patterns (which are dictated by the generalized topography and the process parameters), but it does help reduce the number of "false negative" solutions in which the computed erosion depths and spatial patterns are comparable to the present day but the main streams are shifted to one side or the other in the main valley due to small discrepancies between the actual and modeled initial conditions.

No attempt was made to reconstruct subtle variations in the initial valley topography that may reflect features such as recessional moraines or proglacial lake shorelines. Such features demonstrably exist, but for the most part they are below the resolution of the best available topographic maps, and are therefore subject to considerable uncertainty. Likewise, no attempt was made to correct for postglacial erosion or aggradation within the small tributaries above the valley remnants (in the bedrock region), such as upper Quarry Creek, because there appears to be no data set available at present on which to base such corrections. In the future, acquisition of high-resolution, vegetation-corrected airborne laser-swath maps could allow for greater precision in reconstructions of pre-incision topography because such data would allow for improved Quaternary geologic mapping and feature identification, mapping of smaller terrace features, and quantification of historic rates of land surface change.

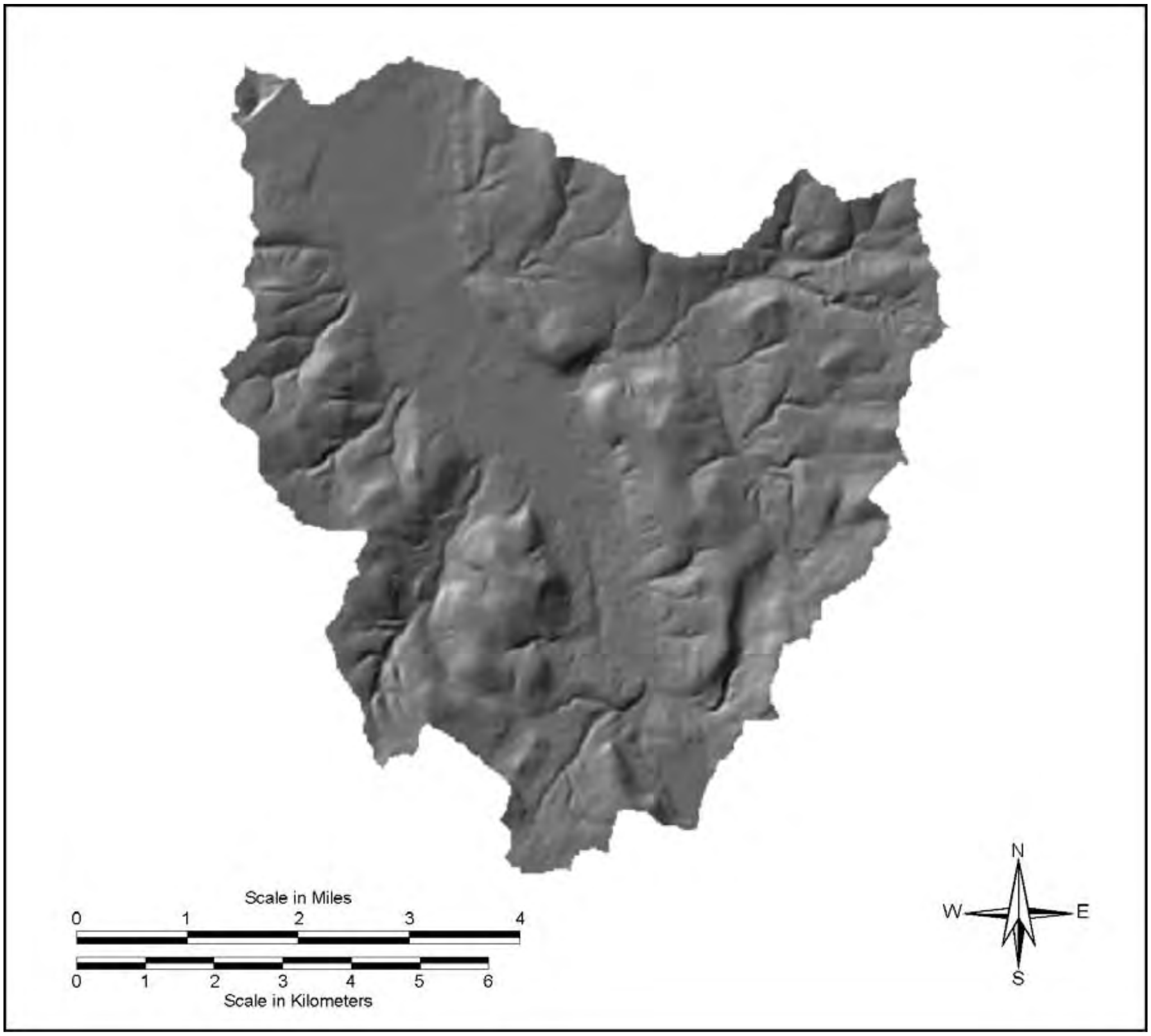


Figure F–7 Topography of the Pre-Incision Buttermilk Creek Valley that was used to Calibrate the Landscape Evolution Models

F.3.1.4.2 Boundary Conditions: Baselevel History

Glacial recession from the Lake Erie basin appears to be the ultimate cause of stream incision within the Cattaraugus Valley and its tributaries. For purposes of erosion evaluation, however, the key boundary condition is the elevation history in the reach of Cattaraugus Creek, for it provides the baselevel for the Buttermilk Creek catchment. In order to estimate this baselevel history, it was necessary to answer the following questions: When did incision begin here? How fast did Cattaraugus Creek incise here? Has this rate varied through time, and if so, how?

In order to constrain the timing of base level lowering, and also provide information on the history of incision within the Buttermilk Creek Valley itself, 10 samples for OSL dating were collected from various points in and around the Buttermilk Creek catchment, as described in Section F.2.2. The samples were analyzed in the USGS Luminescence Dating Laboratory (Mahan 2007). A well-bleached sample obtained from fluvial sediments near the top of the plateau implies that Buttermilk Creek began incision about 17,000 years ago (i.e., 16,800 ±1,530 [1 sigma] from OSL sample 8A [see Table F–3]). This timing agrees, within uncertainty, with the timing of glacial retreat from the Finger Lakes to the east (e.g., at Seneca Lake, final retreat is estimated to have occurred approximately 16,600 calendar years before present [Anderson and Mullins 1997, Ellis et al. 2004]). Note that the common practice in the literature of reporting uncalibrated ^{14}C ages can sometimes cause confusion; for example, 14,000 uncalibrated ^{14}C years corresponds to approximately 16,600 calendar years according to current calibration curves.

A set of alternative baselevel histories was developed by estimating the times at which the Cattaraugus-Buttermilk confluence lay at three different elevations: the starting (postglacial) elevation of the plateau before incision, the elevation of the terrace from which OSL sample 7A was collected, and the elevation of the modern confluence. At the onset of incision, the confluence is assumed to have been at an elevation of 405 meters above modern sea level, as discussed previously. Samples 8A and 9A are believed to bracket the onset of incision. Sample 8A, the higher of the two, is therefore used as the basis for the onset of baselevel lowering. As discussed in Section F.2.2.2, Sample 8A appears to be well bleached, based on its unusually tight equivalent-dose histogram and on the overlap between the CAM and MAM ages. Its CAM 1-sigma age range is 15,240 to 18,300 years. Thus, the five alternative parameter values for the start of baselevel lowering are: [18,300, 17,500, 16,700, 16,000, 15,240] years.

The next parameter to estimate is the time at which the confluence reached the elevation of the terrace from which Sample 7A was collected. As noted earlier, the CAM and MAM age estimates for Sample 7A differ considerably: the former (with 1-sigma uncertainty bounds) is 13,400 to 17,000 years while the latter is 7,000 to 9,800 years. The parameter range explored in the calibration covers this full age range: 7,050, 9,500, 12,000, 14,500, 17,040. In deriving incision rates from this midlevel terrace, it is assumed that the terrace is a strath (bedrock-cut platform mantled by alluvium) rather than a thick fill terrace. Without deeper (backhoe) sampling at this site, this assumption cannot be confirmed, but it is supported by similar ages from two confirmed strath terraces at similar levels in the Buttermilk Creek Valley (samples 1A and 6A).

Uncertainty in the derived baselevel history reflects uncertainty in the dating. Reducing this uncertainty would require additional identification and dating of strath terraces in the vicinity of the Buttermilk–Cattaraugus confluence. This would produce a larger sample size, yield a greater likelihood of identifying well-bleached (and therefore more-reliable) samples and/or material datable by ^{14}C analysis, and (if additional terrace levels could be identified) increase the time resolution in the baselevel reconstruction.

F.3.1.4.3 Boundary Conditions: Glacio-Isostatic Uplift

Removal of the load of the ice sheets leads to isostatic rebound of the lithosphere. From the point of view of a drainage basin subjected to such glacio-isostatic uplift, there are three potential effects. First, if a catchment drains to a body of water such as a lake or ocean that has a fixed altitude, glacio-isostatic uplift (or subsidence) will change the elevation difference between the catchment and its baselevel. It may also alter the length of the catchment by, for example, exposing part of a coastal shelf (or drowning the lower part of a catchment, in the case of subsidence). Isostatic uplift along a shoreline can lead to either increased or decreased erosion and transport rates, depending on the slope of the uplifted shelf relative to the stream slope near the coastline (Summerfield 1986, Snyder et al. 2002). Regional postglacial isostatic uplift in the Lake Erie basin has been well documented, as have fluctuations in lake levels through time (Holcombe et al. 2003). From the point of view of Buttermilk Creek, the net effect of these processes has been to change the baselevel at its junction with Cattaraugus Creek, as discussed previously. In other words, the influence of postglacial isostatic uplift on local baselevel is incorporated in the model by specifying the baselevel history at the Buttermilk–Cattaraugus confluence.

A second potential effect of postglacial isostatic uplift relates to climatology. A substantial increase in the absolute elevation of a catchment can indirectly influence rates of weathering and erosion by altering the catchment's mean temperature (due to the environmental lapse rate) and precipitation (due to orographic effects). However, in this case the magnitude of absolute uplift is sufficiently small (likely less than a few hundred meters [several hundred feet]) that any associated changes in temperature or precipitation fall well within the existing uncertainties regarding postglacial climate variation.

The third potential effect of isostatic adjustment is tilting of the surface due to spatial variations in uplift rate. Spatial variations in glacio-isostatic uplift rates are well documented in eastern North America. For the Lake Erie basin, Holcombe et al. (2003) used bathymetry data to map submerged paleo-shorelines. Based on a tilted 13,400-year-old shoreline, their data suggest about 52 meters (170 feet) of differential uplift over a distance of approximately 130 kilometers (80 miles), which implies a down-to-the-west tilt of about 4×10^{-4}. By comparison, the gradient of the modern Buttermilk Creek Valley in its lower-middle reaches is about 8×10^{-3}, while the gradient of the plateau is approximately 3.5×10^{-3}, as discussed above (see also the generalized Buttermilk Creek Valley profile of LaFleur [1979]; Figure 3 shows an average creek gradient from Riceville Station to the outlet of approximately 0.0085, and a plateau gradient of approximately 0.003). Thus, assuming that Buttermilk Creek experienced postglacial tilting of a similar magnitude to that observed in Lake Erie, even if that tilt were aligned directly along the valley axis, it would alter the initial valley gradient by only about 10 percent. Therefore, the postglacial tilting likely had only a second-order effect on stream gradients. Because the likely magnitude of tilt is comparable to the uncertainty in the estimates of paleo-valley gradient, it is not incorporated in the model calibration.

F.3.1.4.4 Parameters Related to Climate

CHILD uses a stochastic representation of rainfall and runoff in which a sequence of storm and interstorm events is drawn at random from exponential frequency distributions (Eagleson 1978; Tucker and Bras 2000). The rainfall model requires three parameters: the average storm intensity, P, the average fraction of time (between zero and one) that precipitation occurs at the site F_p, and the size of a global model time step T_g, which represents the average duration of a storm and interstorm sequence.

The mean rainfall intensity parameter was derived from 9.8 years of 5-minute resolution precipitation data collected at the WNYNSC weather station. Individual storms were identified using an approach (Eagleson 1978) in which a storm is defined as any period of precipitation that is both preceded and followed by dry periods of 2 hours' duration or longer. The depth and duration were computed for each storm, and the means of each computed for the entire length of record. The mean annual precipitation for the 9.8 years of high-resolution data is 1.02 meters (3.35 feet) per year. The average storm duration for this period of record is 2.57 hours, while the mean depth is 3.73 millimeters (0.15 inches). The estimated mean storm intensity derived from these values is 1.45 millimeters (0.06 inches) per hour; this value falls within the range of monthly values obtained by Hawk and Eagleson (1992) (0.43 to 2.1 millimeters [0.02 to 0.08 inches] per hour) from hourly precipitation data at the Buffalo-Niagara International Airport, New York. The value of the precipitation-duration parameter F_p can be derived from mean annual precipitation P_a via the relation $F_p = P_a / P$, which yields a value of 0.08 (in other words, precipitation occurs on average for 8 percent of any given year).

The model is relatively insensitive to T_g as long as its value is sufficiently small. To determine a reasonable value for T_g, a series of 1,000-year sensitivity tests were conducted using the modern topography of Buttermilk Creek as an initial condition. Results showed that values of T_g of approximately 1 year or smaller produce very similar results (average root-mean-square differences in model-cell height of less than 30 centimeters (11.81 inches) after 1,000 years of erosion). A value of 0.1 years was used in calibration and forward runs.

F.3.1.4.5 Soil Infiltration Capacity

The current version of CHILD provides four alternative means of computing runoff. Of these, the simplest and most commonly used is a single-parameter infiltration capacity model in which any rainfall in excess of a specified infiltration rate contributes to runoff. In general, the use of such a model in a humid temperate setting would be questionable because rainfall intensity rarely exceeds soil infiltration capacity under normal circumstances. In such settings, most runoff tends to be generated in localized areas where soils readily become saturated due to topographic convergence and/or low gradient (Dunne and Black 1970). However, the study area is somewhat unusual in having a high proportion of soils derived from clay-rich and fairly impermeable glacial sediments; therefore, widespread hillslope runoff generation during heavy rains will be more common than in many humid-temperate environments. This is supported by the results of hydrologic monitoring discussed in the Surface Water Environmental Information Document (WVNS 1993c). In the South Plateau disposal area, nearly 80 percent of the gauged flow resulted from runoff, implying that the effective infiltration capacity of soils formed from the clay-rich glacial sediments is rather low (not surprisingly, the study also found a higher effective permeability in the alluvial fan–derived soils of the North Plateau). For purposes of this study, a simple one-parameter infiltration-capacity runoff model is adopted, with the recognition that future studies of hydrologic response may point toward a different choice. The parameter is the effective infiltration capacity I_c (with dimensions of length per time, or L/T). The effective infiltration capacity represents the maximum rate at which rainfall can be absorbed by the soil before generating runoff. When the rainfall rate exceeds the effective infiltration capacity, runoff is generated at a rate equal to the difference between rainfall intensity and infiltration capacity.

Several different methods were used to estimate a range of plausible values for I_c. The first method is based on water-balance models that were developed for the sand and gravel unit on the North Plateau. The method involves combining the derived rainfall intensity parameter with these recharge estimates. The effective infiltration capacity can be related to the storm-intensity parameter P, the mean annual precipitation P_a, and the annual total infiltration I_a as follows:

$$I_c = -P \ln(1 - I_a / P_a)$$

The annual total infiltration I_a represents precipitation that does not generate runoff (though it may contribute to baseflow in streams), and it includes both aquifer recharge and evapotranspiration. Because P_a is known (1.02 meters [3.35 feet] per year) and a value for P has been estimated (1.45 millimeters [0.06 inches] per hour or 12.74 meters (41.80 feet) per year), one can estimate I_c if I_a is known.

Appendix E of the *2008 Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* reviews two water-balance models for the fan sand and gravel unit on the North Plateau. This study cites a figure of 50 centimeters (19.69 inches) per year recharge from precipitation based on Kappel and Harding's data (Kappel and Harding 1987), and notes that Yager (1987) estimates 46 centimeters (18.11 inches) per year. These water-balance calculations give us only a minimum value of I_a, because the aquifer recharge does not include water that initially infiltrates to the unsaturated zone or is intercepted, and later is returned to the atmosphere via evapotranspiration.

Using the formula derived above for I_c, with P = 12.74 meters (41.80 feet) per year, P_a = 1.02 meters (3.35 feet) per year, and I_a = 0.5 meters (1.64 feet) per year, the minimum infiltration capacity on the North Plateau is 8.58 meters (28.15 feet) per year, which is equivalent to 0.979 millimeters (0.04 inches) per hour. With the alternative estimate (Yagers') of I_a = 0.46 meters (1.51 feet) per year, the corresponding minimum I_c = 7.64 meters (25.10 feet) per year, which is equivalent to 0.872 millimeters (0.03 inches) per hour. However, as noted above, these are minima. To get a rough upper bound on I_a, it is reasonable to suppose that runoff is unlikely to be smaller than 10 percent of mean annual precipitation. Taking recharge plus evapotranspiration as 90 percent of the mean annual rainfall of 102 centimeters (40.16 inches), the corresponding maximum I_c = 29.33 meters (96.23 feet) per year, which is equivalent to 3.35 millimeters (0.13 inches) per hour. Because this water balance was developed for the North Plateau, it applies only to that location, but it does provide a range of estimates to work with.

There seems to be some disagreement concerning recharge and runoff on the North Plateau. WVNS (1993c) estimated total infiltration (evapotranspiration plus recharge) at 74.7 centimeters (29.29 inches) per year, with runoff at 25.5 centimeters (10.04 inches) per year and a mean annual precipitation of 100.1 centimeters (39.41 inches). Using these figures, the corresponding I_c = 22.47 meters (73.72 feet) per year, which is equivalent to 2.56 millimeters (0.10 inches) per hour. Other analyses discussed in Appendix E of this environmental impact statement, put recharge as low as 5 to 12 centimeters (1.97 to 4.72 inches) per year. In sum, the North Plateau water-balance estimates, combined with the derived mean precipitation intensity parameter, suggest an effective I_c value somewhere in the range of 1 to 4 millimeters (0.04 to 0.16 inches) per hour.

This range is lower than the estimates of K_{sat} for the North Plateau thick-bedded unit. As discussed in Appendix E, K_{sat} for this unit ranges from 1.25×10^{-4} to 3.78×10^{-2} centimeter (0.00005 to 0.01 inches) per second, which is equivalent to 1,360 millimeters (53.54 inches) per hour. The reason for the difference between these estimates is not known, but one possibility is that a higher clay content in the surface soil layer renders it less permeable than the underlying deposits.

For the weathered Lavery till on the South Plateau, seven measurements record widely varying hydraulic conductivity values, for which the mean is 12 millimeters (0.47 inches) per hour, the median is 6.2 millimeters (0.24 inches) per hour, and the geometric mean is 1.78 millimeters (0.07 inches) per hour (see Appendix E), which is similar to the effective infiltration capacity estimated from the North Plateau water balance. For weathered bedrock, Prudic (1986) estimates a value of 1×10^{-5} centimeters (3.94×10^{-5} inches) per second or 0.36 millimeters (0.01 inches) per hour.

An alternative method for estimating I_c relies on streamflow measurements. The method involves the following steps: (1) estimate the fraction of flow in the stream that arises from runoff (storm flow); (2) convert the storm-flow discharge into a runoff rate by dividing by the area of the basin; and (3) given a mean storm intensity and duration factor, calculate the I_c that would be required to generate an equivalent average-annual runoff. This approach was applied to streamflow measurements obtained from four gauging stations: Buttermilk Creek (October 1961 to September 1968), Franks Creek (December 1975 to September 1979), Cattaraugus Creek near Gowanda (November 1939 to February 2009), and Cattaraugus Creek near Versailles

(October 1915 to September 1923). Baseflow was estimated from these records using the BFLOW program (Arnold et al. 1995) as shown in **Table F–9**. The mean annual basin runoff rate R was calculated by dividing the difference between total flow, Q, and baseflow, Q_{bf}, by the area of the basin. The corresponding effective infiltration capacity, I_c, was then calculated using the formula:

$$I_c = -P \ln(R/P_a)$$

The resulting estimates of I_c range over about a factor of 3, from 0.82 to 2.43 millimeters (0.03 to 0.10 inches) per hour, which is equivalent to 7.2 to 21.3 meters (23.62 to 69.88 feet) per year (see Table F–9). The estimates from Buttermilk Creek and Cattaraugus Creek data are similar to one another, while that for Franks Creek is substantially lower. To test whether the short period of record for Franks Creek was unusually wet, climate data for Buffalo, New York for the 1975–1979 period were compiled. The mean annual precipitation at Buffalo for that time period was 1.11 meters (43.73 inches). Assuming that this figure is representative of precipitation at the site during that period, the corresponding I_c is 0.939 millimeters (0.04 inches) per hour, which is equivalent to 8.29 meters (27.20 feet) per year. Thus, while it does appear that the short period of record may have been wetter than normal, this does not explain the lower effective permeability of soils in the Franks Creek basin relative to the average value of the larger Buttermilk and Cattaraugus watersheds. It is possible that the difference reflects a larger fraction of clay-rich, till-derived soils in the Franks Creek basin.

Collectively, using the corrected value for Franks Creek, the I_c estimates derived from streamflow range from 8.29 to 21.3 meters (27.20 to 69.88 feet) per year, which is equivalent to 0.946 to 2.43 millimeters (0.04 to 0.10 inches) per hour, while the minimum I_c estimates from the North Plateau water balance range from 7.64 to 29.33 meters (25.07 to 96.23 feet) per year, which is equivalent to 0.872 to 3.35 millimeters (0.03 to 0.13 inches) per hour. To choose a range of I_c values for Monte Carlo calibration, a logical approach is to pick three values that are reasonably well supported by data, plus two extreme bracketing values. The three preferred central values are: (1) the Franks Creek stormflow estimate of 8.29 meters (27.20 feet) per year (because it is the most geographically appropriate); (2) the Cattaraugus Creek record of 19.4 meters (63.65 feet) per year at Gowanda, New York, (because it is the longest); and (3) the North Plateau infiltration estimate of 16.8 meters (55.12 feet) per year (because it is also geographically relevant, and comes from a different source). The lowest value, 3.82 meters (12.53 feet) per year, is equal to half of the lowest water-balance estimate (7.64 meters year). The highest value, 68.66 meters (225.26 feet) per year, is somewhat more than twice the highest water-balance estimate. Thus, the five I_c values used in Monte Carlo calibration are: I_c = [3.82, 8.29, 16.8, 19.4, 68.7] meters per year.

Table F–9 Drainage Area, Storm Discharge, and Runoff at Gauging Stations

Gauging Station Location	***Basin area (square miles)***	***Q-Q_{bf} (cubic meters per second)***	***R (meters per year)***	***I_c (meters per year)***
Buttermilk Creek	30.0	0.580	0.236	18.7
Franks Creek	0.28	0.0133	0.579	7.21
Cattaraugus Creek near Gowanda	436	7.99	0.223	19.4
Cattaraugus Creek near Versailles	466	7.35	0.192	21.3

I_c = infiltration capacity, Q = total flow, Q_{bf} = baseflow, R = runoff rate.
Note: To convert square miles to square kilometers, multiply by 2.59; cubic meters to cubic feet, multiply by 2118.9; meters to feet, multiply by 3.281.

F.3.1.4.6 Channel Width Parameters

The channel width, W, at any given node is calculated using an empirical relationship between width and discharge, Q:

where:

$$W_b = k_w Q_b^{\gamma}$$

and:

$$\frac{W}{W_b} = \left(\frac{Q}{Q_b}\right)^{\omega}$$

where the subscript b denotes quantities at the bank-full stage. There are four parameters required: the coefficient k_w, the runoff rate R_b that corresponds to bank-full discharge Q_b, and the exponents γ and ω. There do not appear to be any data available on variations in channel width downstream or at a particular point through time in the Buttermilk Creek watershed. Therefore, parameter values were estimated on the basis of a USGS study of channel hydraulic geometry in New York Hydrologic Region 6, which covers WNYNSC (Mulvihill et al. 2005). The study concluded that the bank-full discharge, Q_b, and bank-full width, W_b, of streams in Region 6 are related to basin area A according to:

$$Q_b = 48.0\ A^{0.842}$$

$$W_b = 16.9\ A^{0.419}$$

where A is in square miles, Q_b is in cubic feet per second, and W_b is in feet. Using a little algebra, one can combine these to convert the Mulvihill et al. (2005) coefficients and exponents into the parameters k_w and γ:

$$W_b = (d/b^{e/c})\ Q^{e/c}$$

where d = 16.9, b = 48.0, e = 0.419, and c = 0.842. Thus, $k_w = (d/b^{e/c})$, while the bank-full width-discharge exponent $\gamma = e/c = 0.419/0.842 = 0.498$ (approximately 0.5). When the coefficient k_w is converted into units of meters and seconds, its value is 4.49.

The remaining parameters are ω and R_b, which describe the changes in channel width at a particular point on the river channel (as opposed to upstream and downstream) as Q rises and falls over time. Unfortunately, data to constrain these parameters for either the onsite streams or the New York Region 6 in general are not available. Data from other rivers suggest that ω is often similar to γ (Leopold et al. 1964). Given the lack of data, the most parsimonious approach is to set ω equal to γ, in which case the value of R_b plays no role. Errors resulting from this assumption are considered to be small relative to other sources of uncertainty.

F.3.1.4.7 Parameters Related to Water Erosion and Sediment Transport

The erosion and transport laws should be appropriate to the processes occurring at the site. Based on reports and field observations, fluvial processes in the Buttermilk Creek watershed include: (1) transport of gravel through the stream network (Boothroyd et al. 1979, 1982), and (2) stream incision into cohesive clay-rich till (as well as other units, e.g., fan gravels, proglacial lake sediments). The presence of coarse bed sediment in Buttermilk Creek suggests that the stream system cannot be realistically treated solely with a detachment-limited model (Howard et al. 1994). One method would be to use a transport-limited fluvial model, which effectively treats the channel bed as loose sediment. However, the active incision of till and bedrock by Franks Creek and other tributaries suggest that a transport-limited model may not correctly capture incision of Lavery till. Therefore, it is reasonable to use a hybrid model that accounts for both bed-load transport of gravel and detachment of the till (or other bedrock) substrate. CHILD's standard water erosion algorithm computes bed lowering as the lesser of (1) bedrock detachment capacity and (2) excess sediment transport capacity per unit surface area.

This approach requires a choice of transport-capacity law and a choice of detachment-capacity law. Because the substance being detached is mostly clay till, it is appropriate to choose a detachment-rate formula that is applicable to cohesive, clay-rich substrates. Howard and Kerby (1983) found that the detachment (lowering) rate of cohesive clay sediments in a badland area was roughly proportional to the cross-section average bed shear stress. Correlations between detachment rate and boundary shear stress have also been found in field tests of soil erosion (Elliot et al. 1989) and in studies of hydrodynamic erosion of cohesive riverbanks (Julian and Torres 2006). This motivates the use of the widely used du Boys formula for computing the detachment capacity of cohesive material:

$$D_c = K_b\left(\tau - \tau_{cb}\right)_+$$

where D_c is the detachment capacity (with dimensions of length per time); τ is boundary shear stress; τ_{cb} is a threshold shear stress below which detachment is negligible; and K_b is a lumped dimensional coefficient that depends on bulk density, effective particle size, and the strength of cohesive bonds between particles. The + subscript indicates that the relationship only applies when $\tau > \tau_{cb}$; otherwise, the detachment capacity is zero.

As noted previously, the Buttermilk Creek basin is underlain by two strongly contrasting types of "bedrock": Paleozoic sedimentary rock, and thick till and related glacio-fluvial units that were deposited in the main valley during the last glacial maximum. This contrast is modeled by using a different set of K_b values for these two lithology classes. The spatial distribution of the two lithology classes is based on the map shown on Figure F–2; those units mapped as Lavery Till Plain and Defiance Lake Escarpment Outwash are considered to be underlain by thick, till-rich material. In contrast, while geologic maps indicate that Olean and Kent tills mantles the uplands, this cover amounts to only a thin (roughly 5 foot) veneer over Paleozoic bedrock. Therefore, those areas mapped as Olean or Kent till are assigned to the "Paleozoic bedrock" category. The initial condition for calibration runs accounts for the thin till cover by placing a 1.5-meter (5-foot) layer of alluvium atop the surface at all nodes.

To the best of our knowledge, no studies have tested the detachment capacity of West Valley glacial sediments or bedrock in response to applied fluid shear stress. Thus, in order to estimate a plausible range of values for the parameters K_b and τ_{cb}, it is necessary to rely on independent data. One data source is a set of field experiments on soil detachment conducted in conjunction with development of the U.S. Department of Agriculture WEPP model (Elliott et al. 1989). Most relevant to the site are test soils with a relatively high clay content. The WEPP experimental data include six test soils with >30 percent clay content: Sharpsburg, Heiden, Los Banos, Pierre, Gaston, and Opequon. The detachment-rate parameters (the K_r parameter) for these six soils are 4.6×10^{-3}, 8.0×10^{-3}, 1.1×10^{-3}, 1.0×10^{-2}, 4.2×10^{-3}, and 3.4×10^{-3} seconds per meter, respectively. The corresponding values of critical shear stress, τ_{cb}, are 3.1, 2.9, 2.9, 4.8, 5.3, and 6.2 pascals, respectively.

Converting the K_b values from the WEPP experiments into CHILD's required unit of meters per year per pascal of excess stress, one obtains a range from 35 to 320. This range should be considered subject to significant uncertainty, because the data come from very different geographical areas and surface conditions and because they were derived from relatively short experimental time scales. Thus, it is appropriate to consider a wide range of potential parameter values in the calibration process. Here, a conservative approach was used in which the central value of 100 meters (328.08 feet) per year per pascal is chosen to reflect the range of values in the WEPP experiments, while the range covers two orders of magnitude on either side of this. The resulting parameters for areas of the Buttermilk basin underlain by thick till are designated by the K_{bt} symbol. The K_{bt} range = [1, 10, 100, 1,000, 10,000] meters per year per pascal.

The detachment coefficient for the Paleozoic bedrock of the uplands is even more difficult to constrain. Bedrock channel erosion is an area of very active research in the geomorphology community, and there is considerable debate over the mechanisms responsible and the resulting rates. The choice of parameters to represent bedrock detachment capacity must therefore be considered speculative. It is assumed that cemented bedrock is, in general, considerably more resistant to detachment than clay till; how much so is unknown. A broad range of values, overlapping somewhat with, but generally much smaller than K_{bt}, is therefore adopted for the rock-detachment coefficient designated with the K_{br} symbol. The K_{bt} range = [0.001, 0.01, 0.1, 1, 10] meters per year per pascal. The primary role of the K_{br} parameter is to control the degree of gullying and sediment production in the bedrock uplands.

The critical shear stress τ_{cb} represents the level of stress below which detachment is negligible. Data from the WEPP test soils show a relatively narrow range of 3 to 6 pascals. Experiments on soils by Dunn (1959) showed a range of values from 2 to over 20 pascals, with a strong dependence on silt-clay percentage. Vegetation tends to enhance the effective value of τ_{cb}. Julian and Torres (2006) report vegetation coefficients—multipliers of t_c that depend on vegetation amount and characteristics—ranging from unity to approximately 20. Thus, according to these data, one could in theory have an effective τ_{cb} as high as 400 (20 pascals times a vegetation coefficient of 20). On the other hand, riverbank erosion data of Julian and Torres (2006) suggested τ_{cb} values as low as approximately 1 pascal. These maximum and minimum values were adopted as bounding parameters values, leading to a range of τ_{cb} values of τ_{cb} = [1, 4, 16, 80, 400].

CHILD offers several alternative formulations for calculating the sediment transport capacity of channelized flow. The coarser fraction of sediment, which tends to move as bed load, is considered to be the limiting factor for erosion of detached sediment. Therefore, a transport formula designed for bed load is considered appropriate. For practical reasons of simplicity and computational efficiency, a single effective grain size, rather than multiple grain-size fractions, is used for this study. The general form is:

$$Q_c = WK_f\left(\tau^p - \tau_{cr}{}^p\right)_+$$

where Q_{c} is the volumetric sediment transport capacity, W is the width of the channel, τ_{cr} is the critical shear stress for entraining loose sediment ("r" for regolith), and K_{f} is a transport efficiency factor that incorporates fluid and sediment density and gravitational acceleration. A number of laboratory and field studies show a strong correlation between transport rate and excess shear stress raised to the 3/2 power, which is consistent with the hypothesis that transport rate depends on unit stream power (which represents the rate of energy expenditure per unit bed area and is equal to the product of shear stress and flow velocity). This motivates a choice of p = 3/2. The transport efficiency factor, K_f, is treated as a calibration parameter. Simons and Sentürk (1992) determined an experimental dimensionless coefficient of 8, and this leads to a dimensional value of K_f in metric units (kilograms, meters, seconds) of about 1.5×10^{-5}. The equivalent converted to time units of years, which CHILD requires as an input parameter, is approximately 500. This should not be considered a highly precise value, for two reasons: (1) experimental data on sediment transport show a high degree of variation depending on experimental conditions, and (2) the transport rate can vary depending on a wide number of factors, including the grain-size mixture on a channel bed and the geometry of bars and other bedforms. Thus, a wide range of values of this parameter is allowed in the Monte Carlo calibration: K_f = [20, 100, 500, 2,500, 12,500].

The critical threshold parameter, τ_{cr}, represents the level of applied fluid shear stress below which the entrainment of loose sediment grains is negligible. Although it obviously plays the same mathematical role as the "bedrock" detachment threshold, it differs in the sense that it represents loose, noncohesive material (such as riverbed sediment) rather than cohesive or indurated material (such as dense clay till or bedrock). Thus, its value may differ from τ_{cb}. The standard method for calculating τ_{cr} is to use the Shields curve (Julien 1995). For the fully turbulent conditions that apply to nearly all natural channelized flows of water, experimental data indicate that initiation of motion of noncohesive sediment occurs when the dimensionless shear stress exceeds a threshold value between 0.03 and 0.06 (Buffington and Montgomery 1997). The corresponding dimensional value depends on the median sediment diameter and the sediment density. Standard practice is to assume sediment density equivalent to quartz (2,650 kilograms per cubic meter). According to grain-size measurements along Buttermilk Creek (Boothroyd et al. 1979), the median grain diameter is approximately 32 millimeters (1.26 inches). However, bed grain size can vary from one reach of a river to another as well as through time. A reasonably broad but still plausible range of median grain-size values considers values a factor of four lower (8 millimeters [0.31 inches]) than the central value estimated from Boothroyd's data, and a factor of four higher (128 millimeters [5.04 inches]). Uncertainty in the value of reference dimensionless shear stress is about a factor of two (Buffington and Montgomery 1997). Combining these ranges, a reasonable spread of possible τ_{cr} values is τ_{cr} = [4, 10, 23, 54, 124].

Note that there is no single generally accepted transport formula for bed-load flux. Rather, there are a number of competing approaches that involve somewhat different scaling of the key variables (Howard 1980, Martin 2003) and have varying degrees of explanatory power depending on which data sets are examined. The choice of the above equation is based on the fact that its scaling is common to a number of frequently used and reasonably successful transport formulas. One limitation is that CHILD presently has no way to handle suspended or wash load: thus, for example, when a cubic meter of clay is eroded, it becomes "sediment" of a specified size. A more-realistic approach would be to specify a percentage of fines for the eroded substrate, and have these directly removed (Kirkby and Bull 2000), but this would require additional model development and testing, and it is considered unlikely to have a significant effect on the behavior of the model in this setting.

The cross-section averaged bed shear stress exerted by running water is based on a force balance between gravity and friction for steady, uniform, fully turbulent flow in a wide channel:

$$\tau = \rho g^{2/3} C_f^{\ 1/3} \left(\frac{Q}{W} \right)^{2/3} S^{2/3}$$

where Q is water discharge, S is channel gradient, ρ is water density (1,000 kilograms [1.1 tons] per cubic meter), g is gravitational acceleration at earth's surface, and C_f is a dimensionless friction factor that depends weakly on relative roughness (flow depth relative to roughness height). The leading factors are collected into a single parameter, K_t that depends weakly on roughness:

$$K_t = \rho g^{2/3} C_f^{\ 1/3}$$

Roughness is often quantified using the Manning n factor, which is related to C_f by:

$$C_f^{\ 1/3} = \frac{g n^2}{H^{1/3}}$$

where H is flow depth. Based on the criteria of Chow (1959), appropriate values of n for Buttermilk Creek range from about 0.033 to 0.06. Flow depth obviously varies from place to place, but C_f is not especially sensitive to it (one takes the cube root). Using a reference depth of 1 foot, the corresponding range of K_t values is 1,150 to 1,750. Rounding up and down, we adopt the following five alternative values of K_t to be explored in Monte Carlo calibration runs: K_t = [1,000, 1,250, 1,500, 1,750, 2,000].

F.3.1.4.8 Parameters Related to Sediment Transport by Soil Creep and Landsliding

For this application, CHILD uses a nonlinear soil creep transport law that was introduced by Howard et al. (1994) and tested in the field and laboratory by Roering et al. (1999, 2003):

$$q_{sc} = -\frac{K_d \nabla z}{1-\phi^2}$$

$$\phi = \begin{cases} |\nabla z| / S_c & \text{if } |\nabla z| \le 0.999 S_c \\ 0.999 & \text{otherwise.} \end{cases}$$

where *z* is land-surface height, K_d is a transport coefficient (L2/T), and S_c is a threshold slope gradient.

At low slope angles, CHILD uses an equation for hillslope mass transport that is equivalent to the well-known slope-linear soil creep law, in which the volumetric rate of downslope sediment transport per unit slope width is equal to the product of slope gradient times a transport coefficient, K_d; (in other words, this is how the above formula behaves when the right-hand term in the denominator is small, reflecting gentle slopes). Values of K_d have been estimated in many parts of the world, often for purposes of morphologic dating of landforms such as earthquake fault scarps. In general, the inferred creep coefficients range over two orders of magnitude, from approximately 10^{-4} to approximately 10^{-2} square meters (0.01 to 1.08 square feet) per year (Hanks 2000). There is some evidence that creep rates vary according to climate, with colder and/or wetter environments generally experiencing higher rates of creep. For example, in the compilation by Hanks (2000), the highest creep coefficients come from Michigan and coastal California, while the lowest are found in desert regions in Israel and the arid U.S. Basin and Range province (Nevada and Utah). Oehm and Hallet (2005) compared modern creep rates across a broad range of climates, and found a strong increase in the effective creep coefficient with latitude north of 50 degrees north.

For purposes of this study, published estimates of K_d were compiled. Among these, the study sites that match most closely in climate include sites in Michigan, Ohio, northern Europe, Montana (Yellowstone National Park), and Japan (**Table F–10**). In a study of fault-scarp degradation in the Rhine River Valley near Basel, Switzerland, Niviere et al. (1998) calibrated a creep coefficient using observed degradation of an approximately 100-year-old railway embankment, arriving at an estimate of 0.0015 square meters (0.016 square feet) per year. A study by Nash (1984) of a single degraded terrace scarp in the subhumid climate of northwestern Montana yielded an estimate of 0.002 square meters (0.021 square feet) per year. In a compilation of modern creep rates and profiles by Oehm and Hallet (2005), data from Japan (latitude 35 degrees north) suggest creep coefficients ranging from 0.0036 to 0.014 square meters (0.039 to 0.151 square feet) per year. The degradation of an 1,800-year-old embankment and trench in south-central Ohio provided Putkonen and O'Neal (2006) an opportunity to estimate a creep coefficient of 0.0005 square meters (0.0054 square feet) per year through forward modeling. Nash (1980) analyzed modern and abandoned cliffs carved in glacial till along the Lake Michigan shoreline, and derived a best-fit estimate of 0.012 square meters (0.129 square feet) per year.

In summary, estimates of K_d obtained in humid to subhumid climates range over more than an order of magnitude, from 5×10^{-4} square meters (0.0054 square feet) per year to a little over 10^{-2} square meters (0.108 square feet) per year. In terms of climate, soil texture, and time scale, the closest match to WNYNSC is that presented in the study of Nash (1980). The regional climate is humid temperate with cold winters; temperatures drop below zero degrees Celsius on 150 or more days per year on average, promoting transport by frost heave. Like WNYNSC, the environment is predominantly forest covered, and both sites are underlain by glacial sediments. Unlike some of the other studies, the time scale for Nash's (1980) estimate spans a large fraction of the postglacial period (10,500 and 4,000 years, respectively, for two different scarp populations), and the data come from a population of scarp profiles rather than a single profile (as used for example by Nash [1984], Putkonen and O'Neal [2006], and Niviere and Marquis [2000]). However, among the other humid-temperate and/or clay-rich sites, there are values that are much smaller than this (0.0003 square meters [0.003 square feet] per year for the lowest Swiss estimate) and somewhat higher than this (0.036 square meters [3.88 square feet] per year from McKean et al. [1993]). These are used as bounding values for a range of five alternative calibration values: K_d = [0.0003, 0.001, 0.003, 0.01, 0.036].

The critical-slope parameter S_c represents the angle above which a hillslope is totally unstable. A commonly accepted threshold angle at the site is 21 degrees, and that value is adopted here for S_c.

Table F–10 Published Values of the Coefficient K_d

Location	***Reference K_d (square meters per year)***	***Source***
Emmet County, Michigan	0.012	Nash 1980a, ESPL 5:331–345
West Yellowstone, Montana	0.002	Nash 1984, GSA Bulletin 95(12):1413–1424
Upper Rhine Graben, Central Europe	0.0014	Nivière B 2000, Geophysical JI 141(3):577
Near Basel, Switzerland	0.0015	Nivière B. 1998, Geophy Res Letters 25(13):2325
Chillicothe, Ohio	0.0005	Putkonen and O'Neal 2006
Switzerland	0.0021	Oehm 2005, Zeithschrift fur Geomorph 49(3):353
Switzerland	0.0031	Oehm 2005, Zeithschrift fur Geomorph 49(3):353
Switzerland	0.0047	Oehm 2005, Zeithschrift fur Geomorph 49(3):353
Switzerland	0.0003	Oehm 2005, Zeithschrift fur Geomorph 49(3):353
Japan	0.0036	Oehm 2005, Zeithschrift fur Geomorph 49(3):353
Japan	0.0093	Oehm 2005, Zeithschrift fur Geomorph 49(3):353
Japan	0.0135	Oehm 2005, Zeithschrift fur Geomorph 49(3):353
Japan	0.0059	Oehm 2005, Zeithschrift fur Geomorph 49(3):353

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

F.3.1.4.9 Model-Data Comparison Metrics

There are a number of different metrics that one could use in comparing observed and modeled topography. Studies of stream and hillslope profile evolution using one-dimensional models typically use metrics based on the differences between observed and modeled surface height at a series of points along the profile (Rosenbloom and Anderson 1994, Stock and Montgomery 1999, Whipple et al. 2000, van der Beek and Bishop 2003, Tomkin et al. 2003). Comparing two-dimensional models of drainage basin evolution with observed topography is less straightforward. Point-by-point comparison of observed and simulated topography suffers from the problem that small differences in drainage pathways can lead to large apparent errors, even though the modeled topography may be statistically very similar to the real landscape. Thus, most tests of drainage basin evolution models have been based on statistical measures of terrain such as the catchment-wide slope–area relationship, the hypsometric curve, and the drainage-area distribution function (Hancock et al. 2002).

The ideal set of metrics should provide a strong filter against "false positive" solutions (in other words, getting the right answer for the wrong reasons). They should also include tests of multiple aspects of predicted topography (for example, elevation properties as well as drainage-network geometry). If possible, they should include information on intermediate states during the course of landscape evolution, rather than just the present-day topography. Given these considerations, the following six model-data comparison metrics were selected: the long profile of Buttermilk Creek, catchment hypsometric curve, log-binned slope–area diagram, width function, cumulative area function, and the time-elevation position of two dated strath terraces. These metrics are described below:

1. **Buttermilk Creek's longitudinal profile** – Stream profiles (the elevation of the stream bed as a function of distance downstream) are closely linked to three-dimensional topography (Tucker and Whipple 2002) and are of critical importance to future erosion at the WNYNSC, because they set the baselevel for surrounding hillslopes. One complication that can arise in comparing observed and predicted topography is that, as noted above, modeled stream profiles may differ slightly from their target landscapes in length, sinuosity, or direction. For example, Buttermilk Creek has a series of entrenched meanders along its lower reach. These meanders will not appear in the simulations because meandering has been omitted (although CHILD has a meandering submodel, it is considered too experimental for this study in terms of additional poorly constrained parameters). Thus, it is expected that the length and exact pathway of the observed and modeled Buttermilk Creek will differ slightly. The solution adopted here is to project the long profiles onto a north–south axis. The comparison procedure applies the following steps to both the 10-meter resolution DEM of the Buttermilk Creek watershed and the simulated CHILD grid: (1) starting at a common headwater point (Universal Transverse Mercator 697,536 meters east, 4,696,570 meters north), extract points along the profile in upstream-to-downstream order until reaching the outlet; (2) remove any small loops using linear interpolation; (3) interpolate the profile to a set of 101 equally spaced points between the head and the outlet; and (4) compute the sum-of-squares difference between observed and modeled profiles.
2. **Hypsometric curve** – The hypsometric curve is a plot of the cumulative area of land (in this case, within the Buttermilk Creek catchment) that lies below a given altitude. It is a widely used indicator of landscape morphology, and it is one of four metrics suggested by Hancock et al. (2002) for testing landscape evolution models. Its role is to provide a statistical comparison of altitudes across the catchment. Modeled and observed hypsometric curves are compared by interpolating each curve to 101 equally spaced altitude intervals (ranging from 300 to 700 meters above sea level), and computing the sum-of-squares difference.
3. **Slope–area diagram** – A slope–area diagram compares the gradients of a set of points on the landscape with their upstream contributing areas. The shape of the slope–area relationship is closely linked to the physics of erosional processes as well as to landscape history, and therefore it represents a valuable statistic for testing landscape evolution theory (Willgoose et al. 1991, Dietrich et al. 1993, Willgoose 1994, Ijjasz-Vasquez and Bras 1995, Snyder et al. 2000, Hancock et al. 2002, Tucker and Whipple 2002). One advantage is that it encompasses both hillslope processes (whose relative strength is reflected in location of the peak of the curve) and fluvial processes (whose behavior is reflected by the graph slope and intercept). Here, the modeled and observed slope–area patterns are compared by computing the average slope in a series of logarithmic bin increments between drainage areas of 10^2 and 10^9 square meters (bin increments are 10^2, $10^{2.2}$, $10^{2.4}$, …10^9). The sum-of-squares differences between observed and modeled average gradients are computed.
4. **Width function** – The catchment width function is a frequency distribution of flow-path length within the catchment, and it reflects drainage network structure and catchment shape. Observed and modeled width functions are compared by interpolating each to a set of 101 equally spaced length intervals between zero and 20 kilometers and calculating the sum-of-squares differences. The width function was among the metrics used by Hancock et al. (2002).
5. **Cumulative area distribution** – Another of the four metrics used by Hancock et al. (2002) for model-data comparison, the cumulative area distribution measures the rate of flow aggregation within a drainage network. It is computed by first calculating the contributing drainage area at each cell in a DEM, then plotting (usually on a log-log graph) the cumulative distribution of drainage areas. The observed and modeled area distributions are compared using the following steps: (1) divide the y-axis (proportion of cells) into 0.1 log increments, ranging from the fractional area of one cell to unity;

(2) interpolate to find the corresponding value of drainage area at each interval; and (3) compute the sum-of-squares difference.

6. **Strath terrace positions** – A strath terrace is a fluvially eroded surface that represents the position of a stream channel at some point in the past. As discussed in Section F.2.2, dating of strath terraces can reveal average rates of downcutting. The existence of dated straths at the site provides a valuable constraint on the model's evolutionary history: a correct model must place Buttermilk Creek at the right altitude at the right time. Two Buttermilk Creek straths are used to test this. The first is located at OSL Sample site 1A, and it is used here because it provides a constraint on elevation history of the upper portion of the main Buttermilk Creek Valley. Its potential age range, based on the 1-sigma bounds for both the CAM and MAM estimates, falls between 9,120 and 16,080 years ago. The second terrace is located at OSL Sample site 5. It is chosen because the OSL sample appears to be of high quality, with no evidence of significant partial bleaching, and because it provides a constraint along the lower reach of Buttermilk Creek Valley. Its age range is 11,990 to 15,610 years. In order to assign altitude ranges to these terraces, several factors must be considered. The 10-meter (32.81-foot) USGS digital elevation model, from which the sample altitudes were estimated, is subject to uncertainty; the USGS website quotes an expected root-mean-square elevation uncertainty of 7 meters (23 feet) for National Elevation Data products. In addition, the altitude of a stream is somewhat fuzzy because the water depth varies from place to place in association with features such as pools and riffles. For a stream the size of Buttermilk Creek, the associated uncertainty is likely to be on the order of a meter. There will also be a difference between the height of a terrace surface and the height of the former bedrock bed because the latter is mantled by a variable amount of sediment (based on our site observations, this is typically on the order of a few meters). Finally, there is uncertainty on the order of 10 meters (32.81 feet) associated with the horizontal sample location, though given the low gradient of the terrace surfaces, the comparable vertical uncertainty is likely to be below 1 meter (3.28 feet). Given these considerations, a conservative estimate of terrace uncertainty is judged to be +/-10 meters (32.81 feet), most of which reflects DEM uncertainty. Simulations that fail to place the channel within the correct altitude range (404 to 424 meters [1,325 to 1,391 feet] for terrace 1 and 369 to 389 meters [1,211 to 1,276 feet] for terrace 5) at the right geographical location within the right time range, are judged to be failures, and are given a score of zero on this metric. Those that do correctly capture the terrace heights are assigned a terrace score of unity.

The scores associated with each of the first five metrics are normalized, so that the minimum possible score is zero and the maximum is close to one. This normalization provides a way to weight the metrics equally; otherwise, metrics yielding large numbers would dominate those yielding small numbers. Ideally, one would like to normalize metrics according to some independent measure of the uncertainty in the data. For example, one might consider that any model whose uncertainty score is less than the intrinsic uncertainty in the measured data might be said to be as close a match to the data as can be feasibly measured. However, we have only one landscape, and only one DEM. Although the root-mean-square uncertainty for the DEM is documented, without having multiple, independently generated DEMs, there is no way to know how the DEM's elevation root-mean-square uncertainty translates into uncertainty in the metrics that are derived from it. Thus, independent estimates of metric uncertainty are not available. In addition to this intrinsic uncertainty, there is also uncertainty involved in comparing a model at one resolution (nominally 90 meters [295.28 feet]) with data at another resolution (10 meters [32.81 feet]). This latter uncertainty, which is hereafter called "resolution uncertainty," can be calculated by computing sum-of-square differences between metrics derived from 10-meter (32.81-foot) data and those derived from the modern topography represented at the calibration resolution of 90 meters (295.28 feet). As a pragmatic choice, then, the metrics are normalized as follows. For each metric, the top scoring 1 percent of calibration runs (10 runs) are identified, and their average sum-of-squares uncertainty is calculated as a "minimum model uncertainty." If the resolution uncertainty is larger than the model uncertainty, then the resolution uncertainty is used to normalize the metrics; otherwise, the minimum model uncertainty is used.

Scores for the first five metrics are averaged to create a composite score, while the sixth metric provides a binary pass/fail criterion.

F.3.1.5 Testing and Calibration Results

A model calibration run is considered to represent an acceptable fit to the modern topography if it meets the following criteria (the numbers in parentheses indicate the number of calibration runs satisfying each criterion):

1. Total average score >0.5 (36 of 1,000 runs),
2. Longitudinal profile score >0.7 (12 of 1,000 runs),
3. Correct elevations at terrace locations 1 and 5 in the correct time span (215 of 1,000 runs), and
4. Qualitative visual agreement between modeled and observed topography, including preservation of extensive remnants of the initial glacial plateau and minimal erosion of the bedrock uplands.

Six runs out of the calibration set of 1,000 met all of the first 3 criteria, and 5 of these were judged to pass the visual-match criterion. The parameters associated with these runs are listed in **Table F–11**. Among the 5, the parameter set with the highest overall score (0.680) is used as a standard case in the forward modeling discussed below. The remaining 4 are considered to be alternative and equally viable parameter sets, and they are also used in forward projections.

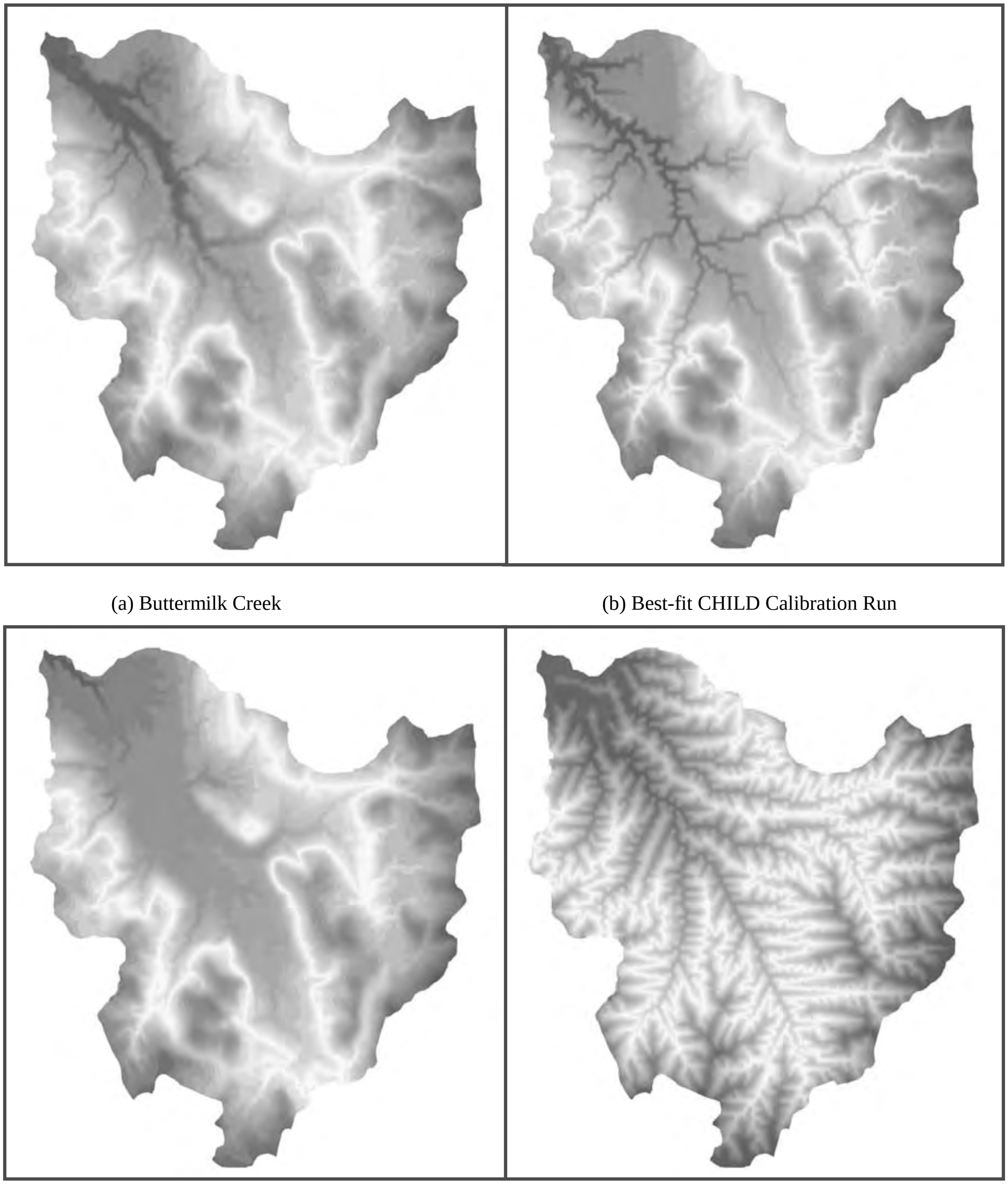
Table F–11 Parameters Associated with the Top Scoring Calibration Runs

Parameter	*Run 298 (0.680)* [a]	*Run 321 (0.677)*	*Run 622 (0.643)*	*Run 891 (0.617)*	*Run 972 (0.669)*
Start of incision (years before present)	17,500	18,300	17,500	17,500	15,200
Time outlet reaches terrace 7 height (years before present)	14,500	14,500	12,000	12,000	14,500
Soil infiltration capacity (meters per year)	19.4	3.82	16.8	19.4	16.8
K_f [b]	2,500	2,500	500	2,500	100
K_t [b]	1,750	1,500	1,000	1,000	1,250
τ_{cb} (pascals)	1	80	1	80	80
τ_{cr} (pascals)	124	124	54	23	54
K_d (square meters per year)	0.001	0.0003	0.0003	0.003	0.003
K_{bt} [b]	10,000	100	10,000	100	10
K_{br} [b]	1	0.1	0.001	0.01	0.001

[a] Five-metric average score.
[b] See Table F–8 for units.
Note: To convert meters to feet, multiply by 3.281; square meters to square feet, multiply by 10.764.

Figures F–8a and F–8b compare the best-fit calibration run with the observed topography. As expected, there are differences in detail. However, the run succeeds in capturing the overall pattern and extent of valley incision, while preserving the uplands. The simulated present-day topography preserves remnants of the till plateau flanking the incised valley, and it predicts about the right depth of incision along the main trunk stream. The simulated drainage patterns in the Franks Creek area are similar to the observed patterns (Figures F–8a and 8b**)**. The modeled valleys are generally narrower, which is to be expected because the model runs did not incorporate the lateral channel migration process (i.e., the lateral shifting in channel position due to natural instabilities in the flow that lead to bank erosion and gradual horizontal migration in the channel position). **Figures F–9** to **F–13** compare the best-fit model with the data for each metric.

Note that the match shown on Figures F–8a and F–8b is by no means inevitable. **Figure F–8c** gives an example of a run that predicts too little erosion, while **Figure F–8d** shows an example of a run that predicts far too much erosion (as well as extreme rearrangement of drainage patterns). Of the 1,000 calibration runs, about 130 failed with numerical errors before running to completion. The numerical instability that leads to such failures arises under extreme erosion scenarios (even more erosive than the clearly unrealistic example on Figure F–8d), and therefore, these cases are assumed to represent unrealistically erosive parameter combinations.



(a) Buttermilk Creek

(b) Best-fit CHILD Calibration Run

(c) CHILD Run with Too Little Erosion

(d) CHILD Run with Too Much Erosion

Figure F–8 Plan-view Images of Buttermilk Creek and Best-fit CHILD Calibration Run and Two Examples of Poor Fit CHILD Calibration Runs (lower left and lower right)

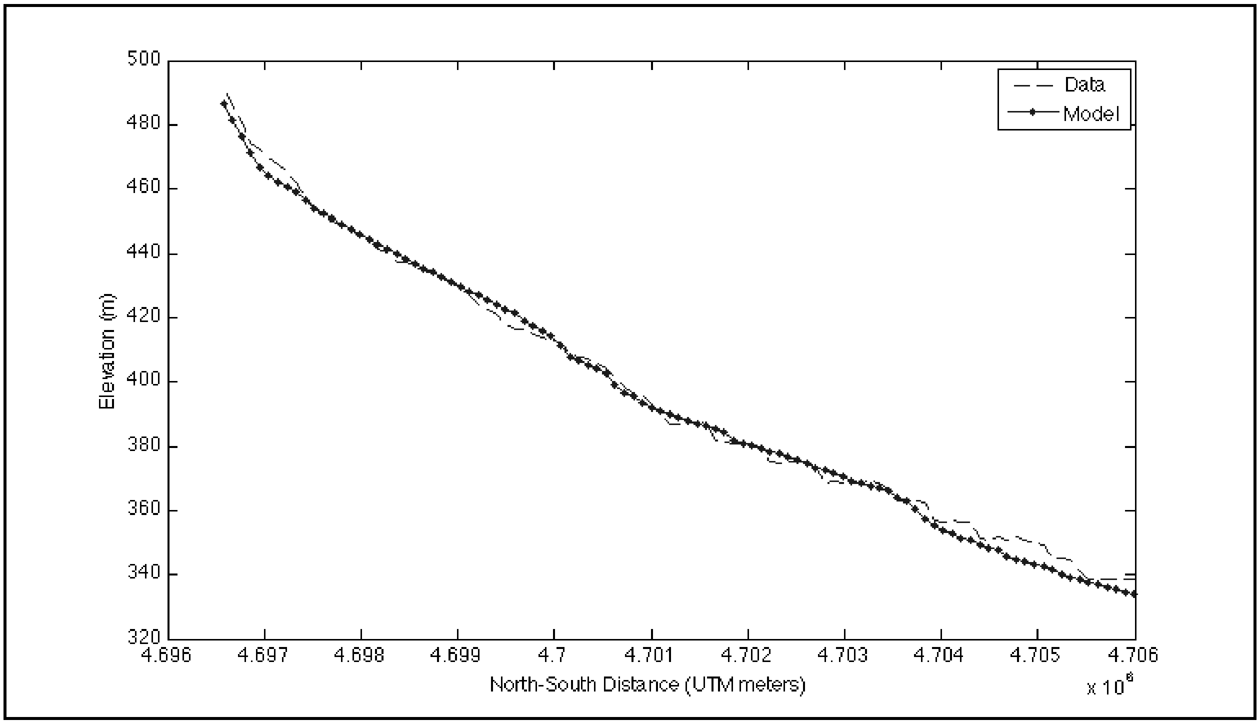


Figure F–9 Comparison of Observed and Best-fit Longitudinal Profile, Projected to North–South Axis

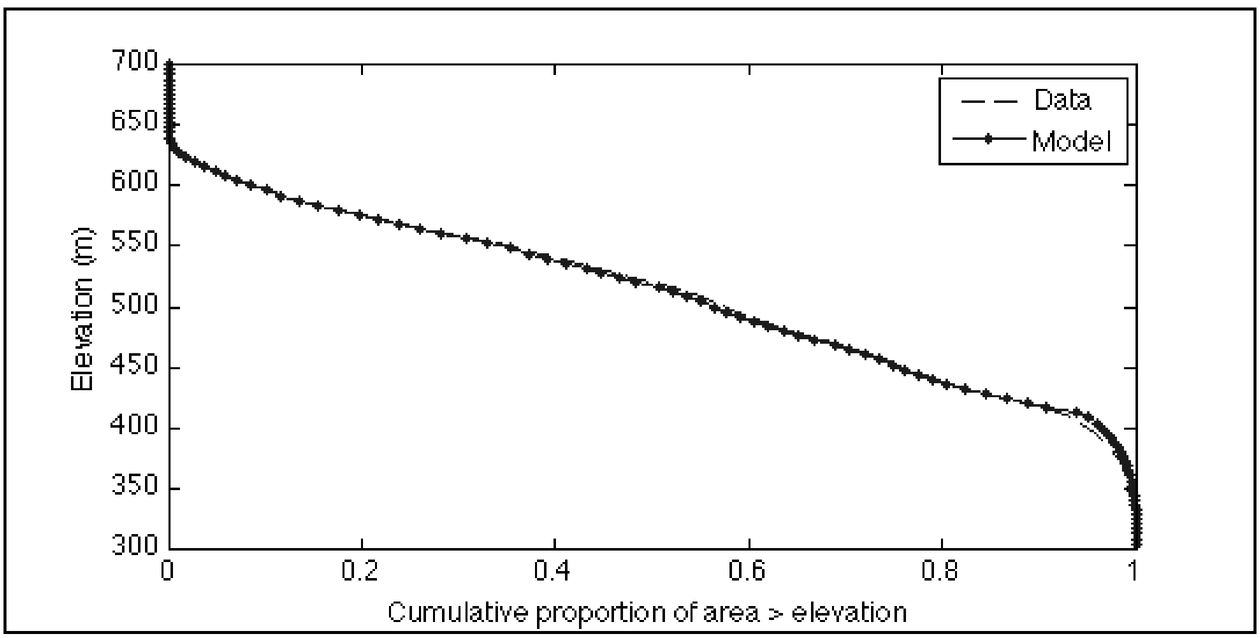


Figure F–10 Comparison Between Observed and Predicted Hypsometric Curve

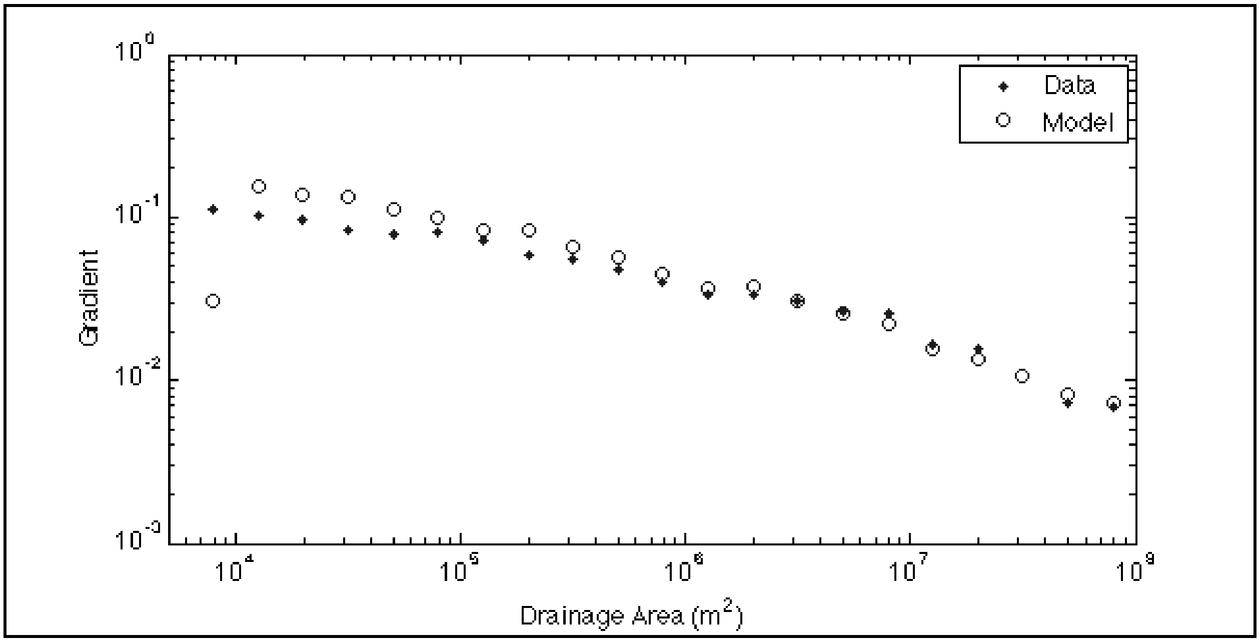


Figure F–11 Observed and Predicted Slope–Area Distribution

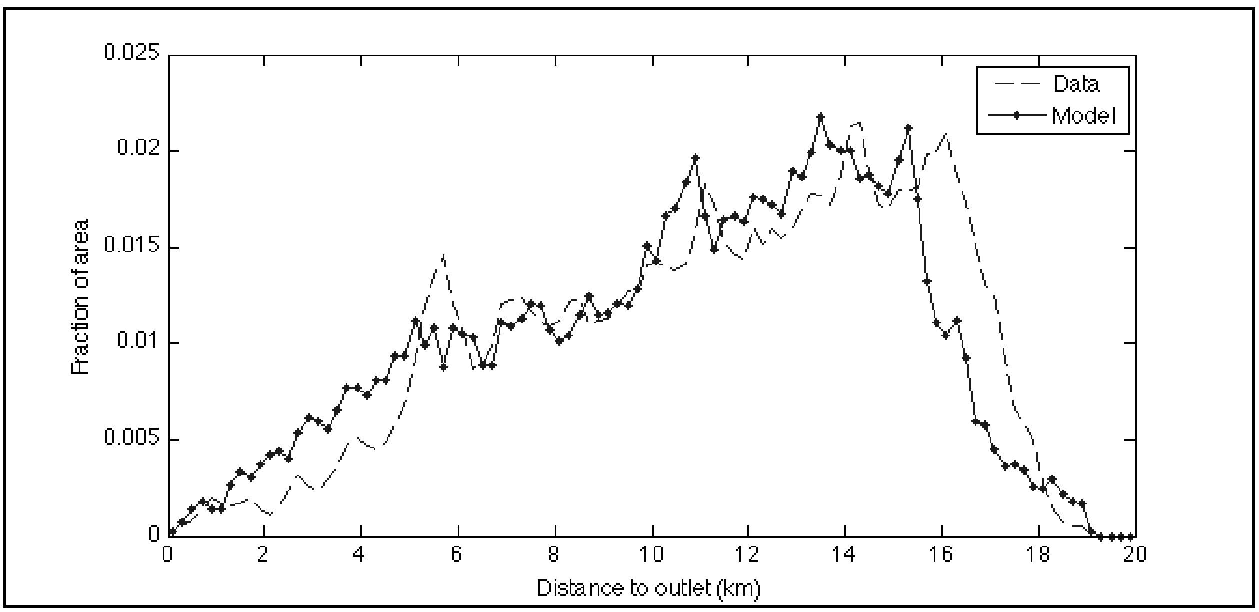


Figure F–12 Observed Versus Best-fit Modeled Width Function

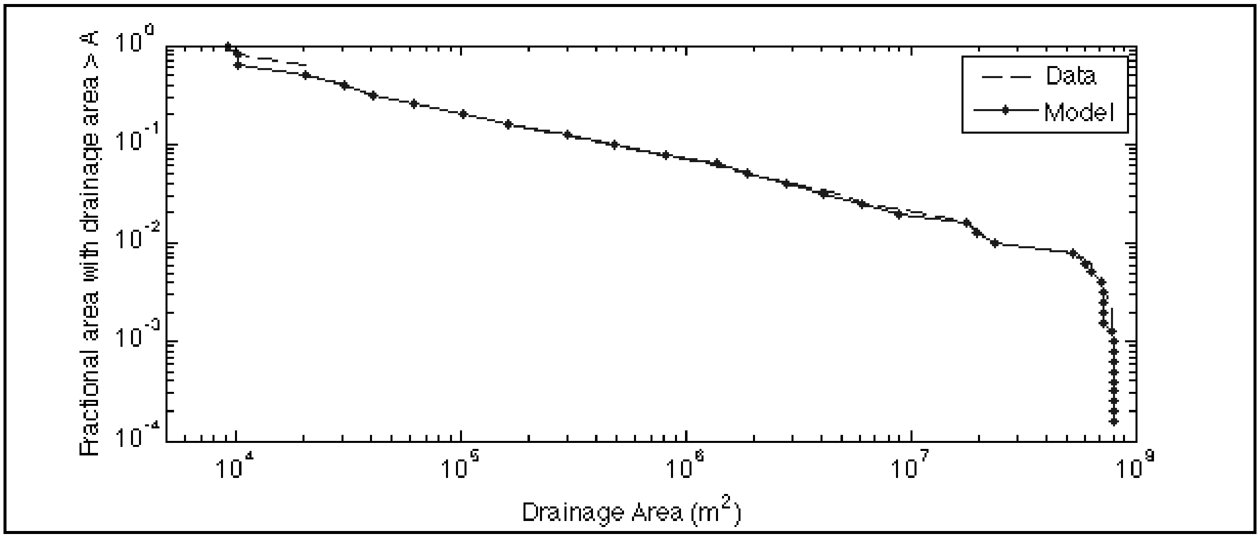


Figure F–13 Observed Versus Best-fit Modeled Cumulative-area Index

F.3.1.6 Forward Modeling of Erosion Patterns

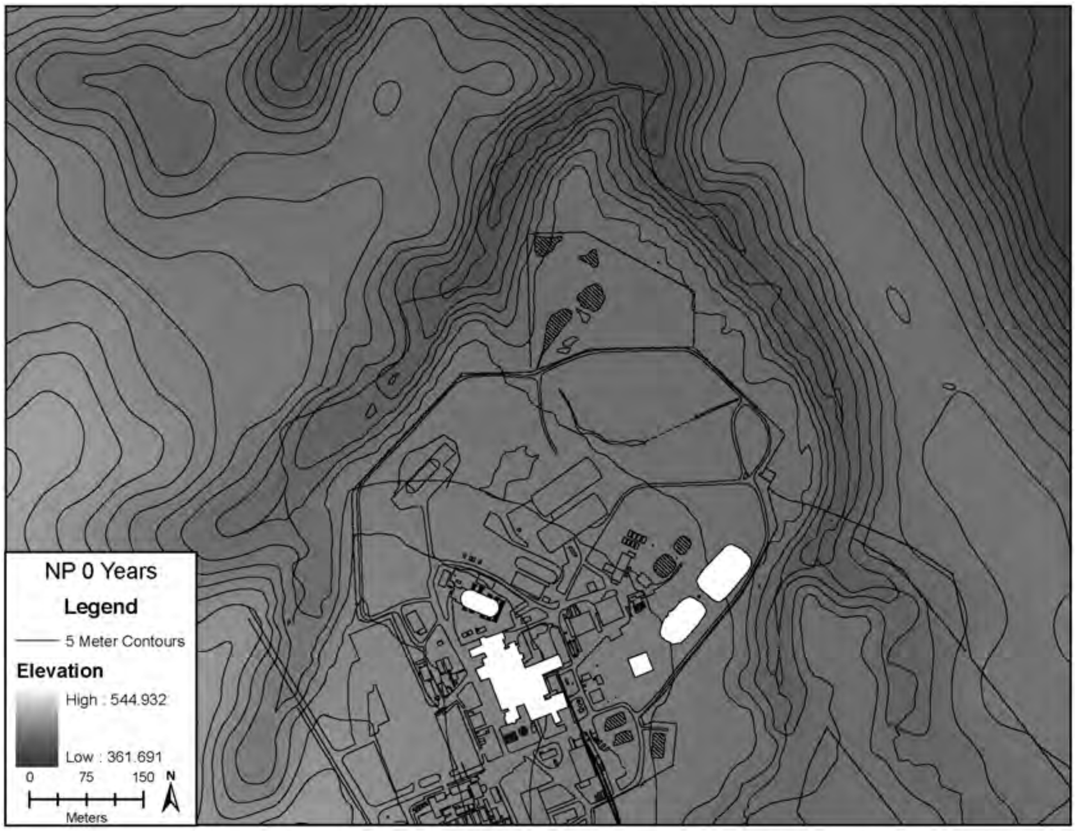
A series of erosion projections were made that take no credit for the effect of active erosion control measures.

F.3.1.6.1 General Approach

The model was run forward in time for a period of 10,000 years using the five calibration parameter sets shown in Table F–11. A sixth parameter set, discussed below, represents a case in which the climate becomes wetter and the soils less permeable. The scenarios represented by the six parameter sets are referred to henceforth as Standard, Alternate 1, Alternate 2, Alternate 3, Alternate 4, and Wet, respectively. In one set of runs, the initial topography was derived from the modern topography of the Buttermilk Creek watershed as shown in **Figure F–14**. In a second set of runs, the initial topography incorporated two burial mounds on the North and South Plateaus that were proposed as part of the Close-In-Place Alternative as shown in **Figure F–15**. To create the initial simulation mesh, the 10-meter (32.81-foot) USGS DEM was interpolated to the model mesh resolution (with the addition of DEMs representing the burial mounds for runs representing the Close-In-Place Alternative). In all cases, the base-level lowering rate applied at the outlet was equal to the final base-level lowering rate in the corresponding calibration run.

F.3.1.6.2 Model Resolution

As discussed in Section F.1.1, gullying is an important mode of erosion at WNYNSC. In order to be able to simulate the potential growth of relatively small gullies, the model resolution must be relatively fine. On the other hand, the resolution must be sufficiently coarse to ensure reasonable model integration times. A series of tests were conducted to determine the highest feasible model resolution. The results indicated that a nominal point spacing of 2.8 meters (9.19 feet) was operationally feasible provided that the area represented at this resolution was relatively small. The tests showed that representing both the North and South Plateaus at this resolution simultaneously would be impractical. Therefore, two different model meshes were generated: one in which only the North Plateau is represented at a 2.8-meter (9.19-foot) resolution while the remainder of the Buttermilk Creek basin is modeled at the calibration resolution of 90 meters (295.28 feet), and another in which only the South Plateau is represented at a 2.8-meter (9.19-foot) resolution. The two mesh configurations are shown on **Figure F–16**.



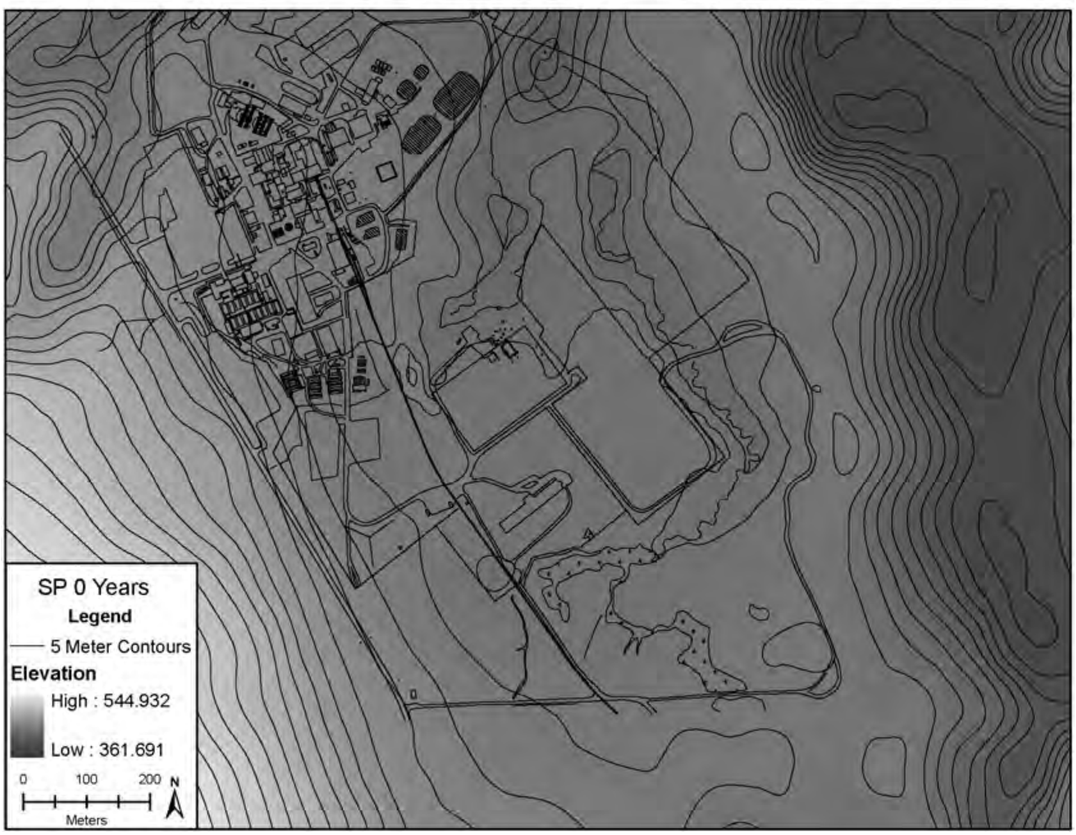


Figure F–14 Modern Topography of Buttermilk Creek Watershed

Figure F–15 Initial In-Place-Closure Topography North and South Plateaus

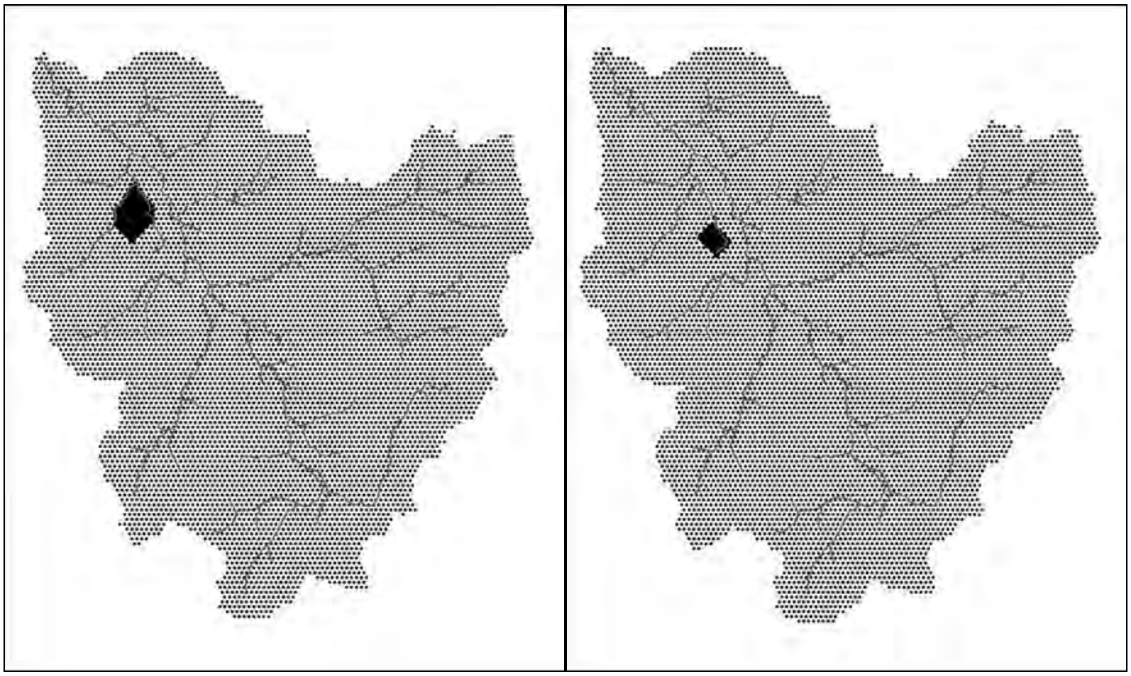


Figure F–16 CHILD Meshes with North Plateau at a 2.8-meter Resolution (left) and South Plateau at a 2.8-meter Resolution (right)

F.3.1.6.3 Mathematical Representation of Proposed Burial Structures

The burial structures (tumuli) proposed under the Sitewide Close-In-Place Alternative (see Appendix C) are designed to withstand direct water erosion, and to be geomechanically stable. However, few engineered structures without deep pilings can withstand being undermined by erosion of the ground that supports them. Thus, the greatest erosional threats to these structures are considered to be undermining by mass movement as valley rims widen in response to stream incision and undermining by adjacent gully incision. It was assumed that, with regard to hillslope mass movement, the materials composing the tumuli would not differ substantially from the natural soils and sediments on which they are built. With regard to water erosion, the material was assigned the same erodibility coefficient as the glacial sediments. This is a conservative assumption, as coarse mound material is likely to be more resistant to entrainment and transport by running water than typical till material.

F.3.1.6.4 "Wet" and "Fast-Creep" Scenarios

A future shift to a wetter climate, and/or a reduction in the infiltration capacity of soils, represents a potential threats to the erosional integrity of the burial areas. In order to assess the potential for accelerated erosion under altered climate and land use conditions, a "Wet" scenario was developed. The Wet scenario was designed to represent conditions in which (1) the mean precipitation intensity is twice the modern value estimated from West Valley rainfall data (2.9 millimeters [0.11 inches] per hour), and (2) the soil infiltration capacity takes on the minimum value in the calibration parameter range (0.436 millimeters [0.02 inches] per hour). The former represents a climatic shift in which both storminess and mean annual precipitation increase (that is, it doesn't rain more often than it does in the present, but when the rain comes it is twice as heavy). The latter a degraded land use condition in which runoff is amplified. In addition to the Wet scenario, a Wet + Fast Creep scenario was developed for the South Plateau only. This scenario was motivated by the possibility that the relatively low creep coefficients identified in the best-fit calibration runs may not be representative of the current or future creep rates. Because the calibration procedure relied heavily on features formed by water erosion (such as the main stream profile, the width function, the drainage-area distribution function, and most of the slope-area curve), the creep coefficients associated with the best fitting runs are not necessarily the best parameters for the site. Accordingly, the Fast Creep scenario uses the highest of the plausible range of values identified in the parameter selection phase (0.036 square meters [0.39 square feet] per year) in addition to the Wet parameters. Because of computing-time limitations, it was only possible to run the Wet + Fast Creep scenario on the South Plateau. It is considered more significant at that location, because its considerably smaller drainage area makes it relatively more susceptible to creep- and landslide-erosion than the North Plateau, where the primary erosional hazard appears to be gullying.

F.3.1.6.5 Summary of Forward-Run Scenarios

Altogether, 26 forward runs were computed (**Table F–12)**. Of these, one—the Wet scenario for the North Plateau under the No Action Alternative—failed with numerical errors, which reflects a combination of high sediment flux and small grid spacing. The remainder ran to completion (Table F–12). The table also indicates the computationally intensive nature of these model calculations, with run times ranging from 5 to over 1,000 hours.

Table F–12 Summary of Forward Runs

Run	*Parameter Set*	*High-resolution Mesh Area*	*Scenario*	*Computation Time (hours)*
NPstd	Standard	North Plateau	No action	54
NPa1	Alternate 1	North Plateau	No action	54
NPa2	Alternate 2	North Plateau	No action	104
NPa3	Alternate 3	North Plateau	No action	459
NPa4	Alternate 4	North Plateau	No action	34
NPwet	Wet	North Plateau	No action	(run failed)
NPTstd	Standard	North Plateau	Sitewide Close-in-place	49
NPTa1	Alternate 1	North Plateau	Sitewide Close-in-place	50
NPTa2	Alternate 2	North Plateau	Sitewide Close-in-place	93
NPTa3	Alternate 3	North Plateau	Sitewide Close-in-place	558
NPTa4	Alternate 4	North Plateau	Sitewide Close-in-place	33
NPTwet	Wet	North Plateau	Sitewide Close-in-place	1,049
SPstd	Standard	South Plateau	No action	8
SPa1	Alternate 1	South Plateau	No action	13
SPa2	Alternate 2	South Plateau	No action	6
SPa3	Alternate 3	South Plateau	No action	15
SPa4	Alternate 4	South Plateau	No action	5
SPwet	Wet	South Plateau	No action	63
SPwc	Wet + Fast Creep	South Plateau	No action	76
SPTstd	Standard	South Plateau	Sitewide Close-in-place	8
SPTa1	Alternate 1	South Plateau	Sitewide Close-in-place	14
SPTa2	Alternate 2	South Plateau	Sitewide Close-in-place	7
SPTa3	Alternate 3	South Plateau	Sitewide Close-in-place	37
SPTa4	Alternate 4	South Plateau	Sitewide Close-in-place	6
SPTwet	Wet	South Plateau	Sitewide Close-in-place	69
SPwc	Wet + Fast Creep	South Plateau	Sitewide Close-in-place	82

F.3.1.6.6 Results: No Action Scenario, North Plateau

The standard, no action case (NPstd; **Figure F–17**) shows incision along Quarry Creek, which drives hillslope erosion on the northwest edge of the plateau. This prediction is consistent with the observed morphology of this stretch of Quarry Creek, which appears to be actively incising and has cut to bedrock along part of the reach. The simulation shows an upstream transition from net incision to (minor) net deposition along the stretch of Franks Creek between the Quarry Creek confluence and the Franks Creek–Erdman Brook junction. Incision along the lower portion of this reach is consistent with onsite observations. Sedimentation or net stability in the vicinity of the Franks Creek–Erdman Brook junction appears to be at odds with present-day observations of active incision, as discussed in the following text.

The simulation shows the formation of an approximately 100-meter (328-foot)-long gully on the northeast plateau rim, north of the present-day NP-2. Erosion is also concentrated along the rim of the plateau. Both of these features are generally consistent with erosion patterns observed at the site, though the position of the modeled gully does not correspond to either of the existing gullies (NP-2 and NP-3) along that portion of the rim. However, there is some concentration of erosion around the present-day NP-3 gully.

The NPa1 case (**Figure F–18**) is similar on the whole to the standard case. By contrast, NPa2 shows considerably more erosion (**Figure F–19**). As in the standard case, the greatest incision occurs along Quarry Creek, and particularly in the stretch northwest of the Process Building. The simulation also shows incision along the full stretch of Franks Creek between Quarry Creek and Erdman Brook. The NP-3 gully deepens and extends headward across the boundary road, while the NP-2 gully extends beyond the boundary fence. The largest gully in the simulation forms north of NP-2, with over 15 meters (49.21 feet) of vertical incision at its deepest point. The NP-1 gully also extends headward and deepens, generating a side branch that advances within the boundary fence. Additional gullies form along the northwestern plateau edge, north-northwest of the Main Plant Process Building.

Scenario NPa3 (**Figure F–20**) shows incision of up to 27 meters (88.58 feet) depth along Quarry Creek. In contrast, the behavior of Franks Creek resembles that of scenarios NPstd. The simulation shows a mixture of net incision and net aggradation around and above the Franks Creek–Erdman Brook confluence, with absolute height changes generally less than 10 meters (32.81 feet). Net incision occurs on the downstream reach of Franks Creek. Deep incision along Quarry Creek drives rim retreat, such that the plateau edge advances several tens of meters beyond the boundary road along the northwest plateau edge. The NP-1 gully lengthens and deepens somewhat. The largest gully to form in this scenario appears on the northeast edge, north of NP-2. This gully pushes the plateau rim some tens of meters beyond the perimeter fence, and shows a maximum deepening between 20 and 25 meters (65.62 and 82.02 feet). Erosion along the eastern plateau edge is much more muted, rarely exceeding 5 meters (16.40 feet). Scenario NPa4 (**Figure F–21**) is generally quite similar to NPa3.

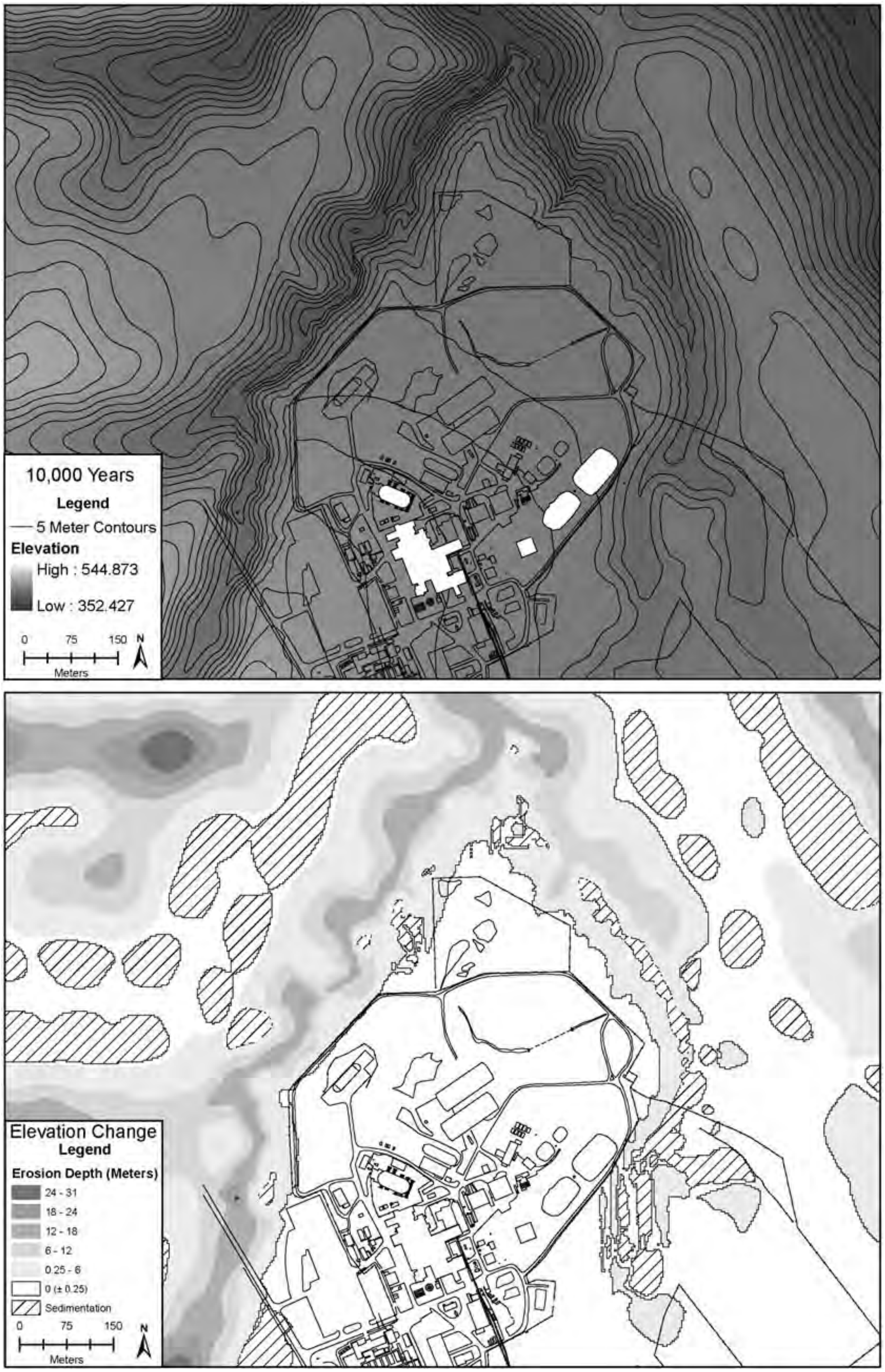
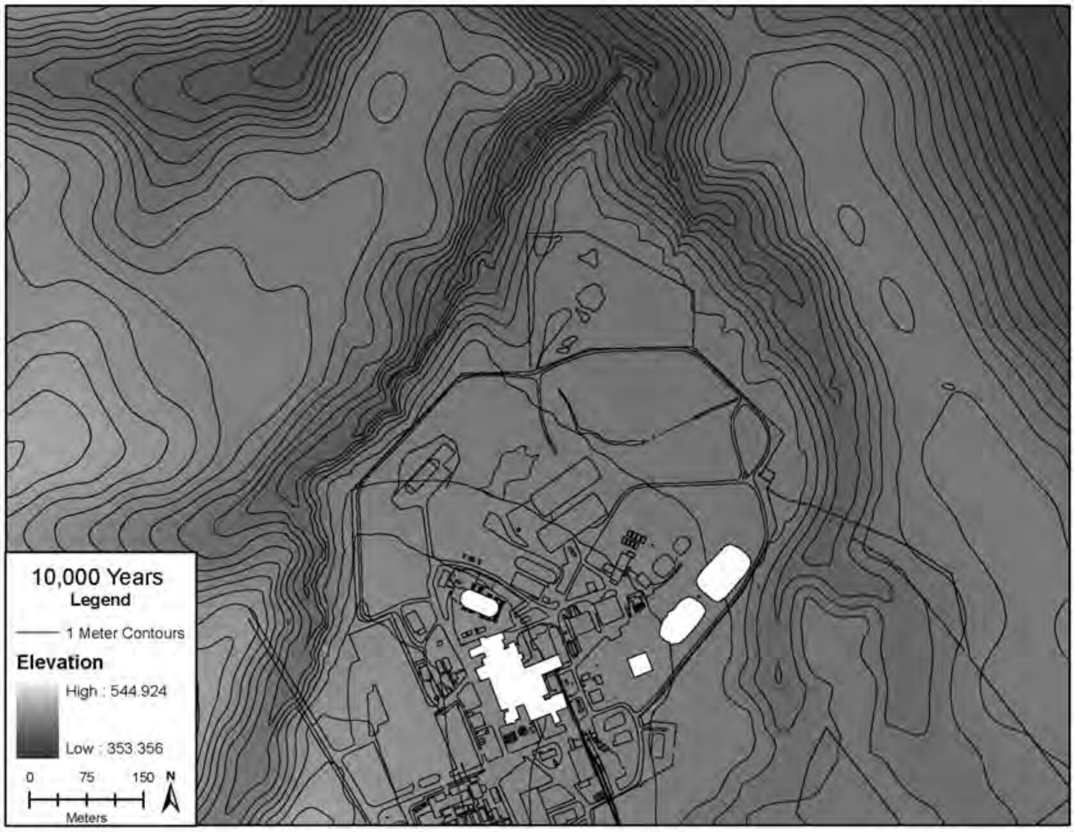


Figure F–17 Results of CHILD North Plateau Standard (NPstd) No Action Case



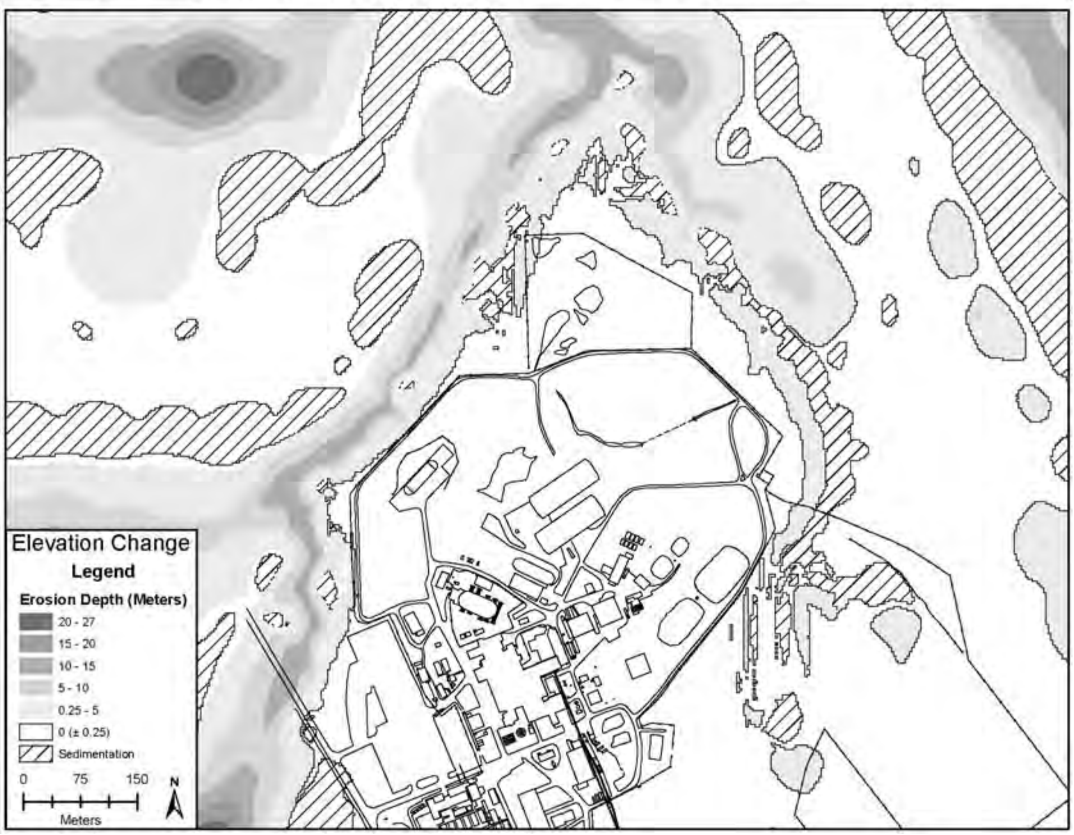


Figure F–18 Results of CHILD NPa1 No Action Case

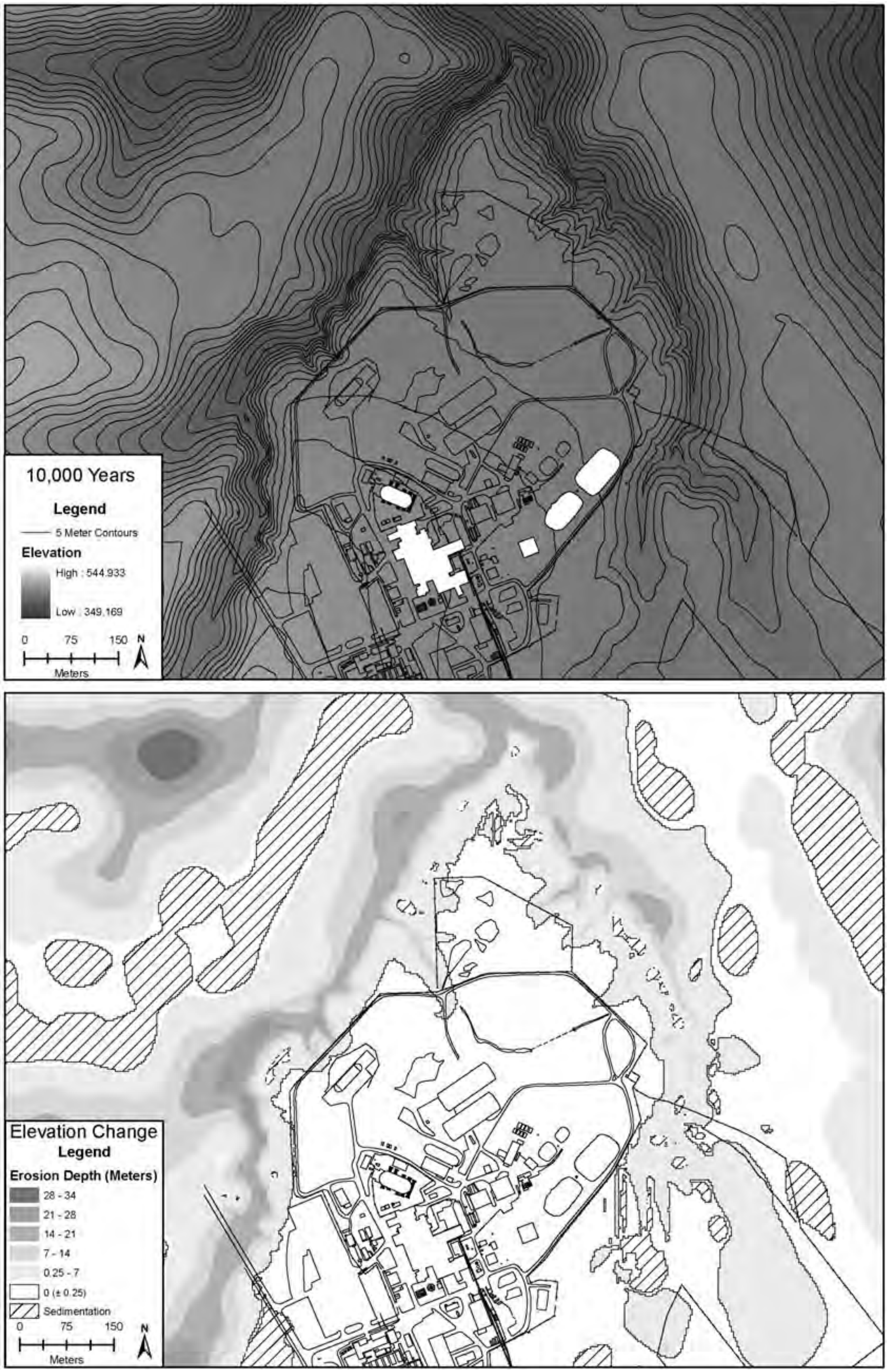


Figure F–19 Results of CHILD NPa2 No Action Case

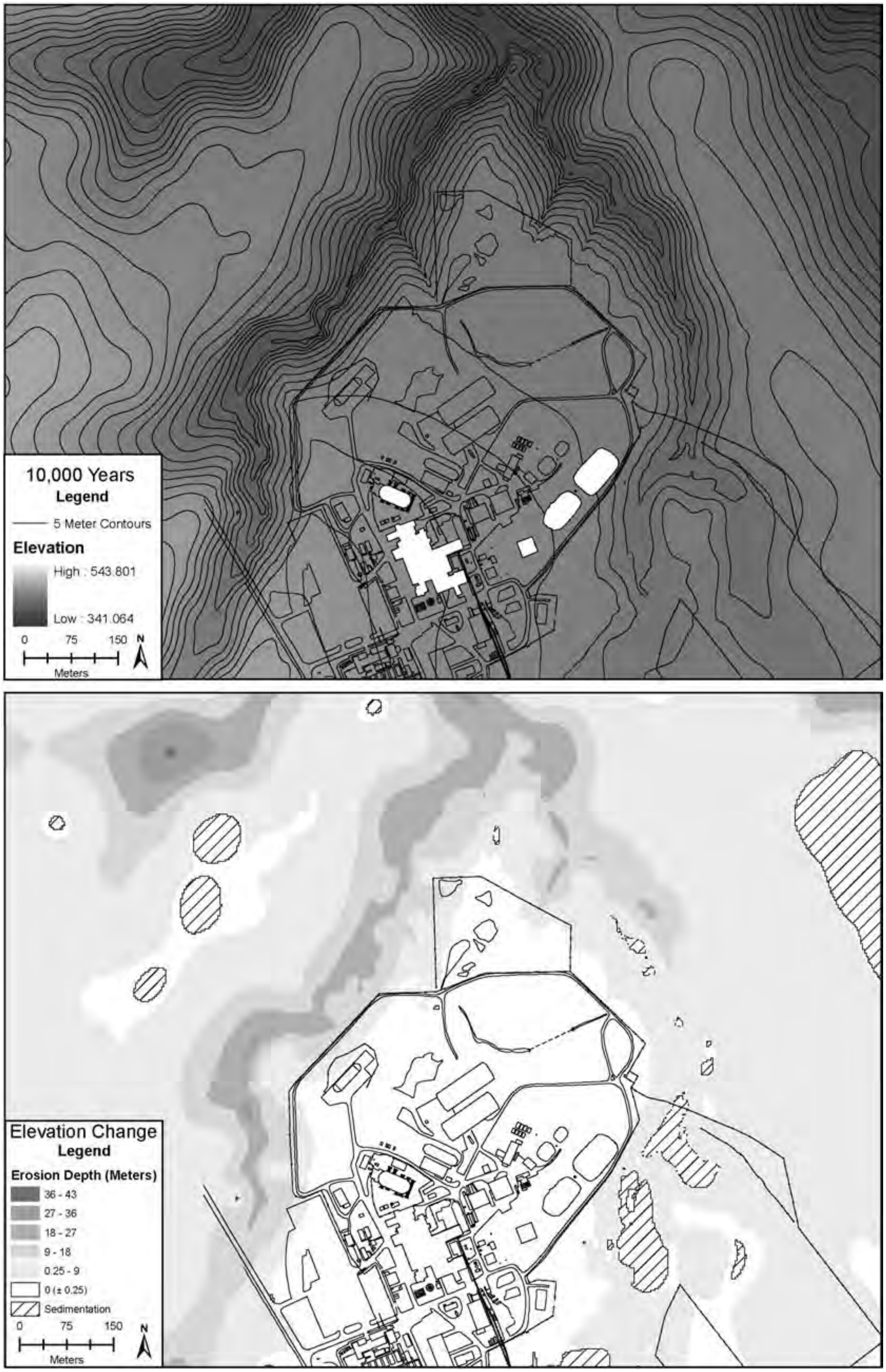


Figure F–20 Results of CHILD NPa3 No Action Case

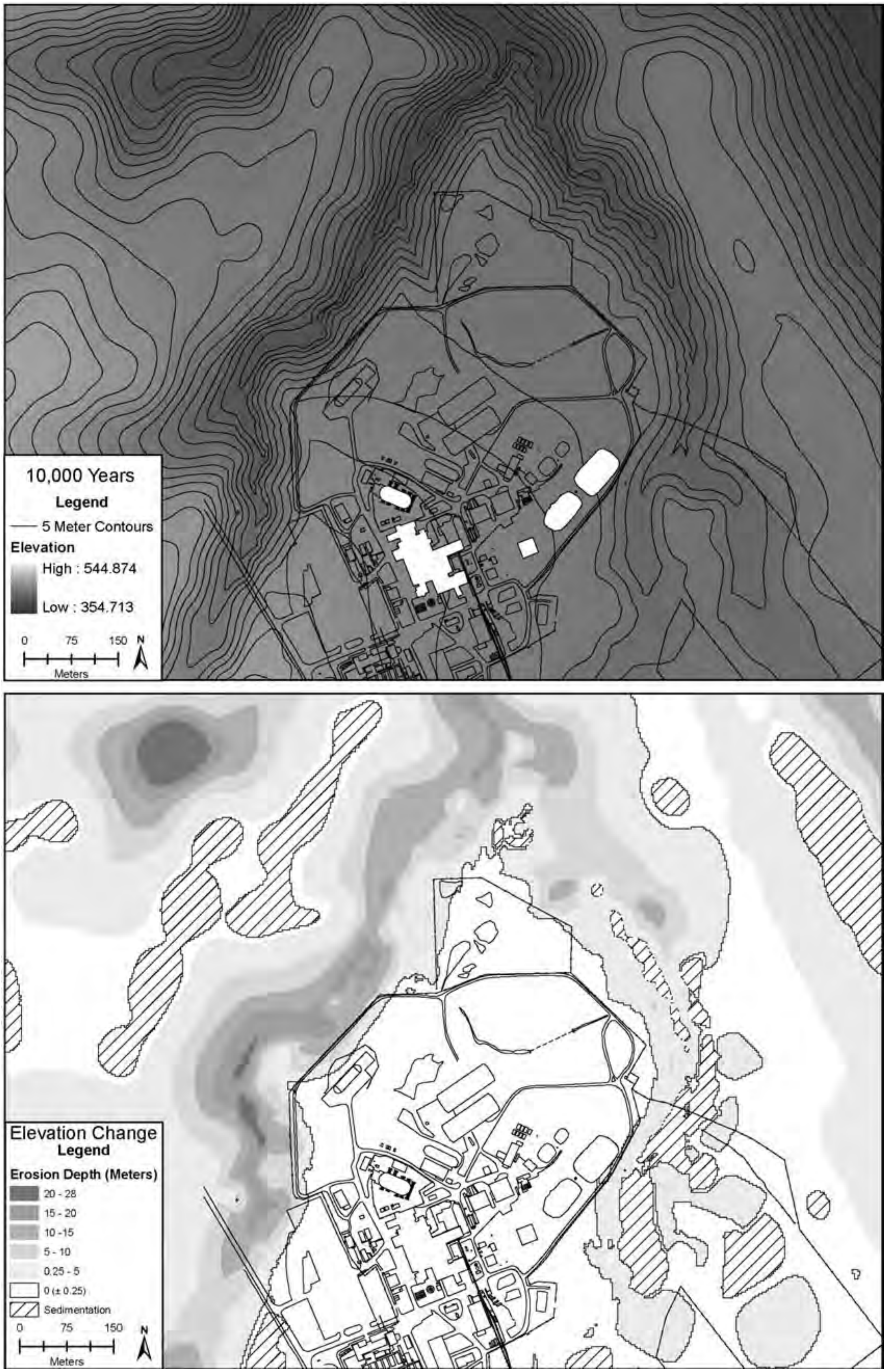


Figure F–21 Results of CHILD NPa4 No Action Case

F.3.1.6.7 Results: No Action Scenario, South Plateau

In general, the simulations using a dense mesh on the South Plateau show considerably less erosion than those for the North Plateau. Scenario SPstd (**Figure F–22**) shows less than 1 meter (3.28 feet) of net erosion along the east edge of the SDA, plus a small localized area of approximately 2 meters (6.56 feet) of erosion at the west corner of the NDA where Erdman Brook makes a right-hand turn. Upper Franks Creek shows stability.

Scenarios SPa1 (**Figure F–23**) and SPa2 (**Figure F–24**) show essentially no significant erosion or deposition. Scenario SPa3 (**Figure F–25**) shows erosion of up to 1 meter (3.28 feet) along the east rim of the SDA, locally higher, and the formation of a shallow (less than 1 meter [3.28 feet] deep) gully in the depression between the SDA and NDA. Upper Franks Creek shows minor incision in runs SPa2 and SPa3. Scenario SPa4 is generally similar to SPa3, but with overall stability in the Erdman Brook and upper Franks Creek drainages.

As expected, the SPwet scenario (**Figure F–26**) shows more-extensive erosion in the South Plateau. The existing shallow trough between the SDA and NDA deepens by up to 6.8 meters (22.31 feet), forming an approximately 200-meter (656.17-foot)-long gully that extends to the road that runs along the southeast side of the NDA. Erdman Brook and upper Franks Creek undergo incision on the order of 10 to 20 meters (32.81 to 65.62 feet), tapering upstream.

In the Wet + Fast Creep scenario (**Figure F–27**), the NDA gully forms but does not grow or deepen nearly as far as in SPwet. This reflects the suppression of incision by enhanced flux of sediment from the surrounding slopes. The east flank of the SDA experiences erosion depths locally approaching 4 meters (13.12 feet), while the north and west sides of the NDA show relatively minor erosion (less than 2 meters [6.56 feet]. Incision along Erdman Brook and upper Franks Creek is similar to the behavior of the SPwet scenario.

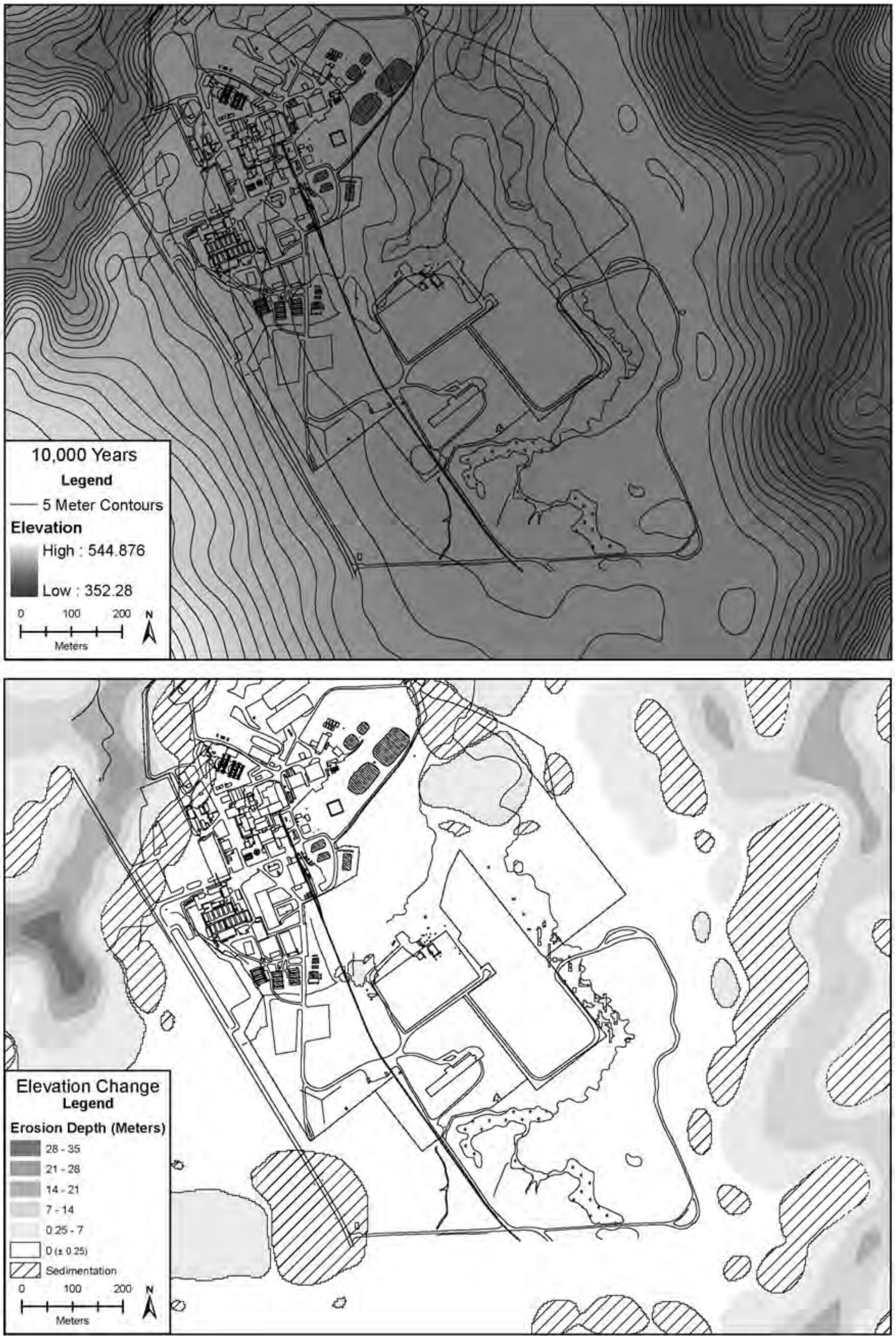


Figure F–22 Results of CHILD South Plateau Standard (SPstd) No Action Case

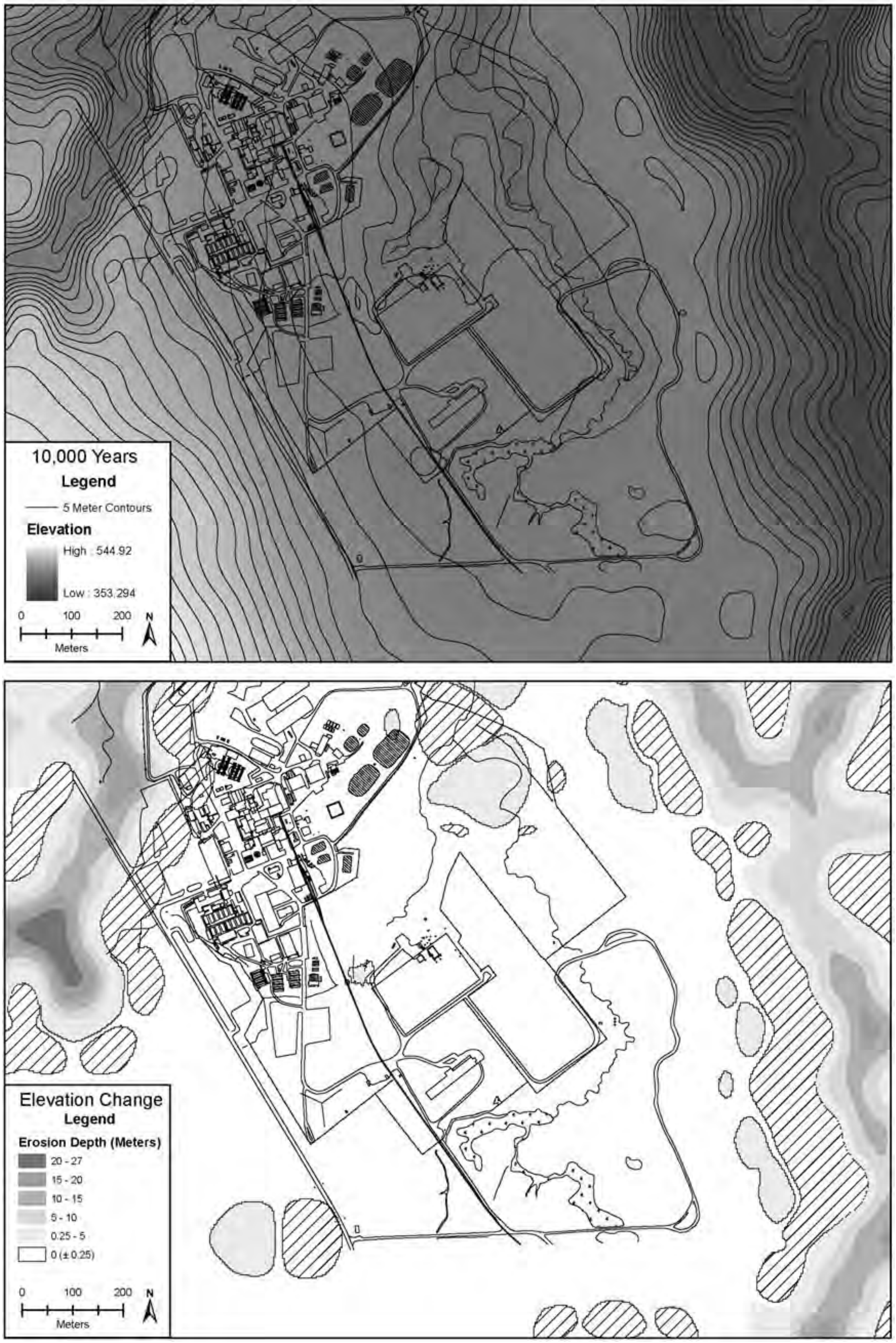


Figure F–23 Results of CHILD SPa1 No Action Case

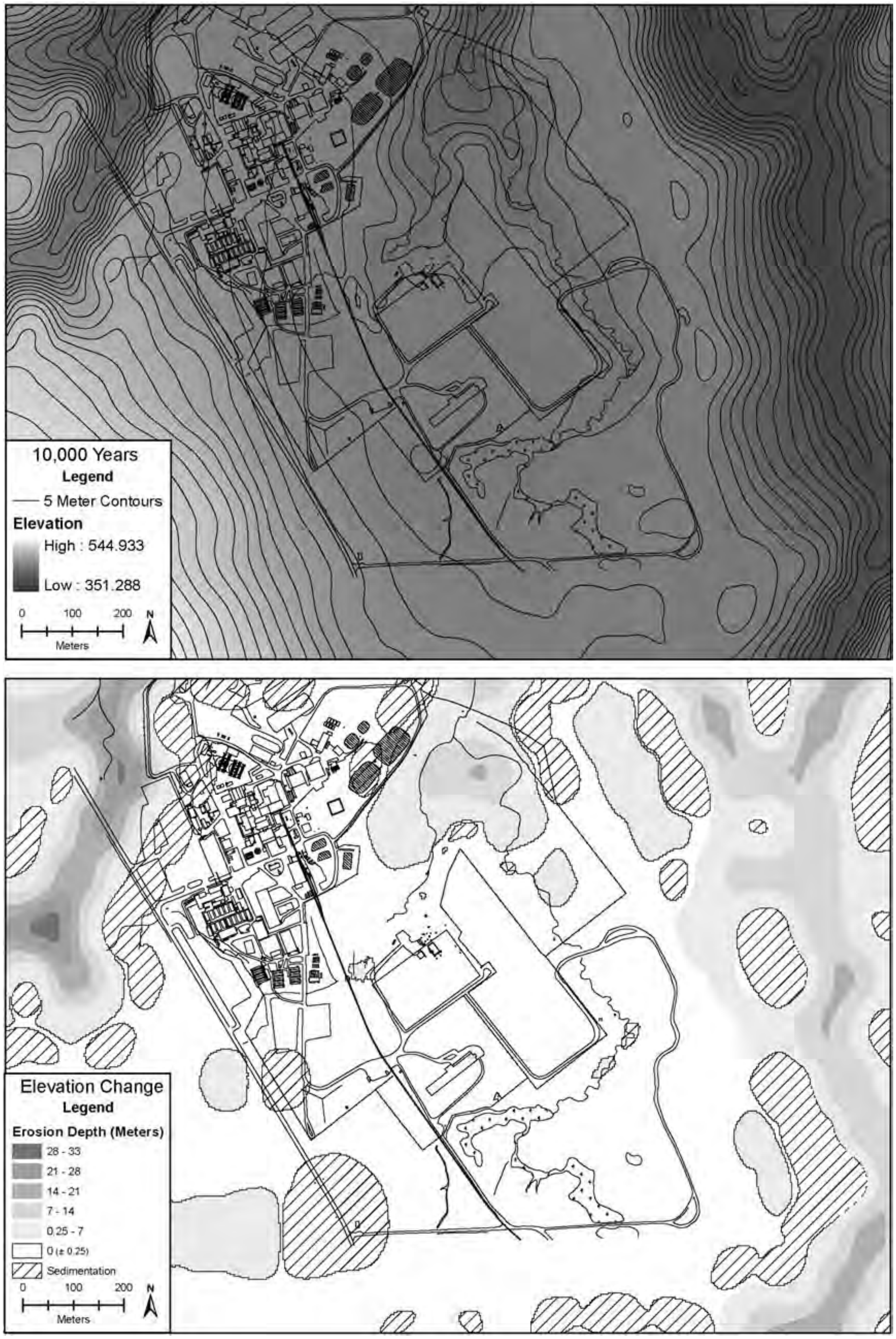
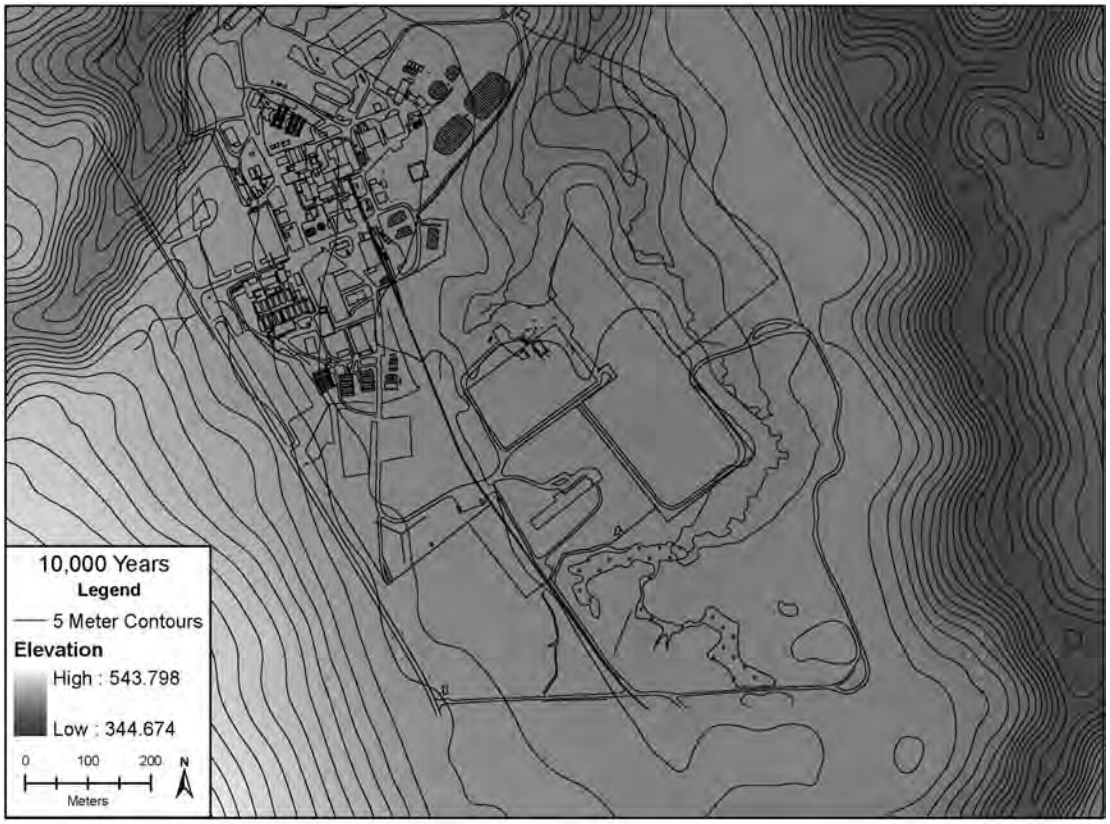


Figure F–24 Results of CHILD SPa2 No Action Case



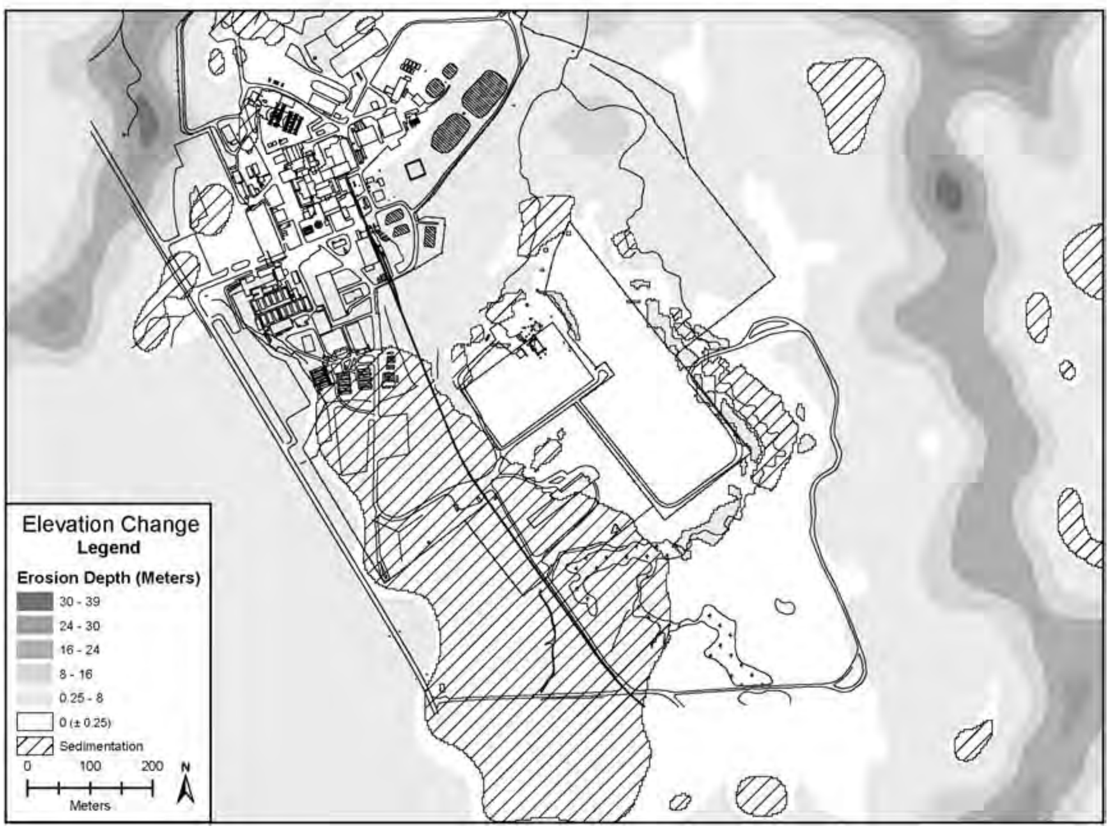


Figure F–25 Results of CHILD SPa3 No Action Case

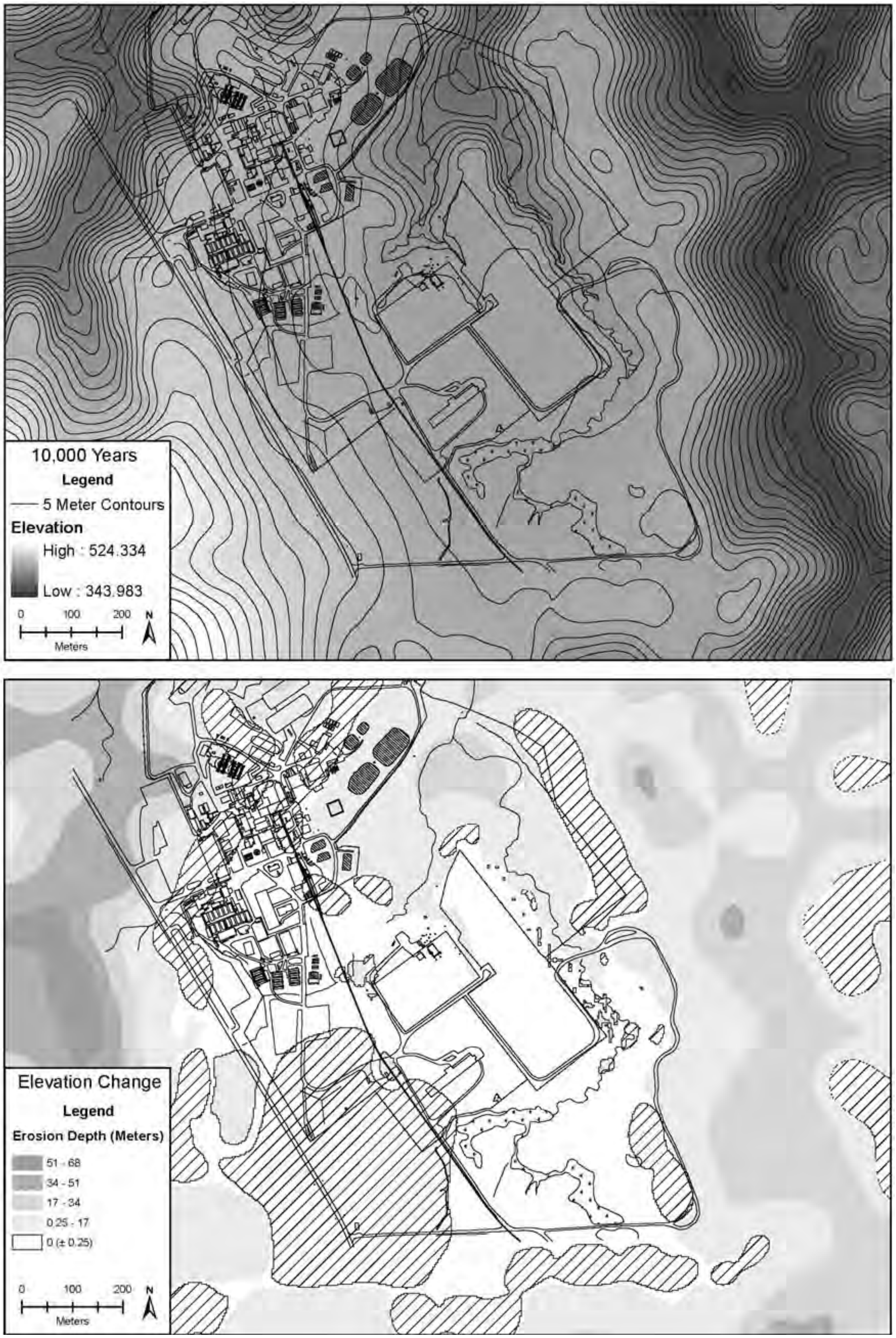
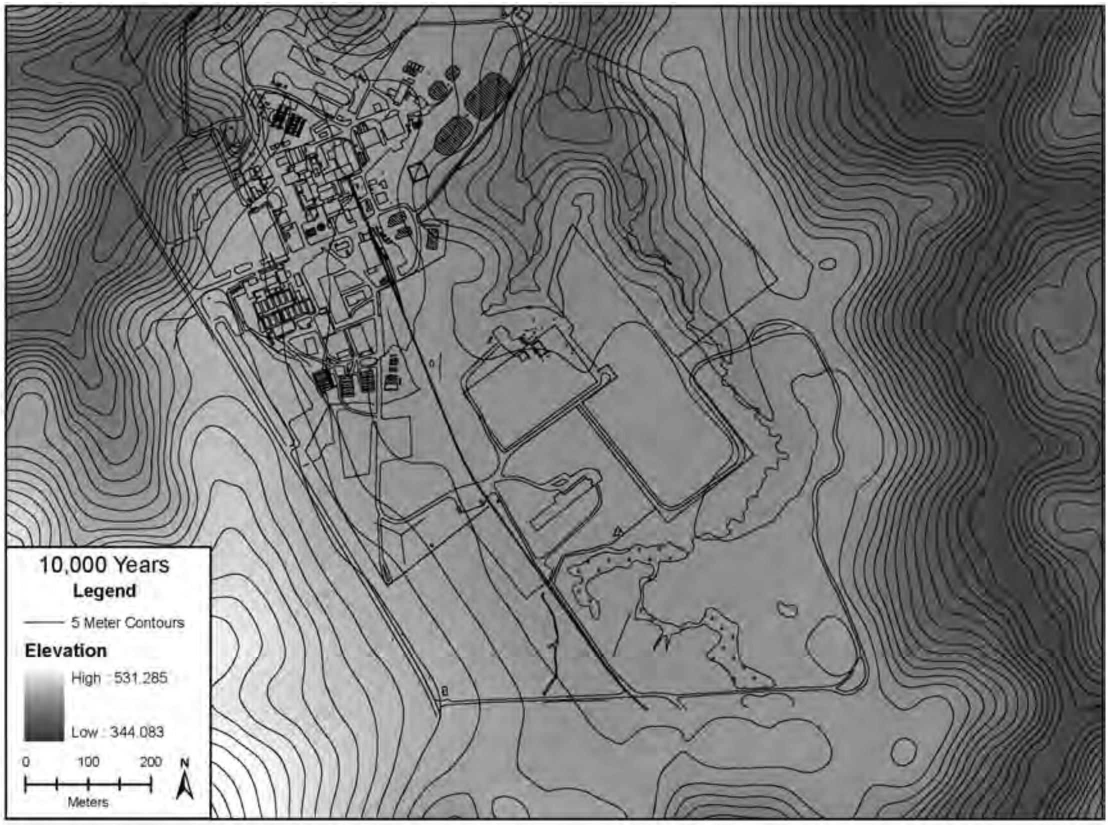


Figure F–26 Results of CHILD SPwet No Action Case



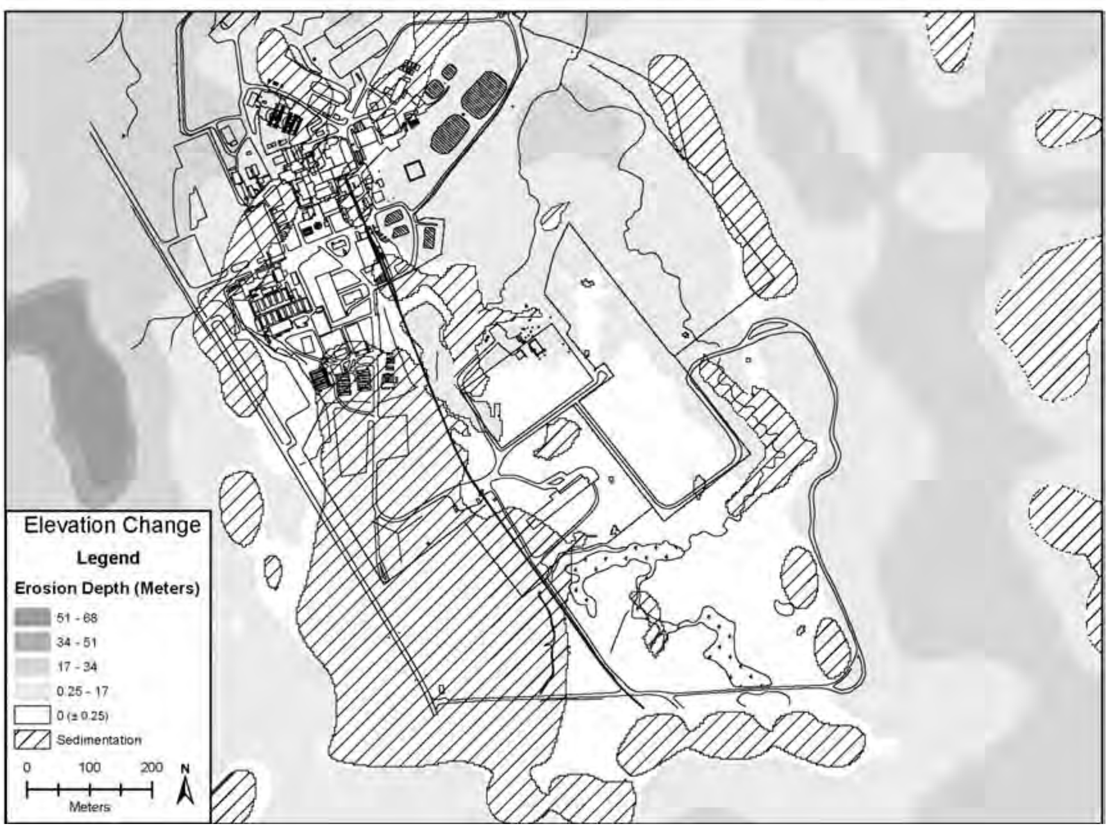


Figure F–27 Results of CHILD SP Wet + Fast Creep No Action Case

F.3.1.6.8 Results: Sitewide Close-In-Place Scenario, North Plateau

There are subtle but meaningful differences between the sitewide close-in-place runs and their no action counterparts. These differences result solely from the effect of the burial-mound structure on the runoff flow paths, and they serve to illustrate the sensitivity of gully networks to upstream topography. In NPTstd (**Figure F–28**), the behavior of the valley bottoms is quite similar to NPstd. However, where NPstd produced one large gully in the northeast, NPTstd generates two: one an approximately 200-meter (656.17-foot) extension of the present NP-2 gully, and the other to the north. The first of these is the longest, and it reaches well beyond the perimeter fence. Both gullies show maximum erosion depths between 8 and 12 meters (26.25 and 39.37 feet). A third small gully forms north of the Main Plant Process Building extending a few tens of meters beyond the site perimeter road.

Scenario NPTa1 (**Figure F–29**) shows patterns similar to NPTstd, with gullies to the northeast and north of the Main Plant Process Building, but with generally less overall erosion. Notably, the NP-1 gully is not active in this scenario, and its lower reach becomes a site of net deposition.

The NPTa2 simulation (**Figure F–30**) shows net incision along most of Franks Creek and lower Erdman Brook. The existing NP-2 gully deepens and extends approximately 200 meters (656.17 feet) into the plateau. The NP-1 gully deepens somewhat but does not significantly extend. A gully on the northwest rim, south of NP-1, advances about 130 meters (426.51 feet) toward the high-level radioactive waste tanks and the Main Plant Process Building. Several other gullies form or grow from existing gullies along the northeast and northwest rims.

The NPTa3 scenario (**Figure F–31**) is broadly similar to NPTa2, but with more extensive erosion. The NP-2 gully broadens and extends to the perimeter road. The NP-1 gully also extends headward to the perimeter road. A second gully on the western side extends toward, but falls about 100 meters (328.08 feet) short of the high-level radioactive waste tank area.

Scenario NPTa4 (**Figure F–32**), like several of the others, shows incision along Quarry Creek and lower Franks Creek, but general stability around upper Franks Creek, with height changes (both erosion and deposition) under 10 meters (32.81 feet). The largest gully (over 12 meters (39.37 feet) of erosion) forms at the northeast end of the plateau, while NP-1 deepens between 4 and 8 meters (13.12 and 26.25 feet). Rim widening along the northwest edge undermines the perimeter road.

Not surprisingly, the NPTwet scenario (**Figure F–33**) shows much more intense erosion in and around the North Plateau. Incision occurs along all of the stream valleys bounding the plateau. The plateau is bisected by the growth of a very large gully that begins near the site of present-day NP-2 and extends several hundred meters into the plateau, reaching to roughly 120 meters (393.70 feet) from the process plant. At the same time, a shorter but deeper gully along the western edge comes very close to the foot of the burial structure, between 100 and 150 meters (328.08 and 492.13 feet) from the Main Plant Process Building. This gully appears to be fed by flow diverted around the burial mound to the west. Overall, the plateau rim undergoes considerable retreat, with additional large gullies forming along both the northeast and southeast margins.

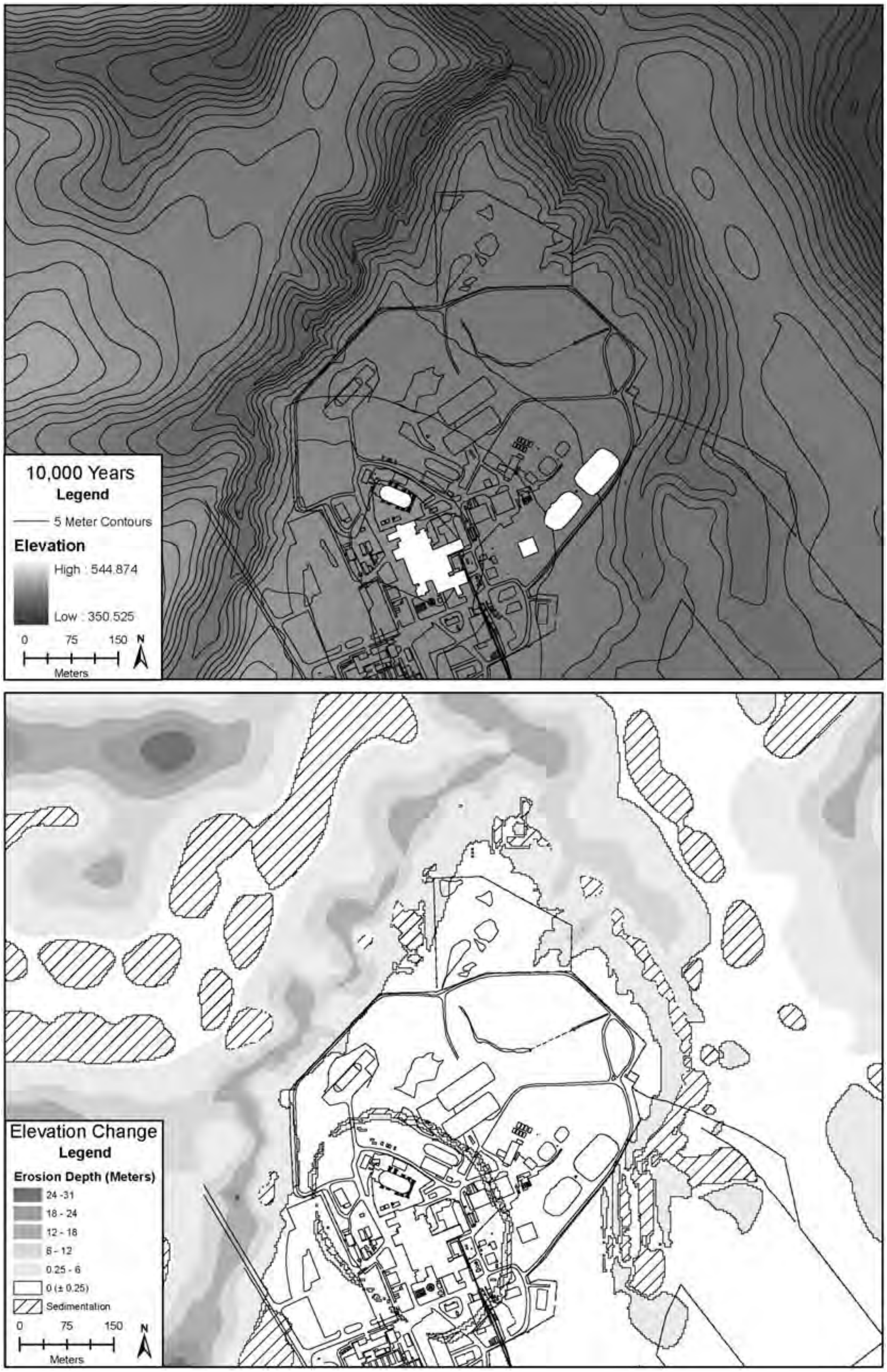


Figure F–28 Results of CHILD North Plateau Tumulus Standard (NPTstd) Sitewide Close-In-Place Case

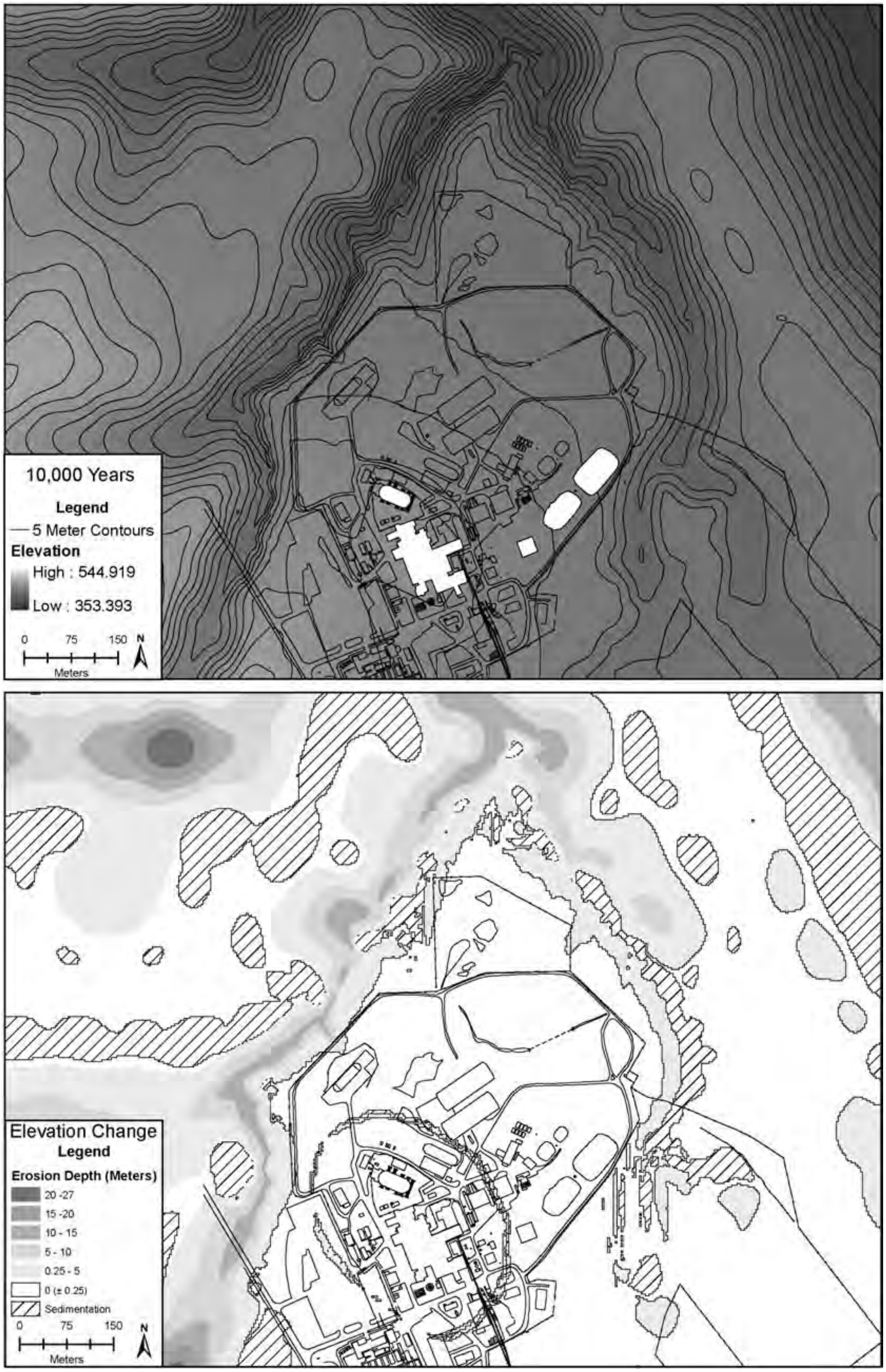


Figure F–29 Results of CHILD NPTa1 Sitewide Close-In-Place Case

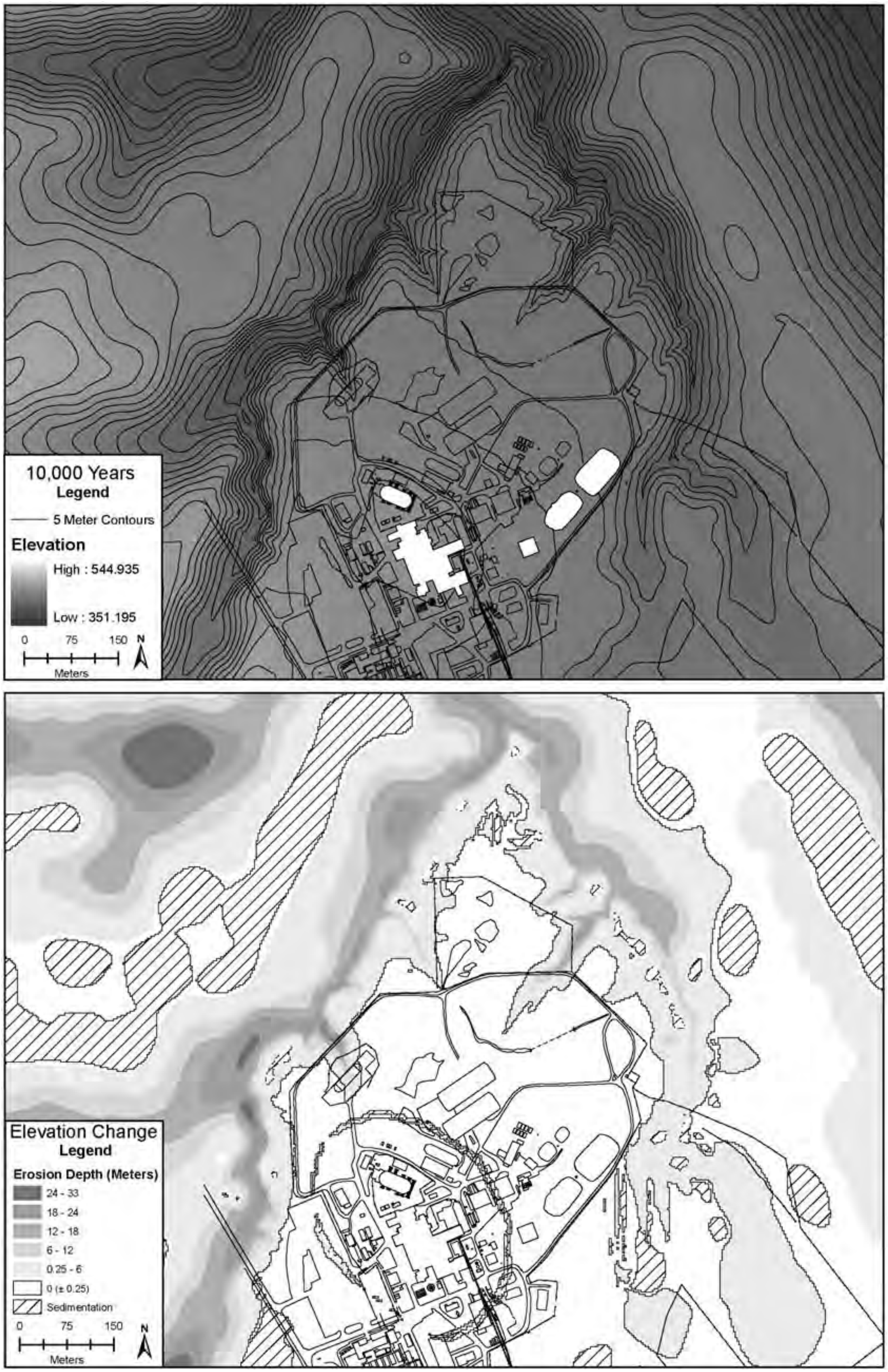


Figure F–30 Results of CHILD NPTa2 Sitewide Close-In-Place Case

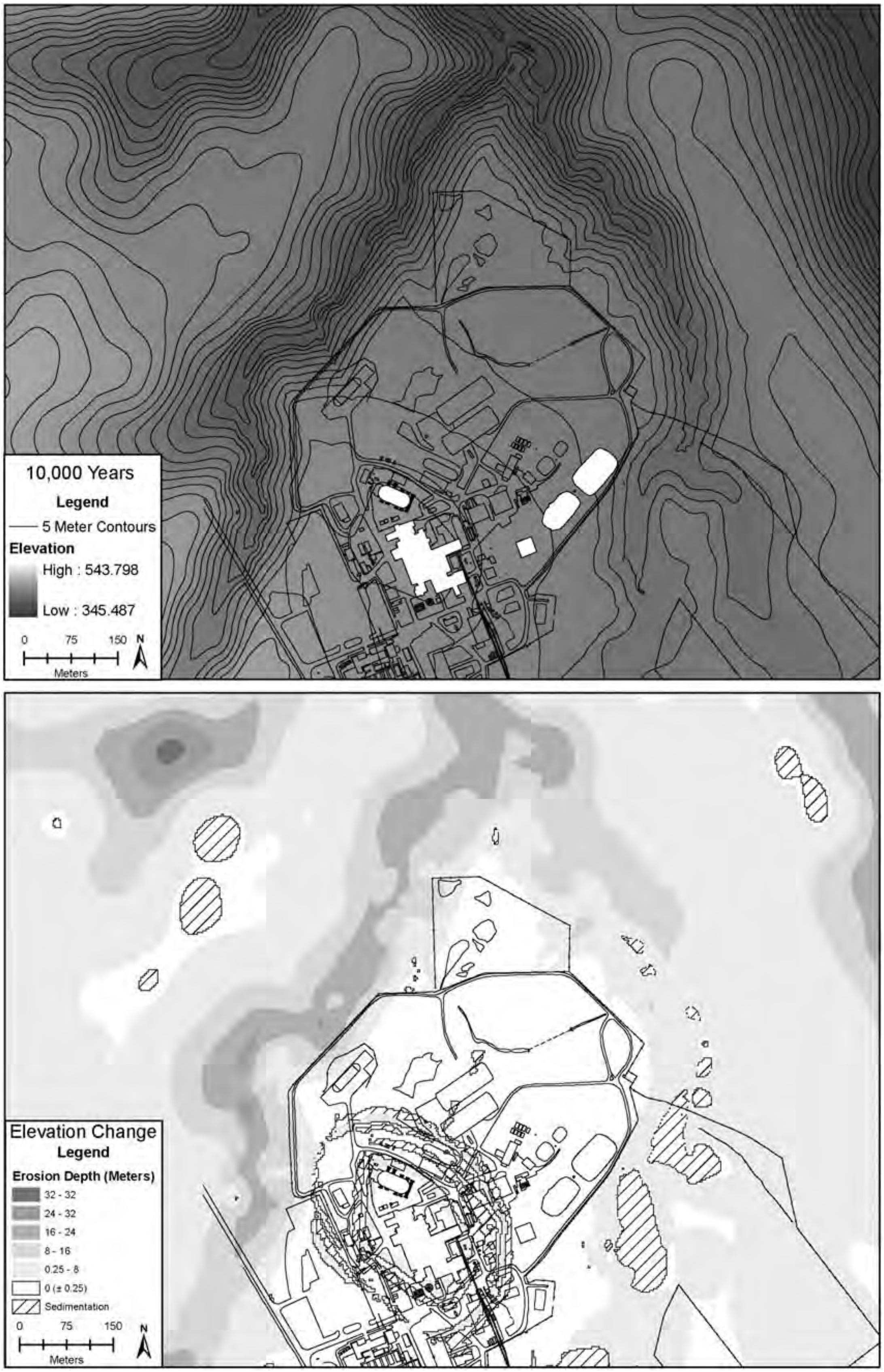


Figure F–31 Results of CHILD NPTa3 Sitewide Close-In-Place Case

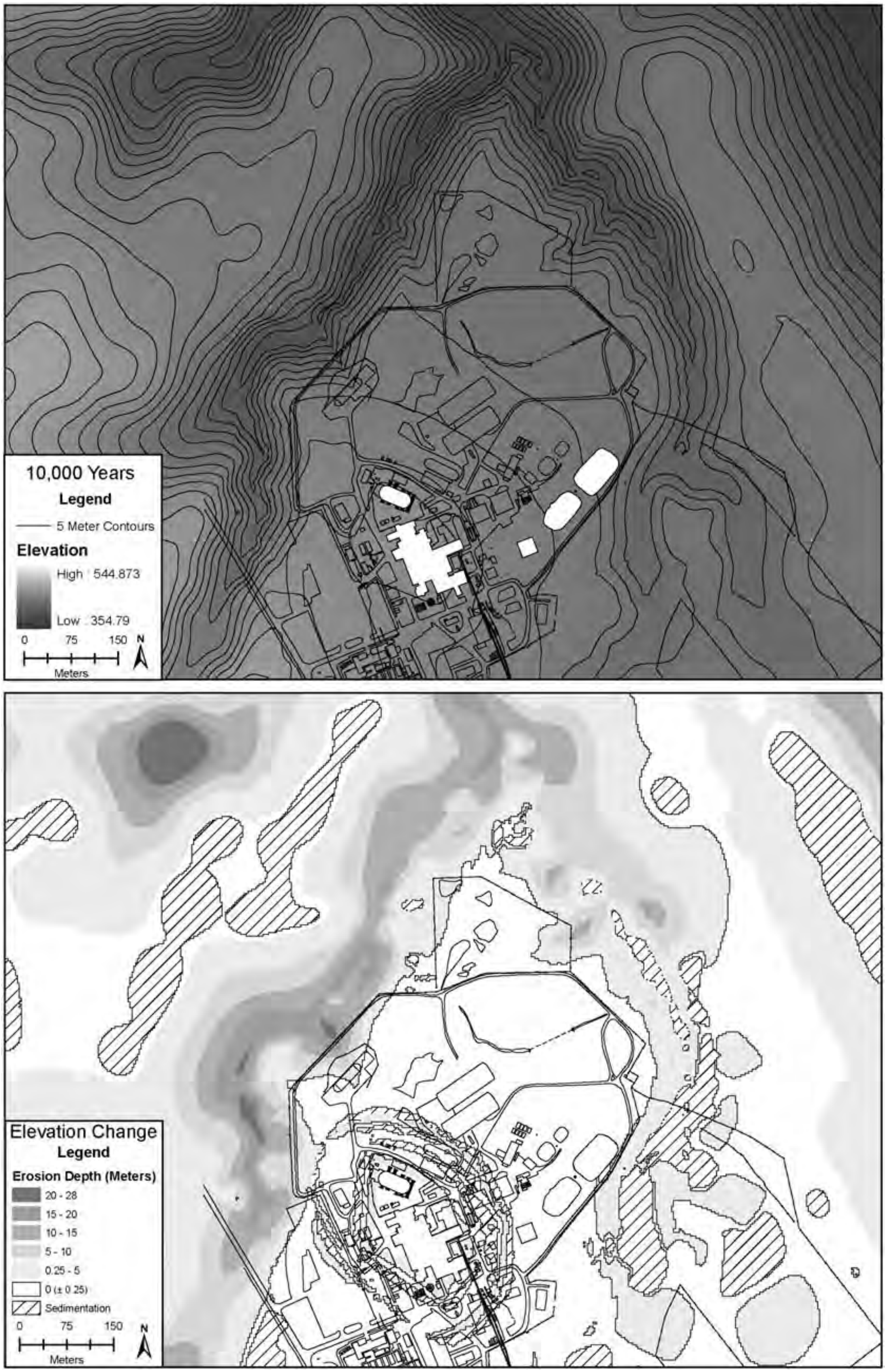


Figure F–32 Results of CHILD NPTa4 Sitewide Close-In-Place Case

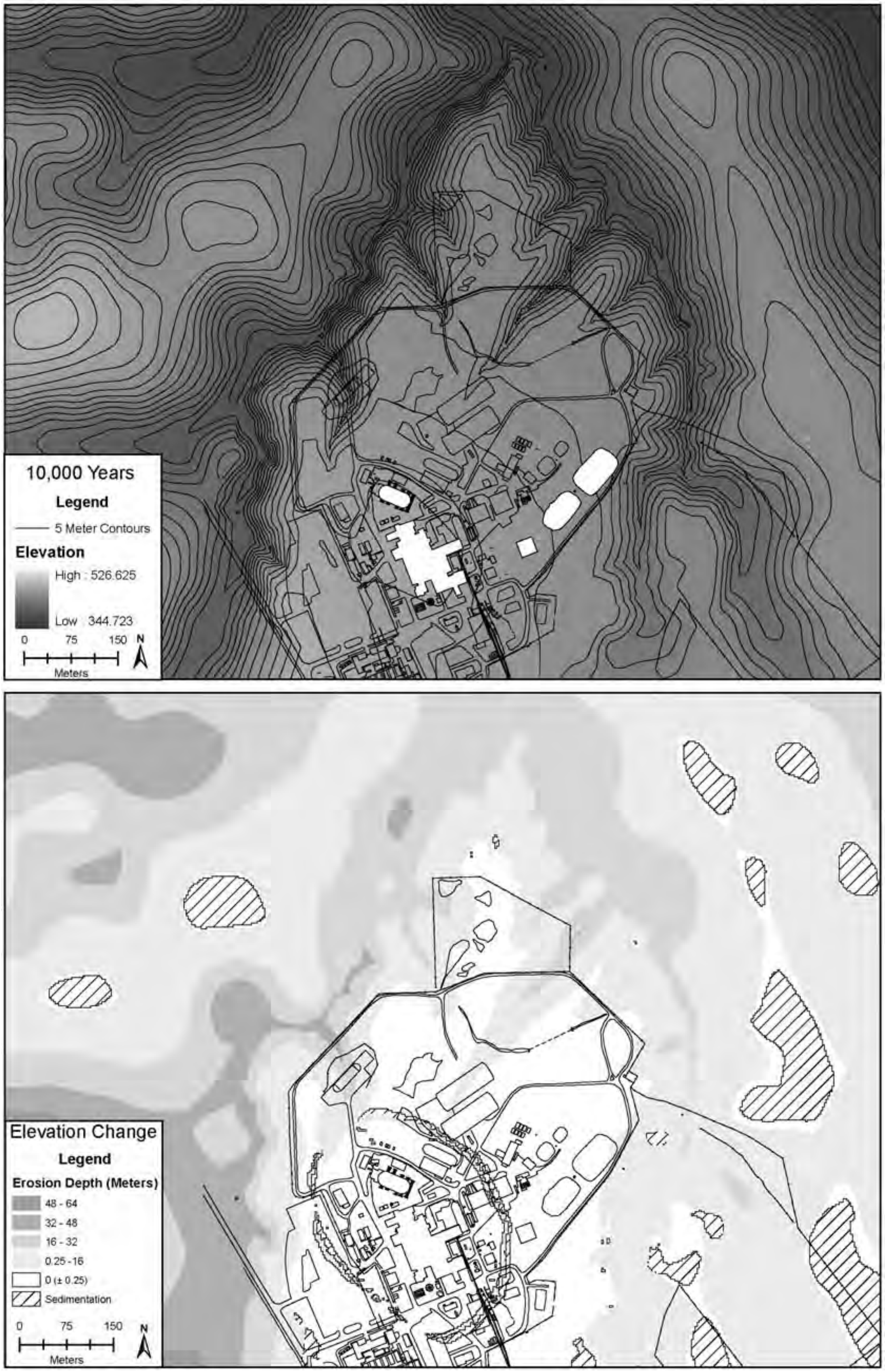
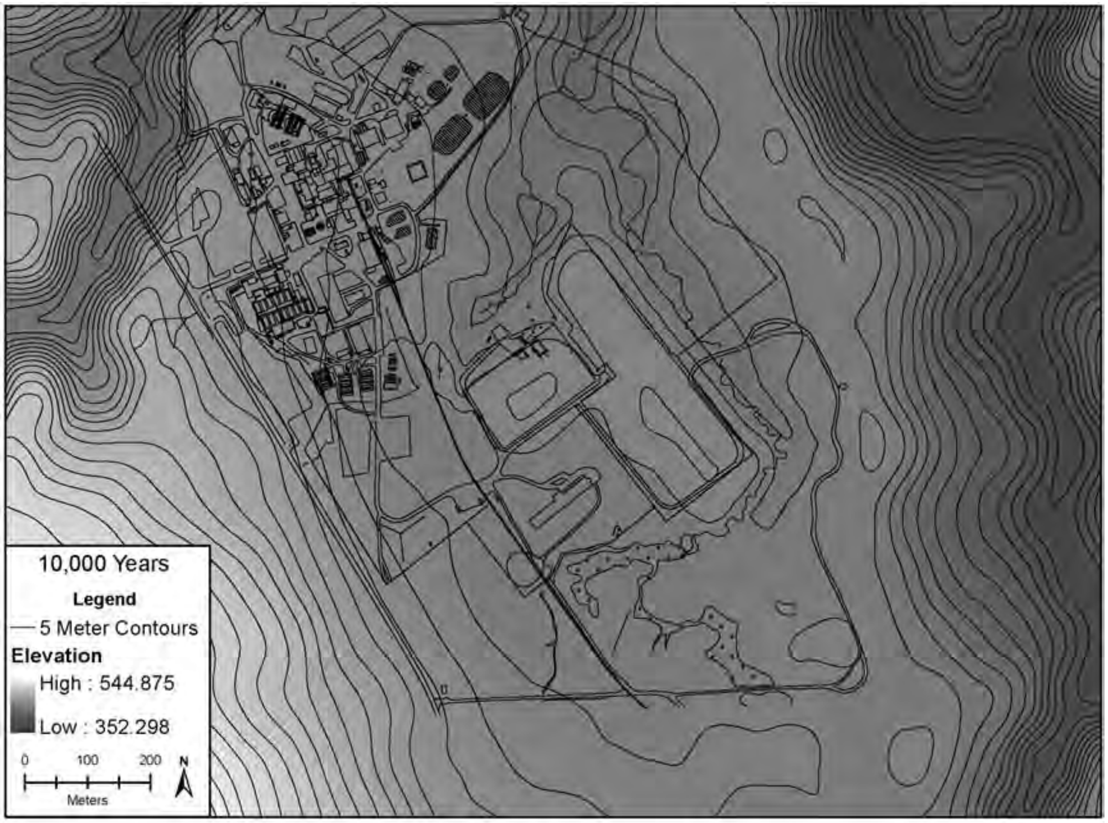


Figure F–33 Results of CHILD NPTwet Sitewide Close-In-Place Case

F.3.1.6.9 Results: Sitewide Close-In-Place Scenario, South Plateau

South Plateau erosion depths tend to be slightly higher under the sitewide close-in-place scenario, simply because the burial mounds add relief to the landscape. The SPTstd run (**Figure F–34**) shows erosion of less than half a meter around the edges of the two mounds, while the NDA gully undergoes aggradation as a result from sediment derived from the mounds. Upper Franks Creek remains essentially stable in this scenario. The pattern is similar but with reduced magnitudes in SPTa1 (**Figure F–35**). Hillslope erosion in SPTa2 (**Figure F–36**) is similar to SPTstd and SPTa1, while net valley incision occurs around the Erdman Brook–Franks Creek confluence depths on the order of 5 meters (16.40 feet), locally up to approximately 13 meters (42.65 feet). Net valley incision extends about halfway up the east flank of the SDA. Scenarios SPTa3 (**Figure F–37**) and SPTa4 (**Figure F–38**) show slightly higher levels of erosion around the mound rims, but overall erosion depths remain low (less than 1 meter [3.28 feet]).

The SPTwet scenario (**Figure F–39**) shows incision along upper Franks Creek in a pattern similar to SPwet, but the burial mounds remain quite stable. The SPTwc (Wet + Fast Creep) scenario (**Figure F–40**), by contrast, shows erosion depths of up to 4 meters (13.12 feet) at the north end of the SDA. The NDA gully undergoes aggradation.



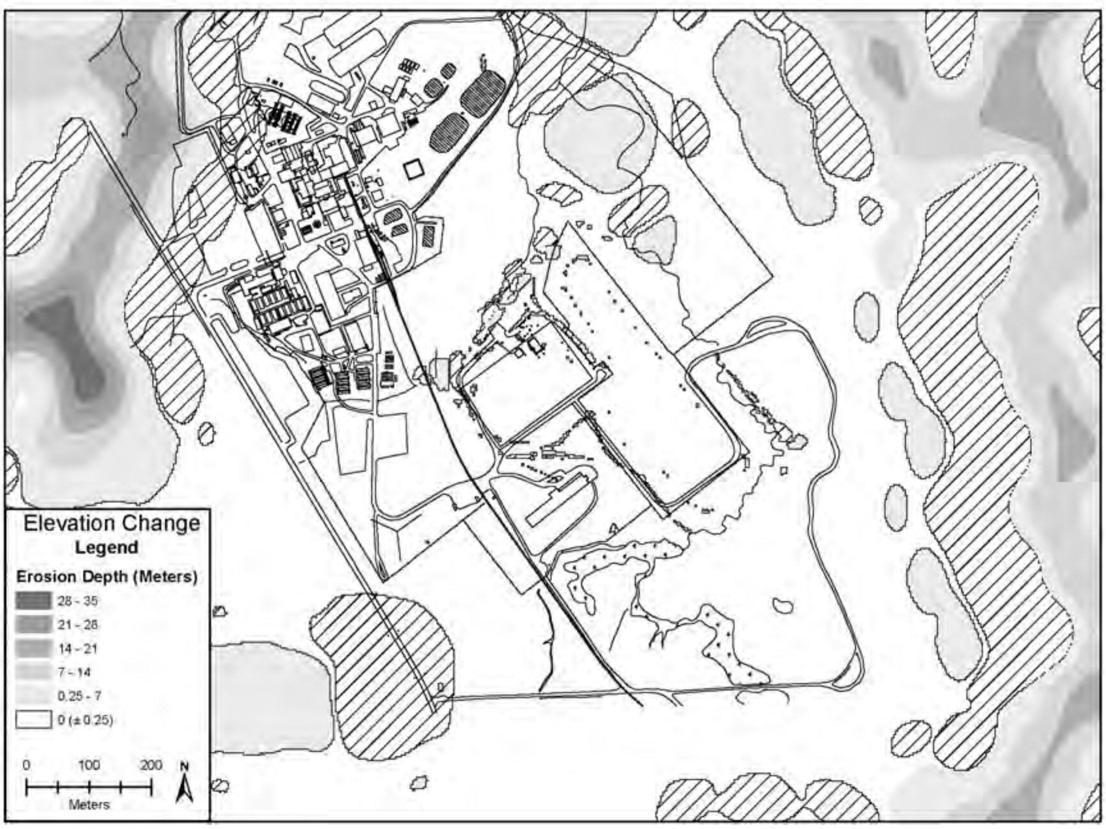


Figure F–34 Results of CHILD South Plateau Tumulus Standard (SPTstd) Sitewide Close-In-Place Case

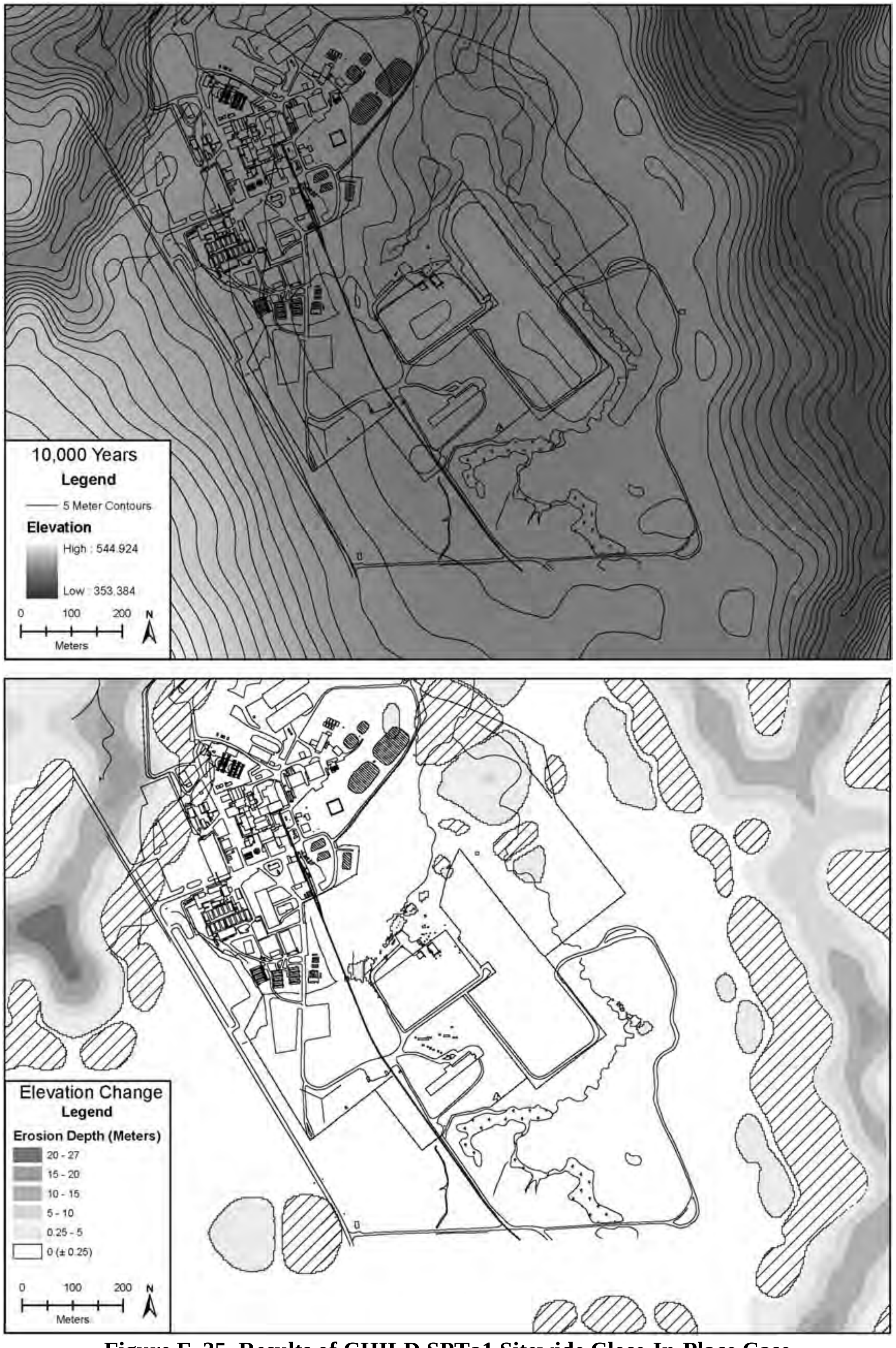


Figure F–35 Results of CHILD SPTa1 Sitewide Close-In-Place Case

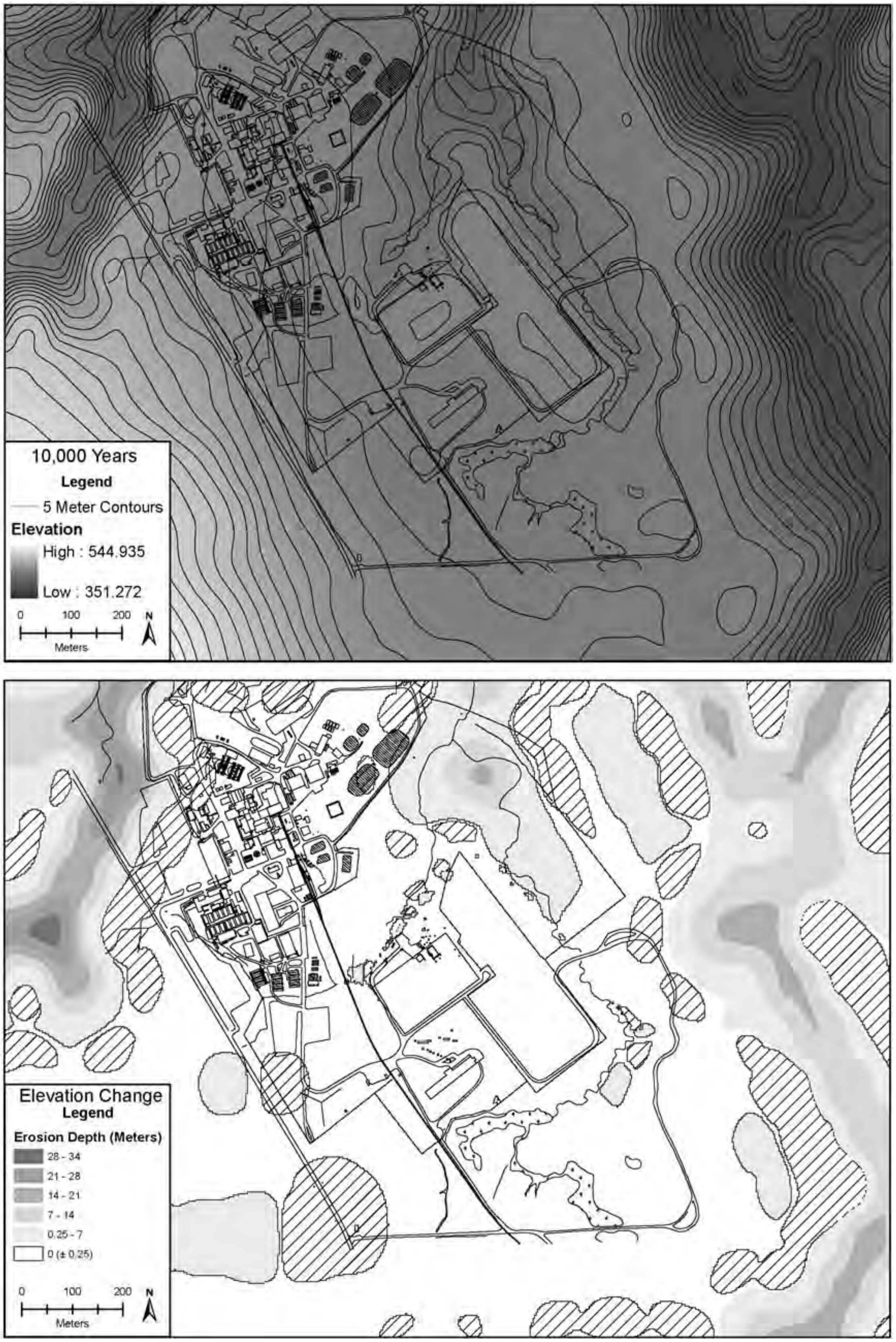


Figure F–36 Results of CHILD SPTa2 Sitewide Close-In-Place Case

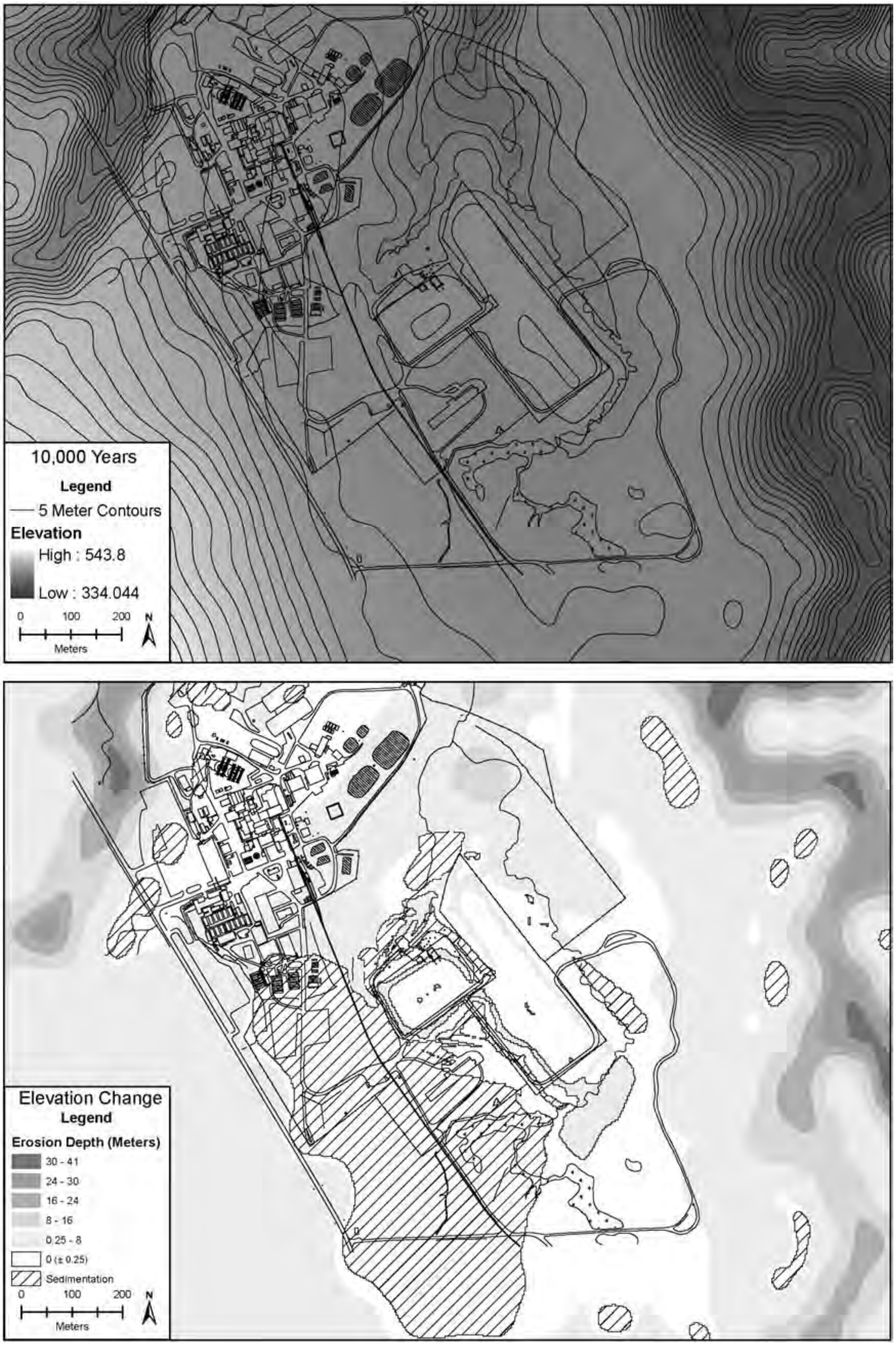


Figure F–37 Results of CHILD SPTa3 Sitewide Close-In-Place Case

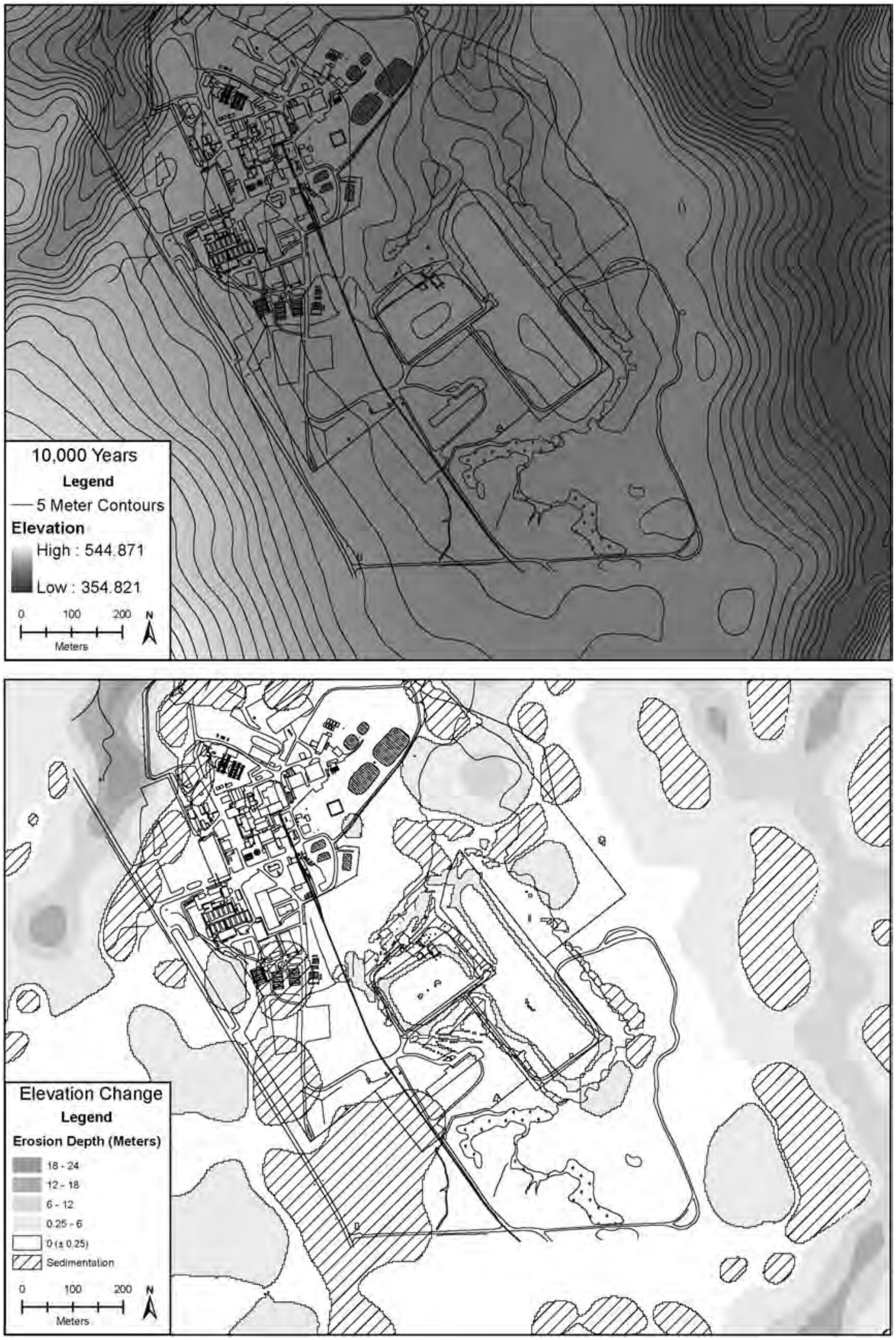


Figure F–38 Results of CHILD SPTa4 Sitewide Close-In-Place Case

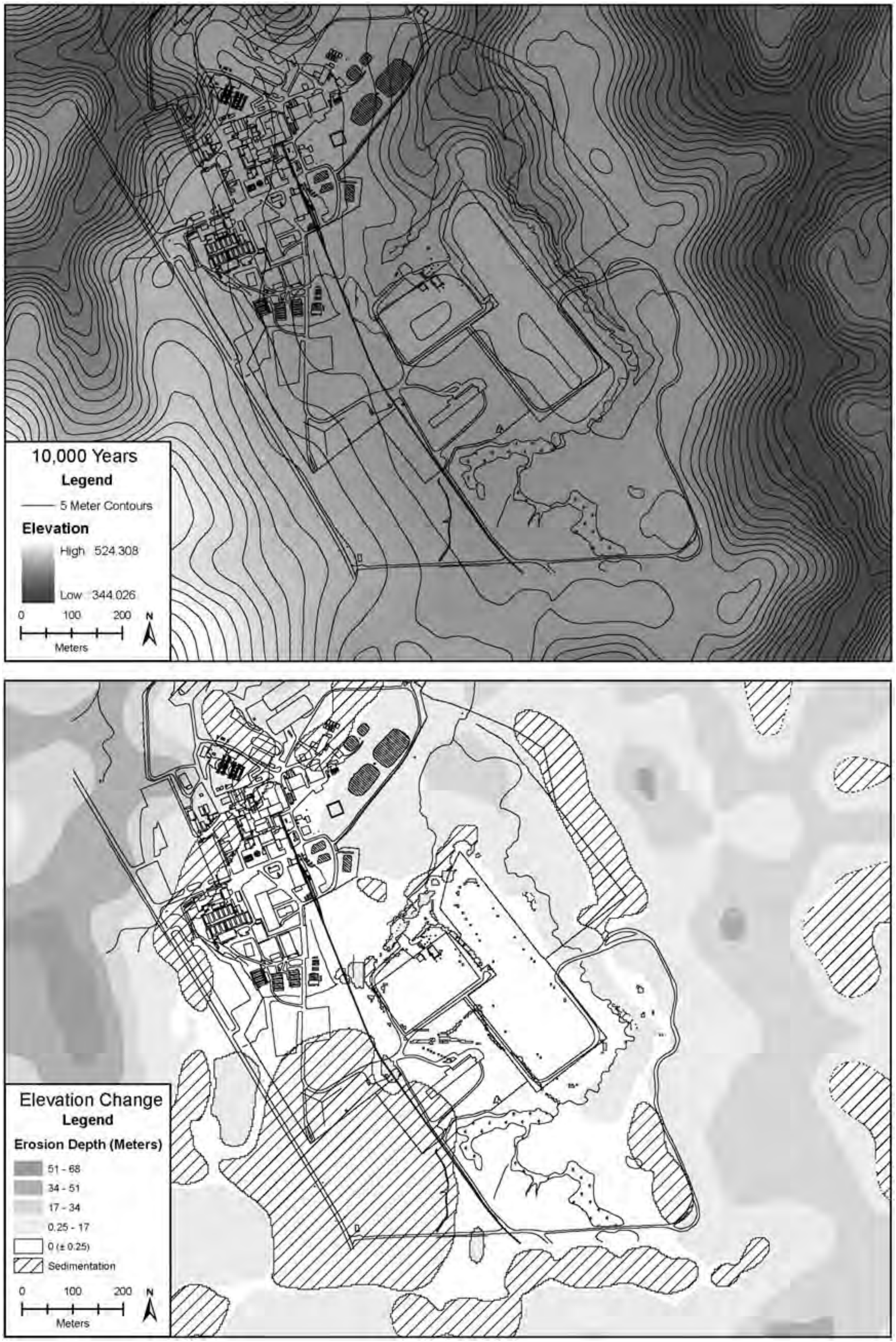


Figure F–39 Results of CHILD SPTwet Sitewide Close-In-Place Case

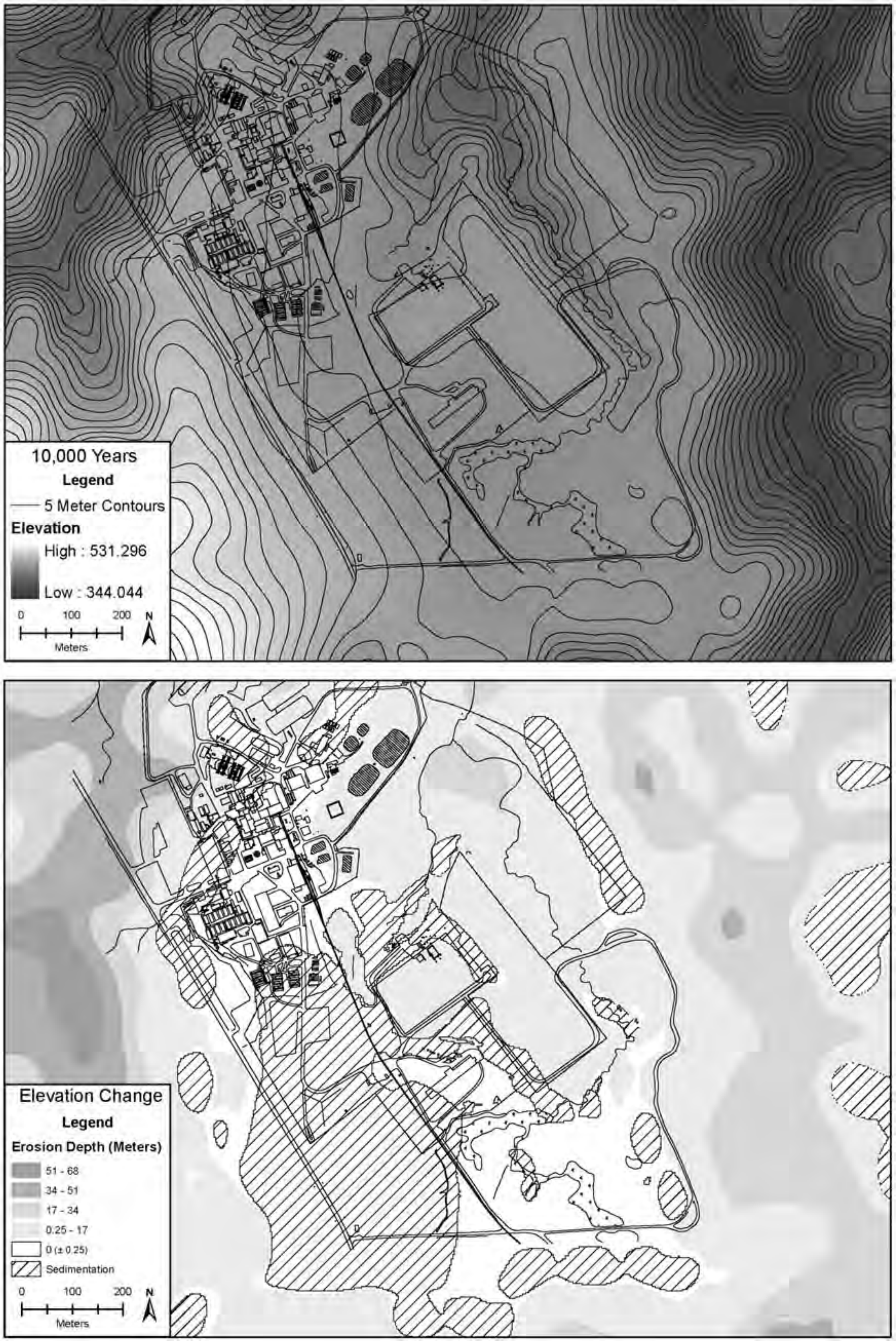


Figure F–40 Results of CHILD SPTwet + Fast Creep Sitewide Close-In-Place Case

F.3.1.6.10 Comparison with Present-Day Features and Processes

The simulations replicate many of the erosional processes and patterns observed in the present-day landscape. All simulations show some degree of gully growth around the North Plateau. The results therefore support the view that the propagation of gullies from the plateau rims represents a potential erosional threat to the site. Rates of modeled gully propagation appear to be consistent with onsite observations. During the first 100 simulation years, typical propagation rates for the largest or fastest simulated gullies are on the order of tens of centimeters per year (averaged over 100 years). This agrees with documented modern gully growth rates discussed in Section F.2.3.3. The simulations are also consistent with observed erosion along rim edges by mass movement processes driven by stream incision. The simulated rapid incision along Quarry Creek is also consistent with present-day behavior. For middle Quarry Creek, the incision rates in the area mapped as till in the model may be considered maxima, because the model does not account for the exposure of bedrock along the middle portion of Quarry Creek. The model is also consistent in predicting significant incision along the reach of Franks Creek between the junctions with Quarry Creek and Erdman Brook.

The biggest discrepancy between the model calculations and observations of present-day erosional activities concerns stream incision in the area around and upstream of the confluence of Erdman Brook and Franks Creek. Onsite observations and previous geomorphic studies (WVNS 1993a) indicate that the reach of Franks Creek between the Quarry Creek confluence and the security fence (just below the Erdman Brook–Franks Creek junction) is actively incising. Above the Erdman Brook confluence, a knickpoint divides an actively incising reach from a flat, marshy stretch with a U-shaped profile. Thus, to be consistent with present-day morphology, a simulation should produce net incision along the reach of Franks Creek downstream of the knickpoint east of the SDA. Model calculations in the A2 scenario are consistent with this pattern, showing a transition from net incision near and above the Franks Creek–Erdman Brook confluence to a generally stable profile upstream. Scenario A3 is similar to A2 in this regard. The Wet scenario predicts the greatest depth and extent and incision in the Franks Creek–Erdman Brook confluence area, with net incision depths along the northeast and northwest sides of the SDA/NDA on the order of 10 to 20 meters (32.81 to 65.62 feet) and locally reaching approximately 25 meters (82.02 feet). Other scenarios, however, show stability of the valley network in the Franks Creek–Erdman Brook confluence area, with some reaches undergoing net deposition and others net incision, all generally less than 10 meters (32.81 feet). Thus, scenarios A2, A3, and Wet are the most consistent with present-day stream incision/deposition patterns.

F.3.1.6.11 Discussion of Forward Modeling Results

There are three general categories of potential outcome that might arise from a study like this. First, one might find that under virtually all sets of scenarios and assumptions, the burial areas are prone to rapid erosional exhumation. Alternatively, one might find that nearly all scenarios point toward long-term future stability against erosion. Finally, one might obtain a more ambiguous result in which some scenarios show a significant erosional threat, and others do not. The results from this study contain elements of both the second and third outcomes. None of the scenarios showed large-scale erosional exhumation of the Main Plant Process Building, NDA, or SDA. However, the Wet scenario and its variations suggest a potential for exposure under certain conditions.

Under the No Action Alternative for the South Plateau, simulations of the Wet scenario show formation of a north-trending gully, approximately 200 meters (656.17 feet) long and up to 6.8-meters (22.31-feet) deep, along the margin between the SDA and NDA. This feature also appears under the “Wet + Fast Creep” scenario; in this case, it is shallower thanks to accelerated sediment contributions from the side slopes. This South Plateau gully disappears under the Sitewide Close-In-Place Alternative because (1) its source of water (i.e., catchment area) is reduced as runoff is diverted southward by the burial mounds, and (2) the NDA–SDA boundary strip receives considerable sediment input from the mounds. This calculation should be analyzed with some caution, however, because it assumes that the mound material is equivalent to typical soil in terms of susceptibility to slope transport. With mound material that is more resistant to erosion and transport, as intended, one would expect less infilling, and possibly net incision, along the NDA–SDA boundary in the sitewide close-in-place scenario.

Apart from gully incision along the NDA–SDA boundary, all scenarios produced relatively little erosion on the South Plateau. The relative lack of computed erosion on the South Plateau may seem surprising, but it appears to be a robust outcome of the modeling. The absence of significant gully erosion along the SDA rim in the simulations, even under the Wet scenario, reflects the restricted surface drainage area available to feed gullies. All of the scenarios, to varying degrees, point toward continued incision of the North Plateau by gullies growing inward from the rim. Not surprisingly, the most extreme gully incision occurs under the Wet sitewide close-in-place scenario. In this scenario, the North Plateau is heavily dissected by several very large gullies extending from the north and west (Figure F–30). While none of these breach the proposed containment mound over the Main Plant Process Building, two of them come close: the tip of the western gully approaches within about 80 meters (262.46 feet) of the high-level radioactive waste tanks, while the tip of the northern gully comes within about 120 meters (393.70 feet).

How realistic is the Wet scenario? Its likelihood as a future-climate scenario is very difficult to quantify, simply because a great deal of uncertainty surrounds future-climate projections (particularly concerning rainfall). Yet one can ask first how representative it may be of modern conditions. The fact that this scenario is consistent with observed erosion around the Franks Creek–Erdman Brook confluence (more so than some of the other cases) suggests that it may be a closer representation of onsite conditions than the unrealistically high rainfall intensity might suggest. One weakness of the model in general is that it treats all soils as hydrologically uniform. Thus, the estimates of effective infiltration capacity discussed previously essentially lump together soils from across the catchment. Evidence from runoff records (Table F–9) suggest that the effective runoff coefficient in the Franks Creek watershed may be higher than that for Buttermilk Creek as a whole, presumably due to a higher proportion of low-permeability, till-derived soils. For this reason, the low infiltration capacity used in the Wet scenario may be a better match for the Franks Creek drainage, particularly in the South Plateau area, than the higher values obtained in the calibration process (with the exception of A1, shown in Table F–11 as Run 321). Thus, while the Wet scenario may be unlikely, it should not be considered implausible.

Another important finding from the forward simulations is variability in the positions and rates of gully growth. Although the overall rates of simulated erosion are robust, the locations of particular gullies are highly sensitive to small variations in parameter values and initial topography. For example, some of the North Plateau scenarios show the NP-2 gully growing substantially, while in other cases the NP-1 gully is more active. These differences reflect variations in the small-scale drainage patterns across the plateau surface. They are consistent with previous studies of drainage-network simulation models, which indicate that the details of a drainage-network pattern forming on a low-relief surface are sensitive to small variations in topography (Ijjasz-Vasquez et al. 1992). This implies that gully positions should be seen as subject to uncertainty. The model simulations indicate which locations along the rim have a high potential to seed large gullies (clearly, the three existing NP gullies have this potential), but they cannot tell us which of these sites will actually develop into a major geomorphic feature.

Finally, the simulation results should be interpreted with caution, for at least two reasons. First, the use of the constant climate assumption in the calibration process adds an unknown degree of uncertainty to the forward projections. It is possible that the postglacial climate was, on average, less erosive than the present-day climate (involving, for example, less total rainfall, less-intense rainfall, or vegetation conditions that would tend to inhibit runoff). If this were the case, then the calibrated model would tend to underestimate erosion rates under the present climate. On the other hand, it is also possible that the past climate was effectively more erosive than the present climate (involving, for example, more-sparse vegetation cover and greater runoff rates in the early postglacial period). If this were true, then the calibrated model would tend to overestimate actual erosion rates. Second, uncertainty is introduced by the use of spatially homogeneous parameters, and in particular the soil infiltration capacity. Use of a homogeneous infiltration capacity means that the model may tend to underestimate runoff in relatively impermeable soils, such as those on the South Plateau, and overestimate runoff on relatively permeable areas, such as the upper headwaters of Franks and Quarry Creeks. These considerations form part of the rationale for introducing the Wet scenarios, which use quite a low value for infiltration capacity (as discussed in Section F.3.1.4.5). In effect, these scenarios can be seen as addressing not only the possibility of a future shift toward a more-erosive climate, but also the risk that the present climate/soil conditions at the site *are already* effectively more erosive (by a factor of more than two) than the calibrated model would suggest, because of possibly inaccurate assumptions in the calibration. In particular, while the Standard and Alternate scenarios are considered to be the most likely projections, the Wet scenario is considered a plausible representation of *either* an erosive future-climate state *or* an effectively more-erosive present-day environment due to a potential climate drift over the late-glacial to Holocene period and/or a potential overestimation of soil permeability in the calibration procedure.

F.3.1.6.12 Potential for Stream Capture

Stream capture occurs when headward or lateral growth drives one stream to intersect another, higher elevation stream, whose flow is then diverted (captured) into the lower elevation stream. Because the bed of Franks Creek lies at a higher altitude than the adjacent Buttermilk Creek Valley, there is a potential for capture either by gullies growing along the western edge of the Buttermilk Creek Valley, or by lateral erosion on Buttermilk Creek. The altitude of Franks Creek at the eastern corner of the SDA is approximately 414 meters (1,358.27 feet). The altitude of the closest reach of Buttermilk Creek, about 400 meters (1,312.34 feet) to the east, ranges from 375 to 381 meters (1,230.31 to 1,250.00 feet). Thus, there is a height difference between the two drainages of up to 40 meters (131.23 feet). Given the distance, capture would require either westward extension of a gully 400 meters (1,312.34 feet) from the Buttermilk Creek Valley, or lateral erosion over that distance, or a combination of the two. The likelihood of capture is difficult to assess definitively with a model like CHILD because the forward simulations did not account for lateral channel erosion. Nonetheless, the model results shed some light on the feasibility of capture. The large gully in the NPTwet scenario is long enough that, were it to have grown from the Buttermilk Creek Valley in the right place, capture might have occurred. However, that particular feature grew as far as it did because it was able to capture a substantial fraction of the drainage area on the North Plateau early in its evolution. The available drainage area for gullies feeding the Buttermilk Creek Valley southeast of the site appears to be far smaller. There may be a potential threat from the unnamed drainage that crosses Rock Springs Road just south of the intersection with Thornwood Drive. Currently, that drainage is diverted southward by the rail embankment into a pond. If the drainage were diverted northward, there is the possibility that it could either join with and accelerate one of the east-draining gullies, or join upper Franks Creek and accelerate incision. However, neither diversion toward Franks Creek, nor capture of Franks Creek by Buttermilk Creek, was observed in any of the 25 forward model runs. Furthermore, there is no obvious evidence for similar capture events elsewhere along Buttermilk Creek Valley. It is concluded therefore, that while capture cannot be ruled out, it is unlikely to occur over the performance-critical period unless climate or other factors change significantly.

F.3.2 Verification of Landscape Evolution Modeling Results – Short-term Modeling Studies

This section presents available, relevant, short-term erosion predictions that were made before the current long-term erosion modeling effort was initiated. The models were used to predict individual erosion processes, such as channel downcutting and sheet and rill erosion. They are included in this section to provide perspective by which to judge the reasonableness of the CHILD landscape evolution modeling results.

F.3.2.1 Short-term Sheet and Rill Erosion Prediction

Four methods were used to predict the sheet and rill erosion rate at WNYNSC. First, the Universal Soil Loss Equation (USLE) was used to predict the average annual soil loss from individual subwatershed areas that collectively represent the Franks Creek, Erdman Brook, and Quarry Creek watershed (referred to as the "Franks Creek watershed"). Second, the SEDMOT [Sedimentology by Distributed Model Treatment] II model was run to account for soil loss that occurs during major storm events within the same subwatershed areas. Third, the CREAMS [Chemicals, Runoff, and Erosion from Agricultural Management Systems] model was used to predict the average annual sediment yield from a small portion of the South Plateau. And fourth, the WEPP model was run to predict the sediment yield that occurs during major storm events as well as the average annual sediment yield from the hillslopes within the Franks Creek watershed.

Universal Soil Loss Equation

The USLE is an empirically derived relationship developed to predict soil loss rates for agricultural conditions. The empirical equation is the product of six major factors that utilize the quantity of rainfall, length and average gradient of the slopes, type of soil, and type of soil cover (e.g., forest, grass, bare soil). It predicts soil loss caused by overland flow from the point of origin to a channel (Weltz et al. 1992) and does not simulate soil deposition or gully and channel erosion (Foster 1982).

The USLE equation is:

$$A = R \times K \times LS \times C \times P$$

where:

A is the potential long-term average annual soil loss in metric tons per hectare per year.

R is the rainfall and runoff factor by geographic location. The greater the intensity and duration of the rainstorm, the higher the erosion potential. The runoff factor takes into account the variation in land use conditions.

K is the soil erodibility factor. It is the average soil loss per unit area (in metric tons per hectare) for a particular soil in cultivated, continuous fallow with an arbitrarily selected slope length of 72.6 feet and a slope steepness of 9 percent. K is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. Texture is the principal factor affecting K, but structure, organic matter, and permeability also contribute.

LS is the slope length–gradient factor. The LS factor represents a ratio of soil loss under given conditions to soil loss at a site with the "standard" slope steepness of 9 percent and slope length of 72.6 feet. The steeper and longer the slope, the higher the risk for erosion.

C is the crop/vegetation and management factor. It is used to determine the relative effectiveness of soil and crop management systems in preventing soil loss. The C factor is a ratio of soil loss from land under a specific crop and management system to soil loss from continuously fallow and tilled land.

P is the support practice factor. It reflects the effects of practices that will reduce the amount and rate of water runoff and thus reduce the amount of erosion. The P factor represents the ratio of soil loss by a support practice to soil loss attributable to straight-row farming up and down the slope.

The USLE method was used to predict the rate of soil loss from the hillslopes within the entire Franks Creek watershed. As shown on **Figure F–41**, the Project Premises and the SDA are near the downgradient end of the 440-hectare (1,040-acre) watershed. The watershed was divided into the same 22 subwatershed areas defined in the hydrologic modeling studies conducted by Dames and Moore (WVNS 1993c) to provide consistency in the analyses. Precipitation data were obtained from the site meteorological tower for the 1-year period of March 1, 1990, through February 28, 1991 (WVNS 1993a). Soil erodibility values were based on standard U.S. Department of Agriculture grain-size classifications of each soil unit, as defined in site-specific studies (WVNS 1993a). Vegetation cover values were based on a vegetation survey of the area (WVNS 1993d). Input values for cover management factors were obtained from source document tables (Wischmeier and Smith 1978). **Table F–13** summarizes input parameters used in the USLE for each of the 22 subwatershed areas and the results.

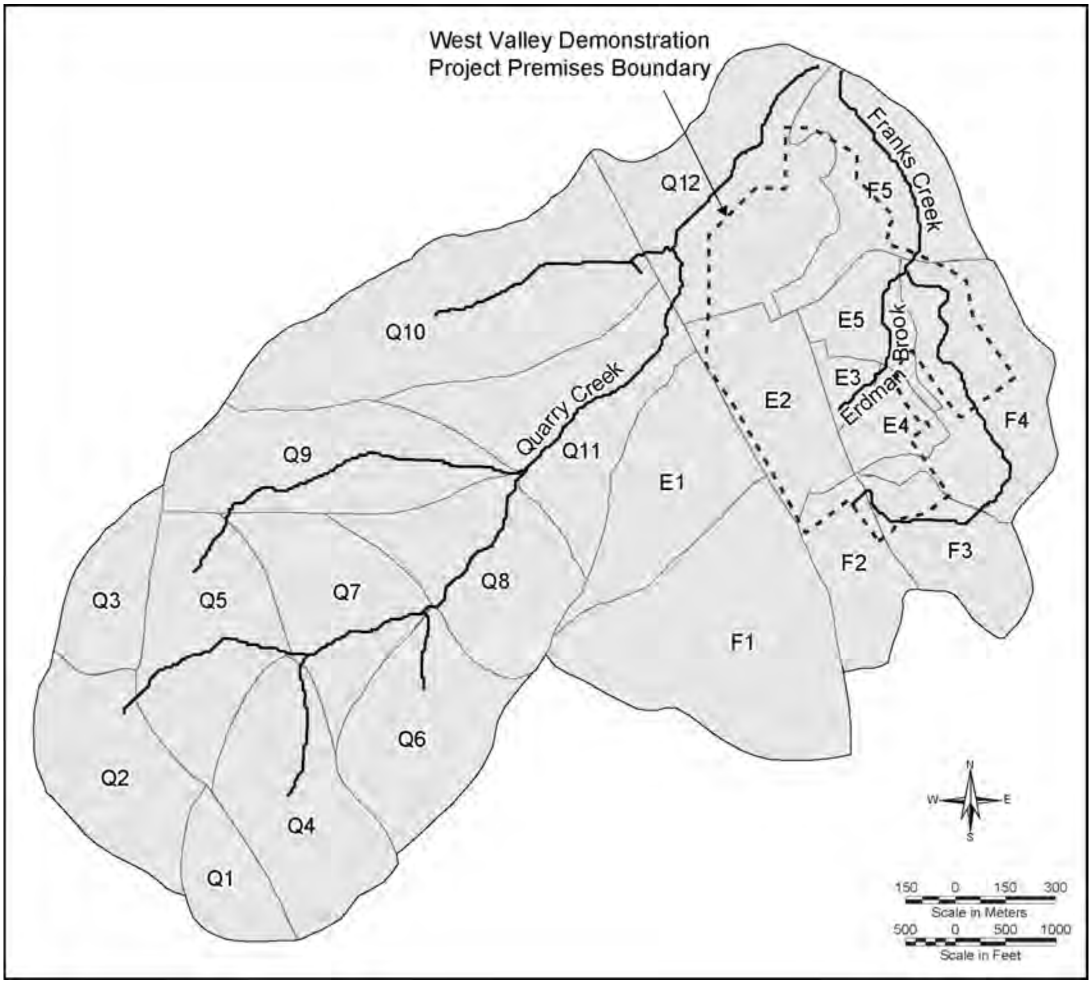


Figure F–41 USLE and SEDIMOT II Modeling Studies Subwatershed Areas

The results indicate that small quantities of soil are being removed from the hillslopes by the sheet and rill erosion process. The correlation indicates that the areas with the greatest soil loss were within the Quarry Creek drainage basin west and northwest of the Project Premises and within the Erdman Brook–Franks Creek drainage basin west and east of the Project Premises. The average soil loss for the watershed was estimated to be 0.19 metric tons per hectare (0.085 tons per acre) per year. This soil loss rate is equivalent to an average decrease in elevation of 12.8 millimeters (0.04 feet) per 1,000 years. These USLE estimates are based on only

1 year of site-specific precipitation data. USLE estimates are more accurate when applied over a period of at least 30 years, which dampens effects of isolated and unpredictable short-term fluctuations.

Table F–13 USLE Input Parameters and Results

Sub-area	*Area (hectares)*	*R (MJ × millimeters per hectare × hour × year)*	*LS*	*K (metric tons × hectares × hour / hectare × MJ × millimeter)*	*Soil Erodi-bility Factor Distr. Percent*	*C*	*P*	*Soil Loss (metric tons per hectare per year)*	*Soil Loss (metric tons per year)*
Q1	10.26	2067.33	3.2	0.0026	100	0.003	0.6	0.03	0.32
Q2	20.63	2067.33	4.3	0.0026	100	0.003	0.6	0.04	0.86
Q3	10.30	2067.33	1.8	0.0026	100	0.003	0.5	0.02	0.15
Q4	26.24	2067.33	11.0	0.0026	100	0.003	0.8	0.14	3.77
Q5	23.01	2067.33	5.0	0.0026	100	0.003	0.6	0.05	1.12
Q6	20.63	2067.33	9.1	0.0026	100	0.003	0.75	0.11	2.30
Q7	17.82	2067.33	5.8	0.0026	100	0.003	0.7	0.07	1.18
Q8	24.30	2067.33	19.2	0.0026	100	0.003	1.0	0.31	7.62
Q9	32.65	2067.33	23.4	0.0026	100	0.003	1.0	0.38	12.48
Q10	45.79	2067.33	16.9	0.0026 0.0020	90 10	0.003 0.003	0.8 0.8	0.20 0.02	9.14 0.76
Q11	26.35	2067.33	27.0	0.0026 0.0020	80 20	0.003 0.003	1.0 1.0	0.35 0.07	9.28 1.74
Q12	34.49	2067.33	3.6	0.0026 0.0020	60 40	0.003 0.003	0.55 0.55	0.02 0.01	0.66 0.34
E1	21.24	2067.33	22.5	0.0026	100	0.003	1.0	0.36	7.81
E2	12.13	2067.33	6.8	0.0026 0.0020	50 50	0.003 0.003	0.8 0.8	0.04 0.03	0.54 0.41
E3	2.99	2067.33	6.4	0.0026 0.0020	70 30	0.003 0.003	0.85 0.85	0.05 0.03	0.14 0.08
E4	6.41	2067.33	1.9	0.0026	100	0.003	0.55	0.02	0.11
E5	9.32	2067.33	1.9	0.0026 0.0020	60 40	0.003 0.003	0.55 0.55	0.01 0.01	0.07 0.06
F1	42.51	2067.33	15.1	0.0026	100	0.003	1.0	0.25	10.49
F2	12.24	2067.33	4.3	0.0026	100	0.003	0.7	0.05	0.60
F3	13.03	2067.33	1.9	0.0026	100	0.003	0.55	0.02	0.23
F4	27.58	2067.33	1.5	0.0026 0.0026	80 20	0.04 0.003	0.55 0.55	0.14 0.001	3.96 11.15
F5	23.47	2067.33	10.9	0.0026 0.0020	50 50	0.14 0	0.17 0.17	0.53 0.00	10.24 0.00

USLE = Universal Soil Loss Equation, R = rainfall and runoff factor, LS = slope length–gradient factor, C = crop/vegetation and management factor, P = support practice factor, MJ = megajoules.
Note: To convert millimeters to inches, multiply by 0.039; hectares to acres, multiply by 2.471; MJ to foot pounds, multiply by 737,562.18; metric tons to tons, multiply by 1.1.

Sedimentology by Distributed Model Treatment (SEDIMOT II)

The quantity of sheet and rill erosion during major storm events was estimated using the SEDIMOT II surface erosion model (WVNS 1993a), which simulates rainfall intensity and depth over a given time period, the resulting in surface-water runoff volume, and soil volume washed from the ground surface.

For WNYNSC, four 24-hour design storms were modeled: 2-, 10-, and 100-year, and the probable maximum precipitation event, which is the maximum rainfall that could conceivably occur. The hillslopes were modeled within the entire Franks Creek watershed. The watershed was divided into the same 22 subwatershed areas defined in the USLE hydrologic modeling study to provide consistency in the analyses. The rainfall amount anticipated from each of the design storm events was taken from standardized maps developed by the Soil Conservation Service (USDA 1986) using a Type II Soil Conservation Service storm designation and rainfall depths of 6.35 centimeters (2.5 inches) for the 2-year storm, 9.4 centimeters (3.7 inches) for the 10-year storm, 13.2 centimeters (5.2 inches) for the 100-year storm, and 63.2 centimeters (24.9 inches) for the probable maximum precipitation event. Hydrologic parameters for each of the subwatershed areas shown in **Table F–14** (WVNS 1993c). Soil properties for each of the subwatershed areas were based on the geotechnical evaluation of samples from the Lavery till, Kent till, and North Plateau surficial sand and gravel unit. The particle-size distribution used for each of these soil units is also shown in Table F–14 (WVNS 1996). The soil's cover condition within each subwatershed area was specified by a general land use condition designation of forest, agricultural, or disturbed.

Table F–14 SEDIMOT II Hydrologic and Soil Input Parameters

Hydrologic Parameters				*Soil Parameters – Particle-Size Distributions*				*Sediment Yield Results*			
Sub-area	*Area (hectares)*	*SCS Runoff Curve Number*	*Time of Concen-tration (hours)*	*Particle Size (mm)*	*Kent Till (%)*	*Surficial Sand and Gravel (%)*	*Lavery Till (%)*	*2-Year Storm Event (metric tons per hectare)*	*10-Year Storm Event (metric tons per hectare)*	*100-Year Storm Event (metric tons per hectare)*	*PMP Storm Event (metric tons per hectare)*
Q1	10.24	76	0.41	19	98	88	82	0.29	0.83	1.79	31.55
Q2	20.96	76	0.59	6.4	94	73	69	0.07	0.21	0.47	8.96
Q3	10.20	74	0.21	4.8	93	67	67	0.06	0.17	0.37	7.14
Q4	25.70	73	0.41	1.9	92	54	62	0.13	0.38	0.86	16.80
Q5	23.15	74	0.56	0.82	91	50	58	0.08	0.22	0.50	9.70
Q6	21.25	73	0.41	0.42	89	47	56	0.13	0.39	0.89	17.66
Q7	17.64	71	0.58	0.15	87	43	53	0.03	0.10	0.24	5.04
Q8	25.01	71	0.51	0.075	83	42	51	0.17	0.56	1.32	27.21
Q9	33.63	70	0.54	0.03	52	32	46	0.11	0.35	0.82	18.09
Q10	46.70	68	0.50	0.02	36	27	43	0.12	0.41	1.02	23.25
Q11	27.15	72	0.52	0.011	28	21	37	0.13	0.41	0.95	19.04
Q12	33.75	77	0.49	0.006	18	14	32	0.12	0.33	0.70	11.48
E1	20.88	72	0.40	0.003	11	9	24	0.08	0.25	0.58	11.89
E2	12.10	95	0.35	0.001	1	5	14	0.09	0.17	0.30	3.46
E3	2.79	80	0.34					0.13	0.34	0.71	12.66
E4	6.39	81	0.20					0.09	0.21	0.43	7.07
E5	11.90	81	0.42					0.17	0.38	0.72	9.79
F1	43.83	67	0.37					0.07	0.24	0.60	14.24
F2	12.18	77	0.48					0.03	0.09	0.20	3.85
F3	13.23	79	0.26					0.03	0.07	0.14	2.80
F4	27.96	70	0.76					1.84	3.77	6.60	92.06
F5	23.43	67	0.52					0.07	0.19	0.41	7.67

% = percent; mm = millimeters, PMP = probable maximum precipitation, SCS = Soil Conservation Service, SEDIMOT = Sedimentology by Distributed Model Treatment.
Note: To convert hectares to acres, multiply by 2.471; metric tons to tons, multiply by 1.1; millimeters to inches, multiply by 0.039.

To predict the average annual soil loss rate, it was assumed that 500 2-year storms, 100 10-year storms, 10 100-year storms, and one probable maximum precipitation event occurred over a 1,000-year period. Thus, the average soil loss for the watershed was estimated to be 0.16 metric tons per hectare (0.07 tons per acre) per year. This soil loss rate is equivalent to an average decrease in elevation of 11 millimeters (0.04 feet) per 1,000 years. The SEDIMOT II simulation results are consistent with the USLE analysis results. As in the USLE calculations, the predicted soil erosion rate was greatest in an area of the Franks Creek–Erdman Brook basin with disturbed or insufficient ground cover. The major determinant of the erosion rate was the large number of high-frequency storms (i.e., 2- and 10-year events), not the few low-frequency storms (i.e., 100-year and probable maximum precipitation events). This conclusion is consistent with other research findings reported in the literature (Wolman and Miller 1960).

Chemicals, Runoff, and Erosion from Agricultural Management Systems (CREAMS)

The CREAMS model was used to estimate erosion rates for a portion of the South Plateau over a 1-year period (Dames and Moore 1987). The purpose of the study was to evaluate the utility of the CREAMS model in predicting surface soil–water balances and erosion rates; therefore, only a small 2-hectare (5-acre) test area was used for the simulations instead of the entire Franks Creek watershed, as shown on **Figure F–42**. Unlike USLE and SEDIMOT II, CREAMS is a physically based, distributed-parameter, continuous-simulation erosion model capable of predicting sediment yield on a field-size area. The South Plateau portion selected for the study was a gently sloping open field covered with low-to-medium grasses.

Major input parameters used in the model are shown in **Table F–15**. The simulations involved the use of daily rainfall data for a single year as recorded at the West Valley Nuclear Services (WVNS) weather station in 1984. Soil properties for the weathered till were obtained from a New York State Geological Survey study conducted at WNYNSC (Hoffman et al. 1980). When site-specific data were not available, input parameter values were estimated from the data provided in the appendices of the Soil Conservation Service model manual (USDA 1984) for conditions similar to those at the site.

The CREAMS simulations produced an estimate of sediment yield for the study area that is greater than the soil loss estimates predicted by the USLE and SEDIMOT II models. According to those simulations, the average sediment yield for the watershed is 10.3 metric tons per hectare (4.6 tons per acre) per year. This rate is equivalent to an average decrease in elevation of 690 millimeters (2.3 feet) per 1,000 years. It should be noted that the CREAMS study is extremely limited in terms of areal extent and range of precipitation conditions. The small area used in the simulations has less protective ground cover and a more-limited range of slope conditions than the balance of WNYNSC, and thus is not considered representative of the watershed as a whole. Also, the 1-year simulation period is too short a time to account for long-term fluctuations in precipitation, and thus cannot be used reliably for long-term projections.

Water Erosion Prediction Project

The WEPP model was used to predict sediment yield based on consideration of the physical processes affecting the watershed for a set of seven storms with return periods ranging from 1 to 100 years. Like CREAMS, WEPP is a physically based, distributed-parameter, continuous-simulation erosion model capable of predicting sediment yield. Unlike CREAMS, WEPP can predict sediment yield on a small-watershed scale; it is not restricted to a field-size area.

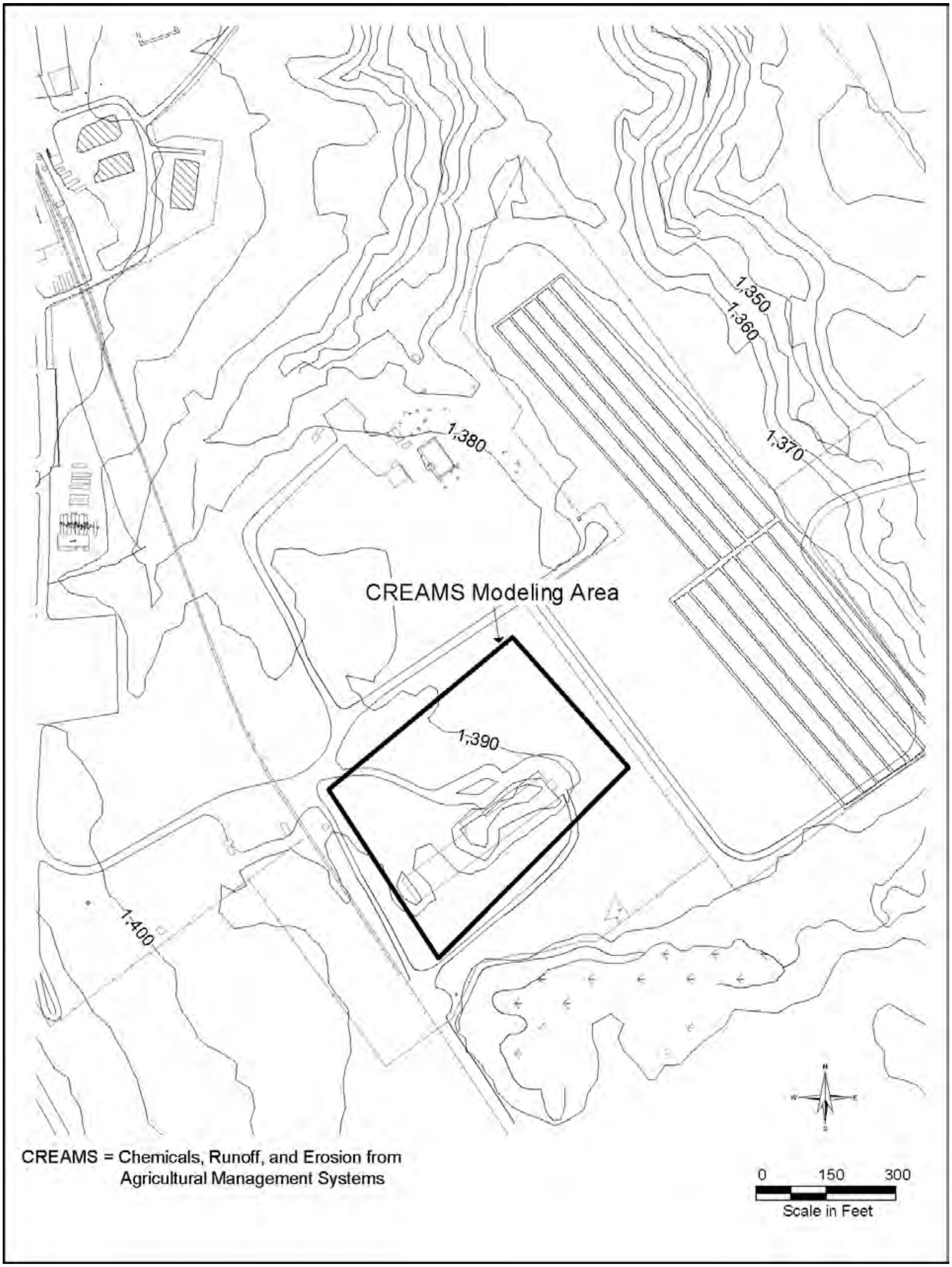


Figure F–42 Location of CREAMS Study Area

Table F–15 CREAMS Model Input Parameters and Results

Input Parameter Names	***Input Parameter Values***
Field Area Acreage	2.2 hectares
Slope of Field	0.02
Length of Field	152 meters
Annual Precipitation (1984)	113.8 centimeters
Soil Type/Hydrologic Soil Group	Silty clay/Hydrologic Soil Group D
Effective Hydraulic Conductivity	0.01 centimeters per year
Soil Conservation Service Curve Number	84
Soil Erodibility Factor	6.0
Soil Loss Ratio	0.26
Mannings ‘*n*’ value for overland flow	0.046
Output Parameter Names	***Output Parameter Values***
Total Evapotranspiration	36.60 centimeters
Percolation	11.49 centimeters
Predicted Runoff	65.81 centimeters
Annual Soil Loss for Area	10.3 metric tons per hectares

CREAMS = Chemicals, Runoff, and Erosion from Agricultural Management Systems, Mannings ‘*n*’ value = roughness coefficient that indicates the resistance to flow of the land surface, Soil Conservation Service Curve Number = a value that describes a catchment’s runoff production behavior.
Note: To convert centimeters to inches, multiply by 0.393; hectares to acres, multiply by 2.471; metric tons to tons, multiply by 1.1.

In this study, the Quarry Creek and Franks Creek watersheds were modeled separately. As shown on **Figure F–43**, a network of 11 channel sections and 28 hillslope areas within the Quarry Creek watershed and 3 channels and 8 hillslope areas within the Franks Creek watershed were used to characterize the same study area as in the USLE and SEDIMOT II simulations. However, the subdrainage areas were defined in a slightly different manner than in those two simulations, because their size was dependent on the geometry of the branched-stream network in accordance with WEPP program constraints (USDA 1995). The subdrainage basin boundaries were delineated using the GeoWEPP ArcX 2004.3 version of the software package. Unlike the USLE and SEDIMOT II simulations, which modeled soil loss from individual hillslopes within the watershed assuming a constant gradient, this study modeled the soil movement down the hillslopes taking into account the variations in the slope gradients. This more-comprehensive modeling approach simulates both erosion and depositional processes on the hillslopes because it also takes into account the soil being deposited in the flatter slope areas and within depressions following initial movement.

Data were entered into the model to describe the climate, topography, soil properties, and cover conditions within the watersheds. WEPP used 24-hour design storms with return intervals of 1, 2, 5, 10, 50, and 100 years to determine single-storm event sediment yield rates. The rainfall amount anticipated from each of the design storms events was taken from standardized maps developed by the Soil Conservation Service (USDA 1986) using a Type II Soil Conservation Service storm designation and rainfall depths of 5.3 centimeters (2.1 inches) for the 1-year storm, 6.4 centimeters (2.5 inches) for the 2-year storm, 8.1 centimeters (3.2 inches) for the 5-year storm, 9.4 centimeters (3.7 inches) for the 10-year storm, 11.2 centimeters (4.4 inches) for the 25-year storm, 11.9 centimeters (4.7 inches) for the 50-year storm, and 13.2 centimeters (5.2 inches) for the 100-year storm. To determine average annual sediment yield rates, WEPP’s climate simulator (CLIGEN) was used to stochastically project changes in the climatic conditions daily over a 100-year period based on records supplied from the Little Valley, New York, weather station (USDA 1995). Topographic profiles were entered for each hillslope area based on a high-resolution topographic map of the Project Premises as compiled by Erdman Anthony Consultants and

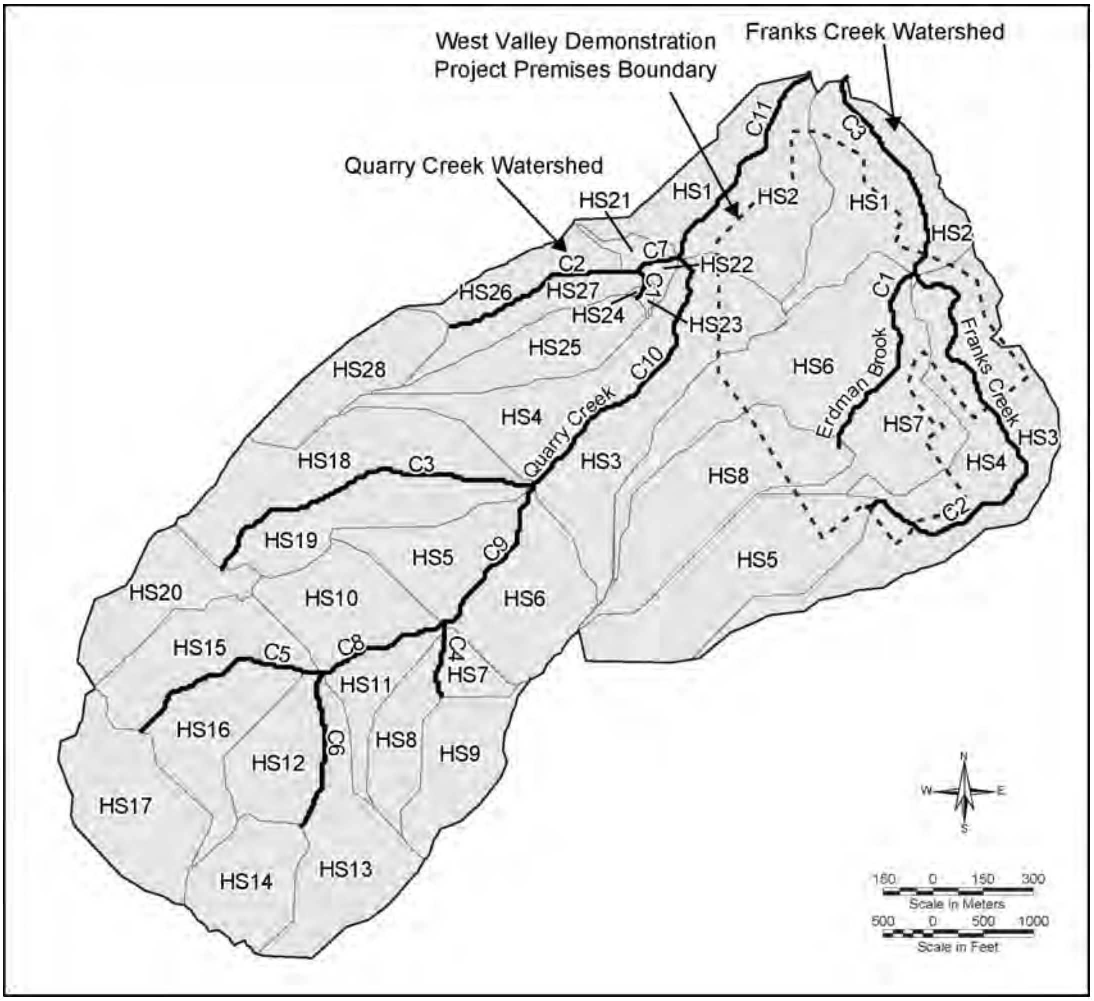


Figure F–43 Water Erosion Prediction Project Modeling Study Channel Network and Hillslope Areas

the 1:24,000 Ashford Hollow Quadrangle map compiled by the USGS. The soil unit distribution within the watershed area was determined from the Soil Conservation Service soil survey for Cattaraugus County (USDA 2006). Other soil parameters were established through review of site conditions and published values for similar conditions (Meyer and Gee 1999), as shown in **Table F–16**. Two cover conditions, 50-year-old forest and Old Field Recessional, were specified within the watershed area based on the site-specific vegetation survey (WVNS 1993a).

The WEPP simulation results are shown in **Table F–17**. The best-estimate value for the average annual sediment yield of the hillslope areas was determined to be 6.1 metric tons per hectare (2.7 tons per acre) per year from regression analysis of the single-storm events. This yield is equivalent to an average decrease in elevation of 408 millimeters (1.3 feet) per 1,000 years. During the 100-year storm event, the sediment yields of individual subwatershed areas vary from 0.0 to 4.9 metric tons per hectare (0.0 to 2.2 tons per acre), with an average value of 1.3 metric tons per hectare (0.60 tons per acre). This is equivalent to an average decrease in elevation of 91 millimeters (0.3 feet) per 1,000 years, indicating that, over a long-term period, the high frequency of smaller storm events has greater impact on erosion rates.

Table F–16 Water Erosion Prediction Project Model Soil Units and Properties

Site Location	*NRCS Soil Unit Number*	*NRCS Soil Unit Name*	*Soil Texture*	*Interrill Erodibility kg*s/mV*	*Rill Erodibility (seconds per meter)*	*Critical Shear (newtons per square meters)*	*Hydraulic Conductivity (millimeters per hour)*
North Plateau	81	Varysburg	Loamy sand	263762	0.00068	0.24	57.600
	135	Hudson	Clay	1083060	0.00206	3.292	0.154
	29	Chenango	Loamy sand	263762	0.00068	0.24	57.600
	32	Churchville	Clay	1083060	0.00206	3.292	0.154
	35	Rhinebeck	Clay	1083060	0.00206	3.292	0.154
South Plateau	32	Churchville	Clay	1083060	0.00206	3.292	0.154
	36	Canadice	Clay	1083060	0.00206	3.292	0.154
	75	Alden	Loam	945944	0.000788	2.508	3.427
	55	Darien	Clay loam	951524	0.001184	2.76	0.446
West hillslopes	51	Chadakoin	Loam	945944	0.000788	2.508	3.427
	55	Darien	Clay loam	951524	0.001184	2.76	0.446
	61	Schuyler	Loam	945944	0.000788	2.508	3.427
	80	Fremont	Loam	945944	0.000788	2.508	3.427
	56	Chautauqua	Loam	945944	0.000788	2.508	3.427
	63	Langford	Silt loam	928308	0.000704	2.62	1.094
	69	Erie	Loam	945944	0.000788	2.508	3.427
	72	Towerville	Loam	945944	0.000788	2.508	3.427
	78	Hornell	Clay	1083060	0.00206	3.292	0.154
	74	Ashville	Loam	945944	0.000788	2.508	3.427
	52	Valois	Loam	945944	0.000788	2.508	3.427
	76	Orpark	Loam	945944	0.000788	2.508	3.427

kg = kilograms; NRCS = ; s/mV = .
Note: To convert kilograms to pounds, multiply by 2.2; millimeters to inches, multiply by 0.03937; newtons to pound-force, multiply by 0.225; square meters to square feet, multiply by 10.764.
Sources: Soil Conservation Service Soil Survey for Cattaraugus County (USDA 2006) for soil unit and texture data and NUREG CR-6656 (Meyer and Gee 1999) for all other data.

Summary

A comparison of the USLE, SEDIMOT II, CREAMS, and WEPP short-term predictions is presented as **Table F–18**. The USLE and SEDIMOT II methods predict the lowest average annual soil loss rate from the hillslope areas, followed by WEPP and, lastly, CREAMS resulting in an erosion prediction range of 11 to 690 millimeters (0.04 to 2.3 feet) per 1,000 years. Although this range is relatively broad, these studies predict that the erosion from the hillslope areas will be relatively small compared to the dominant erosion processes (i.e., stream incision, gully migration, and soil creep/landsliding). This conclusion is in general agreement with the CHILD model's prediction of hillslope erosion. Typical local rates of modeled erosion on the low-gradient plateau surfaces in the CHILD scenarios range from approximately 10 to approximately 200 millimeters per 1,000 years, depending on the scenario. These simulations also predict areas of net deposition, depending on the microtopography, and are somewhat influenced by artifacts in the DEM. The Wet + Fast Creep scenario shows the highest rates of both erosion and deposition on plateau surfaces (typically 100-200 millimeters per 1,000 years), while the Standard, A1, and A2 scenarios show the lowest (typically 1 millimeter per 1,000 years). These rates are broadly consistent with short-term model estimates.

Table F–17 Water Erosion Prediction Project Modeling Hillslope Sediment Yield Results

Watersheds	Hillslopes	Area (hectares)	Storm Event (metric tons per hectare)						
			1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Franks Creek hillslopes	HS1	14.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	HS2	5.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	HS3	20.70	0.11	0.18	0.09	0.16	0.20	0.27	0.15
	HS4	11.80	0.04	0.09	0.16	0.20	0.27	0.34	0.19
	HS5	20.62	0.20	0.47	1.26	1.93	2.76	3.50	2.19
	HS6	23.12	0.07	0.11	0.22	0.31	0.43	0.54	0.28
	HS7	12.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	HS8	19.44	0.07	0.20	0.61	1.10	1.68	2.29	1.73
Quarry Creek hillslopes	HS1	9.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	HS2	14.49	0.04	0.09	0.13	0.20	0.25	0.31	0.36
	HS3	19.24	0.00	0.00	0.09	0.20	0.63	0.99	1.28
	HS4	14.96	0.09	0.11	0.20	0.04	0.02	0.04	0.09
	HS5	9.99	0.04	0.04	0.09	0.18	0.40	0.61	0.96
	HS6	13.67	0.81	1.32	2.17	2.82	3.43	3.90	4.91
	HS7	2.89	0.00	0.00	0.00	0.02	0.09	0.18	0.31
	HS8	7.07	0.00	0.00	0.00	0.00	0.00	0.00	0.07
	HS9	10.14	0.07	0.09	0.18	0.25	0.38	0.61	1.23
	HS10	11.79	0.09	0.29	0.85	1.32	1.91	2.31	3.18
	HS11	5.69	0.00	0.00	0.00	0.00	0.00	0.00	0.18
	HS12	9.52	0.04	0.04	0.11	0.27	0.56	0.83	1.30
	HS13	15.32	0.09	0.13	0.25	0.36	0.47	0.58	0.69
	HS14	10.40	0.04	0.11	0.27	0.40	0.58	0.74	1.08
	HS15	12.24	0.02	0.04	0.07	0.11	0.16	0.20	0.27
	HS16	11.58	0.07	0.11	0.20	0.29	0.38	0.47	0.58
	HS17	16.10	0.07	0.13	0.25	0.34	0.45	0.58	0.69
	HS18	18.78	0.07	0.11	0.18	0.25	0.34	0.45	0.54
	HS19	11.97	0.11	0.16	0.29	0.43	0.58	0.74	0.96
	HS20	10.44	0.04	0.07	0.13	0.20	0.25	0.31	0.43
	HS21	1.48	0.16	0.22	0.02	0.02	0.02	0.02	0.04
	HS22	0.83	0.00	0.00	0.02	0.04	0.11	0.13	0.18
	HS23	0.30	0.02	0.04	0.07	0.11	0.13	0.18	0.20
	HS24	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	HS25	10.38	0.09	0.13	0.25	0.13	0.52	1.12	2.04
	HS26	6.07	0.04	0.07	0.13	0.18	0.25	0.29	0.34
	HS27	5.90	0.04	0.07	0.11	0.02	0.00	0.00	0.02
	HS28	10.08	0.04	0.04	0.09	0.16	0.45	0.76	1.59

Note: To convert metric tons to tons, multiply by 1.1; hectares to acres, multiply by 2.471.

Table F–18 Short-term Modeling Soil Loss/Sediment Yield Results Comparison

Model Name	*Average Annual Soil Loss/Sediment Yield (metric tons per hectare per year)*	*Soil Loss/Sediment Yield During 100-Year Storm (metric tons per hectare)*	*Average Elevation Change (millimeters per 1,000 years)*
USLE	0.19	N/A	12.8
SEDIMOT II	0.16	1.1	11
CREAMS	10.3	N/A	690
WEPP	6.1	1.3	408

CREAMS = Chemicals, Runoff, and Erosion from Agricultural Management Systems, SEDIMOT = Sedimentology by Distributed Model Treatment, USLE = Universal Soil Loss Equation, WEPP = Water Erosion Prediction Project.
Note: To convert metric tons to tons, multiply by 1.1; hectares to acres, multiply by 2.471; millimeters to inches, multiply by 0.039.

F.3.2.2 Short-term Channel Downcutting and Valley Rim–Widening Prediction

An estimate of valley rim-widening was developed by modeling channel downcutting rates for individual storm events. The downcutting rates in both Franks Creek and Erdman Brook were estimated for six different storm events with return intervals of 2, 5, 10, 20, 100, and 500 years. The individual storm downcutting rates were predicted using the Hydrologic Engineering Center (HEC) HEC-6 code, a one-dimensional open-channel-flow numerical model designed to predict scour and/or deposition resulting from gradually changing sediment and hydraulic conditions over moderate time periods. Owing to its one-dimensional nature, HEC-6 is not capable of simulating the bank erosion or lateral-channel migration processes that are actively causing Franks Creek and Erdman Brook to widen and adjust their course. These processes slow the downcutting rate by adding large quantities of sediment that must also be removed from the streambed. In addition, the HEC-6 calculation assumes that no sediment enters at the head of the modeled reach. In a sense then, it represents what would happen if a sediment-retention dam were built just upstream of the modeled reach, leading to scour below. For these reasons, the model will overpredict the downcutting rate, which, will in turn, provide a conservative estimate of valley rim widening.

The model requires measurements of the stream cross-sectional geometry, flow rates, and elevations, as well as the selection of a sediment transport function. The stream cross sections, flow rates, and elevations for the current drainage system were taken from HEC-2 modeling runs performed by Dames and Moore (WVNS 1993c). Closely spaced cross sections (generally 30.5 to 46 meters [100 to 150 feet] apart) were used to approximate a steady, gradually varied flow condition despite stream irregularities. The *SAM Hydraulic Design Package for Channels*, developed by the Waterways Experiment Station (ACE 2002), identified the Laursen (Madden 1993) function as an appropriate sediment transport function based on site-specific measurements of the flow, sediment load, and geometry characteristics of Erdman Brook and Franks Creek (WVNS 1993c).

The calculated downcutting rate for the six reference storms is presented in **Table F–19**. These values represent the average downcutting that occurs along the stream profiles during the reference storms. The results show minimal change in downcutting for the storms with the higher frequency of occurrence, and there is little difference in the downcutting rates between Erdman Brook and Franks Creek. Table F–19 also shows the corresponding rim widening, which results from dividing the downcutting by the tangent of the 21-degree stable slope angle. In other words, these estimates assume that following channel downcutting, the adjacent slope fails at a constant 21-degree angle, resulting in rim widening. This rim-widening rate is the rate at which each of the streambanks moves in the horizontal direction. The rim-widening estimate is considered conservative because it assumes the slope will fail everywhere along the channel profile instead of being restricted to the most susceptible areas, such as the outside of meander loops.

Table F–19 Estimates of Channel Downcutting on Erdman Brook and Franks Creek from Single-Storm Events

Storm Event	Frequency of Occurrence (1 per year)	Average Downcutting Distance from the Single Storm (meters) [a]		Average Rim-Widening Distance from the Single Storm (meters)	
		Erdman Brook	Franks Creek	Erdman Brook	Franks Creek
2-year storm	0.50	0.20	0.14	0.52	0.36
5-year storm	0.20	0.21	0.19	0.55	0.49
10-year storm	0.10	0.22	0.20	0.57	0.52
20-year storm	0.05	0.30	0.23	0.78	0.60
100-year storm	0.01	0.32	0.23	0.83	0.60
500-year storm	0.002	4.10	3.50	10.68	9.12

[a] Positive numbers means degradation and the area is being scoured.
Note: To convert meters to feet, multiply by 3.281.

The storm frequency (return interval) estimates and rim-widening estimates were combined to develop probabilistic estimates for the long-term rim-widening rate from erosion. The probabilistic method estimated the probability of a specific storm combination (e.g., 20, 2-year storms and 5, 100-year storms) and combined it with the estimate for the total rim widening for all storms in the specific combination (e.g., 20 times the 2-year storm rim widening plus 5 times the 100-year storm rim widening). The summation of combinations considered storms of all magnitudes, equivalent to an averaging over an indefinite period of time. Nearly all (99.94 percent) possible storm combinations were considered. The sets of estimates for storm combination probability and total rim widening were arranged in order of increasing total rim widening. The ordered listing was used to estimate likelihood of a specific rim-widening rate. Selecting a rim-widening rate and summing probabilities for all rim-widening rates lower than the selected rate gives an estimated likelihood of the rate being the same as, or less than, the selected rate. The probability of a specific number of storms having the same recurrence interval over a given time was estimated using the Poisson distribution.

This method was used to estimate the long-term rim-widening rates for Erdman Brook and Franks Creek for the current drainage condition. **Table F–20** presents the probabilistic rim-widening rates. Results show that the 90 percent quantile for Erdman Brook is 0.158 meters (0.518 feet) per year, while the 90 percent quantile for Franks Creek is 0.153 meters (0.502 feet) per year, meaning that 90 percent of the erosion rates for the two streams are expected to be equal to or less than their 90 percent quantiles. A narrow distribution for the rim-widening rate is shown because the major determinant in the probabilistic rim-widening rate is the large number of high-frequency storms. This observation is consistent with the results presented in Table F–20.

Table F–20 Estimate of Long-term Rim-Widening for Erdman Brook and Franks Creek

Quantile (percent)	Erdman Brook Average Rim Widening Rate (meters per year)	Franks Creek Average Rim Widening Rate (meters per year)
10	0.138	0.134
20	0.140	0.137
30	0.143	0.139
40	0.145	0.141
50	0.147	0.143
60	0.149	0.145
70	0.151	0.147
80	0.154	0.149
90	0.158	0.153

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

As expected, the incision rates along the reach of Franks Creek between Erdman Brook and Quarry Creek computed in the CHILD scenarios are lower than those in the HEC-6 analysis, which are considered maxima. The CHILD rates range from 0.5 to 2.6 millimeters (1.02 to 0.10 inches) per year for the first 100 simulation years, depending on the scenario and the local grid resolution.

F.3.2.3 Short Term Infiltration Capacity Prediction

The Soil Water Assessment Tool (SWAT) model was used to simulate the Cattaraugus Creek watershed from its headwaters down to the Gowanda USGS gauging station near the town of Gowanda, New York. The model determined the quantity of precipitation, evapotranspiration, runoff, and lateral flow that occurred over the land surface and within the unsaturated soil layers of the watershed, as well as the quantity of flow that percolated to the shallow and deep groundwater aquifers. The simulation results were used to calculate the infiltration capacity at the confluence of Buttermilk and Cattaraugus Creeks, and thus, verify the range of values selected for the CHILD long-term erosion analysis.

SWAT is a physically based model that simulates the dominant processes in the hydrologic cycle on a watershed or basin scale. It operates on a daily time step and is capable of simulation periods of up to a few hundred years. The SWAT model was developed by the U.S. Department of Agriculture Agricultural Research Service to predict the impact of management on water, sediment, and agricultural chemical yields in ungauged watersheds as described in the theoretical documentation (Neitsch et al. 2005).

The SWAT model requires input parameters that describe the site-specific climate, soil properties, vegetation conditions, topographic properties (gradient, length, and width), point sources, and management conditions within the Cattaraugus Creek watershed area. The data input into the model are summarized in **Table F–21**. The SWAT model's automated watershed delineator was used to access the inputted DEM, soil, and land use files; create subbasin areas (see **Figure F–44**), and generate hydrologic response units (HRUs). Each HRU area is a unique combination of soil, slopes, and land use type within a subdrainage area. Slope intervals of 0 to 1 percent, 2 to 4 percent, and greater than 4 percent gradients were specified as break points, which resulted in the creation of 3,480 HRUs. Following the HRU creation step, the SWAT model was used to calculate the flow distribution within each of the HRU areas and the discharge at the outlets to the subdrainage areas.

Table F–21 Data Entered into the SWAT Model

Data Category	***Input Data***	***Data Source***
Daily precipitation Daily temperature	Little Valley (USGS COOP ID 304808) New Albion (USGS COOP ID 305673) Gowanda (USGS COOP ID 303354)	http://waterdata.usgs.gov/nwis/sw
Topography	DEM (10-meter grid spacing)	http://seamless.usgs.gov/index.php
Soil	STATSGO and Soils-5 databases	Databases built in to SWAT model
Land use	National Land Cover Database 2001 National Agricultural Statistics Service crop map 2002	http://datagateway.nrcs.usda.gov/GatewayHome.html) http://www.mric.gov/mrlc2k_nlcd.asp)
Point sources	Waste water treatment plant discharges (Cattaraugus, Otto, Arcade, and Springville) WNYNSC Lagoon 3 discharges	http://oaspub.epa.gov/enviro/ef_home2.water http://www.epa-echo.gov/echo/compliance_report_water.html Nuclear Fuel Services Inc. Quarterly Reports

DEM = Digital Elevation Model, STATSGO = State Soil Geographic Database, SWAT = Soil Water Assessment Tool, WNYNSC = Western New York Nuclear Service Center.
Note: To convert meters to feet, multiply by 3.281.

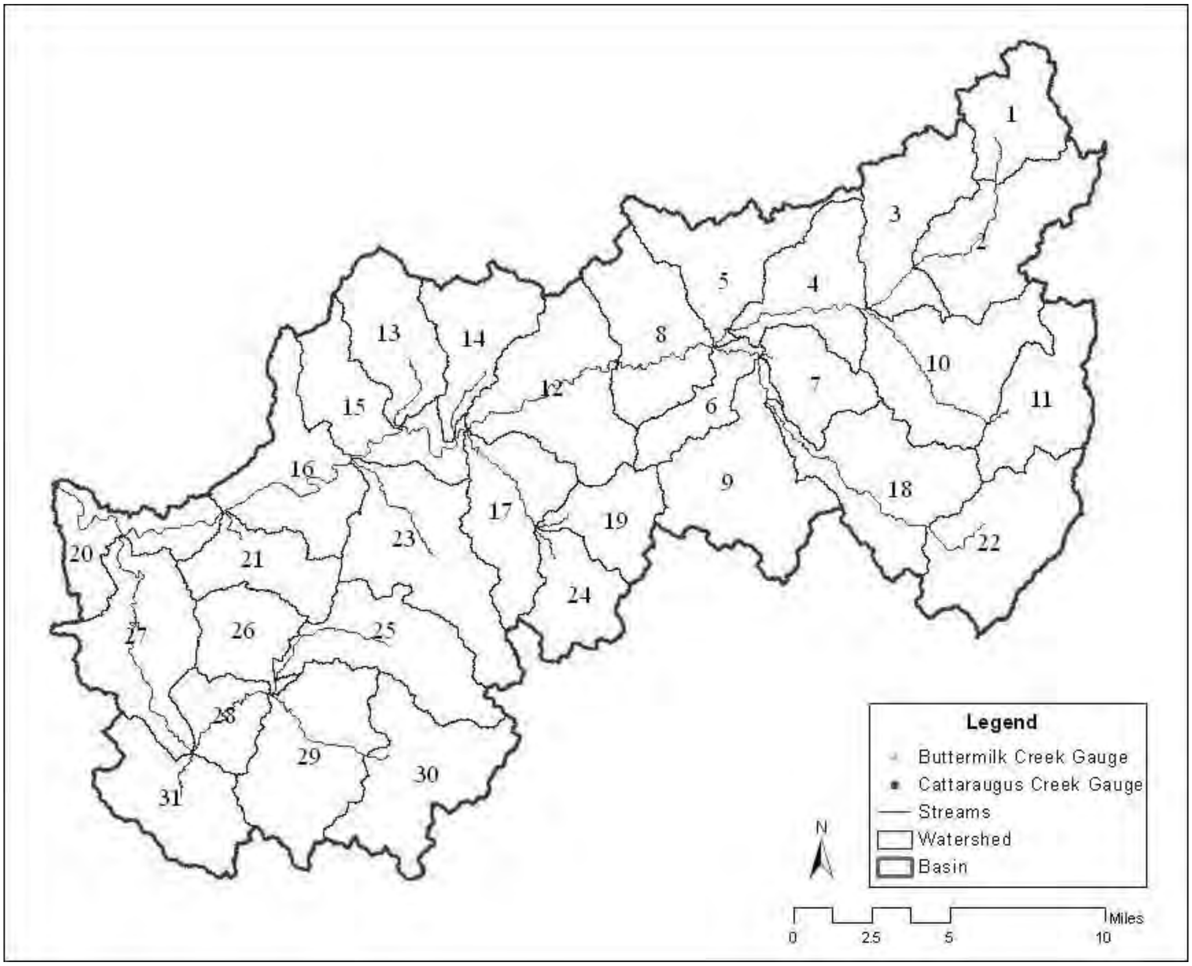


Figure F–44 SWAT Delineation of Subdrainage Basin Areas within Cattaraugus Creek Watershed

The SWAT model was calibrated and validated using available water quantity data to test its performance. Model calibration is the process of fine-tuning the SWAT simulation results to the observed results, whereas model validation is the process of repeating the SWAT simulation using a different time period for input data, without changing any parameter values that may have been adjusted during calibration. In this analysis, the SWAT-predicted daily stream flow data at the model outlet were compared to the daily stream flow data observed at the USGS Cattaraugus Creek gauge station at Gowanda, New York (USGS station number 04213500). The Gowanda gauge station recorded daily flow values from 1945 to 2008 with missing records from April 1998 through November 1999; therefore, a 63-year SWAT simulation was completed with the first 5 years (1945 to 1950) used to "warm up" the model (i.e., establish antecedent moisture conditions). The 1961 through 1965 time period was used for calibration with the remaining 58-year gauge record period (between 1950 and 2008) used for validation. The comparison of the simulated to observed data for the calibration period is shown on **Figure F–45**. The Nash-Sutcliffe efficiency (NSE) and RSR (RMS error–observations standard deviation ratio) goodness-of-fit measures were calculated to test the model's accuracy. The NSE measure can range from negative infinity to 1, with 1 denoting a perfect model with respect to data agreement and 0.5 and above denoting an acceptable model. The RSR measure varies from the optimal value of zero, which indicates perfect model simulation, to a large positive value. Model simulation can be judged as satisfactory if NSE is greater than 0.5 and RSR is less than or equal to 0.70 (Moriasi et al. 2007). In this analysis, NSE was determined to be 0.73 for the calibration period and 0.56 for the validation period, with RSR at 0.52 for the calibration period and 0.67 for the validation period.

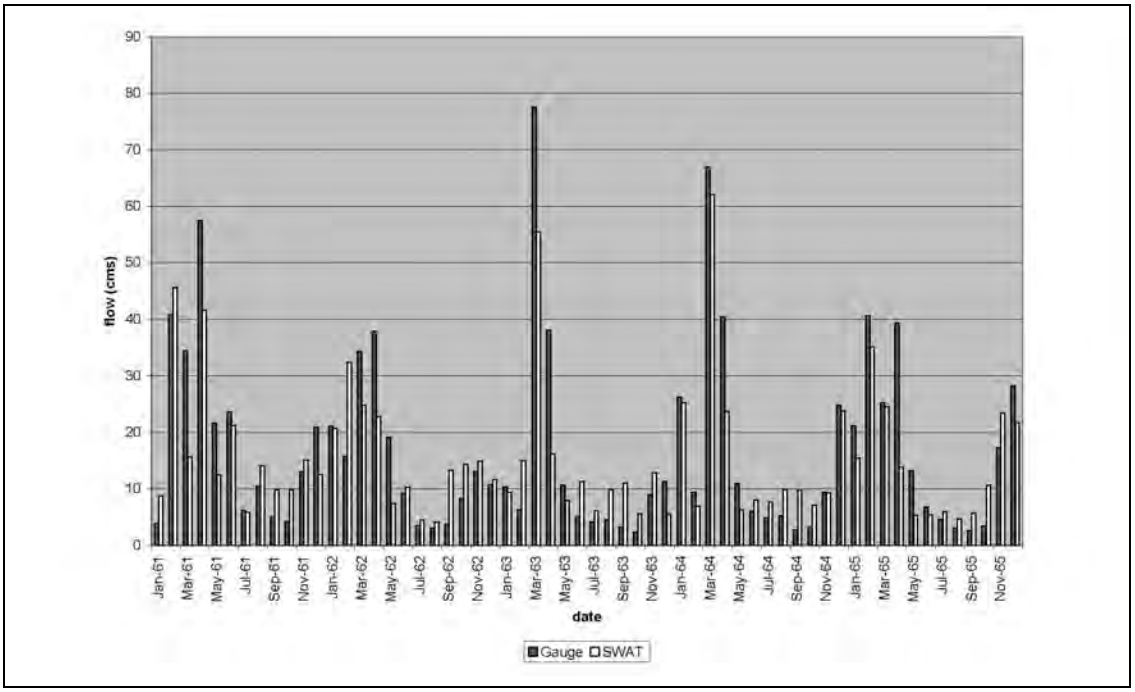


Figure F–45 Comparison of SWAT-simulated Streamflow to USGS Gowanda Gauge Observed Streamflow during Calibration Period 1961–1965.

Following calibration, the SWAT model was run for a 200-year period using climate data generated by SWAT's built-in climate generator. It uses monthly average values from the nearest weather station to stochastically generate daily climate values over the duration of the simulation. **Table F–22** presents the annual results averaged over the Buttermilk Creek watershed (subbasins 17, 19, and 24) for the 200-year period simulation and also for the 58-year calibration run. It shows the quantity of water entering the Buttermilk Creek subbasins as precipitation, as well as the quantity of water removed from the watershed to the atmosphere by evaporation and plant transpiration (evapotranspiration), and the quantity of water percolating past the root zone, which over a long time period is equal to the groundwater recharge (percolation).

Table F–22 Average Annual SWAT Modeling Results

Simulation	***Precipitation (millimeters)***	***Evapotranspiration (millimeters)***	***Percolation (millimeters)***
58-Year calibration run	1155.78	425.48	216.64
200-Year run	891.65	403.50	230.87

SWAT = Soil Water Assessment Tool.
Note: To convert millimeters to inches, multiply by 0.039.

The SWAT average annual values of precipitation, evapotranspiration, and percolation were entered into the infiltration capacity equation as described in Section F.3.1.4.5. The groundwater recharge (I_r) parameter in the infiltration capacity equation was assumed to be equal to the percolation due to the long duration of the simulations. Thus, the resulting infiltration capacity values were determined to be 10.33 meters (33.89 feet) per year and 15.83 meters (51.94 feet) per year for the 58-year calibration run and the 200-year run, respectively. These predictions fall within the expected range of 8.29 to 19.4 meters (27.20 to 63.65 feet) per year; and therefore, verify the appropriateness of the values used in the CHILD model.

F.4 Summary

Observations of modern geomorphic processes, together with results from OSL dating, support the conclusion from earlier studies that the WNYNSC has unusually high rates of erosion for a moderate-relief, humid-temperate setting. Long-term stream incision rates on the order of millimeters per year are more commonly associated with tectonically active landscapes than they are with tectonically quiet, moderate-relief continental interiors. These high rates reflect a combination of the site's postglacial legacy and the relatively soft glacial sediments that fill the main valley and mantle the uplands.

Analysis of landforms and present-day processes supports the view that gully erosion and mass wasting represent the greatest erosional threats to the burial areas. Observations, measurements, and calculations made with short-term erosion models suggest that hillslope erosion by processes such as overland-flow erosion, rill development, and raindrop impact are considerably less significant threats than gullying and landsliding.

The style of erosional development at the site places constraints on the type of geomorphic models that may be usefully applied for estimating long-term erosion. Gully erosion in particular involves substantial changes in topography and surface flow paths, such that there is a dynamic feedback between erosion and surface hydrology as the landscape evolves. Models of long-term potential future erosion at the site must be able to capture this feedback. Given the need to generate future-erosion scenarios that extend over millennia—a timeframe during which topography may be expected to change considerably—a landscape evolution model (which by definition accounts for changing topography) is the logical tool of choice. After review of several such models, the CHILD model was selected as offering the most appropriate range of capabilities and process laws for the site.

The most defensible approach to testing and calibrating such a model is to compare it with the reconstructed geomorphic history of the site over a timeframe comparable to that of the analysis period. At WNYNSC, such an approach is made possible by a fortuitous geological accident: the incised stream network of Buttermilk Creek and its tributaries formed during the period since the retreat of the Laurentide ice sheet about 17,000 years ago, and the nature of the pre-incision topography can be approximately reconstructed from the existing plateau remnants.

A probabilistic calibration process allowed the determination of five alternative sets of best-fit model parameters. The calibration models showed good agreement between observed and predicted present-day topography, both visually and in terms of a series of quantitative measurements of landscape and drainage network morphology. The agreement between modeled and observed topography increases confidence in the ability of the model to generate realistic future-erosion scenarios, though it is recognized that the enormous time span, limited data set, and imperfectly known process laws leave scope for uncertainty that must be acknowledged in interpreting any model results.

A group of 26 alternative forward-in-time simulations was designed. These generated a range of potential future-erosion scenarios. The computed patterns of landscape evolution were consistent with observations of present-day erosion processes in the sense that all predicted some degree of gully development along the North Plateau rim, and all predicted active erosion along steep valley sides. Among the scenarios, some were consistent with observed modern incision along upper Franks Creek and Erdman Brook, while others showed stability or minor sedimentation in these areas; the former scenarios are therefore considered to be more reliable than the latter. Collectively, the model results support the view that gully erosion, and to a lesser extent slope degradation and landsliding, represents the greatest erosional threat to the integrity of waste burial areas.

The model results highlighted several potential erosional "hot spots." These include the area around the present-day NP-2 and NP-3 gullies, the present-day NP-1 gully, and the plateau rim above Quarry Creek in the area north-northwest of the main plant. The low-lying area between the NDA and SDA is also a potential erosional hot spot.

While some degree of gully activity was common in the modeled scenarios, the location of the fastest-growing gullies is difficult to determine because the flow paths that feed the gullies are quite sensitive to small perturbations in topography. This sensitivity makes it essentially impossible to predict the exact positions of gullies, at least in a deterministic sense. The problem is somewhat analogous to the prediction of thunderstorm cells: numerical weather models give meteorologists a good idea of the conditions under which thunderstorms are likely to occur, but the exact position and timing of any particular storm are virtually impossible to predict.

The model scenarios are subject to several important sources of uncertainty. First, there is uncertainty associated with the structure of the model. Any model involves simplifications of nature, and these simplifications will inevitably distort the model's representation of natural phenomena. In some areas of the physical sciences, the resulting distortions are well known and may have a minimal effect on a set of phenomena under study (for example, Newtonian mechanics are known to be "wrong," yet their accuracy is so high that they are used to send spacecraft to Mars). With landscape evolution models, the underlying process theory is provisional (partly because the large time and space scales render direct experimentation impossible) and subject to ongoing research. Models like CHILD may be said to encapsulate the best present understanding of the processes involved over long time scales; their performance will undoubtedly continue to improve as the science evolves. Second, there is uncertainty associated with inputs. In this case, the largest source of uncertainty concerns the assumption of a constant climate state for purposes of model calibration. Errors in this assumption may lead either to overestimates or underestimates of future erosion. Other sources of uncertainty related to inputs are the representation of materials in the landscape, and the applied baselevel history at the outlet of Buttermilk Creek. Third, there is uncertainty in the initial conditions used in calibration. Fourth, there is (relatively minor) uncertainty in the topographic data and in other data sources (such as rainfall and streamflow). Fifth, there is uncertainty associated with possible future changes in climate, vegetation, and soil conditions, and with possible future human modifications to surface drainage patterns. Sixth, there is uncertainty associated with the degree of heterogeneity in soils, sediments, and rocks. The model has been calibrated using a representation that lumps materials into three types with regard to erosion and sediment transport, and one type with regard to runoff generation. Therefore, the model will tend to overpredict erosion for materials that are more resistant than average, and vice versa. Likewise, the model will tend to underpredict runoff from areas that are less permeable than average, and vice versa.

With these caveats in mind, it is notable that none of the scenarios produced stream capture in the headwaters of Franks Creek. Further, in no scenario were the initial steps toward such capture observed. In addition, inspection of topography data showed no obvious signs that similar capture events have occurred elsewhere along Buttermilk Creek in the past. It is concluded therefore that, as best as can be determined given the limits of present knowledge of quantitative landscape evolution, such capture is unlikely to occur during the performance period. However, this conclusion is offered with the caveat that the landscape evolution model used in this study did not account for lateral erosion and slope undercutting by Buttermilk Creek, which could increase the likelihood of stream capture.

None of the future-erosion scenarios showed large-scale erosional exhumation of waste burial areas. Two of the South Plateau scenarios showed partial gully penetration of the SDA (SPa3 and SPwet), while in the more-erosive North Plateau scenarios, gullies advanced to within about 100 to 200 meters (328 to 656 feet) of the Main Plant Process Building. Given (1) the close proximity of large gullies to waste burial areas in some model scenarios, (2) the various sources of uncertainty that influence predicted rates and patterns of erosion, and (3) the indeterminacy of gully positions, it is recommended that large-scale erosional exhumation of burial areas in the next 1,000 to 10,000 years should be considered *unlikely but not implausible*. It is recommended that analyses of the potential radiological threat from erosion take account of the demonstrated uncertainty in the positions and growth rates of large active gullies.

The long-term erosion portion of Section H.2.2.1 discusses how the results from these erosion predictions were used to develop estimates of dose from unmitigated erosion predictions.

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APPENDIX G
MODELS FOR LONG-TERM PERFORMANCE ASSESSMENT

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MODELS FOR LONG-TERM PERFORMANCE ASSESSMENT

Appendix D presented the conceptual approach to long-term performance assessment, discussed the need for site-specific models, and identified site-specific receptors and exposure scenarios. This appendix presents descriptions of the mathematical models used to estimate human health impacts due to releases of radionuclides and hazardous chemicals from facilities located on the Western New York Nuclear Service Center (WNYNSC) over a long term. Facilities include the Main Plant Process Building, the Vitrification Facility, the Low-Level Waste Treatment Facility, the Waste Tank Farm, the State-Licensed Disposal Area (SDA), and the NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area (NDA). Section G.1 summarizes the technical approach to long-term performance assessment discussed in detail in Appendix D and the approach to development of mathematical models. Sections G.2, G.3, G.4, and G.5 describe models used for assessment of scenarios involving residual contamination of surface soil, release to groundwater, direct intrusion into residual contamination, and release to surface water due to erosion, respectively. Locations and activities of receptors and a summary of values of parameters used in the analysis are presented in Section H.1.2 of Appendix H. Results of analysis of base and sensitivity cases are also presented in Appendix H.

G.1 Approach for Development of Mathematical Models

Estimation of long-term impacts is based on analysis of scenarios defined as combinations of site environmental conditions, inventories of hazardous constituents, facility designs, environmental transport pathways, and receptor location and behavior patterns that result in exposure of an individual to hazardous material. Analysis of these scenarios involves use of deterministic models and deterministic sensitivity analysis. The mathematical models are used within the iterative design and analysis procedure represented on **Figure G–1**. Review criteria that may be used at some point in the iterative procedure include dose limits specified by the U.S. Department of Energy (DOE), the NRC, and New York State; correspondence to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) risk range; and Resource Conservation and Recovery Act (RCRA) facility closure requirements. A more detailed discussion of the potential requirements is presented in Chapter 5 of this environmental impact statement (EIS). The result of application of this procedure, described in detail in Appendix D, is a set of site-specific scenarios comprising four general types. The first type of scenario involves contact of an individual with surface soil having residual contamination. The second type of scenario involves release from a disposal facility to groundwater; transport through an aquifer to a well or surface water; and exposure of an agricultural resident to contamination in soil, groundwater, surface water, or fish. The third type of scenario involves contact of an intruder with contamination in soil or buried residual contamination. The fourth type of scenario involves erosion collapse of a facility into surface water resulting in exposure of a downstream agricultural resident to contamination in soil, surface water, or fish.

For scenarios involving contact with residual contamination in surface soil, impacts were estimated using the RESRAD Version 6.4 computer code (Yu et al. 2001) for radionuclides and algebraic equations recommended by Federal guidance (EPA 1996, 1999, 2000) for chemical constituents. For groundwater release, intrusion, and erosion scenarios, the approach developed for this analysis was use of site-specific models comprising release, groundwater transport, and human health impact modules. For groundwater release scenarios, the direction and rate of movement of water around and through the residual contamination was estimated using the near-field flow models described in Appendix E. Results from the near-field flow analysis serve as input data for the release modules of the groundwater release scenario impact models. The balance of this section summarizes the approach followed for development of mathematical models.

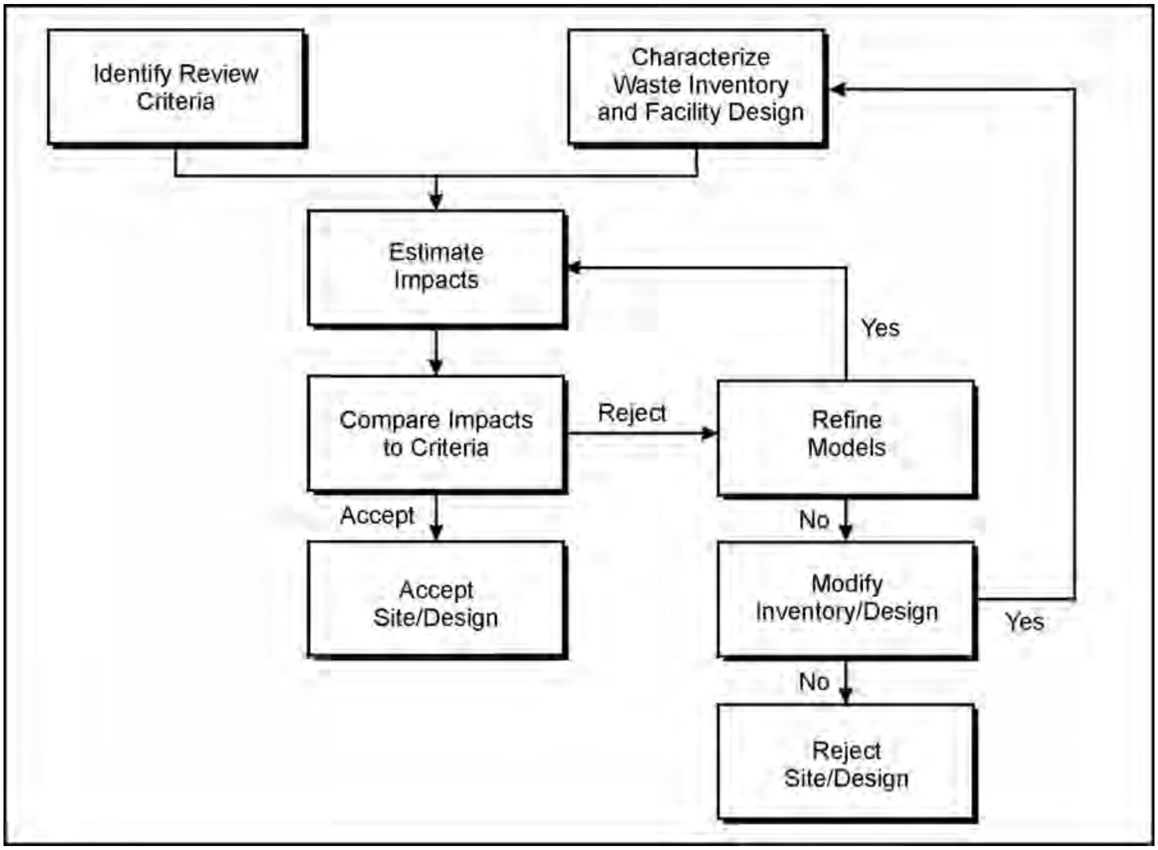

Figure G–1 Schematic of the Design, Analysis, and Evaluation Process

The procedure for development of site-specific models, involving formulation of conceptual and mathematical representations of physical processes, computerized solving of descriptive equations, and use of the computer models, is summarized in the eight steps listed in **Table G–1**.

Table G–1 Steps in Development of Mathematical Models

Step Number	***Content***
1	Characterize physical processes.
2	Develop conceptual model of the physical processes.
3	Develop physical mechanism-based mathematical description of the conceptual model.
4	Develop algorithm for solution of equations.
5	Develop computer code implementing solution algorithm.
6	Verify computer code.
7	Document model concepts, mathematical representations, computer code verification and utilization procedures.
8	Apply model for system analysis.

In the initial two steps of the procedure, descriptions of site physical processes (geologic, hydrologic, meteorological, etc.) are reviewed, important elements are identified, and a simplified representation amenable to mathematical description is developed. For example, the results of site geophysical and hydrologic monitoring programs were reviewed and the complex spatial distribution of soil types and geohydrologic structures were condensed into a simplified geometrical representation comprising a limited number of distinct layers and deposits, each having relatively uniform properties. Details of this element of the analysis are presented in Appendix E. In the third step of the procedure, material and momentum balances were used to describe the magnitudes and rates of movement of water and hazardous constituents through the engineered barriers and the environment. This step involved description of the role of physical processes contributing to movement of water and contaminants through the barriers and environment, identification of simplifying assumptions, and formulation of the balances for appropriate elementary volumes. For example, in the case of groundwater transport through the environment advection, dispersion, retardation, and decay were selected as important physical processes; one-dimensional flow and spatially uniform physical properties were assumed, and the mass balance for a constituent was formulated as an ordinary differential equation with concentration as the dependent variable and time and position as the independent variables. The fourth step in the procedure involved identification of the sequence of steps followed in solving the descriptive equations. Generally, this involved use of analytic solutions to the equations, repetitively applied to differing hazardous constituents, times, and positions. The fifth step in the procedure involved development of computer codes to implement the solution algorithms developed in the preceding step. Code development and maintenance procedures were consistent with standard practice (NRC 1993). The final three steps of the procedure involved verification, documentation, and application. A summary of model development is presented in this appendix and documentation of results of application of the models are presented in Appendix H.

Verification of computer codes involved the five steps summarized in **Table G–2**. Review of the model concept involved checking the system schematic, identifying the nature and role of physical processes, and formal listing of assumptions. Review of development of mathematical relations involved identification of model functions; checking of the basic mass, momentum, and energy balances, supporting correlations, and algorithms; and construction of lists of model parameters and dependent and independent variables. Review of computer implementation of equations and algorithms involved cross-checking of consistency of the programmed equations and algorithms, checking of computer code syntax, and checking for consistency with the rules and procedures of the computer code compiler. The fourth step in the verification procedure involved development and execution of test cases and comparison of results of model calculations with results developed using alternate models and hand calculations. Results of prior steps of the verification process supported selection of the test cases. In the fifth step, results of the first five steps were documented in a verification package. The final step of the verification package was review of the verification package by an independent, qualified analyst.

Table G–2 Verification Procedure for Computer Models

Step Number	***Content***
1	Review model concept.
2	Review development of mathematical relations and algorithms.
3	Review computer code implementation of equations and algorithms.
4	Develop acceptance criteria and test cases and compare predictions of the subject model, alternate models and hand calculations.
5	Document the verification.
6	Provide independent review of the verification.

The verification procedure described above was applied to the integrated codes developed for the groundwater release, intruder, and erosion collapse scenarios. Because the release and groundwater transport elements of the intruder and erosion collapse integrated codes are not complex, verification of these codes was performed in a single step as represented in Table G–2. Because the groundwater release scenario integrated codes involve more complex release and groundwater transport modules, these codes were verified in a process involving repeated application of the process represented in Table G–2. First, stand-alone versions of the release, groundwater transport, and exposure modules were developed and individually verified. Second, the individual modules were combined into integrated codes that were then verified.

G.2 Residual Contamination of Surface Soil

Following removal of waste or decontamination of site facilities, low levels of residual contamination could remain in onsite soil. The residual contamination could comprise radiological or chemical constituents. Because of the differing nature of health endpoints, slightly different approaches are used for estimation of impacts of exposure to radionuclides and chemicals. For radionuclides, impacts are estimated as dose and risk. Cumulative impacts of a mixture of radionuclides are estimated as the sum of dose or risk of the individual radionuclides. For chemicals, health impacts are represented as Hazard Quotients for noncarcinogens and as risk for carcinogens. Cumulative impacts of a mixture are represented as the sum of the Hazard Quotients, termed the "Hazard Index," of the individual noncarcinogenic chemicals, or as the sum of risk of the individual carcinogenic chemicals.

G.2.1 Residual Radioactive Material

Estimation of impacts of residual radioactive contamination of surface soil were estimated using the RESRAD Version 6.4 computer code (Yu et al. 2001) developed for the Formerly Utilized Sites Remedial Action Program. RESRAD estimates annual dose to an individual who establishes a residence on a site having residual contamination; raises and consumes crops; raises livestock and consumes meat, poultry, and milk; drinks contaminated groundwater; and obtains fish from a contaminated pond. Use of the model for site-specific application requires selection of appropriate operating modes of the model and specification of values for parameters characterizing site physical conditions and the range of likely activity of the individual. WNYNSC comprises two areas, the North Plateau and the South Plateau, having different physical properties. In particular, geohydrologic analysis has determined that use of a well is feasible on the North Plateau but not on the South Plateau. The three-dimensional sitewide groundwater model predicts that, although horizontal flow occurs in the Kent recessional sequence, the unit is unsaturated below both the North and South Plateaus. More detail on the three-dimensional groundwater model is presented in Appendix E. Given the above considerations, exposure pathways included in this analysis are:

- Direct radiation;
- Inhalation of dust;
- Ingestion of vegetables, grain, fruits, meat, poultry, and milk, and;
- Inadvertent ingestion of soil

for both the North and South Plateaus and ingestion of drinking water on the North Plateau. The RESRAD code was executed for each radionuclide for a unit source concentration. The result of the analysis was a set of unit dose and risk factors that allow calculation of impacts for differing initial concentrations of each radionuclide in soil. Dose and risk for contact with residual contamination of surface soil by a single radionuclide through the above pathways are estimated as:

$$D_{rsc} = D_{rf} \, C_s \quad \text{(G–1)}$$

$$R_{rsc} = R_{rf} \, C_s \quad \text{(G–2)}$$

where:

D_{rsc} = dose due to contact with residual contamination in soil, rem per year
D_{rf} = unit dose factor for residential farmer pathways, rem per year per picocurie per gram
R_{rsc} = risk due to contact with residual contamination in soil, 1 per year
R_{rf} = unit risk factor for residential farmer pathways, 1 per year per picocurie per gram
C_s = concentration of radionuclide in soil, picocuries per gram

For the case of free release of an area, the unit dose factors may be used in conjunction with a dose criterion to calculate allowable levels of the radionuclide in soil. The allowable levels for a single radionuclide are termed derived concentration guidelines (DCGLs) and are calculated as:

$$DCGL = D_c / D_{rf} \quad \text{(G–3)}$$

where DCGL has units of picocuries per gram of soil, D_c is the dose criterion (rem per year) and D_{rf} is as defined for Equation G–1. For mixtures of radionuclides, the contribution of each radionuclide is incorporated into a DCGL referenced to a single radionuclide using the formula:

$$DCGL_j = 1 / (\Sigma f_i / DCGL_i) \quad \text{(G–4)}$$

where:

$DCGL_j$ is the mixture DCGL referenced to radionuclide j,

$DCGL_i$ is the DCGL for individual radionuclide i, and

f_i is the ratio of concentration of individual radionuclide to the reference radionuclide j, and the summation is taken over all radionuclides in the mixture.

Parameter values selected for WNYNSC and the results of RESRAD analysis are presented in Appendix H.

G.2.2 Residual Chemical Constituents

For hazardous chemicals, hazard and risk for residential farmer exposures are estimated using algebraic equations for inadvertent ingestion of soil; inhalation of fugitive dust; and ingestion of drinking water, crops, meat, and milk consistent with agency guidance (EPA 1996, 1999, 2000).

G.2.2.1 Inadvertent Ingestion of Soil

For inadvertent ingestion of soil, intake of a chemical constituent is estimated as:

$$I_{si} = [(IR_s \, EF_{si} \, ED_{si}) / (BW \, AT)] \, C_s \quad \text{(G–5)}$$

where:

I_{si} = intake rate for chemical constituent by inadvertent ingestion of soil, milligrams per kilogram-day
IR_s = rate of inadvertent ingestion of soil, milligrams per day
EF_{si} = exposure frequency for inadvertent ingestion of soil, days per year
ED_{si} = exposure duration for inadvertent ingestion of soil, years
C_s = concentration of chemical constituent in soil, grams per gram
BW = body weight, kilograms
AT = averaging time, days

The Hazard Quotient for the chemical constituent is calculated as:

$$HQ_{si} = I_{si} / RfD \tag{G–6}$$

where:

HQ_{si} = Hazard Quotient for ingestion of chemical constituent by inadvertent ingestion in soil, unitless
RfD = Integrated Risk Information System (IRIS) reference dose for chronic ingestion of the chemical constituent, milligrams per (kilogram-day)

I_{si} is as defined for Equation G–5.

Risk for the chemical by inadvertent ingestion of soil is calculated as:

$$R_{si} = I_{si}\ SF_{ing} \tag{G–7}$$

where:

R_{si} = lifetime risk unitless
SF_{ing} = IRIS slope factor for ingestion of the chemical constituent, 1 per milligram per kilogram-day

I_{si} is as defined for Equation G–5.

G.2.2.2 Inhalation of Fugitive Dust

For inhalation of a contaminant in fugitive dust, intake concentration is calculated as:

$$I_{fd} = \{ (f_m/PEF)\ EF_{fd}\ ED_{fd}\ [\ ET_o + (\ ET_i\ DF_i\ )\ ]\ C_s\ \} / AT \tag{G–8}$$

where:

I_{fd} = intake concentration of chemical constituent in fugitive dust, milligrams per cubic meter
PEF = particulate emission factor, cubic meters per kilogram
EF_{fd} = exposure frequency for inhalation of fugitive dust, days per year
ED_{fd} = exposure duration for inhalation of fugitive dust, years
ET_o = exposure time fraction, outdoors, unitless
ET_i = exposure time fraction, indoors, unitless
DF_i = dilution factor for indoor inhalation of fugitive dust, unitless
f_m = conversion constant, 1×10^6 milligrams per kilogram

C_s and AT are as defined for Equation G–5.

The Hazard Quotient is calculated as:

$$HQ_{fd} = I_{fd} / RfC \tag{G–9}$$

where:

HQ_{fd} = Hazard Quotient for inhalation of the chemical constituent in fugitive dust, unitless
RfC = IRIS reference concentration for inhalation of the chemical constituent, milligrams per cubic meter

I_{fd} is as defined for Equation G–8.

Lifetime risk due to inhalation of the constituent in fugitive dust is:

$$R_{fd} = I_{fd}\, SF_{inh} \qquad \text{(G–10)}$$

where:

R_{fd} = lifetime risk for inhalation of the chemical constituent in fugitive dust, unitless
SF_{inh} = IRIS slope factor for inhalation of the constituent, 1 per milligram per cubic meter, and

I_{fd} is as defined for Equation G–5.

G.2.2.3 Ingestion of Drinking Water

For ingestion of a chemical in drinking water, intake is defined as:

$$I_{dw} = (f_m / f_t)\ \{ (IR_{dw}\, EF_{dw}\ \ ED_{dw}) / (BW\ AT) \}\, C_c \qquad \text{(G–11)}$$

where:

I_{dw} = chronic intake rate of chemical contaminant in drinking water, milligrams per kilogram-day
C_c = concentration of chemical contaminant in water, grams per cubic meter
EF_{dw} = exposure frequency for drinking water ingestion, days per year
ED_{dw} = exposure duration for drinking water ingestion, years
BW = body weight, kilograms
AT = averaging time, days
f_m = conversion constant, 1,000 milligrams per gram
f_t = conversion constant, 365 days per yr

Other variables are as defined for preceeding equations.

For constituents with noncarcinogenic health effects, the Hazard Quotient is calculated as:

$$HQ_{dw} = I_{dw} / RfD \qquad \text{(G–12)}$$

where:

HQ_{dw} = Hazard Quotient for ingestion of the chemical contaminant in drinking water, unitless
RfD = IRIS reference dose for chronic ingestion of the chemical contaminant, milligrams per kilogram-day

I_{dw} is as defined for Equation G–11.

For carcinogenic constituents, lifetime risk is estimated as:

$$R_{dw} = I_{dw}\ SF_{ing} \qquad \text{(G–13)}$$

where:

SF_{ing} = IRIS slope factor for ingestion of the chemical contaminant, 1 per milligram per kilogram-day

I_{dw} is as defined for Equation G–11.

G.2.2.4 Ingestion of Crops

For ingestion of a chemical constituent in crops, intake is calculated as:

$$I_c = \{ (IR_{vf} + IR_{lv})\,(f_m\, ED_c)\, TF_p / (BW\, AT) \}\, C_s \qquad \text{(G–14)}$$

where:

- I_c = intake of chemical constituent in crops, milligrams per kilograms per day
- IR_{vf} = consumption rate of vegetables and fruit, kilograms per year
- IR_{lv} = consumption rate for leafy vegetables, kilograms per year
- f_m = conversion factor, 1×10^6 milligrams per kilogram
- ED_c = exposure duration for crop ingestion, years
- TF_p = soil to plant transfer factor for chemical constituent, milligrams per kilogram per milligram per kilogram

BW, AT and C_s are as defined for Equations G–5 and G–11.

The Hazard Quotient for ingestion of the chemical constituent in crops is calculated as:

$$HQ_c = I_c / RfD \qquad \text{(G–15)}$$

where:

- HQ_c = Hazard Quotient for ingestion of chemical constituent in crops, unitless, and

I_c and RfD are as defined for preceeding equations.

Lifetime risk due to ingestion of a chemical constituent in crops is calculated as:

$$R_c = I_c\, SF_{ing} \qquad \text{(G–16)}$$

where:

- R_c = lifetime risk due to ingestion of chemical constituent in crops, unitless, and

I_c and SF_{ing} are as defined for preceeding equations.

G.2.2.5 Ingestion of Meat

For ingestion of a chemical in meat, intake is defined as:

$$I_m = (f_m\; B_v\; B_m\, IR_{fm}\; IR_m\; ED_m) / (BW\; AT) \}\; C_s \qquad \text{(G–17)}$$

where:

- I_m = chronic intake rate of chemical contaminant in meat, milligrams per kilogram-day
- C_s = concentration of chemical contaminant in soil, grams per gram
- B_v = soil to plant transfer factor, unitless
- B_m = bioaccumulation factor for meat, grams per kilogram per gram per day
- IR_{fm} = ingestion rate of fodder for meat, kilograms per day
- IR_m = ingestion rate of meat, kilograms per year
- ED_m = exposure duration for meat ingestion, years
- BW = body weight, kilograms
- AT = averaging time, days
- f_m = conversion constant, 1,000,000 milligrams per kilogram

other variables are as defined for preceeding equations.

For constituents with noncarcinogenic health effects, the Hazard Quotient is calculated as:

$$HQ_m = I_m / RfD \qquad (G–18)$$

where:

HQ_m = Hazard Quotient for ingestion of the chemical contaminant in meat, unitless
RfD = IRIS reference dose for chronic ingestion of the chemical contaminant, milligrams per kilogram-day

I_m is as defined for Equation G–17.

G.2.2.6 Ingestion of Milk

For carcinogenic constituents, lifetime risk is estimated as:

$$R_m = I_m \; SF_{ing} \qquad (G–19)$$

where:

SF_{ing} = IRIS slope factor for ingestion of the chemical contaminant, 1 per milligram per kilogram-day

I_m is as defined for Equation G–17.

For ingestion of a chemical in milk, intake is defined as:

$$I_{mlk} = (f_m \; B_v \; B_c \; IR_{fmlk} \; IR_{mlk} \; ED_{mlk}) / (BW \; AT) \} \; C_s \qquad (G–20)$$

where:

I_{mlk} = chronic intake rate of chemical contaminant in milk, milligrams per kilogram-day
C_s = concentration of chemical contaminant in soil, grams per gram
B_v = soil to plant transfer factor, unitless
B_c = bioaccumulation factor for milk, grams per liter per gram per day
IR_{fmlk} = ingestion rate of fodder for milk, kilograms per day
IR_{mlk} = ingestion rate of milk, liters per year
ED_{mlk} = exposure duration for milk ingestion, years
BW = body weight, kilograms
AT = averaging time, days
f_m = conversion constant, 1,000,000 milligram per kilogram

other variables are as defined for preceeding equations.

For constituents with noncarcinogenic health effects, the Hazard Quotient is calculated as:

$$HQ_{mlk} = I_{mlk} / RfD \qquad (G–21)$$

where:

HQ_{mlk} = Hazard Quotient for ingestion of the chemical contaminant in milk, unitless
RfD = IRIS reference dose for chronic ingestion of the chemical contaminant, milligrams per kilogram-day

I_{mlk} is as defined for Equation G–20.

For carcinogenic constituents, lifetime risk is estimated as:

$$R_{mlk} = I_{mlk} \; SF_{ing} \qquad \text{(G–22)}$$

where:

SF_{ing} = IRIS slope factor for ingestion of the chemical contaminant, 1 per milligram per kilogram-day

I_{mlk} is as defined for Equation G–20.

Parameter values selected for estimation of impacts for residential farmer exposure to chemical constituents for WNYNSC and the results of impact analysis are presented in Appendix H.

G.3 Groundwater Release Scenarios

Models developed for analysis of groundwater release scenarios simulate release of hazardous constituents from above- or below-grade facilities, transport of the constituents in groundwater to an access point, and exposure of receptors to hazardous constituents in groundwater, surface water, or soil. The physical relations of the release, transport, and exposure point elements of the integrated models are represented on **Figure G–2** for the case of access at a drinking water or irrigation well. The three horizontal arrows to the left of this figure represent movement of groundwater through and around the wasteform. The two horizontal arrows to the right of the figure represent movement of contaminated and uncontaminated groundwater to the well. Similar flow configurations apply for the cases of access to near-surface soil and surface water. Important features of the integrated model concept represented in the figure are the nature of flow through the wasteform and the aquifer, the degree of dilution in the aquifer and at the access point, and the type of receptor contact with hazardous constituents.

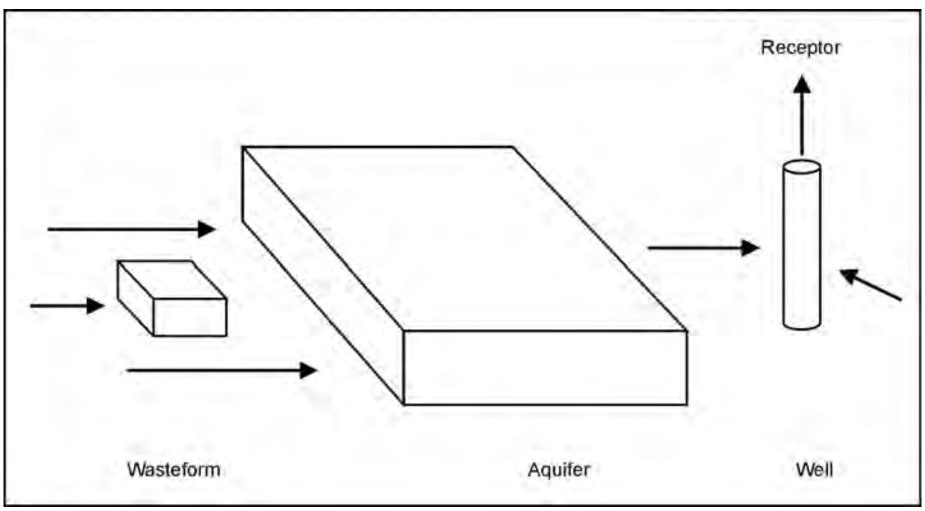

Figure G–2 Concept for Groundwater Scenario Analysis

In the integrated models used to estimate health impacts, flow through the aquifer is represented occurring in one-dimensional flow tubes. The direction of flow and the rate of movement of groundwater in the flow tube were estimated using the three-dimensional near-field flow models described in Appendix E. Similarly, the direction and rate of groundwater flow through wasteforms or disposal areas was estimated using the three-dimensional near-field flow models. Groundwater containing hazardous constituents arriving at the access point is diluted either by mixing in a well or by discharge to surface water. The degree of mixing at the well is specified by considering the minimum daily requirement for a family living at the site and engaged in agriculture. The required quantity of water includes contributions for domestic use and irrigation use. For domestic use, the quantity was estimated using the average of family size for Cattaraugus County and New York State (Census Bureau 2001) and the average per capita water use rate for New York State (Beyeler et al. 1999). For irrigation use, the quantity was calculated using estimates of the garden size that would meet a family's needs and the average irrigation rate for New York State (Beyeler et al. 1999). If the volumetric flow rate through the flow tube representing the aquifer flow is below the minimum required well production rate, the entire plume is captured by the well and constituent concentrations are diluted by mixing into a volume equal to the productivity of the well. If the flow rate within the flow tube exceeds the minimum well productivity, additional dilution does not occur and the concentration in the well is the concentration in the groundwater within the flow tube. If the groundwater discharges to surface water at the access point, concentrations in the surface water are determined by the magnitudes of the flow of groundwater containing hazardous constituents and the flow of surface water. The groundwater is assumed to completely mix in the surface water.

Four types of access points are defined to cover the range of conditions expected at WNYNSC. At the first type of access point, a receptor uses groundwater obtained from a well for drinking water. At the second type of access point, a receptor uses groundwater obtained from a well for drinking water and garden irrigation purposes. At the third type of access point, a receptor uses groundwater for drinking water and grows a garden in soil in direct contact with groundwater containing hazardous constituents. At the fourth type of access point, groundwater discharges to surface water and the surface water is used for drinking water and fish consumption and for irrigation of a garden. The mixing model assumes complete dilution in the average annual flow rate of the stream. The sensitivity of impact estimates to changes in annual conditions is considered in Appendix H. Additionally, at the fourth type of access point, at the point of discharge of groundwater to surface water, groundwater contaminates creek bank soil. Recreational hiking along this section of creek and consumption of vegetation along the creek bank by deer introduces recreational and deer consumption pathways for this type of access point. Impacts of surface water use from this type of point are mitigated by dilution in surface water. Combinations of these four types of access points constitute the residential farmer scenario for groundwater release scenarios.

Two sets of four computerized integrated impact models, incorporating three different release models and two different groundwater transport models, were developed for analysis of releases from WNYNSC facilities using the integrated model concept described in the preceding paragraphs. One set of codes was used to estimate impacts for radiological constituents, while the other set of codes was used to estimate impacts for chemical constituents. Corresponding codes within the two sets are identical in upper level approach and structure of the disposal facility release model. The corresponding codes differ in values of physical properties for the two classes of constituents and in the models translating concentration in environmental media into impacts. These differences are reflected in the discussion of human health effects impact models presented in Section G.3.4. The discussions of modeling of disposal facility release and groundwater transport are presented for a generic constituent with the understanding that this constituent could be either a radiological or chemical constituent.

Each of the eight integrated codes comprise executive routines and three major modules simulating hazardous constituent release, groundwater transport, and impacts on human health. For each code the structures of the executive routines are similar, the exposure modules are identical, and the release modules reflect differences in type of release model and facility geometry and design. The balance of this section discusses the structure of the integrated codes and the details of the release, groundwater transport, and exposure modules.

G.3.1 Structure of Integrated Codes

Calculation of estimates of impacts for the integrated model concept involves data management, logical control, and computational tasks. Data input and output operations, internal transfer of data, control of module calculations, and some calculation tasks are performed in the executive routine.

Two types of release model were developed, one for localized sources such as stabilized rubble or tanks and one for a distributed source such as groundwater contamination of the North Plateau Groundwater Plume. For localized sources, estimation of rate of release of hazardous constituents to groundwater and the concentration of the constituents in groundwater at the release point to the aquifer are performed in the release module. The primary results returned to the executive routine are rate of release to the aquifer for each constituent and the magnitudes and durations of a sequence of concentration pulses of each hazardous constituent at the release point in the aquifer. Data defining each pulse are magnitude of concentration and a start and end time. The duration of a pulse is referred to as a release period. In the groundwater transport model used in conjunction with localized sources, the concentration of a constituent in groundwater at a specified point in the aquifer due to a step function in concentration of the constituent at the release point to the aquifer is calculated. The concentration is calculated as the quotient of the release rate predicted by the release model and the flow rate predicted by the near-field groundwater flow model. The principle of superposition is used in conjunction with the step function response of the groundwater transport module to construct the response to the series of concentration pulses provided by the release module. Logical control of the superposition process is performed in the groundwater transport module. The algorithm used to control the superposition calculation is discussed in Section G.3.3.1 in conjunction with the groundwater transport module. For distributed sources, the release model is an input data specification of initial concentration of the constituent as a function of location within the aquifer. The groundwater transport model used for distributed sources is a finite difference solution of the transport equation that supplies estimates of concentration of the constituent in groundwater and soil and flux of the constituent at specified locations. The approach for specification of initial concentration in the North Plateau Groundwater Plume is described in Appendices E and H. For both types of groundwater transport model, calculated groundwater and soil concentrations are transferred to the health impacts module where dose and risk (radionuclides) or Hazard Quotient and risk (hazardous chemicals) due to exposure in groundwater, soil, or surface water are estimated.

The order of calculations performed in the integrated model is depicted in the two-part flowchart of **Figure G–3**. Input data include information specifying the total time for the simulation, the receptor type and intake rates, the numbers of periods of three types of time intervals used to facilitate the calculations, wasteform and aquifer parameters, and physical properties of radiological and chemical constituents used in the calculations. The three types of time intervals are identified as impact, release, and data periods. An impact period is the length of time between successive calculations of human health impacts. Generally, the length of an impact period is specified as one year, but intervals of ten or one hundred years may be used if the total length of time simulated is large. Human health impacts are estimated for the single year at the beginning of the impact period and all years of the impact period are represented as having this magnitude of impact. As described above, release periods are defined to group release quantities for impact periods (years) into a computationally manageable number of concentration pulses. In order to preserve health impact for the impact period of maximum release, this impact period is saved as an individual release period for each radionuclide. The duration of release periods is greater than the duration of impact periods, except for the impact period of maximum release, in which case the duration of the impact period and release period are the same. The balance of the total release is distributed over the remaining number of release periods. The algorithm used to consolidate releases is discussed in Section G.3.2.1 in conjunction with the rectangular geometry, analytic solution release model. Data periods are defined to provide for time dependence of physical properties of the engineered barriers, that is, to allow simulation of degradation of properties with time. Rate of movement of groundwater in the wasteform and aquifer and tortuosity of the wasteform grout are parameters whose values may change with time.

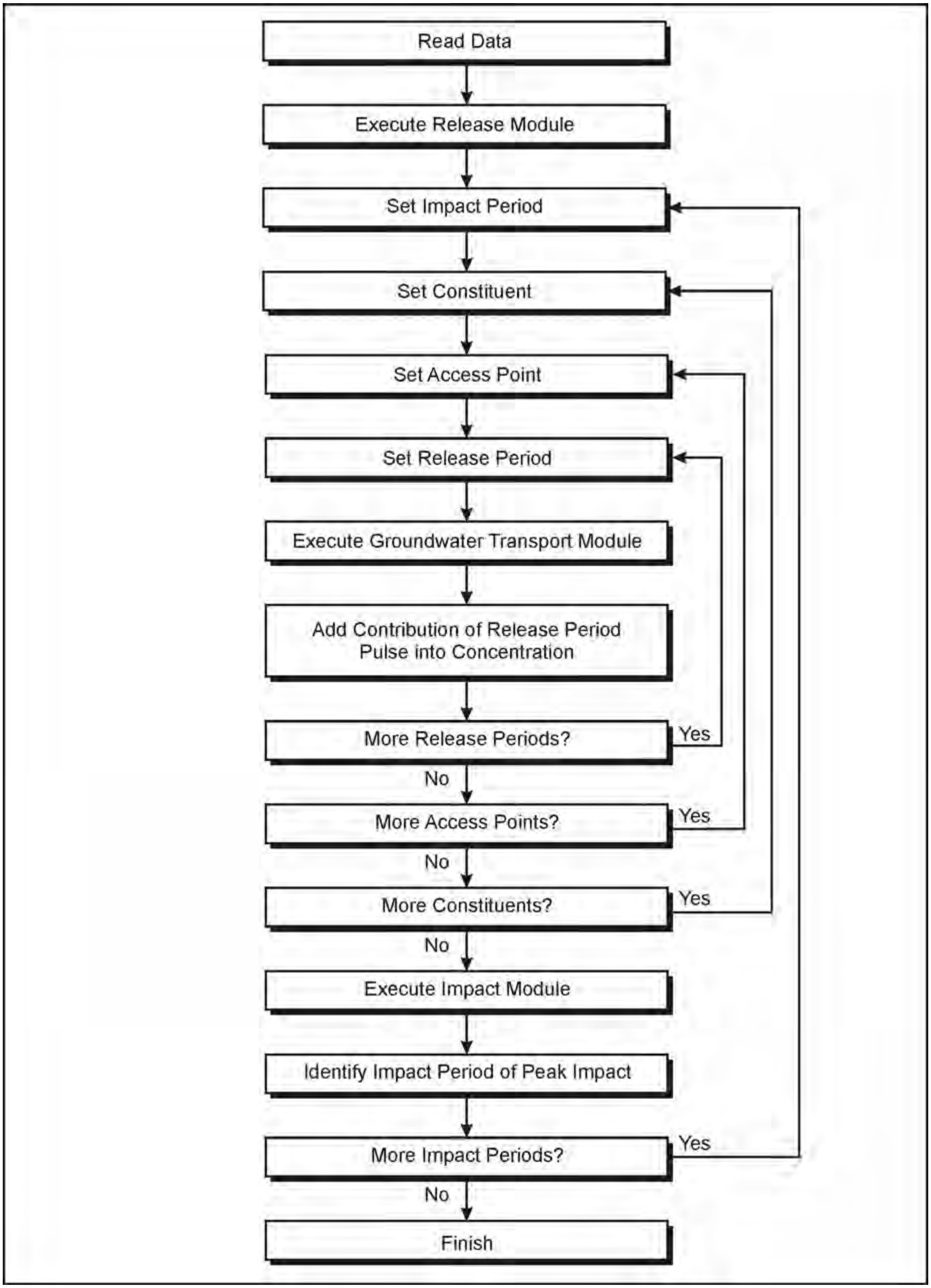

Figure G–3 Organization of Integrated Codes

As indicated on Figure G–3, a simulation begins with reading of input data and estimation of release rates. The calculation proceeds into three loops that provide for calculation of dose for all impact periods, accumulation of contributions of all hazardous constituents, and consideration of all locations defining receptor exposure modes. On completion of the calculation loops, output data for each constituent and location for the impact period of largest annual dose and the time sequence of total dose for all impact periods are transferred to output data files.

Three release modules have been developed for simulation of WNYNSC facilities. The models incorporate flexible representation of closure concepts allowing simulation of the range of conditions and designs expected in EIS alternatives. The release models differentiating these combinations are a one-dimensional, rectangular geometry analytic model; a one-dimensional rectangular geometry, finite difference model; and a two-dimensional, cylindrical geometry finite-difference model. The nature of these release models is described in the following paragraphs in order of increasing complexity.

G.3.2 Release Modules

G.3.2.1 Rectangular Geometry, Analytic Release Model

Closure designs developed for the site incorporate external barriers with wasteforms that may be represented as rectangular prisms oriented perpendicular to groundwater flow. A site-specific wasteform design with this geometry and using a tumulus (multi-layer, engineered cap) and external barriers upstream and downstream of the wasteform is depicted on **Figure G–4**. In the integrated facility, the tumulus is placed at or aboveground level and the layered wasteform is oriented horizontally or vertically below the tumulus. The external barriers and the wasteform have low hydraulic conductivity to limit movement of groundwater through the residual contamination. In addition, the wasteform may contain sorbents that decrease liquid phase concentrations of hazardous constituents and retard their movement. A generic model that contains a French drain located upgradient of the slurry wall would divert groundwater away from the residual contamination reducing the water table within the facility to a level near the bottom of the French drain. The drainage layer of the tumulus has high hydraulic conductivity to divert infiltration away from the wasteform. On Figure G–4, as applied to the North Plateau, the primary flow path is horizontal flow through the Surficial Sand and Gravel Unit. On Figure G–4, as applied to the South Plateau, the potential flow paths are horizontal flow through the weathered Lavery till or vertical flow through the weathered Lavery till and unweathered Lavery till followed by horizontal flow through the Kent recessional sequence. On both the North and South Plateaus, a slurry wall would be placed in the flow system for the Sitewide Close-In-Place Alternative.

The following paragraphs discuss models for calculation of release rates from the wasteform. The models are able to estimate impacts for horizontal or vertical flow through a wasteform but not for both directions simultaneously. For a facility having releases in both directions, as may occur on the South Plateau, the model is executed for each direction separately and the impacts are accumulated as appropriate. For the North Plateau, the model is used to simulate releases from the Main Plant Process Building, the Vitrification Facility, the Low-Level Waste Treatment Facility, and the Waste Tank Farm for the No Action Alternative and from the Low-Level Waste Treatment Facility, for the Sitewide Close-In-Place Alternative. This type of model is selected for this alternative because flow rates are high and the spatial distribution of the contaminant within the wasteform is secondary to the magnitude of the inventory in determining rate of release. For the South Plateau, the model is used to simulate releases from the NDA and SDA for the No Action and Sitewide Close-In-Place Alternatives. This type of model is selected for those cases because flow rates through the wasteform are relatively high and the spatial distribution of contamination may be considered uniform. A schematic of a layered wasteform with central residual contamination layer and external grout and clay layers is presented on **Figure G–5.**

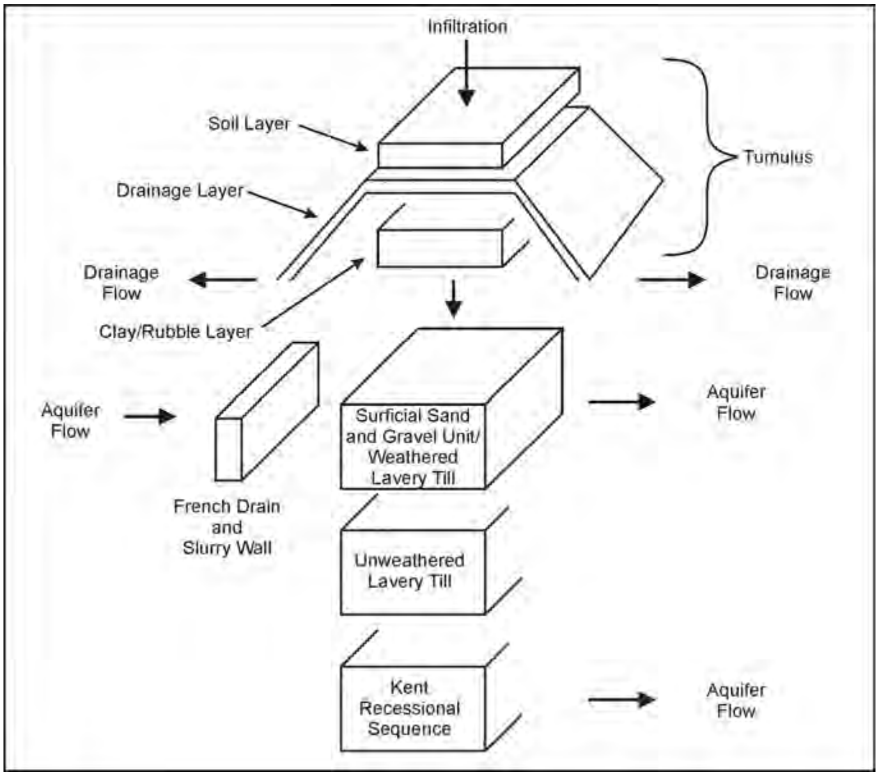

Figure G–4 Disposal System Schematic with Tumulus, French Drain, and Slurry Wall

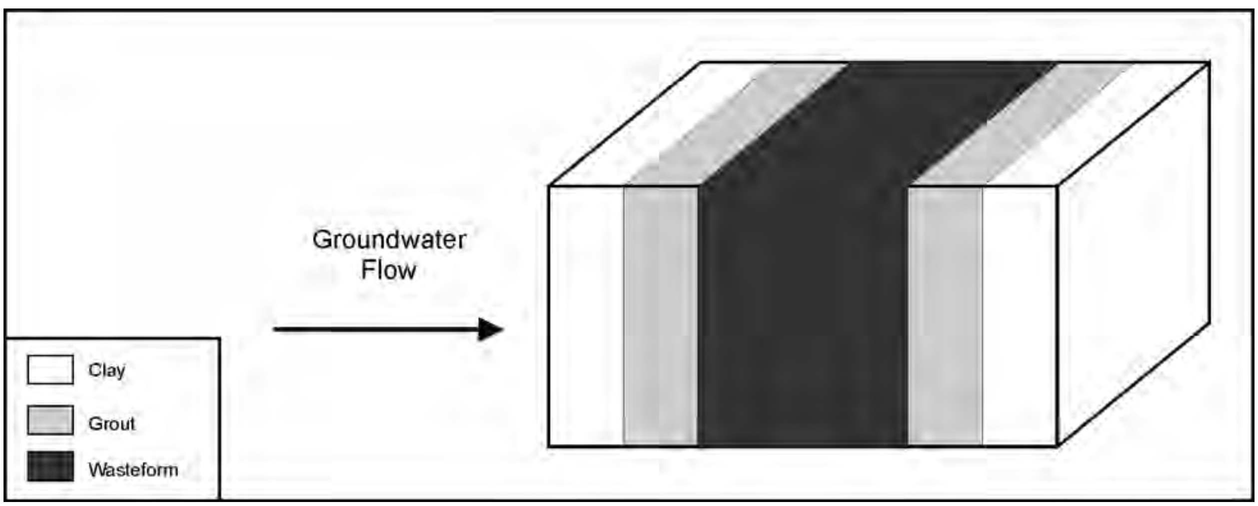

Figure G–5 Schematic for a Layered, Rectangular Geometry Wasteform

Release Model

When release rates due to diffusive or dispersion mechanisms are small relative to the release rate due to advective flow, the release rate from the wasteform may be calculated in an analytic form. The approach for this model is to use an analytic relation to calculate the release rate from the wasteform for a sequence of time periods, thereby representing the continuous release as a sequence of discrete pulses. The pulses then move through the external barriers and enter the surrounding aquifer. The flow rate of water in the aquifer approaching the wasteform may be equal to or greater than the flow rate through the wasteform. Two cases covering the range of mixing within the wasteform are considered. In the first case, constituents are continuously mixed through the wasteform and constituent concentration in the wasteform decreases over time due to release from the wasteform and due to decay (radionuclides) or chemical reaction (chemicals). In this case, some quantity of constituent is present in the wasteform for all time and the release continues indefinitely. In the second case, constituents move through the wasteform in plug flow manner and the average concentration in the wasteform is reduced by release and decay or decomposition until the entire inventory of the constituent has been released to the aquifer. In this case, the release lasts for a definite period of time that, for certain combinations of parameter values, may be relatively short. The following paragraphs describe calculation of release from the wasteform for the two modes of mixing. Following this discussion, transport through the external barriers and grouping of releases into concentration pulses for both modes of mixing is described. As described in Section G.3.1, impact periods are used for specification of time periods for calculation of human health impact and release periods are used to accumulate release quantities and facilitate calculation of concentrations of constituents in groundwater. In this rectangular geometry, analytic solution release model, values of all variables do not change with time and the data period approach is not used.

Well-Mixed Release Model

If constituent concentration in the wasteform is uniform at a given time, mass balances for a constituent may be formulated over both the solid and liquid phases of the wasteform and combined to provide a single differential equation describing constituent concentration within the wasteform. This equation is:

$$dC_l/dt = - \{ Q_w/(\varepsilon_{tw} V_w R_w) + \lambda \} C_l \qquad \text{(G–23)}$$

where:

C_l = constituent liquid phase concentration, grams per cubic meter
t = time since initiation of release, years
Q_w = volumetric flow rate through the wasteform, cubic meters per year
εt_w = total porosity of the wasteform, unitless
R_w = constituent retardation constant, unitless
V_w = volume of wasteform, cubic meters
λ = constituent decay or decomposition constant, 1 per year, and

$$R_w = 1 + [(1-\varepsilon_{tw})/\varepsilon_{tw}]\rho_w K_w \qquad \text{(G–24)}$$

where:

ρ_w = wasteform particle density, grams per cubic centimeter, and
K_w = constituent distribution coefficient, milliliters per gram.

The term on the left hand side of Equation G-23 represents depletion in the wasteform while the first and second terms on the right hand side of the equation represent loss by convective flow and decay, respectively.

The preceeding equations apply to each constituent although subscripts representing the individual constituents have been eliminated for this presentation. The initial condition required for solution of this equation is specification of the initial inventory of the constituent in the wasteform. Concentration in the wasteform at any time is:

$$C_l = I_w/(\varepsilon_{tw} V_w R_w) \exp(-a_w t) \qquad \text{(G–25)}$$

with:

$$a_w = Q_w/(\varepsilon_{tw} V_w R_w) + \lambda \qquad \text{(G–26)}$$

where I_w is the initial inventory of the constituent (grams) in the wasteform and all other variables are as defined as in preceeding equations. The instantaneous release rate from the wasteform is given by the product of volumetric flow rate through the wasteform and the constituent concentration in the wasteform. Integration of the instantaneous release rate over a period of time yields the total release for that period of time. This relation is:

$$R_{w,ip} = \{ (Q_w I_w)/(a_w \varepsilon_{tw} V_w R_w) \} \{ \exp(-a_w t_b) - \exp(-a_w t_e) \} \qquad \text{(G–27)}$$

where:

$R_{w,ip}$ = total constituent release from the wasteform during the impact period, grams
t_b = time at the beginning of the impact period, year
t_e = time at the end of the impact period, year

All other variables are as defined for preceeding equations. Repeated application of Equation G–27 is used to calculate release quantities for the set of impact periods specified for analysis.

Plug Flow Release Model

In the case of plug flow release from the wasteform, the analytic approach may be extended to simulate a non-uniform initial distribution of constituent concentration. This condition is represented schematically on **Figure G–6**, where the non-uniform spatial distribution is represented as a sequence of pulses. The variation in concentration is along the wasteform, parallel to the direction of flow through the wasteform. Specification of this initial condition involves identification of the total constituent inventory of the wasteform, the relative concentration of the pulses, and the length of the wasteform occupied by each pulse. In the plug flow concept, each pulse moves through the wasteform with the release from that pulse beginning when the lead edge of the pulse reaches the boundary of the wasteform and ending when the trailing edge of the pulse reaches the boundary of the wasteform. The concentration of constituent in each pulse decreases by decay or decomposition as the pulse moves through and is released from the wasteform. During movement through the wasteform the length of a pulse remains constant at its initial value but the quantity of material within the wasteform decreases as the pulse is released from the wasteform.

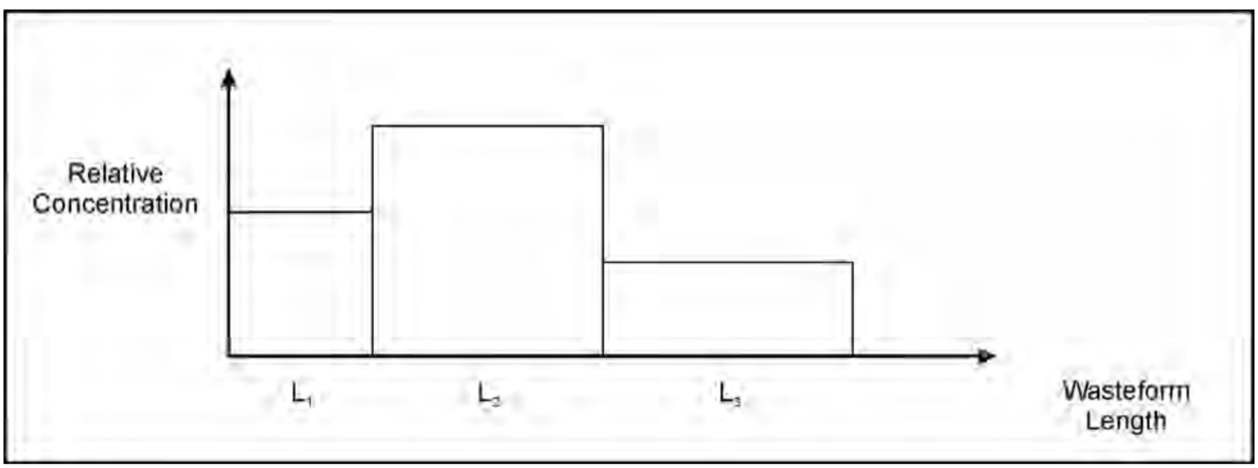

Figure G–6 Schematic of Spatial Distribution of Constituent Concentration for the Plug Flow Analytic Solution Model

As in the case of the well-mixed release model, mass balances for a constituent during its period of release may be formed for the liquid and solid phases and combined into a single differential equation. The mass balance may be expressed as:

$$d\,(L_p C_l) / dt = [\, Q_w / (\varepsilon_{tw} A_w R_w) \,]\, C_l - (L_p \lambda)\, C_l \qquad \text{(G–28)}$$

where:

L_p = length of a pulse during its release, meters
A_w = cross-sectional flow area of the wasteform, square meters

All other variables are as defined for preceeding equations for the well-mixed release case. The condition for change in constituent concentration due to decay or decomposition is:

$$d\,C_l / dt = -\lambda C_l \qquad \text{(G–29)}$$

This relation may be integrated to yield the concentration of a pulse during its release:

$$C_l = \{\, I_p / (\varepsilon_{tw} A_w L_p R_w) \,\} \exp(-\lambda t) \qquad \text{(G–30)}$$

where I_p is the constituent inventory of a pulse at the initiation of its release and all other variables are as defined above. A relation for the change in inventory of a pulse during its period of release may be derived using Equations G–28 and G–29. The mass balance and decay/decomposition relations may be combined to derive a relation for the rate of change of length of the pulse remaining within the wasteform during its period of release:

$$d\,L_p / dt = -Q_w / (\varepsilon_{tw} A_w R_w) \qquad \text{(G–31)}$$

This equation may be integrated and re-arranged to derive an expression for the length of time for release (T_p) of a pulse of initial length L_{p0}:

$$T_p = \{\, (\varepsilon_{tw} A_w R_w) / Q_w \,\}\, L_{p0} \qquad \text{(G–32)}$$

The time for decay or decomposition of any pulse prior to its release (t_d) is then the sum of the time periods of release of all prior pulses.

The instantaneous rate of release from the wasteform is the product of the volumetric flow rate through the wasteform and the constituent concentration in the wasteform at the time of release (Equation G–30). Integration of the instantaneous release rate for a pulse over time yields the release of that pulse for that period of time:

$$R_{w,ip} = \{\, Q_w / (\lambda \varepsilon_{tw} V_{p0} R_w) \,\}\, \{\, \exp(-\lambda t_d)\, I_{p0} \,\}\, \{\, \exp(-\lambda t_b) - \exp(-\lambda t_e) \,\} \qquad \text{(G–33)}$$

where:

$R_{w,ip}$ = release from a pulse from the wasteform during an impact period, grams
V_{p0} = volume of the wasteform occupied by a pulse prior to release of any pulse, cubic meters
I_{p0} = constituent inventory in a pulse before release of any pulse, grams

All other variables are as defined for preceeding equations. Repeated application of Equation G–33 is used to calculate release quantities for the set of impact periods specified for analysis.

Movement Through External Barriers

For both the well-mixed and plug flow analytic models, release quantities are determined for a sequence of pulses leaving the wasteform. The external barrier model translates these pulses through the external layers with no change in sequence but with change in length due to adsorption and decrease in magnitude due to decay or decomposition.

In the general case, the analytic release model simulates the presence of two layers surrounding the wasteform. These layers may represent grout curtains or slurry walls with constituent retention capability determined by length and constituent distribution coefficient specified for the particular design under consideration. For example, for a given constituent and volumetric flow rate through the engineered system, the travel time for movement of the constituent through a grout layer is given by:

$$T_g = L_g / [Q_g/(\varepsilon_{eg} A_g R_g)] \tag{G–34}$$

where:

T_g = constituent travel time through the grout layer, years
L_g = length of grout layer, meters
Q_g = volumetric flow rate through the grout layer, cubic meters per year
ε_{eg} = effective porosity of the grout, unitless
A_g = flow area of the grout layer, square meters
R_g = constituent retardation coefficient for grout, unitless

Similar relations apply for slurry wall or clay layers. Within this model concept, the flow area and volumetric flow rates for the external layers (grout, slurry wall or clay) are equal to the flow area and volumetric flow rate for the wasteform.

Given the above considerations, the release quantity for the engineered system is derived from the release quantity for the wasteform by the relations:

$$R_{ip} = 0.0 \qquad \text{for } t < t_t$$

$$R_{ip} = R_{w,ipw} \exp(-\lambda t_i) \qquad \text{for } t > t_t \tag{G–35}$$
$$ip = i_{pw} + (t_t / \Delta t_{ip})$$

where:

R_{ip} = release from the engineered system during impact period ip, grams
$R_{w,ipw}$ = release from the wasteform during impact period ipw, grams
t_t = constituent travel time through all external layers, years
Δt_{ip} = length of time of an impact period, years

Grouping of Release Pulses

Estimates of human health impacts are calculated on an annual basis for long periods of time. In contrast, releases of constituents may occur over shorter periods of time and the intervals of release of differing constituents may or may not overlap. Thus, reporting of the release quantity for all constituents for each year of the total time specified for calculation of impact produces inefficient utilization of calculation resources. In order to provide efficient use of analysis resources, release quantities are calculated for each constituent for each impact period specified for calculation of impact, but these releases are then grouped into a number of pulses defined for release periods that, in general, are longer in duration than an impact period. Release quantities for release periods are then used in calculation of impacts. Because of the use of maximum impact for comparison with performance criteria, the approach used for release grouping preserves the release for the impact period of maximum release as an individual release period and gathers the remaining releases into the remaining release periods. Using this grouping approach, periods of high release are represented at greater level of detail than periods of low release allowing more precise estimation of peak impacts. The algorithm used for grouping of releases is presented on **Figure G–7**. Constituent concentration in groundwater at the release point to the aquifer is calculated for each release period by dividing the total release for the release period by the aquifer flow passing around the wasteform during the release period.

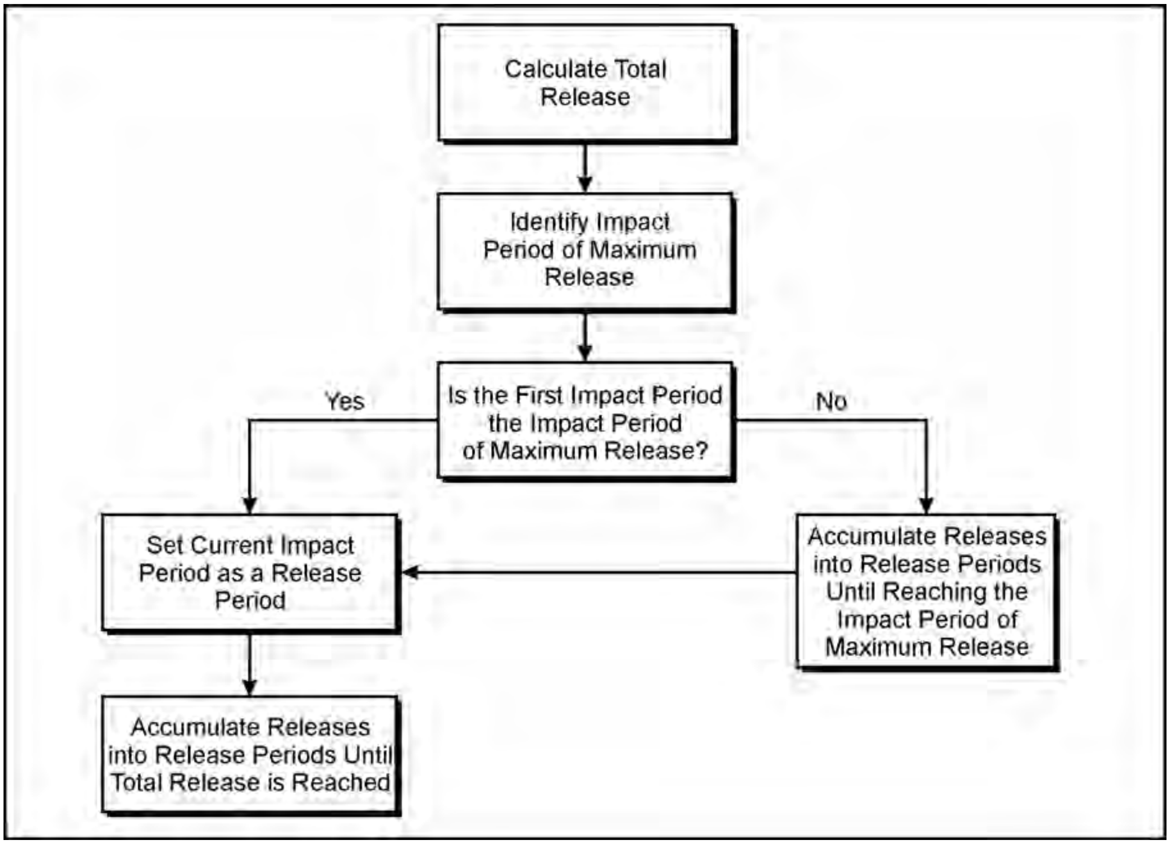

Figure G–7 Algorithm for Grouping Impact Period Releases into Release Period Releases

G.3.2.2 Rectangular Geometry, Finite Difference Release Model

Closure designs under consideration for the Main Plant Process Building, Vitrification Facility, and Waste Tank Farm include a tumulus covering an above-grade rubble pile and below-grade rectangular wasteforms that may or may not be grouted. The portion of the Surficial Sand and Gravel Unit below the tumulus would be enclosed by a slurry wall for the Sitewide Close-In-Place Alternative. The wasteform may be composed of three layers; for example, upper and lower clay layers bounding a grout layer. The primary features of the tumulus are soil, drainage, and clay layers designed to minimize the rate of flow of water through the wasteform. The drainage layer has high hydraulic conductivity and serves as a preferential flow path routing vertical infiltration away from the wasteform. The clay and grout layers have low hydraulic conductivity presenting a high-resistance path for flow through the wasteform. The slurry wall has low hydraulic conductivity and serves to divert horizontal flow around the soil volume below or surrounding the wasteform. In addition, the grout, clay, and slurry wall layers have sorptive properties that retard radionuclide movement through the system. A schematic diagram of the system is that presented on Figure G–4. Analysis of groundwater flow through the tumulus is presented in Appendix E. The model is used to simulate releases from the Main Plant Process Building, the Vitrification Facility, and the Waste Tank Farm (vertical direction) for the Close-In-Place Alternative.

Given the previously-described configuration of the natural and engineered systems, constituents may be released to groundwater by diffusive or convective downward movement to the soil zone below the rubble pile or below- grade wasteforms or by horizontal movement through the below-grade wasteforms. The model developed to simulate this system involved calculation of release rate from the wasteform in downward vertical or horizontal transport to the aquifer surrounding the wasteform. For estimation of release rate from the wasteform, a model of the finite-difference type is needed to simulate the non-uniform spatial distribution of physical properties and radionuclide inventories and the time dependence of physical properties. The following sections describe elements of the release model.

Wasteform Release Model

The wasteform release model simulates advective, dispersive, and diffusive release of constituents from a rectangular block comprising three layers. The primary direction of flow through the wasteform may be parallel or perpendicular to the primary direction of flow of the aquifer. Physical properties are uniform within each layer but may differ between layers. The interstitial velocity and tortuosity in the central layer of the wasteform may vary with time and the initial spatial distribution of concentration of constituents may vary in the vertical direction. The initial concentration of constituents is specified as a piecewise continuous function of vertical or horizontal position. The time dependence of physical properties is established by definition of a set of data periods within which the values of physical properties are constant. The values of the physical properties may change between data periods. The layered spatial dependence of physical properties is simulated by formation of separate activity balances for each layer and the enforcement of the condition of continuity of flux across the interface between layers (Carnahan, Luther and Wilkes 1969). The mass balance for a constituent for any layer is:

$$R\, \partial C/\partial t \;-\; D\, \partial^2 C/\partial z^2 \;+\; v\, \partial C/\partial z \;+\; \lambda R C \;=\; 0 \qquad \text{(G–36)}$$

where:

- R = constituent retardation coefficient, unitless
- C = constituent concentration, grams per cubic meter
- t = time, years
- D = dispersion coefficient, square meters per year
- z = distance in the vertical direction, meters
- v = interstitial velocity, meters per year
- λ = constituent decay constant, 1 per year

The balances are solved using a fully implicit finite difference method defined on a time and one-dimensional space mesh. In this method, the differential equation is replaced by a set of difference equations established at each space node of the wasteform at each time step. The difference forms used are central difference approximation to the first order spatial derivative and Crank-Nicholson approximation to the combination of the time derivative and the second order spatial derivative. At each time step, the difference equations are of the form:

$$\mathbf{A}\,\mathbf{C} = \mathbf{B} \qquad \text{(G–37)}$$

where:

- $\mathbf{A}$ = matrix of coefficients ($a_{j,k}$) defined at each space node j, for adjacent nodes, k
- $\mathbf{C}$ = matrix of concentrations (c_k) defined at each space node k; and
- $\mathbf{B}$ = vector of constants (b_j) defined at each space node, j.

This representation is consistent with the differential equation, the solution method is stable, and the solution of the difference equations converges to the solution of the differential equation (Fletcher 1991). The system of difference equations is of tridiagonal form and is solved using the Thomas algorithm (Fletcher 1991). At the upper boundary of the wasteform, the concentration is specified as negligible. At the lower boundary, the concentration is established by mixing into the horizontal aquifer flow passing below the wasteform. The solution method is second order accurate in time and space. Mass balances accumulated throughout the calculations are used to record the accuracy of the solution process. Space and time steps are adjusted in the code in accordance with values of Peclet and Courant number specified as input data.

The order in which calculations are performed for the wasteform release model is summarized on **Figure G–8**. The initial step is the specification of values of parameters whose values do not change with time and definition of the mesh of space nodes for the specified spatial integration step size. At the next step, data periods are initialized or updated and values of time dependent parameters are established. Next, the matrix of coefficients (**C**) of the set of difference equations is calculated. Values of coefficients within this matrix depend on retardation coefficient, interstitial velocity in the wasteform, dispersion coefficient, decay constant, and time and space step size but do not change with time within a data period. The index for time steps within a data period is then updated and the vector of constants (**B**) is calculated. Definitions of release, impact and data period are presented in Section G.3.1. Coefficients in this vector depend on physical properties as in the matrix of coefficients, but also depend on the values of concentration at the prior time step which are time dependent values. The simultaneous linear equations are solved, yielding the concentration profile at that time step and allowing calculation of release quantity and accumulation of the mass balance. The preceeding steps are repeated for a specified number of time steps within each data period and for all data periods. At this stage, release quantities from the wasteform have been calculated for all impact periods.

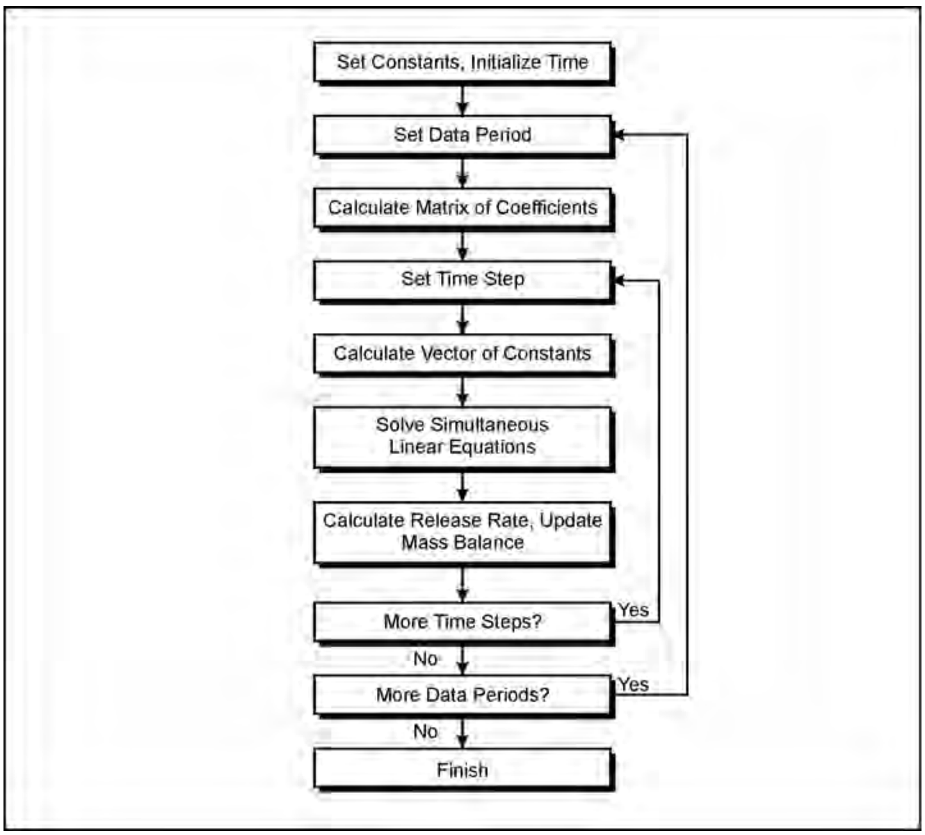

Figure G–8 Solution Algorithm for the Rectangular Geometry, Finite Difference Solution Release Model

The final calculation in this module is grouping of the releases for impact periods into concentrations in the aquifer for release periods. This calculation is performed using the method described in Section G.3.2.1.

Constituent concentrations at the release point to the aquifer are calculated for each release period by dividing the total release for the release period by the aquifer flow passing around the wasteform during the release period.

G.3.2.3 Cylindrical Geometry, Finite Difference Release Model

Closure designs under consideration for the Waste Tank Farm include placement of a tumulus over the tanks, grouting of the interior of the tanks, grouting of the annular space surrounding the tank, and construction of a slurry wall surrounding the tank area. In addition, approximately 3 meters (10 feet) of compacted backfill till surround Tank 8D-1 and Tank 8D-2. The grout, backfill, and slurry wall system have low hydraulic conductivity and divert groundwater flow around the tanks. In addition, the grout and slurry wall components have sorptive capabilities that retard movement of constituents through the system. The tanks are located in an excavation in the thick-bedded unit that extends downward into the unweathered Lavery till and includes a layer of gravel below the tanks. The three-dimensional near-field flow model described in Appendix E indicates that groundwater will enter the excavation and a portion will flow around and through the tanks in the horizontal direction and exit the excavation into the thick-bedded unit. In addition, a portion of the available groundwater will move downward through the tank into the underlying gravel layer and exit the excavation into the thick-bedded unit and the unweathered Lavery till. A schematic of the tank and adjacent layers of the tank closure system is presented on **Figure G–9**. A schematic of the overall closure system is presented on Figure G–4.

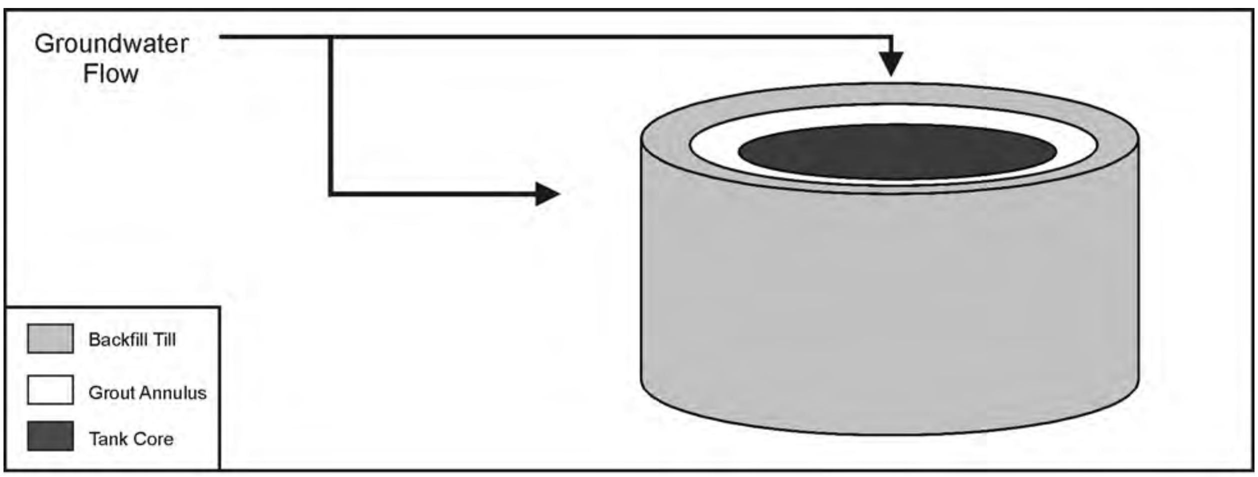

Figure G–9 Schematic of the Tank Closure System

Release may occur by advection, dispersion, and diffusion; material properties may change with time and the radionuclide inventory has a non-uniform distribution in the radial direction. For the Close-In-Place Alternative, flow rates through the tank are low due to the presence of grout; the radial distribution of concentration of contamination may be important in determining rate of release; and flow in the horizontal direction may compete with flow in the vertical direction. In this case, use of the cylindrical geometry, finite difference release model is appropriate. The elements of the release model are described in the following paragraphs.

Release Model

The wasteform release model simulates advective, dispersive, and diffusive release of constituents from a cylinder comprising two layers. Physical properties are uniform within each layer but may differ between layers. The interstitial velocity and tortuosity in the central core of the cylinder, representing the grout core and annulus of the tank, may change with time. The initial spatial distribution of constituent concentration may vary in the radial direction and is specified as a piecewise continuous function of radial position. The time dependence of physical properties is specified through use of a set of data periods. Values of physical properties are constant within a data period but may change between data periods. The spatial dependence of physical properties is simulated by forming separate activity balances in the grout and slurry wall regions and enforcing a condition of equality of flux at the interface between the layers (Carnahan, Luther, and Wilkes 1969). The mass balance for a constituent in any layer is:

$$(\varepsilon_t R)\, \partial C/\partial t \;-\; (\varepsilon_e\, D)\, \partial^2 C/\partial r^2 \;-\; [(\varepsilon_e D)/r^2)]\, \partial^2 C/\partial \theta^2 \;+ \qquad \text{(G–38)}$$

$$\varepsilon_e\, [v_r - (D/r)]\, \partial C/\partial r \;+\; [(\varepsilon_e\, v_\theta)/r]\, \partial C/\partial \theta \;+ \varepsilon_e\, R\, \lambda\, C \;=\; 0$$

$$D \;=\; D_h v_y + (D_w/\tau)$$

$$v_r \;=\; -\, v_y \cos\theta$$

$$v_\theta \;=\; v_y \sin\theta$$

where:

C	=	constituent concentration in the liquid phase, grams per cubic meter,
ε_t	=	total porosity, unitless
R	=	constituent retardation coefficient, unitless
t	=	time, years
ε_e	=	effective porosity, unitless
D	=	dispersion coefficient, square meters per year
D_h	=	dispersivity, meters
D_w	=	constituent diffusion coefficient in water, square meters per year
τ	=	tortuosity, unitless
r	=	distance in the radial direction, meters
θ	=	distance in the azimuthal direction, radians
v_r	=	velocity in the r direction, meters per year
v_θ	=	velocity in the θ direction, meters per year
v_y	=	velocity in the y direction, meters per year
λ	=	constituent decay or decomposition constant, 1 per year

The coordinate system used represents the cylinder as divided into four quadrants with azimuthal direction defined as positive in the counter-clockwise direction from the vertical centerline of Quadrant 1. The directions of the coordinate axes are chosen so that the groundwater velocity is parallel to the y direction indicated on **Figure G–10**. The finite difference method used to solve Equation G–38 uses a spatial mesh defined on radial (r) and angular (θ) coordinates, on which values of constituent concentration are calculated at a series of time steps. The alternating direction-implicit method is used to represent the differential equation as a set of difference equations. The difference forms are centered for first order spatial derivatives and Crank-Nicholson for the combination of the time derivative and the second order spatial derivatives. The difference equation is consistent with the differential equation, the method is stable, and the solution of the difference equations converges to the solution of the differential equation (Fletcher 1991). Concentrations at the boundary are established by mixing the constituent release into the aquifer flow passing around the wasteform. Time step size is adjusted within the code in accordance with a value of Courant number specified as input data.

The order in which calculations are performed is the same as that represented on Figure G–8 for the rectangular, finite difference release model. The methods differ in that the alternating direction method solves the difference equations twice to proceed through a single time step. On the first pass, concentrations are calculated at an intermediate time along diameters extending from Quadrant 3 through Quadrant 1 using implicit difference forms for derivatives taken with respect to radial position and explicit difference forms for derivatives taken with respect to angular position. Concentrations in Quadrants 2 and 4 are calculated by reflection of these results based on symmetry considerations. On the second pass, concentrations for Quadrants 1 and 2 are calculated for the end of the time step using explicit difference forms for derivatives taken with respect to radial position and implicit difference forms for derivatives taken with respect to angular position. Concentrations for Quadrants 3 and 4 are obtained by reflection of the values for Quadrants 1 and 2. Constituent concentration profile and release to the aquifer are calculated at each time step and release quantity is accumulated over impact periods. The mass balance check is updated at each time step.

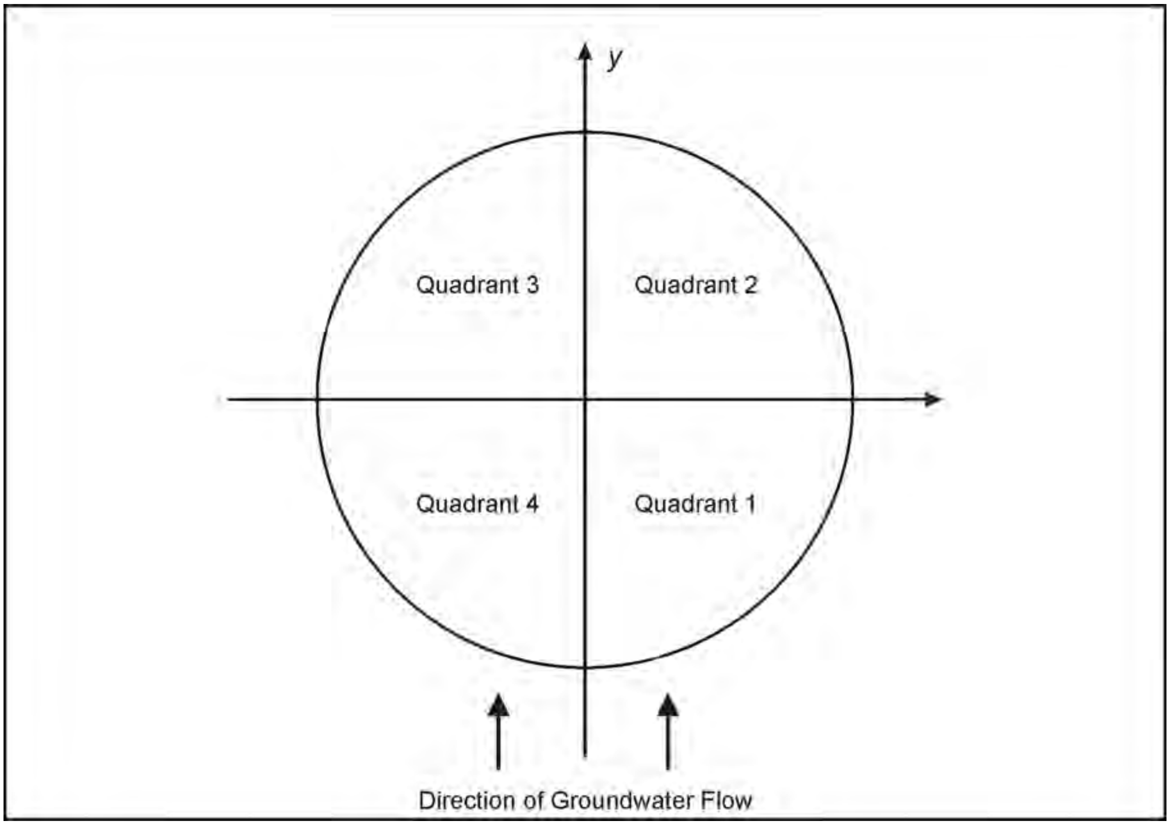

Figure G–10 Schematic of the Cylindrical Model Coordinate System

Grouping of Release Rates

The algorithm used for grouping releases for impact periods into releases for release periods is the same as that described in Section G.3.2.1. Constituent concentration at the release point to the aquifer is calculated for each release period by dividing the release for that release period by the aquifer flow passing around the wasteform during that release period.

G.3.3 Groundwater Transport Module

The concept adopted for analysis of groundwater transport of constituents is that of a flow tube with rectangular cross-section in which groundwater moves at constant velocity and constituents are subject to longitudinal diffusion and dispersion, decay, and reversible exchange between the liquid and solid phases in the aquifer. The value of groundwater velocity used in the flow tube model is derived from the three-dimensional groundwater models described in Appendix E. Mass balances for a constituent are formulated in the liquid and solid phases and combined to derive a single partial differential equation for constituent concentration in the aquifer:

$$R\, \partial C/\partial t \;-\; D\, \partial^2 C/\partial x^2 \;+\; v\, \partial C/\partial x \;+\; R\lambda C \;=\; 0 \qquad \text{(G–39)}$$

where:

C	=	constituent concentration, grams per cubic meter
t	=	time, years
D	=	dispersion coefficient, square meters per year
x	=	position in aquifer, meters
v	=	interstitial velocity of groundwater, meters per year
R	=	constituent retardation coefficient, unitless
λ	=	constituent decay or decomposition constant, 1 per year

Two solutions are developed for this equation: one for localized sources, such as stabilized facilities, and one for distributed sources, such as the North Plateau Groundwater Plume. The two solutions differ in the initial and boundary conditions established to complete specification of the model and in the method of solution of the resulting equations.

G.3.3.1 Localized Sources

For localized sources, the initial and boundary conditions used in conjunction with the mass balance are zero concentration throughout the aquifer at time equal to zero (C = 0 for all x at t = 0) and constant concentration at the release point to the aquifer for all time ($C = C_0$ for all t at x = 0). Given these conditions, the solution to the equation may be expressed as (van Genuchten and Alves 1982):

$$C(x,t) \;=\; (1/2)\exp\{ (v-u)x/2D \}\,\mathrm{erfc}\{X1\} \;+\; (1/2)\exp\{ (v+u)x/2D \}\,\mathrm{erfc}\{X2\}$$

$$u \;=\; \sqrt{(v^2 + 4\lambda R D)}$$

$$X1 \;=\; (Rx - ut) / 2\sqrt{(DRt)} \qquad \text{(G–40)}$$

$$X2 \;=\; (Rx + ut) / 2\sqrt{(DRt)}$$

where erfc(X) is the complementary error function of the argument X and all other variables are as defined for Equation G–39.

The functions presented as Equation G–40 describe the concentration in the aquifer caused by a step function in concentration at the release point to the aquifer. In contrast, the release module used in conjunction with this groundwater transport module specifies pulses in concentration at the release point to the aquifer. The response to a pulse function is constructed by adding and subtracting at appropriate time intervals the response to a step function. Thus, a single pulse at the release point to the aquifer is represented as the sum of a positive step function beginning at the start time of the pulse and a negative step function beginning at the end time of the pulse. The response to multiple pulses is represented by repeated application of the above approach. The algorithm used for this purpose is presented on **Figure G–11**.

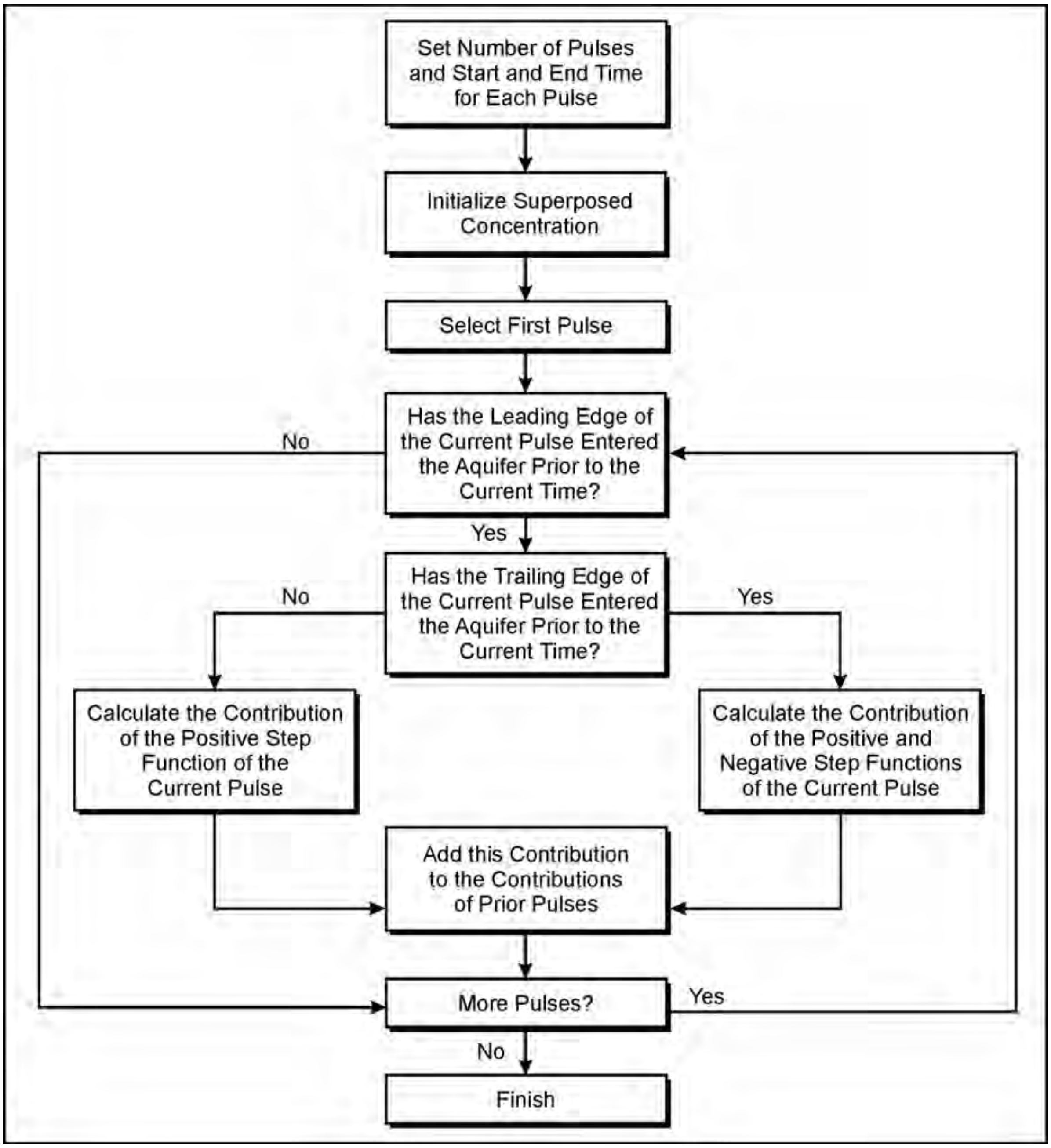

Figure G–11 Algorithm for Accumulation of Concentration Pulses

G.3.3.2 Distributed Sources

The distributed source of primary concern at the site is a plume of contamination that developed in the Surficial Sand and Gravel Unit on the North Plateau following a leak of acidic solution from the Process Building. The near-field flow model used in conjunction with the distributed source groundwater transport model is the tumulus and slurry wall combination depicted on Figure G–4. The approach for solution of the groundwater transport equation (Equation G–39) is similar to that described for the rectangular geometry, finite difference release model. The flow domain is divided into a one-dimensional mesh and the partial differential equation is replaced by a set of algebraic equations using finite difference forms producing an equation set of the form of Equation G–37. Solution of the set of equations provides concentration at nodes defining the mesh and rate of release to the creek located at the upstream end of the flow domain. An initial condition and two boundary conditions are required to solve the set of algebraic equations. The initial condition is specification of concentration of the constituent (radionuclide or hazardous chemical) at each node of the flow domain at the start time for the simulation.

The groundwater velocity is constant throughout the flow domain and the boundary condition specified at the upstream end of the flow domain is zero concentration of the contaminant. At the downstream end of the flow domain, the boundary condition is zero gradient in concentration of contaminant in groundwater exiting the flow domain.

G.3.4 Human Health Effects Impact Module

The human health effects impact module estimates annual impact at a specified time to one of four types of receptors due to exposure to either a radionuclide and its progeny or a hazardous chemical. The three primary functions performed in developing the estimate of impact are calculation of ingrowth and decay, calculation of concentration of hazardous constituents in soil, and calculation of measures of health impact for differing types of receptors. Information used to initiate the calculation includes concentration of the parent radionuclide or hazardous chemical in groundwater at the access point, interstitial velocity of groundwater in the aquifer, and distance between the release point and the access point. Time for ingrowth and decay is calculated by dividing distance between the release point and the access point by the interstitial velocity of the radionuclide in the groundwater. The interstitial velocity of the constituent in groundwater is the interstitial velocity of the groundwater divided by the constituent retardation coefficient. Physical property information used to support the calculation includes decay constants for radionuclides and hazardous chemicals, decay chain structure for radionuclides, distribution coefficients for all constituents, and garden irrigation and infiltration rates. The order in which calculations are performed is represented on **Figure G–12**. The following sections describe methods used to perform the three primary functions.

G.3.4.1 Calculation of Ingrowth and Decay

During transport in groundwater, radioactive or chemical constituents may decay or decompose to alternate species. Decomposition or reaction of chemical constituents depends in a complicated manner on site conditions and presence or absence of microbial organisms. Because these conditions are difficult or impossible to know in advance, concentrations of hazardous chemicals were conservatively assumed to be unaffected by chemical or microbial degradation. Concentrations of radionuclides, however, vary due to ingrowth and decay in predictable, time-dependent manner. In order to provide impact estimates for all potential constituents, the ingrowth of progeny during groundwater transport of their parent nuclides was included in the analysis. The balance of this section describes the method used to estimate rates of ingrowth and decay of radionuclides.

A suite of 72 radionuclides has been developed for consideration in dose analysis. These 72 radionuclides have been organized into 22 decay chains having one or more members. Of the 22 decay chains, 15 include a single radionuclide. The following paragraphs describe the procedure used to calculate ingrowth for decay chains involving one or more progeny.

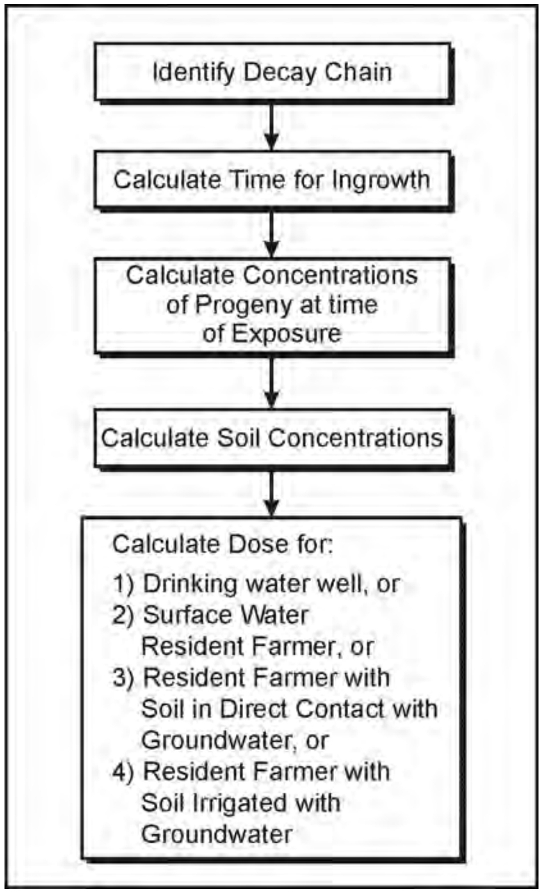

Figure G–12 Order of Calculations for the Human Health Effects Impact Module

A decay chain may be represented as:

$$A_1 \rightarrow A_2 \rightarrow A_3 \rightarrow \ldots A_m \rightarrow A_s \qquad \text{(G–41)}$$

Where A_n represents the nth radioactive nuclide in the chain, A_m represents the final radioactive nuclide in the chain and A_s represent the stable nuclide that terminates the chain. The rates of change of the number of atoms of each nuclide may be expressed as:

$$
\begin{aligned}
dN_1/dt &= -\lambda_1 N_1 \\
dN_2/dt &= \lambda_1 N_1 - \lambda_2 N_2 \\
&\;\;. \\
&\;\;. \qquad \text{(G–42)} \\
&\;\;. \\
dN_n/dt &= \lambda_{n-1} N_{n-1} - \lambda_n N_n
\end{aligned}
$$

where N_n and λ_n represent the number of atoms and decay constant of the nth nuclide in the chain, respectively. The initial condition adopted for solution of this system of equations is that the number of atoms of the parent (first) nuclide is known ($N_{1,0}$) and all other nuclides are not present initially. The solution to the equations may be expressed as (Benedict, Pigford and Levy 1981):

$$N_1 = N_{1,0} \exp(-\lambda_1 t)$$

$$N_n = N_{1,0} \lambda_1 \lambda_2 \cdots \lambda_{n-1} \left\{ \sum_{j=1}^{n} \left[\exp\left(-\lambda_j t\right) / \prod_{\substack{k=1 \\ k \neq j}}^{n} (\lambda_k - \lambda_j) \right] \right\} \qquad \text{(G–43)}$$

where all variables are as defined for Equation G–42. The algorithm used for the ingrowth calculation for a given nuclide, initial inventory and time is summarized on **Figure G–13**. Details that support implementation of the algorithm include definition of a unique index for each nuclide, an index relating a nuclide to its chain, and an index identifying the order of a nuclide in a chain.

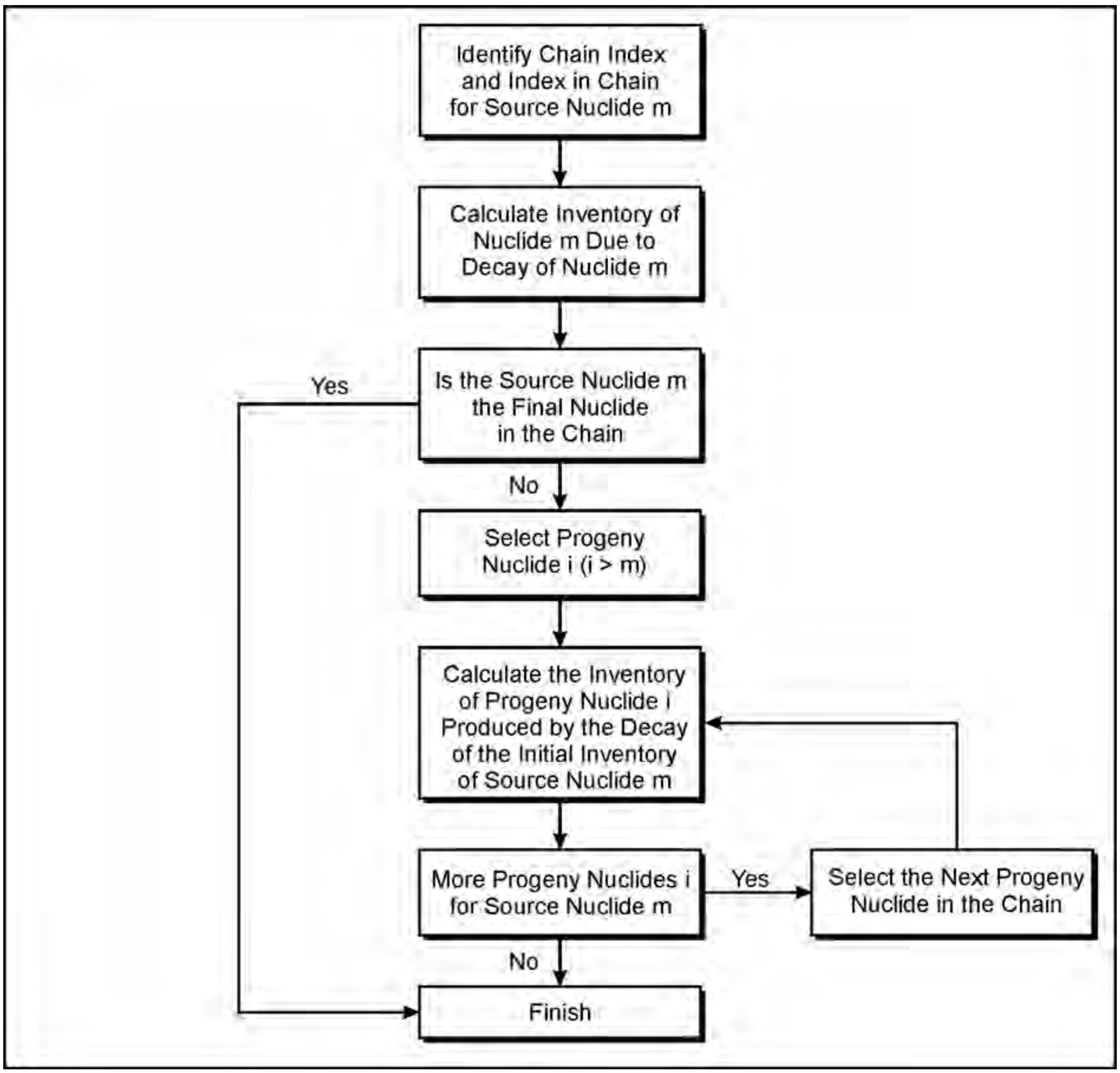

Figure G–13 Algorithm for Radionuclide Ingrowth Calculations

G.3.4.2 Calculation of Concentrations of Hazardous Constituents in Soil

Calculation of concentration of hazardous (radioactive and chemical) constituents in soil is required for two types of exposure scenarios. In the first scenario, groundwater transporting hazardous constituents directly contacts near-surface soil and an individual establishes a residence and garden in the contaminated soil. Because the groundwater transport model represents reversible contact with soil, the concentration of hazardous constituent in soil in contact with contaminated groundwater is given by:

$$C_s = f_v K C_w \tag{G–44}$$

where:

C_s = concentration in soil of hazardous constituent, grams per gram
C_w = constituent concentration in groundwater, grams per cubic meter
f_v = volumetric conversion constant, 1×10^{-6} cubic meters per milliliter
K = distribution coefficient, milliliters per gram

In the second type of scenario, water containing hazardous constituents, either contaminated groundwater produced from a well or surface water recharged by contaminated groundwater, is used to irrigate surface soil. An individual establishes a residence and garden in the soil contaminated in this indirect manner. Initially, the constituent is not present in the soil but the concentration develops with time of irrigation. For this case, the concentration of the constituent in soil is determined by a mass balance formed over the volume of surface soil. Variables determining the time-varying soil concentration include the irrigation rate, the infiltration rate and the distribution coefficient of the constituent. The mass balance is:

$$dC_g/dt = - [V_{inf} / (\varepsilon_g H_g R_g)] C_g + [V_{irg} / (\varepsilon_g H_g R_g)] C_{gw} \tag{G–45}$$

where:

C_g = constituent concentration in groundwater in the garden, grams per cubic meter
t = time, years
V_{inf} = infiltration rate, meters per year
ε_g = porosity of soil in the garden, unitless
H_g = thickness of soil layer in the garden, meters
R_g = retardation coefficient for garden soil, unitless
V_{irg} = irrigation rate, meters per year
C_{gw} = constituent concentration in irrigation water, grams per cubic meter

The solution to this equation is:

$$C_{g,e} = C_{g,b} \exp [-a_g(t_e - t_b)] + (b_g/a_g) C_{gw} \{ 1 – \exp [-a_g(t_e – t_b)] \} \tag{G–46}$$

$$a_g = V_{inf} / (\varepsilon_g H_g R_g)$$

$$b_g = V_{irg} / (\varepsilon_g H_g R_g)$$

where:

$C_{g,e}$ = concentration in groundwater in the garden at the end of the time period, grams per cubic meter
$C_{g,b}$ = constituent concentration in groundwater in the garden at the beginning of the time period, grams per cubic meter
t_b = time at the beginning of the time interval, years
t_e = time at the end of the time period, years

All other variables are as defined for Equation G–45. Equation G–46 is evaluated in each instance the health impact calculation is implemented and the concentration of the hazardous constituent in groundwater in the garden is continuously updated. The concentration of the hazardous constituent in the soil in the garden is:

$$C_{g,s} = f_v K_g C_g \qquad \text{(G–47)}$$

where:

$C_{g,s}$ = constituent concentration in soil in the garden, grams per gram
C_g = constituent concentration in groundwater in the garden, grams per cubic meter
f_v = volumetric conversion constant, 1×10^{-6} cubic meters per milliliter
K_g = distribution coefficient, milliliters per gram

G.3.4.3 Calculation of Measures of Human Health Impact

Modules calculating dose and risk for radionuclides and Hazard Quotient and risk for chemical constituents have been developed. The structure of the two modules is the same and each calculates impacts for each constituent of a specified set of constituents at specified times for specified receptor types. For radionuclides, the calculation includes summing over progeny and accumulates the dose and risk due to progeny in the dose and risk due to the parent. Four types of receptor are considered:

- drinking-water well receptor
- surface-water receptor
- residential farmer receptor obtaining drinking water from a well and contacting soil in direct contact with contaminated groundwater, or obtaining drinking water from a well and contacting soil contaminated with irrigation water from a well
- resident without a farm who may engage in recreational hiking

The following paragraphs describe calculation methods for estimation of impact for these four types of receptor. Exposure pathways for residential farmer receptors are presented in Section G.2.1. Cumulative impacts of a mixture of radionuclides or chemicals are estimated as the sum of the impacts of the individual constituents.

Use of Groundwater for Drinking Water

For a receptor using well water for drinking water, dose due to ingestion of a radionuclide is estimated as:

$$D_{dw} = \Sigma \left(C_{gw} \, IR_{dw} \, DCF_{ing} \right) \qquad \text{(G–48)}$$

where:

D_{dw} = drinking water dose, rem per year
C_{gw} = radionuclide concentration in groundwater, curies per cubic meter
IR_{dw} = drinking water consumption rate, cubic meters per year
DCF_{ing} = dose conversion factor for ingestion, rem per curie

The summation is taken over radionuclides in the decay chain.

Lifetime risk for the radionuclide is estimated as:

$$R_{dw} = \Sigma (f_a \, IR_{dw} \, ED_{dw} \, SF_{dw} \, C_{gw}) \qquad \text{(G–49)}$$

where:

R_{dw} = lifetime risk due to ingestion of the radionuclide in drinking water, unitless
ED_{dw} = exposure duration for the drinking water scenario, years
SF_{dw} = Health Effects Assessment Summary Table (HEAST) radionuclide-specific slope factor for drinking water ingestion, 1 per picocurie
f_a = conversion constant, 1×10^{12} picocuries per curie

Other variables are as defined for Equation G–48 and the summation is taken over radionuclides in the decay chain.

For ingestion of a chemical in drinking water, intake is defined as:

$$I_{dw} = (f_m / f_t) \; \{ (IR_{dw} \, EF_{dw} \; ED_{dw}) / (BW \; AT) \} \; C_c \qquad \text{(G–50)}$$

where:

I_{dw} = chronic intake rate of chemical contaminant in drinking water, milligrams per kilogram-day
C_c = concentration of chemical contaminant in water, grams per cubic meter
EF_{dw} = exposure frequency for drinking water ingestion, days per year
BW = body weight, kilograms
AT = averaging time, days
f_m = conversion constant, 1,000 milligram per gram
f_t = conversion constant, 365 days per year

Other variables are as defined for Equations G–48 and G–49.

For noncarcinogenic constituents, the Hazard Quotient is calculated as:

$$HQ_{dw} = I_{dw} / RfD \qquad \text{(G–51)}$$

where:

HQ_{dw} = Hazard Quotient for ingestion of the chemical contaminant in drinking water, unitless
RfD = IRIS reference dose for chronic ingestion of the chemical contaminant, milligrams per kilogram-day

I_{dw} is as defined for Equation G–50.

For carcinogenic constituents, lifetime risk is estimated as:

$$R_{dw} = I_{dw} \; SF_{ing} \qquad \text{(G–52)}$$

where:

SF_{ing} = IRIS slope factor for ingestion of the chemical contaminant, 1 per milligram per kilogram-day

I_{dw} is as defined for Equation G–50.

Use of Surface Water

Use of contaminated surface water involves drinking water and fish consumption and residential farmer exposure. Discharge of contaminated groundwater to a stream may also contaminate soil along the bank of the stream. The hazard associated with contaminated soil on the bank of the stream is estimated using recreational hiking and deer consumption pathways. Dose for drinking water is calculated using Equation G–48 with the substitution of surface water for groundwater as the source media. Dose for fish consumption is calculated as:

$$D_f = \Sigma \{ C_{sw} (B_f/f_v) IR_f DCF_{ing} \} \qquad \text{(G–53)}$$

where:

D_f = dose due to consumption of fish, rem per year
C_{sw} = radionuclide concentration in surface water, curies per cubic meter
B_f = radionuclide bioaccumulation factor for fish, picocuries per kilogram per picocurie per liter
f_v = conversion constant, 1,000 liters per cubic meter
IR_f = consumption rate for fish, kilograms per year
DCF_{ing} = dose conversion factor for ingestion, rem per curie

The summation indicates accumulation of dose for parent and progeny.

Lifetime risk due to ingestion of the radionuclide in fish is calculated as:

$$R_f = \Sigma [C_{sw} (B_f/f_v) IR_f \; f_a ED_f SF_f] \qquad \text{(G–54)}$$

where:

R_f = lifetime risk for ingestion of contaminant in fish, unitless
SF_f = HEAST slope factor for food ingestion, 1 per picocurie
ED_f = exposure duration for fish consumption, years
f_a = conversion constant, 1×10^{12} picocuries per curie

Other variables are as defined for Equation G–53 above and the summation is taken over progeny of the parent radionuclide.

Dose due to residential farmer exposure pathways is estimated as:

$$D_{ra} = \Sigma \; (C_s D_{rf}) \qquad \text{(G–55)}$$

where:

D_{ra} = dose for residential farmer, rem per year
C_s = radionuclide concentration in soil, picocuries per gram
D_{rf} = RESRAD unit dose factor for residential farmer exposure, rem per year per picocurie per gram

The summation is taken over radionuclides in the decay chain.

Lifetime risk due to residential farmer exposure is estimated as:

$$R_{ra} = \Sigma \; (C_s ED_{ra} R_{rf}) \qquad \text{(G–56)}$$

where:

R_{ra} = lifetime risk for residential farmer, unitless
C_s = radionuclide concentration in soil, picocuries per gram
ED_{ra} = exposure duration for residential farmer, years
R_{rf} = RESRAD unit risk factor for residential farmer exposure, 1 per year per picocurie per gram

The summation is taken over parent and progeny. For the surface water access point receptor, the radionuclide concentration in soil used in Equations G–55 and G–56 is calculated using Equation G–47.

In the recreational hiking and deer consumption scenarios, groundwater contaminates soil over an area equal to the projection of the area of the contaminated portion of the aquifer on the bank of the stream. In the recreational hiking scenario, an individual walks along the length of the contaminated area each day of the year. Time of exposure per day is determined by dividing the width of the contaminated portion of the aquifer by the rate of walking. Exposure pathways for radionuclides are direct external exposure, inadvertent ingestion of soil, and inhalation of fugitive dust. Unit dose and risk factors for the combined pathways were calculated using the RESRAD computer code (Yu et al. 2001). Dose is estimated as:

$$D_{rec} = \Sigma\,(f_{Trec}\ \ DU_{rec}\ \ C_s) \qquad \text{(G–57)}$$

where:

D_{rec} = dose due to recreational hiking, rem per year
f_{Trec} = fraction of time spent in recreation, unitless
DU_{rec} = unit dose factor for recreation, rem per year per picocurie per gram
C_s = concentration of radionuclide in soil, picocurie per grams

The fraction of time spent hiking is estimated as:

$$f_{Trec} = \Sigma\,[\,(\,1/f_t\,)\ W_a\ \ EF_{rec}\ \,]\,/\,V_h \qquad \text{(G–58)}$$

where:

f_{Trec} = fraction of time spent hiking, unitless
f_t = conversion factor for time, hours per year
W_a = distance (width of the contaminated portion of the aquifer) hiked per day, meters per day
EF_{rec} = exposure frequency for recreation, days per year
V_h = hiking speed, meters per hour

Lifetime risk for each radionuclide for recreational hiking is estimated as:

$$R_{rec} = \Sigma\,(f_{Trec}\ \ RU_{rec}\ \ ED_{rec}\ \ C_s) \qquad \text{(G–59)}$$

where:

R_{rec} = lifetime risk due to recreational hiking, unitless
f_{Trec} = fraction of time spent in recreation, unitless
RU_{rec} = unit risk factor for recreation, 1 per year per picocurie per gram
ED_{rec} = exposure duration for recreation, years
C_s = concentration of radionuclide in soil, picocurie per gram

For the deer consumption pathway, deer were assumed to consume vegetation growing in the contaminated area of the bank of the stream. The fraction of their daily intake obtained from the contaminated area is estimated as the ratio of the contaminated area to the average range area of a deer. Dose is estimated as:

$$D_d = IR_d \; C_d \; DCF_{ing} \qquad \text{(G–60)}$$

where:

- D_d = dose due to consumption of deer, rem per year
- IR_d = ingestion rate of deer meat, kilograms per year
- DCf_{ing} = dose conversion factor for ingestion, rem per curie
- C_d = concentration of radionuclide in deer meat, picocuries per kilogram

Concentration in deer is estimated as;

$$C_d = B_d \; IR_{vd} \; [\; (\sin \theta_{sb} \; A_{aq} \;) \; / \; A_d \;] \; [\; f_m \; / \; f_a \;] \; C_v \qquad \text{(G–61)}$$

where:

- B_d = bioaccumulation factor of radionuclide in deer meat, curies per gram per curies per day
- IR_{vd} = ingestion rate of vegetation by deer, kilograms per day
- θ_{sb} = angle of streambank, degrees
- A_{aq} = cross-sectional flow area of contaminated portion of the aquifer, meters squared
- A_d = range area of deer, meters squared
- f_m = conversion factor for mass, grams per kilogram
- f_a = conversion factor for activity, grams per kilogram
- C_v = concentration of radionuclide in vegetation, picocuries per gram

C_d is as defined for Equation G–60. Concentration of radionuclide in vegetation is estimated as:

$$C_v = B_v \; C_s \qquad \text{(G–62)}$$

where:

- B_v = soil to plant transfer factor, picocuries per gram per picocuries per gram
- C_s = concentration of radionuclide in soil, picocuries per gram

Lifetime risk for ingestion of a radionuclide in deer is estimated as:

$$R_d = B_d \; IR_{vd} \; f_m \; B_v \; C_s \; IR_d \; [\; (\sin \theta_{sb} \; A_{aq} \;) \; / \; A_d \;] \; ED_d \; SF_f \qquad \text{(G–63)}$$

where:

- R_d = lifetime risk for consumption of deer, unitless
- f_m = conversion factor for mass, grams per kilogram
- ED_d = exposure duration for consumption of deer meat, years
- SF_f = slope factor for ingestion, 1 per picocurie

Other variables are as defined for preceeding equations.

For chemical contaminants, intake, Hazard Quotient, and risk for consumption of surface water are calculated using Equations G–50, G–51, and G–52 with the concentration in surface water intake substituted for concentration in groundwater. Intake of a chemical constituent due to consumption of fish is calculated as:

$$I_f = (f_m / f_v) \{ (IR_f \; ED_f \; B_f) / (BW \; AT) \} \; C_c \qquad \text{(G–64)}$$

where:

I_f	=	intake of chemical contaminant in fish, milligrams per kilogram-day
C_c	=	concentration of chemical contaminant in surface water, grams per cubic meter
IR_f	=	consumption rate of fish, kilograms per year
ED_f	=	exposure duration for fish consumption, years
B_f	=	bioaccumulation factor for chemical contaminant in fish, milligrams per kilogram per milligram per liter
f_m	=	conversion constant, 1,000 milligrams per gram
f_v	=	conversion constant, 1,000 liters per cubic meter

BW and AT are as defined for Equation G–50.

The Hazard Quotient for consumption of the chemical contaminant in fish is:

$$HQ_f = I_f / RfD \qquad \text{(G–65)}$$

where:

HQ_f	=	Hazard Quotient for ingestion of chemical contaminant in fish, unitless
RfD	=	IRIS reference dose for ingestion of chemical constituent, milligrams per kilogram-day

I_f is as defined for Equation G–64.

Lifetime risk due to ingestion of a chemical constituent in fish is estimated as:

$$R_f = IR_f \; SF_{ing} \qquad \text{(G–66)}$$

where:

R_f	=	lifetime risk, unitless
SF_{ing}	=	IRIS slope factor for ingestion of the chemical contaminant, 1 per milligram per kilogram-day

For residential farmer exposure to a chemical constituent, intake, Hazard Quotient, and risk are calculated using Equations G–5 through G–22 as described in Section G.2.2.

For recreational exposure to hazardous chemicals during hiking, exposure occurs through the inadvertent soil ingestion and fugitive dust inhalation pathways. Impacts are estimated using Equations G–5 through G–9 adjusted by fraction of exposure time estimated using Equation G–58. For impacts due to consumption of deer, the conceptual approach described above for radionuclides was applied. Intake is estimated as:

$$I_d = \{ B_d \; IR_{vd} \; f_m \; B_v \; C_s \; IR_d \; [(\sin \theta_{sb} \; A_{aq}) / A_d] \; ED_d \} / \{ BW \; AT \} \qquad \text{(G–67)}$$

where:

I_d = intake of chemical in deer meat, milligrams per kilogram-day
B_d = bioaccumulation factor of chemical in deer meat, grams per kilogram per gram per day
IR_{vd} = ingestion rate of vegetation by deer, kilograms per day
θ_{sb} = angle of streambank, degrees
A_{aq} = cross-sectional flow area of contaminated portion of the aquifer, meters squared
A_d = range area of deer, meters squared
f_m = conversion factor for mass, milligrams per kilogram
B_v = soil to plant transfer factor, grams per kilogram per gram per kilogram
IR_d = ingestion rate of deer meat, kilograms per year
ED_d = exposure duration for ingestion of deer, years
C_s = concentration of chemical in soil, grams per gram

The Hazard Quotient is estimated as:

$$HQ_d = I_d / RfD \qquad \text{(G–68)}$$

where:

HQ_d = Hazard Quotient for ingestion of a chemical in deer meat, unitless
RfD = reference dose for chemical, milligrams per kilogram-day

Lifetime risk due to ingestion of a hazardous chemical in deer is estimated as:

$$R_d = I_d \, SF_{ing} \qquad \text{(G–69)}$$

where:

R_d = lifetime risk due to ingestion of a chemical in deer meat, unitless
SF_{ing} = IRIS slope factor for ingestion of the chemical, 1 per milligram per kilogram-day

I_d is as defined for Equation G–67.

Soil in Contact with Groundwater

Concentrations of constituents in soil in contact with groundwater are calculated using Equation G–44. Impacts for the residential farmer receptors are calculated using Equations G–55 and G–56 for radionuclides and Equations G–5 through G–22 for chemical constituents.

Soil in Contact with Irrigation Water

Concentrations of constituents in soil in contact with irrigation water are calculated using Equation G–47. Impacts for the residential farmer receptors are calculated using Equations G–55 and G–56 for radionuclides and Equations G–5 through G–22 for chemical constituents.

Use of a Residence Without a Farm

For erosion release scenarios, it is possible that a residence may be established in the vicinity of, but not in direct contact with, residual contamination exposed by erosion processes. In this case, a receptor may be exposed to external radiation from the residual contamination while living in the residence. In addition, the receptor may be exposed to radioactive and chemical constituents while hiking in the vicinity of the residence. The dose due to exposure to external radiation is estimated as:

$$D_{ext} = C_s D_{u,ext} \tag{G–70}$$

where:

D_{ext} = external dose, millirem per year
C_s = concentration of contaminant in soil, picocuries per gram
$D_{u,ext}$ = unit dose factor for external radiation, millirem per year per picocuries per gram

For this scenario, impacts accrued during recreational hiking are estimated using Equations G–57 through G–59 for radionuclides and Equations G–5 through G–10 for chemical constituents.

G.4 Intruder Scenario Models

Past practice, current regulatory frameworks, and site-specific conditions (Case and Otis 1988, DOE 1999, NRC 1981, 1982, 2000) were reviewed to develop a set of three site-specific intrusion scenarios for exposure to radionuclides. These are characterized as home construction, well driller, and recreational intruders. The home construction and well drilling scenarios each involve worker and residential farmer exposure pathways. The condition evaluated for each of the intruders is exposure to near-surface residual contamination having the composition of soil or to near-surface residual contamination. The intruder is present at the site at a series of times specified for analysis, including a delay representing a period of institutional control. The first of the following sections discusses the upper-level organization of the model while the second section discusses details of the dose calculation for each of the receptors. Because impacts are dominated by radiological exposure, analysis of intruder scenarios is limited to consideration of radioactive and not chemical constituents.

G.4.1 Organization of the Model

The intruder model comprises two major elements: an executive routine and a dose module. Functions performed in the executive routine include interpretation of input data, control of sequence of calculations, and writing of results to output files. The overall organization of the code is represented on **Figure G–14**. The input data include specification of radionuclides, radionuclide inventories, and time periods for which dose will be estimated. As indicated in this figure, the code cycles through each radionuclide, intruder, and time step and calculates dose at each step in the process. Following completion of the calculation of dose at each time step, the code identifies the maximum dose and time of maximum dose for each of the intruders. The time sequence of total dose for each intruder and the dose for each radionuclide for the time of maximum dose for each intruder are provided as output data.

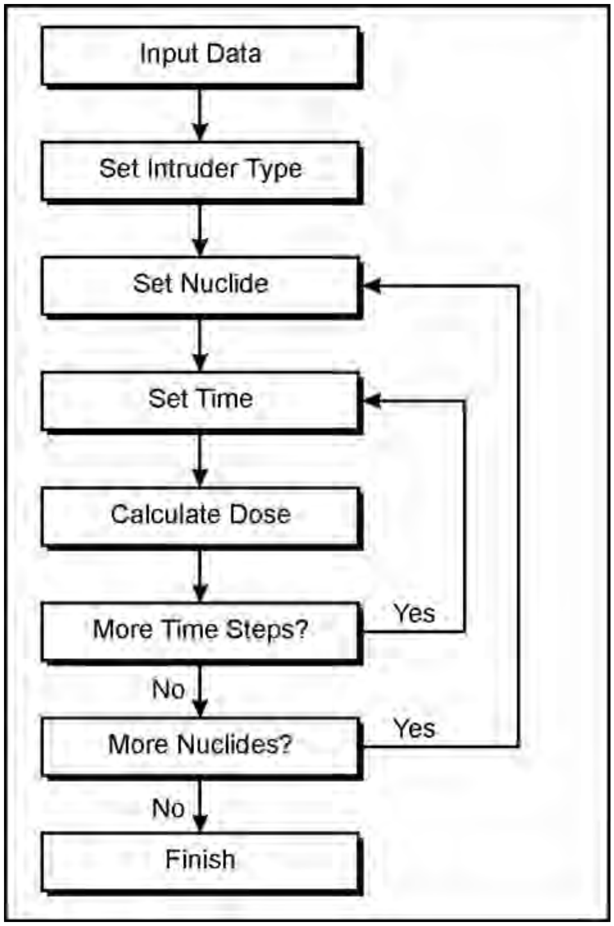

Figure G–14 Organization of Intruder Scenario Analysis Computer Code

G.4.2 Intruder Dose Models

The magnitude of dose estimated for each intruder depends in part on the range of intruder activities. The following sections present equations used for calculation of dose for each type of intruder. Intruder activities and scenario parameter values are consistent with past analyses and current guidance (DOE 1999; Oztunali and Roles 1986; NRC 1981, 1982, 1998, 2000) and dose conversion factors used in the analysis are consistent with current Federal guidance (EPA 1988, 1993). Values used for dose factors and model parameters are presented, along with simulation results, in Appendix H. At each time step during the calculation of dose, radionuclide concentrations are adjusted to reflect decay and ingrowth. The method used for this portion of the calculation is the same as that described in Section G.3.4 and represented schematically on Figure G–14. Cumulative impacts of a mixture of radionuclides are estimated as the sum of the impacts of the individual radionuclides.

G.4.2.1 The Home Construction Intruders

The home construction intruder excavates a foundation for a home and distributes contaminated soil from the excavation into surface soil subsequently used for cultivation of a garden. The excavation work generates airborne dust that is inhaled by the worker. The worker is also simultaneously exposed to direct radiation emitted from radioactive material in the excavation.

The dose due to inhalation of a given radionuclide is estimated as:

$$D_{inh} = (1 / f_a f_m)\ M_{load}\ BR\ T_{exc}\ C_{soil}\ DCF_{inh} \qquad (G–71)$$

where:

D_{inh} = inhalation dose, rem
M_{load} = mass loading of dust in the air, milligrams per cubic meter
BR = breathing rate, cubic meters per year
T_{exc} = time spent in the excavation, year
C_{soil} = radionuclide concentration in the soil, picocuries per gram
f_a = conversion factor, 1×10^{12} picocuries per gram
f_m = conversion, 1,000 milligrams per gram
DCF_{inh} = dose conversion factor for inhalation, rem per curie

Direct external dose is estimated as:

$$D_{ext} = N_s\ DEN_s\ C_s\ T_{exc}\ DCF_{exV} \qquad (G–72)$$

where:

D_{ext} = external dose, rem
C_s = concentration of radionuclide in the soil, picocuries per gram
N_s = number of surfaces in excavation, unitless
T_{exc} = time spent in the excavation, years
DEN_s = density of soil, grams per cubic centimeters
DCF_{exV} = dose conversion for external radiation from a volume source, rem per year per picocurie per cubic centimeter

Five surfaces, four walls and a floor, and dose factors for semi-infinite media not corrected for finite size of the excavation were used in the calculations.

G.4.2.2 Drilling Intruder

In this scenario, a worker completing a well is assumed to inhale dust mobilized by drilling activity and to be exposed to radiation emitted by residual contamination brought to the surface in drilling mud. Dose due to inhalation was estimated using the same approach as described above for the home construction scenario worker. The drilling mud is pumped to a pond where it is covered by 2 feet of water. The worker remains in the vicinity of the pond and is exposed to direct radiation emitted from the radioactive material in the pond. The activity brought to the surface is:

$$A_{dm} = f_v\,(\pi/4)\ D^2_{well}\ Z_{waste}\ DEN_{waste}\ C_{waste} \qquad (G–73)$$

where:

A_{dm} = activity of a radionuclide in the drilling mud deposited in the pond, picocuries
f_v = conversion factor, 1×10^6 cubic centimeters per cubic meter
D_{well} = diameter of the well, meters
Z_{waste} = thickness of waste horizon, meters
DEN_{waste} = density of waste, gram per cubic centimeter
C_{waste} = radionuclide concentration in the waste, picocuries per gram

The activity was distributed at the upper surface of the mud layer, below the overlying water. The shielding of the pond water would reduce the dose by a factor of approximately 75. The dose to a receptor near the pond is estimated as:

$$D_{drill} = [(A_{dm}/f_a)/A_p] \; (1.0/f_{shld}) \; T_{drill} \, DCF_{exS} \qquad \text{(G–74)}$$

where:

- D_{drill} = dose during drilling activity, rem
- A_p = area of pond, square meters
- T_{drill} = time of exposure near pond, years
- f_a = conversion factor, 1×10^{12} picocuries per curie
- f_{shld} = factor for reduction of dose due to shielding by water in pond, unitless
- DCF_{exS} = dose conversion factor for external radiation from a source of surface contamination, rem per year per curie per square meter

A_{dm} is as defined for Equation G–73. After completion of drilling activity, drilling mud is removed from the pond and distributed into soil used for cultivation of a garden.

G.4.2.3 Residential Farmer Intruder

In the residential farmer scenario, an individual lives in a home and cultivates a garden in soil containing residual contamination resulting in exposure to radionuclides through a variety of direct radiation, inhalation, and ingestion pathways. As described in Section G.2, dose for the residential farmer scenario was simulated using unit dose factors developed using the RESRAD Version 6.4 computer code (Yu et al., 2001). For intruder scenarios, contamination of the soil occurs due to distribution of soil excavated from the foundation during home construction or to distribution of mud from the drilling pond.

The amount of a radionuclide brought to the surface during home construction is estimated as:

$$A_{hc} = W_{exc} \, L_{exc} \, H_{rmvd} \, \rho_w \, f_v \, C_w \qquad \text{(G–75)}$$

where:

- A_{hc} = activity of a radionuclide removed from the excavation during home construction, picocuries
- W_{exc} = width of the excavation, meters
- L_{exc} = length of the excavation, meters
- H_{rmvd} = height of residual contamination removed from the excavation, meters
- ρ_w = density of residual contamination removed from the excavation, grams per cubic centimeter
- f_v = conversion constant, 1×10^6 cubic centimeters per cubic meter
- C_w = concentration of radionuclide in residual contamination, picocuries per gram

The activity in drilling mud brought to the surface is that estimated using Equation G–73. The concentration of a radionuclide in soil for residential farmer is estimated as:

$$C_{ra} = A_{rmvd} \; / \; (A_{ra} \, H_{mix} \, f_v \, \rho_s) \qquad \text{(G–76)}$$

where:

C_{ra} = concentration of radionuclide in soil for residential farmer, picocuries per gram
A_{rmvd} = activity removed from the home construction excavation (A_{hc}) or well borehole (A_{dm}), picocuries
A_{ra} = area required for the residence and garden, square meters
H_{mix} = height for mixing activity into soil, meters
f_v = conversion constant, cubic centimeters per cubic meter
ρ_s = density of soil in the garden, grams per cubic centimeter

Unit impact factors derived using RESRAD allow calculation of dose as:

$$D_{ra} = C_{ra}\ DCF_{ra} \qquad \text{(G–77)}$$

where:

D_{ra} = dose to a residential farmer, rem per year
C_{ra} = radionuclide concentration in soil, picocuries per gram
DCF_{ra} = unit dose factor reflecting dose through RESRAD pathways, rem per year per picocuries per gram

G.4.2.4 Recreational Hiking

In the recreational hiker scenario, an individual hikes through an area with residual contamination of surface soil. Potential exposure pathways are direct external exposure, inadvertent ingestion of soil, and inhalation of fugitive dust. Unit dose factors for the combined pathways were calculated using the RESRAD computer code (Yu et al. 1993). Dose for the recreational hiker is estimated as:

$$D_{rec} = T_{rec}\ C_{waste}\ DCF_{rec} \qquad \text{(G–78)}$$

where:

D_{tec} = dose for recreational intruder, rem
T_{rec} = duration of recreational intrusion, years
C_{waste} = concentration of radionuclide in surface soil, picocuries per gram
DCF_{rec} = unit dose factors for recreational intrusion, rem per year per picocurie per gram

G.5 Erosion Collapse Scenario Models

Erosion processes occurring over long timeframes have the potential for disruption of facilities at the site. Mathematical analysis of potential adverse health impacts related to erosion requires prediction of rates and spatial distribution of erosion and estimation of doses caused by erosion-mediated releases. Methods used to predict the nature and extent of erosion and the results of that analysis are presented in Appendix F. This portion of Appendix G discusses the exposure impact models used to estimate impacts caused by specified types and rates of erosion. A model was developed for estimation of erosion release of radionuclides. The following text describes the elements of the erosion release code; health impacts are estimated as described in Section G.3.4. Assessment of uncertainty in estimates of impacts for erosion releases is provided by analysis of multiple cases that bound potential conditions. Parameter values and more complete description of these cases are presented in Appendices F and H.

The concept adopted for estimation of erosion impacts represents the residual contamination as a rectangular prism that may or may not extend to the ground surface. Erosion is represented as composed of two components, vertical downward movement of the ground surface and horizontal movement of near-vertical creek banks. The residual contamination is distributed into a number of rectangular belowground prisms referred to as trenches, each of which comprises several sections. Horizontal distribution of constituents is represented by division of the trench into sections located at differing distances from the creek bank. Constituent inventories of each trench section are specified independently and are corrected for decay and ingrowth or degradation as time proceeds. The relation of the residual contamination matrix, ground surface, and creek bank is represented schematically on **Figure G–15**. In this figure, the parameter X_i indicates the distance of the nth section of the residual contamination matrix from the creek bank and Z_{gs}, Z_{top}, and Z_{bot} indicate positions of the ground surface and top and bottom of the residual contamination matrix, respectively. Radiological and chemical constituents eroded from the residual contamination matrix are deposited into the surface water that is subsequently used by an individual who drinks the contaminated water, consumes fish living in the water, and irrigates a garden with the contaminated water. The model developed to analyze this scenario comprises an executive routine and a dose estimation module. The dose estimation module is the same as that described in Section G.3.4 (Human Health Impacts Module) for the surface water pathway. The balance of this section describes the executive routine used to control estimation of impacts.

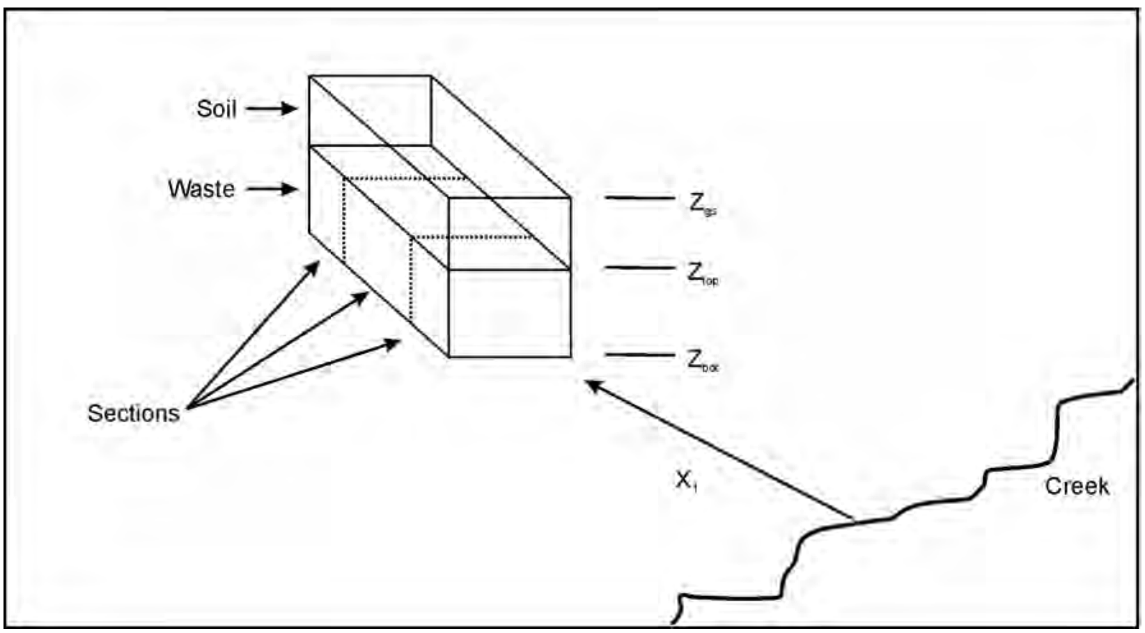

Figure G–15 Concept for Erosion Scenario Impact Analysis

The executive routine developed for this case manages input data; tracks the relative positions of the residual contamination matrix, ground surface, and creek bank; controls execution of the health impacts module, and reports the results of the analysis. Data defining the scenario include the times at which impact is calculated, the inventories of constituents in each section of each trench, the initial vertical and horizontal position of the boundaries of the residual contamination matrix, and the rates of movement of the ground surface and creek bank. Rates of movement of the ground surface and creek bank are specified as piecewise continuous functions of time. Values of these positions at any time are obtained by interpolation between the specified values. The time-dependent rates of movement are provided by either the landscape evolution or simple gully models described in Appendix F.

The order of calculations is represented on **Figure G–16**. Following the reading of input data, the model sets indices identifying the sections of each trench that are nearest the creek. The model then increments time and identifies the position of the ground surface and creek bank and compares these positions with the current positions of the top of the residual contamination matrix and of the trench sections nearest the creek. When the ground surface or creek bank intersects boundaries of the residual contamination matrix, that portion of the residual contamination is transferred to the creek. All material transferred to the creek is assumed to be suspended in the flow of the creek and available for bioaccumulation in fish or use by receptors. When all inventories deposited in the creek during the time interval are accumulated, dose is calculated and the model updates positions and inventories of the residual contamination matrix and proceeds to the next time step. After estimation of dose for all specified time steps, the model searches the time sequence of impact and identifies the time of maximum annual impact. The time sequence of impact and the time and magnitude of maximum impact are reported as model results.

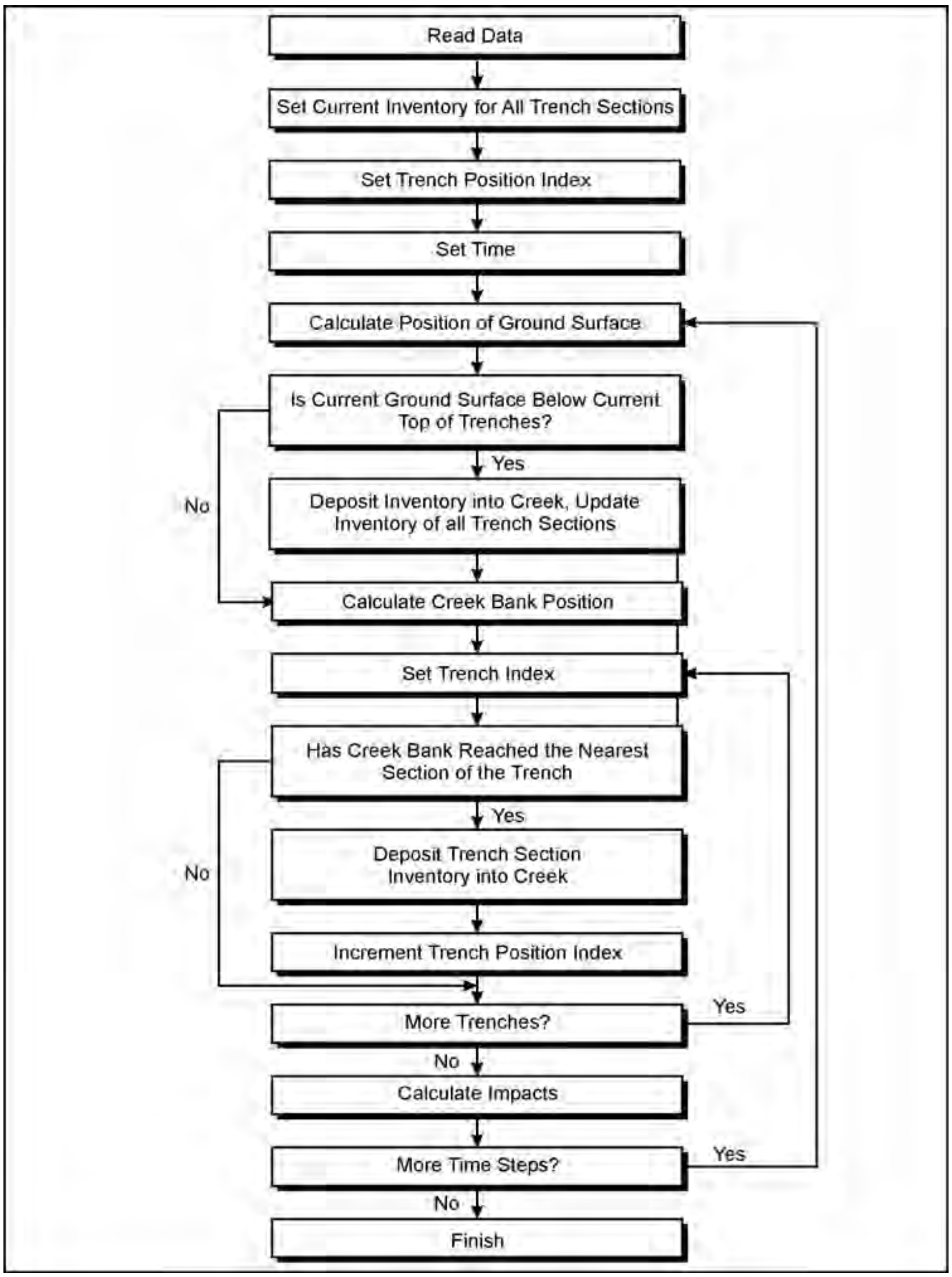

Figure G–16 Algorithm for Erosion Collapse Scenario Impact Estimation

The rate of movement of the ground surface used in the erosion release model may be estimated using the CHILD landscape evolution model described in Appendix F or using a simple model applicable for an individual gully. In the case of the simple gully erosion model used in this analysis, the conceptual gully shown on **Figure G–17** is represented as having triangular cross-section, a rate of advance that may be a function of time, a rate of downcutting that may be a function of time, and a constant angle between the ground surface and the walls of the gully. Given these parameters, the volume of the gully is estimated using a combination of analytic geometry and numerical methods. The volume of soil removed from the residual contamination volume is calculated in similar fashion, given specification of the width of the residual contamination volume and the elevation of the upper and lower surfaces of the residual contamination volume.
Estimation of human health impacts for this Final EIS used the single gully and erosion release dose models and proceeded in three steps. In the first step, time dependent values of parameters of the single gully model, rates of advance and downcutting, were calibrated by comparison against the volume and dimensions of a gully established using the CHILD landscape evolution model. In the second step, the calibrated single gully model was used to estimate the rate of loss of soil and waste material from a selected facility or area. In the third step, the estimated rate of loss of waste material was used in the erosion release impact model to estimate dose to selected receptors. The characteristics of a single large gully predicted using the CHILD model and the results of erosion release impact analysis are presented in Appendix H, Section H.2.2.1.

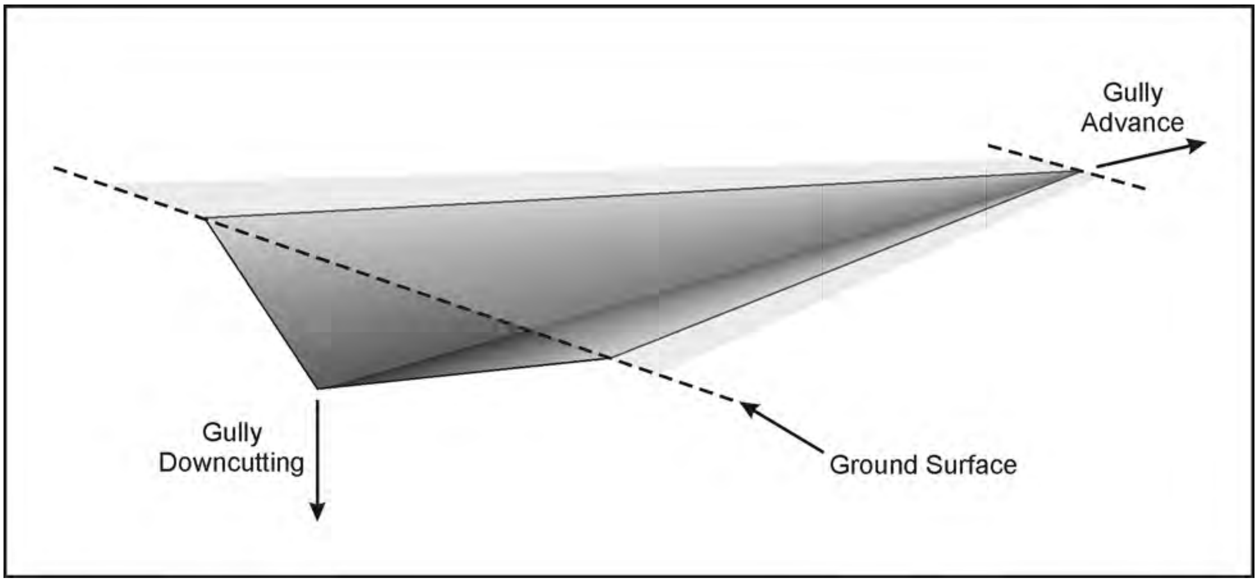

Figure G–17 Schematic of a Simplified Single Gully

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APPENDIX H
LONG-TERM PERFORMANCE ASSESSMENT RESULTS

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LONG-TERM PERFORMANCE ASSESSMENT RESULTS

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.*

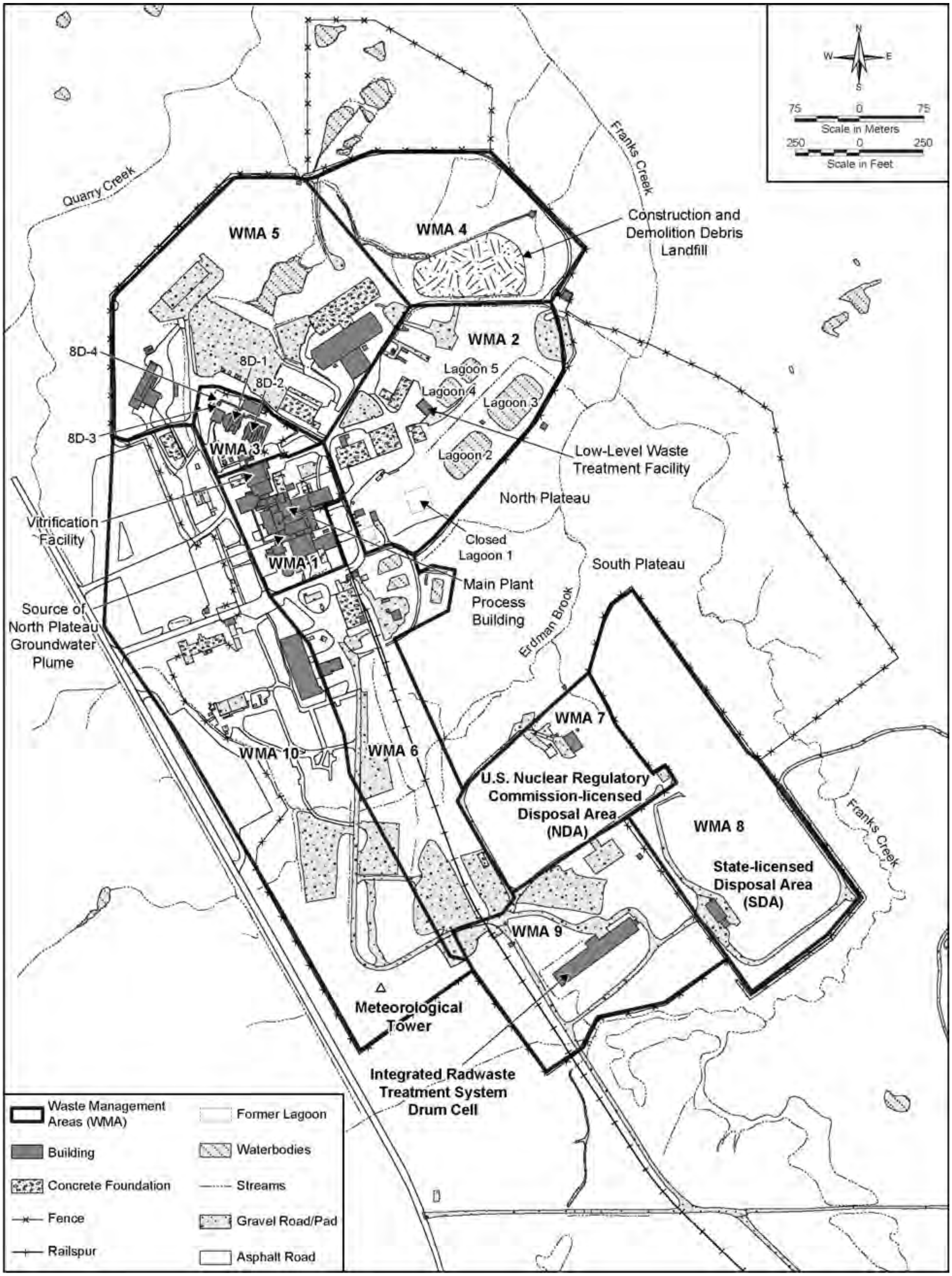

Figure H–1 Location of Waste Management Areas

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.

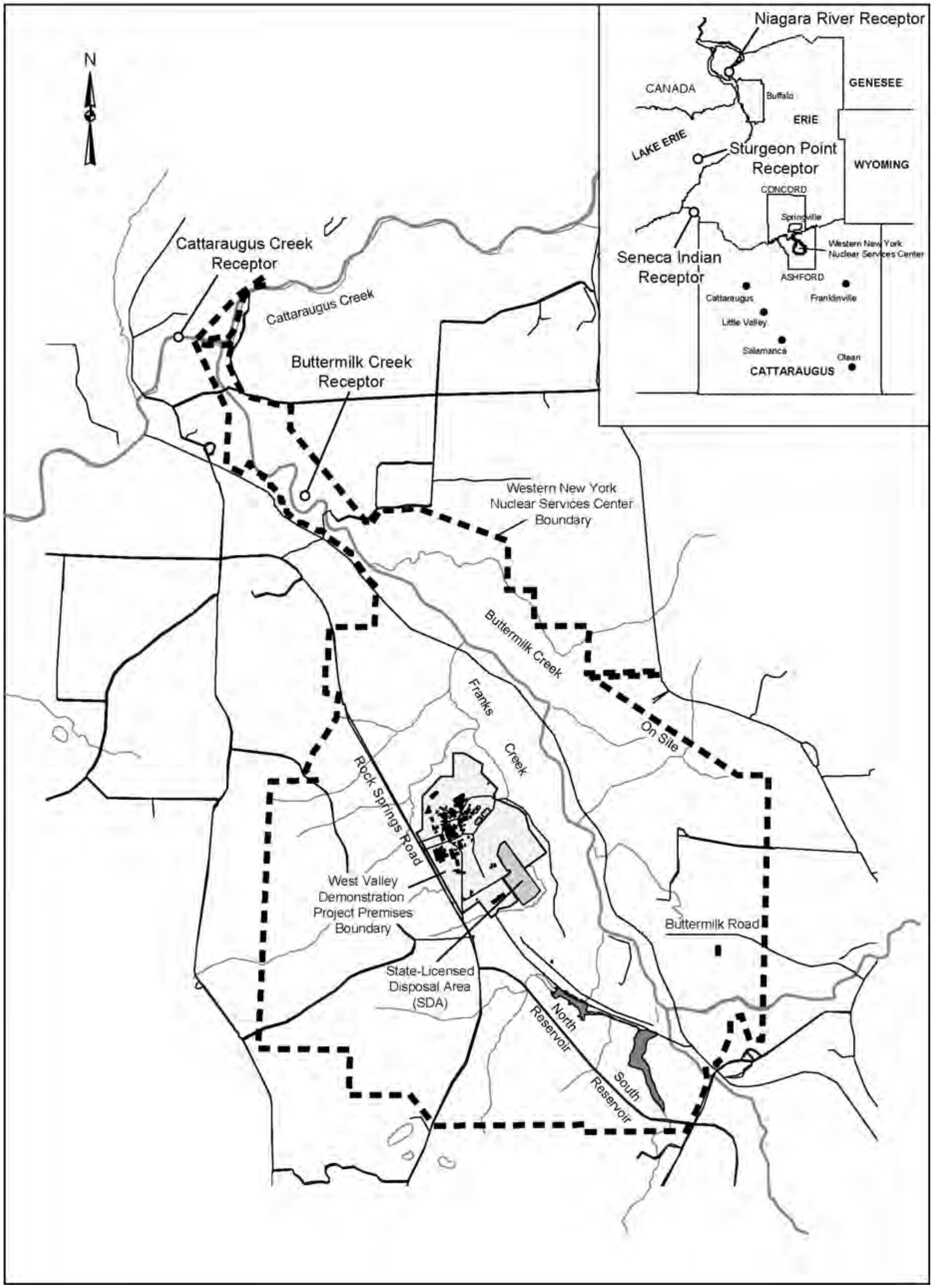

Figure H–2 Location of Offsite Receptors and Buttermilk Creek Receptor

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.*

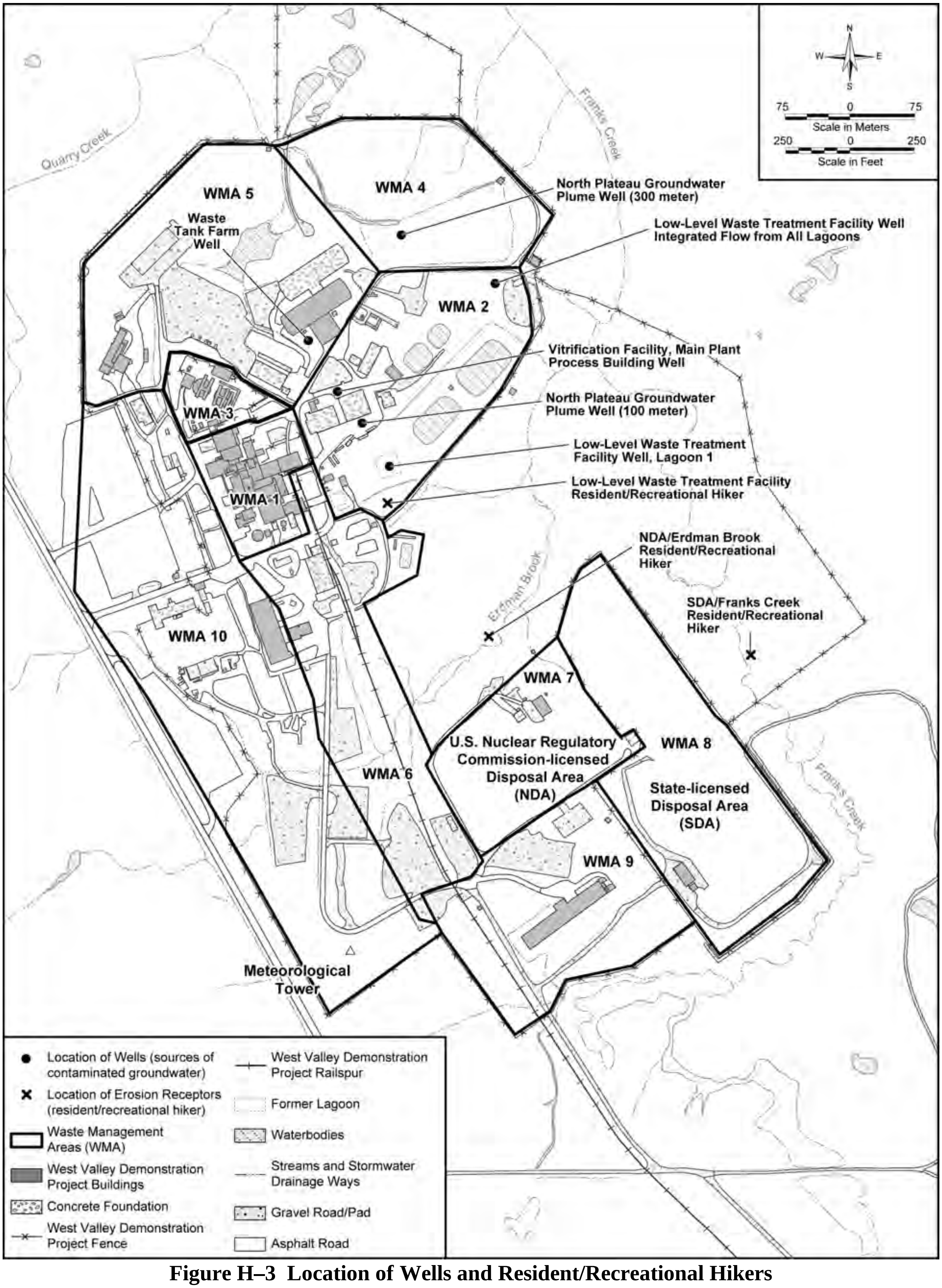

Figure H–3 Location of Wells and Resident/Recreational Hikers

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	Average Linear Velocity (meters per year): 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.

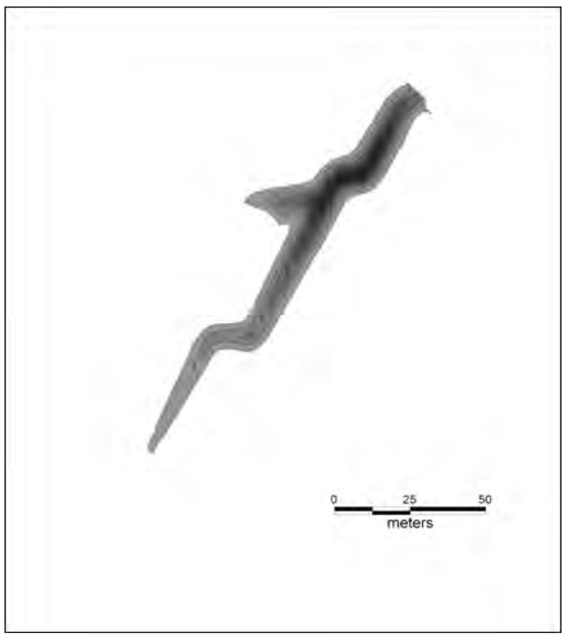

Figure H–4 CHILD Landscape Evolution Model
Single Large Gully at 100 Years

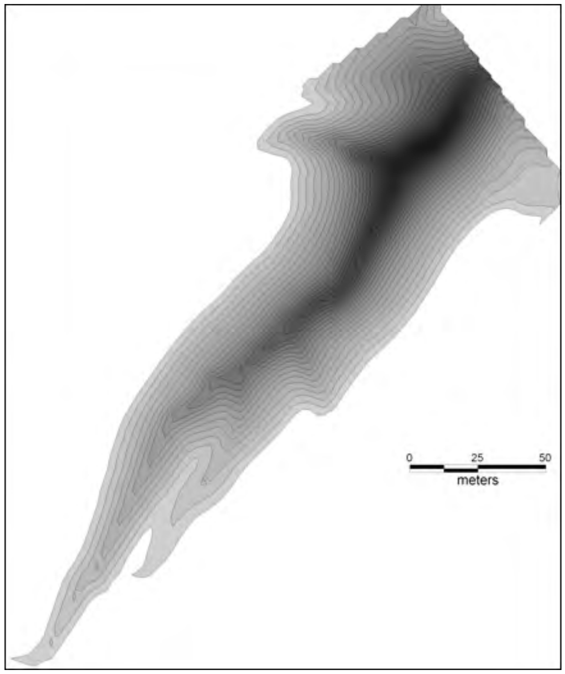

Figure H–5 CHILD Landscape Evolution Model Single Large Gully at 4,000 Years

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.

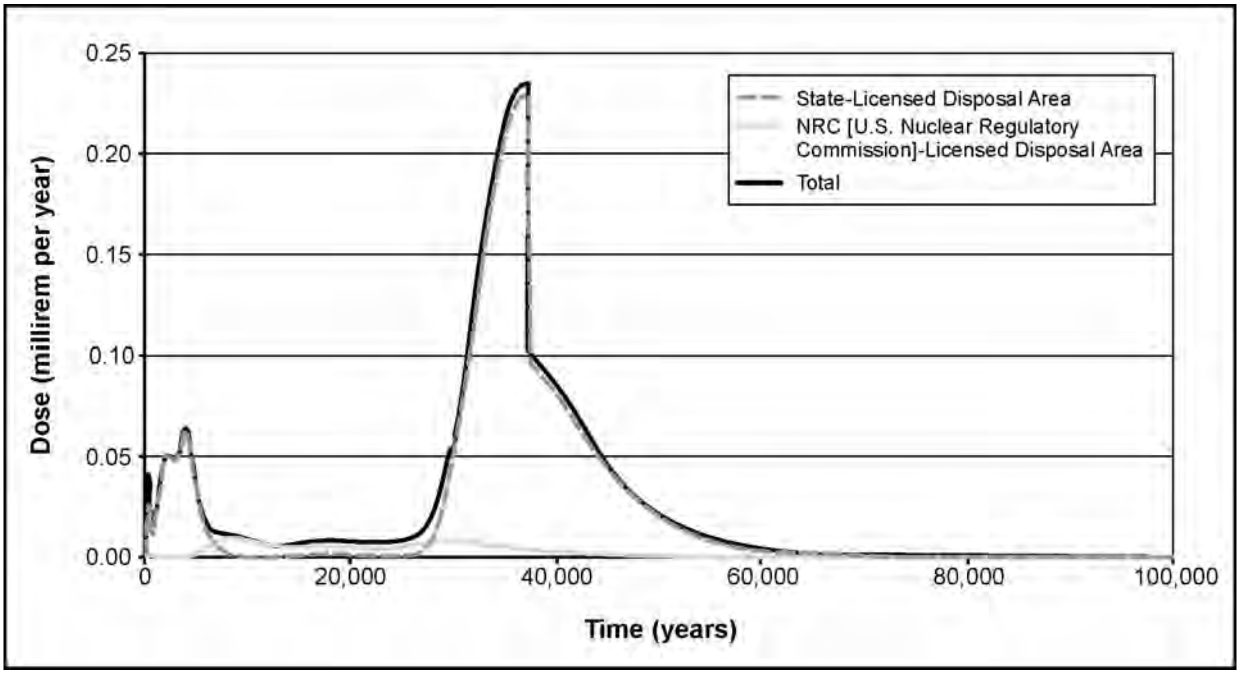

Figure H–6 Annual Total Effective Dose Equivalent for the Cattaraugus Creek Receptor with the Sitewide Close-In-Place Alternative and Indefinite Continuation of Institutional Controls

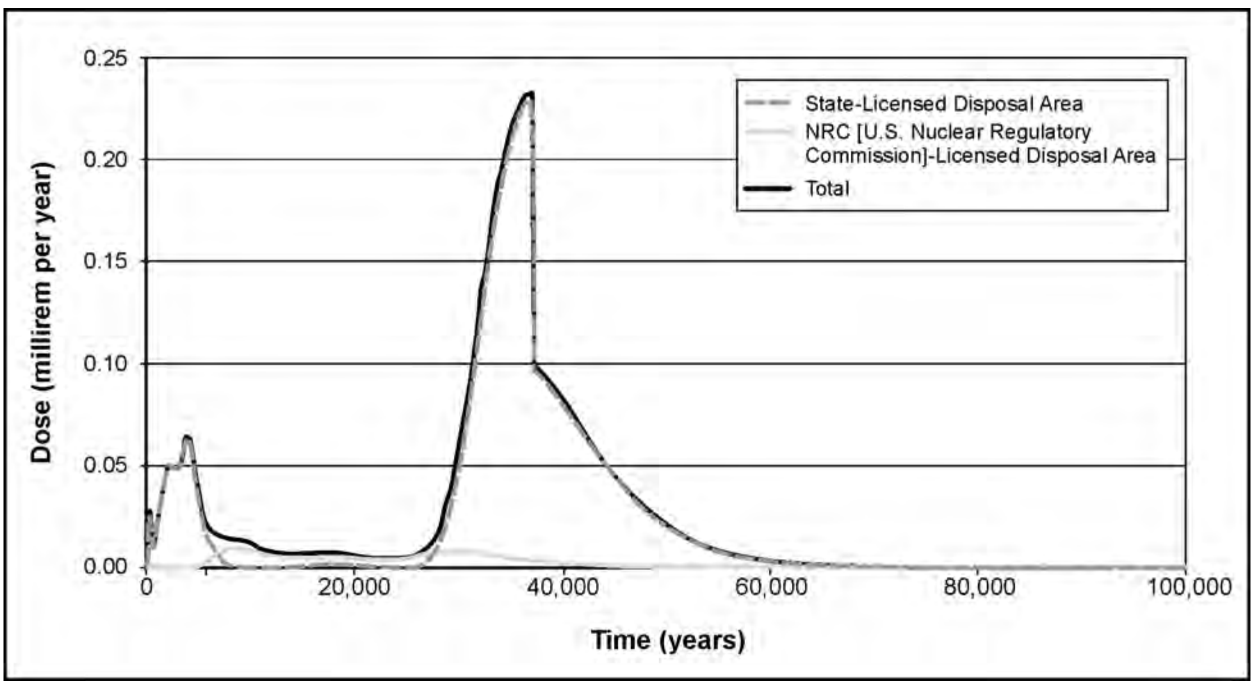

Figure H–7 Annual Total Effective Dose Equivalent for the Cattaraugus Creek Receptor with the No Action Alternative Indefinite Continuation of Institutional Controls

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.

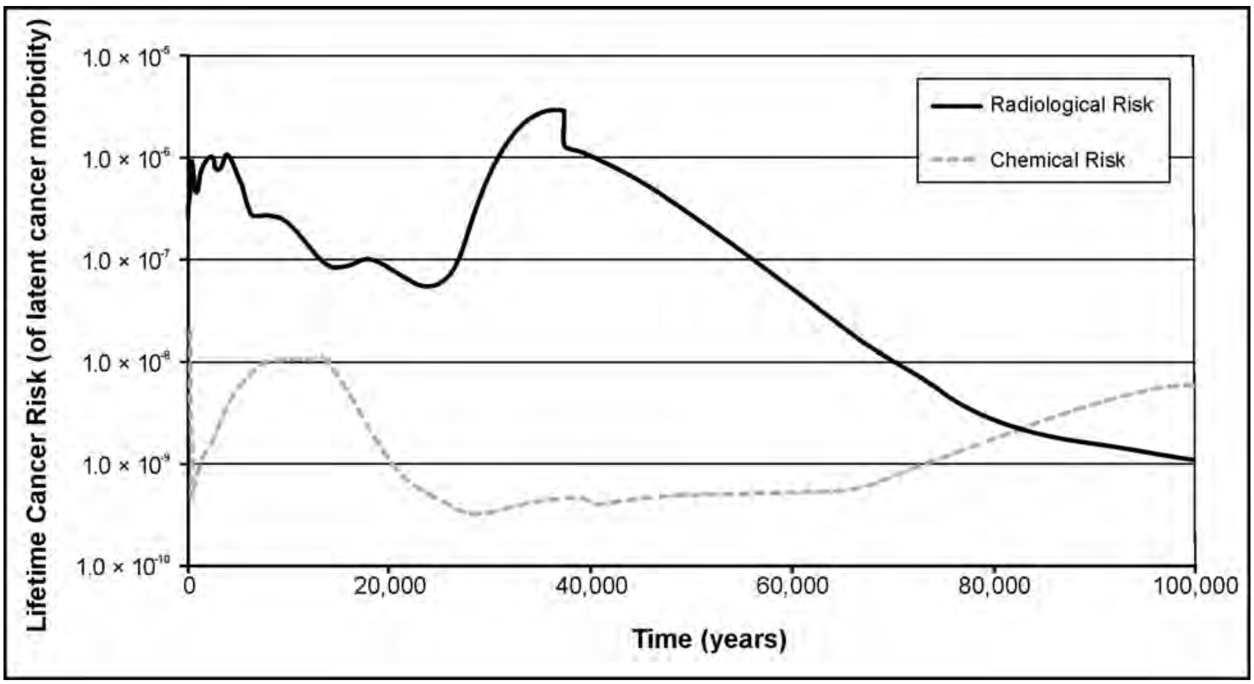

Figure H–8 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Cattaraugus Creek Receptor with the Sitewide Close-In-Place Alternative and Indefinite Continuation of Institutional Controls

[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.*

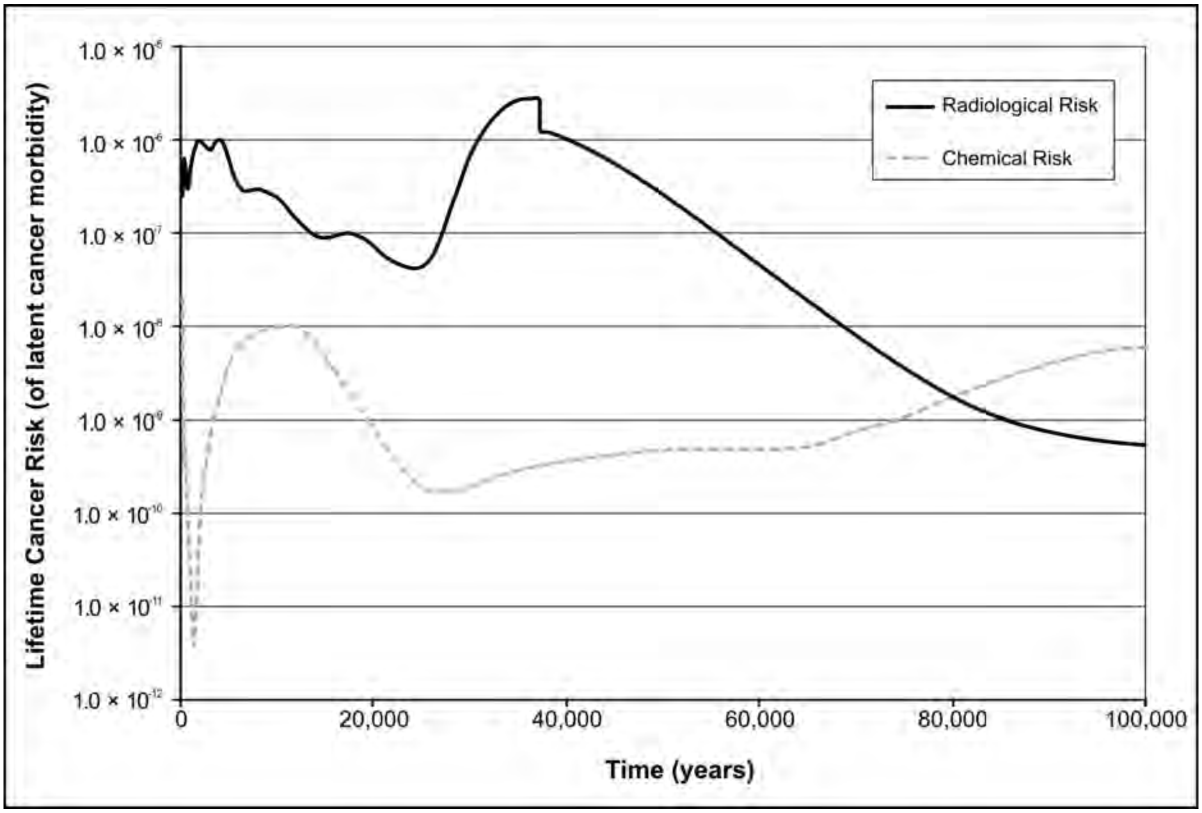

Figure H–9 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Cattaraugus Creek Receptor with the No Action Alternative and Indefinite Continuation of Institutional Controls

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.

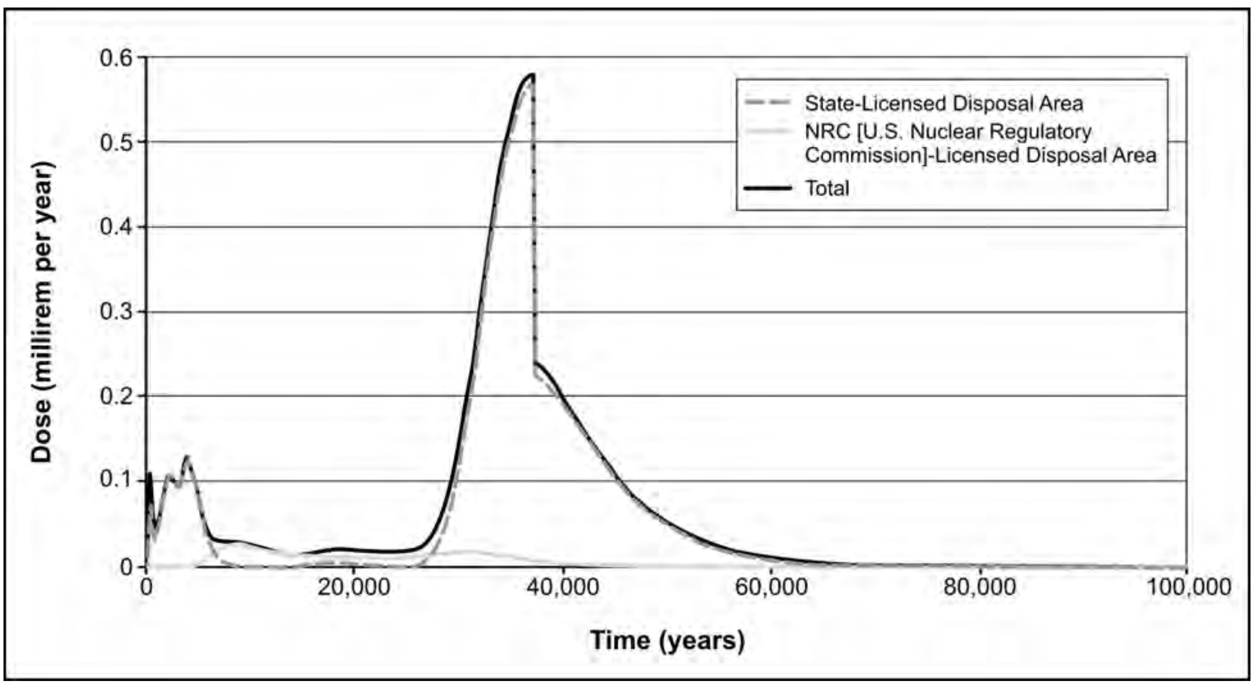

Figure H–10 Annual Total Effective Dose Equivalent for the Seneca Nation of Indians Receptor with the Sitewide Close-In-Place Alternative and Indefinite Continuation of Institutional Controls

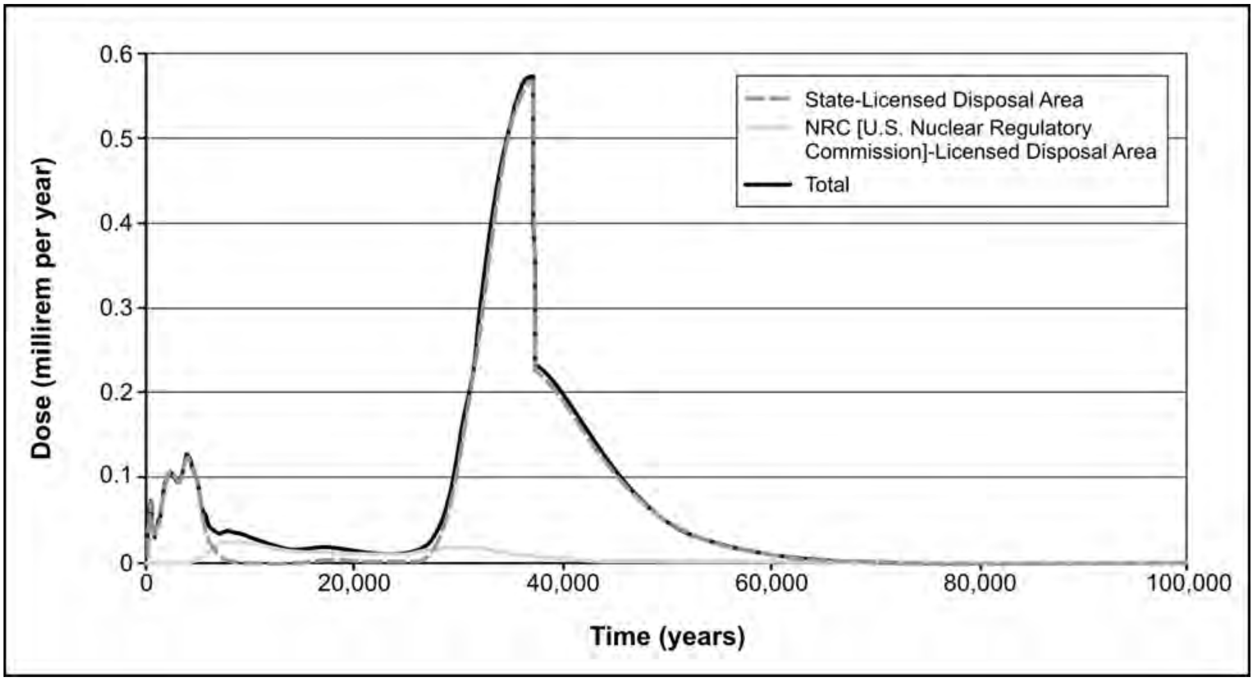

Figure H–11 Annual Total Effective Dose Equivalent for the Seneca Nation of Indians Receptor with the No Action Alternative and Indefinite Continuation of Institutional Controls

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

		Controlling Nuclide/Pathway	
Waste Management Areas [a]	***WMA Components***	***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.

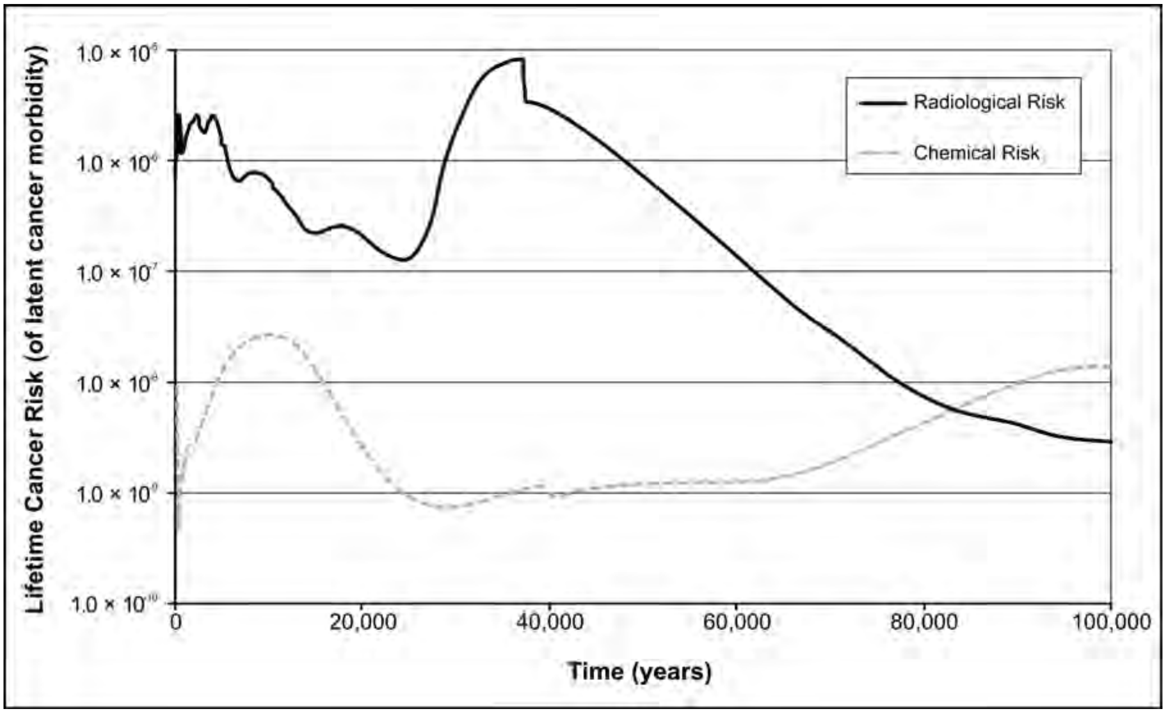

Figure H–12 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Seneca Nation of Indians Receptor with the Sitewide Close-In-Place Alternative and Indefinite Continuation of Institutional Controls

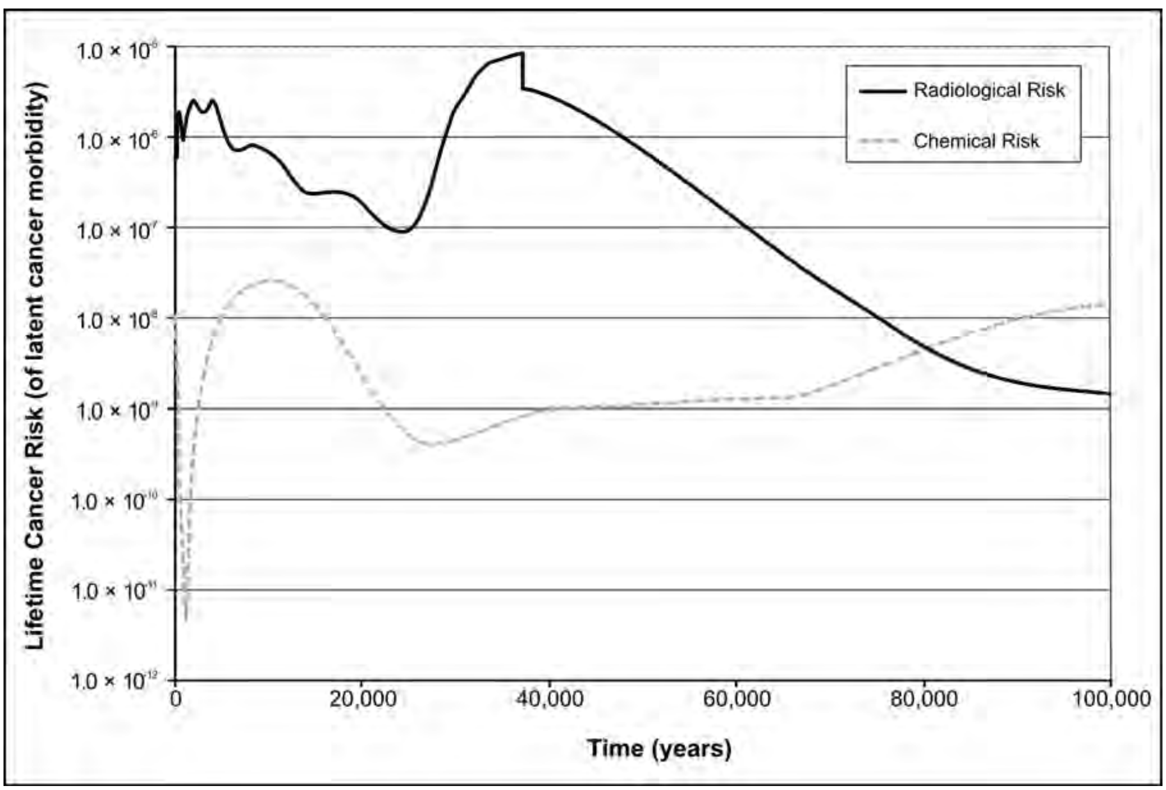

Figure H–13 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Seneca Nation of Indians Receptor with the No Action Alternative and Indefinite Continuation of Institutional Controls

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.

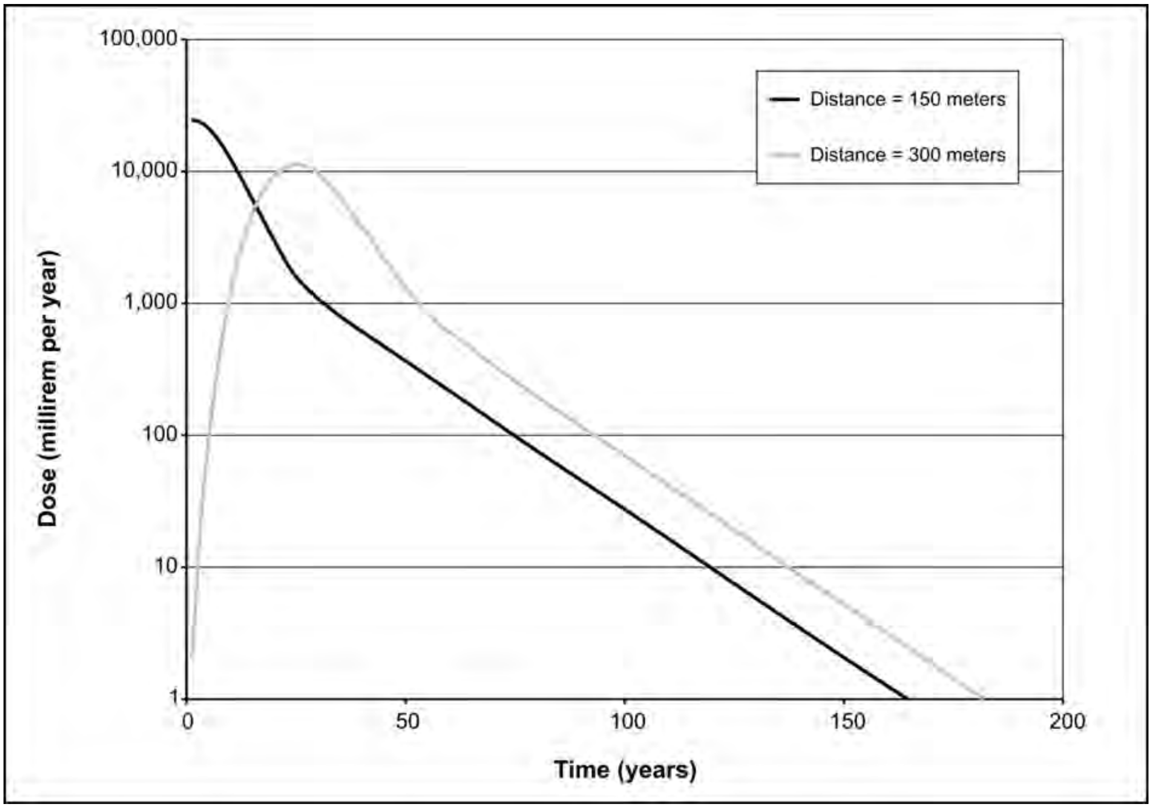

Figure H–14 Time Series of Dose for Onsite Receptors for North Plateau Groundwater Plume Under Sitewide Close-In-Place – Time Measured from Completion of Decommissioning

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.

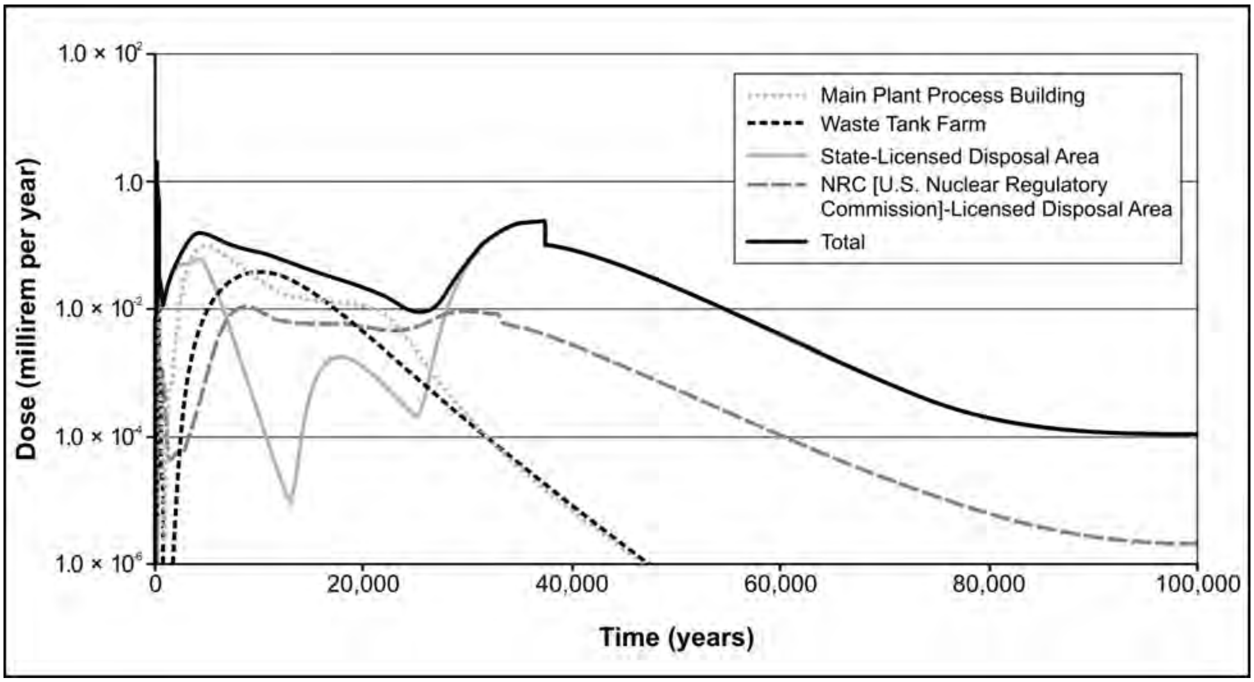

Figure H–15 Annual TotalEffective Dose Equivalent for the Cattaraugus Creek Receptor with the No Action Alternative and Loss of Institutional Controls after 100 Years

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.

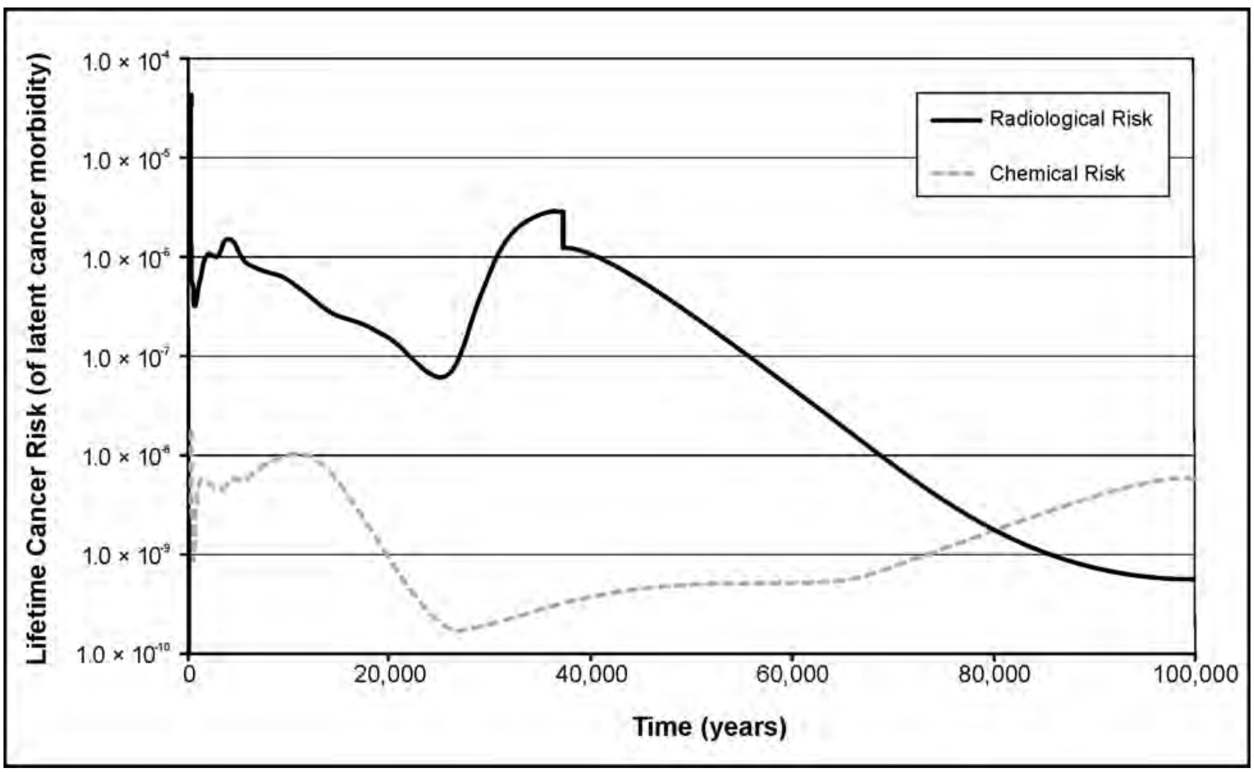

Figure H–16 Lifetime Cancer Risk from Radionuclides and Hazardous Chemicals for the Cattaraugus Creek Receptor with the No Action Alternative and Loss of Institutional Controls After 100 Years

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**.

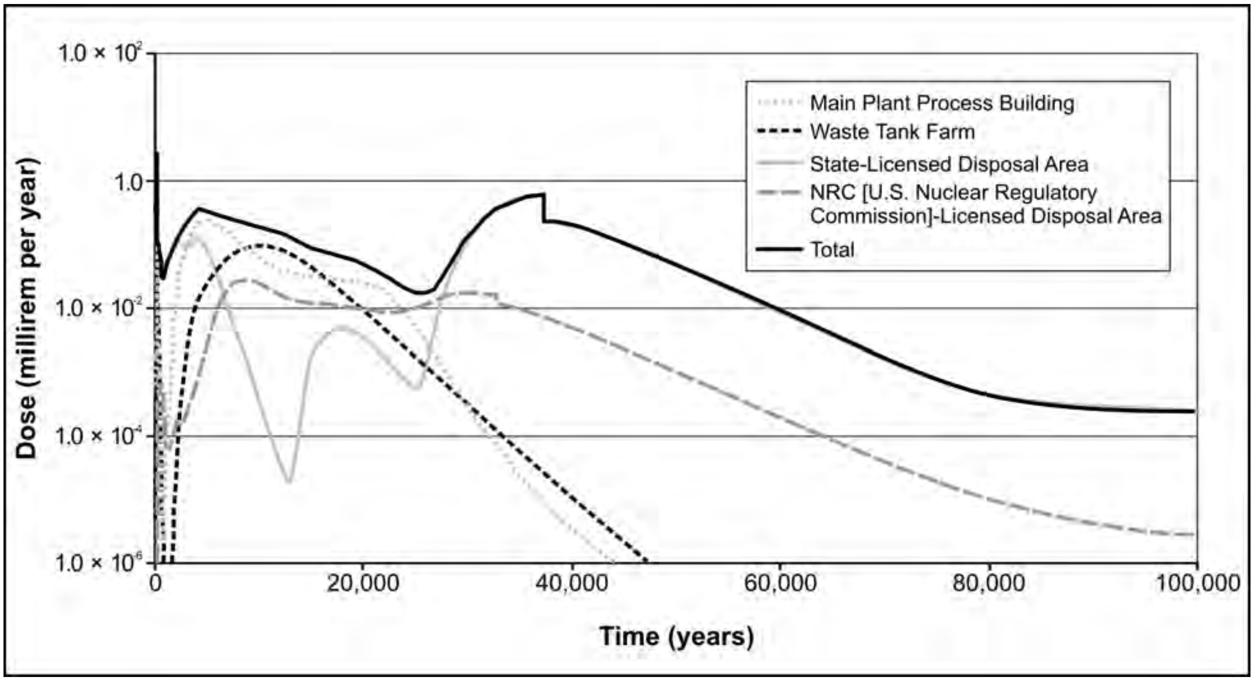

Figure H–17 Annual Total Effective Dose Equivalent for the Seneca Nation of Indians Receptor with the No Action Alternative and Loss of Institutional Controls After 100 Years

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.

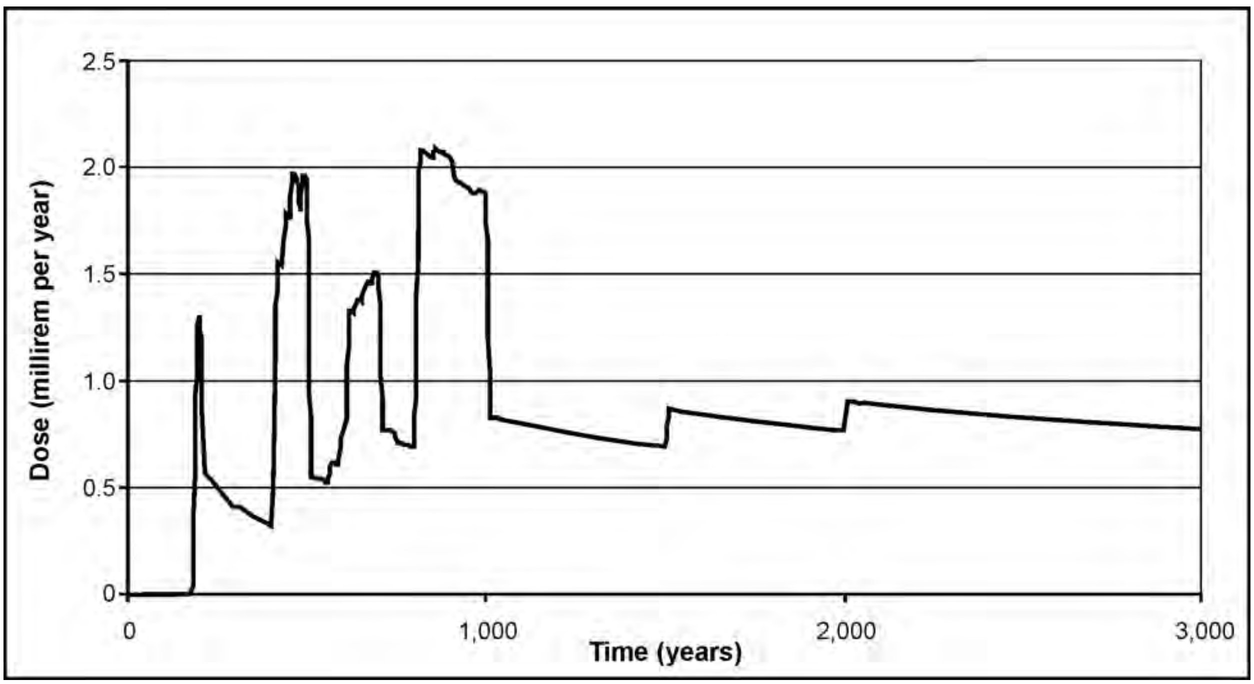

Figure H–18 Annual Total Effective Dose Equivalent (millirem per year) for the Cattaraugus Creek Receptor as a Function of Time with the Sitewide Close-In-Place Alternative and Unmitigated Erosion

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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APPENDIX I
DECOMMISSIONING RADIOLOGICAL AND HAZARDOUS CHEMICAL HUMAN HEALTH IMPACTS EVALUATION

APPENDIX I
DECOMMISSIONING RADIOLOGICAL AND HAZARDOUS CHEMICAL HUMAN HEALTH IMPACTS EVALUATION

I.1 Introduction

This appendix provides a brief general discussion on radiation and its health effects. It also describes the methodologies and assumptions used for estimating potential impacts on and risks to individuals and the general public from exposure to radioactive and hazardous chemical material releases during normal operations and hypothetical accidents during the short-term preparation for the decommissioning phase of the decommissioning alternatives. Long-term radioactive and hazardous chemical release consequences are presented in Appendix H.

This appendix presents numerical information using scientific, or exponential, notation. For example, the number 100,000 can also be expressed as 1×10^5. The number 0.001 can be expressed as 1×10^{-3}. The following chart defines the equivalent numerical notations that may be used in this appendix.

Fractions and Multiples of Units

Multiple	*Decimal Equivalent*	*Prefix*	*Symbol*
1×10^6	1,000,000	mega-	M
1×10^3	1,000	kilo-	k
1×10^2	100	hecto-	h
1×10	10	deka-	da
1×10^{-1}	0.1	deci-	d
1×10^{-2}	0.01	centi-	c
1×10^{-3}	0.001	milli-	m
1×10^{-6}	0.000001	micro-	μ

I.2 Human Health Radiological Impacts

Because radiation exposure and its consequences are of interest to the general public, this environmental impact statement (EIS) provides information about the nature of radiation, explains basic concepts used to evaluate radiation health effects, and presents radiation exposure consequences.

I.2.1 Nature of Radiation and Its Effects on Humans

What Is Radiation?

Radiation is energy transferred in the form of particles or waves. Globally, human beings are exposed constantly to radiation from the solar system and the Earth's rocks and soil. This radiation contributes to the natural background radiation that always surrounds us. Manmade sources of radiation also exist, including medical and dental x-rays and some household smoke detectors.

All matter in the universe is composed of atoms. Radiation comes from the activity of tiny particles within an atom. An atom consists of a positively charged nucleus (central part of an atom) with a number of negatively charged electron particles in various orbits around the nucleus. There are two types of particles in the nucleus:

neutrons that are electrically neutral, and protons that are positively charged. Atoms are categorized as different stable elements based on the number of protons in the nucleus. There are more than 100 natural and manmade elements. An element has equal numbers of electrons and protons. When atoms of an element differ in their number of neutrons, they are called isotopes of that element. All elements have three or more isotopes, some or all of which could be unstable.

Unstable isotopes undergo spontaneous change, known as radioactive disintegration or radioactive decay. The process of continuously undergoing spontaneous disintegration is called radioactivity. The radioactivity of a material decreases with time. The time it takes a material to lose half of its original radioactivity is its half-life. An isotope's half-life is a measure of its decay rate. For example, an isotope with a half-life of 8 days will lose one-half of its radioactivity in that amount of time. In 8 more days, one-half of the remaining radioactivity will be lost, and so on. Each radioactive element has a characteristic half-life. The half-lives of various radioactive elements may vary from millionths of a second to billions of years.

As unstable isotopes change into more stable forms, they emit particles and/or energy. An emitted particle may be an alpha particle (a helium nucleus), a beta particle (an electron), or a neutron, with various levels of kinetic energy. Sometimes these particles are emitted in conjunction with gamma rays. The particles and gamma rays are referred to as "ionizing radiation." Ionizing radiation refers to the fact that the radiation can ionize, or electrically charge, an atom by stripping off one or more of its electrons. Gamma rays, even though they do not carry an electric charge, can ionize atoms as they pass through an element by ejecting electrons. Thus, they cause ionization indirectly. Ionizing radiation can cause a change in the chemical composition of many things, including living tissue (organs), which can affect the way they function.

When a radioactive isotope of an element emits a particle, it changes to an entirely different element or isotope, one that may or may not be radioactive. Eventually a stable element is formed. This transformation, which may take several steps, is known as a decay chain. For example, the isotope radium-226, which is a member of the radioactive decay chain of uranium, has a half-life of 1,622 years. It emits an alpha particle and becomes the isotope radon-222, a radioactive gas with a half-life of only 3.8 days. Radon decays first to polonium; then, through a series of further decay steps, to bismuth; and ultimately to a stable isotope of lead. Meanwhile, the decay products will build up and eventually die away as time progresses.

Characteristics of various forms of ionizing radiation are briefly described in the following text and in the table to the right.

Radiation Type	***Typical Travel Distance in Air***	***Barrier***
α	Few centimeters	Sheet of paper or skin's surface
β	Few meters	Thin sheet of aluminum foil or glass
γ	Very large	Thick wall of concrete, lead, or steel
n	Very large	Water, paraffin, graphite

Alpha (α) – Alpha particles are the heaviest type of ionizing radiation, consisting of two protons and two neutrons. They can travel only a few centimeters in air. Alpha particles lose their energy almost as soon as they collide with anything. They can be stopped easily by a sheet of paper or by the skin's surface.

Beta (β) – Beta particles, consisting of an electron, are much (7,330 times) lighter than alpha particles. They can travel a longer distance than alpha particles in the air. A high-energy beta particle can travel a few meters in the air. Beta particles can pass through a sheet of paper, but can be stopped by a thin sheet of aluminum foil or glass.

Gamma (γ) – Gamma rays (and x-rays), unlike alpha or beta particles, are waves of pure energy. Gamma rays travel at the speed of light. Gamma radiation is very penetrating and requires a large mass, such as a thick wall of concrete, lead, or steel, to stop it.

Neutrons (n) – Neutrons produce ionizing radiation indirectly by collision with hydrogen nuclei (protons) and when gamma rays and alpha particles are emitted following neutron capture in matter. A neutron has about one-quarter the weight of an alpha particle. It will travel in the air until it is absorbed in another nucleus. The most prolific source of neutrons is a nuclear reactor.

I.2.2 Radiation Measuring Units

During the early days of radiological experimentation, there was no precise unit for radiation measure. Therefore, a variety of units were used to measure radiation. These units determined the amount, type, and intensity of radiation. Just as heat can be measured in terms of its intensity or effects using units of calories or degrees, amounts of radiation or its effects can be measured in units of curies, radiation absorbed dose (rad), or dose equivalent (roentgen equivalent man, or rem). The following text summarizes these units.

Curie— The curie, named after scientists Marie and Pierre Curie, describes the intensity of a sample of radioactive material. The decay rate of 1 gram of radium was the original basis of this unit of measure. Because the measured decay rate kept changing slightly as measurement techniques became more accurate, the curie was subsequently defined as exactly 3.7×10^{10} disintegrations (decays) per second.

Rad—The rad is the unit of measurement for the physical absorption of radiation. The total energy absorbed per unit quantity of tissue is referred to as "absorbed dose" (or simply "dose"). As sunlight heats pavement by giving up an amount of energy to it, radiation similarly gives up energy to objects in its path. One rad is equal to the amount of radiation that leads to the deposition of 0.01 joule of energy per kilogram of absorbing material.

Radiation Units and Conversions to International System of Units

1 curie	= 3.7×10^{10} disintegrations per second
	= 3.7×10^{10} becquerels
1 becquerel	= 1 disintegration per second
1 rad	= 0.01 gray
1 rem	= 0.01 sievert
1 gray	= 1 joule per kilogram

Rem—The rem is a measurement of the dose equivalent from radiation based on its biological effects. The rem is used in measuring effects of radiation on the body. One rem of one type of radiation is presumed to have the same biological effects as 1 rem of any other kind of radiation. This allows comparison of the biological effects of radionuclides that emit different types of radiation. One-thousandth of a rem is called a millirem.

Person-rem—The term used for reporting the collective dose, the sum of individual doses received in a given time period by a specified population from exposure to a specified radiation source.

The units of radiation measure in the International System of Units are: becquerel (a measure of source intensity), gray (a measure of absorbed dose), and sievert (a measure of dose equivalent). In accordance with U.S. Department of Energy (DOE) convention, all units presented in this EIS are in terms of curies, rad, rem, and person-rem.

An individual may be exposed to ionizing radiation externally (from a radioactive source outside the body) or internally (from ingesting or inhaling radioactive material). The external dose is different from the internal dose because an external dose is delivered only during the actual time of exposure to the external radiation source, while an internal dose continues to be delivered as long as the radioactive source is in the body. The dose from internal exposure is calculated over 50 years following the initial exposure. Both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time.

I.2.3 Radiation Sources

The average American receives a total of approximately 620 millirem per year from all radiation sources, both natural and manmade, of which approximately 310 millirem per year are from natural sources. Radiation sources can be divided into six different categories: (1) cosmic radiation, (2) terrestrial radiation, (3) internal radiation, (4) consumer products, (5) medical diagnosis and therapy, and (6) other sources (NCRP 2009). These categories are discussed in the following paragraphs.

Cosmic Radiation – Cosmic radiation is ionizing radiation resulting from energetic charged particles from space continuously hitting Earth’s atmosphere where they create secondary particles and protons. These particles and the secondary particles and photons they create compose cosmic radiation. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with the altitude above sea level. The average dose to people in the United States from this source is approximately 34 millirem per year.

External Terrestrial Radiation – External terrestrial radiation is radiation emitted from radioactive materials in Earth’s rocks and soils. The average individual dose from external terrestrial radiation is approximately 22 millirem per year.

Internal Radiation – Internal radiation results from the human body metabolizing natural radioactive material that has entered the body by inhalation or ingestion. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, potassium, rubidium, and carbon. The major contributors to the annual dose equivalent for internal radioactivity are the short-lived decay products of radon, which contribute approximately 210 millirem per year. The average individual dose from other internal radionuclides is approximately 44 millirem per year.

Consumer Products – Consumer products also contain sources of ionizing radiation. In some products, such as smoke detectors and airport x-ray machines, the radiation source is essential to the product’s operation. In other products, such as televisions and tobacco, radiation occurs as the products function. The average dose from consumer products is approximately 13 millirem per year.

Medical Diagnosis and Therapy – Radiation is an important diagnostic medical tool and cancer treatment. Diagnostic x-rays and cancer treatment result in an average exposure of 300 millirem per year.

Other Sources – There are a few additional sources of radiation that contribute minor doses to individuals in the United States. The average dose from nuclear fuel cycle facilities (e.g., uranium mines, mills, and fuel processing plants) and nuclear power plants has been estimated to be less than 1 millirem per year. Radioactive fallout from atmospheric atomic bomb tests, emissions from certain mineral extraction facilities, and transportation of radioactive materials contribute less than 1 millirem per year to the average dose to an individual. Air travel contributes approximately 1 millirem per year to the average dose.

I.2.4 Exposure Pathways

As stated earlier, an individual may be exposed to ionizing radiation both externally and internally. The different ways that could result in radiation exposure to an individual are called exposure pathways. Each type of exposure is discussed separately in the following paragraphs.

External Exposure—External radiation exposure can result from several different pathways, including exposure to a cloud of radioactive particles passing over the receptor (an exposed individual), standing on ground contaminated with radioactivity, and swimming or boating in contaminated water. If the receptor leaves the source of radiation exposure, the dose rate will be reduced if not eliminated. Dose from external radiation is based on time spent exposed to a radiation source. The appropriate dose measure is called the effective dose equivalent (EDE). The external EDE at a tissue depth of 1 centimeter (0.39 inches) is called the deep-dose equivalent (DDE).

Internal Exposure—Internal exposure results from a radiation source entering the human body through either inhalation of contaminated air or ingestion of contaminated food or water. In contrast to external exposure, once a radiation source enters the body, it remains there for a period of time that varies, depending on decay and biological half-life.[1] The absorbed dose to each organ of the body is calculated for a period of 50 years following intake, in accordance with DOE safety analysis application guidance. The calculated absorbed dose is called the committed EDE. Various organs have different susceptibilities to damage from radiation. The committed EDE takes these different susceptibilities into account and provides a broad indicator of the health risk to an individual from radiation. The committed EDE is a weighted sum of the committed dose equivalent in each major organ or tissue. The concept of the committed EDE applies only to internal pathways.

Total Exposure—The sum of external and internal exposures is presented in the EIS as the quantity called total effective dose equivalent (TEDE). All radiation doses presented in Sections I.4.3.5 and I.5.7 are in terms of TEDE.

I.2.5 Radiation Protection Guides

Several organizations have issued radiation protection guides. Responsibilities of the main radiation safety organizations, particularly those that affect policies in the United States, are summarized in the following text.

International Commission on Radiological Protection (ICRP)—ICRP has responsibility for providing guidance in matters of radiation safety. ICRP's operating policy is to prepare recommendations to address basic principles of radiation protection, leaving the various national protection committees to introduce detailed technical regulations, recommendations, or codes of practice best suited to the needs of their countries.

National Council on Radiation Protection and Measurements—In the United States, this council has responsibility for adapting and providing detailed technical guidelines for implementing ICRP recommendations. The Council consists of expert radiation protection specialists and scientists.

National Research Council and National Academy of Sciences—The National Research Council, which provides science and policy research supporting the National Academy of Sciences, associates the broad science and technology community with the Academy's purposes of furthering knowledge and advising the Federal Government. The Council's Nuclear Radiation Studies Board prepares reports to advise the Federal Government on issues related to radiation protection and radioactive materials. The Committee on the Biological Effects of Ionizing Radiation (BEIR), which has issued a number of studies on radiation exposure health conveyances, operates under the Nuclear Radiation Studies Board.

U.S. Environmental Protection Agency (EPA)—EPA has published a series of documents, *Radiation Protection Guidance to Federal Agencies,* used as a regulatory benchmark by a number of Federal agencies, including DOE, to limit public and occupational workforce exposures to the greatest extent possible.

The Interagency Steering Committee on Radiation Standards (ISCORS)—ISCORS' technical reports serve as guidance for Federal agencies to assist them in preparing and reporting analysis results and implementing radiation protection standards in a consistent and uniform manner. ISCORS issued a technical report entitled *A Method for Estimating Radiation Risk from TEDE* (DOE 2002). This report provides dose-to-risk

[1] Biological half-life is the time for one-half of a radioactive source that has entered the body to be removed from the body by natural processes.

conversion factors using TEDE to estimate dose. It is recommended for use by DOE personnel and contractors when computing potential radiation risk from calculated radiation dose for comparison purposes. However, for radiation risk assessments required in risk management decisions, the radionuclide-specific risk coefficients in EPA's Federal Guidance Report No. 13, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides* (EPA 1999b), should be used.

I.2.6 Radiation Exposure Limits

Exposure limits for members of the public and radiation workers are generally consistent with ICRP recommendations. EPA also considers National Council on Radiation Protection and Measurements and ICRP recommendations and sets specific annual exposure limits (usually less than those recommended by ICRP) in *Radiation Protection Guidance to Federal Agencies* documents. Each regulatory organization then establishes its own set of radiation standards. Examples of exposure limits set by DOE, EPA, the U.S. Nuclear Regulatory Commission (NRC), and the New York State Department of Environmental Conservation for radiation workers and members of the public are shown in **Table I–1**.

Table I–1 Exposure Limits for Members of the Public and Radiation Workers

Guidance Criteria (Organization)	*Public Exposure Limits at the Site Boundary* [a]	*Worker Exposure Limits* [a]
10 CFR 835.202 (DOE)	–	5 rem per year [b]
10 CFR 835.1002 (DOE)	–	1 rem per year [c]
40 CFR Part 61 (EPA)	0.01 rem per year (all air pathways)	–
40 CFR Part 141 (EPA)	0.004 rem per year (drinking water pathways)	–
DOE Order 5400.5 (DOE) [d]	0.01 rem per year (all air pathways) 0.004 rem per year (drinking water pathway) 0.1 rem per year (all pathways)	–
10 CFR 20.1301 (NRC)	0.1 rem per year (all pathways)	–
10 CFR 20.1201 (NRC)	–	5 rem per year
New York State Department of Environmental Conservation DSHM-RAD-05-01	0.01 rem per year after cleanup (all pathways)	–

CFR = *Code of Federal Regulations*, EPA = U.S. Environmental Protection Agency, NRC = U.S. Nuclear Regulatory Commission.
[a] All the dose limits are in terms of TEDE as defined in Section I.2.4 except for the 40 CFR Part 141 and DOE Order 5400.5 drinking water pathway limit of 0.004 rem per year, which is a dose equivalent value.
[b] Although this is a limit (or level) enforced by DOE, worker doses must be managed in accordance with as low as is reasonably achievable principles. See footnote c.
[c] This is an objective by DOE for the design of new facilities or modifications of existing facilities, to control personnel exposures from external sources of radiation. DOE recommends that facilities adopt an Administrative Control Level for occupational doses that should not exceed 1 rem per year, although DOE believes that an Administrative Control Level of 0.5 rem per year would be achievable for most facilities (DOE 1999b). Reasonable attempts must be made by the site to maintain individual worker doses below these levels.
[d] Derived from 40 CFR Part 61, 40 CFR Part 141, and 10 CFR Part 20.

I.3 Health Effects

To provide background information for discussions of radiation exposure impacts, this section explains basic concepts used to evaluate radiation effects.

Radiation can cause a variety of damaging health effects in humans. The most significant effects are induced cancer fatalities. These effects are referred to as "latent cancer fatalities" (LCFs) because the cancer may take many years to develop. In the discussions that follow, all fatal cancers are considered latent; therefore, the terms "latent cancer fatalities" (or LCFs) and "fatal cancers" are used interchangeably in this appendix.

The National Research Council's Committee on the BEIR has prepared a series of reports to advise the Federal Government on radiation exposure health consequences. *Health Effects of Exposure to Low Levels of Ionizing Radiation,* BEIR V (National Research Council 1990), provides current estimates for excess mortality from leukemia and other cancers expected to result from exposure to ionizing radiation. BEIR V provides estimates consistently higher than those in its predecessor, BEIR III[2] (National Research Council 1980). This increase is attributed to several factors, including use of a linear dose response model for cancers other than leukemia, revised dosimetry for the Japanese atomic bomb survivors, and additional followup studies of the atomic bomb survivors and associated others. BEIR III employs constant, relative, and absolute risk models, with separate coefficients for each of several sex and age-at-exposure groups. Absolute risks are total population fatal cancer risks directly related to radiation dose. Relative risks account for differences in risk between the different ages and sexes of exposure groups. BEIR V develops models in which excess relative risk is expressed as a function of age at exposure, time after exposure, and sex for each of several cancer categories. The BEIR III models were based on the assumption that absolute risks are comparable between the atomic bomb survivors and the U.S. population. BEIR V models were based on the assumption that the relative risks are comparable. For a disease such as lung cancer, where baseline risks in the United States are much larger than those in Japan, the BEIR V approach leads to larger risk estimates than the BEIR III approach. The BEIR VII report, (National Research Council 2005), issued in 2005, is still being studied and incorporated into U.S. regulations and guidance. At this point, it appears that the BEIR VII report will not result in a change in mortality estimates. Therefore, fatal cancer estimates based on BEIR V are expected to remain valid. However, the BEIR VII report does result in an increase in morbidity estimates. Therefore, morbidity estimates, which are presented in Appendix H of this EIS, are expected to increase when BEIR VII is incorporated into U.S. regulations and guidance.

Models and risk coefficients in BEIR V were derived through analyses of relevant epidemiologic data that included the Japanese atomic bomb survivors, ankylosing spondylitis[3] patients, Canadian and Massachusetts fluoroscopy (breast cancer) patients, New York postpartum mastitis (breast cancer) patients, Israeli tinea capitis (thyroid cancer) patients, and Rochester, New York, thymus (thyroid cancer) patients. Models for leukemia, respiratory cancer, digestive cancer, and other cancers used only the atomic bomb survivor data, although the ankylosis spondylitis patient analysis results were considered. Atomic bomb survivor analyses were based on revised dosimetry, with an assumed relative biological effectiveness of 20 for neutrons, and were restricted to doses less than 400 rad. Estimates of fatal cancer (other than leukemia) risks were obtained by totaling estimates for breast, respiratory, digestive, and other cancers.

The National Council on Radiation Protection and Measurements, based on radiation risk estimates provided in BEIR V and ICRP Publication 60 recommendations (ICRP 1991), estimated the total detriment resulting from low-dose or low-dose-rate exposure to ionizing radiation to be 0.00056 per rem for the working population and 0.00073 per rem for the general population (NCRP 1993). The total detriment includes fatal and nonfatal cancers, as well as severe hereditary (genetic) effects. The major contribution to the total detriment is from fatal cancer, estimated to be 0.0004 and 0.0005 per rem for radiation workers and the general population, respectively. The difference in radiation risk between workers and the public is due to the age of workers as compared to the general population, which includes children and elderly who are more sensitive to radiation. The risk estimator breakdowns for both workers and the general population are shown in **Table I–2**. (Risk estimators are lifetime probabilities that an individual would develop a fatal cancer per rem of radiation received.) Nonfatal cancers and genetic effects are less probable radiation exposure consequences.

[2] BEIR IV discusses the effects of radon and is not relevant to this section.
[3] Ankylosing spondylitis, is a form of arthritis that primarily affects the spine, although other joints can become involved. It causes inflammation of the spinal joints (vertebrae) that can lead to severe, chronic pain and discomfort.

Table I–2 Nominal Health Risk Estimators Associated with Exposure to 1 Rem of Ionizing Radiation

Exposed Individual	*Fatal Cancer* [a, b]	*Nonfatal Cancer* [c]	*Genetic Disorders* [c]	*Total*
Worker	0.0004	0.00008	0.00008	0.00056
Public	0.0005	0.0001	0.00013	0.00073

[a] For fatal cancer, the health effect coefficient is the same as the probability coefficient. When applied to an individual, the unit is the lifetime probability of a cancer fatality per rem of radiation dose. When applied to a population of individuals, the unit is the excess number of fatal cancers per person-rem of radiation dose.
[b] For high individual exposures (greater than or equal to 20 rem) over a time period of up to 1 year, the health factors are multiplied by a factor of 2.
[c] In determining a means of assessing radiation exposure health effects, the ICRP has developed a weighting method for nonfatal cancers and genetic effects.
Source: NCRP 1993.

EPA, in coordination with other Federal agencies involved in radiation protection, issued the September 1999 Federal Guidance Report No. 13, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides* (EPA 1999b). This document is a compilation of risk factors for doses from external gamma radiation and internal intake of radionuclides. Federal Guidance Report No. 13 is the basis of radionuclide risk coefficients used in the EPA *Health Effects Assessment Summary Tables* (EPA 2001a) and in computer dose codes, such as the DOE Argonne Residual Radiation (RESRAD) code. However, DOE and other agencies regularly conduct dose assessments with models and codes that calculate radiation dose from exposure or intake using dose conversion factors and do not compute risk directly. In these cases, where it is necessary or desirable to estimate risk for comparative purposes (e.g., comparing risk associated with alternative actions), it is common practice to simply multiply the calculated TEDE by a risk-to-dose factor. DOE previously recommended TEDE-to-fatal-cancer risk factors of 5×10^{-4} per rem for the public and 4×10^{-4} per rem for working-age populations. These values were based upon Committee on Interagency Radiation Research and Policy Coordination 1992 recommendations, which were superceded by ISCORS guidance. ISCORS recommends that agencies use a conversion factor of 6×10^{-4} fatal cancers per TEDE (rem) for mortality and 8×10^{-4} cancers per rem for morbidity when making qualitative or semi-quantitative estimates of radiation exposure risk to members of the general public[4] (DOE 2002).

The TEDE-to-risk factor provided in *Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE)*, ISCORS Technical Report No. 1, is based upon a static population with characteristics consistent with the U.S. population. There are no separate ISCORS recommendations for workers, but the report does specify the use of the same fatal cancer risk factor as for the general population. For workers (adults), a fatal cancer risk of 5×10^{-4} per rem and a morbidity risk of 7×10^{-4} per rem may be used. However, given the risk estimate uncertainties, for most estimates the value for the general population of 6×10^{-4} per rem could be used for workers (DOE 2002). The DOE Office of Environmental Policy and Guidance recommends these values, but it should be emphasized that they are principally suited for comparative analyses and where it would be impractical to calculate risk using Federal Guidance Report No. 13. If risk estimates for specific radionuclides are needed, cancer risk coefficients in Federal Guidance Report No. 13 should be used (DOE 2002).

The ISCORS report notes that the recommended risk coefficients used with TEDE dose estimates generally produce conservative radiation risk estimates (i.e., they overestimate risk).[5] For the ingestion pathway of 11 radionuclides compared, risks would be overestimated compared with Federal Guidance Report No. 13 values for about 8 radionuclides, and significantly overestimated (by up to a factor of 6) for 4 of the 8. The DOE Office of Environmental Policy and Guidance also compared the risks obtained using the risk conversion factor with the risks in Federal Guidance Report No. 13 for the inhalation pathway, and found a bias toward

[4] *Such estimates should not be stated with more than 1 significant digit.*
[5] *This statement presumes that using the radionuclide-specific risk factors in Federal Guidance Report No. 13 would be a more accurate measure of potential risk than multiplying the TEDE by a single average risk factor.*

overestimation of risk, although it was not as severe as for ingestion. For 16 radionuclides/chemical states evaluated, 7 were significantly overestimated (by more than a factor of 2), 5 were significantly underestimated, and the remainder agreed within about a factor of 2. Generally, these differences are within the uncertainty of transport and uptake portions of dose or risk modeling and, therefore, the approach recommended is fully acceptable for comparative assessments. That notwithstanding, it is strongly recommended that, wherever possible, the more rigorous approach with Federal Guidance Report No. 13 cancer risk coefficients be used (DOE 2002).

The values in Table I–2 are "nominal" cancer and genetic disorder probability coefficients. They are based on an idealized population receiving a uniform whole-body dose. Recent EPA studies, based on age-dependent dose coefficients for members of the public, indicate that the product of the effective dose and the probability coefficient could over- or underestimate radiological risk (EPA 1999b). In support of risk results provided in Federal Guidance Report No. 13, EPA performed an uncertainty analysis on uniform whole-body exposure effects. The analysis resulted in an estimated nominal risk coefficient increase from 0.051 fatal cancers per gray (0.00051 fatal cancers per rad) to 0.0575 fatal cancers per gray (0.000575 fatal cancers per rad) (EPA 1999a). This result indicates a nominal risk coefficient increase of about 20 percent over that provided in *Risk Estimates for Radiation Protection* (NCRP 1993) for the public.

Based on review of recent EPA reports, ISCORS recommended that a risk factor of 0.06 fatal cancers per sievert (0.0006 fatal cancers per rem) be used for estimating risks when using calculated dose (DOE 2002). DOE recommended that 0.0006 fatal cancers per rem be used for both workers and members of the public (DOE 2003a).

Numerical fatal cancer estimates presented in this EIS were obtained using a linear no-threshold extrapolation from the nominal risk estimated for lifetime total cancer mortality that results from a dose of 0.1 gray (10 rad). Other methods of extrapolation to the low-dose region could yield higher or lower numerical fatal cancer estimates. Studies of human populations exposed to low doses are inadequate to demonstrate the actual risk level. There is scientific uncertainty about cancer risk in the low-dose region below the range of epidemiologic observation, and the possibility of no risk cannot be excluded (CIRRPC 1992). The risk factor of 0.0006 fatal cancers per rem was used as the conversion factor for all radiological exposures up to 20 rem per individual due to accidents, including those in the low-dose region. A risk factor of 0.0012, was used for individual doses of 20 rem or greater. For normal operations public radiological exposure, lifetime fatal cancer risk was calculated using radionuclide-specific risk factors. Worker normal operations radiological exposure was calculated using the risk factor of 0.0006 fatal cancers per rem.

EIS Health Effect Risk Estimators

Health impacts of radiation exposure, whether from external or internal sources, generally are identified as somatic (i.e., affecting the exposed individual) or genetic (i.e., affecting descendants of the exposed individual). Radiation is more likely to produce somatic than genetic effects. The somatic risks of most importance are induced cancers. Except for leukemia, which can have an induction period (time between exposure to the carcinogen and cancer diagnosis) of as little as 2 to 7 years, most cancers have an induction period of more than 20 years.

For uniform irradiation of the body, cancer incidence varies among organs and tissues; the thyroid and skin demonstrate a greater sensitivity than other organs. Such cancers, however, also produce relatively low mortality rates because they are relatively amenable to medical treatment. Because fatal cancer is the most serious effect of environmental and occupational radiation exposures, estimates of cancer fatalities, rather than cancer incidence, are presented in this appendix. The numbers of fatal cancers can be used to compare risks among the various alternatives. (Note that cancer incidence [latent cancer morbidity] is analyzed in Appendix H of this EIS, Long-Term Performance Assessment Results, to enable comparison of the potential long-term impacts for the alternatives with the Comprehensive Environmental Response, Compensation, and Liability Act risk range.)

Based on the preceding discussion, the number of fatal cancers to workers and the general public for postulated accidents in which individual doses are less than 20 rem is calculated using a health risk estimator of 0.0006 per person-rem. The risk estimator associated with total cancer incidence among the public is 0.0008 per person-rem (DOE 2002). Federal Guidance Report No. 13 (EPA 1999b) individual radioisotope risk factors are used to calculate public lifetime fatal cancer risk for normal operations whereas the 0.0006 fatal cancer per persons-rem health risk estimator was used for worker exposure during normal operations.

Recent EPA analyses (EPA 1999a, 1999b) addressed the effects of low-dose and low-dose-rate exposure to ionizing radiation. Consistent with the conclusion in *Risk Estimates for Radiation Protection* (NCRP 1993), the risk to individuals receiving doses of 20 rem or more is double that associated with doses of less than 20 rem.

The fatal cancer estimators are used to calculate the statistical expectation of the effects of exposing a population to radiation. For example, if 100,000 people were each exposed to a one-time radiation dose of 100 millirem (0.1 rem), the collective dose would be 10,000 person-rem. The exposed population would then be expected to experience six additional cancer fatalities from the radiation (10,000 person-rem × 0.0006 lifetime probability of cancer fatalities per person-rem = 6 cancer fatalities).

Calculations of the number of excess fatal cancers associated with radiation exposure do not always yield whole numbers. These calculations may yield numbers less than one, especially in environmental impact applications. For example, if a population of 100,000 was exposed to a total dose of only 0.001 rem per person, the collective dose would be 100 person-rem (100,000 persons × 0.001 rem = 100 person-rem). The corresponding estimated number of cancer fatalities would be 0.06 (100 person-rem × 0.0006 cancer fatalities per person-rem = 0.06 cancer fatalities). The 0.06 means that there is 1 chance in 16.6 that the exposed population would experience 1 fatal cancer. In other words, 0.06 cancer fatalities are the *expected* number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people. In most groups, no person would incur a fatal cancer from the 0.001 rem dose each member received. In a small fraction of the groups, 1 cancer fatality would result; in exceptionally few groups, 2 or more cancer fatalities would occur. The *average* expected number of deaths over all the groups would be 0.06 cancer fatalities (just as the average of 0, 0, 0, and 1 is ¼, or 0.25). The most likely outcome is no cancer fatalities.

The same concept is applied to estimate radiation exposure effects on an individual member of the public. Consider the effects of an individual's exposure to a 620-millirem (0.62-rem) annual dose from all radiation sources. The probability that the individual would develop a fatal cancer from continuous exposure to this radiation over an average life of 72 years (presumed) is 0.027 (one person × 0.62 rem per year × 72 years × 0.0006 cancer fatalities per person-rem = 0.027). This corresponds to 1 chance in 37.

I.4 Normal Operations Radiological Impacts During Implementation of Alternatives

Normal operations involving the release of radionuclides to the environment were analyzed with the GENII computer code.

I.4.1 GENII Computer Code Generic Description

Radiological impacts of releases during normal operations were calculated using Version 2 of the GENII computer code (PNNL 2007). GENII is designed to model long-term atmospheric and liquid releases of radionuclides and their human health consequences. Site-specific input data were used, including location, meteorology, population, and source terms. This section briefly describes GENII and outlines the approach used for normal operations.

Code Description

The GENII computer model, developed by Pacific Northwest National Laboratory, is an integrated system of computer modules that analyzes environmental contamination resulting from acute or chronic releases to, or initial contamination in, air, water, or soil. The model calculates radiation doses to individuals and populations. The GENII computer model is well-documented for assumptions, technical approach, method, and quality assurance issues. The GENII computer model has gone through extensive quality assurance and quality control steps, including comparing results from model computations with those from hand calculations and performing internal and external peer reviews (PNNL 2007).

Available release scenarios include chronic and acute releases to water or to air (ground-level or elevated sources), and initial contamination of soil or surfaces. GENII implements NRC models in LADTAP for surface water doses. Exposure pathways include direct exposure via water (swimming, boating, and fishing), as well as soil, air, inhalation, and ingestion. GENII Version 1 implemented dosimetry models recommended by the ICRP in Publications 26, 30, and 48, and approved for use by DOE Order 5400.5. GENII Version 2 implements these models plus those of ICRP Publications 56 through 72, and the related risk factors published in Federal Guidance Report No. 13. Risk factors in the form of EPA-developed slope factors are also included (these are a special subset of the Federal Guidance Report No. 13 values). These dosimetry and risk models are considered state of the art by the international radiation protection community and have been adopted by most national and international organizations as their standard dosimetry methodology (PNNL 2007).

GENII Version 2 consists of four independent atmospheric models, one surface water model, three independent environmental accumulation models, one exposure module, and one dose/risk module, each with a specific user interface code. The computer programs are of several types: user interfaces (i.e., interactive, menu-driven programs to assist the user with scenario generation and data input), internal and external dose factor libraries, environmental dosimetry programs, and file-viewing routines. The Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES) Program serves as the interface for operating GENII. For maximum flexibility, the code has been divided into several interrelated, but separate, exposure and dose calculations (PNNL 2007).

I.4.2 GENII Input Data

To perform dose assessments for this EIS, different types of data were collected and generated. This section discusses the various data, along with assumptions made for performing the dose assessments.

Dose assessments were performed for members of the general public at the West Valley Demonstration Project (WVDP) to determine incremental doses that would be associated with the alternatives addressed in this EIS. Incremental doses for members of the public were calculated (via GENII) for two different types of receptors:

- Maximally exposed individual (MEI) – The MEI for air releases was assumed to be an individual member of the public located at a position on the site boundary, including public roads inside the site, that would yield the highest impacts during normal operations. For this EIS, the MEI for air releases is located approximately 1.3 kilometers (0.8 miles) in the north-northwest direction. For liquid releases, there are two MEI locations on Cattaraugus Creek, one near the site and another on the lower reaches of Cattaraugus Creek representing an individual living on Seneca Nation of Indians Land. These MEI locations are presented on **Figure I–1**.

- Population – The general population living within 80 kilometers (50 miles) of the facility (approximately 1.7 million for this EIS).

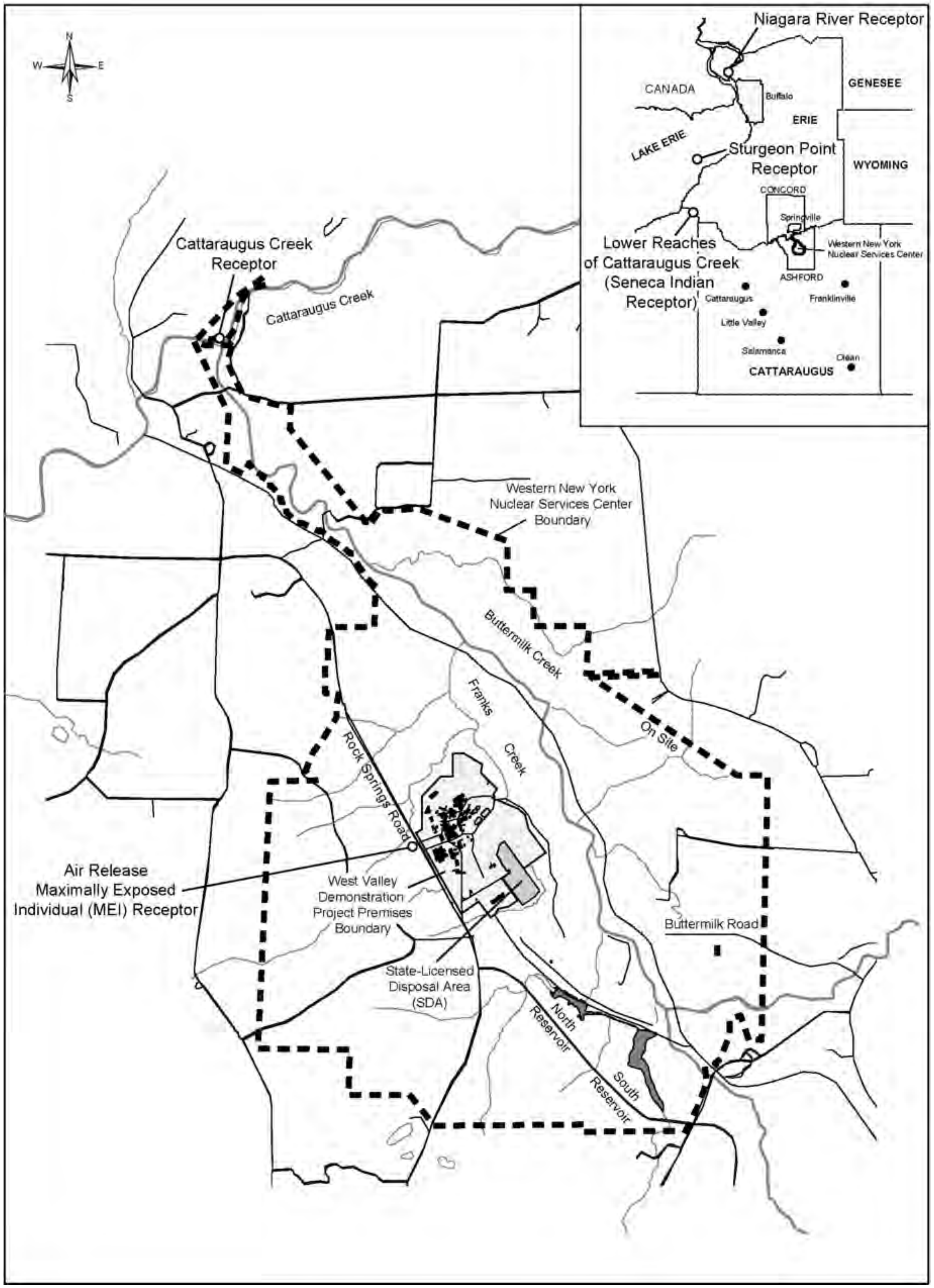

Figure I–1 Location of Maximally Exposed Individual for Normal Operations

I.4.3 Meteorological Data

The meteorological data used for all normal operational scenarios discussed in this EIS were in the form of joint frequency data files. A joint frequency data file is a table listing the fractions of time the wind blows in a certain direction, at a certain speed, and within a certain atmospheric stability class. The joint frequency data files were based on measurements taken over a period of 5 years (1998 to 2002) at WVDP.

I.4.3.1 Population Data

Population distributions were based on U.S. Department of Commerce state population census numbers and Canadian population census data (DOC 2008, ESRI 2008, Statistics Canada 2008). Area population trends have shown a decreasing population over time. Therefore, for conservatism, the 2000 U.S. census (supplemented by the 2001 Canadian census) site-specific population was used in the impact assessments. The population was spatially distributed on a circular grid with 16 directions and 10 radial distances up to 80 kilometers (50 miles). The grid was centered at the location from which the radionuclides were assumed to be released. The 2000-2001 census total population from WVDP out to 80 kilometers (50 miles) is approximately 1.7 million.

I.4.3.2 Source Term Data

Source term(s) (that is, the quantities of radioactive material released to the environment over a given period) for the No Action Alternative normal operational releases were based on measured annual release quantities of all radionuclides reported in Site Environmental Reports from 1982 to 2006 as compiled in the No Action Alternative Technical Report (WSMS 2009d). These Annual Site Environmental Reports identify both airborne and liquid radiological releases. Source terms for each of the three decommissioning alternatives (Sitewide Removal, Sitewide Close-In-Place, and Phased Decisionmaking) were developed based on specific implementing activities described in the technical reports for these alternatives and their estimated airborne and liquid radiological releases for risk dominant radionuclides (WSMS 2009a, 2009b, 2009c). Projected airborne radiological releases for each alternative are presented in **Table I–3**, and liquid releases are provided in **Table I–4**. Tables I–3 and I–4 also present the estimated peak annual releases. The peak annual airborne and liquid releases were determined by evaluating annual releases for each radionuclide. The peak annual release for each radionuclide did not occur during the same year under some alternatives. Therefore, the year when the annual radiological release would result in the highest calculated population and MEI dose was selected. In some cases, this year does not result in the highest annual radiological release rate for every radionuclide.

Source terms used to calculate impacts of postulated accidents are provided in Section I.7.

Table I–3 Total Airborne Radiological Releases by Alternative

Alternative (duration in years)	*Tritium*	*Cobalt-60*	*Strontium-90* [a]	*Iodine-129*	*Cesium-137* [a]	*Transuranic* [c]	*Total* [d]
Average Airborne Radiological Releases (curies per year)							
Sitewide Removal (60)	3.6×10^{-2}	2.9×10^{-4}	1.4×10^{-2}	6.2×10^{-6}	3.7×10^{-3}	1.3×10^{-3}	7.3×10^{-2}
Sitewide Close-In-Place (7)	1.0×10^{-5}	9.0×10^{-5}	5.5×10^{-3}	1.9×10^{-6}	5.0×10^{-3}	2.5×10^{-4}	2.2×10^{-2}
Phased Decisionmaking (8)	2.7×10^{-4}	1.6×10^{-4}	1.7×10^{-2}	4.7×10^{-5}	1.5×10^{-2}	6.4×10^{-3}	7.1×10^{-2}
No Action (60)	2.0×10^{-4}	1.4×10^{-9}	7.2×10^{-7}	3.3×10^{-6}	1.3×10^{-6}	2.7×10^{-8}	2.1×10^{-4} [e]
Peak Annual Airborne Radiological Releases (curies per year)							
Sitewide Removal – year 6	2.8×10^{-2}	4×10^{-4}	2.5×10^{-2}	6.1×10^{-6}	2.0×10^{-2}	9.8×10^{-3}	1.3×10^{-1}
Sitewide Removal – year 50	5.6×10^{-2}	3×10^{-4}	6.9×10^{-2}	9.0×10^{-6}	6.4×10^{-4}	5.8×10^{-4}	2.0×10^{-1}
Sitewide Removal – year 54	0.0	0.0	9.9×10^{-2}	0.0	1.8×10^{-4}	4.7×10^{-6}	2.0×10^{-1}
Sitewide Close-In-Place	7.1×10^{-5}	4.0×10^{-4}	9.5×10^{-3}	1.1×10^{-5}	8.9×10^{-3}	5.2×10^{-4}	3.7×10^{-2}
Phased Decisionmaking	7.1×10^{-5}	7.3×10^{-7}	4.5×10^{-2}	1.4×10^{-5}	3.4×10^{-2}	1.7×10^{-2}	1.8×10^{-1}
No Action	4.1×10^{-1}	2.0×10^{-6}	4.8×10^{-4}	7.4×10^{-3}	8.6×10^{-4}	1.2×10^{-6}	4.2×10^{-1} [f]

[a] An equal release of yttrium-90, a decay daughter radionuclide of strontium-90, was included.
[b] An equal release of barium-137m, a decay daughter radionuclide of cesium-137, was included.
[c] Transuranic radioisotopes were represented by plutonium-239.
[d] Yearly total presented. The activity released over the life of the alternative is the total (curies per year) times the duration (year).
[e] Total also includes 6.1×10^{-8} curies of americium-241, 5.1×10^{-9} curies of europium-154, 7.5×10^{-9} curies of uranium isotopes represented by uranium-238, and 2×10^{-8} curies of plutonium-238.
[f] Total also includes 2.8×10^{-6} curies of americium-241, 4.7×10^{-4} curies of europium-154, 3×10^{-7} curies of uranium isotopes represented by uranium-238, and 8.7×10^{-7} curies of plutonium-238.
Note: Alternative durations are presented in years. There is no decommissioning for the No Action Alternative; for this alternative, a 60-year period of site monitoring and maintenance is analyzed as adapted for the purpose of consistency in comparison to the sitewide removal alternative duration.
Sources: WSMS 2009a, 2009b, 2009c, 2009d.

Table I–4 Total Liquid Radiological Releases by Alternative

Alternative (duration in years)	*Tritium*	*Cobalt-60*	*Strontium-90* [a]	*Cesium-137* [b]	*Transuranic* [c]	*Total* [d]
Average Liquid Radiological Releases (curies per year)						
Sitewide Removal (60)	4.8	4.6×10^{-7}	6.5×10^{-3}	8.2×10^{-4}	7.0×10^{-6}	4.8
Sitewide Close-In-Place (7)	4.1×10^{1}	3.6×10^{-7}	4.3×10^{-2}	2.2×10^{-3}	4.9×10^{-5}	4.1×10^{1}
Phased Decisionmaking (8)	7.5×10^{-3}	1.3×10^{-9}	6.7×10^{-5}	4.1×10^{-7}	7.8×10^{-10}	7.6×10^{-3}
No Action (60)	8.8×10^{-3}	4.3×10^{-6}	5.4×10^{-4}	2.7×10^{-4}	6.0×10^{-7}	1.0×10^{-2} [e]
Peak Annual Liquid Radiological Releases (curies per year)						
Sitewide Removal – year 22	3.4	9.7×10^{-7}	9.4×10^{-5}	1.3×10^{-3}	6.5×10^{-7}	3.4
Sitewide Removal – year 35	1.3×10^{1}	1.1×10^{-6}	2.2×10^{-2}	1.5×10^{-3}	1.4×10^{-5}	1.3×10^{1}
Sitewide Close-In-Place	7.2×10^{2}	6.3×10^{-7}	7.5×10^{-2}	3.8×10^{-3}	8.5×10^{-5}	7.2×10^{2}
Phased Decisionmaking	1.5×10^{-2}	2.6×10^{-9}	9.6×10^{-5}	8.2×10^{-7}	1.6×10^{-9}	1.5×10^{-2}
No Action	7.2	2.3×10^{-3}	9.9×10^{-3}	6.6×10^{-2}	5.2×10^{-5}	7.4 [f]

[a] An equal release of yttrium-90, a decay daughter radionuclide of strontium-90, was included.
[b] An equal release of barium-137m, a decay daughter radionuclide of cesium-137, was included.
[c] Transuranic radioisotopes were represented by plutonium-239.
[d] Yearly total presented. The activity released over the life of the alternative is the total (curies per year) times the duration (year).
[e] Total also includes: 3.6×10^{-5} curies of carbon-14, 7.4×10^{-5} curies of potassium-40, 1.1×10^{-4} curies of technetium-99, 8.1×10^{-6} curies of iodine-129, and 8.2×10^{-5} curies of uranium isotopes (represented by uranium-238).
[f] Total also includes: 1.9×10^{-2} curies of carbon-14, 1.3×10^{-2} curies of potassium-40, 9.6×10^{-2} curies of technetium-99, 1.7×10^{-3} curies of iodine-129, and 1.1×10^{-2} curies of uranium isotopes (represented by uranium-238).
Note: Alternative durations are presented in years. There is no decommissioning for the No Action Alternative; for this alternative, a 60-year period of site monitoring and maintenance is analyzed as adapted for the purpose of consistency in comparison to the sitewide removal alternative duration.
Sources: WSMS 2009a, 2009b, 2009c, 2009d.

I.4.3.3 Food Production and Consumption Data

Generic food consumption rates are available as default values in GENII. The default values are comparable to those established in NRC Regulatory Guide 1.109 (NRC 1977). The Regulatory Guide provides guidance for evaluating ingestion doses from consuming contaminated plant and animal food products using a standard set of assumptions for crop and livestock growth and harvesting characteristics.

Food consumption parameters used to evaluate each alternative are presented in **Tables I–5** and **I–6**.

Table I–5 GENII Usage Parameters for Consumption of Plant Food (Normal Operations)

Food Type	Agriculture Characteristics: Growing Time (Days)	Agriculture Characteristics: Yield (kilograms per square meter)	Maximally Exposed Individual: Holdup Time [a] (days)	Maximally Exposed Individual: Consumption Rate (kilograms per year)	General Population: Holdup Time (days)	General Population: Consumption Rate (kilograms per year)
Leafy vegetables	90	1.5	1	30	14	15
Root vegetables	90	4	5	220	14	140
Fruit	90	2	5	330	14	64
Grains/cereals	90	0.8	180	80	180	72

Note: To convert kilograms to pounds, multiply by 2.2046; square meters to square feet, multiply by 10.8.
[a] Holdup time is the time between absorption of radionuclides and consumption of this food product.
Source: PNNL 2007.

Table I–6 GENII Usage Parameters for Consumption of Animal Products (Normal Operations)

Food Type	Stored Feed: Diet Fraction	Stored Feed: Growing Time (days)	Stored Feed: Yield (kilograms per square meter)	Stored Feed: Storage Time (days)	Fresh Forage: Diet Fraction	Fresh Forage: Growing Time (days)	Fresh Forage: Yield (kilograms per square meter)	Fresh Forage: Storage Time (days)
Beef	0.25	90	0.8	180	0.75	45	2	100
Poultry	1	90	0.8	180	—	—	—	—
Milk	0.25	45	2	100	0.75	30	1.5	0
Eggs	1	90	0.8	180	—	—	—	—

Food Type	Maximally Exposed Individual: Consumption Rate (kilograms per year)	Maximally Exposed Individual: Holdup Time [a] (days)	General Population: Consumption Rate (kilograms per year)	General Population: Holdup Time (days)
Beef	80	15	70	34
Poultry	18	1	8.5	34
Milk	270	1	230	3
Eggs	30	1	20	18

Note: To convert kilograms to pounds, multiply by 2.2046; square meters to square feet, multiply by 10.8.
[a] Holdup time is the time between absorption of radionuclides and consumption of this food product.
Source: PNNL 2007.

Calculations of the population and MEI doses from liquid releases into the local streams and creeks (eventually reaching Buttermilk Creek, Cattaraugus Creek, and Lake Erie) included doses resulting from use of the creek water as a source of drinking water and from the ingestion of fish taken from the creek. (These waters are not a source of irrigation for local crops.) All receptors were assumed to drink 2 liters (0.5 gallons) of water per day. The populations considered in estimating the doses from drinking water were the customers of Lake Erie water treatment plants downstream of Cattaraugus Creek (565,000 individuals) and the Niagara River water treatment plants (386,000 individuals). Fish consumption for the general population was determined to be approximately 0.1 kilograms per year (0.2 pounds per year) based upon estimates of the quantity of fish harvested from local waters, and the MEI was assumed to consume 9 kilograms per year (20 pounds per year) as a conservative assumption as compared to the general population. An additional receptor, an individual living on the Seneca Nation of Indians Land, was identified who would consume a greater quantity of fish than that identified for the MEI. This receptor was assumed to consume 62 kilograms per year (137 pounds per year) of fish harvested from local waters.

I.4.3.4 GENII Basic Assumptions

Other key assumptions used in GENII are delineated in the following text:

- Public population distribution of an 80-kilometer (50-mile) radius in all 16 compass directions for specific distance rings (0 to 1, 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 10, 10 to 20, 20 to 30, 30 to 40, and 40 to 50 miles[6]) based on 2000 U.S. and 2001 Canadian census data.
- MEI location at the WVDP Site for all 16 compass directions, which constitutes the closest public boundary to the site in each of these directions.
- Generic agricultural and food consumption data for the land and the population residing within 80 kilometers (50 miles) of the WVDP Site (NRC 1977).
- Radiological airborne emissions were released to the atmosphere at a height of either 0 or 24 meters (0 or 79 feet) to represent the range of structure heights for decommissioning operations. The tallest height is that of the Main Plant Process Building in Waste Management Area (WMA) 1. This range of lowest and highest airborne emission height results in enveloping public radiation dose calculation results.
- For normal operations calculations, emission of the plume was assumed to continue throughout the year. Plume and ground deposition exposure parameters used in the GENII model for the exposed offsite individual and the general population are provided in **Table I–7**.
- The exposed individual or population was assumed to have adult human characteristics and habits.
- No evacuation or sheltering was assumed, though individuals were assumed to spend some time indoors.
- A Pasquill-Gifford plume model was used for the air immersion doses.

Table I–7 GENII Usage Parameters for Exposure to Plumes (Normal Operations)

Maximally Exposed Individual				*General Population*			
External Exposure		*Inhalation of Plume*		*External Exposure*		*Inhalation of Plume*	
Plume (hours) [a]	*Ground Contamination (hours)* [b]	*Exposure Time (hours)*	*Breathing Rate (cubic centimeters per second)*	*Plume (hours)* [c]	*Ground Contamination (hours)* [b]	*Exposure Time (hours)*	*Breathing Rate (cubic centimeters per second)*
6,132	8,760	8,760	270	4,383	8,760	8,760	270

[a] Assumes 70 percent of the hours per year are outdoor exposure, with the balance indoors.
[b] Assumes 70 percent shielding for time indoors (i.e., 70 percent of the hours per year are located indoors).
[c] Assumes 50 percent of the hours per year are outdoor exposure, with the balance indoors.
Note: To convert cubic centimeters to cubic inches, multiply by 0.061024.
Sources: PNNL 2007, NRC 1977.

[6] *To convert miles to kilometers, multiply by 1.6.*

I.4.3.5 Radiological Consequences from Normal Operations

The following tables provide the estimated impacts, in terms of dose (person-rem) and increased risk of LCFs, to the public from radiological releases associated with normal operations for each of the four alternatives. **Table I–8** provides the yearly average, peak annual, and total population impacts associated with airborne radiological releases from normal operations for the duration of the implementation of each alternative. **Table I–9** provides this information for liquid radiological releases. The peak annual population doses presented in Tables I–8 and I–9 are based on the peak annual releases that are presented in Tables I–3 and I–4. The basis for these peak annual releases is also discussed in Section I.4.3.2.

Table I–8 Population Impacts of Airborne Radiological Releases (Normal Operations)

Alternative	Yearly Average		Peak Annual		Duration Total	
	Population Dose [a] (person-rem)	Increased Risk of LCF [b]	Population Dose [a] (person-rem)	Increased Risk of LCF [b]	Population Dose [a] (person-rem)	Increased Risk of LCF [b]
Sitewide Removal	1.2	1.9×10^{-4}	7.9	1.0×10^{-3}	7.2×10^{1}	1.1×10^{-2}
Sitewide Close-In-Place	3.3×10^{-1}	7.2×10^{-5}	6.4×10^{-1}	1.3×10^{-4}	2.3	5.0×10^{-4}
Phased Decisionmaking (Phase 1)	5.2	6.9×10^{-4}	1.4×10^{1}	1.8×10^{-3}	4.2×10^{1}	5.6×10^{-3}
No Action	4.5×10^{-4}	2.6×10^{-8}	7.9×10^{-1}	2.5×10^{-5}	2.7×10^{-2} [c]	1.6×10^{-6} [c]

LCF = latent cancer fatality.
[a] Based on a population of 1,704,000.
[b] Federal Guidance Report No. 13 (EPA 1999b) individual radioisotope risk factors are used to calculate lifetime fatal cancer risk for normal operations.
[c] Although the duration of the No Action Alternative is in perpetuity, a 60-year time period is analyzed for this table. The 60-year period is analyzed as adapted for the purpose of consistency in comparison to the sitewide removal alternative duration.
Note: All population results for air releases are obtained directly from GENII 2 output.

Table I–9 Population Impacts of Liquid Radiological Releases (Normal Operations)

Alternative	Yearly Average		Peak Annual		Duration Total	
	Population Dose [a] (person-rem)	Increased Risk of LCF [b]	Population Dose [a] (person-rem)	Increased Risk of LCF [b]	Population Dose [a] (person-rem)	Increased Risk of LCF [b]
Lake Erie Downstream of Cattaraugus Creek Water Consumer [a]						
Sitewide Removal	8.2×10^{-1}	2.7×10^{-4}	2.5	8.2×10^{-4}	4.9×10^{1}	1.6×10^{-2}
Sitewide Close-In-Place	5.2	1.7×10^{-3}	2.6×10^{1}	8.2×10^{-3}	3.7×10^{1}	1.2×10^{-2}
Phased Decisionmaking (Phase 1)	6.3×10^{-3}	2.1×10^{-6}	9.2×10^{-3}	3.0×10^{-6}	5.1×10^{-2}	1.6×10^{-5}
No Action	1.0×10^{-1}	3.1×10^{-5}	1.4×10^{1}	4.2×10^{-3}	6.1 [c]	1.9×10^{-3} [c]
Niagara River Water Consumer [a]						
Sitewide Removal	1.3×10^{-2}	4.4×10^{-6}	4.1×10^{-2}	1.3×10^{-5}	8.0×10^{-1}	2.6×10^{-4}
Sitewide Close-In-Place	8.6×10^{-2}	2.8×10^{-5}	4.2×10^{-1}	1.3×10^{-4}	6.0×10^{-1}	1.9×10^{-4}
Phased Decisionmaking (Phase 1)	1.0×10^{-4}	3.4×10^{-8}	1.5×10^{-4}	4.9×10^{-8}	8.3×10^{-4}	2.7×10^{-7}
No Action	1.7×10^{-3}	5.1×10^{-7}	2.2×10^{-1}	6.9×10^{-5}	9.9×10^{-2} [c]	3.0×10^{-5} [c]

LCF = latent cancer fatality.
[a] Affected populations: Lake Erie water treatment plants downstream of Cattaraugus Creek, 565,000; Niagara River water treatment plants 386,000.
[b] Federal Guidance Report No. 13 (EPA 1999b) individual radioisotope risk factors are used to calculate lifetime fatal cancer risk for normal operations.
[c] Although the duration of the No Action Alternative is in perpetuity, a 60-year time period is analyzed for this table. The 60-year period is analyzed as adapted for the purpose of consistency in comparison to the sitewide removal alternative duration.

The following tables provide the estimated individual impacts, in terms of individual yearly dose (in millirem) and increased risk of an LCF, associated with radiological releases from normal operations for the decommissioning activities of each alternative. Three hypothetical individuals have been identified for analysis. Typically, the MEI would be a person at the site boundary (closest location to the point of release) in the direction that yields the highest individual dose from an airborne release, a result of a combination of distance and meteorological conditions. However, this is not the individual who would be the MEI from liquid releases. Therefore, two additional individuals were identified. One lives near the site; the second lives on the Seneca Nation land and is assumed to have a significantly higher consumption of fish taken from local waters. **Table I–10** provides the estimated yearly average, peak annual, and total individual impacts associated with airborne radiological releases from normal operations for the duration of the implementation of each alternative. **Table I–11** provides this information for liquid radiological releases.

Table I–10 Individual Impacts of Airborne Radiological Releases (Normal Operations)

Alternative	*Yearly Average*		*Peak Annual*		*Duration Total*	
	Dose Rate (millirem per year)	*Increased Risk of LCF* [a]	*Total Dose (millirem)*	*Increased Risk of LCF* [a]	*Total Dose (millirem)*	*Increased Risk of LCF* [a]
Maximally Exposed Individual (Site Boundary)						
Sitewide Removal	2.3×10^{-1}	4.8×10^{-8}	1.3	2.0×10^{-7}	1.4×10^{1}	2.9×10^{-6}
Sitewide Close-In-Place	8.3×10^{-2}	2.3×10^{-8}	1.6×10^{-1}	4.2×10^{-8}	5.8×10^{-1}	1.6×10^{-7}
Phased Decisionmaking (Phase 1)	8.5×10^{-1}	1.4×10^{-7}	2.2	3.5×10^{-7}	6.8	1.1×10^{-6}
No Action	1.5×10^{-4}	8.1×10^{-12}	2.9×10^{-1}	9.3×10^{-9}	9.0×10^{-3} [b]	4.9×10^{-10} [b]
Individual on Cattaraugus Creek Near Site						
Sitewide Removal	4.7×10^{-2}	7.8×10^{-9}	3.1×10^{-1}	4.2×10^{-8}	2.8	4.7×10^{-7}
Sitewide Close-In-Place	1.4×10^{-2}	3.1×10^{-9}	2.7×10^{-2}	5.8×10^{-9}	9.8×10^{-2}	2.2×10^{-8}
Phased Decisionmaking (Phase 1)	2.1×10^{-1}	2.8×10^{-8}	5.4×10^{-1}	7.2×10^{-8}	1.7	2.2×10^{-7}
No Action	2.0×10^{-5}	1.1×10^{-12}	3.5×10^{-2}	1.1×10^{-9}	1.2×10^{-3} [b]	6.6×10^{-11} [b]
Individual on Lower Reaches of Cattaraugus Creek						
Sitewide Removal	8.1×10^{-4}	1.2×10^{-10}	5.5×10^{-3}	7.0×10^{-10}	4.9×10^{-2}	7.2×10^{-9}
Sitewide Close-In-Place	2.1×10^{-4}	4.4×10^{-11}	4.2×10^{-4}	8.3×10^{-11}	1.5×10^{-3}	3.1×10^{-10}
Phased Decisionmaking (Phase 1)	3.6×10^{-3}	4.7×10^{-10}	9.5×10^{-3}	1.2×10^{-9}	2.9×10^{-2}	3.8×10^{-9}
No Action	2.7×10^{-7}	1.6×10^{-14}	4.6×10^{-4}	1.5×10^{-11}	1.6×10^{-5} [b]	9.6×10^{-13} [b]

LCF = latent cancer fatality.

[a] Federal Guidance Report No. 13 (EPA 1999b) individual radioisotope risk factors are used to calculate lifetime fatal cancer risk for normal operations.

[b] Although the duration of the No Action Alternative is in perpetuity, a 60-year time period is analyzed for this table. The 60-year period is analyzed as adapted for the purpose of consistency in comparison to the sitewide removal alternative duration.

Table I–11 Individual Impacts of Liquid Radiological Releases (Normal Operations)

Alternative	*Yearly Average*		*Peak Annual*		*Duration Total*	
	Dose Rate (millirem per year)	*Increased Risk of LCF* [a]	*Total Dose (millirem)*	*Increased Risk of LCF* [a]	*Total Dose (millirem)*	*Increased Risk of LCF* [a]
Individual on Cattaraugus Creek Near Site						
Sitewide Removal	4.9×10^{-3}	1.7×10^{-9}	1.4×10^{-2}	4.8×10^{-9}	2.9×10^{-1}	1.0×10^{-7}
Sitewide Close-In-Place	2.7×10^{-2}	9.3×10^{-9}	9.9×10^{-2}	3.3×10^{-8}	1.9×10^{-1}	6.5×10^{-8}
Phased Decisionmaking (Phase 1)	3.3×10^{-5}	1.1×10^{-11}	4.8×10^{-5}	1.6×10^{-11}	2.6×10^{-4}	9.0×10^{-11}
No Action	8.8×10^{-4}	2.9×10^{-10}	1.7×10^{-1}	5.7×10^{-8}	5.3×10^{-2} [b]	1.8×10^{-8} [b]
Individual on Lower Reaches of Cattaraugus Creek						
Sitewide Removal	1.0×10^{-2}	3.6×10^{-9}	2.5×10^{-2}	9.0×10^{-9}	6.0×10^{-1}	2.1×10^{-7}
Sitewide Close-In-Place	4.6×10^{-2}	1.6×10^{-8}	1.2×10^{-1}	4.0×10^{-8}	3.2×10^{-1}	1.1×10^{-7}
Phased Decisionmaking (Phase 1)	4.8×10^{-5}	1.7×10^{-11}	7.0×10^{-5}	2.5×10^{-11}	3.8×10^{-4}	1.4×10^{-10}
No Action	2.6×10^{-3}	8.9×10^{-10}	6.1×10^{-1}	2.1×10^{-7}	1.5×10^{-1} [b]	5.3×10^{-8} [b]

LCF = latent cancer fatality.
[a] Federal Guidance Report No. 13 (EPA 1999b) individual radioisotope risk factors are used to calculate lifetime fatal cancer risk for normal operations.
[b] Although the duration of the No Action Alternative is in perpetuity, a 60-year time period is analyzed for this table. The 60-year period is analyzed as adapted for the purpose of consistency in comparison to the sitewide removal alternative duration.

I.4.3.6 Analysis Uncertainties

The sequence of analyses performed to generate normal operations radiological impact estimates includes selection of normal operational modes, estimation of source terms, estimation of environmental transport and uptake of radionuclides, calculation of radiation doses to exposed individuals, and estimation of health effects. Uncertainties are associated with each of these steps. Uncertainties exist in the way the physical systems being analyzed are represented by the computational models and in the data required to exercise the models (due to measurement, sampling, or natural variability).

In principle, one can estimate the uncertainty associated with each source and predict the remaining uncertainty in the results of each set of calculations. Thus, one can propagate the uncertainties from one set of calculations to the next and estimate the uncertainty in the final results. However, conducting such a full-scale quantitative uncertainty analysis is neither practical nor standard practice for this type of study. Instead, the analysis is designed to ensure—through judicious selection of release scenarios, models, and parameters—that the results conservatively represent the potential risks. This is accomplished by making conservative assumptions in the calculations at each step. The models, parameters, and release scenarios used in the calculations are selected in such a way that most intermediate results and, consequently, final impact estimates are larger than expected. As a result, even though the range of uncertainty in a quantity might be large, the value calculated for the quantity would be close to one of the extremes in the range of possible values, so the chance of the actual quantity being greater than the calculated value would be low. Conservative assumptions in this analysis bound all uncertainties. Key conservative assumptions in this analysis that bound all uncertainties include:

1. Inhalation population radiological exposure continuously for 365 days and 24 hours per day causing the highest possible inhalation radiation dose;

2. A range of the lowest (i.e., ground-level) and highest (i.e., existing ventilation stack) possible airborne release plume heights, resulting in the largest possible radionuclide air concentration from atmospheric dispersion;

3. Use of the 2000 census population data, causing the highest population dose since census data for all counties within 80 kilometers (50 miles) of the Western New York Nuclear Service Center shows a decrease in population since 2000;
4. Location of the MEI at the closest public boundary during all radiological releases, resulting in the largest possible MEI radiation doses;
5. The annual airborne release rate of radionuclides was not reduced to account for the radioactive decay of radionuclides with relatively short half-lifes such as cobalt-60, tritium, cesium-137, and strontium-90, which would significantly reduce the release rates and calculated dose, especially for the longer time periods of the Sitewide Removal and No Action Alternatives.

Routine normal activities may have different human health impacts on specific populations such as American Indians or Hispanics, whose cultural heritage can result in special exposure pathways that are different than those modeled to evaluate doses to the general population and MEI. The analyses performed to evaluate public impacts of the alternatives did include normally significant pathways and were designed to be conservative. Higher fish consumption for individuals living on Seneca Nation Land was analyzed to calculate impacts on this population group. A qualitative evaluation of potential impacts on other specific population groups was performed based on the radionuclides emitted and an understanding of the most significant pathways.

Parameter selection and population and MEI practices were chosen to be conservative. For example, it was assumed that the population breathed contaminated air all the time (spent no time away from the local area). The dose to a member of the public was dominated by internal exposures from inhalation and ingestion.

I.5 Impacts of Accidents During Alternative Implementation

I.5.1 Accident Relationship to Environmental Impact Statement Alternative

Each alternative considered in this EIS has specific aspects that may affect which accidents are analyzed for that alternative. This section evaluates the alternatives in terms of their applicable accident scenarios. Accident scenarios have been identified for radioactive waste packages, the radioactive waste tanks in WMA 3, the Main Plant Process Building in WMA 1, the NRC-Licensed Disposal Area (NDA) in WMA 7, and the State-Licensed Disposal Area (SDA) in WMA 8. **Table I–12** lists those aspects of the four alternatives that affect accident analyses.

Table I–12 shows that accidents involving the Main Plant Process Building, the radioactive waste tanks, and the Low-Level Waste Treatment Facility could occur under all alternatives, and that the same radioactive waste packages would not be transported under each alternative. The No Action Alternative monitoring of facility and structure residual radioactivity does not preclude an accident in which this radioactivity could be released to the environment.

Based on the preparation for decommissioning actions and affected facilities for each alternative described in Table I–12, **Table I–13** was developed to correlate the accident scenarios with each specific alternative. The greatest difference, for accidents, between the alternatives is that the No Action Alternative does not have any remote-handled transuranic waste package, Greater-Than-Class C waste package, or high-integrity container (HIC) package accident scenarios.

Table I–12 Alternative Parameters Affecting Accident Analysis Scenarios

Alternative	*Sitewide Removal Alternative*	*Sitewide Close-In-Place Alternative*	*Phased Decisionmaking Alternative (Phase 1)*	*No Action Alternative*
Main Plant Process Building	Demolish and exhume	Demolish to floor slab	Demolish and exhume	Monitor and maintain
Radioactive Waste Tanks in the Waste Tank Farm	Demolish and exhume	Fill and cap	Monitor and maintain	Monitor and maintain
Radioactive Waste Package Transportation	Yes	Yes	Yes	Yes
Low-Level Waste Treatment Facility	Demolish and exhume	Demolish and exhume	Demolish and exhume	Monitor and maintain
Lagoons, trenches, Groundwater Plume, Cesium Prong	Exhume	Manage in place	Remove lagoons, monitor others	Monitor and maintain
NRC-Licensed Disposal Area	Exhume	Remove leachate and fill	Monitor and maintain	Monitor and maintain
State-Licensed Disposal Area	Exhume	Remove leachate and fill	Monitor and maintain	Monitor and maintain

NRC = U.S. Nuclear Regulatory Commission.

Table I–13 Accident Scenarios Applicable to Each Alternative

Accident Category	*Sitewide Removal Alternative*	*Sitewide Close-In-Place Alternative*	*Phased Decisionmaking Alternative (Phase 1)*	*No Action Alternative*
Main Plant Process Building	Yes	Yes	Yes	Yes
Radioactive Waste Tanks	Yes	Yes	Yes	Yes
Radioactive Waste Package Transportation	Yes (most)	Yes	Yes	Yes (least)
NRC-Licensed Disposal Area Exhumation	Yes	No	No	No
State-Licensed Disposal Area Exhumation	Yes	No	No	No

NRC = U.S. Nuclear Regulatory Commission.

I.5.2 Radiological Source Term Methodology

The accident source term is the amount of respirable radioactive material released to the air or particles released to the water, in terms of curies or grams, assuming the occurrence of a postulated accident. The airborne source term is typically estimated by the following equation:

$$\text{Source term} = \text{MAR} \times \text{DR} \times \text{ARF} \times \text{RF} \times \text{LPF}$$

where:

MAR = material at risk
DR = damage ratio
ARF = airborne release fraction
RF = respirable fraction
LPF = leak path factor

The MAR is the amount of radionuclides (in curies of activity or grams for each radionuclide) available for release when acted upon by a given physical stress or accident. The MAR is specific to a given process in the facility of interest. It is not necessarily the total quantity of material present, but is that amount of material in the postulated scenario of interest that would be available for release.

The DR is the fraction of material exposed to the effects of the energy, force, or stress generated by the postulated event. For the accident scenarios discussed in this analysis, the DR value varies from 0.1 to 1.0.

The ARF is the fraction of material that becomes airborne due to the accident. In this analysis, ARFs were obtained from the *Final West Valley Demonstration Project Waste Management Environmental Impact Statement (WVDP Waste Management EIS)* (DOE 2003c), *Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site (Plutonium Residues EIS)* (DOE 1998), or *DOE Handbook* on ARFs (DOE 1994).

The RF is the fraction of PM_{10}[7] that could be retained in the respiratory system following inhalation. The RF values are also taken from the *WVDP Waste Management EIS* (DOE 2003c), *Plutonium Residues EIS* (DOE 1998), or *DOE Handbook* on ARFs (DOE 1994).

The LPF accounts for the action of removal mechanisms—for example, containment systems, filtration, and deposition—to reduce the amount of airborne radioactivity ultimately released to occupied spaces in the facility or environment. An LPF of 1.0 (no reduction) is assigned in accident scenarios involving a major failure of confinement barriers. LPFs were obtained from the *WVDP Waste Management EIS* (DOE 2003c), *Plutonium Residues EIS* (DOE 1998), and site-specific evaluations.

I.5.3 Accident Scenario Development Methodology

The methodology used to develop accident scenarios and their associated parameters involved several steps. First, other relevant EISs and the *DOE Handbook* on ARFs (DOE 1994) were evaluated to develop a list of likely accident scenarios. This evaluation examined the types of structures and equipment at WVDP expected to contain any significant residual radioactivity in the form of fixed or mobile chemical or physical forms of radionuclides. Experience from previous EISs involving nonreactor facilities was also used to establish accident scenarios. This first step led to the conclusion that accidents at a facility like WVDP could fall into one of the following categories:

- Drops
- Punctures
- Spills
- Leaks
- Seismically induced structural failures
- Fires
- Explosions
- Seismically induced structural failures followed by fires and/or explosions
- Nuclear criticality events
- Chemical reactions

Evaluation of systems, components, and facilities at WVDP that would be subject to decommissioning activities resulted in elimination of explosion, nuclear criticality, and chemical reaction as accident event scenarios. No explosive materials exist at WVDP, and explosives would not be used for decommissioning activities. Any fissionable radionuclides at WVDP are in quantities and concentrations too small to constitute

[7] *PM_{10} is particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (0.0004 inches).*

any nuclear criticality risk or cause any nuclear criticality accident. Chemicals at WVDP intended for decommissioning activities are not capable of reaction with other chemicals already at WVDP or with each other in such a way that could initiate any accident releasing radionuclides. However, it was determined that drops, punctures, spills, leaks, seismically induced structural failures, fires, and seismically induced structural failures followed by fires are all possible accident scenarios during decommissioning activities at WVDP. Further evaluation of fires eliminated them for large structures because of the absence of combustible materials and the distributed nature of radioactive contamination over large surface areas and room volumes. Although it would be possible for a fire to occur in an individual room or cell, the lack of combustible materials throughout a facility such as the Main Plant Process Building would preclude a facility-wide fire and would therefore limit the release of radionuclides to one room. Fires are still considered for radioactive waste package handling.

Several accidents were postulated at WVDP during decommissioning activities. These involve the high-level radioactive waste tanks and the Main Plant Process Building, all of which contain both mobile and fixed residual radionuclide contamination, because these structures appear to contain the largest residual radioactivity available for release to the environment during an accident.

The seismically induced structural failure of one high-level radioactive waste tank is another accident analyzed for this EIS. In this accident, a seismic event occurs that causes failure of tank supports or other tank structures, thereby resulting in direct exposure of the tank radiological inventory to the environment. The seismic event is also assumed to cause any isolating or confinement covers around the high-level radioactive waste tanks to fail. Fires in and around the radioactive waste tanks in the Waste Tank Farm were dismissed because of a lack of combustible material, thereby resulting in an extremely low probability (i.e., less than the screening limit of 1.0×10^{-6} per year). Although this postulated accident would result in both airborne and liquid releases, the relatively slow dispersion of a liquid, the ability to contain a liquid release, and the relatively longer timeframe that allows for emergency response would result in protection of the public from radiation doses due to liquids. The risk- and consequence-dominant release from this accident scenario is the airborne release.

The Main Plant Process Building consists of a number of cells and other enclosed areas. Five accidents were postulated for this structure, that involve either the single cell having the largest residual radionuclide contamination inventory or the entire Main Plant Process Building and its concomitant total residual radionuclide contamination inventory. As in the case of the high-level radioactive waste tanks, these accidents involve either a fire or seismic structural collapse of either the hottest cell or the entire Main Plant Process Building, with failure of any confinement enclosure. The fifth accident assumes a seismic event that causes both structural collapse and a fire in the Main Plant Process Building. Additionally, as in the case of the radioactive waste tanks, this last accident scenario was dismissed from detailed analysis because its estimated frequency of occurrence is less than the screening limit of 1×10^{-6} per year. Furthermore, as the Main Plant Process Building, as a whole, contains the bounding radionuclide inventory (i.e., MAR), accidents involving the hottest process cell were eliminated from analysis. A lack of combustible material in and around the Main Plant Process Building eliminated the fire accident scenario. The Main Plant Process Building accident scenario that was analyzed is the seismically induced complete collapse of the entire Main Plant Process Building.

Ten different types of radioactive waste transportation packages were identified as being used under one or more of the four alternatives considered in this EIS. As in the *WVDP Waste Management EIS* (DOE 2003c), drops and/or fires resulting in package confinement failure were postulated for each of these packages. Eleven accident scenarios involving all 10 of these packages were analyzed for this EIS and are described in Sections I.5.4 and I.5.5.

The exhumation, removal, and backfill of contaminated areas such as the lagoons in WMA 2; NDA trenches, holes, and lagoons in WMA 7; SDA trenches and lagoons in WMA 8; North Plateau Groundwater Plume; and

Cesium Prong involve handling large quantities of soil, sediment, and other solid materials and their subsequent shipment off site to a suitable waste facility. The magnitude of contamination per unit mass or volume of these areas is much smaller than that of the high-level radioactive waste tanks, radioactive waste shipping packages, and Main Plant Process Building.

Two accident scenarios were postulated to occur during exhumation of the waste in the NDA and SDA. The radioactive waste in these areas consists of a wide range of materials including solvents, soil, filters, fuel rod segments, and clothing. Each scenario involves the ignition of a flammable solvent or diesel fuel spill from exhumation equipment. The fire affects 0.3 cubic meters (11 cubic feet) of exposed contaminated waste. This release fraction is based on a conservative assumption that the waste consists of uncontained combustible material containing radioactive contamination. For the NDA, combination waste is assumed for the radioisotope composition, and, for the SDA, Trench 10 was assumed for the accident scenario. Both the NDA and SDA scenarios use the largest respirable radioisotope inventory of all the buried waste categories and trenches. These scenarios were analyzed as either a plume with no energy or one with the energy associated with a postulated concomitant fire.

An accident scenario involving any liquid releases (e.g., leachate from transfer piping, used to transfer groundwater from the NDA interceptor trench sump) would involve smaller quantities of radionuclides and, being in a liquid form, would pose a much smaller risk to the public and workers. All accidental liquid releases are amenable to mitigation because public and worker radiation doses are dependent upon ingestion or immersion in the liquid. Emergency response to such a liquid release would prevent contaminated water ingestion or exposure. The timeframe to avoid radiological doses is sufficient for such a response. In contrast, the timing and nature of airborne releases from a postulated accident make it more difficult to mitigate and preclude radiation doses to workers and the public. Hence, the short-term consequences and risks of postulated accidents involving liquid releases are bounded by accidents that were analyzed involving the airborne release of radionuclides.

Worker accidents involving exposure to radiologically contaminated liquids and volatile compounds could result in significant health impacts due to external exposure, inhalation, and ingestion. However, the EIS does not calculate any specific impacts on workers with regard to an accident scenario because of the wide range of locations and actions of such workers. All accident consequences and risks are calculated for the MEI and population. Workers may experience the most severe consequences of the accidents analyzed in this EIS. For example, the postulated seismic collapse of the waste tank or Main Plant Process Building could lead to fatalities of nearby workers due to the seismic event and associated structural collapse. Liquid releases and volatile chemical exposure would most likely not lead to a worker fatality, and the worker consequences would be much less severe than those of a seismic collapse. Furthermore, worker exposure to radiologically contaminated liquids, volatile chemicals, and other hazardous or chemical substances are considered part of the category of occupational hazards (Occupational Safety and Health Administration regulations) and not a lower probability accident as is analyzed in this appendix. In any industrial or waste cleanup situation, there are numerous possible opportunities for spills or mishaps that are not considered bounding conservative accidents.

A postulated accident involving a drop, puncture, or fire involving packages containing vitrified high-level radioactive waste would not release respirable particles of radioactive material. The physical properties of vitrified high-level radioactive waste preclude the generation of respirable particles under these accident conditions. Moreover, the vitrified high-level radioactive waste packaging design provides a greater confinement than the packaging used for smaller quantities of radioactive materials. Therefore, although considered, no accident involving vitrified high-level radioactive waste packaging was analyzed because no release of respirable particles would occur under postulated accident conditions (DOE 1994).

The MEI location for postulated accident scenarios is based on the closest location to the accident scene at which a member of the public could be present. The MEI location for each accident scenario is:

183 meters (600 feet) for radioactive waste packages, 259 meters (850 feet) for the radioactive waste tanks, 244 meters (800 feet) for the Main Plant Process Building, 366 meters (1,200 feet) for the NDA, and 549 meters (1,800 feet) for the SDA. Analysis of the maximum public individual dose rate for each accident scenario using the MACCS2 computer code showed that the NDA and SDA exhumation fire accident scenarios resulted in a higher MEI dose at a distance of 2,500 meters (8,200 feet) than at the nearest geographically determined distance. This greater distance is due to the plume rise associated with fire energy postulated for these two accidents. The highest MEI dose, regardless of location outside the site, was presented for all accident scenarios.

I.5.4 Accident Source Term

To calculate accident source terms, the MAR was first determined for key facilities at WVDP containing significant residual radioactive contamination inventories. These were identified as the radioactive waste tanks in the Waste Tank Farm and Main Plant Process Building. Their respective radionuclide inventories are presented in **Tables I–14** and **I–15** (WSMS 2005a, WVNSCO 2005). Waste tanks have mobile and fixed inventories. Mobile inventories at the starting point of this EIS as described in Chapter 2 are physically present in the remaining liquid heel in these tanks. Fixed inventories are radionuclides physically attached to surfaces inside the tanks. The peak residual inventory varies between Tanks 8D-1 and 8D-2 for individual radioisotopes and is delineated in the following text for the conservative case. A bounding tank was synthesized from the two highest inventory tanks to represent the highest total inventory of any one tank and assigned the designation of Bounding Tank 8D-B. Bounding Tank 8D-B is assumed to be the MAR for accidents involving the Waste Tank Farm area at WVDP, based on the highest individual radionuclide value for either Tank 8D-1 or 8D-2.

Table I–14 Waste Management Area 3 High-Level Radioactive Waste Tank Material at Risk

Radionuclide	*Tank 8D-1 (curies)*	*Tank 8D-2 (curies)*	*Bounding Tank 8D-B (curies)*
Carbon-14	2.0×10^{-2}	2.7×10^{-3}	2.0×10^{-2}
Strontium-90	2.3×10^{3}	3.4×10^{4}	3.4×10^{4}
Technetium-99	5.4	2.9	5.4
Iodine-129	6.8×10^{-3}	3.8×10^{-3}	6.8×10^{-3}
Cesium-137	2.5×10^{5}	8.6×10^{4}	2.5×10^{5}
Uranium-232	6.0×10^{-1}	1.2×10^{-1}	6.0×10^{-1}
Uranium-233	2.6×10^{-1}	5.9×10^{-2}	2.6×10^{-1}
Uranium-234	1.0×10^{-1}	2.2×10^{-2}	1.0×10^{-1}
Uranium-235	3.4×10^{-3}	1.1×10^{-3}	3.4×10^{-3}
Uranium-238	3.1×10^{-2}	5.2×10^{-3}	3.1×10^{-2}
Neptunium-237	2.3×10^{-2}	5.0×10^{-1}	5.0×10^{-1}
Plutonium-238	5.6	1.5×10^{2}	1.5×10^{2}
Plutonium-239	1.5	3.6×10^{1}	3.6×10^{1}
Plutonium-240	1.1	2.6×10^{1}	2.6×10^{1}
Plutonium-241	4.4×10^{1}	7.4×10^{2}	7.4×10^{2}
Americium-241	3.8×10^{-1}	3.8×10^{2}	3.8×10^{2}
Curium-243	1.1×10^{-3}	3.6	3.6
Curium-244	5.0×10^{-2}	8.0×10^{1}	8.0×10^{1}

Note: Consistent with the starting point of this EIS as defined in Chapter 2.
Source: WVNSCO 2005.

Table I–15 Main Plant Process Building Total Residual Radioactivity Material at Risk

Radionuclide	*Total Process Building Residual Activity (curies)*	*Radionuclide*	*Total Process Building Residual Activity (curies)*
Carbon-14	1.3×10^{1}	Neptunium-237	5.7×10^{-1}
Strontium-90	2.4×10^{3}	Uranium-238	9.0×10^{-2}
Technetium-99	5.0	Plutonium-238	2.1×10^{2}
Iodine-129	6.3×10^{-1}	Plutonium-239	6.4×10^{1}
Cesium-137	3.2×10^{3}	Plutonium-240	4.7×10^{1}
Uranium-232	8.1×10^{-1}	Plutonium-241	1.5×10^{3}
Uranium-233	4.2×10^{-1}	Americium-241	2.7×10^{2}
Uranium-234	2.0×10^{-1}	Curium-243	3.4×10^{-1}
Uranium-235	3.0×10^{-2}	Curium-244	8.4

Source: WSMS 2008.

Numerous waste packages would be transported off site under each alternative. Accidents are postulated to occur with these packages, including drops, punctures, and fires. The MAR for each type of waste package is presented in **Table I–16**.

Table I–16 Waste Package [a] Material at Risk

Isotope	*Truck Class B/C (HIC) (curies)*	*GTCC (Drum) (curies)*	*TRU (RH) (Drum) (curies)*	*Low-Specific-Activity Container per cubic meter [b]*	*Fuel and Hardware (Drum) (curies)*	*Class A Drum (curies)*	*Class C-R-D Drum (curies)*	*Class B/C Box (curies)*	*Class A Box (curies)*
Tritium	73.5	2.00	0.0	0.0284	3.11	0.0114	0.0	37.2	0.124
Carbon-14	0.545	0.0148	1.6×10^{-6}	0.00163	0.475	8.44×10^{-5}	1.42×10^{-6}	0.276	9.18×10^{-4}
Iron-55	0.330	0.00898	0.0	0.0	0.0	5.12×10^{-5}	0.0	0.167	5.57×10^{-4}
Cobalt-60	9.49	0.258	0.0	0.0031	27.3	0.00147	0.0	4.8	0.016
Nickel-63	36.7	0.999	0.0	0.0	0.0	0.00569	0.0	18.6	0.062
Strontium-90	0.403	1.85	49.3	9.2×10^{-4}	1,330	4.12×10^{-4}	2.16	0.204	4.49×10^{-3}
Yttrium-90	0.403	1.85	49.3	9.2×10^{-4}	1,330	4.12×10^{-4}	2.16	0.204	4.49×10^{-3}
Cesium-137	26.0	2.35	88.2	0.00152	1,730	0.00403	640	13.2	0.0439
Thorium-234	0.341	0.0268	8.93×10^{-6}	0.0	0.131	5.29×10^{-5}	2.85×10^{-5}	0.173	5.76×10^{-4}
Neptunium-237	0.0	0.0	6.64×10^{-4}	0.0	0.00794	0.0	2.79×10^{-5}	0.0	0.0
Uranium-238	0.341	0.00928	8.93×10^{-6}	0.0	0.131	5.29×10^{-5}	2.85×10^{-5}	0.173	5.76×10^{-4}
Plutonium-238	0.200	26.7	0.183	1.1×10^{-6}	10.5	3.09×10^{-5}	0.00401	0.101	3.73×10^{-4}
Plutonium-239	0.328	0.0363	0.0458	1.1×10^{-6}	41.2	5.08×10^{-5}	7.59×10^{-4}	0.166	5.53×10^{-4}
Plutonium-240	0.195	0.188	0.0332	1.1×10^{-6}	22.1	3.02×10^{-5}	5.46×10^{-4}	0.0985	3.28×10^{-4}
Plutonium-241	69.1	10.5	0.985	1.1×10^{-6}	671.0	0.00107	0.0451	3.5	0.0117
Americium-241	0.780	0.116	0.481	1.1×10^{-6}	79.9	1.21×10^{-4}	0.0115	0.395	1.23×10^{-3}
Curium-244	0.0	0.0	0.0997	0.0	0.626	0.0	0.00202	0.0	0.0

C-R-D = remote-handled Class C, GTCC = Greater-Than-Class C, HIC = high-integrity container, RH = remote-handled, TRU = transuranic.

[a] Vitrified high-level radioactive waste canisters were not included because their physical form would preclude the release of respirable particles in the event of a postulated accident.

[b] Each container holds 7.306 cubic meters.

Note: To convert cubic meters to cubic feet, multiply by 35.3.

Source: Karimi 2005.

The MAR for the SDA and NDA is presented in **Table I-17**. This MAR is based on the largest radionuclide concentration waste category in the NDA and the largest radionuclide waste concentration trench in the SDA.

Table I–17 NRC-Licensed Disposal Area and State-Licensed Disposal Area Material at Risk

Radionuclide	*NRC-Licensed Disposal Area (curies)*	*State-Licensed Disposal Area Trench 10 (curies)*
Tritium	2.3×10^{-4}	2.2×10^{-1}
Carbon-14	1.5×10^{-6}	2.2×10^{-4}
Cobalt-60	1.2×10^{-4}	8.4×10^{-5}
Nickel-63	3.5×10^{-4}	4.6×10^{-5}
Strontium-90	1.7×10^{-1}	7.4×10^{-5}
Yttrium-90	1.7×10^{-1}	7.4×10^{-5}
Cesium-137	2.3×10^{-1}	3.4×10^{-4}
Samarium-151	2.5×10^{-3}	Not reported
Thorium-234	7.3×10^{-6}	7.6×10^{-5}
Uranium-233	6.7×10^{-5}	9.5×10^{-9}
Uranium-234	3.4×10^{-6}	4.2×10^{-5}
Uranium-235	6.5×10^{-7}	1.3×10^{-6}
Uranium-238	7.3×10^{-6}	7.6×10^{-5}
Plutonium-238	2.2×10^{-3}	6.7×10^{-2}
Plutonium-239	3.0×10^{-3}	1.5×10^{-5}
Plutonium-240	2.2×10^{-3}	3.0×10^{-7}
Plutonium-241	9.0×10^{-2}	1.8×10^{-5}
Americium-241	1.0×10^{-2}	6.1×10^{-5}

NRC = U.S. Nuclear Regulatory Commission.
Source: URS 2000, 2002.

In two other EISs, the nature and form of radionuclide source term, available for release during an accident scenario were found to be similar to that for this EIS. These are the *Plutonium Residues EIS* (DOE 1998) and the *WVDP Waste Management EIS* (DOE 2003c). Further guidance on airborne source terms was also found in the *DOE Handbook on ARFs* (DOE 1994). After the spectrum of accidents was identified, it was necessary to estimate a release fraction for each of the accidents. Release fraction estimates were developed based on review of available information on facility design and operation, as well as information in the *DOE Handbook on ARFs* (DOE 1994), relevant EISs (DOE 1998, 2003c), and Safety Analysis Reports (DOE 2006; WVNSCO 2004, 2007). The release fractions selected were also reviewed against each other to ensure that the relative magnitude was considered reasonable. Based on evaluation of the nature of contamination present in WVDP, the following **Table I–18** lists values of the DR, ARF, RF, and LPF developed from the aforementioned references and used in this EIS. These values are based on the discussion and references in **Table I–19**.

The release fraction is the fraction of the material at risk that becomes airborne and could be inhaled by humans, causing a radiation dose. It is calculated by multiplying the four factors DR, ARF, RF, and LPF. Table I–19 summarizes release fractions considered appropriate for the identified severe accidents, and the rationale for their selection.

Table I–18 Accident Scenario Damage Ratio, Respirable Fraction, Airborne Release Fraction, and Leak Path Factor

Accident Scenario	*Damage Ratio (DR)*	*Leak Path Factor (LPF)*	*Airborne Release Fraction (ARF)*	*Respirable Fraction (RF)*	*DR × LPF × ARF × RF*
Main Plant Process Building					
Main Plant Process Building seismic collapse	1.0	0.1	1.0×10^{-3}	1.0×10^{-2}	1.0×10^{-6}
High-Level Radioactive Waste Tanks					
High-level radioactive waste tank seismic collapse	1.0	1.0	$\sim 3.0 \times 10^{-5}$	$\sim 3.0 \times 10^{-3}$	1.0×10^{-7}
Radioactive Waste Package					
Transuranic remote-handled drum puncture	0.1	1.0	1.0×10^{-3}	1.0	1.0×10^{-4}
Greater-Than-Class C drum puncture	0.1	1.0	1.0×10^{-3}	1.0	1.0×10^{-4}
High-integrity container fire	1.0	1.0	6.0×10^{-3}	1.0×10^{-2}	6.0×10^{-5}
High-integrity container puncture	1.0	1.0	4.0×10^{-5}	1.0	4.0×10^{-5}
Class A box puncture	0.1	1.0	1.0×10^{-3}	1.0	1.0×10^{-4}
Class A pallet drop	0.1	1.0	1.0×10^{-3}	1.0	1.0×10^{-4}
Low-specific-activity container puncture	0.1	1.0	1.0×10^{-3}	1.0	1.0×10^{-4}
Fuel and hardware drum puncture [a]	0.1	1.0	1.0×10^{-3}	1.0×10^{-2}	1.0×10^{-6}
Class A drum puncture	0.1	1.0	1.0×10^{-3}	1.0	1.0×10^{-4}
Class C-R-D drum puncture [a]	0.1	1.0	1.0×10^{-3}	1.0×10^{-2}	1.0×10^{-6}
Class B/C box puncture	0.1	1.0	1.0×10^{-3}	1.0	1.0×10^{-4}
NRC-Licensed Disposal Area					
Exhumation plume release	1.0	1.0	1.0×10^{-4}	1.0	1.0×10^{-4}
State-Licensed Disposal Area					
Exhumation plume release	1.0	1.0	1.0×10^{-4}	1.0	1.0×10^{-4}

C-R-D = remote-handled Class C, NRC = U.S. Nuclear Regulatory Commission.
[a] Radioactive waste in these packages is in the form of grout and has different dispersion properties during an accident.

Table I–19 Basis for Specific Accident Radionuclide Release Fraction

Accident	*Release Fraction (DR × RF × ARF × LPF)*	*Basis*
Main Plant Process Building collapse due to seismic event	1.0×10^{-6}	The *Plutonium Residues EIS* (DOE 1998) assumed a release fraction of 5×10^{-6} for release of material being processed through a canyon building. In the Main Plant Process Building, there is less material and it is not located in large quantities in process equipment. In many cases, easily removed material has already been removed. The largest inventories are in the lower cells of the facility and would have a much longer leak path than material from the actual process cells. A factor of 5 reduction in overall release fraction appears reasonable.
High-level radioactive waste tank collapse due to seismic event	1.0×10^{-7}	Factors similar to this were used in the *WVDP Waste Management EIS* (DOE 2003c). Much of the inventory is fixed (not easily removed), and such a low release fraction appears reasonable.
Waste package puncture or drop, nonsolidified waste	1.0×10^{-4}	This release fraction has been used in the *WVDP Waste Management EIS* and WVDP Safety Analysis Report (WVNSCO 2004) and is considered reasonable for contaminated material.
High-integrity container drop and puncture	4.0×10^{-5}	Factors similar to this were used in the *WVDP Waste Management EIS* (DOE 2003c). Much of the inventory is fixed (not easily removed), and such a low release fraction appears reasonable. Also recommended in *DOE Handbook* (DOE 1994).

Accident	Release Fraction (DR × RF × ARF × LPF)	Basis
High-integrity container fire	6.0×10^{-5}	Factors similar to this were used in the *WVDP Waste Management EIS* (DOE 2003c). Much of the inventory is fixed (not easily removed), and such a low release fraction appears reasonable. Also recommended in *DOE Handbook* (DOE 1994).
Waste package puncture or drop, solidified waste	1.0×10^{-6}	This number was used in the *WVDP Waste Management EIS* (DOE 2003c), and a similar number was used in the WVDP Safety Analysis Report (WVNSCO 2004) for a dropped high-level radioactive waste canister.
NDA or SDA exhumation plume release	1.0×10^{-4}	The measured combustible contaminated waste ARF from experiments recommended in DOE Airborne Release Handbook (DOE 1994).

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

Puncture and high-integrity container drop accident source terms for all containers are listed in **Table I–20**. The source terms in Table I–20 were calculated by multiplying the MAR in Table I–16 by the radionuclide release fraction in Table I–18, as discussed in Section I.5.2. Pallet drop accident source terms are listed in **Table I–21**. The high-level radioactive waste tank and Main Plant Process Building accident source terms are presented in **Table I–22**. The NDA and SDA accident source terms are presented in **Table I–23**.

Table I–20 Waste Package Puncture and High-Integrity Container Drop Accident Source Terms

Isotope	Truck Class B/C (HIC Drop) (curies)	GTCC (Drum) (curies)	TRU (RH) (Drum) (curies)	Low-Specific-Activity Container [a] (curies)	Fuel and Hardware (Drum) (curies)	Class A Drum (curies)	Class C-R-D Drum (curies)	Class B/C Box (curies)	Class A Box (curies)
Tritium	2.9×10^{-3}	2.0×10^{-4}	0.0	2.1×10^{-5}	3.1×10^{-6}	1.1×10^{-6}	0.0	3.7×10^{-3}	1.2×10^{-5}
Carbon-14	2.2×10^{-5}	1.5×10^{-6}	1.6×10^{-10}	1.2×10^{-6}	4.2×10^{-7}	8.4×10^{-9}	1.4×10^{-12}	2.8×10^{-5}	9.2×10^{-8}
Iron-55	1.3×10^{-5}	9.0×10^{-7}	0.0	0.0	0.0	5.1×10^{-9}	0.0	1.7×10^{-5}	5.6×10^{-8}
Cobalt-60	3.8×10^{-4}	2.6×10^{-5}	0.0	0.0	2.7×10^{-5}	1.5×10^{-7}	0.0	4.8×10^{-4}	1.6×10^{-6}
Nickel-63	1.5×10^{-3}	1.0×10^{-4}	0.0	0.0	0.0	5.7×10^{-7}	0.0	1.9×10^{-3}	6.2×10^{-6}
Strontium-90	1.6×10^{-5}	1.8×10^{-4}	4.9×10^{-3}	6.7×10^{-7}	1.3×10^{-3}	4.1×10^{-8}	2.2×10^{-6}	2.0×10^{-5}	4.5×10^{-7}
Yttrium-90	1.6×10^{-5}	1.8×10^{-4}	4.9×10^{-3}	6.7×10^{-7}	1.3×10^{-3}	4.1×10^{-8}	2.2×10^{-6}	2.0×10^{-5}	4.5×10^{-7}
Cesium-137	1.0×10^{-3}	2.4×10^{-4}	8.8×10^{-3}	1.1×10^{-6}	1.7×10^{-3}	4.0×10^{-7}	6.4×10^{-4}	1.3×10^{-3}	4.4×10^{-6}
Thorium-234	1.4×10^{-5}	2.7×10^{-6}	8.9×10^{-10}	0.0	1.3×10^{-7}	5.3×10^{-9}	2.9×10^{-11}	1.7×10^{-5}	5.8×10^{-8}
Neptunium-237	0.0	0.0	6.6×10^{-8}	0.0	7.9×10^{-9}	0.0	2.8×10^{-11}	0.0	0.0
Uranium-238	1.4×10^{-5}	9.3×10^{-7}	8.9×10^{-10}	0.0	1.3×10^{-7}	5.3×10^{-9}	2.9×10^{-11}	1.7×10^{-5}	5.8×10^{-8}
Plutonium-238	8.0×10^{-6}	2.7×10^{-3}	1.8×10^{-5}	8.0×10^{-10}	1.0×10^{-5}	3.1×10^{-9}	4.0×10^{-9}	1.0×10^{-5}	3.7×10^{-8}
Plutonium-239	1.3×10^{-5}	3.6×10^{-6}	4.6×10^{-6}	8.0×10^{-10}	4.1×10^{-5}	5.1×10^{-9}	7.6×10^{-10}	1.7×10^{-5}	5.5×10^{-8}
Plutonium-240	7.8×10^{-6}	1.9×10^{-6}	3.3×10^{-6}	8.0×10^{-10}	2.2×10^{-5}	3.0×10^{-9}	5.5×10^{-10}	9.8×10^{-6}	3.3×10^{-8}
Plutonium-241	2.8×10^{-3}	1.0×10^{-3}	9.8×10^{-5}	8.0×10^{-10}	6.7×10^{-4}	1.1×10^{-7}	4.5×10^{-8}	3.5×10^{-4}	1.2×10^{-6}
Americium-241	3.1×10^{-5}	1.2×10^{-5}	4.8×10^{-5}	8.0×10^{-10}	8.0×10^{-5}	1.2×10^{-8}	1.2×10^{-8}	4.0×10^{-5}	1.2×10^{-7}
Curium-244	0.0	0.0	1.0×10^{-5}	0.0	6.3×10^{-7}	0.0	2.0×10^{-9}	0.0	0.0

C-R-D = remote-handled Class C, GTCC = Greater-Than-Class C, HIC = high-integrity container, RH = remote-handled, TRU = transuranic.

[a] Based on a volume of 7.306 cubic meters.

Table I–21 Waste Pallet [a] Drop Accident Source Terms

Isotope	*Class A Pallet Drop (curies)*	*Isotope*	*Class A Pallet Drop (curies)*
Tritium	6.8×10^{-6}	Uranium-238	3.2×10^{-8}
Carbon-14	5.1×10^{-8}	Plutonium-238	1.9×10^{-8}
Iron-55	3.1×10^{-8}	Plutonium-239	3.1×10^{-8}
Cobalt-60	8.8×10^{-7}	Plutonium-240	1.8×10^{-8}
Nickel-63	3.4×10^{-6}	Plutonium-241	6.4×10^{-7}
Strontium-90	2.5×10^{-7}	Americium-241	7.3×10^{-8}
Yttrium-90	2.5×10^{-7}	Neptunium-237	0.0
Cesium-137	2.4×10^{-6}	Curium-244	0.0
Thorium-234	3.2×10^{-8}		

[a] Waste pallet contains six Class A Drums.

Table I–22 High-level Radioactive Waste Tank and Main Plant Process Building Accident Source Terms

Radionuclide	*Tank Total Inventory or Material at Risk (curies)*	*Accident Source Term (curies)*	*Radionuclide*	*Main Plant Process Building Residual Activity or Material at Risk (curies)*	*Accident Source Term (curies)*
Carbon-14	2.0×10^{-2}	2.0×10^{-9}	Americium-241	2.7×10^{2}	2.7×10^{-4}
Strontium-90	3.4×10^{4}	3.4×10^{-3}	Carbon-14	1.3×10^{1}	1.3×10^{-5}
Technetium-99	5.4	5.4×10^{-7}	Curium-243	3.4×10^{-1}	3.4×10^{-7}
Iodine-129	6.8×10^{-3}	6.8×10^{-10}	Curium-244	8.4	8.4×10^{-6}
Cesium-137	2.5×10^{5}	2.5×10^{-2}	Cesium-137	3.2×10^{3}	3.2×10^{-3}
Uranium-232	6.0×10^{-1}	6.0×10^{-8}	Iodine-129	6.3×10^{-1}	6.3×10^{-7}
Uranium-233	2.6×10^{-1}	2.6×10^{-8}	Neptunium-237	5.7×10^{-1}	5.7×10^{-7}
Uranium-234	1.0×10^{-1}	1.0×10^{-8}	Plutonium-238	2.1×10^{2}	2.1×10^{-4}
Uranium-235	3.4×10^{-3}	3.4×10^{-10}	Plutonium-239	6.4×10^{1}	6.4×10^{-5}
Uranium-238	3.1×10^{-2}	3.1×10^{-9}	Plutonium-240	4.7×10^{1}	4.7×10^{-5}
Neptunium-237	5.0×10^{-1}	5.0×10^{-8}	Plutonium-241	1.5×10^{3}	1.5×10^{-3}
Plutonium-238	1.5×10^{2}	1.5×10^{-5}	Strontium-90	2.4×10^{3}	2.4×10^{-3}
Plutonium-239	3.6×10^{1}	3.6×10^{-6}	Technetium-99	5	5×10^{-6}
Plutonium-240	2.6×10^{1}	2.6×10^{-6}	Uranium-232	8.1×10^{-1}	8.1×10^{-7}
Plutonium-241	7.4×10^{2}	7.4×10^{-5}	Uranium-233	4.2×10^{-1}	4.2×10^{-7}
Americium-241	3.8×10^{2}	3.8×10^{-5}	Uranium-234	2×10^{-1}	2×10^{-7}
Curium-243	3.6	3.6×10^{-7}	Uranium-235	3×10^{-2}	3×10^{-8}
Curium-244	8.0×10^{1}	8.0×10^{-6}	Uranium-238	9×10^{-2}	9×10^{-8}

Source: WVES 2008.

Table I–23 NRC-Licensed Disposal Area and State-Licensed Disposal Area Accident Source Terms[a]

Radionuclide	*NRC-Licensed Disposal Area (curies)*	*State-Licensed Disposal Area Trench 10 (curies)*
Tritium	2.5×10^{-7}	2.4×10^{-4}
Carbon-14	1.7×10^{-9}	2.4×10^{-7}
Cobalt-60	1.3×10^{-7}	9.2×10^{-8}
Nickel-63	3.8×10^{-7}	5.1×10^{-8}
Strontium-90	1.9×10^{-4}	8.1×10^{-8}
Yttrium-90	1.9×10^{-4}	8.1×10^{-8}

Radionuclide	***NRC-Licensed Disposal Area (curies)***	***State-Licensed Disposal Area Trench 10 (curies)***
Cesium-137	2.5×10^{-4}	3.7×10^{-7}
Samarium-151	2.8×10^{-6}	Not reported
Thorium-234	8.0×10^{-9}	8.4×10^{-8}
Uranium-233	7.4×10^{-8}	1.0×10^{-11}
Uranium-234	3.7×10^{-9}	4.6×10^{-8}
Uranium-235	7.1×10^{-10}	1.4×10^{-9}
Uranium-238	8.0×10^{-9}	8.4×10^{-8}
Plutonium-238	2.4×10^{-6}	7.4×10^{-5}
Plutonium-239	3.3×10^{-6}	1.7×10^{-8}
Plutonium-240	2.4×10^{-6}	3.3×10^{-10}
Plutonium-241	9.9×10^{-5}	2.0×10^{-8}
Americium-241	1.1×10^{-5}	6.7×10^{-8}

NRC = U.S. Nuclear Regulatory Commission.
[a] Based on a volume of 0.3 cubic meters (11 cubic feet).

I.5.5 Accident Frequency

The annual frequency of each accident is used to calculate the annual risk of a fatal latent cancer associated with each accident. The annual accident risk is calculated by multiplying the accident risk of a fatal latent cancer by the annual frequency of the accident. Each specific accident's annual frequency is determined by data from operational experience or an analysis of the sequence of events necessary for the accident to occur. Accidents with an annual frequency of less than 1×10^{-6} per year or 1 in 1 million are not analyzed in this appendix because they are so unlikely to occur that their risks are extremely small. However, the consequences of intentional destructive acts, which have a lower frequency than 1×10^{-6} per year, are analyzed in Appendix N.

Radioactive waste accidents analyzed in the *WVDP Waste Management EIS* (DOE 2003c) and their frequencies are:

- Class A low-level radioactive waste drum puncture (0.1 to 0.01 per year)
- Class A low-level radioactive waste pallet drop (0.1 to 0.01 per year)
- Class A low-level radioactive waste box puncture (0.1 to 0.01 per year)
- Drum cell drop (0.1 to 0.01 per year)
- Class C low-level radioactive waste drum puncture (0.1 to 0.01 per year)
- Class C low-level radioactive waste pallet drop (0.1 to 0.01 per year)
- Class C low-level radioactive waste box puncture (0.1 to 0.01 per year)
- HIC drop (0.1 to 0.01 per year)
- Remote-handled transuranic waste drum puncture (0.1 to 0.01 per year)
- Load-out bay fire (1×10^{-4} to 1×10^{-6} per year).

The *WVDP Waste Management EIS* (DOE 2003c) addressed the shipment of 46,839 radioactive waste packages over a 10-year time period for both its alternatives. Using the annual frequency value range of 0.1 to 0.01 per year for all waste package mishandling drop and puncture accidents, the accident frequency for handling each individual package is 2.1×10^{-5} to 2.1×10^{-6} per year. The larger value of 2.1×10^{-5} per package year was used with the individual alternative average annual radioactive waste package rate

(WSMS 2009a, 2009b, 2009c, 2009d) to calculate an annual frequency for each accident scenario, which is delineated in **Table I–24**. For comparison purposes, a separate radioactive waste handling accident analysis performed for the Waste Isolation Pilot Plant resulted in a calculation of 7×10^{-6} per year for radioactive waste package puncture and drop accidents, which is within the range of 2.1×10^{-5} and 2.1×10^{-6} per year (DOE 2006). The accident frequency for the high-level radioactive waste tank, Main Plant Process Building, and HIC fire were all assumed at the identical value for all alternatives because package handling rate is not a factor. In all cases, the largest value of the range of possible accident frequencies was conservatively used for this EIS. Accident scenarios developed for WVDP decommissioning activities are listed, along with their annual frequency, for each alternative in Table I–24.

Table I–24 Accident Scenario Annual Frequency

West Valley Demonstration Project Location and Accident Scenario	*Accident Initiator*	*Sitewide Removal Alternative Annual Frequency*	*Sitewide Close-In-Place Alternative Annual Frequency*	*Phased Decisionmaking Alternative (Phase 1) Annual Frequency*	*No Action Alternative Annual Frequency*
Radioactive waste tank collapse	Seismic event	0.0001	0.0001	0.0001	0.0001
Main Plant Process Building collapse	Seismic event	0.0001	0.0001	0.0001	0.0001
Transuranic (remote-handled) drum puncture	Mishandling or drop	0.09	0.01	0.1	Not applicable
Greater-Than-Class C Class 2 drum puncture	Mishandling or drop	0.09	Not applicable	Not applicable	Not applicable
High-integrity container fire	Human error	0.0001	0.0001	0.0001	Not applicable
High-integrity container puncture	Mishandling or drop	0.09	0.01	0.1	Not applicable
Class A box puncture	Mishandling or drop	0.09	0.01	0.1	0.005
Class A pallet drop	Mishandling or drop	0.09	0.01	0.1	0.005
Low-specific-activity container puncture	Mishandling or drop	0.09	0.01	0.1	0.005
Fuel and hardware drum puncture	Mishandling or drop	0.09	Not applicable	Not applicable	Not applicable
Class A drum puncture	Mishandling or drop	0.09	0.01	0.1	0.005
Class C-R-D drum puncture	Mishandling or drop	0.09	0.01	0.1	Not applicable
Class B/C box puncture	Mishandling or drop	0.09	0.01	0.1	Not applicable
NRC-Licensed Disposal Area exhumation fire	Human error	0.0001	Not applicable	Not applicable	Not applicable
State-Licensed Disposal Area exhumation fire	Human error	0.0001	Not applicable	Not applicable	Not applicable

C-R-D = remote-handled Class C, NRC = U.S. Nuclear Regulatory Commission.
Not applicable = these radioactive waste packages or decommissioning actions are not part of the alternative.

I.5.6 MACCS2 Code Description

The MACCS2 computer code V.1.13.1 (Chanin and Young 1997) is used to estimate the radiological doses and health effects that could result from postulated accidental releases of radioactive materials to the atmosphere. MACCS2 was used to analyze health impacts of postulated accidents instead of GENII due to the following factors:

- MACCS2 uses actual hourly meteorological data (i.e., wind speed, wind direction, rainfall, atmospheric dispersion stability) from the site, whereas GENII uses a statistically interpreted joint frequency distribution that averages this data. The use of actual hourly data is more accurate in calculating the probabilistic dose distribution for accident analyses;

- The GENII tritium model assumes equilibrium between tritium concentrations in the air and vegetation, which is a good assumption for long-term releases, but may overpredict short-duration releases (DOE 2003b);

- MACCS2 has the capability to model the effects of population evacuation or relocation during or after an accident. This capability is not in GENII; and

- GENII cannot be used to calculate 95th percentile radiation dose according to DOE Standard 3009-94 Appendix A (DOE 2003b), whereas MACCS2 can calculate this dose.

Conversely, GENII was used to analyze human health impacts of normal operations because:

- GENII can model liquid radiological releases, whereas MACCS2 does not have this capability; and

- GENII can model long-term radiological releases, whereas MACCS2 is limited to a maximum plume release time of 24 hours.

The specification of the release characteristics, designated a “source term,” can consist of up to four Gaussian plumes that are often referred to simply as “plumes.”

The radioactive materials released are modeled as being dispersed in the atmosphere while being transported by the prevailing wind. During transport, particulate material can be modeled as being deposited on the ground. The extent of this deposition can depend on precipitation. If contamination levels exceed a user-specified criterion, mitigating actions can be triggered to limit radiation exposure.

Atmospheric conditions during an accident scenario’s release and subsequent plume transport are taken from the annual sequential hourly meteorological data file. Scenario initiation is assumed to be equally likely during any hour contained in the file’s data set, with plume transport governed by the succeeding hours. The model was applied by calculating the exposure to each receptor for accident initiation during each hour of the 8,760-hour data set. The mean results of these samples, which include contributions from all meteorological conditions, are presented in this EIS.

Two aspects of the code’s structure are important to understanding its calculations: (1) the calculations are divided into modules and phases; and (2) the region surrounding the facility is divided into a polar-coordinate grid. These concepts are described in the following sections.

MACCS2 is divided into three primary modules: ATMOS, EARLY, and CHRONC. Three phases are defined as the emergency, intermediate, and long-term phases. The relationship among the code's three modules and the three phases of exposure are summarized in the following text.

The ATMOS module performs all of the calculations pertaining to atmospheric transport, dispersion, and deposition, as well as the radioactive decay that occurs before release and while the material is in the atmosphere. It uses a Gaussian plume model with Pasquill-Gifford dispersion parameters. The phenomena treated include building wake effects, buoyant plume rise, plume dispersion during transport, wet and dry deposition, and radioactive decay and in-growth. Local topography is not modeled for calculating atmospheric dispersion, which results in conservatively higher plume concentrations, doses, and risks to the public. The results of the calculations are stored for subsequent use by EARLY and CHRONC. In addition to the air and ground concentrations, ATMOS stores information on wind direction, arrival and departure times, and plume dimensions.

It is noted that dispersion calculations such as those used in MACCS2 are generally recognized to be less applicable within 100 meters (328 feet) of a release than they are to distances further downwind (DOE 2004); such close-in results frequently overpredict the atmospheric concentrations because they do not account for the initial momentum or size of the release, or for the impacts of structures and other obstacles on plume dispersion. Most of the results presented in this EIS are for distances at least 100 meters (328 feet) downwind from a hypothesized release source.

The EARLY module models the period immediately following a radioactive release. This period is commonly referred to as the emergency phase. The emergency phase begins at each successive downwind distance point when the first plume of the release arrives. The duration of the emergency phase is specified by the user, and it can range between 1 and 7 days. The exposure pathways considered during this period are direct external exposure to radioactive material in the plume (cloud shine), exposure from inhalation of radionuclides in the cloud (cloud inhalation), exposure to radioactive material deposited on the ground (ground shine), inhalation of resuspended material (resuspension inhalation), and skin dose from material deposited on the skin. Mitigating actions that can be specified for the emergency phase include evacuation, sheltering, and dose-dependent relocation.

The CHRONC module performs all of the calculations pertaining to the intermediate and long-term phases. CHRONC calculates the individual health effects that result from both direct exposures to contaminated ground and inhalation of resuspended materials.

The intermediate phase begins at each successive downwind distance point upon conclusion of the emergency phase. The user can configure the calculations with an intermediate phase that has a duration as short as 0 or as long as 1 year. In the zero-duration case, there is essentially no intermediate phase, and a long-term phase begins immediately upon conclusion of the emergency phase.

Intermediate models are implemented on the assumption that the radioactive plume has passed and the only exposure sources (ground shine and resuspension inhalation) are from ground-deposited material.

The mitigating action model for the intermediate phase is very simple. If the intermediate phase dose criterion is satisfied, the resident population is assumed to be present and subject to radiation exposure from ground shine and resuspension for the entire intermediate phase. If the intermediate phase exposure exceeds the dose criterion, then the population is assumed to be relocated to uncontaminated areas for the entire intermediate phase.

The long-term phase begins at each successive downwind distance point upon conclusion of the intermediate phase. The exposure pathways considered during this period are ground shine and resuspension inhalation.

The exposure pathways considered are those resulting from ground-deposited material. A number of protective measures, such as decontamination, temporary interdiction, and condemnation, can be modeled in the long-term phase to reduce doses to user-specified levels.

The decisions on mitigating action in the long-term phase are based on two sets of independent actions: (1) decisions related to whether land at a specific location and time is suitable for human habitation (habitability), and (2) decisions related to whether land at a specific location and time is suitable for agricultural production (ability to farm). For this EIS, no mitigation or special protective measures were assumed for the exposure calculations.

All of the calculations of MACCS2 are stored based on a polar-coordinate spatial grid with a treatment that differs somewhat between calculations of the emergency phase and calculations of the intermediate and long-term phases. The region potentially affected by a release is represented with a (r, Θ) grid system centered on the location of the release. Downwind distance is represented by the radius "r." The angle, "Θ", is the angular offset from the north, going clockwise.

The user specifies the number of radial divisions as well as their endpoint distances. The angular divisions used to define the spatial grid are fixed in the code. They correspond to the 16 points of the compass, each being 22.5 degrees wide. The 16 points of the compass are used in the United States to express wind direction. The compass sectors are referred to as the coarse grid.

Since emergency phase calculations use dose-response models for early fatalities and early injuries that can be highly nonlinear, these calculations are performed on a finer grid basis than the calculations of the intermediate and long-term phases. For this reason, the calculations of the emergency phase are performed with the 16 compass sectors divided into 3, 5, or 7 equal angular subdivisions. The subdivided compass sectors are referred to as the fine grid.

Lifetime doses are the conventional measure of detriment used for radiological protection. These are 50-year dose commitments to a weighted sum of tissue doses defined by the ICRP and referred to as "effective dose equivalent." Lifetime doses may be used to calculate the stochastic health effect risk resulting from exposure to radiation. The calculated lifetime dose was used in cancer risk calculations.

I.5.7 Radiological Accident Results

The MACCS2-calculated results for all 15 analyzed accident scenarios are presented in **Table I–25**. Results are presented in terms of 80-kilometer (50-mile) radius population and MEI radiation dose, LCF, and annual risk. The LCF for all accidents was calculated using the 0.0006 LCF per rem risk factor discussed in Section I.3. Although the Main Plant Process Building and high-level radioactive waste tank accidents apply to all four alternatives, not all the radioactive waste package handling accidents are relevant to each alternative because the actions under each alternative do not necessarily require all the package types. In addition, the NDA and SDA exhumation accidents only apply to the Sitewide Removal Alternative. Therefore, the term, "Not Applicable," is placed under alternatives where a specific package, NDA, or SDA accident is not relevant.

Table I–25 MACCS2 Calculated Accident Risk and Consequences for Each Alternative

Bounding Accident	*Sitewide Removal Alternative*	*Sitewide Close-In-Place Alternative*	*Phased Decisionmaking Alternative (Phase 1)*	*No Action Alternative*
Main Plant Process Building				
Main Plant Process Building Seismic Collapse				
-Population dose -MEI dose -Population annual risk -MEI annual risk	0.68 person-rem 0.046 rem 4.1×10^{-8} 2.7×10^{-9}	0.68 person-rem 0.046 rem 4.1×10^{-8} 2.7×10^{-9}	0.68 person-rem 0.046 rem 4.1×10^{-8} 2.7×10^{-9}	**0.68 person-rem** **0.046 rem** $\mathbf{4.1 \times 10^{-8}}$ $\mathbf{2.7 \times 10^{-9}}$
Radioactive Waste Tanks				
High-Level Radioactive Waste Tank Seismic Collapse				
-Population dose -MEI dose -Population annual risk -MEI annual risk	0.59 person-rem 0.014 rem 3.6×10^{-8} 8.3×10^{-10}	0.59 person-rem 0.014 rem 3.6×10^{-8} 8.3×10^{-10}	0.59 person-rem 0.014 rem 3.6×10^{-8} 8.3×10^{-10}	0.59 person-rem 0.014 rem 3.6×10^{-8} 8.3×10^{-10}
Radwaste Package				
Transuranic (remote-handled) Drum Puncture				
-Population dose -MEI dose -Population annual risk -MEI annual risk	0.27 person-rem 0.029 rem 1.5×10^{-5} 1.6×10^{-6}	0.27 person-rem 0.029 rem $\mathbf{1.6 \times 10^{-6}}$ 1.8×10^{-7}	0.27 person-rem 0.029 rem $\mathbf{1.6 \times 10^{-5}}$ 1.7×10^{-6}	Not Applicable
GTCC Drum Puncture				
-Population dose -MEI dose -Population annual risk -MEI annual risk	1.9 person-rem **0.68 rem** $\mathbf{1.0 \times 10^{-4}}$ $\mathbf{3.7 \times 10^{-5}}$	Not Applicable	Not Applicable	Not Applicable
HIC Fire				
-Population dose -MEI dose -Population annual risk -MEI annual risk	**3.4 person-rem** 0.053 rem 2.0×10^{-7} 3.2×10^{-9}	**3.4 person-rem** **0.053 rem** 2.0×10^{-7} 3.2×10^{-9}	**3.4 person-rem** **0.053 rem** 2.0×10^{-7} 3.2×10^{-9}	Not Applicable
HIC Puncture				
-Population dose -MEI dose -Population annual risk -MEI annual risk	0.12 person-rem 0.033 rem 6.5×10^{-6} 1.8×10^{-6}	0.12 person-rem 0.033 rem 7.3×10^{-7} $\mathbf{2.0 \times 10^{-7}}$	0.12 person-rem 0.033 rem 7.2×10^{-6} $\mathbf{2.0 \times 10^{-6}}$	Not Applicable
Class A Box Puncture				
-Population dose -MEI dose -Population annual risk -MEI annual risk	0.00038 person-rem 9.1×10^{-5} rem 2.0×10^{-8} 5.0×10^{-9}	0.00038 person-rem 9.1×10^{-5} rem 2.3×10^{-9} 5.5×10^{-10}	0.00038 person-rem 9.1×10^{-5} rem 2.3×10^{-8} 5.5×10^{-9}	.00038 person-rem 9.1×10^{-5} rem 1.1×10^{-9} 2.7×10^{-10}
Class A Pallet Drop				
-Population dose -MEI dose -Population annual risk -MEI annual risk	0.00021 person-rem 5.2×10^{-5} rem 1.1×10^{-8} 2.8×10^{-9}	0.00021 person-rem 5.2×10^{-5} rem 1.3×10^{-9} 3.1×10^{-10}	0.00021 person-rem 5.2×10^{-5} rem 1.3×10^{-8} 3.1×10^{-9}	0.00021 person-rem 5.2×10^{-5} rem 6.3×10^{-10} 1.6×10^{-10}
Low-Specific-Activity Container Puncture				
-Population dose -MEI dose -Population annual risk -MEI annual risk	2.8×10^{-5} person-rem 1.1×10^{-6} rem 1.5×10^{-9} 6.0×10^{-11}	2.8×10^{-5} person-rem 1.1×10^{-6} rem 1.6×10^{-10} 6.6×10^{-12}	2.8×10^{-5} person-rem 1.1×10^{-6} rem 1.7×10^{-9} 6.6×10^{-11}	2.8×10^{-5} person-rem 1.1×10^{-6} rem 8.3×10^{-11} 3.3×10^{-12}

Bounding Accident	***Sitewide Removal Alternative***	***Sitewide Close-In-Place Alternative***	***Phased Decisionmaking Alternative (Phase 1)***	***No Action Alternative***
Fuel and Hardware Drum Puncture				
-Population dose -MEI dose -Population annual risk -MEI annual risk	0.19 person-rem 0.054 rem 1.1×10^{-5} 2.9×10^{-6}	Not Applicable	Not Applicable	Not Applicable
Class A Drum Puncture				
-Population dose -MEI dose -Population annual risk -MEI annual risk	3.5×10^{-5} person-rem 8.6×10^{-6} rem 1.9×10^{-9} 4.6×10^{-10}	3.5×10^{-5} person-rem 8.6×10^{-6} rem 2.1×10^{-10} 5.1×10^{-11}	3.5×10^{-5} person-rem 8.6×10^{-6} rem 2.1×10^{-9} 5.2×10^{-10}	3.5×10^{-5} person-rem 8.6×10^{-6} rem 1.1×10^{-10} 2.5×10^{-11}
Class C-R-D Drum Puncture				
-Population dose -MEI dose -Population annual risk -MEI annual risk	0.013 person-rem 2.5×10^{-5} rem 7.0×10^{-7} 1.4×10^{-9}	0.013 person-rem 2.5×10^{-5} rem 7.8×10^{-8} 1.5×10^{-10}	0.013 person-rem 2.5×10^{-5} rem 7.8×10^{-7} 1.5×10^{-9}	Not Applicable
Class B/C Box Puncture				
-Population dose -MEI dose -Population annual risk -MEI annual risk	0.12 person-rem 0.028 rem 6.5×10^{-6} 1.5×10^{-6}	0.12 person-rem 0.028 rem 7.3×10^{-7} 1.6×10^{-7}	0.12 person-rem 0.028 rem 7.2×10^{-6} 1.7×10^{-6}	Not Applicable
NDA and SDA				
NDA Exhumation Release				
-Population dose -MEI dose -Population annual risk -MEI annual risk	0.038 person-rem 0.0023 rem 2.3×10^{-9} 1.4×10^{-10}	Not Applicable	Not Applicable	Not Applicable
SDA Exhumation Release				
-Population dose -MEI dose -Population annual risk -MEI annual risk	0.078 person-rem 0.0034 rem 4.7×10^{-9} 2.0×10^{-10}	Not Applicable	Not Applicable	Not Applicable

C-R-D = remote-handled Class C, GTCC = Greater-Than-Class C, HIC = high-integrity container, MEI = maximally exposed individual, NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, SDA = State-Licensed Disposal Area.
Notes: Maximum accident consequence and risk for each alternative is displayed in **bold**. To convert from rem or person-rem to sieverts or person-sieverts, multiply by 0.01.

Table I–25 shows that the Sitewide Removal, Sitewide Close-In-Place, and Phased Decisionmaking (Phase 1) Alternatives have the same largest calculated accident dose consequence of 3.4 person-rem for the population (from the HIC Fire), and the Sitewide Removal Alternative has the highest MEI accident dose consequence of 0.68 rem (from the Greater-Than-Class Drum Puncture). The Sitewide Removal Alternative has the largest calculated accident annual risk of 1.0×10^{-4} for the population and 3.7×10^{-5} for the MEI, as compared to the other three alternatives. This alternative has the highest risk because it is the only alternative that handles Greater-Than-Class C Drums, which have a relatively large source term as shown in Tables I–17 and I–20. The Remote-Handled Transuranic Drum Puncture, Greater-Than-Class C Drum Puncture, and HIC Fire accidents are dominant for dose and risk for the Sitewide Removal, Sitewide Close-In-Place, and Phased Decisionmaking (Phase 1) Alternatives. The highest calculated dose and risk for the No Action Alternative is the Main Plant Process Building Seismic Collapse accident. For all four alternatives, none of the accident population or MEI doses or risks would cause any fatality or serious injury due to radiation exposure.

The maximum MEI latent cancer risk (3.7×10^{-5}) means there is about 1 chance in 27,000 of an LCF to the MEI for the most severe accident. For comparison, the latest National Cancer Institute statistics (NCI 2005) indicate that the chance of a fatal latent cancer in all Americans over their lifetime is about 0.22, or about slightly greater than one chance in five.

A perspective on the population dose from this postulated bounding accident is that the risk to the average individual in the general population in terms of developing an LCF from this dose is 1.3×10^{-9} or 1 chance in 765 million. The maximum accident radiation dose to each individual in the 80-kilometer (50-mile) radius population averages is 0.0000021 rem. This dose is less than 0.2 percent of the radiation received in a year by using a computer monitor of 0.001 rem.

In considering the overall risk from accidents for an alternative, it is necessary to consider the number of years that decommissioning actions would occur. In addition, in the case of radioactive waste package handling accidents, the total number of packages and annual handling rate must also be considered. **Table I–26** presents a summary of the estimated number of years that each type of operation would occur for each alternative and the respective number of radioactive waste packages handled. This table shows that the largest number of radioactive waste packages would be handled during the Sitewide Removal Alternative, but Phase 1 of the Phased Decisionmaking Alternative has the largest radioactive waste package annual handling rate.

Table I–26 Risk Duration for Major Accident Scenarios

Parameter	*Sitewide Removal Alternative*	*Sitewide Close-In-Place Alternative*	*Phased Decisionmaking Alternative (Phase 1)*	*No Action Alternative*
Years before initiating Main Plant Process Building removal or stabilization	5	1	1	No removal or stabilization
Years before radioactive waste tanks' removal or stabilization	20	5	No removal or stabilization	No removal or stabilization
Years of radioactive waste package handling during decommissioning actions	60	7	8	0 [a]
Number of radioactive waste packages handled	256,564	3,904	35,069	4,294 every 20 years [a]
Annual radioactive waste package handling rate	4,276	558	4,384	215 [a]

[a] Average over 20-year time intervals to account for periodic waste disposal along with annual expected waste disposal volumes, and assumes drums for Class A waste and low-specific-activity containers for low-specific-activity waste. This alternative does not involve preparation for decommissioning. The annual average includes a large spike when NDA/SDA covers are being replaced about every 20 years.

Sources: WSMS 2009a, 2009b, 2009c, 2009d.

The combination of the annual risk estimate for various accident types and the activity duration estimates supports the development of an overall relative risk estimate for the four alternatives for accidents that would involve short-term releases of radionuclides to the atmosphere. Activity duration is used to qualitatively assess the time period when a specific facility or action would occur and therefore be vulnerable to a postulated accident. For example, the risk for a radioactive waste tank accident would be the largest for the No Action and Phased Decisionmaking (Phase 1) Alternatives because no removal or stabilization is planned for this facility. This overall relative risk is presented in **Table I–27**. The terms used in this table (highest, low, and lowest) are intended to convey a relative qualitative assessment of the accident risk among the alternatives. The absolute magnitude of accident consequences and risks for all alternatives is estimated to be very small and is not expected to present a significant health risk to the general population.

Table I–27 Relative Accident Risk Comparison Rating Between Alternatives for Entire Time Period

Sitewide Removal Alternative	*Sitewide Close-In-Place Alternative*	*Phased Decisionmaking Alternative (Phase 1)*	*No Action Alternative*
Highest [a]	Low [a]	Low [a]	Lowest [a]

[a] These ratings are relative to each other among the alternatives. The absolute magnitude of accident risk for all alternatives is characterized as very small.

The Sitewide Removal Alternative has the greatest potential for an accident with the highest consequences and is expected to have the highest overall accident risk because it has the greatest number and duration of higher radioactivity content waste removal, packaging, and handling operations, and because it occurs over a longer period of time.

The most significant short-term accidents for the Sitewide Close-In-Place, Phased Decisionmaking (Phase 1), and No Action Alternatives have lower projected consequences than the dominant Sitewide Removal Alternative accident scenarios. The overall accident risk for these alternatives is estimated to be less than the overall accident risk for the Sitewide Removal Alternative. The overall accident risk for Phase 1 of the Phased Decisionmaking Alternative is slightly higher than the risk for the Sitewide Close-In-Place and No Action Alternatives as a result of the additional activity related to the Main Plant Process Building removal and the greater number of annual radioactive waste handling operations.

The most serious accident for the No Action Alternative, in terms of population dose, is smaller than the other three alternatives. The No Action Alternative does, however, have a higher risk of groundwater contamination over the long-term as a result of degradation or accidents involving the Main Plant Process Building and high-level radioactive waste tanks, as these facilities are not remediated under this alternative. It should also be noted that Phase 1 of the Phased Decisionmaking Alternative also has no plans for removal of the high-level radioactive waste tanks, and, depending on decisions made for Phase 2, could have similar long-term degradation and accident risks with regard to the high-level radioactive waste tanks. Long-term consequences for each alternative are presented in Appendix H.

I.5.8 Toxic Chemical Accidents

Data on toxic chemicals at WVDP provide inventories of toxic metal elements such as chromium, lead, and mercury and salts in the Waste Tank Farm and Main Plant Process Building (WSMS 2005a, 2005b). These inventories exist within equipment and individual components such as switches, lamps, and shielded windows and are not concentrated in one tank or physical location. Their physical and chemical forms are not conducive to an accident because of their highly dispersed distribution. No quantities of toxic chemicals of the same magnitude as in the Waste Tank Farm or Main Plant Process Building have been identified in a specific tank, drum, or pressurized component. Based on the type, form, and distribution of toxic chemicals at WVDP, no credible hazardous chemical accidents can occur that would affect worker or public health.

Although no significant health effects from postulated accidents involving toxic chemicals are expected, an evaluation of the toxic chemical inventory was performed. **Table I–28** presents a tabulation of all the toxic chemicals present at WVDP along with their quantities and relevant properties. EPA minimum release reportable quantities (EPA 2001b) and DOE health effect air concentration guidelines (DOE 2005) for each chemical are also presented in this table. In addition, Table I–28 presents the boiling point and vapor pressure (at 21 degrees Celsius [^{o}C] [70 degrees Fahrenheit [^{o}F]) of each toxic chemical. The purpose of providing the boiling point is to indicate that none of these chemicals could boil into vapor at expected temperatures during normal operations, and that only arsenic, cadmium, mercury, and selenium could vaporize if exposed to typical flame temperatures assumed for accidents of 800 ^{o}C (1475 ^{o}F) (10 CFR 71.73). The vapor pressure is used as another screening parameter in eliminating toxic chemicals. Screening methods in other EISs (DOE 1999a) eliminate chemicals with a vapor pressure of less than 0.5 millimeters mercury (Hg) or 0.01 pounds per square inch at normal temperatures. For example, water vapor pressure is 18 millimeter Hg or 0.35 pounds per square inch at 21 °C (70 °F).

Table I–28 Inventory, Properties, and Serious Health Effect Limits of the West Valley Demonstration Project Toxic Chemicals

Chemical	*Highest Total Main Plant Process Building Inventory* [a] *Kilograms (pounds)*	*Highest Individual Tank Inventory Kilograms (pounds)*	*EPA CERCLA Reportable Release Quantity* [b] *Kilograms (pounds)*	*Chemical Boiling Point Temperature at Atmospheric Pressure*	*Chemical Vapor Pressure At 25 °C, (77 °F) Millimeter Hg*	*ERPG-3 TEEL3* [c] *Milligrams per Cubic Meter*
Silver	14 (30.8)	1.98 (4.36)	454 (1,000)	2,162 °C (3,294 °F)	0	10
Arsenic	28 (61.6)	3.92 (8.63)	0.454 (1)	614 °C (1,137 °F)	0	5
Barium	39 (85.8)	17.5 (38.6)	None	1,870 °C (3,398 °F)	0	125
Beryllium	2.8 (6.2)	0.608 (1.34)	4.54 (10)	2,469 °C (4,476 °F)	0	0.1
Cadmium	9.4 (20.7)	1.66 (3.66)	4.54 (10)	767 °C (1,413 °F)	0	7.5
Chromium	80 (176)	85.6 (188.6)	2,270 (5,000)	2,671 °C (4,840 °F)	0	250
Mercury	0.45 (1.0)	1.15 (2.53)	0.454 (1)	357 °C (674 °F)	0.0018	4.1
Nickel	254 (558.8)	85.9 (189.2)	45.4 (100)	2,913 °C (5,275 °F)	0	10
Lead	187 (411.4)	14.2 (31.3)	4.54 (10)	1,749 °C (3,180 °F)	0	100
Antimony	9.9 (21.8)	9.76 (21.5)	2,270 (5,000)	1,587 °C (2,889 °F)	0	50
Selenium	16 (35.2)	4.87 (10.7)	45.4 (100)	685 °C (1,265 °F)	0	1
Thallium	3.3 (7.3)	9.68 (21.3)	454 (1,000)	1,473 °C (2,683 °F)	0	15

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act, EPA = U.S. Environmental Protection Agency, ERPG-3 = Emergency Response Planning Guideline 3, TEEL3 = Temporary Emergency Exposure Limits 3.

[a] This total inventory represents the sum of the existence of this element distributed in components and structures throughout the Main Plant Process Building.

[b] For metals (silver, beryllium, cadmium, chromium, nickel, lead, antimony, selenium, and thallium) no reporting of solid form releases in these quantities is required unless the release is in the form of pieces with a mean diameter of 100 micrometers (100 microns) or smaller. For all materials, only particles of this size are reportable.

[c] Both the Emergency Response Planning Guideline 3 (ERPG-3) and Temporary Emergency Exposure Limits 3 (TEEL3) are the maximum concentration in air below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects. 1 millimeter Hg = 0.019 pounds per square inch.

Shading indicates that inventory is less than EPA CERCLA reportable release quantity.

Sources: DOE 2005; EPA 2001b; NYenvlaw 2002; URS 2008; WebElements 2006; WSMS 2005b, 2005c, 2008, 2009a, 2009b.

Based on the ratio of individual toxic chemical inventory to Emergency Response Planning Guideline (ERPG)-3 limit for those chemicals that are above the EPA Comprehensive Environmental Response, Compensation, and Liability Act reportable release quantity, an accidental release of beryllium encompasses the impacts of the other toxic chemicals listed in Table I–28. Assuming an accident that would release toxic chemicals from the Main Plant Process Building or high-level radioactive waste tanks having the same respirable particle release fraction that was used for the radiological accidents as presented in Table I–15, the higher inventory of toxic chemicals in the Main Plant Process Building would bound the inventory of the high-level radioactive waste tanks. The Main Plant Process Building Seismic Collapse accident scenario also results in a higher source term than the high-level radioactive waste tank accident scenario.

A postulated seismic collapse accident involving all 2.8 kilograms (6.2 pounds) of beryllium in the Main Plant Process Building would result in a concentration of respirable particles of beryllium at 100 meters (328 feet) of 0.00024 milligrams per cubic meter (6.6×10^{-7} milligrams per cubic foot) for a 10-minute release time and average meteorology atmospheric dispersion conditions. This is a factor of more than 400 below, or about 0.2 percent, of the ERPG-3 value of 0.1 milligrams per cubic meter (0.003 milligrams per cubic foot). If conservative meteorology atmospheric dispersion were to be assumed, the 100 meter (328 feet) air concentration would be 0.0012 milligrams per cubic meter, which is still significantly below the ERPG-3 limit of 0.1 milligrams per cubic meter (0.003 milligrams per cubic foot). The conservative meteorology 100-meter (328-foot) beryllium concentration is also below the ERPG-2 and ERPG-1 values of 0.025 milligrams per cubic meter and 0.005 milligrams per cubic meter (DOE 2005). Air concentrations below the ERPG-1 level do not cause any long-term or serious health effects. This calculation conservatively assumes that all the beryllium dispersed throughout the Main Plant Process Building would be affected by the Seismic Collapse accident scenario. It should also be noted that the distance of 100 meters (328 feet) is selected for the noninvolved worker and that the nearest public boundary is at a greater distance, thereby resulting in an even lower concentration for public exposure to this postulated accident.

Since the beryllium accident release air concentration at 100 meters (328 feet) is below the ERPG-3, ERPG-2, and ERPG-1 levels, accident releases of all other toxic chemicals would be expected to be significantly less than their respective ERPG limits. Therefore, the risk to noninvolved workers and the public due to toxic chemicals released to the atmosphere from accidents is very small and insignificant as compared to the radiological accident risks presented in Section I.5.7.

The aforementioned evaluation is for accidental releases of toxic chemicals into the atmosphere and short-term exposure for the public and noninvolved workers. The risks of cancer due to exposure from toxic chemicals have been extensively studied. EPA has developed an Integrated Risk Information System (IRIS) which presents chemical cancer risk data. Studies have shown that long-term exposure to certain chemicals is associated with an increase in the risk of specific organ cancer. For the chemicals listed in Table I–28 that are associated with cancer risk for long-term exposure, IRIS data show that cadmium has the highest cancer risk level of 1×10^{-6} (a chance of one in one million) for lung cancer. This risk is from a long-term cadmium respirable particle air concentration of 6×10^{-4} micrograms per cubic meter (EPA 2006). Assuming that the entire cadmium inventory in the Main Plant Process Building was released as respirable particles over a 1-year period of time, the air concentration at 100 meters (328 feet) for the noninvolved worker would be less than this cancer risk level. The air concentration of cadmium at the nearest public boundary would be lower than that for the noninvolved worker. Accident short-term atmospheric release of toxic chemicals would not result in an air concentration that would cause a cancer risk to noninvolved workers or the public. Long-term atmospheric release of toxic chemicals at WVDP results in air concentrations less than the value estimated to result in a cancer risk of 1×10^{-6} (a chance of one in one million) for the noninvolved worker or the nearest public member.

I.5.9 Accident Radiological and Chemical Impacts Conclusion

Radiological analyses of 15 different accidents involving the Main Plant Process Building, radioactive waste tanks, NDA, SDA, and radioactive waste packages for all four alternatives were performed using the

MACCS2 computer code. Radiation doses were calculated for the MEI and the 80-kilometer- (50-mile-) radius population. Doses were converted to LCFs and annual risk based on 0.0006 LCFs per rem and the annual frequency for each accident scenario. The largest accident consequence and risk for each alternative is summarized in **Table I–29**; estimated normal background radiation doses and associated cancer mortality are presented for perspective.

The largest radiological accident risk is calculated for the Sitewide Removal Alternative, while the smallest calculated accident risk exists for the No Action Alternative. For all alternatives, the relative radiological accident risk is very small as compared to such risks as the normal lifetime fatal cancer risk of about one in five.

An evaluation of the nature and quantity of toxic chemicals was performed to determine if a postulated accident could result in the release of these chemicals resulting in a hazard to workers or the public. Although the annual frequency of a postulated accident involving the release of toxic chemicals is equivalent to the radiological release accidents, the relatively low quantity and physical characteristics of the toxic chemicals preclude any significant health hazards in the event of an accidental release of toxic liquids or gases.

Table I–29 Largest Accident Radiological Consequence and Risk

Parameter	*Sitewide Removal Alternative*	*Sitewide Close-In-Place Alternative*	*Phased Decisionmaking Alternative (Phase 1)*	*No Action Alternative*
MEI dose (rem)	0.68	0.053	0.053	0.046
MEI LCF if the accident occurs	4.1×10^{-4}	3.2×10^{-5}	3.2×10^{-5}	2.7×10^{-5}
MEI annual risk	3.7×10^{-5} or 1 chance in 27,000	2.0×10^{-7} or 1 chance in 5 million	2.0×10^{-6} or 1 chance in 500,000	2.7×10^{-9} or 1 chance in 370 million
Population dose (person-rem)	3.4	3.4	3.4	0.68
Population LCF if the accident occurs	0.002	0.002	0.002	0.0004
Population annual risk	1.0×10^{-4} or 1 chance in 10,000	1.6×10^{-6} or 1 chance in 625,000	1.6×10^{-5} or 1 chance in 62,500	4.1×10^{-8} or 1 chance in 24 million
Population normal background radiation dose [a] (person-rem)	1.1×10^{6}	1.1×10^{6}	1.1×10^{6}	1.1×10^{6}
Population normal background radiation annual LCFs	633	633	633	633

LCF = latent cancer fatality, MEI = maximally exposed individual.

[a] Based on an average of 0.62 rem per person annually (NCRP 2009) and a population of 1.7 million.

Note: Different accident scenarios are represented by the value in the table for each alternative.

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Appendix J
Evaluation of Human Health Effects from Transportation

APPENDIX J
EVALUATION OF HUMAN HEALTH EFFECTS FROM TRANSPORTATION

J.1 Introduction

Transportation of any commodity involves a risk to both transportation crew members and members of the public. This risk results directly from transportation-related accidents and indirectly from increased levels of pollution from vehicle emissions, regardless of the cargo. The transportation of certain materials, such as hazardous or radioactive waste, can pose an additional risk due to the unique nature of the material itself. To permit a complete appraisal of the environmental impacts of the Proposed Action and alternatives, the human health risks associated with the transportation of radioactive materials on public highways and railroads were assessed.

This appendix provides an overview of the approach used to assess the human health risks that could result from transportation. The topics in this appendix include the scope of the assessment, packaging and determination of potential transportation routes, analytical methods used for the risk assessment (e.g., computer models), and important assessment assumptions. In addition, to aid in the understanding and interpretation of the results, specific areas of uncertainty are described with an emphasis on how the uncertainties may affect comparisons of the alternatives.

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

J.2 Scope of Assessment

The scope of the transportation human health risk assessment, including the alternatives and options, transportation activities, potential radiological and nonradiological impacts, and transportation modes, is described in this section. There are several shipping arrangements for various radioactive wastes that cover all alternatives evaluated. This evaluation focuses on using public highways and rail systems. Additional details of the assessment are provided in the remaining sections of this appendix.

J.2.1 Transportation-related Activities

The transportation risk assessment is limited to estimating the human health risks related to transportation under each alternative. The risks to workers or to the public during loading, unloading, and handling prior to or after shipment are addressed in Section 4.1.9, Human Health and Safety, of this environmental impact statement (EIS). The impacts of increased transportation levels on local traffic flow and infrastructure are addressed in Section 4.1.2, Site Infrastructure.

J.2.2 Radiological Impacts

For each alternative, radiological risks (i.e., those risks that result from the radioactive nature of the materials) are assessed for both incident-free (i.e., normal) and accident transportation conditions. The radiological risk associated with incident-free transportation conditions would result from the potential exposure of people to external radiation in the vicinity of a shipment. The radiological risk from transportation accidents would come from the potential release and dispersal of radioactive material into the environment during an accident and the subsequent exposure of people.

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

J.2.3 Nonradiological Impacts

In addition to the radiological risks posed by transportation activities, vehicle-related risks are also assessed for nonradiological causes (i.e., causes related to the transport vehicles and not the radioactive cargo) for the same transportation routes. The nonradiological transportation risks, which would be incurred for similar shipments of any commodity, are assessed for accident conditions. The nonradiological accident risk refers to the potential occurrence of transportation accidents that result in fatalities unrelated to the radioactive nature of the cargo.

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

J.2.4 Transportation Modes

All shipments were assumed to take place by either dedicated truck or rail.

J.2.5 Receptors

Transportation-related risks are calculated and presented separately for workers and members of the general public. The workers considered are truck and rail crew members involved in transportation and inspection of the packages. The general public includes all persons who could be exposed to a shipment while it is moving or stopped during transit. For the incident-free operation, the affected population includes individuals living within 800 meters (0.5 miles) of each side of the road or rail line. Potential risks are estimated for the affected populations and for the hypothetical maximally exposed individual (MEI). For incident-free operation, the MEI would be a resident living near the highway or rail line and exposed to all shipments transported on the road or rail line. For accident conditions, the affected population includes individuals residing within 80 kilometers (50 miles) of the accident, and the MEI would be an individual located 100 meters (330 feet) directly downwind from the accident. The risk to the affected population is a measure of the radiological risk posed to society as a whole by the alternative being considered. As such, the impact on the affected population is used as the primary means of comparing various alternatives.

J.3 Packaging and Transportation Regulations

This section provides a high-level, brief summary of packaging and transportation regulations. The regulations pertaining to the transportation of radioactive materials from the Western New York Nuclear Service Center (WNYNSC) are detailed in the CFR published by the U.S. Department of Transportation (DOT) and U.S. Nuclear Regulatory Commission (NRC). Specifics on details on these regulations can be found in

49 CFR Parts 106, 107, and 171-178 (DOT regulations); 10 CFR Parts 20, 61, and 71 (NRC regulations); and 39 CFR Part 121 (U.S. Postal Service regulations). Interested readers are encouraged to visit the cited sections of the CFR for current detailed regulations, or review the DOT RAMREG-001-98 (DOT 1998) for a comprehensive discussion on radioactive material regulations.

J.3.1 Packaging Regulations

The primary regulatory approach to promote safety from radiological exposure is the specification of standards for the packaging of radioactive materials. Packaging represents the primary barrier between the radioactive material being transported and the public, workers, and the environment. Transportation packaging for radioactive materials must be designed, constructed, and maintained to contain and shield its contents during normal transport conditions. For highly radioactive material, such as high-level radioactive waste or spent nuclear fuel, packaging must contain and shield the contents in the event of severe accident conditions. The type of packaging used is determined by the total radioactive hazard presented by the material within the packaging. Four basic types of packaging are used: Excepted, Industrial, Type A, and Type B. Specific requirements for these packages are detailed in 49 CFR Part 173, Subpart I. All packages are designed to protect and retain their content under normal operations.

Excepted packagings are limited to transporting materials with extremely low levels of radioactivity and very low external radiation. Industrial packagings are used to transport materials that, because of their low concentration of radioactive materials, present a limited hazard to the public and the environment. Type A packagings are designed to protect and retain their contents under normal transport conditions, and because of higher radioactive content it must maintain sufficient shielding to limit radiation exposure to handling personnel. Type A packaging, typically a 0.21-cubic-meter (55-gallon) drum or standard waste box, is commonly used to transport radioactive materials with higher concentrations or amounts of radioactivity than Excepted or Industrial packages. Type B packagings are used to transport material with the highest radioactivity levels, and are designed to protect and retain their contents under transportation accident conditions. They are described in more detail in the following sections. Packaging requirements are an important consideration for transportation risk assessment.

Radioactive materials shipped in Type A containers, or packagings, are subject to specific radioactivity limits, identified as A1 and A2 values in 49 CFR 173.435, “Table of A1 and A2 Values for Radionuclides.” In addition, external radiation limits, as prescribed in 49 CFR 173.441, “Radiation Level Limitations”, must be met. If the A1 or A2 limits are exceeded, the material must be shipped in a Type B container unless it can be demonstrated that the material meets the definition of “low specific activity.” If the material qualifies as low-specific-activity as defined in 10 CFR Part 71, “Packaging and Transportation of Radioactive Material”, and 49 CFR Part 173, it may be shipped in a shipping container such as Industrial or Type A Packaging (49 CFR 173.427); see also RAMREG-001-98 (DOT 1998). Type B containers, or casks, are subject to the radiation limits in 49 CFR 173.441, but no quantity limits are imposed except in the case of fissile materials and plutonium.

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

- Operating temperatures ranging from -40 degrees Celsius (°C) (-40 degrees Fahrenheit [°F]) to 70 °C (158 °F);
- External pressures ranging from 0.25 to 1.4 kilograms per square centimeter (3.5 to 20 pounds per square inch);
- Normal vibration experienced during transportation;

- Simulated rainfall of 5 centimeters (2 inches) per hour for 1 hour;
- Free fall from 0.3 to 1.2 meters (1 to 4 feet), depending on the package weight;
- Water immersion-compression tests; and
- Impact of a 6-kilogram (13-pound) steel cylinder with rounded ends dropped from 1 meter (3.3 feet) onto the most vulnerable surface.

Type B packagings are designed to retain their radioactive contents in both normal and accident conditions. In addition to the normal conditions outlined earlier, under accident conditions, a Type B package must withstand:

- Free drop from 9 meters (30 feet) onto an unyielding surface in a position most likely to cause damage;
- Free drop from 1 meter (3.3 feet) onto the end of a 15-centimeter (6-inch) diameter vertical steel bar;
- Exposure to temperatures of 800 °C (1,475 °F) for at least 30 minutes;
- For all packages, immersion in at least 15 meters (50 feet) of water;
- For some packages, immersion in at least 0.9 meters (3 feet) of water in an orientation most likely to result in leakage; and
- For some packages, immersion in at least 200 meters (660 feet) of water for 1 hour.

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

J.3.2 Transportation Regulations

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

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

DOT regulates the transportation of hazardous materials in interstate commerce by land, air, and water. DOT specifically regulates the carriers of radioactive materials and the conditions of transport, such as routing, handling and storage, and vehicle and driver requirements. DOT also regulates the labeling, classification, and marking of radioactive material packagings.

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

DOE, through its management directives, Orders, and contractual agreements, ensures the protection of public health and safety by imposing on its transportation activities standards equivalent to those of DOT and the NRC. According to 49 CFR 173.7(d), packagings made by or under the direction of DOE may be used for transporting Class 7 materials (radioactive materials) when the packages are evaluated, approved, and certified by DOE against packaging standards equivalent to those specified in 10 CFR Part 71.

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

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

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

J.4 Transportation Analysis Impact Methodology

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

Transportation impacts calculated in this EIS are presented in two parts: impacts of incident-free or routine transportation and impacts of transportation accidents. Impacts of incident-free transportation and transportation accidents were further divided into nonradiological and radiological impacts. Nonradiological impacts could result from transportation accidents in terms of traffic fatalities. Radiological impacts of incident-free transportation include impacts on members of the public and crew from radiation emanating from materials in the shipment. Radiological impacts from accident conditions consider all foreseeable scenarios that could damage transportation packages leading to releases of radioactive materials to the environment.

The impact of transportation accidents is expressed in terms of probabilistic risk, which is the probability of an accident multiplied by the consequences of that accident and summed over all reasonably conceivable accident conditions. Hypothetical transportation accident conditions ranging from low-speed “fender-bender” collisions to high-speed collisions with or without fires were analyzed. The frequencies of accidents and consequences were evaluated using a method developed by the NRC and previously published in the *Final Environmental Impact Statement on the Transportation of Radioactive Materials by Air and Other Modes*, NUREG-0170 (NRC 1977); *Shipping Container Response to Severe Highway and Railway Accident Conditions*, NUREG/CR-4829 (NRC 1987); and *Reexamination of Spent Fuel Shipping Risk Estimates*, NUREG/CR-6672 (NRC 2000). Hereafter, these reports are cited as: *Radioactive Material Transport Study*, NUREG-0170; *Modal Study*, NUREG/CR-4829; and *Reexamination Study*, NUREG/CR-6672. Radiological accident risk is expressed in terms of additional LCFs, and nonradiological accident risk is expressed in terms of additional immediate (traffic) fatalities. Incident-free risk is also expressed in terms of additional LCFs.

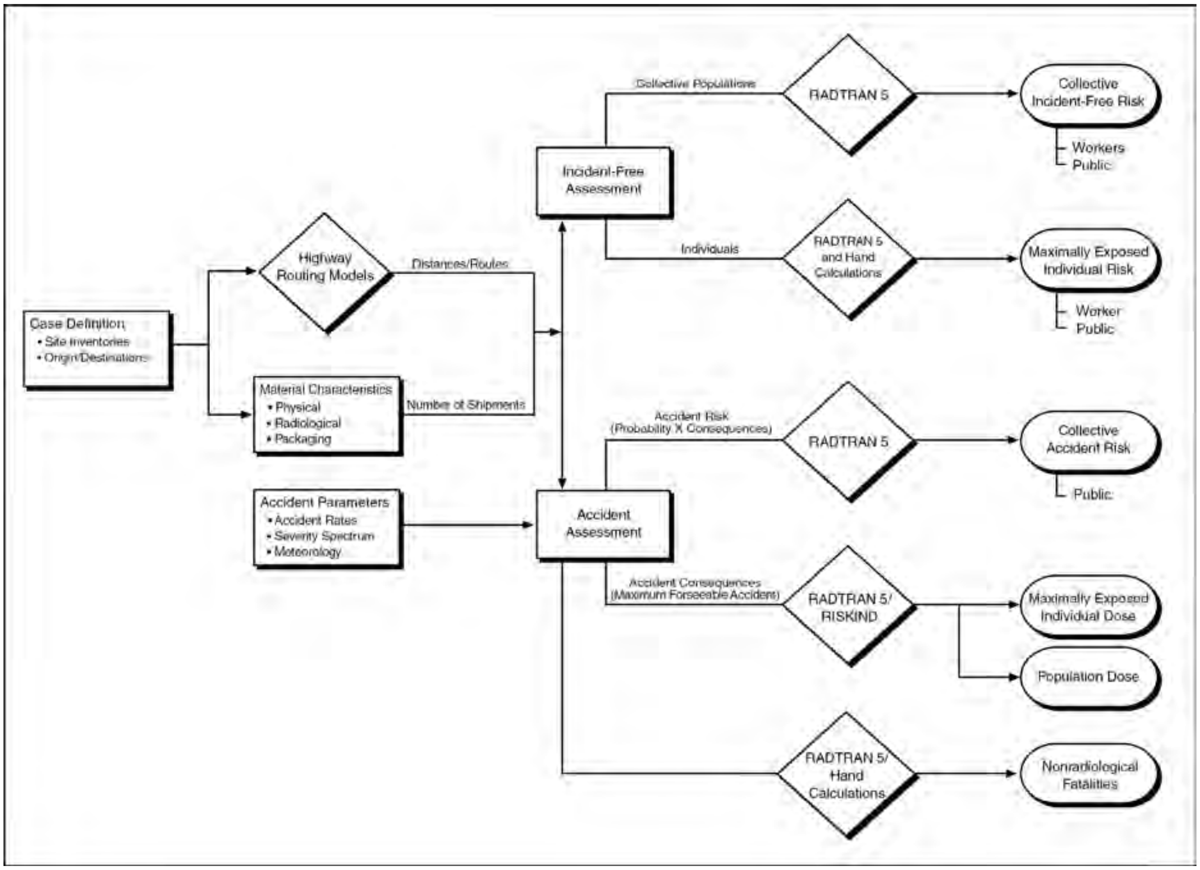

Figure J–1 Transportation Risk Assessment

Transportation-related risks were calculated and are presented separately for workers and members of the general public. The workers considered are truck/rail crew members involved in the actual transportation. The general public includes all persons who could be exposed to a shipment while it is moving or stopped during transit.

The first step in the ground transportation analysis was to determine the distances and populations along the routes. The Transportation Routing Analysis Geographic Information System (TRAGIS) computer program (Johnson and Michelhaugh 2003) was used to choose representative routes and the associated distances and populations. This information, along with the properties of the material being shipped and route-specific accident frequencies, was entered into the RADTRAN 5 computer code (Neuhauser and Kanipe 2003), which calculates incident and accident risks on a per-shipment basis. The risks under each alternative were determined by summing the products of per-shipment risks for each waste type by its number of shipments.

The RADTRAN 5 computer code (Neuhauser and Kanipe 2003) was used for incident-free and accident risk assessments to estimate the impacts on populations. RADTRAN 5 was developed by Sandia National Laboratories to calculate population risks associated with the transportation of radioactive materials by a variety of modes, including truck, rail, air, ship, and barge. RADTRAN 5 was used to calculate the doses to MEIs during incident-free operations.

The RADTRAN 5 population risk calculations include both the consequences and probabilities of potential exposure events. The RADTRAN 5 code consequence analyses include the following exposure pathways: cloud shine, ground shine, direct radiation (from loss of shielding), inhalation (from dispersed materials), and resuspension (inhalation dose from resuspended materials) (Neuhauser et al. 2000). The collective population risk is a measure of the total radiological risk posed to society as a whole by the alternative being considered. As such, the collective population risk is used as the primary means of comparing the various alternatives.

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

The RISKIND calculations were conducted to supplement the collective risk results calculated with RADTRAN 5. Whereas the collective risk results provide a measure of the overall risks of each alternative, the RISKIND calculations are meant to address areas of specific concern to individuals and population subgroups. Essentially, the RISKIND analyses are meant to address "What if" questions, such as "What if I live next to a site access road?" or "What if an accident happens near my town?"

J.4.1 Transportation Routes

To assess incident-free and transportation accident impacts, route characteristics were determined for offsite shipments from WNYNSC. Some of the wastes that would be generated do not currently have available disposal options. For these wastes, existing disposal sites in the eastern and western United States were used as proxy locations to define route characteristics for purposes of analysis. Route characteristics between WNYNSC and the following locations were analyzed:

- the Hanford Site in Richland, Washington (western proxy site for commercial Class B and C waste disposal);
- the Nevada Test Site (NTS) in Mercury, Nevada (DOE low-level radioactive waste; western proxy site for Greater-Than-Class C waste disposal);[1]
- the EnergySolutions site in Clive, Utah;
- the Barnwell site in Barnwell, South Carolina[2] (eastern proxy site for commercial Class B and C waste disposal); and
- the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico (proxy site for transuranic waste disposal).[3]

For offsite transport, highway and rail routes were determined using TRAGIS (Johnson and Michelhaugh 2003).[4]

[1] A disposal facility for Greater-Than-Class C low-level radioactive waste and potential non-defense transuranic waste will be evaluated in the Disposal of Greater-Than-Class C Low-Level Radioactive Waste Environmental Impact Statement (DOE/EIS-0375).
[2] Since July 2008, Barnwell does not accept waste from sites outside the Southeast Compact.
[3] See note 1.
[4] There is direct rail access to the Hanford Site, Barnwell, and EnergySolutions. Direct rail access to NTS is not available at the present time. However, for purposes of comparison between alternatives, a rail line with routing characteristics consistent with those used in the Final Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada is being used. For WIPP, while there is currently rail infrastructure at WIPP, there are no current plans to upgrade it so that rail shipments can be received.

The TRAGIS computer program is a geographic information system-based transportation analysis computer program used to identify and select highway, rail, and waterway routes for transporting radioactive materials within the United States. Both the road and rail network are 1:100,000-scale databases, which were developed from the U.S. Geological Survey digital line graphs and the U.S. Bureau of the Census Topological Integrated Geographic Encoding and Referencing System. The population densities along each route were derived from 2000 census data (Johnson and Michelhaugh 2003). The features in TRAGIS allow users to determine routes for shipment of radioactive materials that conform to DOT regulations as specified in 49 CFR Part 397.

Offsite Route Characteristics

Route characteristics that are important to the radiological risk assessment include the total shipment distance and population distribution along the route. The specific route selected determines both the total potentially exposed population and the expected frequency of transportation-related accidents. Route characteristics for Hanford, NTS, EnergySolutions, Barnwell, and WIPP transportation are summarized in **Table J–1**. Rural, suburban, and urban areas are characterized according to the following breakdown:

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

Table J–1 Offsite Transport Truck and Rail Route Characteristics

Origin	Destination	Nominal Distance (kilometers)	Distance Traveled in Zones (kilometers)			Population Density in Zone (number per square kilometer)			Number of Affected Persons [a]
			Rural	Suburban	Urban	Rural	Suburban	Urban	
Truck Routes									
WNYNSC	Hanford [b]	4,112	3,242	789	82	11.2	293.3	2,309.4	729,874
	NTS	3,922	3,058	753	112	11.0	307.5	2,428.4	857,664
	EnergySolutions	3,245	2,508	657	81	11.6	301.7	2,352.8	669,173
	Barnwell [b]	1,507	885	587	35	17.4	310	2,198.5	439,565
	WIPP	3,154	2,104	947	104	14.5	319.2	2,254	906,393
Rail Routes									
WNYNSC	Hanford	4,195	3,348	680	167	7.3	388.7	2,420	1,106,817
	NTS [c]	4,330	3,533	629	167	7.4	387.2	2,433.1	1,083,071
	EnergySolutions	3,425	2,636	622	167	9.6	387.5	2,434	1,077,838
	Barnwell [b]	1,784	1,170	519	95	15.7	385.6	2,404.2	715,606
	WIPP	2,962	2,344	486	132	8.7	438.3	2,391.9	878,996

NTS = Nevada Test Site, WIPP = Waste Isolation Pilot Plant, WNYNSC = Western New York Nuclear Service Center.

[a] The estimated number of persons residing within 800 meters (0.5 miles) along the transportation route.

[b] WNYNSC–Hanford Site route characteristics were used as a proxy for a commercial western U.S. disposal site for Class B/C wastes. Barnwell Site disposal of this waste was also evaluated in this appendix as a proxy for an eastern U.S. disposal site for Class B/C wastes, to provide environmental impact coverage and flexibility for use, should a site become available in future.

[c] For the purpose of analysis, NTS rail route characteristics were assumed to be the same as those used in the *Final Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*.

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

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

Analyzed truck and rail routes for shipments of radioactive waste materials to the Hanford, NTS, Barnwell, EnergySolutions, and WIPP sites are shown on **Figure J–2**.

J.4.2 Radioactive Material Shipments

Transportation of all waste types was assumed to be in certified or certified-equivalent packaging on exclusive-use vehicles. Legal-weight heavy-haul combination trucks are used for highway transportation. Type A packages are transported on common flatbed or covered trailers; Type B packages are generally shipped on trailers designed specifically for the packaging being used. For transportation by truck, the maximum payload weight is considered to be about 22,000 kilograms (about 48,000 pounds), based on the Federal gross vehicle weight limit of 36,288 kilograms (80,000 pounds). While there are large numbers of multi-trailer combinations (known as longer combination vehicles) with gross weights in excess of the Federal limit in operation on rural roads and turnpikes in some states (FHWA 2003), for evaluation purposes, the load limit for the legal truck was based on the Federal gross vehicle weight.

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

Several types of containers would be used to transport the generated waste. The various wastes that would be transported under the alternatives in this EIS include demolition and construction debris and hazardous waste, low-level radioactive waste, transuranic waste, and mixed low-level radioactive waste. **Table J–2** lists the types of containers used, along with their volumes and the number of containers in a shipment. A shipment is defined as the amount of waste transported on a single truck or a single railcar. Multiple railcars (two or more railcars carrying waste) per train could be used to reduce the number of rail transport. As the rail accident and fatalities data are per railcar-kilometer (see section J.6.2), the transportation analysis presented here is based on one railcar (carrying waste) per transport. While it may be possible to reduce the number of transports by using multiple railcars per train, there would be a proportional increase in the transportation risks per transport.

The number of shipping containers per shipment was estimated on the basis of dimensions and weight of the shipping containers, the Transport Index,[5] and the transport vehicle dimensions and weight limits. In general, the various wastes were assumed to be transported on standard truck semi-trailers and railcars in a single stack.

Waste materials to be transported offsite for disposal were classified in three broad disposal groupings: construction and demolition debris, hazardous wastes, and radioactive wastes. Trash, such as waste paper generated from routine office work, is not included. Radioactive wastes were classified in accordance with NRC regulations in 10 CFR Part 61. For DOE radioactive waste to be transported to a DOE radioactive waste disposal site (e.g., NTS) it was assumed that the wastes would meet the disposal facility's waste acceptance criteria. Wastes exceeding Class C limits that were buried in the NRC-Licensed Disposal Area (NDA) and State-Licensed Disposal Area (SDA) prior to establishment of the West Valley Demonstration Project (WVDP) were assumed to be Greater-Than-Class C wastes. This waste includes the irradiated, unprocessed reactor fuels that were mixed with concrete in drums and disposed of at NDA. All other wastes exceeding Class C limits were assumed to be transuranic wastes.

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

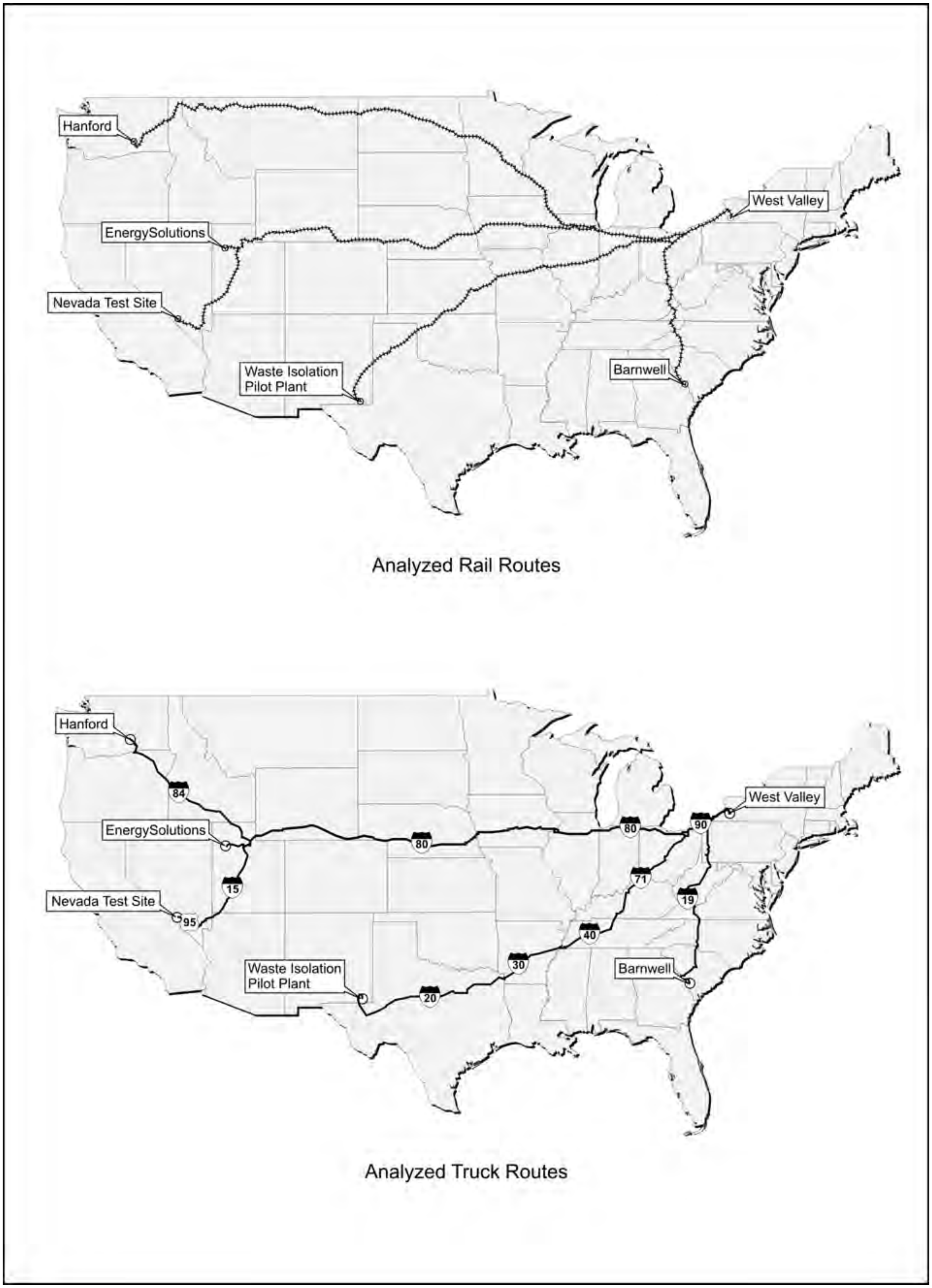

Figure J–2 Analyzed Truck and Rail Routes

Table J–2 Waste Type and Container Characteristics

Waste Type	***Container***	***Container Volume (cubic meters)*** [a]	***Container Mass (kilograms)*** [b]	***Number of Containers per Shipment***
Class A low-level radioactive waste	208-liter drum	0.21	399	80 per truck 160 per rail
Class A low-level radioactive waste and mixed low-level radioactive waste	B-25 Box	2.55	4,536	5 per truck 10 per rail
Class B and Class C low-level radioactive waste	B-25 Box	2.55	4,536	5 per truck 10 per rail
Class B and Class C low-level radioactive waste	High-integrity container [c]	5.10	9,072	1 per truck 2 per rail
Class C (remote-handled) [d]	208-liter drum	0.21	399	10 per truck cask 2 casks per rail
Greater-Than-Class C waste [d]	208-liter drum	0.21	399	10 per truck cask 2 casks per rail
Low-specific-activity waste	Lift liner	7.31	10,886	2 per truck 4 per rail
Transuranic waste (remote-handled) [e]	208-liter drum	0.21	399	3 per truck cask 2 casks per rail
Transuranic waste (contact-handled)	208-liter drum	0.21	399	14 per TRUPACT II; 3 TRUPACT IIs per truck 6 TRUPACT IIs per rail
Construction/demolition debris	Roll-on/Roll-off	15.30	Not applicable	1 per truck
Hazardous	208-liter drum	0.21	399	40 per truck

NRC = U.S. Nuclear Regulatory Commission, TRUPACT II = transuranic waste package transporter II.
[a] Container exterior volume. To convert from cubic meters to cubic feet, multiply by 35.315; from liters to gallons, by 0.26417.
[b] Filled container maximum mass. Container mass includes the mass of the container shell, its internal packaging, and the materials within. To convert from kilograms to pounds, multiply by 2.2046.
[c] High-integrity containers (NUHIC-205) would be transported in a shielded cask, if needed to limit the external dose rate.
[d] Remote-handled Class C and Greater-Than-Class C waste drums are transported in Type B shipping casks. The Greater-Than-Class C waste includes fuel and hardware wastes buried in the NRC-Licensed Disposal Area. Class B wastes packaged in drums, were assumed to be transported using shielded cask.
[e] Remote-handled transuranic waste drums must be transported in a Type B cask.
Note: Construction debris and hazardous wastes would be shipped to a local offsite location by truck only.
Source: WSMS 2009e.

For the purposes of analysis, this EIS assumes that all DOE low-level radioactive waste can be disposed of at NTS or EnergySolutions in Clive, Utah, depending on waste classification. It also assumes that low-level radioactive waste from the SDA, and pre-1982 NDA waste, would be disposed of at a commercial disposal site.

The commercial sites considered include EnergySolutions for low-specific-activity and Class A waste, and the eastern and western proxy sites of Barnwell and Hanford, respectively, for Class B and C waste.

It is also expected that Greater-Than-Class C waste would be generated during the exhumation and closure of the SDA and the pre-WVDP burial areas in the NDA. There is no known disposal facility for this waste at the present time. A disposal facility for Greater-Than-Class C low-level radioactive waste and potential non-defense transuranic waste will be determined in the Record of Decision for the *Disposal of Greater-Than-Class C Low-Level Radioactive Waste Environmental Impact Statement (GTCC EIS)* (DOE/EIS-0375). However, for the purposes of analyses in this EIS, it was assumed that Greater-Than-Class C waste would be disposed of at NTS. In addition to NTS, several other DOE sites and generic commercial locations for the disposal of Greater-Than-Class C waste will be evaluated in the *GTCC EIS*.

Transuranic and Class A mixed low-level radioactive waste would also be generated during closure activities. Class A mixed low-level radioactive waste was assumed to be disposed of at EnergySolutions under all disposal options. The only disposal location currently approved for transuranic waste is WIPP. WIPP is currently authorized to accept only DOE defense waste, and the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement (WIPP SEIS)* (DOE 1997) evaluated disposal of WVDP transuranic waste. However, WVDP non-defense transuranic waste cannot be disposed of at WIPP. As previously stated, a disposal facility for Greater-Than-Class C low-level radioactive waste and potential non-defense transuranic waste will be determined in the Record of Decision for the *GTCC EIS* (DOE/EIS-0375). Nevertheless, for the purposes of analysis only, in this EIS, the generated transuranic waste was assumed to be disposed of at WIPP.

J.4.3 Radionuclide Inventories

The details on the volumes and types of generated wastes and potential radioactive inventories at each of the waste management areas (WMAs) are provided in the technical reports and their supporting documents for each of the alternatives (WSMS 2009a, 2009b, 2009c, 2009d), and are summarized in Appendix C of this EIS. As indicated in Appendix C and the related referenced documents, the activities under each alternative would include closure (excavation) or remediation of 12 WMAs, the Cesium Prong, and North Plateau Groundwater Plume; decontamination, demolition, and decommissioning of buildings and underground structures; and construction, operation, and demolition of additional support facilities. These activities would result in multiple waste volumes of similar waste class with different radioactive inventories. Among the WMAs, the three largest radionuclide inventories are in the buried waste or equipment in the NDA, SDA, and Waste Tank Farm. Therefore, for the purposes of evaluating transportation accidents, the radionuclide inventories in various waste classes were estimated from radionuclide inventories in these three areas (URS 2000, 2002; WVNS 2005). The radionuclide inventory estimates at these areas were converted to radionuclide concentrations in each waste class based on the estimated disposed waste volumes in the NDA and SDA area, and the expected waste volumes in the Waste Tank Farm. The use of disposed waste volumes would lead to a higher calculated radionuclide concentration than would be expected using that of retrieved waste volumes. The waste retrieval process would lead to a higher waste volume due to cross contamination of the soil around the disposed waste. For similar waste classes with different radionuclide concentrations, the maximum radionuclide concentrations were selected to lead to the greatest radiological hazards for transportation risk assessment. The selected radionuclide concentrations were assumed to represent the concentrations for all similar waste classes that could be generated in other WMAs. This method was deemed necessary to eliminate producing multiple radionuclide concentrations for the same waste class and to produce an enveloping set of transportation accident risks.

Tables J–3 and **J–4** provide the container radionuclide inventories for each waste class. The list of radionuclides in these tables is limited to those that, in sum, contribute more than 99 percent of the total dose in an accident. Given the list, the corresponding concentration is derived from waste inventory. Note that the values given represent the maximum concentration that could be present in a container. If the actual waste container inventory were to exceed the A_2 limit (10 CFR Part 71; 49 CFR 173.435), the waste class would be shipped in a Type B cask. As Class B and Class C wastes could be shipped to a disposal site on the same type of transporter, a conservative inventory applicable to both waste class types was selected and provided in Table J–3. In the absence of a precise waste characterization for the low-specific-activity waste, the inventory for low-specific-activity waste was assumed to correspond to a low-specific-activity waste with the maximum concentration that was disposed of at the SDA.

Table J–3 Low-Specific-Activity, Class A, B, C and Greater-Than-Class C Waste Container Inventories (curies)

	Low Specific Activity	*Class A LLW*		*Class B and Class C LLW*		*GTCC Waste*
Radionuclides	***Lift liner*** [a]	***Drum***	***Box*** [b]	***Box***	***HIC***	***Drum***
Tritium	2.84×10^{-2}	1.14×10^{-2}	1.24×10^{-1}	3.72×10^{1}	7.35×10^{1}	2.00
Carbon-14	1.63×10^{-3}	8.44×10^{-5}	9.18×10^{-4}	2.76×10^{-1}	5.45×10^{-1}	1.48×10^{-2}
Iron-55	–	5.12×10^{-5}	5.57×10^{-4}	1.67×10^{-1}	3.30×10^{-1}	8.98×10^{-3}
Cobalt-60	3.10×10^{-3}	1.47×10^{-3}	1.60×10^{-2}	4.80	9.49	2.58×10^{-1}
Nickel-63	–	5.69×10^{-3}	6.20×10^{-2}	1.86×10^{1}	3.67×10^{1}	9.99×10^{-1}
Strontium-90	9.20×10^{-4}	4.12×10^{-4}	4.49×10^{-3}	2.04×10^{-1}	4.03×10^{-1}	1.85
Yttrium-90	9.20×10^{-4}	4.12×10^{-4}	4.49×10^{-3}	2.04×10^{-1}	4.03×10^{-1}	1.85
Cesium-137	1.52×10^{-3}	4.03×10^{-3}	4.39×10^{-2}	1.32×10^{1}	2.60×10^{1}	2.35
Barium-137m	1.44×10^{-3}	3.81×10^{-3}	4.15×10^{-2}	1.25×10^{1}	2.46×10^{1}	2.23
Thorium-234	–	5.29×10^{-5}	5.76×10^{-4}	1.73×10^{-1}	3.41×10^{-1}	2.68×10^{-2}
Uranium-238	–	5.29×10^{-5}	5.76×10^{-4}	1.73×10^{-1}	3.41×10^{-1}	9.28×10^{-3}
Plutonium-238 [c]	1.10×10^{-6}	3.09×10^{-5}	3.37×10^{-4}	1.01×10^{-1}	2.00×10^{-1}	2.67
Plutonium-239 [c]	1.10×10^{-6}	5.08×10^{-5}	5.53×10^{-4}	1.66×10^{-1}	3.28×10^{-1}	3.63×10^{-2}
Plutonium-240 [c]	1.10×10^{-6}	3.02×10^{-5}	3.28×10^{-4}	9.85×10^{-2}	1.95×10^{-1}	1.88×10^{-1}
Plutonium-241 [c]	1.10×10^{-6}	1.07×10^{-3}	1.17×10^{-2}	3.50	6.91	1.05
Americium-241	1.10×10^{-6}	1.21×10^{-4}	1.32×10^{-3}	3.95×10^{-1}	7.80×10^{-1}	1.16×10^{-1}

GTCC = Greater-Than-Class C, HIC = high integrity container, LLW = low-level radioactive waste.
[a] The values are curies per cubic meter.
[b] Also used for mixed low-level radioactive waste.
[c] These radionuclides were added to the low-specific-activity waste using similar concentration as that for Americium-241.

Table J–4 Fuel and Hardware, Remote-Handled Class C and Transuranic Container Inventories (curies)

Radionuclides	***Fuel/ Hardware***	***Class C-R***	***TRU***	***Radionuclides***	***Fuel/ Hardware***	***Class C-R***	***TRU***
Tritium	3.11	–	–	Neptunium-237	7.94×10^{-3}	2.79×10^{-5}	6.64×10^{-4}
Carbon-14	4.75×10^{-1}	1.42×10^{-6}	1.60×10^{-6}	Uranium-238	1.31×10^{-1}	2.85×10^{-5}	8.93×10^{-6}
Cobalt-60	2.73×10^{1}	–	–	Plutonium-238	1.05×10^{1}	4.01×10^{-3}	1.83×10^{-1}
Strontium-90	1.33×10^{3}	2.16	4.93×10^{1}	Plutonium-239	4.12×10^{1}	7.59×10^{-4}	4.58×10^{-2}
Yttrium-90	1.33×10^{3}	2.16	4.93×10^{1}	Plutonium-240	2.21×10^{1}	5.46×10^{-4}	3.32×10^{-2}
Cesium-137	1.73×10^{3}	6.40×10^{2}	8.82×10^{1}	Plutonium-241	6.71×10^{2}	4.51×10^{-2}	9.85×10^{-1}
Barium-137m	1.64×10^{3}	6.05×10^{2}	8.34×10^{1}	Americium-241	7.99×10^{1}	1.15×10^{-2}	4.81×10^{-1}
				Curium-244	6.26×10^{-1}	2.02×10^{-3}	9.97×10^{-2}

Class C-R = Class C remote-handled waste, TRU = transuranic.
The inventories refer to the amount of curies in a 208-liter (55-gallon) drum.

J.5 Incident-free Transportation Risks

J.5.1 Radiological Risk

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

Radiological impacts were determined for crew members and the general population during incident-free transportation. For truck shipments, the crew members are the drivers of the shipment vehicle. For rail shipments, the crew consists of workers in close proximity to the shipping containers during inspection or classification of railcars. The general population is composed of persons residing within 800 meters (0.50 miles) of the truck or rail routes (off-link), persons sharing the road or railway (on-link), and persons at stops. Exposures to workers who would load and unload the shipments are not included in this analysis, but are included in the occupational estimates for plant workers. Exposures to the inspectors and escorts are evaluated and presented separately.

Collective doses for the crew and general population were calculated by using the RADTRAN 5 computer code (Neuhauser and Kanipe 2003). The radioactive material shipments were assigned an external dose rate based on their radiological characteristics. Offsite transportation of the radioactive material has a defined regulatory limit of 10 millirem per hour at 2 meters (about 6.6 feet) from the cask (10 CFR 71.47; 49 CFR 173.441). If a waste container shows a high external dose rate that could exceed the DOT limit of 10 millirem per hour at 2 meters (6.6 feet) from the outer, or lateral, edge of the vehicle, it would be transported in a Type A or Type B shielded shipping container. Waste container dose rate, or its Transport Index, is dependent on distribution and quantities of radionuclides, waste density, shielding provided by the packaging, and self-shielding provided by the waste mixture. The most important gamma-emitting radionuclides in the waste are cobalt-60 and cesium-137. The MicroShield computer program (Grove 2003) was used to estimate the external dose rates for the various waste containers based on the unit concentrations of cobalt-60 and cesium-137. Dose rate calculations were performed assuming both shielded and bare containers. For the shielded option, waste containers were assumed to be in appropriate Type A or Type B shipping containers. For example, Greater-Than-Class C and remote-handled transuranic wastes were assumed to be shipped in a CNS 10-160B or a RH-72B cask (both are Type B casks), and Class C remote-handled waste in a CNS 10-160B cask. Using an enveloping waste composition (i.e., wastes with the highest potential cobalt-60 and/or cesium-137 concentrations) for each waste type, a conservative dose rate for its container was calculated. These dose rates were compared with those used in other DOE NEPA documentation, and an appropriate conservative value was assigned to each waste type. Dose rates for Class A low-level radioactive waste and mixed low-level radioactive waste were assigned at 2 millirem per hour at 1 meter (about 3.3 feet). Dose rate for low-specific-activity waste was assigned at 0.10 millirem per hour at 1 meter. Dose rates for the remote-handled Class C and Greater-Than-Class C wastes in Type B casks were assigned at 16 millirem per hour at 1 meter. Dose rates for the contact-handled Class B and Class C wastes in unshielded B-25 boxes or high integrity containers were also assigned at 16 millirem per hour at 1 meter. The dose rate for the remote-handled transuranic waste in a CNS 10-160B package at 1 meter was assigned at 5 millirem per hour. The dose rate for the contact-handled transuranic[6] waste was assigned at 4 millirem per hour at 1 meter (DOE 1997). In all cases, the maximum external dose rate is less than, or equal to the regulatory limit of 10 millirem per hour at 2 meters from each container.

To calculate the collective dose, a unit risk factor was developed to estimate the impact of transporting one shipment of radioactive material over a unit distance of travel in a given population density zone. The unit risk factors were combined with routing information, such as the shipment distances in various population density zones, to determine the risk for a single shipment (a shipment risk factor) between a given origin and destination. Unit risk factors were developed on the basis of travel on interstate highways and freeways, as required by 49 CFR Parts 171 through 177 for highway-route-controlled quantities of radioactive material within rural, suburban, and urban population zones by using RADTRAN 5 and its default data. In addition, the analysis assumed that, 10 percent of the time, travel through suburban and urban zones would encounter rush-hour conditions, leading to lower average speed and higher traffic density. **Table J–5** provides an example of the unit risk factors (not specific to shipments of WNYNSC waste) for a truck and rail shipment

[6] *Note that no contact-handled transuranic waste was identified, however, this dose rate was given for completeness.*

with a Transport Index of 1 (i.e., dose rate of 1 millirem per hour at 1 meter [3.3 feet]) from the surface of the shipping container, or the conveyance. This table identifies the contributing factors to the estimated exposures considered for the crew (occupational) and the general public. Note that the size of the waste package and assumptions regarding public shielding afforded by its general housing structure within each zone would be major contributing factors in the calculated dose.

Table J–5 Incident-free Unit Risk Factors for a Dose Rate of 1 Millirem per Hour at 1 Meter from the Shipping Container for Truck and Rail Shipments

Mode	*Exposure Group*	*Unit Risk Factors* [a] *Rural*	*Suburban* [b]	*Urban* [b]
Truck	Occupational [c] (person-rem per kilometer)	5.33×10^{-6}	5.86×10^{-6}	5.86×10^{-6}
	General Population			
	Off-link [d] (person-rem per kilometer per person per square kilometer)	2.62×10^{-9}	2.50×10^{-9}	5.18×10^{-11}
	On-link [e] (person-rem per kilometer)	7.21×10^{-7}	1.79×10^{-6}	5.66×10^{-6}
	Stops [f] (person-rem per kilometer per person per square kilometer)	2.30×10^{-10}	2.30×10^{-10}	2.30×10^{-10}
	Escorts [g] (person-rem per kilometer)	2.42×10^{-7}	2.55×10^{-7}	2.55×10^{-7}
Rail	Occupational [h] (person-rem per kilometer)	2.10×10^{-7}	2.10×10^{-7}	2.10×10^{-7}
	General Population			
	Off-link [d] (person-rem per kilometer per person per square kilometer)	3.52×10^{-9}	4.90×10^{-9}	1.69×10^{-10}
	On-link [e] (person-rem per kilometer)	8.23×10^{-9}	1.06×10^{-7}	2.94×10^{-7}
	Stops [f] (person-rem per kilometer per person per square kilometer)	8.10×10^{-10}	8.10×10^{-10}	8.10×10^{-10}
	Escorts [i] (person-rem per kilometer)	1.57×10^{-6}	2.52×10^{-6}	4.21×10^{-6}

[a] The methodology, equations, and data used to develop the unit risk factors are discussed in the *RADTRAN 5 User Manual* (Neuhauser and Kanipe 2003). The risk factors provided here are for a truck and rail cask with the following characteristic length and diameters: 5.2-meter (17.06-foot) length and 1.0-meter (3.28-foot) diameter for a truck cask, and 5.06-meter (16.6-foot) length and 2.0-meter (6.56-foot) diameter for a rail cask. Because the characteristics of transuranic waste shipment are different from those used here, the contact-handled transuranic shipment risk factors would be higher than the values given here by a factor of 1.387 and 1.756 for the population dose and crew dose, respectively.

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

[c] Maximum dose in the truck cabin (crew dose) is 2 millirem per hour, per 10 CFR 71.47, unless the crew member is a trained radiation worker, which would administratively limit the annual dose to 2 rem per year (DOE Administrative Control, DOE-STD-1098-99 [DOE 1999]).

[d] Off-link general population refers to persons within 800 meters (0.50 miles) of the transportation route. The difference in doses between the rural, suburban, and urban populations is due to the assumptions regarding public shielding afforded by its general housing structure within each zone.

[e] On-link general population refers to persons sharing the transportation route.

[f] Dose to residents from frequent stops along the routes.

[g] Escorts (two persons) in a vehicle that follows or leads the truck by 60 meters (about 200 feet). The dose to this vehicle is estimated to be 0.15 millirem per hour for a cask at the regulatory dose limit (i.e., 10 millirem per hour at 2 meters), (DOE 2002a).

[h] Need to add the nonlinear component of incident-free rail dose for crew members because of railcar inspections and classifications, which is 0.000233 person-rem per shipment. *RADTRAN 5 Technical Manual*, Appendix B (Neuhauser et al. 2000), contains an explanation of the rail exposure model.

[i] Escorts (two persons) at a distance of 30 meters (about 100 feet) from the end of the shipping cask. The dose to the escort is estimated to be 0.71 millirem per hour for a cask at the regulatory dose limit (DOE 2002a).

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

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

J.5.2 Nonradiological Risk

The nonradiological risks, or vehicle-related health risks, resulting from incident-free transport may be associated with the generation of air pollutants by transport vehicles during shipment and are independent of the radioactive nature of the shipment. The health endpoint assessed under incident-free transport conditions is the excess latent mortality due to inhalation of vehicle emissions. Unit risk factors for pollutant inhalation in terms of mortality have been generated (Rao et al. 1982); however, the emergence of considerable data regarding threshold values for various chemical constituents of vehicle exhaust has made linear extrapolation to estimate the risks from vehicle/rail emissions untenable (Neuhauser et al. 2000). This calculation has been dropped from RADTRAN in its recent revision (Neuhauser and Kanipe 2003). Therefore, no risk factors have been assigned to the vehicle emissions in this EIS.

J.5.3 Maximally Exposed Individual Exposure Scenarios

The maximum individual doses for routine offsite transportation were estimated for transportation workers, as well as for members of the general population.

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

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

The hypothetical MEI doses were accumulated over a single year for all transportation shipments. However, for the scenario involving an individual caught in traffic next to a shipping container, the radiological exposures were calculated for only one event because it was considered unlikely that the same individual would be caught in traffic next to all containers for all shipments. For truck shipments, the maximally exposed transportation worker is the driver who was assumed to have been trained as a radiation worker and to drive shipments for up to 2,000 hours per year, or accumulate an exposure of 2 rem per year. A member of the truck crew would be a non–radiation worker; the maximum annual dose rate for a non–radiation worker is 100 millirem (10 CFR 20.1301).

Three hypothetical scenarios were also evaluated for railcar shipments. They are:

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

The maximally exposed transportation worker for both truck and rail shipments is an individual inspecting the cargo at a distance of 1 meter (3.3 feet) from the shipping container for 1 hour.

J.6 Transportation Accident Risks

J.6.1 Methodology

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

To provide DOE and the public with a reasonable assessment of radioactive waste transportation accident impacts, two types of analysis were performed. First, an accident risk assessment was performed that takes into account the probabilities and consequences of a spectrum of potential accident severities using a methodology developed by the NRC (NRC 1977, 1987, 2000). For the spectrum of accidents considered in the analysis, accident consequences in terms of collective "dose risk" to the population within 80 kilometers (50 miles) were determined using the RADTRAN 5 computer program (Neuhauser et al. 2000). The RADTRAN 5 code sums the product of consequences and probability over all accident severity categories to obtain a probability-weighted risk value referred to in this appendix as "dose risk," which is expressed in units of person-rem. Second, to represent the maximum reasonably foreseeable impacts to individuals and populations should an accident occur, maximum radiological consequences were calculated in an urban or suburban population zone for an accidental release with a likelihood of occurrence greater than 1-in-10 million per year using the RISKIND computer program (Yuan et al. 1995).

For accidents in which a waste container or the cask shielding was undamaged, population and individual radiation exposure from the waste package was evaluated for the duration that would be needed to recover and resume shipment. The collective dose over all segments of transportation routes was evaluated for an affected population up to a distance of 800 meters (0.5 miles) from the accident location. This dose is an external dose, and is approximately inversely proportional to the square of the distance of the affected population from accident. Any additional dose to those residing beyond 800 meters (0.5 miles) from the accident would be negligible. The dose to an individual (first responder) was calculated assuming that the individual would be located at 2 to 10 meters (6.6 to 33 feet) from the package. For the accidents leading to loss of cask shielding, a method similar to that provided in the *Reexamination Study* and adapted in the *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (*Yucca Mountain EIS)* was used (NRC 2000; DOE 2002b, 2008).

J.6.2 Accident Rates

Whenever material is shipped, the possibility of a traffic accident that could result in vehicular damage, injury, or death exists. Even when drivers are trained in defensive driving and taking great care, there is a risk of a traffic accident. To date, DOE and its predecessor agencies have a successful 50-year history in transporting radioactive materials. In the years of moving radioactive and hazardous materials, DOE has not had a single fatality related to the hazardous or radioactive material cargo (DOE 2009).

For the calculation of accident risks, vehicle accident and fatality rates were taken from data provided in *State-Level Accident Rates for Surface Freight Transportation: A Reexamination*, ANL/ESD/TM-150 (Saricks and Tompkins 1999). Accident rates are generically defined as the number of accident involvements (or fatalities) in a given year per unit of travel in that same year. Therefore, the rate is a fractional value, with accident involvement count as the numerator of the fraction and vehicular activity (total travel distance in truck kilometers) as its denominator. Accident rates were generally determined for a multi-year period. For assessment purposes, the total number of expected accidents or fatalities was calculated by multiplying the total shipment distance for a specific case by the appropriate accident or fatality rate. No reduction in accident or fatality rates was assumed even though radioactive material carrier drivers are better trained and have better-maintained equipment.

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

For offsite transportation, the accident and fatality rates for this EIS are based on the state-level data provided in the Saricks and Tompkins report, ANL/ESD/TM-150 (Saricks and Tompkins 1999). The rates in the Saricks and Tompkins report are given in terms of accident and fatality per car-kilometer and railcar-kilometer traveled. The selected accident and fatality rates used in this EIS are limited to the rates in those states where trucks and rails would traverse transporting wastes from the WNYNSC to the designated disposal sites. For trucks, the selected state-level rates are those associated with accidents and fatalities on interstate highways.

Recent review of the truck accidents and fatalities reports by the Federal Carrier Safety Administration indicated that state-level accidents and fatalities were underreported. For the years 1994 through 1996, which were the basis for the analysis in the Saricks and Tompkins report, a review identified that accidents were underreported by about 39 percent and fatalities were underreported by about 36 percent (UMTRI 2003). Therefore, state-level truck accident and fatality rates in the Saricks and Tompkins report were increased by factors of 1.64 and 1.57, respectively, in this Final EIS to account for the underreporting. For each rail shipment, it was assumed that each train would consist of at least three cars: a locomotive, a crew car, and a rail car carrying waste.

For local and regional transport, New York State accident and fatality rates were used. The data were provided in ANL/ESD/TM-150 (Saricks and Tompkins 1999). The rates used were 3.45 accidents per 10 million truck kilometers and 1.24 fatalities per 100 million truck kilometers.

J.6.3 Accident Severity Categories and Conditional Probabilities

Accident severity categories for potential radioactive waste transportation accidents are described in the *Radioactive Material Transportation Study* (NRC 1977) for radioactive waste in general, the *Modal Study* (NRC 1987), and the *Reexamination Study* (NRC 2000) for spent nuclear fuel. The methods described in the *Modal Study* and the *Reexamination Study* are applicable to transportation of radioactive materials in a Type B spent fuel cask. The accident severity categories presented in the *Radioactive Material Transportation Study* would be applicable to all other waste transported off site.

The *Radioactive Material Transportation Study* (NRC 1977) originally was used to estimate conditional probabilities associated with accidents involving transportation of radioactive materials. The *Modal Study* and the *Reexamination Study* (NRC 1987, 2000) are initiatives taken by the NRC to refine more precisely the analysis presented in *Radioactive Material Transportation Study* for spent nuclear fuel shipping casks.

Whereas the *Radioactive Material Transportation Study* (NRC 1977) analysis was primarily performed using best engineering judgments and presumptions concerning cask response, the later studies relied on sophisticated structural and thermal engineering analysis and a probabilistic assessment of the conditions that could be experienced in severe transportation accidents. The latter results are based on representative spent nuclear fuel casks assumed to have been designed, manufactured, operated, and maintained according to national codes and standards. Design parameters of the representative casks were chosen to meet the minimum test criteria specified in 10 CFR Part 71. The study is believed to provide realistic, yet conservative, results for radiological releases under transport accident conditions.

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

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

For the accident risk assessment, accident "dose risk" was generically defined as the product of the consequences of an accident and the probability of occurrence of that accident, an approach consistent with the methodology used by RADTRAN 5 computer code. The RADTRAN 5 code sums the product of consequences and probability over all accident categories to obtain a probability-weighted risk value referred to in this appendix as "dose risk," which is expressed in units of person-rem.

J.6.4 Atmospheric Conditions

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

Neutral weather conditions (Pasquill Stability Class D) are the most frequently occurring atmospheric stability condition in the United States and are thus most likely to be present in the event of an accident involving a radioactive waste shipment. Neutral weather conditions are typified by moderate windspeeds, vertical mixing within the atmosphere, and good dispersion of atmospheric contaminants. Stable weather conditions are typified by low windspeeds, very little vertical mixing within the atmosphere, and poor dispersion of atmospheric contaminants. The atmospheric condition used in RADTRAN 5 is an average weather condition that corresponds to a stability class spread between Class D (for near distance) and Class E (for farther distance).

The accident consequences for the maximum reasonably foreseeable accident (an accident with likelihood of occurrence greater than 1 in 10 million per year) were assessed under both stable (Class F with a wind speed of 1 meter [3.3 feet] per second) and neutral (Class D with a wind speed of 4 meters [13 feet] per second) atmospheric conditions. The population dose is evaluated under neutral atmospheric conditions and the MEI dose under stable atmospheric conditions. The MEI dose would represent an accident under worst-case weather conditions (stable condition, with minimum diffusion and dilution). The population dose would represent an average weather condition.

J.6.5 Radioactive Release Characteristics

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

Representative release fractions were developed for each waste and container type on the basis of DOE and NRC reports (DOE 1994, 2002b, 2003a; NRC 1977, 2000). The severity categories and corresponding release fractions provided in these documents cover a range of accidents from no impact (zero speed) to impacts with speeds in excess of 193 kilometers (120 miles) per hour onto an unyielding surface. Traffic accidents that could occur at the site would be of minor impact due to lower local speed, with no release potential.

For radioactive wastes transported in a Type B cask, the particulate release fractions were developed consistent with the models in the *Reexamination Study* (NRC 2000) and adapted in the *West Valley Demonstration Project Waste Management Environmental Impact Statement* (DOE 2003b). For wastes transported in Type A containers (e.g., 208-liter [55-gallon] drums and boxes), the fractions of radioactive material released from the shipping container were based on recommended values from *Radioactive Material Transportation Study* and *DOE Handbook on Airborne Release and Respirable Fractions* (NRC 1977, DOE 1994). For contact-handled and remote-handled transuranic waste, the release fractions corresponding to the *Radioactive Material Transportation Study* severity categories as adapted in the *WIPP SEIS* were used (DOE 1997, 2002b). For wastes transported in high integrity containers, and lift liners in intermodal (or Sealand) containers, release fractions were calculated using a method similar to that used in the *WIPP SEIS*.

For those accidents where the waste container or cask shielding was undamaged and no radioactive material released, it was assumed that it would take 12 hours to recover from the accident and resume shipment. During this period, no individual would remain close to the cask. A first responder could stay at a location 2 to 10 meters (6.6 to 33 feet) from the package, at a position where the dose rate would be the highest, for 30 minutes in a loss of shielding accident, and 1 hour for other accidents with no release (DOE 2002b).

J.6.6 Acts of Sabotage or Terrorism

In the aftermath of the events of September 11, 2001, DOE is continuing to assess measures to minimize the risk or potential consequences of radiological sabotage. While it is not possible to determine terrorists' motives and targets with certainty, DOE considers the threat of terrorist attack to be real, and makes all efforts to reduce any vulnerability to this threat.

Nevertheless, DOE has evaluated the impacts of acts of sabotage and terrorism on transportation of spent nuclear fuel and high-level radioactive waste shipments (DOE 1996, 2002a). The spectrum of accidents considered ranges from a direct attack on the cask from afar to hijacking and exploding the shipping cask in an urban area. Both of these actions would result in damaging the cask and its contents and releasing radioactive materials. The fraction of the materials released is dependent on the nature of the attack (type of explosive or weapon used). The sabotage event evaluated in the *Yucca Mountain EIS* was considered as the enveloping analysis for this EIS. The event was assumed to involve either a truck-sized, or a rail-sized cask containing light water reactor spent nuclear fuel. The consequences of such an act were calculated to result in an MEI dose (at 140 meters [460 feet]) of 40 to 110 rem for events involving a rail-sized or truck-sized cask, respectively. These events would lead to an increase in risk of fatal cancer to the MEI by 2 to 7 percent (DOE 2002a). The quantity of radioactive materials transported under all decommissioning alternatives considered here would be less than that considered in this analysis. Therefore, estimates of risk in the *Yucca Mountain EIS* envelop the risks from an act of sabotage or terrorism involving the radioactive material transported under all alternatives considered in this EIS.

J.7 Risk Analysis Results

Per-shipment risk factors have been calculated for the collective populations of exposed persons and for the crew for all anticipated routes and shipment configurations. Radiological risks are presented in doses per shipment for each unique route, material, and container combination. Radiological risk factors per shipment for incident-free transportation and accident conditions are presented in **Table J–6**. For incident-free transportation, both dose and LCF risk factors are provided for the crew and exposed population. The radiological risks would result from potential exposure of people to external radiation emanating from the packaged waste. The exposed population includes the off-link public (i.e., people living along the route), on-link public (i.e., pedestrian and car occupants along the route), and public at rest and fuel stops.

Risk factors are given for both radiological, transportation accidents in terms of potential LCFs in the exposed population, and nonradiological, accidents in terms of the number of traffic fatalities. LCFs represent the number of additional latent fatal cancers among the exposed population. Under accident conditions, the population would be exposed to radiation from released radioactivity if the package is damaged, and would receive a direct dose if the package is unbreached. For the accidents with no release, the analysis conservatively assumed that it would take about 12 hours to remove the package and/or vehicle from the accident area (DOE 2002a). Accidents leading to a loss of cask shielding would only be applicable to those shipments that use shielded casks, such as shipments of Greater-Than-Class C, remote-handled Class C, and remote-handled transuranic wastes.

As indicated in this table, all risk factors are less than one. This means that no LCFs or traffic fatalities are expected to occur during each transport. For example, the risk factors to truck crew and population for transporting one shipment of Class B and Class C waste to NTS are given as 3.8×10^{-4} and 1.2×10^{-4} LCFs, respectively. This risk can also be interpreted as meaning that there is a chance of 1 in 2,600 that an additional latent fatal cancer could be experienced among the exposed workers from exposure to radiation during one shipment of Class B and Class C waste to Nevada. Similarly, there is a chance of 1 in 8,300 that an additional latent fatal cancer could be experienced among the exposed population residing along the transport route. These are essentially equivalent to zero risk. It should be noted that the maximum allowable dose rate in the truck cabin is less than or equal to 2 millirem per hour, and the maximum annual dose to a commercial truck driver is 100 millirem per year, unless the individual is a trained radiation worker who would have an administrative annual dose limit of 2 rem (DOE 1999). The values could be higher if drivers are radiation workers operating under a Federal or state-licensed program (49 CFR 173.441). An individual receiving a dose of 100 millirem would have an expected risk of developing a latent fatal cancer of 6.0×10^{-5}. The same individual is expected to receive a dose of about 620 millirem per year on average from ubiquitous background and other sources of radiation (NCRP 2009).

Table J–6 Risk Factors per Shipment of Radioactive Waste

		Incident-Free				*Accident*	
Waste Materials and Mode of Transport	***Transport Destination***	***Crew Dose (person-rem)***	***Crew Risk (LCF)***	***Population Dose (person-rem)***	***Population Risk (LCF)***	***Radiological Risk (LCF)***	***Non-radiological Risk (traffic fatalities)***
Truck Shipments							
Class A (B) [a]	NTS	7.9×10^{-2}	4.7×10^{-5}	2.5×10^{-2}	1.5×10^{-5}	4.7×10^{-10}	7.6×10^{-5}
Class A (D) [b]		9.4×10^{-2}	5.7×10^{-5}	4.2×10^{-2}	2.5×10^{-5}	7.4×10^{-10}	7.6×10^{-5}
Class B and Class C [c]		6.3×10^{-1}	3.8×10^{-4}	2.0×10^{-1}	1.2×10^{-4}	8.0×10^{-8}	7.6×10^{-5}
Class C (RH) [d]		5.5×10^{-1}	3.3×10^{-4}	6.9×10^{-2}	4.2×10^{-5}	9.9×10^{-10}	7.6×10^{-5}
Low specific activity		4.3×10^{-3}	2.6×10^{-6}	8.7×10^{-4}	5.2×10^{-7}	1.5×10^{-10}	7.6×10^{-5}
GTCC [e]	NTS [f]	3.4×10^{-2}	2.1×10^{-5}	4.3×10^{-3}	2.6×10^{-6}	2.0×10^{-9}	7.6×10^{-5}
GTCC [g]		3.2×10^{-1}	1.9×10^{-4}	9.0×10^{-2}	5.4×10^{-5}	4.8×10^{-9}	7.6×10^{-5}
Low specific activity	EnergySolutions	3.6×10^{-3}	2.1×10^{-6}	7.1×10^{-4}	4.3×10^{-7}	2.5×10^{-10}	9.8×10^{-5}
Class A (B) [a]		6.5×10^{-2}	3.9×10^{-5}	2.0×10^{-2}	1.2×10^{-5}	8.2×10^{-10}	9.8×10^{-5}
Class A (D) [b]		7.8×10^{-2}	4.7×10^{-5}	3.5×10^{-2}	2.1×10^{-5}	1.3×10^{-9}	9.8×10^{-5}
Class B and Class C [h]	Barnwell	3.5×10^{-1}	2.1×10^{-4}	2.0×10^{-2}	1.2×10^{-5}	1.1×10^{-6}	8.2×10^{-5}
Class C (RH) [d]		2.1×10^{-1}	1.3×10^{-4}	2.8×10^{-2}	1.7×10^{-5}	2.1×10^{-9}	8.2×10^{-5}
RH-TRU	WIPP [i]	1.4×10^{-1}	8.3×10^{-5}	2.1×10^{-2}	1.3×10^{-5}	1.2×10^{-9}	1.0×10^{-4}
Class B and Class C [h]	Hanford Site [j]	9.3×10^{-1}	5.6×10^{-4}	5.2×10^{-2}	3.1×10^{-5}	1.4×10^{-6}	1.3×10^{-4}
Class C (RH) [d]		5.7×10^{-1}	3.4×10^{-4}	7.1×10^{-2}	4.3×10^{-5}	2.0×10^{-9}	1.3×10^{-4}
Rail Shipments							
Class A (B) [a]	NTS	7.0×10^{-3}	4.2×10^{-6}	1.1×10^{-2}	6.6×10^{-6}	3.9×10^{-10}	2.8×10^{-4}
Class A (D) [b]		6.3×10^{-3}	3.8×10^{-6}	8.9×10^{-3}	5.4×10^{-6}	4.4×10^{-10}	2.8×10^{-4}
Class B and Class C [c]		5.6×10^{-2}	3.3×10^{-5}	8.7×10^{-2}	5.2×10^{-5}	5.8×10^{-8}	2.8×10^{-4}
Class C (RH) [d]		4.0×10^{-2}	2.4×10^{-5}	4.6×10^{-2}	2.8×10^{-5}	1.5×10^{-9}	2.8×10^{-4}
Low specific activity		2.8×10^{-4}	1.7×10^{-7}	3.5×10^{-4}	2.1×10^{-7}	1.3×10^{-10}	2.8×10^{-4}
GTCC [e]	NTS [f]	2.5×10^{-3}	1.5×10^{-6}	2.9×10^{-3}	1.7×10^{-6}	3.4×10^{-9}	2.8×10^{-4}
GTCC [g]		3.5×10^{-2}	2.1×10^{-5}	4.0×10^{-2}	2.4×10^{-5}	8.1×10^{-9}	2.8×10^{-4}
Low specific activity	EnergySolutions	2.3×10^{-4}	1.4×10^{-7}	3.5×10^{-4}	2.1×10^{-7}	1.7×10^{-10}	2.8×10^{-4}
Class A (B) [a]		5.7×10^{-3}	3.4×10^{-6}	1.1×10^{-2}	6.5×10^{-6}	5.0×10^{-10}	2.8×10^{-4}
Class A (D) [b]		5.1×10^{-3}	3.1×10^{-6}	8.8×10^{-3}	5.3×10^{-6}	5.6×10^{-10}	2.8×10^{-4}
Class B and Class C [h]	Barnwell	1.6×10^{-2}	9.4×10^{-6}	2.5×10^{-2}	1.5×10^{-5}	7.5×10^{-7}	3.9×10^{-4}
Class C (RH) [d]		1.9×10^{-2}	1.2×10^{-5}	3.8×10^{-2}	2.3×10^{-5}	2.5×10^{-9}	3.9×10^{-4}
RH-TRU	WIPP [i]	9.1×10^{-3}	5.4×10^{-6}	1.3×10^{-2}	7.8×10^{-6}	6.0×10^{-10}	3.1×10^{-4}
Class B and Class C [h]	Hanford Site [j]	3.2×10^{-2}	1.9×10^{-5}	3.2×10^{-2}	1.9×10^{-5}	1.2×10^{-6}	4.4×10^{-4}
Class C (RH) [d]		3.9×10^{-2}	2.4×10^{-5}	4.8×10^{-2}	2.9×10^{-5}	2.9×10^{-9}	4.4×10^{-4}

GTCC = Greater-Than-Class C, LCF = latent cancer fatality, NTS = Nevada Test Site, RH = remote-handled, TRU = transuranic, WIPP = Waste Isolation Pilot Plant.

[a] Class A low-level radioactive waste transported in Type A B-25 boxes.

[b] Class A low-level radioactive waste transported in 208-liter (55-gallon) drums.

[c] Class B and Class C wastes are transported to NTS in Type A B-25 boxes. Because these wastes have similar external dose rate and could be transported on the same truck or rail, a single radiological accident risk factor that maximizes the hazards is provided.

[d] Remote-handled Class C wastes are transported in 208-liter (55-gallon) drums.

[e] Greater-Than-Class C waste other than fuel and hardware described in footnote g.

[f] For purposes of analysis only, Greater-Than-Class C waste is assumed to be shipped to NTS. Any decision on disposal of WVDP Greater-Than-Class C low-level radioactive waste must await the analysis contained in and decisions resulting from the *Disposal of Greater-Than-Class C Low-Level Radioactive Waste Environmental Impact Statement* (DOE/EIS-0375).

[g] Greater-Than-Class C waste includes the unprocessed irradiated fuel and the hulls and hardware from the processed fuel.

[h] Class B and Class C low-level radioactive wastes are transported to this site in high-integrity containers.

[i] For purposes of analysis only, it is assumed that transuranic waste would be shipped to WIPP. A disposal facility for potential non-defense transuranic waste is currently being evaluated in the *Disposal of Greater-Than-Class C Low-Level Radioactive Waste Environmental Impact Statement* (DOE/EIS-0375).

[j] This site is used as a proxy for shipment of commercial Class B and Class C wastes to a western U.S. disposal facility.

Transportation risks were calculated assuming that wastes are transported using either all rail or all truck. DOE could decide to use a combination of both truck and rail for transporting wastes to any of the disposal site options. Shipments involving a combination of rail and truck for a specific shipment would involve workers who would transfer waste containers from railcars to trucks (or vice versa) at an intermodal station. Based on a study of total risk to workers and population from truck-only transportation and a combination of truck-rail transportation (PNNL 1999), it is estimated that the total dose to workers and public for a combination of rail and truck shipment is less than would occur if the entire transportation occurred on truck. The accident and fatality rates are per truck-kilometer or railcar-kilometer.

Table J–7 provides the estimated number of shipments for various wastes under all alternatives and waste disposal site options. The shipment numbers were calculated using the estimated waste volumes for each waste type as given in Appendix C and summarized in Section 4.1.7 of this EIS, and the waste container and shipment characteristics provided in Table J–2. The shipment numbers are for truck transport of various wastes for the DOE/Commercial Disposal Option (where DOE wastes are disposed of at DOE facilities and commercial wastes are sent to commercial facilities) and the Commercial Disposal Option (where only commercial disposal options were assumed). Some of the wastes would be sent to commercial sites irrespective of the disposal site option considered. In the commercial disposal site option, there is no disposition for transuranic and Greater-Than-Class C wastes; no commercial disposal sites are available for these wastes. As explained earlier, a disposal facility for Greater-Than-Class C low-level radioactive waste and potential non-defense transuranic waste will be determined through the Record of Decision for the *GTCC EIS* (DOE/EIS-0375). However, for purposes of analysis only, in this EIS, it was assumed that these wastes would be transported to NTS and WIPP, respectively.

Both the radiological dose risk factor and nonradiological risk factor for transportation accidents are presented in Table J–6. The radiological and nonradiological accident risk factors are provided in terms of potential fatalities per shipment. The radiological risks are in terms of LCFs. For the population, the radiological risks were calculated by multiplying the accident dose risks by the health risk factor of 6×10^{-4} cancer fatalities per person-rem of exposure. The nonradiological risk factors are non-occupational traffic fatalities resulting from transportation accidents.

As discussed in Section J.6.3, the accident dose is called "dose risk" because the values incorporate the spectrum of accident severity probabilities and associated consequences (e.g., dose). The accident dose risks are very low because accident severity probabilities (i.e., the likelihood of accidents leading to confinement breach of a package or shipping cask and release of its contents) are small, and the content and form of the wastes (solid dirt-like contamination) are such that they would lead to nondispersible and mostly noncombustible release. Although persons reside within an 80-kilometer (50-mile) radius along the transportation route, they are generally quite far from the route. Because RADTRAN 5 uses an assumption of homogeneous population, it would greatly overestimate the actual doses.

Table J–8 shows the risks of transporting radioactive waste under each alternative. In this table, Barnwell is used as an eastern proxy site for disposal of commercial Class B and C wastes. **Table J–9** shows the risks of transporting radioactive wastes under each alternative considering the Hanford Site as a western proxy site for disposal of commercial Class B and C waste. The risks are calculated by multiplying the previously given per-shipment factors by the number of shipments over the duration of the program and, for radiological doses, by the health risk conversion factors. The risks are for the total offsite transport of the radioactive wastes over the entire period under each alternative. Review of the sequence of activities under each alternative indicates that, except for the Sitewide Removal Alternative where activities would constantly generate waste requiring offsite transport over a period of about 60 years, the duration of intensive waste generating activities under other alternatives would be less than 10 years. These activities would occur at the beginning of implementation of the alternatives.

Table J–7 Estimated Number of Truck Shipments Under Each Alternative

Number of Shipments					
DOE/Commercial Disposal Option					
Waste Types	***Assumed Disposal Location***	***Removal Alternative***	***Close-In-Place Alternative***	***Phased Decisionmaking Alternative (Phase 1)***	***No Action Alternative*** [i]
Low specific activity	NTS/EnergySolutions [j]	92,263	831	10,799	151
Class A (B) [a]	NTS/EnergySolutions [j]	8,212	288	1,473	470
Class A (D) [b]	NTS/EnergySolutions [j]	46	5	29	1
Class B and C [c]	NTS/Commercial [j]	924	0	80	0
Class C (RH) [d]	NTS/Commercial [j]	124	34	20	0
Mixed LLW	EnergySolutions	40	28	3	1
GTCC [e]	Nevada Test Site	2,357	0	0	0
Transuranic [f]	Waste Isolation Pilot Plant	477	17	335	0
Hazardous [g]	Local	2	1	1	2
Other [h]	Local	8,881	1,003	2,155	43
Commercial Disposal Option					
Waste Types	***Assumed Disposal Location***	***Removal Alternative***	***Close-In-Place Alternative***	***Phased Decisionmaking Alternative (Phase 1)***	***No Action Alternative*** [i]
Low specific activity	EnergySolutions	92,263	830	10,799	151
Class A (B) [a]	EnergySolutions	8,211	287	1,473	470
Class A (D) [b]	EnergySolutions	46	5	28	1
Class B and C [c]	Commercial	1,075	0	224	0
Class C (RH) [d]	Commercial	124	33	20	0
Mixed LLW	EnergySolutions	40	28	3	1
GTCC [e]	Nevada Test Site	2,357	0	0	0
Transuranic [f]	Waste Isolation Pilot Plant	477	17	335	0
Hazardous [g]	Local	2	1	1	2
Other [h]	Local	8,881	1,003	2,155	43

GTCC = Greater-Than-Class C, LLW = low-level radioactive waste, RH = remote-handled.

[a] Class A low-level radioactive waste transported in Type A B-25 boxes.

[b] Class A low-level radioactive waste transported in 208-liter (55-gallon) drums.

[c] For the purposes of analysis, for the Commercial Disposal Option, all Class B and C contact-handled wastes are assumed to be packaged in high-integrity containers for transport to either an eastern or a western United States disposal site (i.e., Barnwell or Hanford). For the DOE/Commercial Disposal Option, all commercial Class B and C contact-handled wastes are assumed to be packaged in high-integrity containers for transport to either an eastern or a western United States disposal site, while DOE Class B and C contact-handled wastes are assumed to be packaged in Type A B-25 boxes for transport to NTS.

[d] Class C remote-handled wastes packaged in drums or high-integrity containers and transported in Type B casks. Class B wastes packaged in drums are also transported in Type B casks.

[e] For purposes of analysis only, Greater-Than-Class C waste is assumed to be shipped to NTS. Any decision on disposal of WVDP Greater-Than-Class C low-level radioactive waste must await the analysis contained in and decisions resulting from the *Disposal of Greater-Than-Class C Low-Level Radioactive Waste Environmental Impact Statement* (DOE/EIS-0375).

[f] For purposes of analysis only, it is assumed that transuranic waste would be shipped to WIPP. A disposal facility for potential non-defense transuranic waste is currently being evaluated in the *Disposal of Greater-Than-Class C Low-Level Radioactive Waste Environmental Impact Statement* (DOE/EIS-0375).

[g] Hazardous waste would be disposed of at landfills within 160 kilometers (100 miles) of the site.

[h] This includes construction/demolition debris or other wastes that go to local landfills within about 160 kilometers (100 miles) of the site.

[i] Under the No Action Alternative, waste is generated both annually and periodically. Here, for the purposes of comparison to other alternatives, waste shipments are given for monitoring and maintenance activities over a 20-year period, which would continue to recur in 20-year cycles.

[j] DOE waste would go to NTS, or to EnergySolutions, or another appropriate commercial facility. Commercial waste would only go to EnergySolutions or another appropriate commercial facility because commercial wastes cannot be disposed of in a DOE facility.

Note: The values given in this table are for truck shipments. Rail shipments were assumed to be one-half of the number of truck shipments because each rail shipment was assumed to carry twice as much waste as a truck shipment.

Table J–8 Risks of Transporting Radioactive Waste Under Each Alternative [a] (using Barnwell as the eastern U.S. proxy site for commercial Class B and C waste disposal)

Disposal Option	Transport Mode	Number of Shipments	One-way Kilometers Traveled (million)	Incident-Free: Crew Dose (person-rem)	Incident-Free: Crew Risk [b]	Incident-Free: Population Dose (person-rem)	Incident-Free: Population Risk [b]	Accident: Radiological Risk [b]	Accident: Non-radiological Risk [b]
Sitewide Removal Alternative									
DOE/ Commercial	Truck	104,443	356.1	1,578.7	0.95	343.1	0.21	9.3×10^{-4}	9.7
	Rail	52,224	190.2	58.5	0.035	91.3	0.055	3.3×10^{-4}	14.7
Commercial	Truck	104,593	341.1	1,523.2	0.91	313.0	0.19	1.2×10^{-3}	10.2
	Rail	52,299	180.1	54.8	0.033	89.9	0.054	4.2×10^{-4}	14.7
Sitewide Close-In-Place Alternative									
DOE/ Commercial	Truck	1,203	4.3	44.3	0.027	10.5	0.0063	4.2×10^{-7}	0.10
	Rail	604	2.3	1.8	0.0011	2.8	0.0017	1.7×10^{-7}	0.17
Commercial	Truck	1,200	3.9	33.3	0.02	8.5	0.0051	5.6×10^{-7}	0.12
	Rail	602	2.1	1.4	0.00085	2.6	0.0016	2.0×10^{-7}	0.17
Phased Decisionmaking Alternative – Phase 1									
DOE/ Commercial	Truck	12,739	49.6	273.1	0.16	71.5	0.043	9.2×10^{-6}	1.0
	Rail	6,371	27.3	10.9	0.0065	16.3	0.0098	3.4×10^{-6}	1.8
Commercial	Truck	12,882	41.8	265.9	0.16	51.1	0.031	2.4×10^{-4}	1.3
	Rail	6,442	22.0	9.0	0.0054	15.3	0.0092	8.6×10^{-5}	1.8
No Action Alternative [c]									
DOE/ Commercial	Truck	623	2.4	37.8	0.023	11.8	0.0071	2.4×10^{-7}	0.05
	Rail	313	1.4	1.7	0.0010	2.6	0.0016	1.0×10^{-7}	0.09
Commercial	Truck	623	2.0	31.3	0.019	9.8	0.0059	4.3×10^{-7}	0.06
	Rail	313	1.1	1.4	0.0008	2.6	0.0016	1.3×10^{-7}	0.09

[a] For purposes of analysis only, the Greater-Than-Class C and transuranic wastes are assumed to be shipped to NTS and WIPP, respectively. A disposal facility for Greater-Than-Class C low-level radioactive waste and potential non-defense transuranic waste will be evaluated in the *Disposal of Greater-Than-Class C Low-Level Radioactive Waste Environmental Impact Statement* (DOE/EIS-0375).
[b] Risk is expressed in terms of LCFs, except for the nonradiological risk, where it refers to the number of traffic accident fatalities.
[c] Under the No Action Alternative, for the purposes of comparisons to other alternatives, transportation impacts are provided for monitoring and maintenance activities over a 20-year period.
Note: To convert kilometers to miles, multiply by 0.62137.

Tables J–7 and J–8 indicate that the maximum risk is associated with the Sitewide Removal Alternative, followed by Phase 1 of the Phased Decisionmaking Alternative, and the Sitewide Close-In-Place Alternative. The duration of decommissioning activities analyzed for the latter two alternatives is 7 and 8 years, respectively, followed by long-term sitewide monitoring and maintenance for the Close-In-Place Alternative and annual monitoring for 22 years for Phase 1 of the Phased Decisionmaking Alternative. For the Sitewide Close-In-Place Alternative, the long-term maintenance contribution over 53 years[7] following decommissioning activities includes: about 41 percent of shipments, about 17 percent of population dose, 14.5 percent of transportation worker dose, and between 38 and 40 percent of traffic fatalities; this translates to less than 0.002 fatalities per year. In Phase 1 of the Phased Decisionmaking Alternative, the contribution from temporary maintenance would be small.

[7] *For the purposes of analysis, the time period analyzed for the Close-In-Place Alternative is assumed to be 60 years. Long-term monitoring and maintenance (stewardship) would continue in perpetuity with very small annual transportation risks to members of the general public.*

Table J–9 Risks of Transporting Radioactive Waste Under Each Alternative [a] (using the Hanford Site as the western U.S. proxy site for commercial Class B and C waste disposal)

Disposal Option	Transport Mode	Number of Shipments	One-way Kilometers Traveled (million)	Incident-Free				Accident	
				Crew		Population			
				Dose (person-rem)	Risk [b]	Dose (person-rem)	Risk [b]	Radiological Risk [b]	Non-radiological Risk [b]
Sitewide Removal Alternative									
DOE/ Commercial	Truck	104,443	356.8	2,074.5	1.2	369.8	0.22	1.2×10^{-3}	9.7
	Rail	52,224	190.5	65.4	0.039	94.3	0.057	5.4×10^{-4}	14.8
Commercial	Truck	104,593	342.1	2,196.8	1.3	351.9	0.21	1.6×10^{-3}	10.2
	Rail	52,299	180.5	64.7	0.039	94.3	0.057	6.8×10^{-4}	14.8
Sitewide Close-In-Place Alternative									
DOE/ Commercial	Truck	1,203	4.3	48.6	0.029	11.0	0.0066	4.2×10^{-7}	0.10
	Rail	604	2.3	1.9	0.0012	2.8	0.0017	1.5×10^{-7}	0.17
Commercial	Truck	1,200	3.9	45.1	0.027	9.9	0.0060	5.6×10^{-7}	0.12
	Rail	602	2.1	1.4	0.00085	2.6	0.0016	2.0×10^{-7}	0.17
Phased Decisionmaking Alternative – Phase 1									
DOE/ Commercial	Truck	12,739	49.6	273.1	0.16	71.5	0.043	9.2×10^{-6}	1.0
	Rail	6,371	27.3	10.9	0.0065	16.3	0.0098	3.4×10^{-6}	1.8
Commercial	Truck	12,882	42.0	397.0	0.24	58.1	0.035	3.2×10^{-4}	1.3
	Rail	6,442	22.1	10.8	0.0065	16.1	0.0097	1.4×10^{-4}	1.8
No Action Alternative [c]									
DOE/ Commercial	Truck	623	2.4	37.8	0.023	11.8	0.0071	2.4×10^{-7}	0.05
	Rail	313	1.4	1.7	0.0010	2.6	0.0016	1.0×10^{-7}	0.09
Commercial	Truck	623	2.0	31.3	0.019	9.8	0.0059	4.3×10^{-7}	0.06
	Rail	313	1.1	1.4	0.0008	2.6	0.0016	1.3×10^{-7}	0.09

[a] For purposes of analysis only, the Greater-Than-Class C and transuranic wastes are assumed to be shipped to NTS and WIPP, respectively. A disposal facility for Greater-Than-Class C low-level radioactive waste and potential non-defense transuranic waste will be evaluated in the *Disposal of Greater-Than-Class C Low-Level Radioactive Waste Environmental Impact Statement* (DOE/EIS-0375).
[b] Risk is expressed in terms of LCFs, except for the nonradiological risk, where it refers to the number of traffic accident fatalities. Accident dose risk can be calculated by dividing the risk values by 0.0006 (DOE 2003a).
[c] Under the No Action Alternative, for the purposes of comparisons to other alternatives, transportation impacts are provided for monitoring and maintenance activities over a 20-year period.
Note: To convert kilometers to miles, multiply by 0.62137.

The values presented in Tables J–8 and J–9 show that the total radiological risks (the product of consequence and frequency) are very small under all alternatives. It should be noted that the maximum annual dose to a transportation worker would be limited to 100 millirem per year, unless the individual is a trained radiation worker who would have an administrative annual dose limit of 2 rem (DOE 1999).[8] The potential for a trained radiation worker to develop a latent fatal cancer from the maximum annual exposure is 0.0012. Therefore, no individual transportation worker would be expected to develop a latent fatal cancer from exposures during the activities under all alternatives.

[8] *A DOE transportation contractor may choose another dose limit for workers, but this dose is limited to 5 rem per year per 10 CFR 20.1201.*

Nonradiological accident risks (the potential for fatalities as a direct result of traffic accidents) present the greatest risks. Considering that the transportation activities analyzed in this EIS would occur over periods ranging from 7 to 60 years and that the average number of traffic fatalities in the United States is about 40,000 per year (NHTSA 2006), the traffic fatality risk under all alternatives would be very small.

The risks to various exposed individuals under incident-free transportation conditions have been estimated for hypothetical exposure scenarios identified in Section J.5.3. The estimated doses to workers and the public are presented in **Table J–10**. Doses are presented on a per-event basis (person-rem per event, per exposure, or per shipment), as it is generally unlikely that the same person would be exposed to multiple events. For those individuals that could have multiple exposures, the cumulative dose could be calculated. The maximum dose to a crew member is based on the same individual being responsible for driving every shipment for the duration of the campaign. Note that the potential exists for larger individual exposures under one-time events of a longer duration. For example, the dose to a person stuck in traffic next to a shipment of Class B or Class C wastes for 30 minutes is calculated to be 0.026 rem (26 millirem). This is generally considered a one-time event for that individual. This individual may encounter another exposure of a similar or longer duration in his or her lifetime.

Table J–10 Estimated Dose to Maximally Exposed Individuals Under Incident-Free Transportation Conditions

Receptor	*Dose to Maximally Exposed Individual*
Workers	
Crew member (truck/rail driver)	2 rem per year [a]
Inspector	0.062 rem per event per hour of inspection
Rail yard worker	0.018 rem per event
Public	
Resident (along the rail route)	1.9×10^{-6} rem per event
Resident (along the truck route)	9.3×10^{-7} rem per event
Person in traffic congestion	0.026 rem per event per one-half hour of stop
Resident near the rail yard during classification	2.5×10^{-4} rem per event
Person at a rest stop/gas station	2.4×10^{-4} rem per event per hour of stop
Gas station attendant	7.9×10^{-4} rem per event

[a] Maximum administrative dose limit per year for a trained radiation worker (truck/rail crew member). The value could be higher if drivers are radiation workers operating under a Federal or state-licensed program (49 CFR 173.441).

A member of the public residing along the route would likely receive multiple exposures from passing shipments. The cumulative dose to this resident can be calculated assuming all shipments pass his or her home. The cumulative dose is calculated assuming that the resident is present for every shipment and is unshielded at a distance of 30 meters (about 98 feet) from the route. Therefore, the cumulative dose depends on the number of shipments passing a particular point and is independent of the actual route being considered. If one assumes the maximum resident dose provided in Table J–10 for all waste transport types, then the maximum dose to this resident, if all the materials were to be shipped via this route, would be less than 100 millirem. This dose corresponds to that for truck (or rail) shipments under the Sitewide Removal Alternative, which has an estimated number of shipments of about 104,440 (or 52,220) over about 60 years. This dose translates to less than 2 millirem per year, with a risk of developing a latent fatal cancer of less than 6×10^{-5} over the 60-year duration of transport.

The accident risk assessment and the impacts shown in Tables J–8 and J–9 take into account the entire spectrum of potential accidents, from a fender bender to an extremely severe accident. To provide additional insight into the severity of accidents in terms of the potential dose to an MEI and the public, an accident consequence assessment has been performed for a maximum reasonably foreseeable hypothetical transportation accident with a likelihood of occurrence greater than 1 in 10 million per year. The results, presented in Tables J–8 and J–9, include all conceivable accidents, irrespective of their likelihood.

The following assumptions were used to estimate the consequences of maximum reasonably foreseeable offsite transportation accidents:

- The accident is the most severe with the highest release fraction; high-impact and high-temperature fire accident (highest severity category).
- The individual is 100 meters (330 feet) downwind from a ground release accident.
- The individual is exposed to airborne contamination for 2 hours and ground contamination for 24 hours with no interdiction or cleanup. A stable weather condition (Pasquill Stability Class F) with a wind speed of 1 meter per second (2.2 miles per hour) is considered.
- The population is assumed to be a uniform density within an 80 kilometer (50 mile) radius, and exposed to the entire plume passage and 7 days of ground exposure without interdiction and cleanup. A neutral weather condition (Pasquill Stability Class D) with a wind speed of 4 meters per second (8.8 miles per hour) is considered. As the consequence is proportional to the population density, the accident is assumed to occur in an urban[9] area with the highest density (see Table J–1).
- The number of containers involved in the accident is listed in Table J–2. When multiple Type B or shielded Type A shipping casks are transported in a shipment, a single cask is assumed to have failed in the accident. It is unlikely that a severe accident would breach multiple casks.

Table J–11 provides the estimated dose and risk to an individual and population from a maximum foreseeable truck or rail transportation accident with the highest consequences under each alternative and disposal option. Except for the No Action Alternative and Sitewide Close-In-Place Alternative, the highest consequences for the maximum foreseeable accident are from accidents involving Class B/C waste in a high integrity container in a severe impact in conjunction with a long-duration fire. The consequences are driven by the container structural materials, i.e., a poly-hydrocarbon polymer, which in a fire would lead to high airborne releases. Under the No Action and Sitewide Close-In-Place Alternatives, the highest consequences for the maximum foreseeable accident are those involving Class A wastes in boxes.

[9] If the likelihood of accident in an urban area is less than 1-in-10 million per year, then the accident is evaluated for a suburban area.

Table J–11 Estimated Dose to the Population and to Maximally Exposed Individuals Under Most Severe Accident Conditions [a]

Main Disposal Option/ Transport Mode	*Waste Material in the Accident With the Highest Consequences*	*Likelihood of the Accident (per year)*	*Population [b]*		*MEI [c]*	
			Dose (person-rem)	*Risk (LCF)*	*Dose (rem)*	*Risk (LCF)*
Sitewide Removal Alternative						
DOE/Commercial (truck)	Class B and Class C in HIC	1.0×10^{-7}	593	0.356	0.15	9.0×10^{-5}
DOE/Commercial (rail)	Class B and Class C in HIC	3.3×10^{-7}	1,186	0.71	0.30	1.8×10^{-4}
Commercial (truck)	Class B and Class C in HIC	1.3×10^{-7}	593	0.356	0.15	9.0×10^{-5}
Commercial (rail)	Class B and Class C in HIC	4.2×10^{-7}	1,186	0.71	0.30	1.8×10^{-4}
Sitewide Close-In-Place Alternative						
DOE/Commercial (truck) [d]	Class A in Box	3.8×10^{-7}	0.020	1.2×10^{-5}	3.6×10^{-5}	2.2×10^{-8}
DOE/Commercial (rail) [d, e]	Class A in Box	4.2×10^{-8}	0.054	3.2×10^{-5}	7.2×10^{-5}	4.3×10^{-8}
Commercial (truck) [d]	Class A in Box	8.7×10^{-7}	0.020	1.2×10^{-5}	3.6×10^{-5}	2.2×10^{-8}
Commercial (rail) [d, e]	Class A in Box	6.5×10^{-8}	0.054	3.2×10^{-5}	7.2×10^{-5}	4.3×10^{-8}
Phased Decisionmaking Alternative – Phase 1						
DOE/Commercial (truck) [d]	Class B and Class C in Box	1.3×10^{-7}	6.13	0.0037	0.011	6.6×10^{-6}
DOE/Commercial (rail) [d, e]	Class B and Class C in Box	1.4×10^{-8}	16.4	0.0098	0.022	1.3×10^{-5}
Commercial (truck)	Class Band Class C in HIC	1.4×10^{-7}	593	0.356	0.15	9.0×10^{-5}
Commercial (rail)	Class B and Class C in HIC	4.6×10^{-7}	1,186	0.71	0.30	1.8×10^{-4}
No Action Alternative						
DOE/Commercial (truck) [d]	Class A in Box	3.2×10^{-7}	0.020	1.2×10^{-5}	3.6×10^{-5}	2.2×10^{-8}
DOE/Commercial (rail) [d, e]	Class A in Box	3.4×10^{-8}	0.054	3.2×10^{-5}	7.2×10^{-5}	4.3×10^{-8}
Commercial (truck) [d]	Class A in Box	5.8×10^{-7}	0.020	1.2×10^{-5}	3.6×10^{-5}	2.2×10^{-8}
Commercial (rail) [d, e]	Class A in Box	4.3×10^{-8}	0.054	3.2×10^{-5}	7.2×10^{-5}	4.3×10^{-8}

HIC = high-integrity container, LCF = latent cancer fatality, MEI = maximally exposed individual.

[a] The frequencies are based on using a western U.S. disposal site for commercial Class B and Class C wastes. If Barnwell is used, the frequencies would be equal to, or smaller than those given in this table.

[b] Population extends at a uniform density to a radius of 80 kilometers (50 miles). The weather condition was assumed to be Pasquill Stability Class D with a wind speed of 4 meters per second (8.8 miles per hour). Unless otherwise noted, the population doses and risks are presented for an urban area on the transportation route.

[c] The MEI was assumed to be 100 meters (300 feet) downwind from the accident and exposed to the entire plume of the radioactive release. The weather condition was assumed to be Pasquill Stability Class F with a wind speed of 1 meter per second (2.2 miles per hour).

[d] Population dose and risk are for a suburban area along the route. The probability of a maximum foreseeable accident in an urban area along the transportation route is less than 10^{-7} per year.

[e] This accident would have a likelihood of less than 1 in 10 million. It is only provided for completeness.

J.8 Impact of Construction and Operational Material Transport

This section evaluates the impacts of transporting construction/demolition debris and hazardous wastes as well as materials required to construct new facilities, barriers, and erosion controls. The construction materials considered are concrete, cement, sand/gravel/dirt, asphalt, geomembrane fabric, steel, and piping. The impacts were evaluated based on the number of truck shipments required for each of the materials and the distances from their point of origin to the WNYNSC. The origins of these materials were assumed to be at an average distance of 160 kilometers (100 miles) from the site. The truck kilometers for all material shipments under each alternative were calculated by summing all of the activities from construction through closure (where applicable). The truck accident and fatality rates were assumed to be those that were provided earlier for the onsite and local area transports. **Table J–12** summarizes the impacts in terms of total number of kilometers, accidents, and fatalities for all alternatives. The results indicate that there are no large differences in the impacts among all alternatives. Under all alternatives, the expected potential traffic fatalities are very low.

Table J–12 Estimated Impacts of Construction and Operational Material Transport

Alternative	*Total Distance Traveled (kilometers)*	*Number of Accidents*	*Number of Fatalities*
Sitewide Removal	57.8×10^6	19.9	0.7
Sitewide Close-In-Place	95.2×10^6	32.8	1.2
Phased Decisionmaking (Phase 1)	8.2×10^6	2.8	0.1
No Action	0.014×10^6	0.005	0.0002

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

J.9 Conclusions

Based on the results presented in the previous section, the following conclusions have been reached (see Tables J–6 and J–9 through J–11):

- It is unlikely that the transportation of radioactive waste would cause an additional fatality as a result of radiation, either from incident-free operation or postulated transportation accidents.
- The highest risk to the public would be under the Sitewide Removal Alternative, NTS Disposal Site Option, where about 104,440 truck or 52,220 rail shipments of radioactive wastes would be transported to Hanford and other commercial (i.e., EnergySolutions and a western U.S. site) and Government (i.e., assumed, for analysis only, to be WIPP and NTS) disposal sites.
- The lowest risk to the public would be under the Sitewide Close-In-Place Alternative, Commercial Disposal Site Option, where about 1,200 truck or 600 rail shipments of radioactive wastes would be transported to commercial (i.e., EnergySolutions and a western U.S. site) disposal sites.
- The nonradiological accident risks (the potential for fatalities as a direct result of traffic or rail accidents) present the greatest risks. The maximum risks would occur under the Sitewide Removal Alternative using rail shipments. Considering that the transportation activities would occur over a period of time from about 10 to 60 years and that the average number of traffic fatalities in the United States is about 40,000 per year, the traffic fatality risks under all alternatives are very small.

J.10 Long-term Impacts of Transportation

The *Yucca Mountain EIS* (DOE 2002a, 2008) analyzed the cumulative impacts of the transportation of radioactive material, consisting of impacts of historical shipments of radioactive waste and spent nuclear fuel, reasonably foreseeable actions that include transportation of radioactive material, and general radioactive material transportation that is not related to a particular action. The collective dose to the general population and workers was the measure used to quantify cumulative transportation impacts. This measure of impact was chosen because it may be directly related to the LCFs using a cancer risk coefficient. **Table J–13** provides a summary of the total worker and general population collective doses from various transportation activities. The table shows that the impacts of this program are quite small compared with the overall transportation impacts. The total collective worker dose from all types of shipments (historical, the alternatives, reasonably foreseeable actions, and general transportation) was estimated to be about 380,500 person-rem (228 LCFs) for the period 1943 through 2073 (131 years). The total general population collective dose was estimated to be about 349,600 person-rem (210 LCFs). The majority of the collective dose for workers and the general population was due to the general transportation of radioactive material. Examples of these activities are shipments of radiopharmaceuticals to nuclear medicine laboratories and shipments of commercial low-level radioactive waste to commercial disposal facilities. The total number of LCFs (among the workers and the general population) estimated to result from radioactive material transportation over the period between 1943 and 2073 is about 440, or an average of about 4 LCFs per year. Over this same period (131 years), approximately 73 million people would die from cancer, based on the National Center for Heath Statistics data. The average annual number of cancer deaths in the United States is about 554,000, with less than 1 percent fluctuation in the number of cancer fatalities in any given year (CDC 2007). The transportation-related LCFs would be 0.0006 percent of the total number of LCFs; therefore, it is indistinguishable from the natural fluctuation in the total annual death rate from cancer.

Table J–13 Cumulative Transportation-related Radiological Collective Doses and Latent Cancer Fatalities (1943 to 2047)

Category	*Collective Worker Dose (person-rem)*	*Collective General Population Dose (person-rem)*
Transportation Impacts in this EIS	2,197 [a]	370 [a]
Other Nuclear Material Shipments		
Historical	330	230
Reasonably Foreseeable Actions	28,000	49,000
General Radioactive Material Transport (1943 to 2073)	350,000	300,000
Total Collective Dose [b] (up to 2073)	380,500	349,600
Total Latent Cancer Fatalities [c]	228	210

[a] Maximum values from Table J–9.
[b] The values are rounded to the nearest hundred.
[c] Total LCFs are calculated assuming 0.0006 LCFs per rem of exposure.
Sources: DOE 2002a, 2008.

J.11 Uncertainty and Conservatism in Estimated Impacts

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

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

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

J.11.1 Uncertainties in Material Inventory and Characterization

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

Uncertainties in the inventory and characterization are reflected in the transportation risk results. If the inventory is overestimated (or underestimated), the resulting transportation risk estimates are also overestimated (or underestimated) by roughly the same factor. However, the same inventory estimates are used to analyze the transportation impacts of each of the alternatives. Therefore, for comparative purposes, the observed differences in transportation risks among the alternatives, as given in Tables J–8 and J–9, are believed to represent unbiased, reasonably accurate estimates from current information in terms of relative risk comparisons.

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

The transportation required for each alternative is based in part on assumptions concerning the packaging characteristics and shipment capacities for commercial trucks. Representative shipment capacities have been defined for assessment purposes based on probable future shipment capacities. In reality, the actual shipment capacities may differ from the predicted capacities such that the projected number of shipments and, consequently, the total transportation risk, would change. However, although the predicted transportation risks would increase or decrease accordingly, the relative differences in risks among alternatives would remain about the same.

J.11.3 Uncertainties in Route Determination

Analyzed routes have been determined between all origin and destination sites considered in this EIS. The routes have been determined to be consistent with current guidelines, regulations, and practices, but may not be the actual routes that would be used in the future. In reality, the actual routes could differ from the representative ones with regard to distances and total population along the routes. Moreover, because materials could be transported over an extended time starting at some time in the future, the highway infrastructure and the demographics along routes could change. These effects have not been accounted for in the transportation assessment; however, it is not anticipated that these changes would significantly affect relative comparisons of risk among the alternatives considered in this EIS. Specific routes cannot be identified in advance because the routes are classified to protect national security interests.

J.11.4 Uncertainties in the Calculation of Radiation Doses

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

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

J.11.5 Uncertainties in Traffic Fatality Rates

Vehicle accident and fatality rates were taken from data provided in *State-Level Accident Rates for Surface Freight Transportation: A Reexamination*, ANL/ESD/TM-150 (Saricks and Tompkins 1999). Truck and rail accident rates were computed for each state based on statistics compiled by the Federal Highway Administration, Office of Motor Carriers and Federal Railroad Administration, from 1994 to 1996. The rates are provided per unit car-kilometers for each state, as well as national, average and mean values. In this analysis route-specific (origin-destination) rates were used.

The accident statistics in the Saricks and Tompkins report indicate large variations among the state-level accident data. For rail, the state-level fatality rates range between 0.0 to 1.3×10^{-6} with national mean, average, and median values of 7.8×10^{-8}, 2.1×10^{-8}, and 2.3×10^{-8} per car-kilometer, respectively. The route-specific rates, analyzed in this EIS, range between 1.3×10^{-8} and 2.5×10^{-8}. These data show that, depending on the selection of data, mean versus route-specific or median versus route-specific, the fatality rate could vary by, at most, a factor of 3. Recent analysis of rail accident fatality rates for the years 2000 through 2004 indicates a national average value of 1.15×10^{-8} per rail car (DOE 2008). This new value indicates a reduction in fatality rates compared to the average value for the years 1994 through 1996.

For truck, the state-level interstate fatality rates range between 0.0 to 1.7×10^{-8}, with national mean, average, and median values of 8.8×10^{-9}, 9.6×10^{-9}, and 9.2×10^{-9} per car-kilometer, respectively. The route-specific rates, analyzed in this EIS, range between 8.0×10^{-9} and 1.6×10^{-8}. These data show that route-specific rates are within the range of the state-level, and the same order of magnitude as that of the national, mean values.

Finally, it should be emphasized that the analysis was based on accident data for the years 1994 through 1996. While these data may be the best available data, subsequent and future accident and fatality rates may change as a result of vehicle and highway improvements. The recent DOT national accident and fatality statistics for large trucks and buses indicate lower accident and fatality rates for recent years as compared to those of 1994 through 1996 and earlier statistics data (DOT 2009).

J.12 References

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APPENDIX K
METHOD FOR ESTIMATING NONRADIOLOGICAL AIR QUALITY IMPACTS

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K.1 Introduction

This appendix presents the methodology used to estimate nonradiological air quality concentrations for each alternative evaluated in this environmental impact statement (EIS). Air quality impacts were assessed by estimating onsite and offsite concentrations of criteria pollutants and toxic air pollutants of environmental concern and comparing them to Federal and state health-based ambient air quality standards. Sources for potential air quality impacts include particulate matter (PM) generated by onsite activities and combustion product releases from operating construction equipment and other equipment and vehicles. The extent of the activities and modeled results varies among the alternatives, with the highest peak year emissions under the Sitewide Close-In-Place Alternative for most pollutants, and the lowest peak year emissions under the No Action or Phased Decisionmaking Alternatives.

Ambient air quality monitoring is conducted in the region to demonstrate that air emissions do not result in violation of the ambient air quality standards. The State of New York has adopted ambient air quality standards for carbon monoxide, sulfur dioxide, and nitrogen dioxide comparable to the National Ambient Air Quality Standards (NAAQS) set by the U.S. Environmental Protection Agency (EPA) to protect public health and welfare. In addition, the state has adopted ambient standards for suspended particulates, settleable particulates, nonmethane hydrocarbons, fluorides, beryllium, and hydrogen sulfide. The state uses the annual standard for suspended particulates (PM with an aerodynamic diameter less than or equal to 10 micrometers [PM_{10}]) of 45 micrograms per cubic meter for prediction purposes. The state has not yet adopted the 8-hour ozone standard or the $PM_{2.5}$ (PM with an aerodynamic diameter less than or equal to 2.5 micrometers) standard. For the purpose of analysis, the more restrictive of the Federal and state ambient standards, as shown in **Table K–1,** is used for assessing compliance and potential for impacts on public health and welfare (40 *Code of Federal Regulations* [CFR] 50, 6 New York Code of Rules and Regulations [NYCRR] Part 257). The Western New York Nuclear Service Center (WNYNSC) and the surrounding area in Cattaraugus County are in attainment for all regulated pollutants as described in Chapter 3, except for the northern portion of WNYNSC in Erie County, which is classified as nonattaining for the ozone 8-hour standard. The city of Buffalo, located about 48 kilometers (30 miles) from WNYNSC, and Erie and Niagara Counties are designated as nonattainment areas for ozone (8-hour averaging). The NAAQS are health-based and generally require that short-term (1 to 24 hours) and annual average concentrations of certain common criteria pollutants do not exceed specified levels. These levels were established at concentrations EPA has determined are "necessary, with an adequate margin of safety, to protect the public health" (40 CFR Part 50.2, "National Primary and Secondary Ambient Air Quality Standards"). These standards, or more-restrictive state standards, were used as a basis for comparing the nonradiological air impacts of implementing each alternative.

Five nonradiological air pollutants are of potential concern under the alternatives: nitrogen dioxide, sulfur dioxide, PM_{10}, $PM_{2.5}$, and carbon monoxide. Lead would be produced in such small quantities under the alternatives considered that it was not considered in this analysis. Ozone is not directly emitted, but results from emissions of precursor pollutants, including nitrogen dioxide and volatile organic compounds. These pollutants are quantified in this analysis, and nitrogen dioxide is evaluated separately. In addition to the criteria pollutants of concern, toxic pollutants, including benzene, toluene, xylene, and other pollutants, are emitted from diesel- and gasoline-fueled equipment. For the purpose of this EIS, benzene was evaluated as one of the primary toxic pollutants from gasoline equipment. To evaluate the effect of activities on ambient air quality, the following criteria pollutants were modeled using the EPA dispersion model Industrial Source Complex

Short Term 3 (ISCST3): carbon monoxide, nitrogen dioxide, PM_{10}, $PM_{2.5}$, and sulfur dioxide (EPA 1995, 2002, 2003a). Concentrations of benzene were also modeled. Modeling results presented in this appendix are derived from emission estimates for the alternatives based on information in the technical reports prepared for each alternative and regional and site-specific meteorological data. Emissions reported in the technical reports represent a conservative (worst-case) estimate for compiling emissions during closure because it was assumed that no mitigative measures to control emissions would be used, except 75 percent control of fugitive dust on unpaved roads using chemical controls and water sprays (EPA 2006). Generally, the use of mitigative control measures during excavation, grading, and construction can reduce fugitive dust and PM_{10} emissions by as much as 80 percent (EPA 2003b). The emissions inventory included fugitive dust as total suspended particulates. It was assumed 36 percent of total suspended particulates could be considered to be PM_{10} (EPA 2006) for the fugitive dust component of the emissions inventory, and that 15 percent of PM_{10} was $PM_{2.5}$ (MRI 2006).

Table K–1 Applicable Ambient Air Quality Standards

Pollutant	*Averaging Period*	*Most Stringent Standard [a] (micrograms per cubic meter)*
Carbon monoxide	8-hour 1-hour	10,000 [b] 40,000 [b]
Nitrogen dioxide	Annual	100 [b]
PM_{10} [c]	Annual 24-hour	45 [d] 150 [b]
$PM_{2.5}$	Annual 24-hour	15 [e] 35 [e]
Sulfur dioxide	Annual 24-hour [f] 3-hour [f]	80 [b] 365 [b] 1,300 [b]
Benzene	Annual 1-hour	0.13 [g] 1,300 [g]

PM_{10} = particulate matter less than or equal to 10 micrometers in diameter, $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter.

[a] The more stringent of the Federal and New York State standards is presented if both exist for the averaging period. The NAAQS (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the standard is not exceeded more than once per year over a 3-year average. The annual $PM_{2.5}$ standard is attained when the 3-year average of the weighted annual mean concentration does not exceed the standard. The 24-hour $PM_{2.5}$ standard is attained when the 3-year average of the 98th percentile of the 24-hour concentrations does not exceed the standards. The 8-hour ozone standard is met when the average of the annual fourth-highest daily maximum 8-hour average concentration is less than or equal to the standard (40 CFR 50).

[b] Federal and New York State standard.

[c] New York State also has particulate matter (PM_{10}) standards, applicable to this area, for 30-, 60-, and 90-day averaging periods of 80, 70, and 65 micrograms per cubic meter, respectively, but assesses the prediction of conformity on the annual average concentration.

[d] New York State standard.

[e] Federal standard.

[f] New York State also has 3- and 24-hour standards for sulfur dioxide, which are met when 99 percent of the concentrations during a year do not exceed the standard value. For the purpose of assessing predicted conformity, the state considers meeting the standards shown (not to be exceeded more than once per year) to be adequate.

[g] New York State air toxic guidance.

Sources: 40 CFR 50, 6 NYCRR 257, NYSDEC 2003.

Emissions were estimated for shipment of waste and other materials for each alternative based on the number of shipments, total travel distances, and emission factors for heavy-duty diesel trucks. The emission factors were calculated using EPA's MOBILE 6.2 vehicle emission factor model (EPA 2003c). These calculations were based on the higher of the truck shipment numbers presented in Chapter 4, Section 4.1.12, of this EIS.

Emissions for rail shipment were not calculated because the fuel efficiency of rail shipments is higher than truck shipments, being on average approximately three or more times more fuel efficient than trucks (AAR 2008). Thus, the corresponding emissions from rail shipments on a ton-mile basis would be expected to be less than the truck shipments reported in this EIS by a factor of three or more.

K.2 Model Description

A dispersion modeling approach using ISCST3 (EPA 1995, 2002) was used to estimate nonradiological pollutant (i.e., carbon monoxide, nitrogen dioxide, PM_{10}, $PM_{2.5}$, sulfur dioxide, and benzene) concentrations at the WNYNSC boundary and along public roads through WNYNSC (see Chapter 3, Figure 3–2, of this EIS for the boundary and nearby roads). Emission rates by pollutant, activity, and year were used to estimate maximum concentrations. The ISCST3 is an EPA dispersion model applicable to areas in complex terrain. U.S. Geological Survey Digital Elevation Model data for the region were used to determine receptor elevations for a polar grid having 16 compass directions (22.5 degrees from north through 360 degrees) at 5 different radial distances (1.6, 3.2, 4.8, 6.4, and 8.0 kilometers [1, 2, 3, 4, and 5 miles]) from the center of the grid. The center of the grid was chosen to be a point centrally located in the West Valley Demonstration Project (WVDP) and was located near the southwest corner of Waste Management Area (WMA) 2. In addition, elevations were determined for special receptors in each direction at the nearest public access (road) and at the WNYNSC boundary. **Tables K–2** and **K–3** summarize the direction, distance, and elevation of each modeled receptor location (directions for the polar grid are shown in **Figure K–1** for reference). The use of the elevation data is discussed in the *ISCST3 User's Guide* (EPA 1995). Where there is elevated simple terrain, the ISCST3 model assumes the mixing height follows the terrain, and the plume stays at the same elevation. The wind speed is a function of height above the surface. Initial runs were made that indicated that the maximum concentrations would occur at the roadway receptors or the WNYNSC boundary. Therefore, concentration runs for each pollutant and alternative were made only for the roadway and WNYNSC boundary receptors.

Table K–2 Elevations at Polar Grid Receptors for ISCST3 Modeling (meters)

Compass Orientation		*Downwind Distance*				
Heading	***Direction***	***1,600***	***3,200***	***4,800***	***6,400***	***8,000***
22.5º	NNE	402	434	391	364	408
45.0º	NE	421	497	486	434	424
67.5º	ENE	440	498	481	518	570
90.0º	E	458	472	479	546	629
112.5º	ESE	426	434	566	540	605
135.0º	SE	422	412	443	561	627
157.5º	SSE	438	442	579	527	603
180.0º	S	462	581	546	610	588
202.5º	SSW	537	557	581	522	590
225.0º	SW	516	533	426	552	538
247.5º	WSW	538	494	414	452	492
270.0º	W	527	476	388	421	469
292.5º	WNW	474	422	409	395	329
315.0º	NW	460	413	389	410	410
337.5º	NNW	412	372	399	420	441
360.0º	N	360	414	363	418	423

ISCST3 = Industrial Source Complex Short Term 3.
Note: To convert meters to feet, multiply by 3.2808.

Table K–3 Elevations at Special Receptor Locations for ISCST3 Modeling (meters)

Compass Orientation		*Nearest Public Access* [a]		*Service Center Fence Line*	
Heading	***Direction***	***Distance***	***Elevation***	***Distance***	***Elevation***
22.5º	NNE	1,067	369	1,638	409
45.0º	NE	914	373	1,372	421
67.5º	ENE	838	378	1,753	421
90.0º	E	991	378	2,286	457
112.5º	ESE	1,105	386	2,438	436
135.0º	SE	1,181	419	2,629	421
157.5º	SSE	914	423	2,515	500
180.0º	S	838	434	2,286	494
202.5º	SSW	495	439	2,248	530
225.0º	SW	381	442	2,210	555
247.5º	WSW	381	445	1,676	536
270.0º	W	457	427	1,524	524
292.5º	WNW	610	439	1,295	476
315.0º	NW	1,372	442	1,524	451
337.5º	NNW	1,905	375	1,905	375
360.0º	N	1,295	369	2,248	396

ISCST3 = Industrial Source Complex Short Term 3.
[a] Although receptors were included along the rail line (receptors in direction NNW through ESE) they were not included in the analysis of short-term concentrations, since this rail line is not in use by the public.
Note: To convert meters to feet, multiply by 3.2808.

The input parameters for ISCST3 include hourly meteorological data, upper air data, receptor location, terrain elevation, emission rate, and source location. Site-specific data for the period 1998 through 2002 were obtained from the onsite meteorological station. This was the most recent data set available when the analysis was begun and is considered to be representative of the site. Upper air data (twice-daily mixing heights) were obtained for the Buffalo National Weather Service Station for 1998 through 2002. The surface and upper air data sets were preprocessed using an EPA code, Meteorological Processor for Regulatory Models (EPA 1996, 1999), to format the data for use in ISCST3.

The mixing height data are derived values, presented twice daily, and were obtained from the National Climatic Data Center, Asheville, North Carolina. The Buffalo station was selected because it is most representative of the WNYNSC location (latitude and longitude) and station elevation.

Values for total emissions by alternative by year were calculated using data from the technical reports (WSMS 2009a–d). These emission estimates were calculated using EPA emission factors as discussed in the technical reports (WSMS 2009e). Emission rates were annualized and converted to grams per second for each alternative. For the purpose of analysis, it was assumed that the work schedule included an 8-hour workday, a 7-day workweek, and 52 workweeks per year. If the activities were to be conducted over only a 5-day workweek, this would result in concentrations 40 percent higher. Annual emissions by alternative used as input to the modeling are summarized in **Table K–4**. Annual emissions for similar activities that occur under more than one alternative vary as a result of the duration of the activity under each alternative. Descriptions of the activities as they would occur under each alternative are provided in Chapter 2 of this EIS. To conservatively estimate impacts, it was assumed that all implementation actions during each year would occur simultaneously.

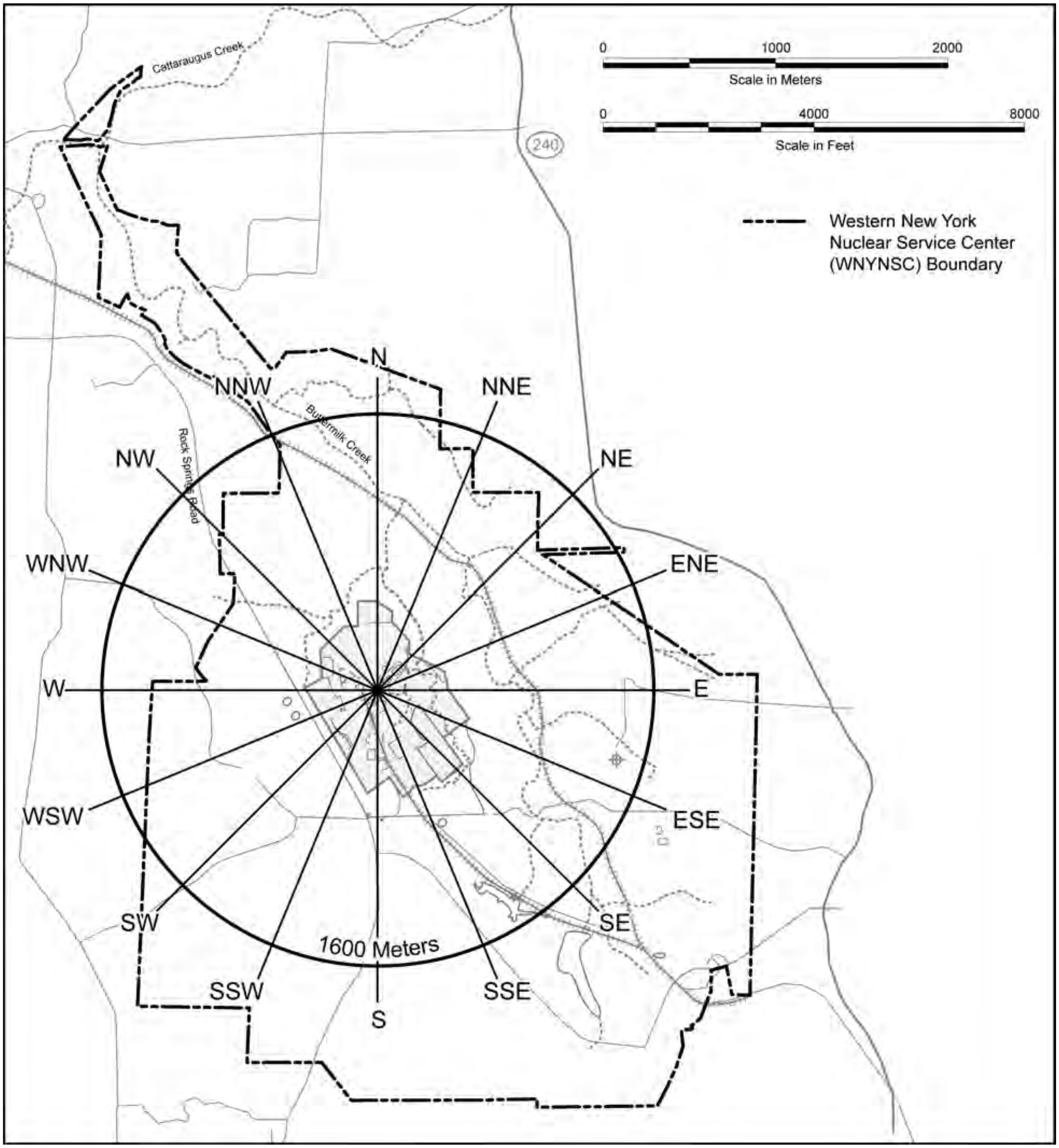

Figure K–1 Directions for Polar Grid

Table K–4 Emissions in Tons Per Year by Alternative

Activities for Each Alternative	*Period*		*Emissions*						
	Start Year	*End Year*	*Carbon Monoxide (tons per year)*	*Nitrogen Dioxide (tons per year)*	*PM_{10} (tons per year)*	*$PM_{2.5}$ (tons per year)*	*Sulfur Dioxide (tons per year)*	*Benzene (tons per year)*	*Nonmethane Hydrocarbons (tons per year)*
Sitewide Removal Alternative									
High-level Radioactive Waste Canister Removal – Construction of Dry Cask Storage Area	4	5	0.51	0.71	0.27	0.06	< 0.01	< 0.01	0.09
High-level Radioactive Waste Canister Removal – Load-In/Load-Out Modification and Operation	4	5	0.27	0.32	0.02	0.02	< 0.01	< 0.01	0.02
High-level Radioactive Waste Canister Removal – Operation of Dry Cask Storage Area	5	35	0.03	0.04	0.00	0.00	< 0.01	< 0.01	0.00
High-level Radioactive Waste Canister Removal – Demolition of Dry Cask Storage Area	36	38	0.2	0.34	0.19	0.04	< 0.01	< 0.01	0.06
WMA 1 Closure – Surface Structure Removal	5	11	4.6	3.34	4.51	0.82	0.01	< 0.01	0.66
WMA 1 Closure – Subsurface Soil Removal	11	15	0.58	0.86	2.23	0.38	< 0.01	< 0.01	0.11
WMA 2 Closure	56	58	1.27	1.9	1.72	0.35	0.01	< 0.01	0.24
WMA 3 Removal of Surface Structures	20	20	0.84	1.13	1.47	0.26	< 0.01	< 0.01	0.17
WMA 3 Closure – WTF WPF Construction	15	20	3.54	1.43	0.33	0.13	< 0.01	< 0.01	0.25
WMA 3 Closure – WTF WPF Operation	20	39	0.8	0.97	0.07	0.07	0.01	< 0.01	0.06
WMA 3 Closure – WTF WPF Demolition	40	47	1.03	2.12	1.66	0.33	< 0.01	< 0.01	0.43
WMA 4 Closure	56	59	0.1	0.25	0.31	0.06	< 0.01	< 0.01	0.03
WMA 5 Closure	59	59	4.59	2.23	3.43	0.6	< 0.01	< 0.01	0.46
WMA 6 Closure	59	59	0.24	0.32	0.74	0.12	< 0.01	< 0.01	0.05
Leachate Treatment Facility Construction	1	3	0.23	0.05	0.01	0.0	< 0.01	< 0.01	0.01
Leachate Treatment Facility Operation	4	52	0.07	0.08	0.01	0.01	< 0.01	< 0.01	< 0.01
Leachate Treatment Facility Closure	53	53	0.59	0.26	0.1	0.03	< 0.01	< 0.01	0.04
Container Management Facility Construction	1	3	13.5	2.78	0.41	0.23	0.01	0.02	0.61
Container Management Facility Operation	4	52	0.64	0.81	0.06	0.06	< 0.01	< 0.01	0.06
Container Management Facility Closure	53	56	2.9	1.08	1.02	0.2	< 0.01	< 0.01	0.19
WMA 7 Closure – Surface Structure Removal	1	1	0.1	0.11	2.78	0.42	< 0.01	< 0.01	0.02
WMA 7 Closure – Interceptor Trench Excavation	1	1	0.06	0.13	0.34	0.06	< 0.01	< 0.01	0.02
WMA 7 Closure – NDA EE Construction	1	3	4.54	1.15	0.09	0.08	< 0.01	0.01	0.22
WMA 7 Closure – WVDP Area EE Construction	3	4	0.24	0.59	0.09	0.03	< 0.01	< 0.01	0.13
WMA 7 Closure – NDA MSEE Construction	4	21	0.04	0.07	0.0	0.0	< 0.01	< 0.01	0.01
WMA 7 Closure – NDA Excavation/Backfill	4	21	0.57	0.72	0.2	0.07	< 0.01	< 0.01	0.06
WMA 7 Closure – WVDP Area EE Demolition	21	25	0.16	0.26	0.6	0.1	< 0.01	< 0.01	0.04

Activities for Each Alternative	Period		Emissions						
	Start Year	End Year	Carbon Monoxide (tons per year)	Nitrogen Dioxide (tons per year)	PM_{10} (tons per year)	$PM_{2.5}$ (tons per year)	Sulfur Dioxide (tons per year)	Benzene (tons per year)	Nonmethane Hydrocarbons (tons per year)
WMA 7 Closure – NDA EE Demolition	21	25	9.53	1.21	0.8	0.21	< 0.01	0.01	0.28
WMA 8 Closure – Surface Structure Removal	21	21	0.37	0.16	0.04	0.01	< 0.01	< 0.01	0.02
WMA 8 Closure – South SDA EE Construction	26	31	4.36	1.03	4.12	0.68	< 0.01	0.01	0.2
WMA 8 Closure – North SDA EE Construction	19	21	6.3	1.57	3.23	0.57	< 0.01	0.01	0.30
WMA 8 Closure – SDA MSEE Construction	22	52	0.08	0.15	0.01	0.01	< 0.01	< 0.01	0.03
WMA 8 Closure – Lagoon Confinement Construction	22	23	2.47	0.62	0.06	0.04	< 0.01	< 0.01	0.12
WMA 8 Closure – SDA Waste Excavation	22	52	0.85	1.06	0.36	0.12	0.01	< 0.01	0.07
WMA 8 Closure – Lagoon Confinement Demolition	36	39	4.44	0.54	0.18	0.07	< 0.01	0.01	0.13
WMA 8 Closure – North SDA EE Demolition	36	45	6.28	0.86	0.91	0.2	< 0.01	0.01	0.2
WMA 8 Closure – South SDA EE Demolition	52	56	17.7	2.31	0.36	0.22	0.01	0.02	0.54
WMA 9 Closure	1	1	0.63	1.51	1.22	0.24	< 0.01	< 0.01	0.25
WMA 10 Closure	59	59	0.36	0.85	8.45	1.29	< 0.01	< 0.01	0.13
WMA 11 Closure	59	59	0.1	0.22	0.31	0.05	< 0.01	< 0.01	0.03
WMA 12 Closure	59	60	1.2	1.62	2.16	0.39	< 0.01	< 0.01	0.21
Soil Drying Facility Construction	8	10	0.82	0.94	7.68	1.19	< 0.01	< 0.01	0.17
Soil Drying Facility Operation (also years 48-55)	11	15	0.76	0.98	1.35	0.26	0.01	< 0.01	0.07
Soil Drying Facility Closure	56	58	9.45	1.22	1.45	0.3	< 0.01	0.01	0.28
North Plateau Groundwater Plume	48	55	0.54	1.69	16.4	2.5	< 0.01	< 0.01	0.26
Cesium Prong	55	58	0.32	0.51	1.64	0.27	< 0.01	< 0.01	0.05
Monitoring and Maintenance	1	58	0.33	0.28	0.01	0.01	< 0.01	< 0.01	0.01
Security	1	60	0.36	0.31	0.02	0.02	< 0.01	< 0.01	0.02
Sitewide Close-In-Place Alternative									
High-level Radioactive Waste Canister Removal – Construction of Dry Cask Storage Area	1	1	1.02	1.42	0.54	0.12	< 0.01	< 0.01	0.18
High-level Radioactive Waste Canister Removal – Load-In/Load-Out Modification and Operation	1	2	0.27	0.32	0.03	0.03	< 0.01	< 0.01	0.02
High-level Radioactive Waste Canister Removal – Operation of Dry Cask Storage Area	3	32	0.03	0.04	0.00	0.00	< 0.01	< 0.01	< 0.01
High-level Radioactive Waste Canister Removal – Demolition of Dry Cask Storage Area	33	33	0.51	0.88	0.05	0.05	< 0.01	< 0.01	0.18
WMA 1 Closure	1	7	3.62	2.03	2.08	0.4	0.01	< 0.01	0.41
WMA 2 Closure	3	5	0.49	0.92	7.29	1.12	< 0.01	< 0.01	0.13
WMA 3 Surface Structure Removal	2	2	0.59	1.05	1.12	0.21	< 0.01	< 0.01	0.13
WMA 3 Grouting Operations	3	5	0.08	0.15	0.25	0.04	< 0.01	< 0.01	0.03

Activities for Each Alternative	Period		Emissions						
	Start Year	***End Year***	***Carbon Monoxide (tons per year)***	***Nitrogen Dioxide (tons per year)***	***PM_{10} (tons per year)***	***$PM_{2.5}$ (tons per year)***	***Sulfur Dioxide (tons per year)***	***Benzene (tons per year)***	***Nonmethane Hydrocarbons (tons per year)***
North Plateau Cap Construction	5	7	1.09	1.89	9.32	1.45	< 0.01	< 0.01	0.29
WMA 4 Closure	1	6	0.00	0.00	0.00	0.00	< 0.01	0.0	0.00
WMA 5 Closure	7	7	0.59	1.6	0.5	0.12	< 0.01	< 0.01	0.36
WMA 6 Closure	7	7	0.14	0.08	0.13	0.02	< 0.01	< 0.01	0.01
WMA 6 Leachate Treatment Facility Construction	1	1	0.69	0.16	0.02	0.02	< 0.01	< 0.01	0.03
WMA 6 Leachate Treatment Facility Operation	2	6	0.64	0.76	0.06	0.06	< 0.01	< 0.01	0.04
WMA 6 Leachate Treatment Facility Closure	6	6	0.59	0.26	0.1	0.03	< 0.01	< 0.01	0.04
WMA 7 Closure	2	6	3.17	1.67	6.83	1.08	< 0.01	< 0.01	0.31
WMA 8 Closure	2	6	16.7	6.12	54.7	8.45	0.01	0.02	1.28
WMA 9 Closure	1	1	0.53	1.33	1.13	0.21	< 0.01	< 0.01	0.23
WMA 10 Closure	7	7	0.06	0.22	0.1	0.02	< 0.01	< 0.01	0.03
WMA 12 Closure	7	7	0.02	0.09	0.06	0.01	< 0.01	< 0.01	0.01
North Plateau Groundwater Plume (nonsource area)	5	5	0.04	0.01	0.01	0.00	< 0.01	< 0.01	0.00
Existing Facility Maintenance	1	6	0.23	0.18	0.01	0.01	0.01	< 0.01	0.02
Security [a]	1	60	0.2	0.17	0.01	0.01	< 0.01	< 0.01	0.01
Environmental Monitoring Installations	7	7	0.37	2.24	1.29	0.23	< 0.01	< 0.01	0.31
Security Installations	7	7	1.0	0.44	2.45	0.39	< 0.01	< 0.01	0.06
Erosion Control System Replacement (assume WMA 8)	6	7	7.81	20.2	79.0	12.3	0.01	0.01	3.27
Long-term Monitor/Maintain [a]	8	60	1.4	0.19	5.13	0.79	< 0.01	< 0.01	0.11
North Plateau Groundwater Plume Permeable Reactive Barrier Replacement (also Years 40 and 60)	20	20	0.08	0.06	0.1	0.02	< 0.01	< 0.01	0.01
Phased Decisionmaking Alternative (Phase 1)									
High-level Radioactive Waste Canister Removal – Construction of Dry Cask Storage Area	1	1	1.02	1.42	0.54	0.12	< 0.01	0.0008	0.18
High-level Radioactive Waste Canister Removal – Load-In/Load-Out Modification and Operation	1	2	0.27	0.32	0.03	0.03	< 0.01	< 0.01	0.02
High-level Radioactive Waste Canister Removal – Operation of Dry Cask Storage Area	3	29	0.03	0.04	< 0.01	< 0.01	< 0.01	< 0.01	0.00
High-level Radioactive Waste Canister Removal – Demolition of Dry Cask Storage Area	30	30	0.61	1.03	0.58	0.13	< 0.01	< 0.01	0.19
WMA 1 Closure – Surface Structure Removal	1	4	8.05	5.85	7.89	1.43	0.01	0.007	1.16
WMA 1 Closure – Subsurface Soil Removal	4	8	0.58	0.84	2.25	0.38	< 0.01	0.0001	0.11
WMA 2 Closure	5	8	1.03	1.47	1.29	0.27	0.01	0.0002	0.17
WMA 3 Closure	3	3	0.98	0.9	1.35	0.25	< 0.01	0.0006	0.12

Activities for Each Alternative	*Period*		*Emissions*						
	Start Year	***End Year***	***Carbon Monoxide (tons per year)***	***Nitrogen Dioxide (tons per year)***	***PM_{10} (tons per year)***	***$PM_{2.5}$ (tons per year)***	***Sulfur Dioxide (tons per year)***	***Benzene (tons per year)***	***Nonmethane Hydrocarbons (tons per year)***
WMA 5 Closure	5	7	1.53	0.74	1.14	0.2	< 0.01	0.0017	0.15
WMA 6 Closure	7	7	0.18	0.18	0.57	0.1	0.00	0.0001	0.03
WMA 7 Maintenance	1	30	0.07	0.05	< 0.01	< 0.01	< 0.01	< 0.0001	0.00
WMA 8 Maintenance	1	30	0.18	0.15	0.01	0.01	< 0.01	0.0001	0.01
WMA 9 Closure	5	7	0.21	0.5	0.41	0.08	< 0.01	< 0.0001	0.09
WMA 10 Closure	7	7	0.11	0.3	6.96	1.06	< 0.01	< 0.0001	0.04
WMA 12 Closure	7	7	0.11	0.19	0.01	0.01	< 0.01	< 0.0001	0.03
Environmental Monitoring Installations	8	8	0.37	2.24	1.29	0.23	< 0.01	< 0.0001	0.31
Security Installations	8	8	1.0	0.44	2.45	0.39	< 0.01	0.0012	0.06
Annual Environmental Monitoring	8	30	1.24	0.45	0.02	0.02	< 0.01	0.0015	0.07
North Plateau Groundwater Plume Permeable Reactive Barrier Replacement	20	20	0.07	0.16	0.09	0.02	0.00	< 0.0001	0.02
SDA (WMA 8) Geomembrane Replacement	15	15	0.29	0.38	12.7	1.94	< 0.01	< 0.0001	0.03
Existing Facility Maintenance	1	7	0.89	0.71	0.05	0.05	< 0.01	0.0004	0.05
Security	1	30	0.29	0.25	0.02	0.02	< 0.01	0.0001	0.02
No Action Alternative									
WVDP Annual Maintenance [b]	1	60	1.02	0.86	0.07	0.07	0.005	0.00	0.05
SDA Annual Maintenance [b]	1	60	0.1	0.11	0.01	0.01	0.0	0.00	0.01
Process Building Roof Replacement [c]	16	16	1.8	0.36	0.03	0.03	0.002	0.00	0.02
Other Roof Replacements [c]	11	11	0.61	0.13	0.01	0.01	0.000	0.00	0.01
SDA Geomembrane Replacement [c]	15	15	0.54	2.71	8.63	1.32	0.002	0.00	0.32
NDA Geomembrane Replacement [c]	22	22	0.13	1.05	3.21	0.49	0.000	0.00	0.11
Permeable Treatment Wall Media Replacement [d]	20	20	0.05	0.06	0.01	0.01	0.000	0.00	< 0.01

EE = Environmental Enclosure, MSEE = Modular Shielded Environmental Enclosure, NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, PM_{10} = particulate matter less than or equal to 10 micrometers in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter, SDA = State-Licensed Disposal Area, WMA = Waste Management Area, WTF WPF = Waste Tank Farm Waste Processing Facility, WVDP = West Valley Demonstration Project.

[a] For the purposes of analysis, the time period analyzed for the Sitewide Close-In-Place Alternative was assumed to be 60 years. Long-term monitoring and maintenance and security would continue in perpetuity with small annual air pollutant emissions.

[b] For the purposes of analysis, the time period analyzed for the No Action Alternative was assumed to be 60 years. WVDP and SDA annual maintenance would continue in perpetuity with very small annual air pollutant emissions.

[c] These activities would recur approximately every 25 years.

[d] This activity would recur approximately every 20 years.

Note: To convert tons to metric tons, multiply by 0.90718.

Sources: WSMS 2009a, 2009b, 2009c, 2009d.

Nitrogen dioxide and nonmethane hydrocarbon emissions, which are ozone precursors, were compared to 2002 county emissions of nitrogen dioxide and volatile organic compounds for each alternative. The comparison of the peak year emissions to the county emissions by alternative is presented in **Table K–5**. The 2002 emissions data was the most recent year for which EPA reported county data on its Air Data Website.

Table K–5 Comparison of Ozone Precursor Emissions to Cattaraugus County Emissions by Alternative (percent) [a]

Pollutant	*Sitewide Removal Alternative*	*Sitewide Close-In-Place Alternative*	*Phased Decisionmaking Alternative (Phase 1)*	*No Action Alternative*
Nitrogen dioxide	0.23	0.97	0.25	0.11
Nonmethane hydrocarbons	0.02	0.08	0.02	0.01

[a] Based on the most recent year reported (2002) in the EPA Air Data database (EPA 2009).

K.3 Summary of Modeling Results

Air pollutant concentrations were modeled for carbon monoxide, nitrogen dioxide, PM_{10}, $PM_{2.5}$, sulfur dioxide, and benzene for the years with highest emissions. Concentrations were modeled at the WNYNSC boundary and along public roads passing through WNYNSC. Short-term concentrations along the rail line through WNYNSC were not evaluated as the rail line is not used by the public. Emission estimates for shipments of waste and other materials are presented in Section K.4.

K.3.1 Sitewide Removal Alternative

Under the Sitewide Removal Alternative, the highest concentrations for both PM_{10} (Year 55) and $PM_{2.5}$ (Year 55) would be attributed to activity at the North Plateau Groundwater Plume. The highest concentration for carbon monoxide, nitrogen dioxide, and benzene (Year 56) would be attributed to WMA 8 closure. The highest concentrations appropriate for comparison to the ambient standards and guidelines for each pollutant and averaging time and corresponding ambient standards are presented in **Table K–6**. Concentrations to which the public would be exposed are expected to be below the ambient standards, with the exception of $PM_{2.5}$, when background concentrations are included. Background concentrations are based on the nearest available ambient monitoring data as discussed in Chapter 3, Section 3.7, of this EIS.

K.3.2 Sitewide Close-In-Place Alternative

Under the Sitewide Close-In-Place Alternative, the highest concentration for PM_{10}, $PM_{2.5}$, carbon monoxide, sulfur dioxide, benzene, and nitrogen dioxide (Year 6) would be attributed to WMA 1 closure, North Plateau Cap construction, WMA 8 closure, and Erosion Control System replacement. The highest concentrations appropriate for comparison to the ambient standards and guidelines for each pollutant and averaging time and corresponding ambient standards are presented in Table K–6. Concentrations to which the public would be exposed are expected to be below the ambient standards when background concentrations are included, with the exception of PM_{10} and $PM_{2.5}$. PM_{10} and $PM_{2.5}$ 24-hour concentrations would be above the ambient standards. Concentrations are above standard without addition of background concentrations.

Table K–6 Nonradiological Air Pollutant Concentrations by Alternative

Criteria Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meter) [a]	Maximum Incremental Concentration (micrograms per cubic meter) [b]				Background Concentration (micrograms per cubic meter) [c]
			Sitewide Removal Alternative	Sitewide Close-In-Place Alternative	Phased Decisionmaking Alternative (Phase 1)	No Action Alternative	
Carbon monoxide	8 hours 1 hour	10,000 40,000	304 1,070	223 1,270	141 641	39.4 214	3,500 7,000
Nitrogen dioxide	Annual	100	0.64	1.49	0.518	0.163	30
PM_{10}	Annual 24 hours	45 150	1.37 29.7	7.02 262 [e]	0.607 24.5	0.411 16.6	13 28
$PM_{2.5}$	Annual 24 hours	15 35	0.23 4.65 [d]	1.1 40.2 [e]	0.119 4.09 [d]	0.0651 2.43	11 34
Sulfur dioxide	Annual 24 hours 3 hours	80 365 1,300	0.00195 0.109 0.442	0.0017 0.0833 0.5	0.0016 0.0948 0.489	0.00041 0.0364 0.203	7.9 34 94
Benzene	Annual 1 hours	0.13 1,300	0.00204 1.3	0.00154 1.29	0.0005 0.539	0 0	Not reported Not reported

PM_{10} = particulate matter less than or equal to 10 micrometers in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter.

[a] The more stringent of the Federal and state standards is presented if both exist for the averaging period. The NAAQS (40 CFR 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The 24-hour PM_{10} standard is met when the expected number of exceedances is 1 or less over a 3-year period. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. Standards and monitored values for pollutants other than particulate matter are stated in parts per million. These values have been converted to micrograms per cubic meter.

[b] Concentrations were analyzed at locations to which the public has continual access and at the WNYNSC boundary.

[c] Based on available regional monitoring data as discussed in Chapter 3, Section 3.7, of this EIS.

[d] Standard could be exceeded when background is added to the modeled increment for this alternative.

[e] Standard could be exceeded.

K.3.3 Phased Decisionmaking Alternative

Under Phase 1 of the Phased Decisionmaking Alternative, the highest concentration for carbon monoxide, nitrogen dioxide, sulfur dioxide, and benzene (Year 1) would be attributed to WMA 1 closure – surface structure removal. The highest concentrations for PM_{10} (Year 15) would be attributed to the State-Licensed Disposal Area (SDA) geomembrane replacement. The highest concentrations for $PM_{2.5}$ (Year 7) would be attributed to WMA 10 closure. The highest concentrations appropriate for comparison to the ambient standards and guidelines for each pollutant and averaging time and corresponding ambient standards are presented in Table K–6. Concentrations to which the public would be exposed are expected to be below the ambient standards, with the exception of $PM_{2.5}$, when background concentrations are included.

K.3.4 No Action Alternative

Under the No Action Alternative, the highest concentration for all air pollutants would occur in the years when Process Building roof replacement or SDA geomembrane replacement activities occur. For the purpose of this analysis, those are years 15 and 16. These activities would recur approximately every 25 years. The highest concentrations appropriate for comparison to the ambient standards and guidelines for each pollutant and averaging time and corresponding ambient standards are presented in Table K–6. Concentrations to which the public would be exposed are expected to be below the ambient standards, with the exception of $PM_{2.5}$, when background concentrations are included.

K.4 Comparison of Modeling Results

Table K–6 summarizes modeling results for each alternative, along with regional background concentrations measured at urban and suburban sites in Buffalo, New York, and ambient air quality standards for each modeled pollutant. For comparison, the highest average values are presented for carbon monoxide, nitrogen dioxide, sulfur dioxide, benzene, annual PM_{10}, and annual $PM_{2.5}$. The 98th percentile 24-hour value for $PM_{2.5}$ is presented (represented by the average eighth highest 24-hour value) and the average sixth high 24-hour value for PM_{10} is presented (as recommended by EPA for comparison to the standard).

Regional background concentrations (see Chapter 3) are less than the ambient standards for all the modeled pollutants. The estimated WNYNSC boundary concentrations for each alternative would be below those for the regional background and below the ambient standards, except for 24-hour PM_{10} and $PM_{2.5}$ concentrations. The sum of background concentrations and the modeled results for all pollutants at all locations would be less than the ambient air quality standards, except for PM_{10} and $PM_{2.5}$. The ambient standards were developed based on criteria to protect public health and welfare. Therefore, the modeling results indicate that the impact on public health of nonradiological emissions (except for PM_{10} and $PM_{2.5}$) would be minor under all alternatives.

Generally, it can be concluded that nonradiological air quality impacts under the No Action Alternative would be less than those under the other alternatives. The Sitewide Close-In-Place Alternative results in the highest peak incremental short-term concentrations, except for carbon monoxide (8-hour) and benzene, for which the Sitewide Removal Alternative has the highest concentrations. For Phase 1 of the Phased Decisionmaking Alternative, impacts principally occur over the first 8 years of alternative implementation. Impacts from Phase 2 activities would be expected to be bounded by the Sitewide Removal Alternative and the Sitewide Close-In-Place Alternative. The impacts of the Sitewide Removal Alternative occur over a period of about 60 years. Most of the activities with larger emissions for the Sitewide Close-In-Place Alternative occur in the first 7 years.

Air quality impacts in Canada from the activities under the alternatives considered would be negligible as a result of the distance to the nearest border, and the low release height of the nonradiological pollutants. As discussed in Chapter 4, Section 4.1.5.1, of this EIS, the Region of Influence is the area in which concentrations of criteria pollutants would increase more than a significant amount. This distance is expected to be a few kilometers from the source. The increases in concentration resulting from the peak year of activity under each alternative are presented in Table K–6 and are less than the significance levels at the WVDP boundary, except for PM_{10} for all alternatives and for nitrogen dioxide for the Sitewide Close-In-Place Alternative. In the Region of Influence (8 kilometers [5 miles]) in the direction of the closest distance to the Canadian border, the PM_{10} concentrations under the Sitewide Close-In-Place Alternative are estimated to be 0.535 and 10.8 micrograms per cubic meter, respectively, for the annual and 24-hour averaging periods, just below the significance level for the annual average and above for the 24-hour average. At the Canadian border (50 kilometers [31 miles]), the PM_{10} concentrations under the Sitewide Close-In-Place Alternative are estimated to be 0.0489 and 1.4 micrograms per cubic meter, respectively, for the annual and 24-hour averaging periods. Concentrations from other alternatives would be less. As most of the nonradiological releases are from construction-type equipment, which releases exhaust close to the ground, and particulate emissions from soil disturbance within a few feet of the ground, the highest concentrations are generally expected to occur on or near the site.

Emissions from shipping wastes and other materials by truck are shown by alternative in **Table K–7**. The highest emissions would be from the Sitewide Removal Alternative, and the lowest from the No Action Alternative. Emissions from shipment by rail would be expected to be less by a factor of 3 or more.

Table K–7 Nonradiological Emissions from Trucking Shipments of Waste and Other Materials (metric tons)

Pollutant	*Sitewide Removal Alternative*	*Sitewide Close-In-Place Alternative*	*Phased Decisionmaking Alternative (Phase 1)*	*No Action Alternative*
Carbon monoxide	1,440	17.9	201	9.67
Nitrogen dioxide	5,050	62.9	704	33.9
PM_{10}	142	1.77	19.9	0.957
$PM_{2.5}$	118	1.46	16.4	0.79
Volatile organic compounds	247	3.07	34.4	1.66

PM_{10} = particulate matter less than or equal to 10 micrometers in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter.

K.5 References

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APPENDIX L
REGULATORY COMPLIANCE DISCUSSION

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REGULATORY COMPLIANCE DISCUSSION

This appendix discusses compliance with three requirements that would apply to site decommissioning actions:

- Regulations promulgated under the Resource Conservation and Recovery Act (RCRA) of 1976 (42 United States Code 6901 *et seq*.) and the New York State Industrial Hazardous Waste Management Act govern the generation, storage, handling, and disposal of hazardous wastes and the closure of treatment, storage, or disposal systems that handle those wastes. The act was created to ensure that hazardous wastes are managed in a way that protects human health, safety, and the environment. Operation and closure of RCRA-regulated units are performed in accordance with 6 New York Code of Rules and Regulations (NYCRR) Part 373. Corrective actions for Solid Waste Management Units (SWMUs) are performed in accordance with the RCRA Section 3008(h) Administrative Order on Consent.

- The West Valley Demonstration Project (WVDP) decommissioning policy statement/License Termination Rule establishes radiological criteria for decommissioning of WVDP facilities and termination of the U.S. Nuclear Regulatory Commission (NRC) licenses (NRC 2002). The policy statement/License Termination Rule provides for flexibility in establishing the final levels of residual contamination, but, in all cases, requires decontamination to the extent technically and economically feasible.

- The new regulations that the New York State Department of Environmental Conservation (NYSDEC) is proposing to adopt for the cleanup of sites contaminated with radioactive materials (NYSDEC 2008) will be compatible with the NRC's License Termination Rule and will be applied as applicable and whenever NYSDEC requires the cleanup of a site contaminated with radioactive material.

RCRA regulations and the License Termination Rule are discussed more fully in Chapter 5 of this *Final Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship of the West Valley Demonstration Project and Western New York Nuclear Service Center*.

Compliance with these key regulations is discussed in the following sections. The discussion draws on information and analytical results presented in this environmental impact statement (EIS). Actual determinations of compliance or noncompliance are made by the regulatory authorities in response to documents submitted by the regulated entities. The information and assessments presented in this appendix do not constrain the judgments that will be made by regulators in evaluating compliance for the alternative finally selected.

Three decommissioning alternatives are described in Chapter 2 of this EIS: Sitewide Removal, Sitewide Close-In-Place, and Phased Decisionmaking. The Sitewide Removal Alternative will, by definition, meet NYSDEC requirements for clean closure of RCRA-regulated units, NRC requirements for license termination without restriction for the NRC-regulated portion of the site, and NYSDEC cleanup requirements for the State-Licensed Disposal Area (SDA). The actual determination of when removal is adequate for the Sitewide Removal Alternative to meet the various decommissioning requirements would be made through the appropriate NYSDEC and NRC regulatory review processes, as noted in Chapter 1, Section 1.5, of this EIS.

While it is conceptually possible that the Sitewide Close-In-Place Alternative could meet NYSDEC, RCRA, and NRC policy statement/License Termination Rule requirements, it is less clear if or under what conditions this alternative would meet these requirements. The balance of this appendix discusses RCRA and policy statement/License Termination Rule requirements that would apply to this alternative and the issues associated with compliance, while drawing (as appropriate) on the information developed as part of this EIS.

The *Phase 1 Decommissioning Plan for the West Valley Demonstration Project (Decommissioning Plan)*, a document that describes the proposed Phase 1 decommissioning actions was submitted to the NRC. (If a different approach is selected in the Record of Decision, this plan will be revised as necessary to reflect the changes.) This document develops allowable residual contamination levels for those areas where facilities would be removed under Phase 1 of the Phased Decisionmaking Alternative. These allowable residual contamination levels are termed Derived Concentration Guideline Levels (DCGLs) and are based on limiting the dose to a potential onsite receptor to a total effective dose equivalent of 25 millirem per year, the dose standard for unrestricted release in the NRC License Termination Rule. The technical basis for the establishment of these West Valley-specific DCGLs is being reviewed by the NRC. Cleanup/closure activities performed during Phase 1 or under the Sitewide Removal Alternative would be performed in accordance with RCRA closure and/or corrective action requirements, as applicable. This appendix does not discuss Phase 2 of the Phased Decisionmaking Alternative because Phase 2 actions have not been defined. If Phase 2 were removal of the remaining Waste Management Areas (WMAs), the overall alternative would be the same as the Sitewide Removal Alternative. If Phase 2 were in-place closure of the remaining WMAs, it would involve the same issues identified for the Sitewide Close-In-Place Alternative, although they would be slightly reduced because the Main Plant Process Building and the Low-Level Waste Treatment Facility would have been removed under Phase 1. This appendix does not address the No Action Alternative because it is not intended to meet decommissioning requirements.

L.1 Resource Conservation and Recovery Act

Site cleanups under RCRA are conducted under its corrective action and permitting programs. The RCRA corrective action program is used to perform corrective actions for SWMUs following the process defined in a facility operating permit or Consent Order, beginning with investigation of potential releases and ending with selection and implementation of a remedy. Corrective Measures Studies (CMSs) would be prepared by the U.S. Department of Energy (DOE) and/or New York State Energy Research and Development Authority (NYSERDA) for SWMUs identified by NYSDEC or the U.S. Environmental Protection Agency (EPA). These reports would propose a preferred corrective measure alternative for the SWMUs, including applicable or appropriate cleanup standards. These CMSs would be reviewed by NYSDEC and EPA, and a corrective measure alternative would be selected by the respective regulatory agency in accordance with the required administrative procedures. This process would also include providing the public with an opportunity to review and comment.

Under any of the alternatives evaluated in this EIS, SWMUs subject to RCRA permitting (referred to as "regulated units") would be remediated pursuant to respective closure standards and requirements as defined in the regulations. A regulated unit–specific closure plan would be prepared by the owner or operator of a particular regulated unit or the organization that would implement the plan on the owner's or operator's behalf. The plan would then be submitted to NYSDEC and/or EPA for review and approval. Upon approval, the closure plan would be implemented for the specific regulated unit. Closure standards may be met through a variety of methods, depending upon the type, design, and performance of the unit and whether any wastes remain in place. Clean closure is the method of closure in which all wastes are removed from the regulated unit and the surrounding media. In-place management is the method of closure in which some or all wastes remain in place, generally subjecting the unit to long-term controls. In-place closure is typically reserved for land disposal units and in the West Valley situation would require both a regulatory variance and a postclosure permit or Order to document the monitoring and maintenance requirements. Closure requirements usually satisfy the corrective action requirements. However, closed units may be further subject to corrective action requirements, if deemed necessary. Information regarding SWMUs and RCRA interim status units is provided in Chapter 2, Table 2–2, of this EIS.

For the Sitewide Close-In-Place Alternative, the acceptable steps to closure for each regulated unit would be subject to regulatory review through a closure plan for each of the regulated units. Because wastes would be left in place under this option, engineered measures (such as a cover) or long-term controls could be proposed as part of the process. The adequacy of these additional measures would be determined by NYSDEC and/or EPA, as would the need for special administrative provisions, such as a variance to the regulations. It is not clear what the regulators' decisions would be for this alternative, particularly for the units that have the greatest inventory of hazardous constituents (Main Plant Process Building, Waste Tank Farm, NRC-Licensed Disposal Area [NDA], and SDA). If such close-in-place actions were authorized for regulated units, it is expected that it would involve a permit with postclosure monitoring and maintenance requirements that would require a review of performance and options on some recurring interval, such as 5 years.

L.2 U.S. Nuclear Regulatory Commission Decommissioning Criteria

The NRC License Termination Rule (10 *Code of Federal Regulations* [CFR] Part 20, Subpart E) governs the decommissioning of the NRC-licensed portion of the Western New York Nuclear Service Center (WNYNSC). There is flexibility in the License Termination Rule with criteria for unrestricted use (10 CFR 20.1402), criteria for restricted use (10 CFR 20.1403), and alternate criteria (10 CFR 20.1404). In all cases it is necessary to decontaminate to the maximum extent technically and economically feasible. The License Termination Rule is discussed more in Chapter 5 of this EIS.

The NRC established decommissioning criteria for WVDP through issuance of a policy statement (NRC 2002) under its authority in the WVDP Act, prescribing the License Termination Rule as the decommissioning criteria for WVDP. In this policy statement, the NRC recognized that decommissioning of the West Valley Site would present unique challenges and acknowledged that the final end state may involve a long-term, or even a perpetual, license or other innovative approach for some parts of the site where cleanup to License Termination Rule requirements would be prohibitively expensive or technically impractical. DOE submitted its *Decommissioning Plan*, which identifies proposed removal actions and proposed cleanup levels to the NRC on December 3, 2008 for its review and evaluation should the Phased Decisionmaking Alternative be selected. The NRC policy statement on decommissioning criteria for WVDP is also discussed in Chapter 5 of this EIS.

For the Sitewide Close-In-Place Alternative, there appear to be two primary options under the License Termination Rule: license termination under restricted conditions (10 CFR 20.1403) and license termination under alternate criteria (10 CFR 20.1404). While these options are applicable for those portions of the site where waste or contamination is closed in place, other portions of the site with minimal residual contamination could be released for unrestricted reuse under the criteria of 10 CFR 20.1402.

The various decommissioning requirements include dose standards, standards for institutional controls, and procedural requirements. This appendix only addresses comparison with dose standards. **Table L–1** presents a summary matrix of the regulatory dose standards for the various regulatory options that could be applied to the Sitewide Close-In-Place Alternative.

Table L–1 Sitewide Close-In-Place Alternative Summary of U.S. Nuclear Regulatory Commission Dose Standards for Regulatory Options

Regulatory Option	Dose Standards	
	Dose Standard Assuming Institutional Controls	***Dose Standard Assuming Immediate Loss of Institutional Controls***
License termination with restriction (10 CFR 20.1403)	25 millirem per year	100/500 millirem per year
License termination under alternate criteria (10 CFR 20.1404)	Up to 100 millirem per year from all manmade sources other than medical	100/500 millirem per year

CFR = *Code of Federal Regulations.*

The balance of this section presents and discusses the result of the dose assessment for the NRC-regulated facilities on WNYNSC under the Sitewide Close-In-Place Alternative. The estimated doses for the situation where it is assumed that institutional controls remain in place are presented first in Section L.2.1.[1]

The estimated doses for the situation where it is assumed that institutional controls fail are presented second in Section L.2.2. Consistent with License Termination Rule compliance guidance (NRC 2006), the analysis assumes loss of institutional controls immediately after license termination. There is uncertainty about when the license might be terminated, so two timeframes are analyzed and presented in the tables. The first assumes license termination immediately following completion of the decommissioning actions. The second assumes license termination after 100 years, a timeframe that might be used to allow for decay of short-lived radionuclides in the North Plateau Groundwater Plume or Cesium Prong. It is possible that even longer timeframes might be used to allow for decay prior to license termination, but the effect of these longer timeframes was not analyzed.

L.2.1 Sitewide Close-In-Place Alternative with Continuation of Institutional Controls

The following are three offsite receptors, in order of distance from the site.

- An individual outside the current site boundary who uses contaminated Cattaraugus Creek water for drinking and irrigation and consumes fish raised in the local Cattaraugus Creek waters
- An individual along the lower reaches of Cattaraugus Creek near Gowanda who also uses contaminated Cattaraugus Creek water for drinking and irrigation and consumes large amounts of fish raised in the Cattaraugus Creek waters near Gowanda, assumed to be a member of the Seneca Nation of Indians (Seneca Nation)
- An individual who uses water from Lake Erie or the Niagara River

In addition to the offsite receptors, a dose estimate for an onsite worker engaged in postclosure monitoring and maintenance activities is presented. The dose estimate is based on information from historical measurements for similar activities.

Estimated peak annual doses to each of these receptors are presented in Sections L.2.1.1 through L.2.1.4.

[1] *This information for the offsite receptors is a subset of that presented in Chapter 4, Section 4.1.10, of this EIS, but is limited to the NRC-regulated facilities or areas.*

L.2.1.1 Cattaraugus Creek Receptor

Table L–2 presents the dose to a Cattaraugus Creek receptor immediately outside the current WNYNSC. The total peak annual dose to this receptor from all NRC-regulated facilities/areas is projected to be about 0.5 millirem; the peak would be dominated by the North Plateau Groundwater Plume.

Table L–2 Sitewide Close-In-Place Alternative with Continuation of Institutional Controls Peak Annual Dose [a] to Cattaraugus Creek Receptor

Waste Management Areas	*Sitewide Close-In-Place Alternative (millirem per year) (years until peak exposure)*
Main Plant Process Building – WMA 1	0.019 (200)
Vitrification Facility – WMA 1	0.000037 (1,000)
Low-Level Waste Treatment Facility – WMA 2	0.00026 (100)
Waste Tank Farm – WMA 3	0.0019 (300)
NDA – WMA 7	0.010 (8,700)
North Plateau Groundwater Plume	0.51 (34)
Total	0.51 (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

Figure L–1 shows this same information with emphasis on the peak annual dose as a function of time. The figure does not show the short-term peak from the North Plateau Groundwater Plume which occurs in year 34 as shown in Table L–2. It is not shown because, for the timescale used in the figure, the peak would essentially lie on the y-axis. The figure does show the later peaks including those due to releases from the NDA.

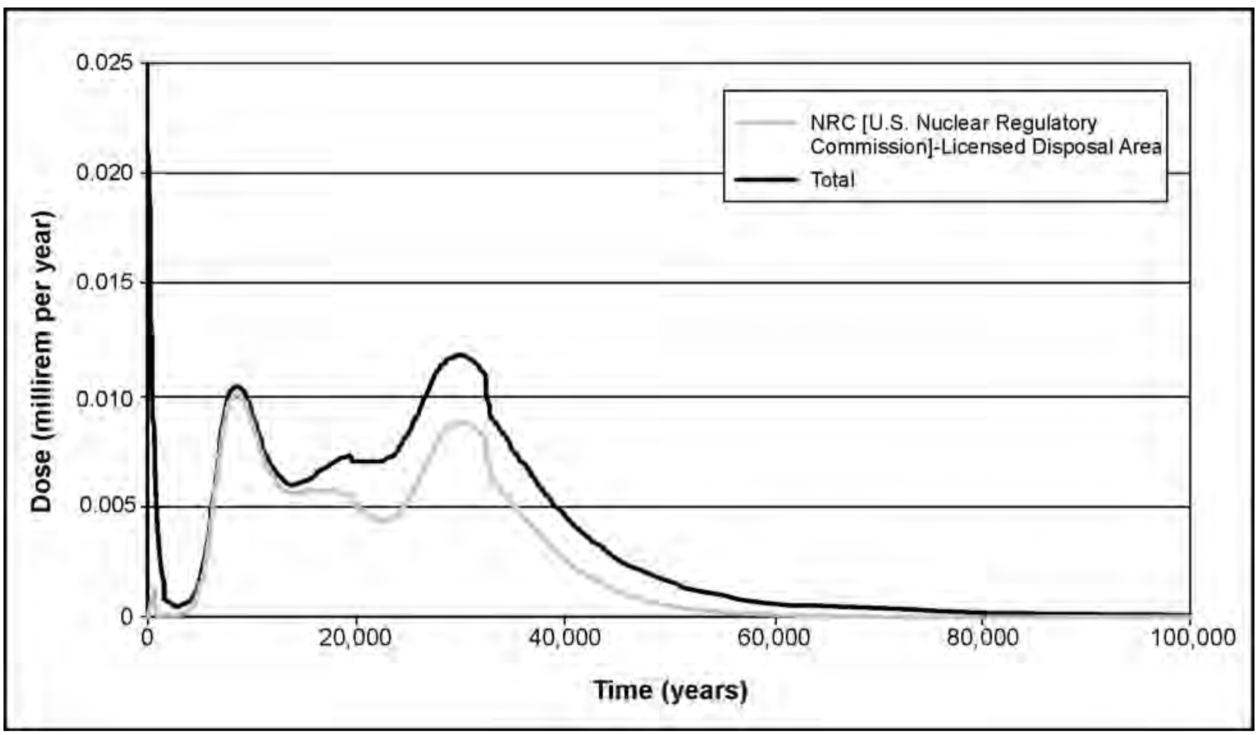

Figure L–1 Sitewide Close-In-Place Alternative with Continuation of Institutional Controls Peak Annual Dose to Cattaraugus Creek Receptor

L.2.1.2 Seneca Nation of Indians Receptor

Table L–3 presents the peak annual dose to the Seneca Nation of Indians receptor. The total peak annual dose to this receptor would be slightly higher than the dose to the Cattaraugus Creek receptor because of the higher assumed fish consumption rate. The total peak annual dose is about 0.7 millirem per year and would be dominated in the first 200 years by releases from the North Plateau Groundwater Plume and the Main Plant Process Building.

Table L–3 Sitewide Close-In-Place Alternative with Continuation of Institutional Controls Peak Annual Dose [a] to Seneca Nation of Indians Receptor

Waste Management Areas	*Sitewide Close-In-Place Alternative (millirem per year) (years until peak exposure)*
Main Plant Process Building – WMA 1	0.053 (200)
Vitrification Facility – WMA 1	0.000090 (1,000)
Low-Level Waste Treatment Facility – WMA 2	0.00047 (100)
Waste Tank Farm – WMA 3	0.0019 (300)
NDA – WMA 7	0.027 (8,600)
North Plateau Groundwater Plume	0.68 (34)
Total	0.68 (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

L.2.1.3 Lake Erie/Niagara River Water User

The Lake Erie/Niagara River water user that would receive the highest dose would be a Sturgeon Point water user because the water entering this intake structure would have higher concentrations of radionuclides than water from other intake structures. The peak annual dose to this receptor is presented in **Table L–4**. This receptor is assumed to drink water and eat fish from Lake Erie and to raise produce in a garden irrigated with water from Sturgeon Point. The small total peak annual dose (0.17 millirem per year) would be dominated by releases from the North Plateau Groundwater Plume.

Table L–4 Sitewide Close-In-Place Alternative with Continuation of Institutional Controls Peak Annual Dose [a] to Sturgeon Point Receptor

Waste Management Areas	*Sitewide Close-In-Place Alternative (millirem per year) (years until peak exposure)*
Main Plant Process Building – WMA 1	0.002 (200)
Vitrification Facility – WMA 1	0.000005 (1,000)
Low-Level Waste Treatment Facility – WMA 2	0.00007 (100)
Waste Tank Farm – WMA 3	0.0007 (300)
NDA – WMA 7	0.002 (30,100)
North Plateau Groundwater Plume	0.17 (34)
Total	0.17 (34)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

L.2.1.4 Site Worker

Site workers would be responsible for monitoring and maintenance activities after the site is closed in place. The peak annual dose to such a worker has been estimated based on a review of historical exposure records for workers that have participated in environmental monitoring and grounds maintenance activities (WVES 2008). The estimated annual dose to site workers is estimated to be in the range of 10 to 20 millirem per year.

L.2.1.5 Conclusion

The analysis of future offsite receptors indicates that the peak annual dose to an average member of the critical group (receptors outside the current site boundary) for the Sitewide Close-In-Place Alternative with continuation of institutional controls is projected to be well below 25 millirem per year, the dose standard for unrestricted release in the NRC License Termination Rule. The historical information on occupational exposure of site monitoring and maintenance workers suggests that the annual dose to monitoring and maintenance workers who would work at the site following implementation of the Sitewide Close-In-Place actions is projected to be below 25 millirem per year.

L.2.2 Sitewide Close-In-Place Alternative with Loss of Institutional Controls

Multiple scenarios have been analyzed in Appendix H of this EIS. For presentation in this Appendix L, the scenarios are organized according to the estimated time for the scenario to develop, from shortest to longest. These specific scenarios are presented in **Table L–5**. The last column in the table provides information on the duration of the exposure once it is initiated. As discussed earlier, two time frames for license termination are analyzed in this appendix. The first analysis assumes the intruder scenario occurs immediately after completion of the decommissioning activities, consistent with license termination immediately after decommissioning. The second analysis assumes the intruder scenario occurs 100 years after completion of the decommissioning actions. This second analysis would be consistent with an assumption that the license was terminated after 100 years, a strategy that could be used for management of areas such as the Cesium Prong or North Plateau Groundwater Plume, where dominant contaminating radionuclides have a moderately short half-life (30 years or less).

Table L–5 Exposure Scenarios and Estimated Scenario Development Time

Scenario	***Estimated Scenario Development Time (time until the start of exposure)***	***Duration of Exposure***
Well driller (Section L.2.2.1)	On the order of a few weeks	On the order of hours, acute
Resident farmer (with or without a well) (Section L.2.2.2)	1 – 2 years	Ongoing, chronic
Erosion (Section L.2.2.3)	Hundreds of years of unmitigated erosion	Ongoing, chronic

L.2.2.1 Well Driller

Table L–6 presents the doses to an intruder worker assumed to be a well driller. 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.

The projected peak annual dose to the well driller in the area of the Low-Level Waste Treatment Facility is projected to be 4.8 millirem per year if the license is terminated immediately after completion of the Sitewide Close-In-Place decommissioning actions. A well driller in areas other than the Low-Level Waste Treatment Facility and North Plateau Groundwater Plume was not analyzed because it was assumed that well-drilling equipment would not be placed over areas protected by multi-layered engineered barriers with rock on the sides and top.

Table L–6 Sitewide Close-In-Place Alternative with Loss of Institutional Controls Peak Annual Dose [a] to Well Driller

Waste Management Areas	*Sitewide Close-In-Place Alternative* Immediate License Termination (millirem per year)	License Termination After 100 Years (millirem per year)
Main Plant Process Building – WMA 1	Not applicable	Not applicable
Vitrification Facility – WMA 1	Not applicable	Not applicable
Low-Level Waste Treatment Facility – WMA 2	4.8	1.0
Waste Tank Farm – WMA 3	Not applicable	Not applicable
NDA – WMA 7	Not applicable	Not applicable
North Plateau Groundwater Plume	5×10^{-8}	1×10^{-6}

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

L.2.2.2 Resident Farmer (with or without a well)

Three types of resident farmers are presented in this section. The first is a resident farmer along Buttermilk Creek below the confluence with Franks Creek. This receptor is assumed to experience the impacts of releases from all the WMAs on the North and South Plateaus. The second is a resident farmer whose garden contains contaminated soil from either home construction or well drilling directly into a WMA that is not covered by an intrusion barrier for the Sitewide Close-In-Place Alternative. The third is a resident farmer who drills a well downgradient of a WMA. This scenario is particularly relevant for WMAs that have engineered multi-layer caps that would make direct intrusion more difficult.

Resident Farmer Along Buttermilk Creek

A resident farmer along the lower reaches of Buttermilk Creek was analyzed. This receptor would use contaminated water in the lower reaches of Buttermilk Creek for drinking and irrigation and would consume fish assumed to be raised in the local contaminated waters. The results of this analysis are presented in **Table L–7**.

Table L–7 Sitewide Close-In-Place Alternative with Loss of Institutional Controls Peak Annual Dose [a] to Buttermilk Creek Receptor

Waste Management Areas	*Sitewide Close-In-Place Alternative* Immediate License Termination (millirem per year) (years until peak exposure)	License Termination After 100 Years (millirem per year) (years until peak exposure)
Main Plant Process Building – WMA 1	0.14 (200)	0.14 (200)
Vitrification Facility – WMA 1	0.00028 (1,000)	0.00028 (1,000)
Low-Level Waste Treatment Facility – WMA 2	0.0020 (100)	0.0020 (100)
Waste Tank Farm – WMA 3	0.014 (300)	0.014 (300)
NDA – WMA 7	0.076 (8,700)	0.076 (8,700)
North Plateau Groundwater Plume	3.9 (34)	0.00067 (4,800)
Total	3.9 (34)	0.16 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

The predicted peak annual dose to the Buttermilk Creek receptor would be about 4 millirem per year for the immediate license termination and less than 0.2 millirem per year for the delayed license termination analysis. The peaks are both dominated by releases from the North Plateau Groundwater Plume.

Resident Farmer Using Contaminated Soil

Table L–8 presents the doses to a resident farmer as a result of direct contact with contaminated soil that would be brought to the surface and placed in a garden following a house construction or well-drilling scenario. The highest dose would affect a farmer whose garden is contaminated by cuttings from the Low-Level Waste Treatment Facility. These peak doses would occur in the year of license termination.

Table L–8 Sitewide Close-In-Place Alternative with Loss of Institutional Controls Peak Annual Dose [a] to Resident Farmer Using Contaminated Soil

	Sitewide Close-In-Place Alternative	
Waste Management Areas	*Immediate License Termination (millirem per year) (years until peak exposure)*	*License Termination After 100 Years (millirem per year) (years until peak exposure)*
Main Plant Process Building – WMA 1	Not applicable	Not applicable
Vitrification Facility – WMA 1	Not applicable	Not applicable
Low-Level Waste Treatment Facility – WMA 2	69 (1)	7 (100)
Waste Tank Farm – WMA 3	Not applicable	Not applicable
NDA – WMA 7	Not applicable	Not applicable
North Plateau Groundwater Plume	0.2 (1)	0
Cesium Prong	44 (1)	4.4 (100)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

Resident Farmer Using Contaminated Groundwater

Table L–9 presents the doses to a 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) are assumed to have wells in the sand and gravel layer on the North Plateau about 100 meters (330 feet) downgradient from source area in each WMA. For units other than the North Plateau Groundwater Plume, the estimate of peak annual dose is not strongly sensitive to well location because the dose is dominated by long-lived radionuclides that do not decay appreciably as they travel downgradient and because conservative assumptions were made about lateral dispersion that would reduce downgradient radionuclide concentrations. The scenario is not applied to the NDA because of the low hydraulic conductivity of the unweathered Lavery till and the unsaturated conditions in the Kent Recessional Sequence.

Table L–9 Sitewide Close-In-Place Alternative with Loss of Institutional Controls Annual Peak Dose [a] to Resident Farmer Using Contaminated Groundwater

	Sitewide Close-In-Place Alternative	
Waste Management Areas	*Immediate License Termination (millirem per year) (years until peak exposure)*	*License Termination After 100 Years (millirem per year) (years until peak exposure)*
Main Plant Process Building – WMA 1	162 (165)	162 (165)
Vitrification Facility – WMA 1	1.9 (1,000)	1.9 (1,000)
Low-Level Waste Treatment Facility – WMA 2	42 (66)	32 (100)
Waste Tank Farm – WMA 3	157 (231)	157 (231)
NDA – WMA 7	Not applicable	Not applicable
North Plateau Groundwater Plume	25,590 (2)	72 (100)
Cesium Prong	44 (1)	4.4 (100)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

The dose would be greatest to a resident farmer with a well in the North Plateau Groundwater Plume, but there is a noticeable decrease with time for this situation due to decay, and the dose is projected to decrease to levels below 100 millirem per year after 100 years as shown on **Figure L–2**. The dose would be greater than 100 millirem per year to receptors with wells downgradient of the Main Plant Process Building and the Waste Tank Farm, but there is not as noticeable a decrease in the dose from these wells with a delay in license termination.

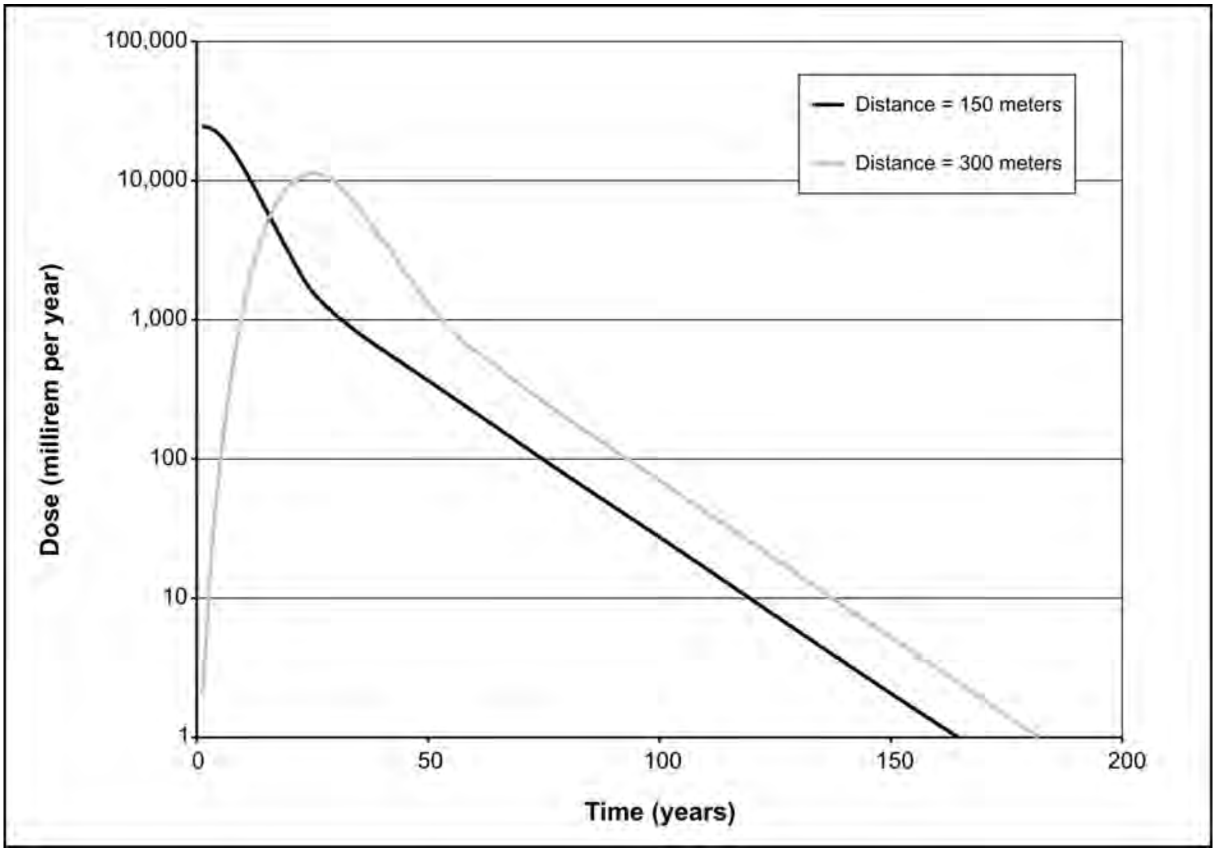

Figure L–2 Sitewide Close-In-Place Alternative with Loss of Institutional Controls Time Series of Peak Dose to Onsite Receptors of North Plateau Groundwater Plume

The time series of doses to receptors 150 and 300 meters (490 and 980 feet) from the source of the North Plateau Groundwater Plume under the Sitewide Close-In-Place Alternative is presented on Figure L–2. The figure illustrates how sensitive the dose is to the time at which the intrusion occurs and where the intruder places his or her well. The peak dose for immediate license termination in Table L–9 comes from the receptor at 150 meters (490 feet). The peak dose for termination after 100 years comes from the receptor at 300 meters (980 feet) as shown in Figure L–2. The distance of 150 meters (490 feet) is in the vicinity of the peak concentration of the plume at the first year of the period of analysis and just outside of 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.

L.2.2.3 Scenarios Leading to Unmitigated Erosion

Erosion is recognized as a site phenomenon, so a conservative erosion scenario (unmitigated erosion where no credit is taken for monitoring and maintenance of erosion control structures) was analyzed to estimate the dose to various receptors. The erosion scenarios presented here are the same ones analyzed in Appendix H of this

EIS, although the timeframes for initiation of unmitigated erosion in this analysis are (1) immediately after completion of the sitewide close-in-place actions, and (2) 100 years after completion of the sitewide close-in-place actions. This is consistent with the assumptions stated earlier in this appendix. The scenarios for erosion in the area of the NDA and Low-Level Waste Treatment Facility are presented in this section in an order that reflects their distance from the industrialized portion of the site.

NDA Resident/Recreational Hiker

Table L–10 presents the peak annual dose to a resident/recreational hiker in the area of the Low-Level Waste Treatment Facility and the NDA if unmitigated erosion of the site were allowed to take place. Exposure modes for a hiker include inadvertent ingestion of soil, inhalation of fugitive dust, and exposure to direct radiation. The peak annual dose to this receptor is not sensitive to the timing of license termination.

Table L–10 Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Peak Annual Dose [a] to Resident/Recreational Hiker Near the Low-Level Waste Treatment Facility and NRC-Licensed Disposal Area

	Sitewide Close-In-Place Alternative	
Waste Management Areas	***Immediate License Termination (millirem per year) (years until peak exposure)***	***License Termination After 100 Years (millirem per year) (years until peak exposure)***
Low-Level Waste Treatment Facility – WMA 2	11 (180)	11 (180)
NDA – WMA 7	34 (200)	34 (200)
Total	41 (200)	41 (200)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

Buttermilk Creek Resident Farmer

Table L–11 presents the peak annual dose to a Buttermilk Creek resident farmer given unmitigated erosion at the Low-Level Waste Treatment Facility and NDA. A receptor at this location would experience a dose contribution from both the Low-Level Waste Treatment Facility and the NDA, but the peaks are in the future and would occur in very different timeframes. The greater peak is associated with the NDA. The peak annual doses to this receptor are not sensitive to the timing of license termination.

Table L–11 Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Peak Annual Dose [a] to a Buttermilk Creek Receptor

	Sitewide Close-In-Place Alternative	
Waste Management Areas	***Immediate License Termination (millirem per year) (years until peak exposure)***	***License Termination After 100 Years (millirem per year) (years until peak exposure)***
Low-Level Waste Treatment Facility – WMA 2	6 (200)	6 (200)
NDA – WMA 7	12 (490)	12 (490)
Total	13 (490)	13 (490)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

Cattaraugus Creek Resident Farmer

Table L–12 presents the peak annual dose to a Cattaraugus Creek resident farmer from the Low-Level Waste Treatment Facility and the NDA under the unmitigated erosion scenario.

Table L–12 Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Peak Annual Dose [a] to Cattaraugus Creek Receptor

	Sitewide Close-In-Place Alternative	
Waste Management Areas	*Immediate License Termination (millirem per year) (years until peak exposure)*	*License Termination After 100 Years (millirem per year) (years until peak exposure)*
Low-Level Waste Treatment Facility – WMA 2	0.74 (200)	0.74 (200)
NDA – WMA 7	1.5 (490)	1.5 (490)
Total	1.7 (490)	1.7 (490)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

The results for this receptor show a similar pattern to that seen for the Buttermilk Creek resident farmer, but the doses are lower because of the reduced contaminant concentrations further downstream. Again, the doses are not sensitive to the timing of license termination.

An illustration of how the peak annual dose to the Cattaraugus Creek receptor would vary as a function of time under the Sitewide Close-In-Place Alternative is presented on **Figure L–3**. The figure shows the short-term peak for erosion of the Low-Level Waste Treatment Facility and the later peak for erosion of the NDA. The dose-time curve would have a similar pattern for all offsite receptors, but the magnitude of the peaks would vary.

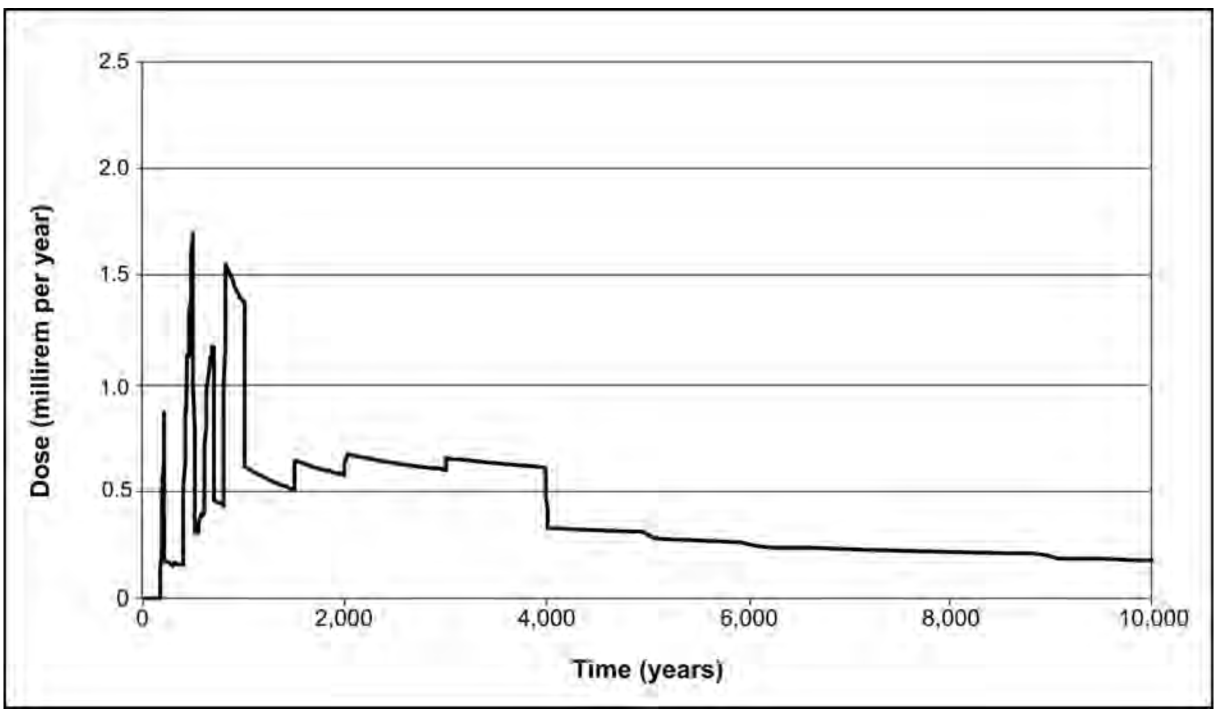

Figure L–3 Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Time Series of Peak Annual Dose to Cattaraugus Creek Resident Farmer

Seneca Nation of Indians Receptor

A Seneca Nation receptor is postulated to use Cattaraugus Creek near Gowanda for drinking water and to consume large quantities of fish raised in these waters. The peak annual dose to this receptor under the unmitigated erosion scenario is presented in **Table L–13**. The greater peak is associated with the NDA. None of the doses is sensitive to the timing of license termination.

As noted in Section L.2.1.2, the dose-time pattern for the Seneca Nation receptor is similar to that seen for the other downgradient water users, but the numerical values of the peaks are greater as a result of the higher assumed fish consumption rate.

Table L–13 Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Peak Annual Dose [a] to Seneca Nation of Indians Receptor

	Sitewide Close-In-Place Alternative	
Waste Management Areas	*Immediate License Termination (millirem per year) (years until peak exposure)*	*License Termination After 100 Years (millirem per year) (years until peak exposure)*
Low-Level Waste Treatment Facility – WMA 2	2 (200)	2 (200)
NDA – WMA 7	4 (490)	4 (490)
Total	4 (490)	4 (490)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

Lake Erie Niagara River Water User

In addition to the Cattaraugus Creek and Seneca Nation receptors, the peak annual dose to a Sturgeon Point water user has been projected for the unmitigated erosion release scenario (see **Table L–14**). Again, two separate peaks are shown, with releases from the NDA producing the higher dose level. Doses are the same regardless of the timing of license termination.

Table L–14 Sitewide Close-In-Place Alternative with Loss of Institutional Controls, Unmitigated Erosion Scenario, Peak Annual Dose [a] to Sturgeon Point Receptor

	Sitewide Close-In-Place Alternative	
Waste Management Areas	*Immediate License Termination (millirem per year) (years until peak exposure)*	*License Termination After 100 Years (millirem per year) (years until peak exposure)*
Low-Level Waste Treatment Facility – WMA 2	0.14 (200)	0.14 (200)
NDA – WMA 7	0.24 (490)	0.24 (490)
Total	0.27 (490)	0.27 (490)

NDA = NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area, WMA = Waste Management Area.
[a] Total effective dose equivalent.

Dose from Multiple Sources

The previous discussion presented information on the doses to various receptors from individual WMAs. There is the potential for receptors to come in contact with contamination from multiple areas and therefore experience higher doses than those from a single WMA. The highest doses would generally affect resident farmers who use contaminated water near a specific WMA (see Table L–9). It is conceivable that a single well on the North Plateau could intercept contamination from multiple sources. The information in Table L–9 suggests there may be combined impacts for plumes that have peaks that occur during similar timeframes.

A water well on the North Plateau that would intercept the plume from both the Main Plant Process Building and the Waste Tank Farm appears to have the greatest potential to distribute a multisource dose. The peak dose for the Main Plant Process Building and Waste Tank Farm is estimated to occur around year 200 (see Table L–9). A conservative estimate of the combined dose from the Main Plant Process Building and the Waste Tank Farm is projected to be about 300 millirem per year (approximately 162 from Main Plant Process Building and approximately 157 from the Waste Tank Farm).

Other combinations for the Sitewide Close-In-Place Alternative appear to have much less potential for high doses. The thick engineered caps would limit the peak annual dose for well-drilling or home construction scenarios to a few millirem, doses that are small in comparison to the doses from using contaminated water for drinking and irrigation.

L.2.2.4 Conclusions

Assuming the area of institutional controls is consistent with the current site boundary, the analysis in Section L.2.1 indicates that the Sitewide Close-In-Place Alternative could comply with the dose criteria that apply when institutional controls are in effect.

The analysis in Section L.2.2 indicates that, in some cases, the Sitewide Close-In-Place Alternative could exceed the dose criteria for situations involving the loss of institutional controls. It is recognized that there is uncertainty about which scenarios would be appropriate for assessing compliance with the License Termination Rule as well as uncertainty about the acceptability of the models and parameters used in the analysis. For scenarios assuming institutional controls as well as scenarios assuming loss of institutional control, the determination of what constitutes the License Termination Rule compliance scenarios and what are justifiable assumptions for the long-term performance will be critical in determining whether the dose criteria are met.

These issues, along with compliance with the decommissioning requirements for institutional controls and procedural requirements, are being addressed and resolved as part of the *Decommissioning Plan* preparation and review process.

L.3 Radiological Decommissioning of the State-Licensed Disposal Area

It is expected that the SDA would continue to be regulated via a 6 NYCRR Part 380 permit and a New York State Department of Health license. Decommissioning criteria that would apply for a close-in-place option for the SDA have not been established. The 6 NYCRR Part 384 regulations being developed by NYSDEC (NYSDEC 2008) could apply to the SDA, but it is not clear that these regulations would accommodate a close-in-place option. The outreach materials requesting public comment on the planned 6 NYCRR Part 384 regulations did not mention the SDA.

L.4 References

NRC (U.S. Nuclear Regulatory Commission), 2002, *Decommissioning Criteria for the West Valley Demonstration Project (M-32) at the West Valley Site; Final Policy Statement*, 67 *Federal Register* 5003, Washington, DC, February 1.

NRC (U.S. Nuclear Regulatory Commission), 2006, *Consolidated Decommissioning Guidance*, NUREG-1757, Volume 2, Rev. 1, Washington, DC, September.

NRC (U.S. Nuclear Regulatory Commission), 2007, *Radiological Criteria for License Termination*, 10 CFR Part 20, Subpart E, Washington, DC, January.

NYSDEC (New York State Department of Environmental Conservation), 2008, *Public Outreach for Proposed Regulation 6 NYCRR Part 384, New Regulations for Cleanup of Radioactively Contaminated Sites* (accessed August 29, 2008, http://www.dec.ny.gov/ chemical/42047.html), February 11.

WVES (West Valley Environmental Services) 2008, Personal Communication (email) from K. Mortensen to R. Steiner, Washington Safety Management Solutions, "EIS Dose Information," September 3.

APPENDIX M
FLOODPLAIN AND WETLAND ASSESSMENT

APPENDIX M
FLOODPLAIN AND WETLAND ASSESSMENT

M.1 Introduction

The U.S. Department of Energy (DOE) proposes to decontaminate and decommission the waste storage tanks and other facilities of the Western New York Nuclear Service Center (WNYNSC) in which the high-level radioactive waste solidified under the West Valley Demonstration Project (WVDP) was stored, the facilities used in the solidification of the waste, and any material and hardware used in connection with WVDP, in accordance with the requirements of the WVDP Act. DOE is preparing this *Final Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center (Decommissioning and/or Long-Term Stewardship EIS*) (DOE/EIS-0226) to present the environmental impacts associated with the range of reasonable alternatives to meet the DOE and New York State Energy Research and Development Authority (NYSERDA) National Environmental Policy Act (NEPA) and New York State Environmental Quality Review Act (SEQR) requirements, respectively.

Executive Order 11988, *Floodplain Management*, directs Federal agencies to evaluate the potential effects of any actions that may be taken in a floodplain. When conducting activities in a floodplain, Federal agencies are required to take actions to reduce the risk of flood damage; minimize the impact of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values served by floodplains. Executive Order 11990, *Protection of Wetlands*, directs Federal agencies to ensure consideration of wetlands protection in decisionmaking and to evaluate the potential impacts of any new construction proposed in a wetland. Federal agencies shall avoid the destruction or modification of wetlands and avoid direct or indirect support of new construction in wetlands if a practicable alternative exists.

DOE requirements for compliance with Executive Orders 11988 and 11990 are set forth in 10 *Code of Federal Regulations* (CFR) Part 1022, "Compliance with Floodplain and Wetland Environmental Review Requirements." These Executive Orders direct Federal agencies to implement floodplain and wetland requirements through existing procedures and guidelines such as those established to implement NEPA or those developed by individual states, to the extent practicable. Pursuant to 10 CFR Part 1022, this appendix addresses actions that would affect floodplains or wetlands under each of the alternatives evaluated in this environmental impact statement (EIS).

M.2 Alternatives and Affected Environment

A detailed description of the alternatives is found in Chapter 2 of this EIS. The alternatives include the Sitewide Removal Alternative, which would allow unrestricted release of the entire WNYNSC; the Sitewide Close-In-Place Alternative, under which all existing facilities and contamination would be managed at their current locations, and, in areas with higher levels of long-lived contamination, engineered barriers would be used to control contamination; the Phased Decisionmaking Alternative, under which there would be initial (Phase 1) decommissioning actions for some facilities and a variety of activities intended to expand the information available to support later, additional decommissioning decisionmaking (Phase 2) for those facilities/areas not addressed in Phase 1; and the No Action Alternative. This appendix addresses potential floodplain and wetland impacts under each of these alternatives.

WNYNSC, shown on **Figure M–1**, occupies 1,351 hectares (3,338 acres) of land primarily in Cattaraugus County, New York, with approximately 5.7 hectares (14 acres) of the site in southern Erie County, New York. WNYNSC is drained by Buttermilk Creek, which joins Cattaraugus Creek at the northern end of the property. Cattaraugus Creek flows northwest into Lake Erie approximately 50 kilometers (30 miles) southwest of Buffalo, New York.

WNYNSC is divided into 12 Waste Management Areas (WMAs). WMA 1 through 10 are shown on **Figure M–2**, and WMA 11 and 12 are shown on **Figure M–3**. The Region of Influence addressed in this "Floodplain and Wetland Assessment" includes WNYNSC and nearby offsite areas.

M.2.1 Floodplains

Floodplain is defined as "the lowlands adjoining inland and coastal waters and relatively flat areas and floodprone areas of offshore islands" (10 CFR 1022.4). A floodplain is the area of land adjacent to a river, stream, or creek that may become inundated by floodwaters, often following heavy rainfall events that cause the channel to exceed bankfull discharge. Floodplains retain excess water following flood events, allowing water to be slowly released into the river system and seep into groundwater aquifers. Likewise, floodplains are natural recharge areas that help replenish the baseflow of the river system, as well as supply recharge to underlying groundwater aquifers. Vegetation and woody debris in floodplains slow surface flow and floodwaters and act like a sediment trap by causing sediment to settle out of floodwaters, thereby preventing alteration of the downstream channel geography due to sedimentation. This is a benefit because sedimentation can have adverse ecological impacts, as well as impacts on the channel hydraulics and geomorphology. Floodplains often support important wildlife habitat and are frequently used by humans as recreational areas.

A 100-year flood is a flood that has a 1 percent probability of being equaled or exceeded in any given year (10 CFR 1022.4). The area inundated by the 100-year flood is called the 100-year floodplain. A 500-year flood is a flood that has a 0.2 percent probability of being equaled or exceeded in any given year, inundating the flood area known as the 500-year floodplain. Probable maximum precipitation is defined as the greatest depth (amount) of precipitation, for a given storm duration, that is theoretically possible for a particular area and geographic location. The probable maximum flood (PMF) is the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area (i.e., the worst theoretical flood that could be expected to occur).

A critical action floodplain means, at a minimum, the 500-year floodplain (10 CFR 1022.4). Critical action means any DOE action for which even a slight chance of flooding would be too great. Such actions may include, but are not limited to, the storage of highly volatile, toxic, or water-reactive materials. In a case where an action is determined to be a critical action, a flood less frequent than a 500-year flood may be appropriate for determining the floodplain.

As described in the *Final Environmental Assessment for Decontamination, Demolition, and Removal of Certain Facilities at the West Valley Demonstration Project* (DOE/EA-1552), WNYNSC's topographic setting renders major flooding unlikely; local runoff and flooding is adequately accommodated by natural and manmade drainage systems in and around WVDP (DOE 2006). The flood inundation area for the 100-year storm (see **Figure M–4**) shows that no existing facilities are in the 100-year floodplain. This is primarily attributable to the fact that Cattaraugus and Buttermilk Creeks, as well as Franks Creek, Quarry Creek, and Erdman Brook, are located in deep valleys such that floodwaters would not overtop their banks, flooding the plateau areas where WVDP facilities are located. The floodplains depicted on Figure M–4 are those that would be affected by implementation of alternatives for decommissioning activities, as described in this appendix. None of the proposed activities would affect the Buttermilk Creek floodplain in the southern part of WNYNSC (FEMA 1984).

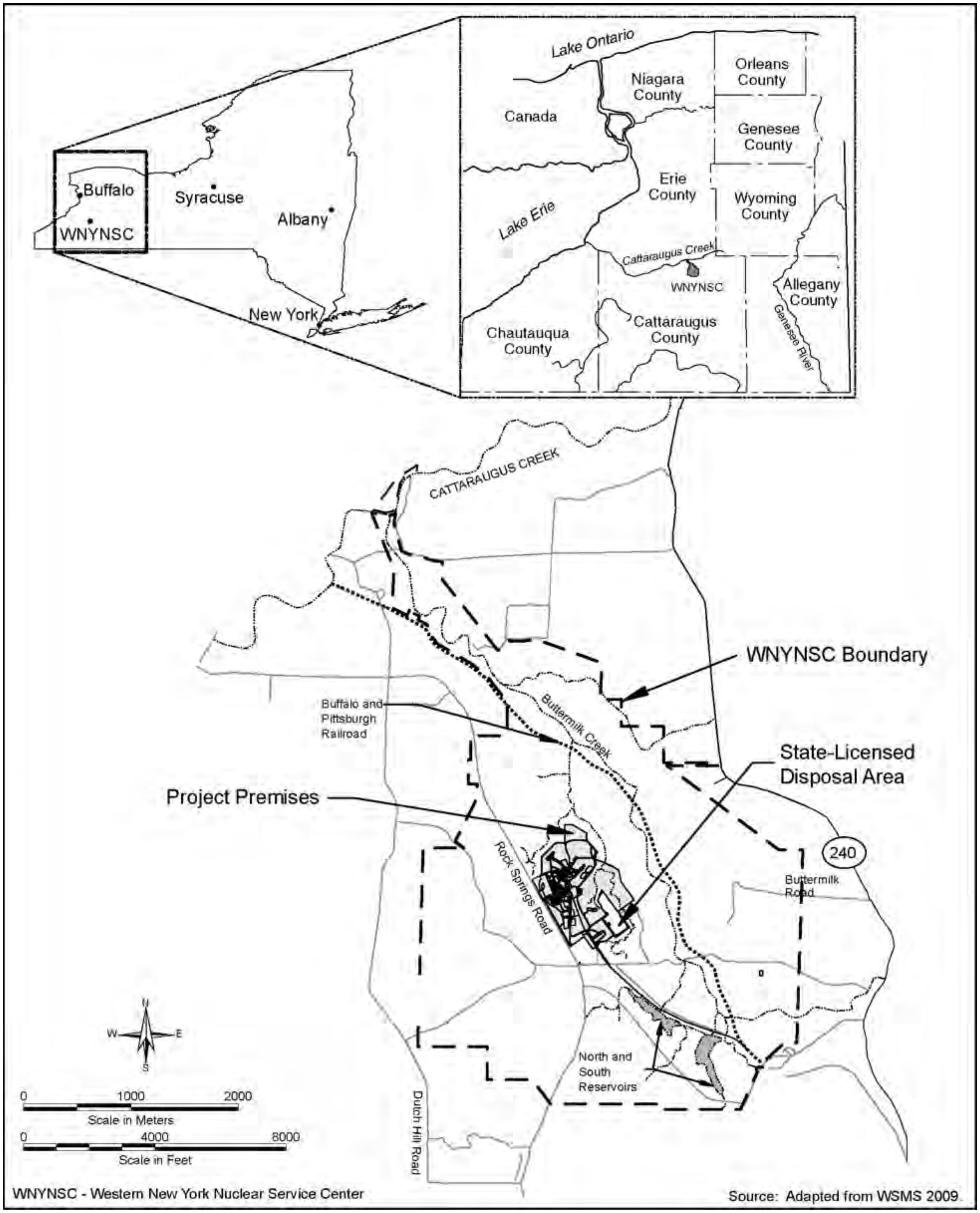

Figure M–1 The Western New York Nuclear Service Center

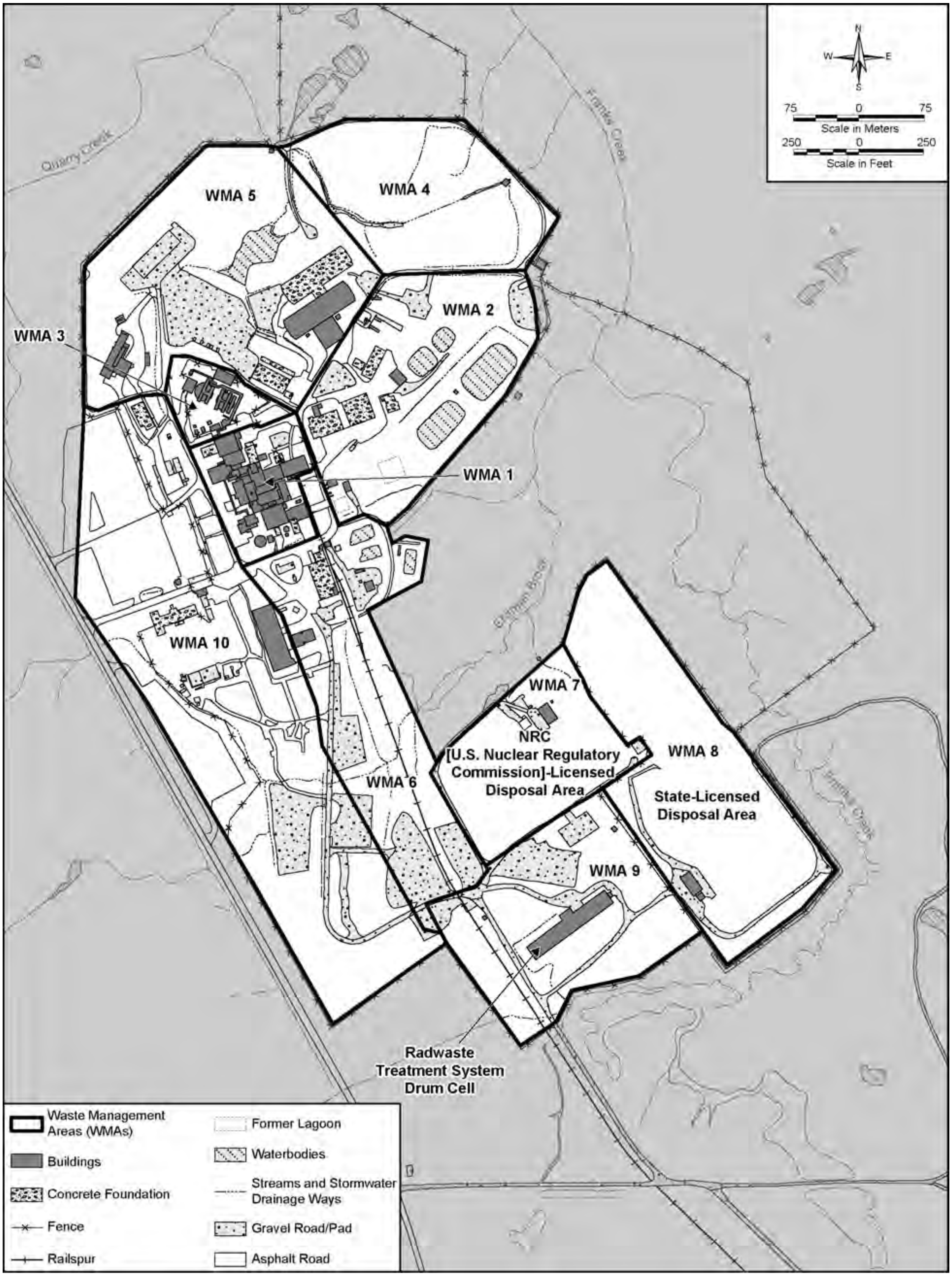

Figure M–2 Location of Waste Management Areas 1 Through 10

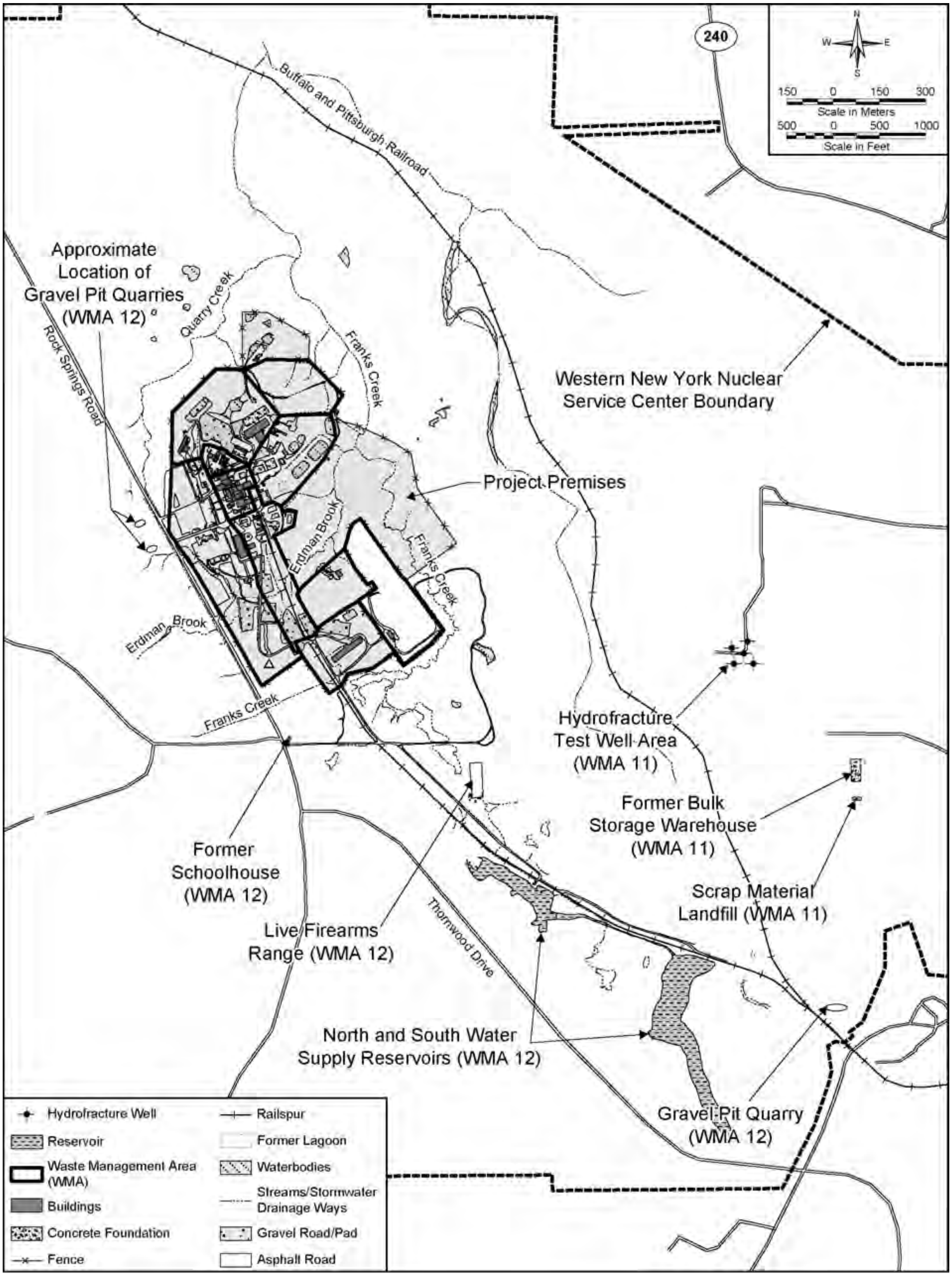

Figure M–3 Waste Management Areas 11 and 12 – Bulk Storage Warehouse Area and Balance of the Western New York Nuclear Service Center

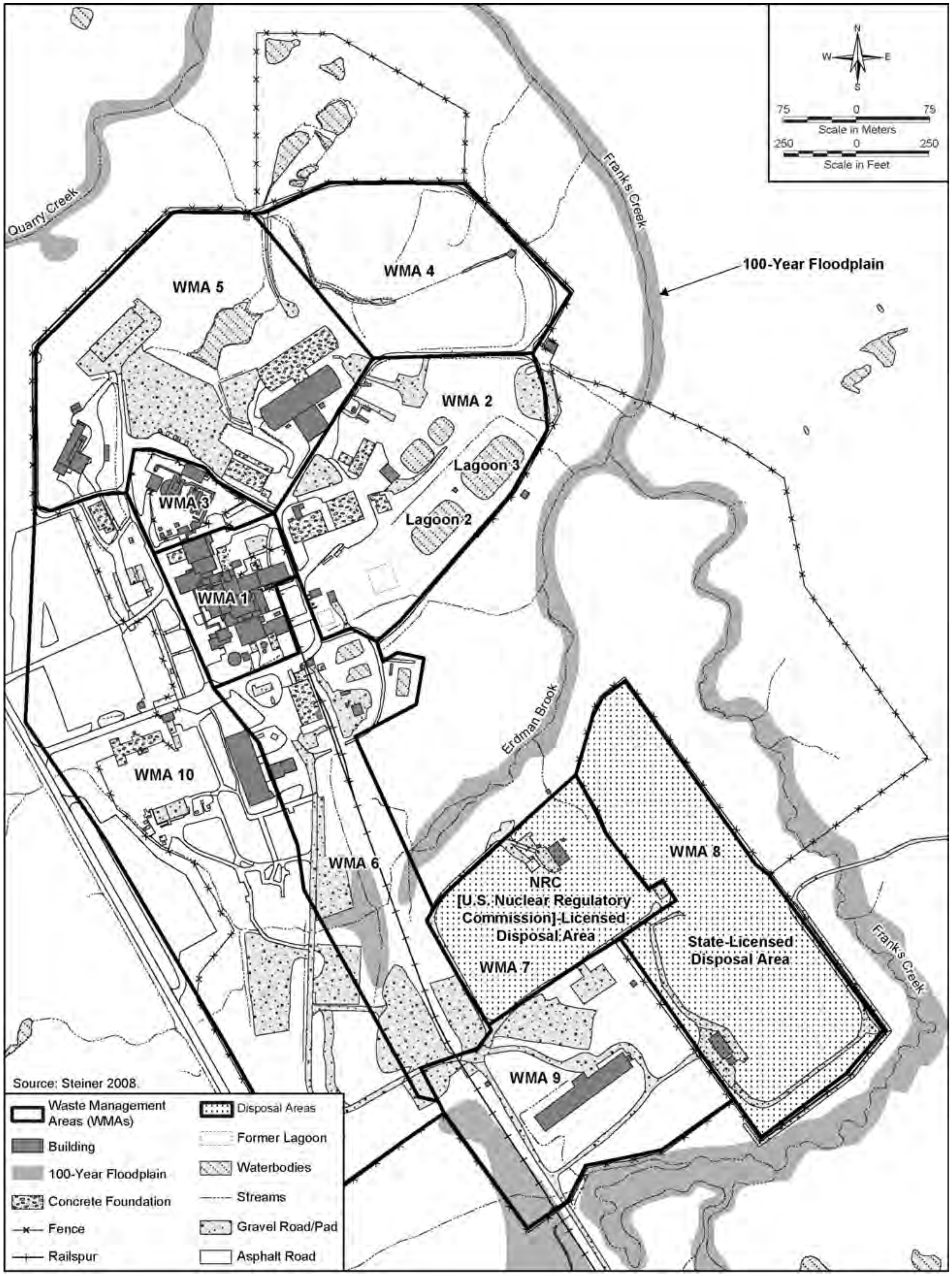

Figure M–4 100-Year Floodplain Near the West Valley Demonstration Project

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps for the town of Ashford, New York, delineate areas of the 100-year floodplain and areas above the 500-year floodplain (FEMA 1984). However, the FEMA maps do not show the floodplains on streams near the developed portion of the site. An analysis of the PMF based on probable maximum precipitation has been performed for this EIS (see **Figure M–5**). The PMF is generally more conservative than the 500-year flood because it is defined as the flood resulting from the most severe combination of meteorological and hydrologic conditions that are reasonably possible in a particular area (DOE 2002). The results of this analysis indicate that the PMF floodplain is very similar to the 100-year floodplain, particularly in areas adjacent to the industrialized or developed portions of the site, including areas where waste is stored or buried (URS 2008). Most of the stream channels near the industrialized area have relatively steep sides; the PMF flow would remain in these channels. The PMF floodplain is wider than the 100-year floodplain in areas where the topography is relatively flat, such as the extreme upper reaches of Erdman Brook and Franks Creek. Indirect short-term impacts, including streambank failure and gully head advancement in the event of high streamflows, could, in turn, impact Lagoons 2 and 3 in WMA 2, the NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area (NDA), and site access roads in several locations. Under PMF conditions, it is possible that the integrity of the northern slope of the State-Licensed Disposal Area (SDA) could be compromised (WVNS 2007). See Appendix F of this EIS for results of predictive erosion modeling, including the effects of sheet and rill erosion, stream valley rim widening, and gully advance over a longer term.

M.2.2 Wetlands

Wetlands include "those areas that are inundated or saturated by surface- or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (EPA 2002). Wetlands perform numerous environmental functions that benefit ecosystems as well as society, such as removing excess nutrients from the water that flows through them. The benefit derived from nutrient removal is improved or maintained water quality. This in turn promotes clean drinking water, safe recreation, and secure fish and wildlife habitat. Further, wetlands absorb, store, and slowly release rain and snowmelt water, which minimizes flooding, stabilizes water flow, retards runoff erosion, and controls sedimentation. Wetlands filter natural and manufactured pollutants by acting as natural biological and chemical oxidation basins. Water leaving a wetland is frequently cleaner than the water entering. Wetlands can also be helpful in recharging groundwater and serve as groundwater discharge sites, thereby maintaining the quality and quantity of surface-water supplies. Wetlands are one of the most productive and valuable habitats for feeding, nesting, breeding, spawning, resting, and cover for fish and wildlife (NYSDEC 2005).

The most recent wetland delineation was conducted in July and August of 2003 and verified in November 2005 on approximately 152 hectares (375 acres) of WNYNSC, including the Project Premises and adjacent parcels to the south and east of the Project Premises (Wierzbicki 2006, WVNS and URS 2004). Wetland plant communities identified within the limits of the assessment area included wet meadow, emergent marsh, scrub-shrub, and forested wetland.

A field investigation conducted on November 2, 2005, by the U.S. Army Corps of Engineers in conjunction with review of relevant reports and maps, confirmed the 2003 wetland delineation results that there are wetlands totaling 68 areas comprising approximately 14.78 hectares (36.52 acres), with each area ranging from 0.004 to 2.95 hectares (0.01 to 7.3 acres), as shown on **Figures M–6** and **M–7**. Twelve distinct wetlands, totaling 0.98 hectares (2.43 acres), were observed to exhibit no surface-water connection to waters of the United States, and were at that time considered isolated, intrastate, and non-navigable wetlands. It was concluded that 13.8 hectares (34.09 acres) of wetlands were waters of the United States subject to regulation under Section 404 of the Clean Water Act. These waters were determined to be part of an ecological

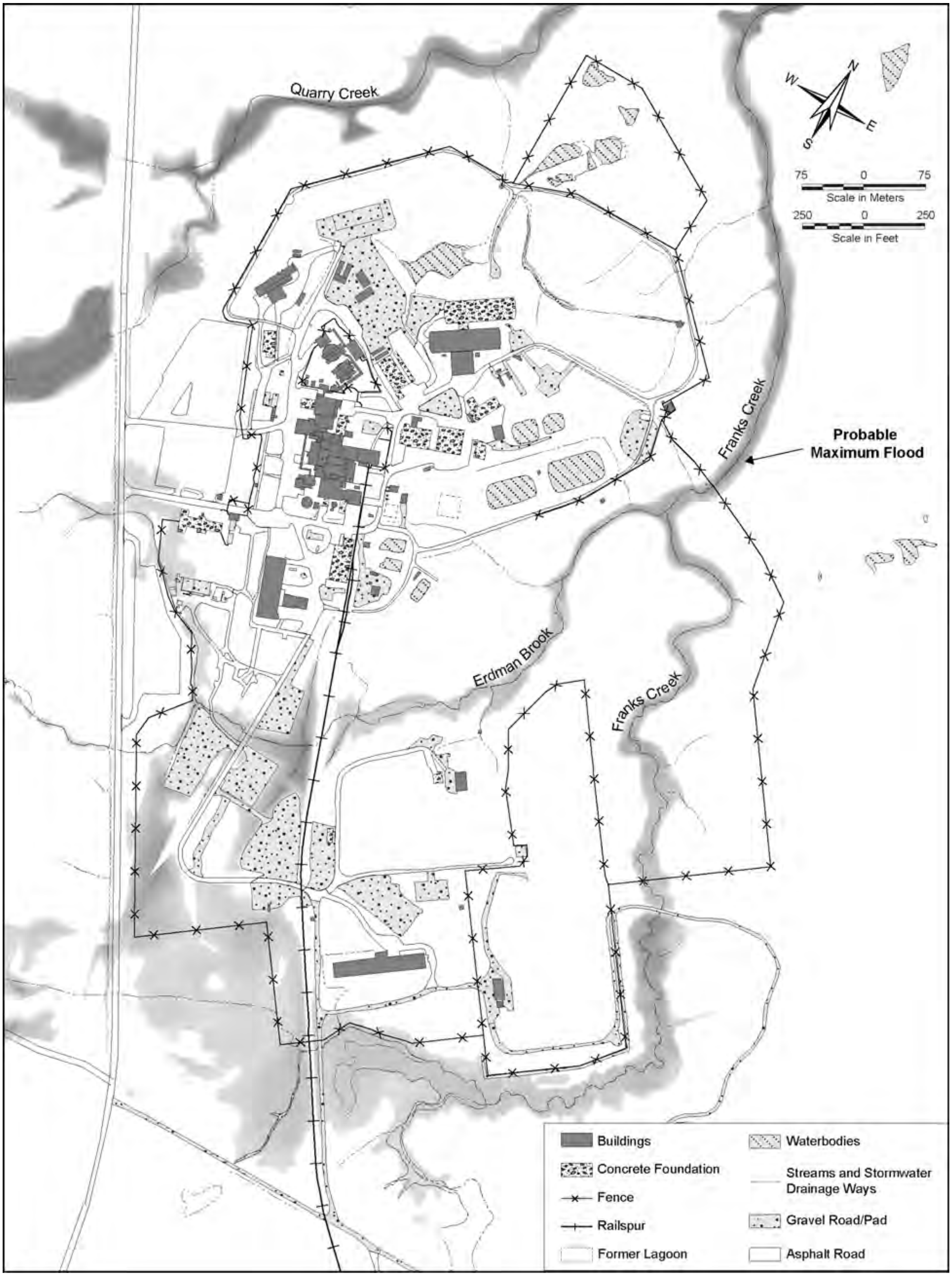

Figure M–5 Probable Maximum Flood

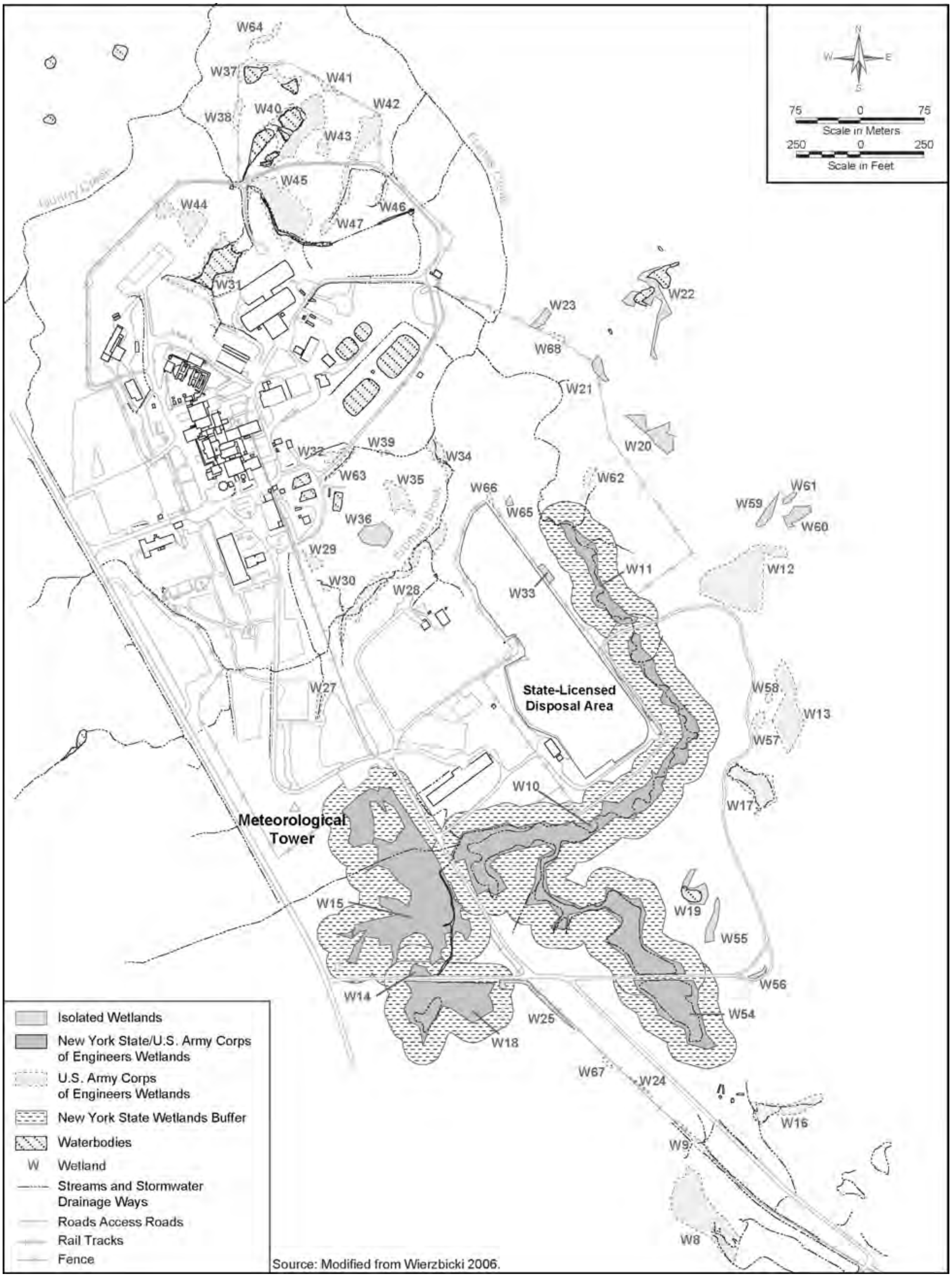

Figure M–6 Wetlands in the Vicinity of the Project Premises

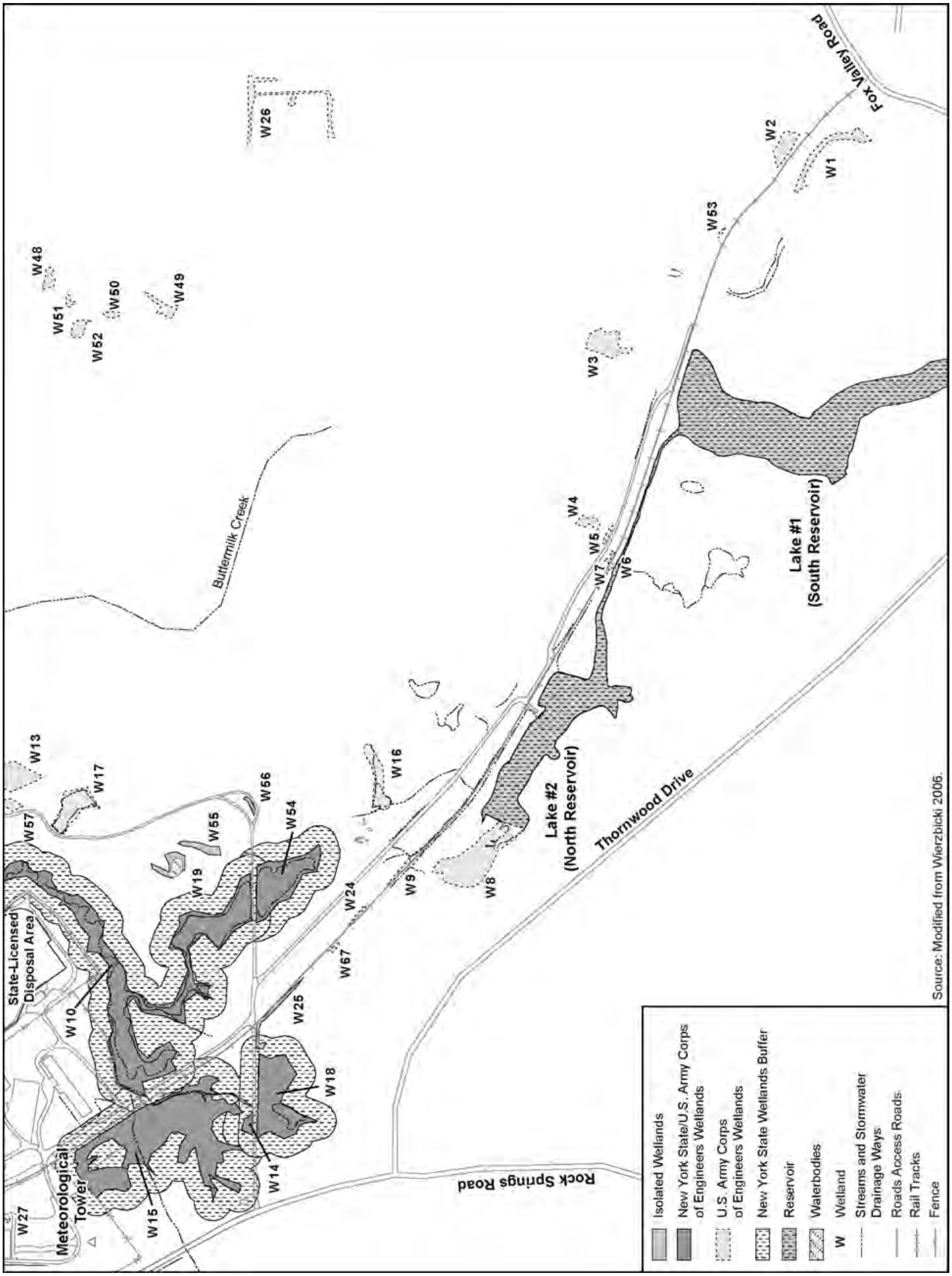

Figure M–7 Wetlands in the Southern Vicinity of the Project Premises

continuum constituting a surface water tributary system of Buttermilk Creek, Cattaraugus Creek, and Lake Erie. The U.S. Army Corps of Engineers approved DOE's wetland determination application on January 26, 2006, valid for a period of 5 years unless new information would warrant revision prior to the expiration date (Senus 2006).

Since the November 2005 wetland review, the U.S. Army Corps of Engineers, in conjunction with the U.S. Environmental Protection Agency, has provided new guidance regarding the agency's determination of jurisdiction over "wetlands adjacent to, but not directly abutting, a relatively permanent tributary" (i.e., isolated wetlands) (EPA and ACE 2007). This guidance states that the U.S. Army Corps of Engineers will decide jurisdiction of such a wetland "…based on a fact-specific analysis to determine whether they have a significant nexus with a traditional navigable water." The guidance goes on to state that the "…analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by all wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical and biological integrity of downstream traditional navigable waters." Although a specific analysis has not been conducted, the 12 isolated wetlands identified in 2003 are similarly situated to the site tributaries as are area wetlands under U.S. Army Corps of Engineers' jurisdiction. Further, these wetlands could be expected to function similarly since, like many jurisdictional wetlands, nearly all are wet meadows. For the purpose of this analysis and based on the new guidance, DOE has conservatively included the 12 isolated wetlands as part of the jurisdictional wetland total, thereby giving a total area of regulated wetlands of 14.78 hectares (36.52 acres). The analysis presented in Chapter 4 of this EIS has been revised to reflect the new total.

In addition to being considered jurisdictional by the U.S. Army Corps of Engineers, certain wetlands are also regulated by New York as freshwater wetlands. Article 24 of New York State's Freshwater Wetlands Act regulates draining, filling, construction, pollution, or any activity that substantially impairs any of the functions and values provided by wetlands 5.0 hectares (12.4 acres) or larger. The state also regulates work within a 30.5-meter (100-foot) adjacent area around designated freshwater wetlands. Although there are no wetlands currently mapped by the New York State Department of Environmental Conservation (NYSDEC), six wetlands (W10, W11, W14, W15, W18, and W54), encompassing 7.0 hectares (17.3 acres) and delineated in the 2003 field investigation, appear to be hydrologically connected (see Figure M–7). The majority of these wetlands are located just south of the south Project Premises fence (WVNS and URS 2004). On December 28, 2005, NYSDEC-Region 9 concurred with the wetland delineation conducted in 2003. NYSDEC concluded that the six wetland areas are hydrologically connected, exceed 5.0 hectares (12.4 acres), and therefore, in aggregate, constitute an Article 24 state-jurisdictional wetland (Ermer 2005). These wetland areas are dominated by wet meadow plant communities but also include emergent marsh, scrub-shrub (shrub swamp), and forested wetland (deciduous swamp) plant communities (WVNS and URS 2004). The character of this area is consistent with the New York State Freshwater Wetlands classification system definition of a Class IV wetland (of the four classes, Class I has the highest value) (WVNS and URS 2004). The classification system recognizes that different wetland types have different values and applies different standards for permit issuance.

M.3 Floodplain and Wetland Impacts

M.3.1 Sitewide Removal Alternative

M.3.1.1 Floodplains

Short-term impacts on the 100-year floodplain would be expected for the delineated floodplain zone in the proximity of Cesium Prong remediation work, the north and south reservoirs and dam removal, and streambed sediment remediation in Erdman Brook and Franks Creek. Although major flooding is unlikely, these activities could result in short-term floodway or floodplain alteration, impeding or redirecting flows or surface-flow impacts on the 100-year floodplain. Changes in floodplain erosion and sedimentation rates are not expected to create adverse unmitigatible impacts, as appropriate mitigation measures to control erosion and sediment during decommissioning and closure activities would decrease impacts (see Section M.4.1).

Results of the PMF analysis indicate that the delineation of the PMF floodplain is close to that of the 100-year floodplain (URS 2008). New facilities proposed for construction under the Sitewide Removal Alternative would not be located in the 100-year floodplain. Preliminary analysis using current topography indicates the only facility near the PMF floodplain would be the planned Interim Storage Facility. A more-detailed analysis would be required as part of detailed design of the Interim Storage Facility to minimize potential impacts, if any, to the floodplain.

No permanent losses to the 100-year or PMF floodplain areas in the WNYNSC vicinity would result from implementation of the Sitewide Removal Alternative, and loss of flood storage volume would not occur.

M.3.1.2 Wetlands

Under the Sitewide Removal Alternative, no wetlands would be affected during construction of temporary facilities because none are present on the proposed building sites. However, wetlands would be directly and indirectly impacted by demolition and remediation activities, particularly during remediation of the Cesium Prong. Indirect impacts include alteration or destruction of wetlands resulting from sedimentation following earthmoving activities and the removal of contaminated sediments from streams. Noise and human presence may also impact wildlife present within wetland areas.

Direct impacts on wetlands would occur in connection with remediation of the Cesium Prong where six delineated wetland areas (W31, W37, W38, W40, W44, and W45) totaling 2.1 hectares (5.1 acres) are located in and around WMAs 3, 4, and 5. Removal of the SDA would directly impact three jurisdictional wetlands (W33, W65, and W66) totaling 0.04 hectares (0.1 acres). Removal of the SDA also has the potential to impact the 30.5-meter (100-foot) adjacent area around the New York State Freshwater Wetlands (W10 and W11) that border the SDA to the east and south (see Figure M–6). Any work within the adjacent area would require a permit from the state. Additionally, five other wetland areas (W4, W5, W6, W7, and W8) measuring a total of 0.7 hectares (1.8 acres) would be affected as a result of altered water levels and siltation during closure of the dams and reservoirs in WMA 12 (see Figure M–7). The largest of these wetlands is located at the head end of the North Reservoir, while the other four smaller wetlands are located just downstream from the discharge point from the North Reservoir. Noise and human presence may impact wildlife within the wetland areas. Wetlands not disturbed by activities associated with the Sitewide Removal Alternative would continue to perform water quality functions such as sediment retention and stabilization, nutrient transformation, and flood flow attenuation.

If needed, prior to the disturbance of any jurisdictional wetland, a Section 404 permit would be acquired from the U.S. Army Corps of Engineers, and, in the case of a New York State freshwater wetland, a permit would be acquired from NYSDEC. Additionally, a mitigation plan would be developed that would fully address the compensation mechanism selected (i.e., compensatory mitigation, mitigation bank, or in-lieu fee mitigation) to mitigate wetland impacts (73 *Federal Register* [FR] 19594). Best management practices, including erosion and sediment controls, would be implemented during any remediation work potentially affecting wetlands.

M.3.2 Sitewide Close-In-Place Alternative

M.3.2.1 Floodplains

Construction of new facilities proposed under the Sitewide Close-In-Place Alternative (e.g., the Interim Storage Facility and the Leachate Treatment Facility) would not impact the 100-year floodplain because none of these facilities would be constructed in the 100-year floodplain. However, replacement of existing geomembrane covers with robust multi-layer caps (i.e., engineered barriers) on the South Plateau in WMAs 7 and 8 (on the upgradient side of the NDA and SDA, respectively) would intrude into the 100-year floodplain delineated for Erdman Brook and Franks Creek (see **Figure M–8**). The erosion control structures planned under the Sitewide Close-In-Place Alternative would increase water flow around two sides of WMA 8 in the proximity of the 100-year floodplain. This redirection of water to Franks Creek on the floodplain would increase the potential for erosion from the increased flow.

Constructing permanent structures in the 100-floodplain could directly impact channel hydraulics and the extent of downstream flood inundation areas as a result of increasing the floodplain elevation in the vicinity of the South Plateau. If there is a major increase in structures constructed in the 100-year floodplain of the South Plateau, flood events extending into the 100-year floodplain delineated for Erdman Brook and Franks Creek, shown on Figure M–8, could occur more often because there would be less area for the water to spread. This could also result in an increase in flooding downstream of the South Plateau because a larger volume of water would be traveling downstream rather than inundating the floodplain in the South Plateau. As a result of a larger volume of water flowing in the downstream direction, the frequency and intensity of flood events occurring downstream of the South Plateau could increase.

The PMF floodplain is very similar to the 100-year floodplain, and most of the impacts on the PMF floodplain due to implementation of the Sitewide Close-In-Place Alternative are expected to be similar to those identified in this section for the 100-year floodplain. Preliminary analysis using current topography indicates the only facility in or near the PMF floodplain would be the planned Interim Storage Facility. A more-detailed analysis would be required as part of detailed design of the Interim Storage Facility to minimize potential impacts, if any, on the floodplain.

Potential long-term impacts may occur from repeated flooding events (i.e., 100-year floods or greater) affecting the integrity of the engineered barriers. If the barriers were to be breached, releases could occur, particularly when institutional controls can no longer be assumed to be in place. Long-term impacts under the Sitewide Close-In-Place Alternative are presented in Section H.2.2 of Appendix H, "Long-term Performance Assessment Results." Section H.2.2 discusses an indefinite continuation of institutional controls, including impacts following releases to the local groundwater, discharges to onsite streams (Erdman Brook, Franks Creek, and Buttermilk Creek), and flow into Cattaraugus Creek. Additionally, the loss of institutional controls leading to unmitigated erosion of the NDA and SDA (i.e., no credit is taken for monitoring and maintenance of erosion control structures) is analyzed in Appendix H.

M.3.2.2 Wetlands

Construction of new facilities proposed under the Sitewide Close-In-Place Alternative would not affect wetlands because no wetlands are present on the proposed building sites. However, construction of erosion control measures under this alternative would directly impact two jurisdictional wetlands (W34 and W39) totaling approximately 0.1 hectares (0.3 acres), while placement of the multi-layer cap over the NDA and SDA would directly impact five jurisdictional wetlands (W10 and W11 [both also New York State Freshwater Wetlands], and W33, W65, and W66) totaling 3.4 hectares (8.4 acres). The actual disturbance to the jurisdictional wetlands associated with the multi-layer cap would be less than half of their total area. Impacts on these wetlands would be similar to those identified in Section M.3.1.2. Additionally, placement of the multi-layer cap has the potential to cause indirect impacts (e.g., sedimentation) on those portions of the New York State wetlands not directly impacted. Placement of the multi-layer cap would impact the 30.5-meter (100-foot) adjacent area around the New York State wetlands. Any work within the state wetlands (and adjacent area) would require a permit from the state, as well as the U.S. Army Corps of Engineers. Mitigation measures identified in Section M.4.2 would be implemented to address direct and indirect impacts.

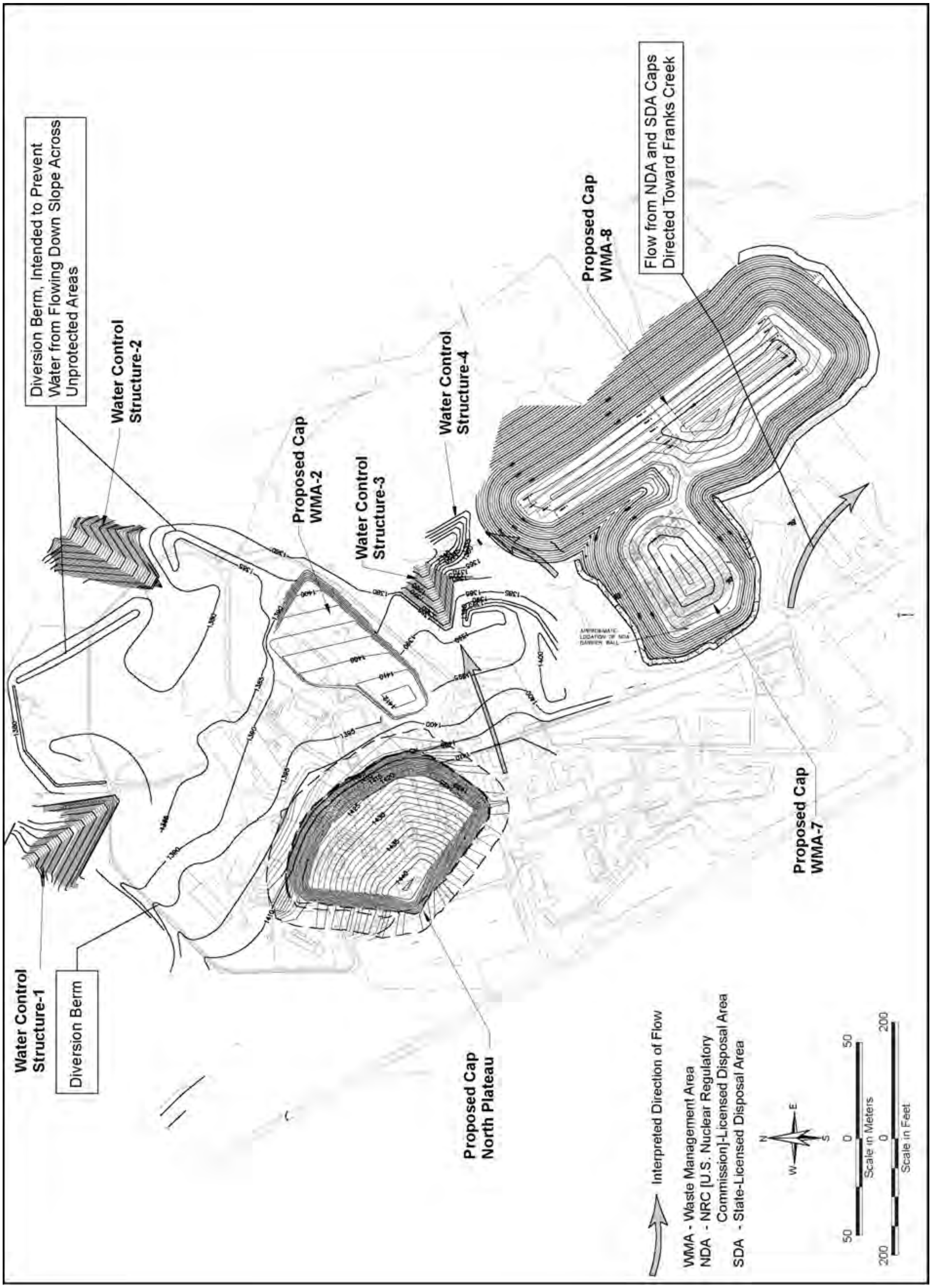

Figure M–8 Floodplain Encroachment by Multi-layer Covers for Waste Management Areas 7 and 8

Similar to the Sitewide Removal Alternative, five wetland areas comprising 0.7 hectares (1.8 acres) could be affected during activities associated with closure of the dams and reservoirs. Direct and indirect impacts resulting from remediation and closure activities, as well as mitigation measures, would be similar to those identified for the Sitewide Removal Alternative. Because the North Plateau Groundwater Plume and Cesium Prong would not involve removal of soils in nonsource areas, there would be no indirect impacts on wetlands in that area of the site.

M.3.3 Phased Decisionmaking Alternative

Phase 1 of the Phased Decisionmaking Alternative would involve some decommissioning actions, but would also include additional characterization of site contamination and studies to provide information to support additional consensus decommissioning decisionmaking. Phase 2 would complete the decommissioning activities.

M.3.3.1 Floodplains

No construction proposed under Phase 1 of this alternative (the Interim Storage Facility) would be located in the 100-year floodplain. The Cesium Prong would be managed in place, dams and reservoirs would be monitored and maintained, and contaminated sediment would not be removed from Erdman Brook and Franks Creek. Most of the impacts on the PMF floodplain due to implementation of Phase 1 would be similar to those identified for the 100-year floodplain; preliminary analysis using current topography indicates the only facility in or near the PMF floodplain would be the planned Interim Storage Facility. A more-detailed analysis would be required as part of detailed design of the Interim Storage Facility to minimize potential impacts, if any, on the floodplain.

If Phase 2 actions under the Phased Decisionmaking Alternative include removal activities, short-term impacts could be expected on the delineated floodplain zone in the proximity of activities, resulting in short-term floodway or floodplain alteration, which could impede or redirect surface flows on the 100-year floodplain. Changes in floodplain erosion and sedimentation rates are not expected to create adverse, unmitigatible impacts, as appropriate mitigation measures to control erosion and sediment during decommissioning and closure activities would be utilized to decrease impacts. Similar impacts would result if the Phase 2 decision for the SDA is continued active management. If the Phase 2 decision is to proceed with in-place closure, direct impacts on the floodplains would not be expected to exceed those identified for the Sitewide Close-In-Place Alternative and would mainly be attributed to the construction of permanent structures (i.e., engineered barriers for the NDA and SDA in WMAs 7 and 8) that would intrude into the 100-year floodplain. If the Phase 2 decision is continued active management of the SDA and in-place closure of the remaining waste and contamination, impacts would be less than those for the Sitewide Close-In-Place Alternative because there would be no multi-layer cap and erosion control features constructed at the SDA that could intrude into the 100-year floodplain.

M.3.3.2 Wetlands

During Phase 1 of this alternative, construction of temporary facilities would not affect wetlands because none are present on the proposed building sites. Further, with the exception of possible remediation of streambed sediment, remediation and closure activities planned under this alternative would not directly impact wetlands because none are present in the associated WMAs. The removal of existing facilities, however, could lead to indirect impacts on nearby wetlands as described for the Sitewide Removal Alternative in Section M.3.1.2. Because there would not be any remediation activities for the nonsource area of the North Plateau Groundwater Plume and Cesium Prong, there would be no impacts on wetlands in this area.

If Phase 2 closure activities are similar to those of the Sitewide Removal Alternative, impacts on wetlands would be similar to those addressed for that alternative in Section M.3.1.2. Thus, direct impacts on wetlands totaling 2.8 hectares (7.0 acres) and indirect impacts are possible and would result largely from the remediation of the North Plateau Groundwater Plume and Cesium Prong and removal of the north and south reservoirs. If activities associated with Phase 2 are similar to those of the Sitewide Close-In-Place Alternative, direct impacts on wetlands totaling 4.2 hectares (10.4 acres) and indirect impacts would be similar to those identified in Section M.3.2.2. In this case, impacts would largely result from the installation of erosion control measures and the placement of multi-layer caps over the SDA. If the Phase 2 decision for the SDA is continued active management while the remaining waste and contamination at the site is either removed or closed in place, there would be fewer wetlands disturbed (i.e., W10, W11, W33, W65, and W66), because the SDA and the immediately surrounding area would remain in their current condition.

M.3.4 No Action Alternative

M.3.4.1 Floodplains

No decommissioning activities would take place under the No Action Alternative; therefore, no floodplain impacts (or changes from the baseline condition) would occur. Floodplains in the vicinity of WVDP would continue natural recharge functions such as replenishing the base flow of the nearby creek system, as well as supplying recharge to underlying groundwater aquifers. Additionally, vegetation and woody debris in the floodplains would continue to slow surface flow (i.e., floodwaters) and act like a sediment trap, thereby preventing alteration of the downstream channel geography due to sedimentation.

M.3.4.2 Wetlands

Under the No Action Alternative, no decommissioning actions would be undertaken. Once deactivation activities were completed, a portion of WNYNSC (693 hectares [1,713 acres]) could be released, while remaining portions would continue to be monitored and maintained, as required by Federal and state regulations. Therefore, there would be no decommissioning impacts under this alternative.

M.4 Mitigation Measures

This section discusses the floodplain and wetland mitigation measures considered under the alternatives, which, where necessary and feasible, would be implemented during construction, operational, and decommissioning activities.

In accordance with 10 CFR 1022.12(a)(3), DOE must address measures to mitigate the adverse impacts of actions in a floodplain or wetlands, including but not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecologically sensitive areas. Wherever possible, DOE would avoid disturbing floodplains and wetlands and would minimize impacts to the extent practicable if avoidance is not possible.

M.4.1 Floodplains

In accordance with Executive Order 11988, *Floodplain Management,* if activities directly impacting the floodplain are implemented under the Sitewide Removal Alternative or the Sitewide Close-In-Place Alternative, flood protection measures would be implemented to reduce the risk of flood damage; minimize the impact of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values served by the floodplain. Erosion controls for the engineered barriers, depicted on Figure C–28 in Appendix C of this EIS, would be designed to accommodate the PMF consistent with guidance in NUREG-1623, *Design of Erosion Protection for Long-Term Stabilization* (NRC 2002).

NYSDEC is the state's National Flood Insurance Program coordinating agency. Coordination with NYSDEC for technical assistance and guidance would occur prior to Cesium Prong remediation work, north and south reservoir decommissioning and associated dam removal, and contaminated sediment removal from Erdman Brook and Franks Creek (under the Sitewide Removal Alternative), or installation of engineered multi-layer covers in the South Plateau (under the Sitewide Close-In-Place Alternative). This coordination relative to affected floodplains would ensure that requirements of NYSDEC's *Floodplain Development and Floodway Guidance* are met (NYSDEC 2008).

The potential effects of flood hazards are expected to be minimal under Phase 1 of the Phased Decisionmaking Alternative and for the No Action Alternative. Where activities would affect the 100-year floodplain and PMF floodplain (Sitewide Removal Alternative, Close-In-Place Alternative, and possibly Phase 2 of the Phased Decisionmaking Alternative), appropriate mitigation measures would be taken to minimize construction in the floodplain, establish vegetated buffer zones, and avoid soil-disturbing activities during wet seasons. Stormwater runoff and erosion control measures identified in the following paragraph would be employed to reduce impacts on the floodplain.

Potential short-term impacts on the existing stormwater drainage infrastructure with the potential to impact floodplains would be mitigated by using appropriate stormwater runoff management during construction and operational phases. These measures include adherence to the State Pollutant Discharge Elimination System (SPDES) General Permit, which requires the implementation of best management practices during regulated construction activities to reduce nonsource pollutant loadings into waters of the state. For all of the proposed alternatives, stormwater runoff and erosion can be minimized during construction through the use of best management practices including, but not limited to, the following:

- Diversion structures designed to channel runoff away from disturbed surfaces
- Structures designed to collect, retain, or treat any water that contacts disturbed surfaces
- Permanent stabilization of exposed surfaces once construction is complete
- Locating roads and access where the effect on water quality will be the least
- Implementing good housekeeping practices, such as proper storage and spill prevention measures to prevent runoff from fuels, solvents, and other hazardous materials
- Properly designing, constructing, and maintaining affected property in a manner that will minimize contribution of pollutants to the water

Specific requirements for a Sitewide Stormwater Pollution Prevention Plan are listed in Section M.4.2.

M.4.2 Wetlands

Mitigation measures for impacts on wetlands associated with implementation of the proposed alternatives are described in the following paragraphs.

Activities affecting wetlands would be coordinated with the U.S. Army Corps of Engineers and NYSDEC, and through project planning, the graded sequence of avoidance to the extent practicable, minimization, and mitigation would be applied. Section 402 of the Clean Water Act requires permits for stormwater discharges from construction activities that disturb 1 or more acres of land. A Sitewide Stormwater Pollution Prevention Plan for controlling runoff and pollutants from the site during and after construction activities would be required to obtain a permit under NYSDEC's General Permit (GP-0-08-001) for Stormwater Discharges from

Construction Activities. The Sitewide Stormwater Pollution Prevention Plan would address the following mitigating measures: (1) reducing or eliminating erosion and sediment loading, (2) controlling the impact of runoff on the water quality of the receiving water, (3) controlling of the increased volume and peak rate of runoff, and (4) maintaining stormwater controls during and after completion of construction.

If needed, prior to the disturbance of any jurisdictional wetland, a Section 404 permit would be acquired from the U.S. Army Corps of Engineers along with a Section 401 Water Quality Certificate from the State of New York. Additionally, a mitigation plan would be developed that would fully address the compensation mechanism selected (i.e., compensatory mitigation, mitigation bank, or in-lieu fee mitigation) to minimize wetland impacts (73 FR 19594). Best management practices, including erosion and sediment controls and stormwater runoff control measures, would be implemented during all remediation work potentially affecting wetlands. These control measures would be inspected and maintained to prevent indirect impacts on wetlands. Properly maintained equipment and keeping workers within defined work zones would help mitigate the impacts on wildlife by minimizing noise and the extent of disturbed areas from which wildlife would tend to temporarily move during work activities. Should any land-clearing operations be required, the areas to be disturbed would be surveyed for nests of migratory birds in accordance with the Migratory Bird Treaty Act, and mitigation measures, such as undertaking clearing operations outside of the breeding season, might be required.

Filling of wetlands during construction and operations would be minimized to the extent practicable. Short-term surface-water-quality impacts would be mitigated through the use of administrative controls (e.g., delineating work area restrictions and erecting exclusion fencing) and physical controls (e.g., best management practices to decrease erosion, sedimentation, and stormwater runoff) (DOE 2006). Best management practices, as applicable, would include erosion and sediment control structures, runoff interceptor trenches or swales, filter or silt berms/fences, sediment barriers or basins, rock-lined ditches/swales, slope shaping and retaining fences, surface-water runoff management, stormwater drainage structures, and waste management systems.

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APPENDIX N
INTENTIONAL DESTRUCTIVE ACTS

APPENDIX N
INTENTIONAL DESTRUCTIVE ACTS

The purpose of this appendix is to evaluate the human health impacts of intentional destructive acts (IDAs) at the Western New York Nuclear Service Center. The term "IDA" is used to include intentional malevolent acts, intentional malicious acts, and acts of terrorism.

N.1 Introduction

In accordance with recent U.S. Department of Energy (DOE) National Environmental Policy Act (NEPA) guidance (DOE 2006), this appendix was developed to explicitly consider the potential impacts of intentional destructive acts (IDAs) in NEPA documents. A wide range of IDA scenarios involving the release of radiological or toxic chemical materials can be postulated for the Western New York Nuclear Service Center (WNYNSC). Each involves an action by intruders or insiders that affects existing inventories and their distribution at one of the waste management areas (WMAs) or during the transportation of radioactive waste packages from WNYNSC. The human health impacts of an IDA are directly related to the magnitude of radiological or chemical material available for dispersal, as well as the means of dispersing it to the environment. Other factors that affect impacts include population density, distance to the population, and meteorology. Appendix I of this *Final Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center (Decommissioning and/or Long-Term Stewardship EIS)* identifies five locations at WNYNSC: high-level radioactive waste tanks in the Waste Tank Farm (WMA 3); the Main Plant Process Building (WMA 1); radioactive waste packages; the NRC [U.S. Nuclear Regulatory Commission]-Licensed Disposal Area (NDA) (WMA 7); and the State-Licensed Disposal Area (SDA) (WMA 8). These accident locations were evaluated for IDA scenarios.

IDA scenarios were selected based on the magnitude of radioactive or chemical materials at a facility or in a package. Other factors that were considered included the physical and chemical form of radioactive or chemical materials that made them more susceptible to environmental dispersion. For each onsite IDA scenario, a calculation of noninvolved worker, maximally exposed individual (MEI) member of the public, and population doses was performed, as appropriate, using the same computer codes and conservative modeling assumptions for accidents that were used for Appendices I and J of this environmental impact statement (EIS). The MACCS2 V1.13.1 computer code (NRC 1998) was used to calculate IDA radiological consequences from onsite airborne releases. The MACCS2 computer code is described in detail in Appendix I, which also provides detailed discussions of the methods used in calculating radiation doses and their human health effects. The GENII Version 2 computer code (PNNL 2007) was used to calculate radiological consequences from onsite aqueous releases. GENII Version 2 is described in detail in Appendix I. Human health impacts of IDAs relative to the transportation of radioactive waste packages from WNYNSC were also analyzed for each site waste management alternative. The RISKIND computer code (ANL 1995) was used to calculate radiation doses to the MEI and population from such an IDA. RISKIND, a code that has been extensively used in transportation accident analyses, is described in Appendix J of this EIS.

The radiological source term for each scenario was developed to represent the consequences of any carefully planned and executed IDA. Acute (short-term) and chronic (long-term) radiation doses were calculated, as was the likelihood of short-term and latent cancer fatalities from such doses. Health effects of acute exposure were assumed to appear within 1 year of exposure, and those of chronic exposure sometime later. As the frequency of success of these postulated IDA scenarios cannot be quantified, no annual risk was calculated.

N.2 Scenario Development

For onsite IDA scenarios, a group of outsiders is postulated to gain entrance to WNYNSC with the help of an inside employee. These outsiders are carrying weapons, backpacks containing high explosives, and associated detonation equipment. They overpower and eliminate security personnel and gain access to the high-level radioactive waste tanks, Main Plant Process Building, radioactive waste package storage area, NDA, or SDA. They attach the explosives to preselected locations that allow for the breach of any containment or confinement structure or container and cause release of the maximum possible radioactive source term in the form of respirable airborne particles.

The assumed target is the High-Level Waste Tank 8D-B in WMA 3, which has a larger radioisotope inventory than the Main Plant Process Building, the waste packages, or the licensed disposal areas. Tank 8D-B is a bounding composite of Tanks 8D-1 and 8D-2, which are described in Appendix I of this EIS. The explosive charge brought on site is designed, located, and timed to breach the wall of the tank and cylindrical concrete vault, thereby creating a Radiological Dispersal Device (RDD). An RDD usually consists of an explosive with associated detonation and timing equipment and radioactive material which would be dispersed after detonation of the explosive. In this scenario, the radioactive material in the tank constitutes the material for dispersal, so the intruders need only bring in the appropriate quantities and types of explosive and associated detonation and timing equipment.

No airborne release IDA scenarios were analyzed for the NDA and SDA, due to two factors: (1) the radioactive material is distributed over a large area with a concomitantly small density and (2) radioactive material is interspersed with soil and affixed to solids resulting in a relatively small respirable release fraction from any IDA scenario. Tank 8D-B IDA scenario consequences envelope NDA and SDA IDA scenario consequences. The detonation of high explosives on or near radioactive waste as it is being exhumed from the NDA, which has a higher radioactivity inventory than the SDA, would result in the airborne release of some of the radionuclide inventory. The NDA radioactive waste is distributed over 10,280 cubic meters (363,000 cubic feet) of disposal volume over an area of 22,300 square meters (240,000 square feet) in burial holes, trenches, and caissons (URS 2000). Assuming that the largest radionuclide inventory NDA burial site is targeted during exhumation and that the same fraction of material (0.1 percent) is released to the air as is assumed in the Tank 8D-B IDA scenario, the resulting source term would be 1 percent of that assumed for the Tank 8D-B IDA scenario. The total radionuclide inventory in the NDA and SDA is significantly smaller than that of the high-level radioactive waste tanks (see Appendix C of this EIS).

One IDA scenario involving liquid releases was analyzed for the NDA because of its close juxtaposition to Erdman Brook, which drains to Buttermilk Creek and Cattaraugus Creek. The attackers have inside knowledge regarding when the largest radioisotope inventory NDA burial is scheduled for exhumation. They use explosives to disperse this material into Erdman Brook where it releases radionuclides into the creek that are transported to Cattaraugus Creek, Lake Erie, and the Niagara River using the same models that are used in normal operations liquid releases in Appendix I, Section I.4, of this EIS. The liquid release conservatively assumes no cleanup or interception of the released material. In addition, the release is not assumed to be depleted by sediment deposition over the 64 kilometers (40 miles) of flow through Cattaraugus Creek. Furthermore, Erdman Brook is identified as an intermittent stream (Chapter 3, Section 3.6.1, of this EIS), but is assumed to be flowing to Buttermilk Creek at the time of the IDA event.

Another IDA scenario analyzed for human health consequences is the attack of a group of outsiders on a radioactive waste transport vehicle en route from WNYNSC to a waste repository. The attackers are postulated to eliminate all crew and use weapons to penetrate the radioactive waste package confinement, resulting in a release of respirable radionuclides to the environment. The waste package with the largest radionuclide inventory is the fuel and hardware drum, which is only transported for the Sitewide Removal Alternative, as shown in Appendix I of this EIS. Therefore, the transportation scenario assumes an attack on a vehicle transporting such drums. The attack and resulting radionuclide release occur when the vehicle is traveling through the area with the highest population density along its route, thus delivering the highest population dose.

The fuel and hardware drum is not transported for the Sitewide Close-In-Place, Phased Decisionmaking, or No Action Alternative. The same IDA scenario assumptions for transportation are analyzed for these alternatives, but the containers are different: a Greater-Than-Class C drum is used for the Sitewide Close-In-Place and Phased Decisionmaking Alternatives, and a Class A box for the No Action Alternative. For each of the alternatives, a transportation IDA involving these radioactive waste packages has the greatest MEI and population consequences.

Appendix I of this EIS identifies the bounding toxic chemical as the beryllium that is present in the Main Plant Process Building. Therefore, another IDA scenario was postulated in which outsiders, with assistance from an employee, carry in and set off explosive charges in and around that building, creating a Chemical Dispersal Device (CDD) to release the maximum respirable quantity of beryllium into the atmosphere. Although its effects would include the release of radioactivity present in the Main Plant Process Building, the radioactive source term and human health impacts would be lower than those of the high-level radioactive waste tank RDD scenario.

N.3 Scenarios Considered but Not Analyzed

Other IDA scenarios that were postulated but not analyzed for this appendix are: (1) a commercial or military aircraft crash into the high-level radioactive waste tanks or Main Plant Process Building; (2) vehicular bomb detonation next to the high-level radioactive waste tanks, Main Plant Process Building, licensed disposal areas, or radioactive waste storage area; (3) use of armor-piercing missiles on the high-level radioactive waste tanks, Main Plant Process Building, or radioactive waste storage facility; (4) detonation of high explosives in the proximity of radioactive waste storage packages; and (5) use of an improvised nuclear device.

Three factors affect the magnitude of a radioactive source term from a commercial or military aircraft crash into the high-level radioactive waste tanks or the Main Plant Process Building: (1) size of each facility; (2) underground location of some cells; and (3) structural design of the exterior walls and roof. The terrorist attacks of September 11, 2001 involved crashing commercial jets into the two World Trade Center towers which had an average height of 1,365 feet (416 meters) and the Pentagon, which occupies an area of 11.7 hectares (29 acres) with each side being 921 feet (281 meters) long (FEMA 2002, DoD 2009). In the case of the Pentagon, the aircraft impacted the ground in front of the building. In contrast, the area of the Main Plant Process Building is 0.3 hectares (0.8 acres) and that of the four high-level radioactive waste tanks comprises a conglomerate total of 0.1 hectares (0.25 acres). Moreover, the highest point of the Main Plant Process Building is 79 feet (24 meters) while that of the high-level radioactive waste tanks is 36 feet (11 meters). The area and height of these structures would make them a much more difficult target for an aircraft crash. Several cells within the Main Plant Process Building are located as much as 30 feet (9 meters) below the ground surface. This underground location offers additional protection from an impact and mitigation of any release. The Main Plant Process Building and the high-level radioactive waste tanks are constructed of or surrounded by reinforced concrete vaults, walls and roofs with a thickness of from 1 to 6 feet (0.3 to 1.8 meters). If an aircraft were to impact these structures, this reinforced concrete would either preclude or ameliorate the release of radioactivity by absorbing much of the impact energy. Even if structural failure were to occur, it would be expected to be localized and only affect a fraction of the radioactivity within these structures. The high-level waste tank IDA scenario that is analyzed assumes a composite of both tanks' radioactive inventory is affected and that the explosives used eliminate the entire concrete structure as presented in Section N.4 (WSMS 2008).

The aircraft crash was not analyzed because the radionuclide source term resulting from such a scenario at any of the locations that contain radionuclides would be enveloped by that assumed for the high-explosive detonation scenario analyzed for High-Level Radioactive Waste Tank 8D-B.

The vehicle bomb scenario was not analyzed because it may not fail the confinement structure of the high-level radioactive waste tanks, Main Plant Process Building, or radioactive waste packages and is not estimated to result in a source term greater than that assumed for the analyzed IDA event at Tank 8D-B.

Although armor-piercing missiles could fail confinement at the high-level radioactive waste tanks, Main Plant Process Building, or radioactive waste packages, the resulting source term would not be as high as that caused by the carefully designed and placed high explosives that are central to the IDA scenario for Tank 8D-B.

High explosives detonated next to high-level radioactive waste packages would fail their confinements and release a significant fraction of their radionuclide inventories. The effects, however, would be limited by the distance between the packages and that between the package and the explosive. (Explosive overpressure drops as the cube of the distance.) Thus, only a limited number of packages could fail and release radionuclides. Also limiting is the total radionuclide inventory of each package (see Appendix I of this EIS); between 23 and 2,500 packages would have to release their inventories to yield a source term equal to that assumed for the high-level radioactive waste tank IDA scenario. These limiting factors, in addition to the confinement integrity of each waste package, would not release a radiological source term equivalent to that of a failure of the high-level radioactive waste tanks.

The detonation of high explosives on or near the vitrified high-level radioactive waste stored at WNYNSC was not analyzed because the physical and chemical form of this waste would inherently restrict the release of respirable particles to the environment. Tests have shown that the vitrified high-level radioactive waste material, which is similar to glass, is very resistant to fracture into very small respirable particles. Explosives or fires would more likely result in segmentation of some of this waste into large, nonrespirable solid forms (DOE 1994, EPA 1992).

An improvised nuclear device requires access to a critical mass of either weapons-grade plutonium or highly enriched uranium, along with extremely sophisticated high explosives and electronic detonation equipment. None of these materials is expected to be present at WNYNSC. Any plutonium or uranium that is present exists in a distributed and diluted form in liquid and solid wastes—not the single, relatively pure mass required for an improvised nuclear device. Thus, intruders would have to construct such a device with components obtained outside of WNYNSC and purposefully bring it onto the site for detonation. The low population density in the area of WNYNSC also makes the site less desirable as a target for an improvised nuclear device or any other IDA scenario.

N.4 Source Terms

Calculations of the source terms for the high-level radioactive waste tank RDD, Main Plant Process Building CDD, and radioactive waste transportation IDA assume dispersal of a fraction of the entire waste inventory via a direct, open pathway to the atmosphere. The source term for the high-level radioactive waste tank RDD, presented as **Table N–1**, is based on a 0.1 percent (0.001) airborne respirable release fraction (DOE 1994) for the material at risk (MAR). Most of the radionuclide activity in Tank 8D-B (the same radionuclide activity assumed in Appendix I accident analyses) is fixed and in nonliquid form, making it more vulnerable to airborne release from the effects of an explosion. Also assumed (see Appendix I of this EIS) is a composite high-level radioactive waste tank, that is, a tank denoted as 8D-B that has the largest inventory of radioisotopes and, thus, one whose breach would result in the highest radiation dose.

Table N–1 High-Level Radioactive Waste Tank Radiological Dispersal Device Source Term

Radionuclide	*Source Term (curies)*
Carbon-14	0.000020
Strontium-90	34
Technetium-99	0.0054
Iodine-129	6.8×10^{-6}
Cesium-137	250
Uranium-232	0.00060
Uranium-233	0.00026
Uranium-234	0.00010
Uranium-235	3.4×10^{-6}
Uranium-238	0.000031
Neptunium-237	0.00050
Plutonium-238	0.15
Plutonium-239	0.036
Plutonium-240	0.026
Plutonium-241	0.74
Americium-241	0.38
Curium-243	0.0036
Curium-244	0.080
Total	285.4

Source: WVNSCO 2005.

The source term for the NDA liquid dispersal to Erdman Brook during exhumation of the most radioactive burial site is presented in **Table N–2**. The material with the largest amount of radioactivity in the NDA is spent nuclear fuel and its hardware (URS 2000); a liquid release fraction of 0.01 percent (0.0001) is assumed. This is identical to the airborne release fraction assumed for the fuel and hardware radioactive waste drum IDA. This source term also assumes that no emergency response actions are taken during the time period in which this source term would enter Erdman Brook.

Table N–2 NRC-Licensed Disposal Area Radiological Dispersal Device Liquid Release Source Term

Radionuclide	*Activity (curies)*	*Radionuclide*	*Activity (curies)*	*Radionuclide*	*Activity (curies)*
Tritium	1.4×10^{-3}	Niobium-94	1.5×10^{-3}	Uranium-235	4.8×10^{-6}
Carbon-14	5.2×10^{-2}	Antimony-125	3.9×10^{-3}	Uranium-238	6.4×10^{-5}
Iron-55	1.8×10^{-1}	Cesium-137	1.2	Neptunium-237	6.7×10^{-6}
Nickel-59	1.1×10^{-1}	Barium-137m	1.2	Plutonium-238	1.4×10^{-2}
Cobalt-60	8.1×10^{-1}	Promethium-147	1.6×10^{-3}	Plutonium-239	2.4×10^{-2}
Nickel-63	1.1×10^{1}	Samarium-151	2.0×10^{-2}	Plutonium-240	1.6×10^{-2}
Strontium-90	9.5×10^{-1}	Europium-154	8.0×10^{-3}	Plutonium-241	5.7×10^{-1}
Yttrium-90	9.5×10^{-1}	Uranium-233	3.8×10^{-4}	Americium-241	5.7×10^{-2}
Zirconium-93	1.2×10^{-3}	Uranium-234	2.0×10^{-5}	Total	17.1

NRC = U.S. Nuclear Regulatory Commission.
Source: URS 2000.

The source terms for the different packages that could be breached in a radioactive waste transportation IDA are presented in **Tables N–3, N–4,** and **N–5**. For the fuel and hardware drum, the source term is based on a 0.01 percent (0.0001) respirable release fraction; and for the Greater-Than-Class C drum and Class A box, a

0.1 percent (0.001) airborne respirable release fraction. The different respirable release fractions reflect the distinctive nature and radionuclide content of the waste packages (DOE 1994).

Table N–3 Fuel and Hardware Drum Intentional Destructive Act Source Term

Radionuclide	***Source Term (curies)***
Tritium	0.000311
Carbon-14	4.2×10^{-5}
Cobalt-60	0.0027
Strontium-90	0.133
Yttrium-90	0.133
Cesium-137	0.173
Thorium-234	0.0000131
Uranium-238	0.0000131
Plutonium-238	0.00105
Plutonium-239	0.00412
Plutonium-240	0.00221
Plutonium-241	0.0671
Americium-241	0.00799
Neptunium-237	7.94×10^{-7}
Curium-244	0.0000626
Total	0.56

Source: Karimi 2005.

Table N–4 Greater-Than-Class C Drum Intentional Destructive Act Source Term

Radionuclide	***Source Term (curies)***
Tritium	0.0020
Carbon-14	0.0000148
Iron-55	8.98×10^{-6}
Cobalt-60	0.000258
Nickel-63	0.000999
Strontium-90	0.00185
Yttrium-90	0.00185
Cesium-137	0.00235
Thorium-234	0.0000268
Uranium-238	9.28×10^{-6}
Plutonium-238	0.0267
Plutonium-239	0.0000363
Plutonium-240	0.000188
Plutonium-241	0.0105
Americium-241	0.000116
Total	0.047

Source: Karimi 2005.

Table N–5 Class A Box Intentional Destructive Act Source Term

Radionuclide	*Source Term (curies)*
Tritium	1.2×10^{-4}
Carbon-14	9.2×10^{-7}
Iron-55	5.6×10^{-7}
Cobalt-60	1.6×10^{-5}
Nickel-63	6.2×10^{-5}
Strontium-90	4.5×10^{-6}
Yttrium-90	4.5×10^{-6}
Cesium-137	4.4×10^{-5}
Thorium-234	5.8×10^{-7}
Uranium-238	5.8×10^{-7}
Plutonium-238	3.7×10^{-7}
Plutonium-239	5.5×10^{-7}
Plutonium-240	3.3×10^{-7}
Plutonium-241	1.2×10^{-5}
Americium-241	1.2×10^{-6}
Total	2.7×10^{-4}

Source: Karimi 2005.

The release plume for the waste transportation IDA is modeled for two different scenarios: a zero-energy, ground-level plume release and a plume with the energy of a fire created by combustion of the diesel fuel carried in the tanks of the transport truck. As in the case of the RDD, the plume energy assumptions for these two scenarios envelop both close and distant human health impacts.

N.5 Human Health Effects

Calculations by the MACCS2, GENII Version 2, and RISKIND computer codes and chemical dispersion modeling result in different human health impacts of the IDA scenarios discussed in Section N.2. Differences have been determined in radiological doses delivered to, and related latent cancer fatalities (LCFs)[1] for, the worker, the MEI, and the population at varying distances from the release site.

N.5.1 High-Level Radioactive Waste Tank Radiological Dispersal Device

The calculated radiation doses to the noninvolved worker, the MEI, and the population within 80, 160, 320, and 480 kilometers (50, 100, 200, and 300 miles) of an RDD-induced failure of the high-level radioactive waste tank are presented in **Table N–6**. Two plume models were assumed for this scenario: ground-level and elevated plume. The ground-level plume assumes that all the energy of the high explosives is expended in failing the tank confinement and in aerosolizing radioactive material. The elevated plume conversely assumes that all of the energy of the high explosives is available to the plume, resulting in an elevated release. These two diametrically opposite assumptions were used to calculate the range of close-in and distant human health consequences. Doses for the population beyond 80 kilometers (50 miles) were calculated to evaluate the public health impact of an elevated plume in comparison to a ground-level plume. The analysis assumed no emergency response such as evacuation or sheltering of the population. This assumption is very conservative for the population 320 to 480 kilometers (200 to 300 miles) away, because the plume would not reach these distances for at least 1 day. According to the 2000 U.S. census and the 2001 Canada census (DOC 2008, ESRI 2008, Statistics Canada 2008), the U.S. and Canadian populations within 80, 160, 320, and

[1] Since fatal cancer is the most probable serious effect of environmental and occupational radiation exposures, estimates of cancer fatalities rather than cancer incidence are presented in this EIS. These effects are referred to as "latent" cancer fatalities (LCFs) because the cancer may take many years to develop.

480 kilometers (50, 100, 200, and 300 miles) are, respectively, 1.705 million, 7.872 million, 25 million, and 75.1 million.

Table N–6 Radiological Consequences of High-Level Radioactive Waste Tank Radiological Dispersal Device

Radiological Dispersal Device Scenario	Ground-level Release		Elevated-plume Release	
	Dose	LCFs	Dose	LCFs
Noninvolved worker (rem)	608 [a]	0.7	0.0177	0.000010
MEI member of the public (rem)	138	0.2	0.15	0.000090
50-mile population (person-rem)	3,600	2.2	5,860	3.5
100-mile population (person-rem)	4,610	2.8	8,240	4.9
200-mile population (person-rem)	5,240	3.1	9,620	5.8
300-mile population (person-rem)	5,890	3.5	10,700	6.4
Highest population average individual member [b] (rem)	0.0021	1.3×10^{-6}	0.0034	2.1×10^{-6}

LCFs = latent cancer fatalities, MEI = maximally exposed individual.

[a] This dose of 608 rem, equivalent to 0.7 LCFs, can cause a fatality from acute effects in more than 50 percent of humans, but this fatality may be ameliorated by immediate proper medical treatment (NRC 2008, PNNL 2005).

[b] Calculated by dividing the total population dose by the total population for each of the four distances; the highest average for the four distances is presented.

Note: LCFs calculated by multiplying dose by 0.0006 LCFs per rem (DOE 2002); an individual dose of 20 rem or greater is multiplied by twice the 0.0006 LCFs factor.

Table N–6 shows that the ground-level release results in higher noninvolved worker and MEI doses, whereas the elevated release results in a larger population dose. The largest noninvolved worker dose (608 rem) results in 0.7 LCFs, and the largest MEI dose (138 rem) in 0.2 LCFs. The elevated-plume model results in about a 60 to 80 percent larger population dose than the ground-level release model. The difference is due to the combined effect of dispersion, dilution, and differences in population distribution at distances from WNYNSC. Although population dose increases with distance, the change in population dose relative to the increase in population is slight. The highest average individual dose in the population (0.0034 rem) for the four distances analyzed occurs for the 80-kilometer (50-mile) population. The largest population consequence within 480 kilometers (300 miles) is 6.4 LCFs, assuming no emergency response, evacuation, or sheltering over this distance. The WNYNSC meteorological data used in the MACCS calculations include an average annual wind speed of 2.1 meters per second (4.7 miles per hour). At this wind speed, the plume would reach 80 kilometers (50 miles) 10.6 hours after its release. The time for the plume to travel 320 to 480 kilometers (200 to 300 miles) would be 43 to 64 hours. It is expected that emergency response actions, in the form of public evacuation and sheltering, could be taken during this time period, so that the population dose associated with these distances would be significantly lower.

N.5.2 NRC-Licensed Disposal Area Radiological Dispersal Device

The GENII Version 2 calculated radiation doses and likelihood of an LCF to the MEI and population of an RDD-induced liquid release from exhumed radioactive spent fuel and hardware at the NDA are presented in **Table N–7**. Workers were not assumed to survive an NDA exhumation liquid release RDD. The calculations were performed using the same GENII Version 2 model that was used for normal operations liquid releases in Appendix I of this EIS.

Table N–7 Radiological Consequences of NRC-Licensed Disposal Area Radiological Dispersal Device

Dose Receptor	Dose	LCFs
Individual on Cattaraugus Creek Near Site	0.019 rem	4.5×10^{-6}
Individual on Lower Reaches of Cattaraugus Creek	0.021 rem	5.6×10^{-6}
Lake Erie Downstream of Cattaraugus Creek Water Consumers [a]	5,500 person-rem	1.2
Niagara River Water Consumers [a]	90 person-rem	0.02

LCFs = latent cancer fatalities, NDA = NRC (U.S. Nuclear Regulatory Commission)-Licensed Disposal Area.
[a] Affected populations: Lake Erie Treatment Plants Downstream of Cattaraugus Creek, 565,000 consumers; Niagara River Treatment Plants, 386,000 consumers.

Table N–7 shows that the largest MEI member of the public dose (0.021 rem or 21 millirem) results in 5.6×10^{-6} LCFs and the total population dose to both Lake Erie and Niagara River water consumers of 5,590 person-rem results in 1.22 LCFs.

The calculated population dose assumes no actions to restrict water consumption during a 1-year time period following this IDA scenario. Unlike air releases, liquid releases require considerable time (i.e., days) to reach the large population of water consumers, and emergency water consumption restriction actions could be used to mitigate any radiological consequences. Therefore, the population dose calculated for this IDA scenario represents a conservative estimate with no ameliorating effect of emergency response actions.

N.5.3 Radioactive Waste Transportation Intentional Destructive Act

Workers were assumed not to survive a transportation IDA. The only dose receptors for this event are the MEI within 100 meters (328 feet) of the plume release and the population within 80 kilometers (50 miles). As in the case of the high-level radioactive waste tank RDD scenario, no emergency response, such as evacuation or sheltering of the population, is assumed within 80 kilometers (50 miles) of the IDA. The highest population density of the route is assumed so as to envelop the calculated population dose. Consequences for the three transportation IDA scenarios are presented in **Table N–8**. The low-energy plume assumes a release with no fire, while the high-energy plume assumes a fire occurring simultaneously with the release.

Table N–8 Transportation Intentional Destructive Act Radiological Consequences

Radiological Consequence	Low-energy Plume	High-energy Plume
Sitewide Removal Alternative: Fuel and Hardware Drum		
MEI dose, rem	9.65	0.00347
MEI LCFs	0.006	2.0×10^{-6}
50-mile population dose, person-rem	281	82.6
50-mile population LCFs	0.17	0.05
Sitewide Removal, Sitewide Close-In-Place, and Phased Decisionmaking Alternatives: Greater-Than-Class C Drum		
MEI dose, rem	13.9	0.0389
MEI LCFs	0.008	0.000020
50-mile population dose, person-rem	404	119
50-mile population LCFs	0.24	0.07
No Action Alternative: Class A Box		
MEI dose, rem	1.1×10^{-2}	9.1×10^{-5}
MEI LCFs	7.0×10^{-6}	6.0×10^{-6}
50-mile population dose, person-rem	3.49	3.46
50-mile population LCFs	2.1×10^{-3}	2.1×10^{-3}

LCFs = latent cancer fatalities, MEI = maximally exposed individual.
Note: LCFs calculated by multiplying dose by 0.0006 LCFs per rem (DOE 2002). To convert miles to kilometers, multiply by 1.6.

N.5.4 Chemical Dispersal Device

The CDD source term assumes that the entire inventory (5.1 kilograms [11.2 pounds]) of beryllium in the Main Plant Process Building is released as respirable particles, and that the release lasts for 10 minutes under average atmospheric conditions. The result is a respirable particle concentration of 0.00043 milligrams per cubic meter within 100 meters (328 feet) of the building, which is the location of the noninvolved worker. Such a concentration is a factor of more than 200 below (i.e., about 0.4 percent of) the Emergency Response Planning Guideline 3 (ERPG-3) value of 0.1 milligrams per cubic meter. If conservative atmospheric dispersion were assumed, the air concentration within the same distance from the release would be 0.0021 milligrams per cubic meter, still significantly below the ERPG-3 value, and even below the respective ERPG-2 and ERPG-1 values of 0.025 and 0.005 milligrams per cubic meter (DOE 2008). Air concentrations below the ERPG-1 level do not cause any serious health effects.

As the CDD-induced atmospheric concentration of beryllium at 100 meters (328 feet) from the release point is below the ERPG-3, ERPG-2, and ERPG-1 levels, similar results can be expected for all other toxic chemicals; concentrations should be significantly below their respective ERPGs. Accordingly, the risk to workers and the public due to the release of toxic chemicals to the atmosphere is very small. Nevertheless, a CDD is expected to result in toxic chemical deposition around the Main Plant Process Building area that will require cleanup, and workers within 100 meters (328 feet) of the CDD would presumably be injured from blast pressure and airborne debris associated with the explosion.

N.6 Summary of Intentional Destructive Acts Consequences

The IDA human health consequence analyses were performed for each IDA scenario and *Decommissioning and/or Long-Term Stewardship EIS* alternative. The same computer codes (MACCS and RISKIND), analytical methods, and site models were used for these IDA scenarios as for accidents analyzed in Appendices I and J of this EIS. Regardless of the alternative, the highest radiological source term for an IDA affecting onsite facilities is that associated with a breach of the high-level radioactive waste tank; the highest hazardous chemical source term, from damage to the Main Plant Process Building. For the three action alternatives, the radioactive waste transportation IDA scenario with the most significant human health consequences is that involving the Greater-Than-Class C Drum; for the No Action Alternative, it is failure of the Class A Box. **Table N–9** presents a summary of the human health consequences of onsite facility and offsite transportation IDA scenarios for the alternatives. As indicated, the only distinction in consequences between action and no action alternatives is that of the radioactive waste transportation IDA. Radioactive waste transportation IDA consequences are significantly lower for the No Action Alternative because only Class A waste is transported.

Another aspect of IDA consequences that can be evaluated is the vulnerable time period of each scenario. The vulnerable time periods of those scenarios are presented in **Table N–10** under each alternative. As indicated, the longest vulnerable time periods (i.e., highest consequences) occur with the high-level radioactive waste tank RDD scenario; the shortest vulnerable time periods (i.e., lowest consequences) occur with the Main Plant Process Building CDD and the No Action Alternative radioactive waste (i.e., specifically, Class A waste) transportation scenarios. The longest vulnerable time period for the high-level radioactive waste tank RDD occurs under the Sitewide Close-In-Place and No Action Alternatives; the longest for the radioactive waste package transportation scenario occurs under the Sitewide Removal Alternative. As the CDD consequences are not significant, the difference between the Main Plant Process Building vulnerable time periods under the alternatives is not considered a significant discriminator of IDA risk.

Table N–9 Range of Intentional Destructive Acts Human Health Consequences for the Alternatives

Onsite Radiological IDA		
Receptor	***All Alternatives***	
Noninvolved worker	Fatal [a] (tank ground-level release) to 0.00001 LCFs (tank elevated-plume release)	
MEI	0.2 LCF (tank ground-level release) to 4.5×10^{-6} LCFs (NDA liquid release)	
Population, airborne	2 LCF [b] (80 kilometer [50 mile] population, ground-level release) to 7 LCFs [b] (300 mile population, elevated-plume release)	
Population, liquid	1 LCF [b] (Lake Erie and Niagara River water consumer)	
Onsite Chemical IDA		
Receptor	***All Alternatives***	
Worker	No significant health impacts	
MEI	No significant health impacts	
Population	No significant health impacts	
Radioactive Waste Package Transportation IDA		
Receptor	***Action Alternatives***	***No Action***
Worker	Not applicable	
MEI	0.008 LCFs (low-energy plume) to 0.00002 LCFs (high-energy plume)	7.0×10^{-6} LCFs
Population	0.2 LCFs (low-energy plume) to 0.07 LCFs (high-energy plume)	2.1×10^{-3} LCFs

IDA = intentional destructive act, LCFs = latent cancer fatalities, MEI = maximally exposed individual.
[a] Dose of 608 rem, equivalent to 0.7 LCFs, may cause short-term fatality in more than 50 percent of humans, but may be ameliorated by immediate medical treatment.
[b] Lower consequences if there is emergency response such as sheltering or evacuation.

Table N–10 Intentional Destructive Act Scenario Vulnerable Time Period for Each Alternative

	Alternative			
IDA Scenario	***Sitewide Removal***	***Sitewide Close-In-Place***	***Phased Decisionmaking (Phase 1)***	***No Action***
High-level radioactive waste tanks	20 years	In perpetuity	Up to 30 years [a]	In perpetuity
Main Plant Process Building	11 years	7 years	5 years	In perpetuity
Radioactive waste transport	60 years	7 years	8 years	In perpetuity

IDA = intentional destructive act.
[a] The total vulnerable time period for the alternative will depend on the implementation decisions and schedule for Phase 2.
Sources: WSMS 2009a, 2009b, 2009c, 2009d.

The data in Table N–8 provide a basis for a qualitative comparison of the IDA risks for each alternative, which is presented in **Table N–11**. Specific attention is accorded on site, off site (waste transport), and overall IDA risks, taking into account the vulnerable time period for each scenario. The No Action Alternative is judged to have the highest IDA risk because vulnerable onsite facilities remain in place and periodic offsite transportation of radioactive waste packages is expected to continue in perpetuity. The three action alternatives have lower IDA risks because they involve the demolition of onsite facilities that would otherwise constitute potential targets for IDAs, and because the offsite transport of radioactive waste packages would occur during a finite period of time (albeit involving a higher radioactivity content than the No Action Alternative). The Sitewide Removal Alternative has a higher IDA risk than the other two action alternatives because it involves transport of the largest number of radioactive waste packages over the longest time period, and because removal of the Main Plant Process Building is deferred for longer than the Phased Decisionmaking (Phase 1) and Sitewide Close-In-Place Alternatives (12 versus 5 and 7 years, respectively).

Table N–11 Qualitative Comparison of Intentional Destructive Act Risks for Each Alternative [a]

Type of IDA Risk	*Alternative*			
	Sitewide Removal	*Sitewide Close-In-Place*	*Phased Decisionmaking (Phase 1)*	*No Action*
Onsite radiological	High	Very High	Very High	Highest
Onsite chemical	Medium	Low	Lowest	Highest
Radiological waste transportation	Highest	Medium	Medium	Lowest
Overall	High	Medium	Medium	Highest

IDA = intentional destructive act.
[a] A qualitative comparison of accident risks for each alternative is presented in Chapter 4, Table 4–23, and Appendix I, Table I–27, of this EIS.

N.7 Intentional Destructive Acts Emergency Planning, Response, and Security

DOE's strategy for environmental protection from extreme events, including IDAs or terrorism, has three distinct components: (1) prevent or reduce the probability of occurrence; (2) plan and provide a timely and adequate response to emergency situations; and (3) ensure progressive recovery through long-term response in the form of monitoring, remediation, and support for affected communities and their environment.

DOE sites and facilities produce, store, use, and dispose of many different hazardous substances, including radioactive materials, toxic chemicals, and biological agents and toxins. In managing these hazards, DOE considers the safety of workers and the public to be of paramount importance. Owing to high standards for facility design, conduct of operations, safety oversight, and personnel training, DOE activities consistently achieve accident and injury rates that compare very favorably with those of the private sector.

DOE employs a well-established system of engineered and administrative controls in key facilities to prevent or reduce the probability of occurrence of extreme events and to limit their potential impacts on the environment. This system has evolved over time and will continue to evolve as new environment, safety, and health requirements are identified; as new technologies become available; and as new engineering standards or best practices are developed. The framework and specific requirements for implementing this system of controls are embodied in the *Code of Federal Regulations* and DOE Orders. These are invoked as contractual requirements for DOE management and operating contractors. DOE safety requirements and quality assurance guidelines and controls cover all aspects of the life-cycle of key nuclear and nonnuclear facilities—design requirements, construction practices, startup and operational readiness reviews, and routine operations and maintenance. They also cover deactivation and disposal activities required at the end of a facility's useful service life. The contractor and Federal staff associated with these facilities receive screening for trustworthiness and reliability. Moreover, they are trained to operate the facilities safely and to recognize quickly, and respond appropriately to, departures from normal operating conditions. Workers with a potential for exposure to harmful substances or radiation are enrolled in monitoring programs to safeguard their health and welfare. In addition to the oversight provided by DOE, reviews and audits of key facilities by outside experts play a role in reducing the probability of occurrence of many potentially extreme events associated with facility design, condition, or operation.

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APPENDIX O
CONSULTATION LETTERS

New York State Office of Parks, Recreation and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island, PO Box 189, Waterford, New York 12188-0189
518-237-8643

Bernadette Castro
Commissioner

June 15, 1995

Paul L. Piciulo, Ph.D.
Program Director
Radioactive Waste Management Program
Department of Energy
P.O. Box 191
West Valley, NY 14171

Dear Dr. Piciulo:

Re: DOE
West Valley Demonstration Project
Ashford, Cattaraugus County
95PR1233

Thank you for requesting the comments of the State Historic Preservation Office (SHPO). We have reviewed the materials submitted in accordance with Section 106 of the National Historic Preservation Act of 1966 and the relevant implementing regulations.

Based upon this review, it is the SHPO's opinion that the West Valley Demonstration Project Site (the site of the former Nuclear Fuels Service Irradiated Fuels Processing Plant) is not eligible for inclusion in the National Register of Historic Places.

When responding, please be sure to refer to the SHPO project review (PR) number noted above. If you have any questions, please feel free to call me at (518) 237-8643 ext. 255.

Sincerely,

Robert D. Kuhn, Ph.D.
Historic Preservation Coordinator
Field Services Bureau

RDK:cm

DEPARTMENT OF THE ARMY

BUFFALO DISTRICT, CORPS OF ENGINEERS
1776 NIAGARA STREET
BUFFALO, NEW YORK 14207-3199

REPLY TO
ATTENTION OF:

March 21, 2006

Regulatory Branch

SUBJECT: Acceptance of Wetland Delineation, Application No. 98-973-0092(2), New York State Department of Environmental Conservation No. 9-0422-00005/00100

Mr. John H. Swailes
Director, West Valley Demonstration Project
U.S. Department of Energy
10282 Rock Springs Road
West Valley, New York 14171

Dear Mr. Swailes:

This pertains to your submission of an October 2004 wetlands delineation report (URS Group, Inc.) regarding wetlands adjacent to a tributary of Buttermilk Creek, located at the West Valley Demonstration Site, Town of Ashford, Cattaraugus County, New York.

The Corps of Engineers regulatory responsibilities under Section 404 of the Clean Water Act establishes jurisdiction over the discharge of dredged or fill material into waters of the United States, including wetlands.

The wetland delineation you submitted confirms that wetlands under Federal Jurisdiction exist on the property. Based on a field visit conducted November 2, 2005 as well as a review of applicable topographic and wetland maps of the area, I have determined that 34.09-acres of wetland are waters of the United States subject to regulation under Section 404 of the Clean Water Act. These waters are part of an ecological continuum constituting a surface water tributary system of Buttermilk Creek, Cattaraugus Creek, and Lake Erie. Accordingly, Department of the Army authorization is required to commence work in these areas.

On the contrary, no clear surface water connection exists between W19, W20, W21, W22, W23, W36, W55, W56, W59, W60, W61, and W65 (totaling 2.43-acres), as labeled on the attached drawings, and a water of the United States. Therefore, these wetlands are considered to be isolated, non-navigable, intrastate water that is not subject to regulation under Section 404 of the Clean Water Act. Accordingly, you do not need Department of the Army authorization to commence work in these areas.

The wetland delineation you submitted confirms that wetlands

Regulatory Branch
SUBJECT: Acceptance of Wetland Delineation, Application No. 98-973-0092(2), New York State Department of Environmental Conservation No. 9-0422-00005/00100

under Federal jurisdiction exist on the property, but I understand that you do not intend to impact them at this time. In this regard, I would like to point out that the Federal wetland boundaries located on your property, as shown on the attached drawings, was confirmed on January 26, 2006 and will remain valid for a period of five (5) years from the date of this correspondence unless new information warrants revision of the delineation before the expiration. Further, this delineation/determination has been conducted to identify the limits of the Corps Clean Water Act jurisdiction for the particular site identified in this request. This delineation/determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985, as amended. If you or your tenant are USDA program participants, or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resource Conservation Service prior to starting work.

Based upon my review of the submitted delineation and on-site observations, I have determined that the wetlands on the subject parcel are part of a surface water tributary system to a navigable water of the United States as noted on the attached Jurisdictional Determination form. Therefore, the wetlands are regulated under Section 404 of the Clean Water Act. Department of the Army authorization is required if you propose a discharge of dredged or fill material in this area.

Finally, this letter contains an approved jurisdictional determination for the subject parcel. If you object to this determination, you may request an administrative appeal under Corps regulations at 33 CFR Part 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet and Request for Appeal (RFA) form. If you request to appeal the above determination, you must submit a completed RFA form within 60 days of the date on this letter to the Great Lakes/Ohio River Division Office at the following address:

Mr. Mike Montone, Regulatory Review Officer
Great Lakes and Ohio River Division
CELRD-PDS-O
550 Main Street
Cincinnati, Ohio 45201-1159
Phone: 513-684-6212

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria

Regulatory Branch
SUBJECT: Acceptance of Wetland Delineation, Application No. 98-973-0092(2), New York State Department of Environmental Conservation No. 9-0422-00005/00100

for appeal under 33 C.F.R. part 331.5, and that it has been received by the Division Office within 60 days of the date of the NAP. Should you decide to submit an RFA form, it must be received at the above address by **May 20, 2006**.

It is not necessary to submit an RFA to the Division office if you do not object to the determination in this letter.

Questions pertaining to this matter should be directed to me at (716) 879-4309, by writing to the following address: U.S. Army Corps of Engineers, 1776 Niagara Street, Buffalo, New York 14207, or by e-mail at: michael.p.senus@usace.army.mil

Sincerely,

for Mick Senus
Hydrologist

Enclosures

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL			
Applicant: West Valley Demonstration Project		File Number: 98-973-0092(2)	Date: 3/21/06
Attached is:			See Section below
	INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)		A
	PROFFERED PERMIT (Standard Permit or Letter of permission)		B
	PERMIT DENIAL		C
X	APPROVED JURISDICTIONAL DETERMINATION		D
	PRELIMINARY JURISDICTIONAL DETERMINATION		E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://usace.army.mil/inet/functions/cw/cecwo/reg or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- **ACCEPT:** If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.

- **OBJECT:** If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- **ACCEPT:** If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.

- **APPEAL:** If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- **ACCEPT:** You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.

- **APPEAL:** If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT

REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)

ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.

POINT OF CONTACT FOR QUESTIONS OR INFORMATION:

If you have questions regarding this decision and/or the appeal process you may contact:	If you only have questions regarding the appeal process you may also contact:
Mick Senus U.S. Army Corps of Engineers 1776 Niagara Street Buffalo, New York 14207 (716) 879-4309 michael.p.senus@usace.army.mil	Mr. Michael Montone U.S. Army Corps of Engineers Great Lakes and Ohio River Division 550 Main Street Cincinnati, OH 45201-1159 (513) 684-6212;FAX(513) 684-2460 michael.g.montone@lrdor.usace.army.mil

RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.

Signature of appellant or agent.	Date:	Telephone number:

Revised 8/13/04

JURISDICTIONAL DETERMINATION

U.S. Army Corps of Engineers

DISTRICT OFFICE: BUFFALO (CELRB)
FILE NUMBER: 98-973-0092(2)

PROJECT LOCATION INFORMATION:

State: New York
County: Cattaraugus
Center coordinates of site (latitude/longitude): ASHFORD HOLLOW 7.5 Minute Quad Map lat:42-26-12.7680 lon:78-38-11.4000
Approximate size of area (parcel) reviewed, including uplands: 375-acres.
Name of nearest waterway: Buttermilk Creek
Name of watershed: CATTARAUGUS

JURISDICTIONAL DETERMINATION

Completed: Desktop determination [x] Date: January 23, 2006
Site visit(s) [x] Date(s): November 2, 2005

Jurisdictional Determination (JD):

[ ] Preliminary JD - Based on available information, [ ] *there appear to be* (or) [ ] *there appear to be no* "waters of the United States" and/or "navigable waters of the United States" on the project site. A preliminary JD is not appealable (Reference 33 CFR part 331).

[X] Approved JD - An approved JD is an appealable action (Reference 33 CFR part 331).
Check all that apply:

[ ] *There are* "navigable waters of the United States" (as defined by 33 CFR part 329 and associated guidance) within the reviewed area. Approximate size of jurisdictional area: .

[x] *There are* "waters of the United States" (as defined by 33 CFR part 328 and associated guidance) within the reviewed area. Approximate size of jurisdictional area: .

[x] *There are "isolated, non-navigable, intra-state waters or wetlands"* within the reviewed area.
[x] Decision supported by SWANCC/Migratory Bird Rule Information Sheet for Determination of No Jurisdiction.

BASIS OF JURISDICTIONAL DETERMINATION:

A. Waters defined under 33 CFR part 329 as "navigable waters of the United States":

[ ] The presence of waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce.

B. Waters defined under 33 CFR part 328.3(a) as "waters of the United States":

[ ] (1) The presence of waters, which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide.
[ ] (2) The presence of interstate waters including interstate wetlands[1].
[ ] (3) The presence of other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate commerce including any such waters (check all that apply):
[ ] (i) which are or could be used by interstate or foreign travelers for recreational or other purposes.
[ ] (ii) from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.
[ ] (iii) which are or could be used for industrial purposes by industries in interstate commerce.
[ ] (4) Impoundments of waters otherwise defined as waters of the US.
[x] (5) The presence of a tributary to a water identified in (1) - (4) above.
[ ] (6) The presence of territorial seas.
[x] (7) The presence of wetlands adjacent[2] to other waters of the US, except for those wetlands adjacent to other wetlands.

Rationale for the Basis of Jurisdictional Determination (applies to any boxes checked above). *If the jurisdictional water or wetland is not itself a navigable water of the United States, describe connection(s) to the downstream navigable waters. If B(1) or B(3) is used as the Basis of Jurisdiction, document navigability and/or interstate commerce connection (i.e., discuss site conditions, including why the waterbody is navigable and/or how the destruction of the waterbody could affect interstate or foreign commerce). If B(2, 4, 5 or 6) is used as the Basis of Jurisdiction, document the rationale used to make the determination. If B(7) is used as the Basis of Jurisdiction, document the rationale used to make adjacency determination:* Wetlands adjacent to Buttermilk Creek are present on the 375-acre parcel of property that was submitted for jurisdictional detrmination. Buttermilk Creek is connected to Cattaraugus Creek, which flows into Lake Erie (a navigable water). There are total of 34.09-acres of federally jurisdictional wetlands.

Lateral Extent of Jurisdiction: (Reference: 33 CFR parts 328 and 329)

[X] Ordinary High Water Mark indicated by:
- [X] clear, natural line impressed on the bank
- [X] the presence of litter and debris
- [ ] changes in the character of soil
- [ ] destruction of terrestrial vegetation
- [ ] shelving
- [ ] other:

[ ] High Tide Line indicated by:
- [ ] oil or scum line along shore objects
- [ ] fine shell or debris deposits (foreshore)

[X] physical markings/characteristics
[ ] tidal gages
[ ] other:

[ ] Mean High Water Mark indicated by:
[ ] survey to available datum; [ ] physical markings; [ ] vegetation lines/changes in vegetation types.

[X] Wetland boundaries, as shown on the attached wetland delineation map and/or in a delineation report prepared by:

Basis For Not Asserting Jurisdiction:

[ ] The reviewed area consists entirely of uplands.
[ ] Unable to confirm the presence of waters in 33 CFR part 328(a)(1, 2, or 4-7).
[ ] Headquarters declined to approve jurisdiction on the basis of 33 CFR part 328.3(a)(3).
[X] The Corps has made a case-specific determination that the following waters present on the site are not Waters of the United States:
- [ ] Waste treatment systems, including treatment ponds or lagoons, pursuant to 33 CFR part 328.3.
- [ ] Artificially irrigated areas, which would revert to upland if the irrigation ceased.
- [ ] Artificial lakes and ponds created by excavating and/or diking dry land to collect and retain water and which are used exclusively for such purposes as stock watering, irrigation, settling basins, or rice growing.
- [ ] Artificial reflecting or swimming pools or other small ornamental bodies of water created by excavating and/or diking dry land to retain water for primarily aesthetic reasons.
- [ ] Water-filled depressions created in dry land incidental to construction activity and pits excavated in dry land for the purpose of obtaining fill, sand, or gravel unless and until the construction or excavation operation is abandoned and the resulting body of water meets the definition of waters of the United States found at 33 CFR 328.3(a).
- [X] Isolated, intrastate wetland with no nexus to interstate commerce.
- [ ] Prior converted cropland, as determined by the Natural Resources Conservation Service. Explain rationale:
- [ ] Non-tidal drainage or irrigation ditches excavated on dry land. Explain rationale:
- [ ] Other (explain):

DATA REVIEWED FOR JURISDICTIONAL DETERMINATION (mark all that apply):

[X] Maps, plans, plots or plat submitted by or on behalf of the applicant.
[X] Data sheets prepared/submitted by or on behalf of the applicant.
- [X] This office concurs with the delineation report, dated October 2004, prepared by (company): URS Group, Inc.
- [ ] This office does not concur with the delineation report, dated , prepared by (company):

[ ] Data sheets prepared by the Corps.
[ ] Corps' navigable waters' studies:
[ ] U.S. Geological Survey Hydrologic Atlas:
[X] U.S. Geological Survey 7.5 Minute Topographic maps: ASHFORD HOLLOW
[ ] U.S. Geological Survey 7.5 Minute Historic quadrangles:
[ ] U.S. Geological Survey 15 Minute Historic quadrangles:
[X] USDA Natural Resources Conservation Service Soil Survey: CATTARAUGUS COUNTY
[X] National wetlands inventory maps:
[X] State/Local wetland inventory maps: NYS DEC wetland map
[ ] FEMA/FIRM maps (Map Name & Date):
[ ] 100-year Floodplain Elevation is: (NGVD)
[ ] Aerial Photographs (Name & Date):
[X] Other photographs (Date): October 2004 wetland delineation report (URS Group, Inc.)
[ ] Advanced Identification Wetland maps:
[X] Site visit/determination conducted on: November 2, 2005
[ ] Applicable/supporting case law:
[ ] Other information (please specify):

---

[1]Wetlands are identified and delineated using the methods and criteria established in the Corps Wetland Delineation Manual (87 Manual) (i.e., occurrence of hydrophytic vegetation, hydric soils and wetland hydrology).

[2]The term "adjacent" means bordering, contiguous, or neighboring. Wetlands separated from other waters of the U.S. by man-made dikes or barriers, natural river berms, beach dunes, and the like are also adjacent.

INFORMATION SHEET

DETERMINATIONS OF NO JURISDICTION FOR ISOLATED, NON-NAVIGABLE, INTRA-STATE WATERS RESULTING FROM U.S. SUPREME COURT DECISION IN SOLID WASTE AGENCY OF NORTHERN COOK COUNTY V. U.S. ARMY CORPS OF ENGINEERS

DISTRICT OFFICE: Buffalo District

FILE NUMBER: 98-973-0092(2)

REGULATORY PROJECT MANAGER: Mick Senus **Date:** January 25, 2006

PROJECT REVIEW/DETERMINATION COMPLETED: **In the office (Y/N)** Y **Date:** January 23, 2006

At the project site (Y/N) Y **Date:** November 2, 2005

PROJECT LOCATION INFORMATION:

State: NY

County: Cattaraugus

Center coordinates of site by latitude & longitude coordinates:
LAT:42.4505 LON:78.6455

Approximate size of site/property (including uplands): 375 acres

Name of waterway or watershed: Buttermilk Creek

Type of Aquatic Resource[1]:	0-1 ac	1-3 ac	3-5 ac	5-10 ac	10-25 ac	25-50 ac	> 50 ac	Linear Feet	Unknown
Lake									
River									
Stream									
Mudflat									
Sandflat									
Wetlands		X							
Slough									
Prairie Pothole									
Wet Meadow									
Playa Lake									
Vernal Pool									
Natural Pond									
Other Water (identify type)									

[1]Check appropriate boxes that best describe type of isolated, non-navigable, intra-state water present and best estimate for size of non-jurisdictional aquatic resource area.

Migratory Bird Rule Factors[1]	If Known		If Unknown Use Best Professional Judgment		
	Yes	No	Predicted to Occur	Not Expected to Occur	Not Able to Make Determination
Is or would be used as habitat for birds protected by Migratory Bird Treaties?	X				
Is or would be used as habitat by other migratory birds that cross state lines?			X		
Is or would be used as habitat for endangered species?				X	
Is used to irrigate crops sold in interstate commerce?		X			

[1]Check appropriate boxes that best describe potential for applicability of the Migratory Bird Rule to apply to onsite, non-jurisdictional, isolated, non-navigable, intra-state aquatic resource area.

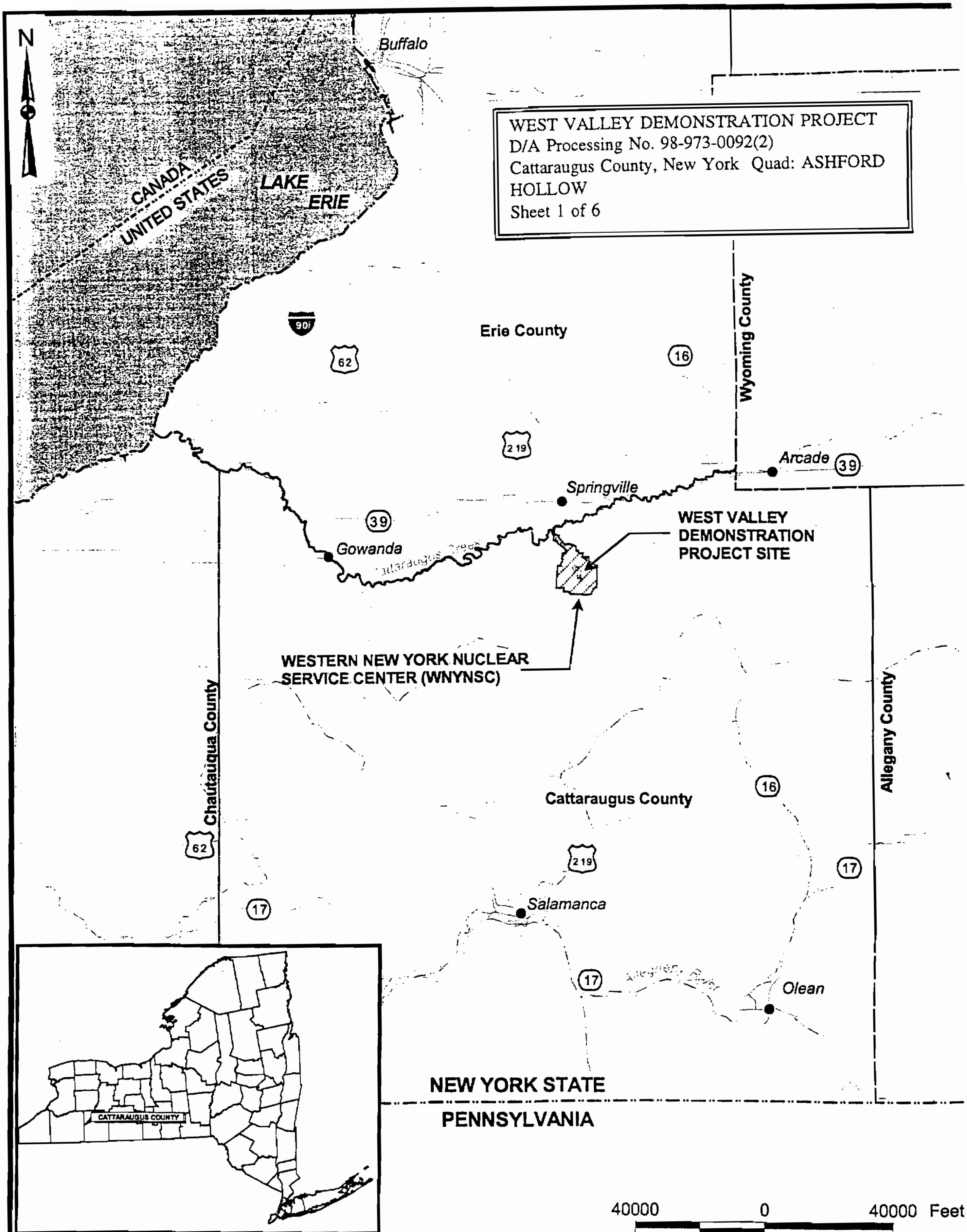
TYPE OF DETERMINATION: **Preliminary** **Or Approved X**

ADDITIONAL INFORMATION SUPPORTING NJD (e.g., paragraph 1 site conditions; paragraphs 2-3 rationale used to determine NJD, including information reviewed to assess potential navigation or interstate commerce connections; and paragraph 4 site information on waters of the U.S. occurring onsite):

The project manager visited the site on November 2, 2005 and observed a wetland area totaling 36.52 acres of a 375-acre parcel. Twelve (12) distinct wetlands exhibited no surface water connection to a water of the U.S (WOUS). The total combined area of these isolated wetlands is 2.426-acres. These wetlands are isolated, intrastate, and nonnavigable wetlands. This determination is based upon field observations and office evaluation. The project manager was not able to determine a nexus to interstate commerce.

Adjacent wetlands and wetlands associated with unnamed tributaries of Buttermilk Creek are connected to Cattaraugus Creek which flows into Lake Erie (a navigable water).

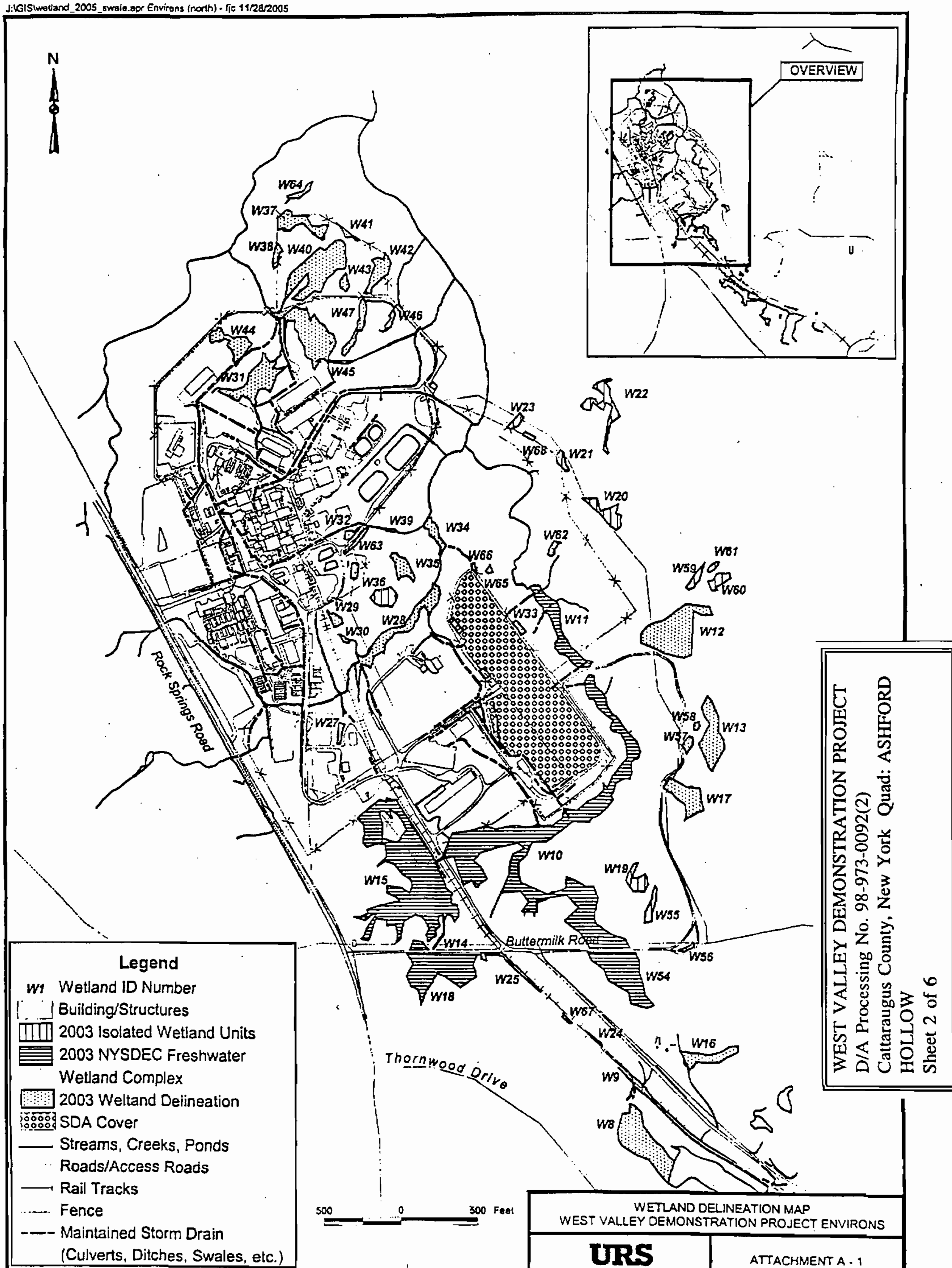
The total acreage of jurisdictional wetlands is 34.09-acres.



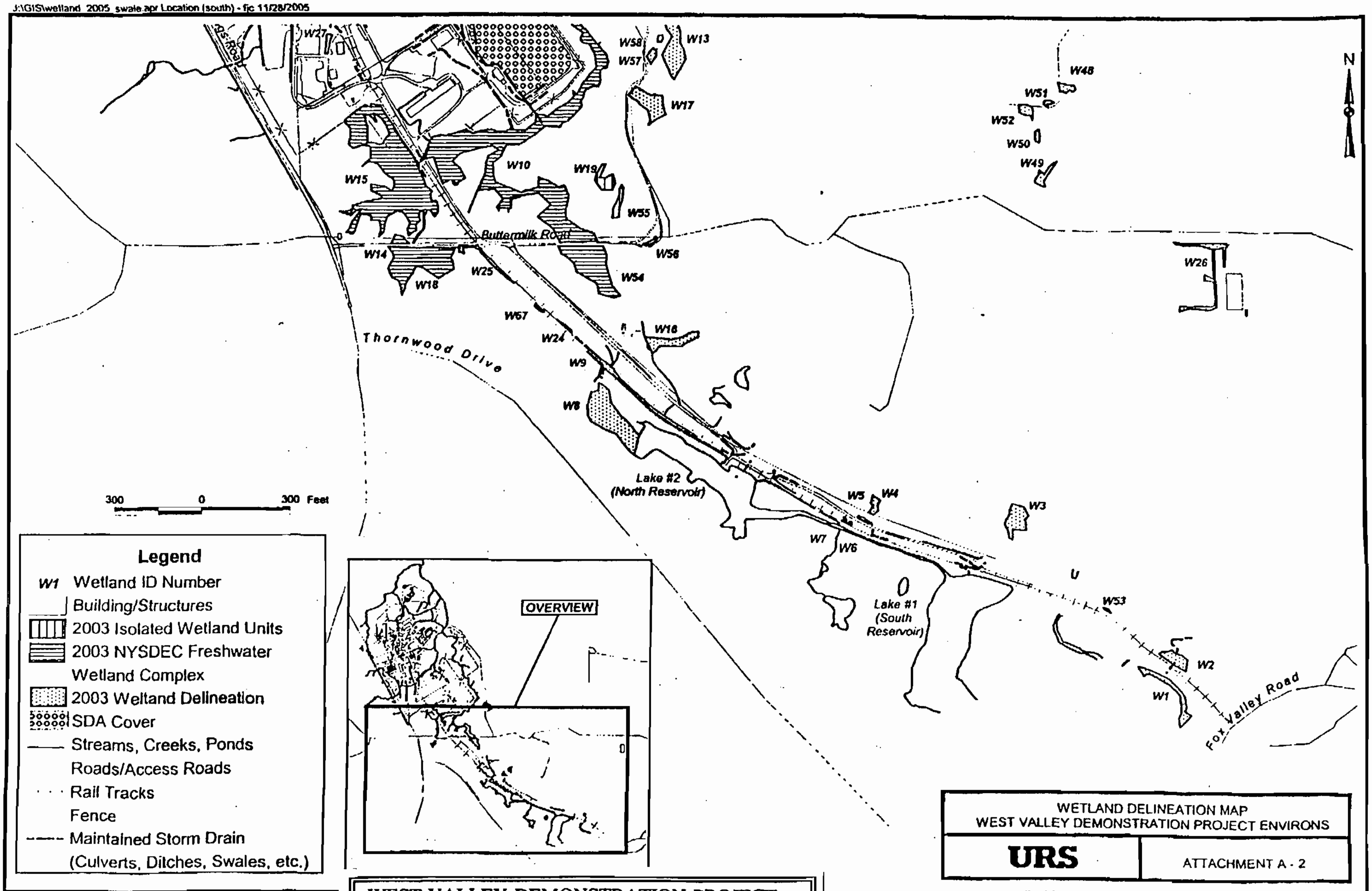
J:\GIS\2003 Wetlands Delineation REGIONAL SITE LOCATION MAP
2/9/2004

URS	REGIONAL SITE LOCATION MAP	FIGURE 1
	WEST VALLEY NUCLEAR SERVICES COMPANY TOWN OF ASHFORD, CATTARAUGUS COUNTY, NY	

J:\GIS\wetland_2005_swale.apr Environs (north) - fjc 11/28/2005

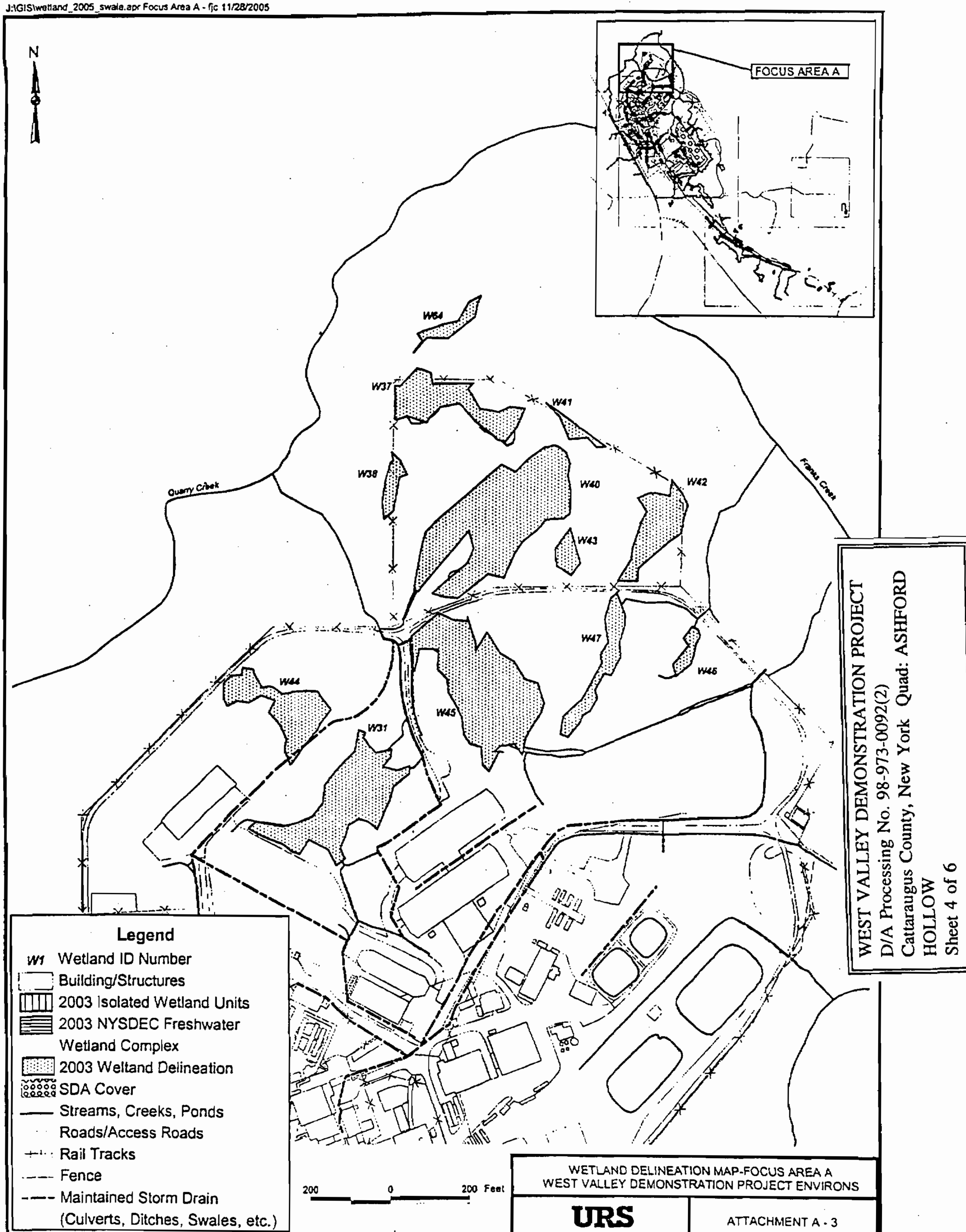


J:\GIS\wetland_2005_swale.apr Location (south) - fjc 11/28/2005

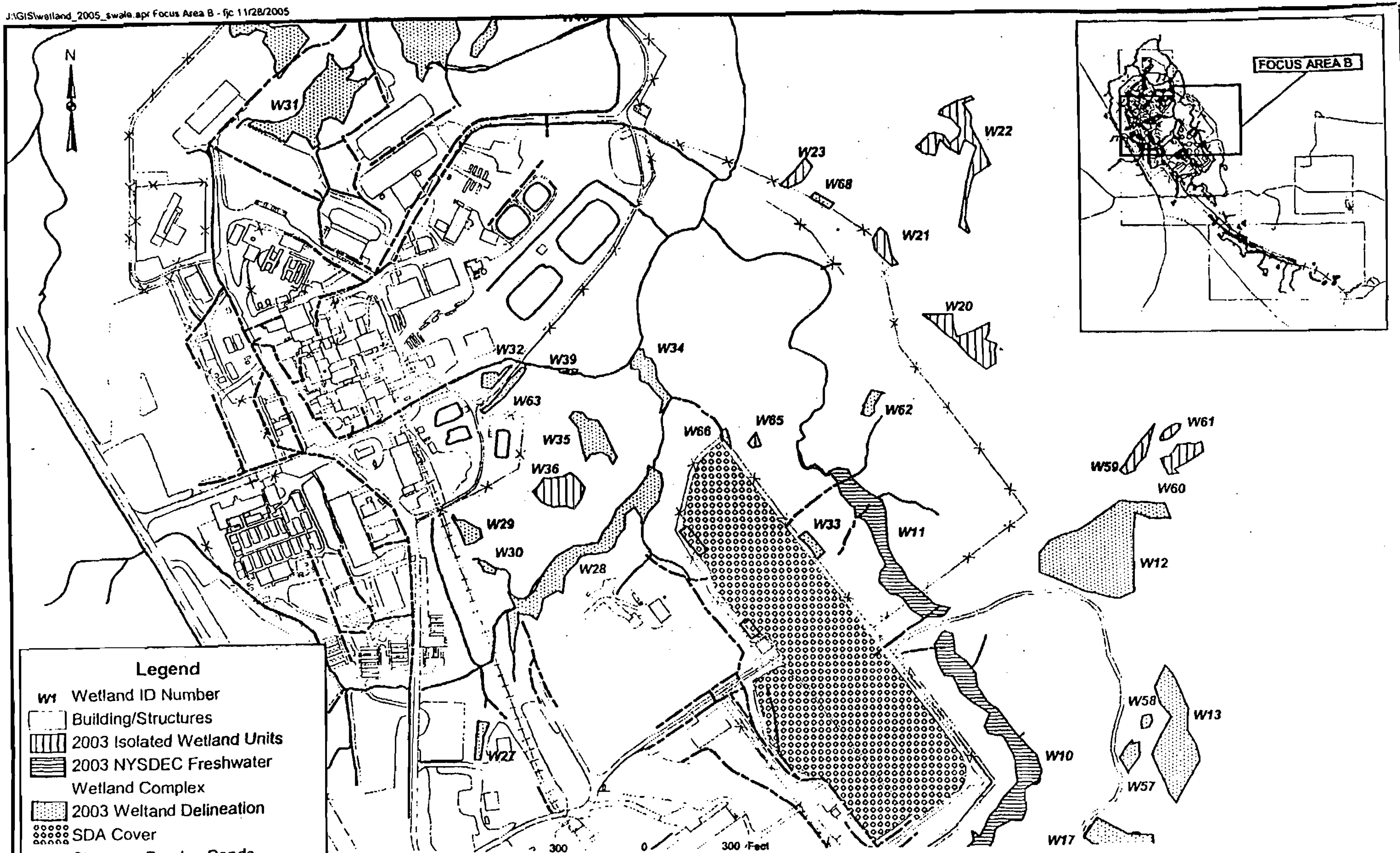


WEST VALLEY DEMONSTRATION PROJECT
D/A Processing No. 98-973-0092(2)
Cattaraugus County, New York Quad: ASHFORD HOLLOW
Sheet 3 of 6

J:\GIS\wetland_2005_swale.apr Focus Area A - fjc 11/28/2005



J:\GIS\wetland_2005_swale.apr Focus Area B - fjc 11/28/2005



Legend

- W1 Wetland ID Number
- Building/Structures
- 2003 Isolated Wetland Units
- 2003 NYSDEC Freshwater Wetland Complex
- 2003 Weltand Delineation
- SDA Cover
- Streams, Creeks, Ponds
- Roads/Access Roads
- Rail Tracks
- Fence
- Maintained Storm Drain (Culverts, Ditches, Swales, etc.)

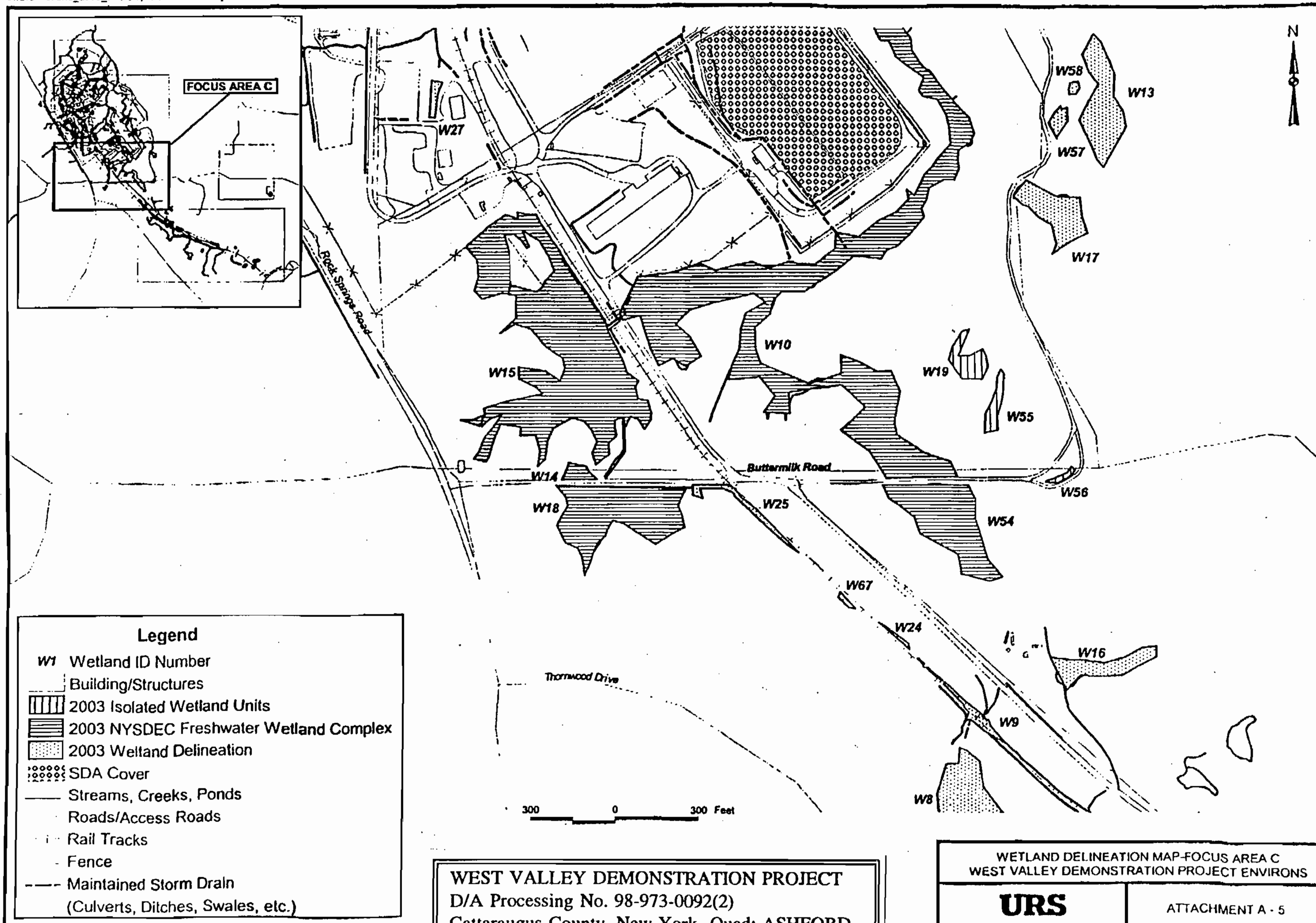
WEST VALLEY DEMONSTRATION PROJECT
D/A Processing No. 98-973-0092(2)
Cattaraugus County, New York Quad: ASHFORD HOLLOW
Sheet 5 of 6

WETLAND DELINEATION MAP-FOCUS AREA B
WEST VALLEY DEMONSTRATION PROJECT ENVIRONS

URS

ATTACHMENT A - 4

J:\GIS\wetland_2005_swale.apr Focus Area C - ljc 11/28/2005



WEST VALLEY DEMONSTRATION PROJECT
D/A Processing No. 98-973-0092(2)
Cattaraugus County, New York Quad: ASHFORD HOLLOW
Sheet 6 of 6

DW:2006:0065

bcc:	J. P. Bleech	AC-EA
	J. R. Gerber	AC-ESHQ
	W. M. Wierzbicki	AC-EA

Department of Energy
West Valley Demonstration Project
10282 Rock Springs Road
West Valley, NY 14171-9799

June 12, 2007

Migratory Bird Permit Office
U.S. Fish and Wildlife Service
P.O. Box 779
Hadley, MA 01035-0779

New York State Department of Environmental Conservation
Division of Fish, Wildlife, and Marine Resources
Special Licenses Unit
625 Broadway
Albany, New York 12233-4752

SUBJECT: Request for Renewal of Federal Bird Depredation Permit No. MB747595-0 and New York State Fish and Wildlife Depredation License No. 32, U.S. Department of Energy (DOE) - West Valley Demonstration Project (WVDP)

REFERENCE: Letter (97257), U.S. Department of the Interior Fish and Wildlife Service to West Valley Demonstration Project, U.S. Department of Energy, "Renewal of Your Federal Migratory Bird Depredation Permit," dated April 26, 2007

Dear Madam or Sir:

Enclosed is the completed application package (Attachments A-1 through A-5) requesting renewal of the Federal Migratory Bird Depredation Permit No. MB747595-0 and New York State Fish and Wildlife Depredation License No. 32 for the WVDP.

The enclosed application, which was prepared in accordance with the recent referenced letter from the U.S. Fish and Wildlife Service and the terms and conditions of the existing depredation permit and license, consists of the following:

1. The completed renewal application form, including signed renewal certification statement (Attachment A-1);

2. Supplemental Information Sheets addressing information requested under Items A through Item C on the renewal application form (Attachment A-2);

3. A copy of the current New York State Fish and Wildlife Depredation License (Attachment A-3);

4. A copy of the current Federal Migratory Bird Depredation permit (Attachment A-4); and

5. The Annual Report of the activities conducted under the Federal Permit (Attachment A-5).

Please note that the reporting period for the Annual Report (Attachment A-5) begins May 1, 2006, which corresponds with the period end date on the previous Annual Report submission.

Please note that since the WVDP is a Federal agency (DOE) project, it is our understanding the \$100 processing fee is not required per 50 CFR 13.11(d)(3).

If you have any questions or require additional information, please do not hesitate to contact Jennifer M. Dundas of my staff at (716) 942-4287.

Sincerely,

Bryan C. Bower, Director
West Valley Demonstration Project

Enclosures:
1) Attachment A-1 - Completed Application with Signed Certification for Renewal of Federal Migratory Bird Depredation Permit and New York State Fish and Wildlife Depredation License

2) Attachment A-2 – Supplemental Information Sheets for Renewal of Federal Migratory Bird Depredation Permit and New York State Depredation License

3) Attachment A-3 – Copy of New York State Fish and Wildlife Depredation License No. 32

4) Attachment A-4 – Copy of Federal Bird Depredation Permit No. MB747595-0

5) Attachment A-5 – Completed Depredation Annual Report

cc: Wildlife Services, U.S. Department of Agriculture APHIS, Wildlife Services, 1930 Route 9, Castleton, NY 12033, w/enc.

M. N. Maloney, DOE-WVDP, AC-DOE, w/enc.
H. R. Moore, DOE-WVDP, AC-DOE, w/enc.
L. J. Chilson, WVNSCO, AC-NSQA, w/enc.
J. R. Gerber, WVNSCO, AC-ESHQ, w/enc.
J. J. Hoch, WVNSCO, WV-MP3, w/enc.

JMD:97449 – 457.2

ATTACHMENT A-1

COMPLETED APPLICATION WITH SIGNED CERTIFICATION
FOR RENEWAL OF FEDERAL MIGRATORY BIRD DEPREDATION PERMIT
AND NEW YORK STATE DEPREDATION LICENSE
West Valley Demonstration Project
Permit No. MB747595-0/License No. 32

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Post Office Box 779
Hadley, Massachusetts 01035-0779
Migratory Bird Permit Office
413-253-8643

April 26, 2007

WEST VALLEY DEMONSTRATION PROJECT
U.S. DEPARTMENT OF ENERGY
10282 ROCK SPRINGS ROAD
WEST VALLEY, NY 14171-9799 U S A.

Re: RENEWAL OF YOUR FEDERAL MIGRATORY BIRD DEPREDATION PERMIT

Your Federal Migratory Bird DEPREDATION (DPRD) , Permit MB747595-0, expires on June 30, 2007.

Please indicate if you wish to renew your permit: X YES ____ NO
If you do not wish to renew your permit, return this form along with your **annual report** of activities conducted under your permit. **You must submit an annual report even if you are not requesting renewal of your permit.**

If you do wish to renew your permit, please provide the information requested in section A below, and sign and date the renewal certification statement (section B). Mail the completed form and any necessary supporting information to our office at the address above, attention Migratory Bird Permit Office.

A. **If you are renewing your permit,** please attach:
1. A specific description of the damage or other interests harmed over the past year, an estimate of the economic loss suffered as a result, and an estimate of the number of each species involved.
2. A description of the nonlethal control techniques you have used to alleviate or eliminate the problem over the past year, including how long and how often they have been conducted.
3. A copy of your **current State permit/license** (if applicable).
4. Application **processing fee:** Enclose a check or money order payable to the US Fish & Wildlife Service in the amount of $100. If you are a private homeowner requesting a permit for damage to your personal residence or property, enclose $50. Federal, tribal, state, and local government agencies, and individuals and institutions acting on behalf of such agencies, are exempt from the processing fee. (Processing fees increased effective May 11, 2005. 50 CFR 13.11(d))
5. Your annual report of the activities conducted under the permit you wish to renew.
6. ____ If this is checked, a completed USDA/APHIS Wildlife Services Migratory Bird Damage Project Report (WS form 37).

See Attachments A-2 through A-5

B. **Renewal Certification Statement.**
I certify that I have read and am familiar with the regulations contained in Title 50, Part 13, of the Code of Federal Regulations and the applicable parts in subchapter B of chapter I of title 50, Code of Federal Regulations. I further certify that the information submitted in support of my original application for the permit indicated above is still current and correct except for the changes, if any, indicated below, and I hereby request renewal of that permit. I understand that any false statement may subject me to criminal penalties of 18 U.S.C. 1001.

Permittee's signature: ____________ Date: 06-12-2007

C. **Changes in your Permit Information.**
Review your current permit and permit files carefully. Provide a description of any changes (e.g., change in **Principal Officer**, address, phone number, email address, subpermittees, species or quantity, project, activity or location of activity, facilities or location of facilities, etc.) Attach a separate sheet if necessary.

Phone No: (716) 942-4368 Email: Bryan.C.Bower@wv.doe.gov Fax: (716) 942-4703
Species/Quantity: ____________
Other: See attached

C. **Changes in your Permit information.**

Please change information on the Federal Fish and Wildlife Permit as follows:

Box 8: BRYAN C. BOWER
DIRECTOR

Please change information on the New York State Fish and Wildlife License as follows:

Licensee: BRYAN C. BOWER
U.S. DEPARTMENT OF ENERGY
WVDP
10282 ROCK SPRINGS ROAD
WEST VALLEY, NY 14171-9799

DOB: N/A

Business Phone Number: (716) 942-4368

ATTACHMENT A-2

SUPPLEMENTAL INFORMATION SHEETS FOR RENEWAL OF FEDERAL MIGRATORY BIRD DEPREDATION PERMIT AND NEW YORK STATE DEPREDATION LICENSE

West Valley Demonstration Project
Permit No. MB747595-0/License No. 32

ATTACHMENT A-2
SUPPLEMENTAL INFORMATION SHEETS FOR RENEWAL OF FEDERAL MIGRATORY BIRD DEPREDATION PERMIT AND NEW YORK STATE DEPREDATION LICENSE
West Valley Demonstration Project
Depredation Permit No. MB747595-0/Depredation License No. 32

1. **Item A.1.: Provide a specific description of the damage or other interests harmed over the past year.**

Bird nesting activities have resulted in the transport and spread of radiological contamination and asbestos from delineated, controlled areas, such as the wastewater treatment lagoon system and encapsulated insulated piping, to areas free of radiological contamination or asbestos. Transport and spread of radiological contamination and asbestos poses potential human health and safety concerns and disrupts clean-up operations at the West Valley Demonstration Project (WVDP) site. The WVDP is a radiological waste demonstration project, under the operational control of the U.S. Department of Energy (DOE) as authorized by act of U.S. Congress (Public Law 96-368)). The approximate 200-acre DOE-controlled WVDP premises are located within the approximately 3300-acre Western New York Nuclear Services Center in West Valley, New York. Figures 1 and 2 show the location of the WVDP premises within Western New York.

Bird nest removal is a required measure to protect health and safety of site employees and visitors.

2. **Item A.1: Provide an estimate of the economic loss suffered as a result.**

In the last year, the cost impact from transport/spread of radioactive contamination from migratory bird nesting activities and implementing bird problem prevention, including non-lethal control techniques, was estimated at roughly $ 280,000. If the spread of radioactive contamination is not prevented, the costs associated with work delays and/or decontamination of humans or work spaces can range from minimal to extensive. The cost of time expended in decontamination can be overtaken by additional costs associated with maintaining and disposing of radioactive wastes generated during the decontamination effort. Depending on the work activity impacted, lost time, schedule delays, etc., costs could range from $ 10,000 to well over $ 1,000,000.

3. **Item A.1.: Give an estimate (quantity) of each species (common name) involved.**

Estimated numbers of migratory birds causing damage are listed by species in Table 1 below.

TABLE 1

Species	Estimated Number Causing Damage
American Robin (*Turdus migratorius*)	15 or less
Barn Swallow (*Hirundus rustica*)	15 or less
Eastern Phoebe (*Sayornis phoebe*)	10 or less
Canada Goose (*Branta Canadensis*)	6 or less

ATTACHMENT A-2
SUPPLEMENTAL INFORMATION SHEETS FOR RENEWAL OF FEDERAL MIGRATORY BIRD DEPREDATION PERMIT AND NEW YORK STATE DEPREDATION LICENSE *(Cont'd)*
West Valley Demonstration Project
Depredation Permit No. MB747595-0/Depredation License No. 32

4. **Item A.2: Describe the non-lethal control techniques you have used to alleviate or eliminate the problem over the past year, including how long and how often they have been conducted.**

The WVDP implements an Environmental Management System (EMS) as required by U.S. Department of Energy Order 450.1. Site policies that implement this EMS include WV-980, "WVNS Environmental Management System," and WV-921, "Hazards Identification and Analysis." As part of site policy WV-921, proposed work activities and instructions must be reviewed by environmental professionals, prior to initiating such work, to identify potential environmental issues, including those associated with migratory bird nesting at inappropriate locations. Where potential issues, including those associated with migratory bird nesting are identified, measures to prevent or minimize environmental consequences are specified and implemented as conditions for work authorization. Existing structure retrofit work and repairs incorporate wildlife exclusion features (e.g., closed soffitts, sealed or screened pipeways, and tightly fitted door and window enclosures). In 2005 office trailers and other temporary structures, such as tents, which are prone to bird nesting, were removed from the WVDP site. Removal of other structures continued in 2006 and 2007. This is expected to reduce safety concerns reported by workers.

A sound-making and amplification system was installed near the wastewater lagoons and used to discourage Canada Geese from nesting in a radiological controlled area. In addition general harassment during the day, night time harassment with lights, wildlife exclusion features, and employee education were used to control and prevent migratory bird nesting activities in radiologically controlled areas. In past years, other bird scare devices, such as balloons with eyes and reflective tape marketed by suppliers as targeting nuisance birds, were used. These devices were found to be basically ineffective. For the last ten (10) years, the WVDP has employed an education program for employees on methods to prevent unwanted entry by birds to indoor areas.

Operational practices for the wastewater lagoons have been modified. These procedures require that, during migratory bird nesting season, water levels in the lagoon be kept high to cover as much exposed embankment mud as possible. Bird netting was also purchased for application to existing buildings. In addition, the pH of the radioactive wastewater in the lagoon is adjusted to control, and minimize to the extent practicable, the population of radiologically contaminated insects, a potential food source for avians.

Other approaches are unsuitable to the type of operation at the WVDP or present their own human health and safety concerns.

5. **Item A.3: Copy of current State Permit/License:**

The corollary license, issued by the New York State Department of Environmental Conservation is provided as Attachment A-3.

ATTACHMENT A-2
SUPPLEMENTAL INFORMATION SHEETS FOR RENEWAL OF FEDERAL MIGRATORY BIRD DEPREDATION PERMIT AND NEW YORK STATE DEPREDATION LICENSE *(Cont'd)*
West Valley Demonstration Project
Depredation Permit No. MB747595-0/Depredation License No. 32

6. **Item A.4: Application processing fee ($100 check or money order payable to U.S. Fish and Wildlife Service), if applicable. Federal agencies are exempt from the processing fee:**

   Since, the WVDP is a U.S. Department of Energy project, the processing fee is not required per 50 CFR Part 13.11(d)(3).

7. **Item A.5: Your annual report of activities conducted under the permit you wish to renew:**

   Attached is the annual report (U.S. F&WS form 3-202-9 (Rev 03/2004)) of activities conducted under the Federal permit and State depredation license for the WVDP. Note that the annual report includes the depredation activities associated with both active and abandoned/inactive migratory bird nests that occurred during the period beginning May 1, 2006, which is end date for the annual report submitted last year, through May 1, 2007, the date for which this report was prepared.

8. **Item A.6: If this is checked a completed USDA/APHIS Wildlife Services Migratory Bird Damage Project Report (WS Form 37):**

   This form was not requested.

9. **Item B: Renewal Certification**

   See signed form, provided as Attachment A-1.

10. **Item C: Changes in your Federal Permit and New York State License information:**

    Phone No.: 716-942-4368
    Email: Bryan.C.Bower@wv.doe.gov
    Fax: 716-942-4703

Please change information on the Federal Fish and Wildlife Permit as follows:

Box 8: BRYAN C. BOWER
DIRECTOR

Please change information on the New York State Fish and Wildlife License as follows:

Licensee: BRYAN C. BOWER
U.S. DEPARTMENT OF ENERGY
WVDP
10282 ROCK SPRINGS ROAD
WEST VALLEY, NY 14171-9799

DOB: N/A Business Phone Number: (716) 942-4368

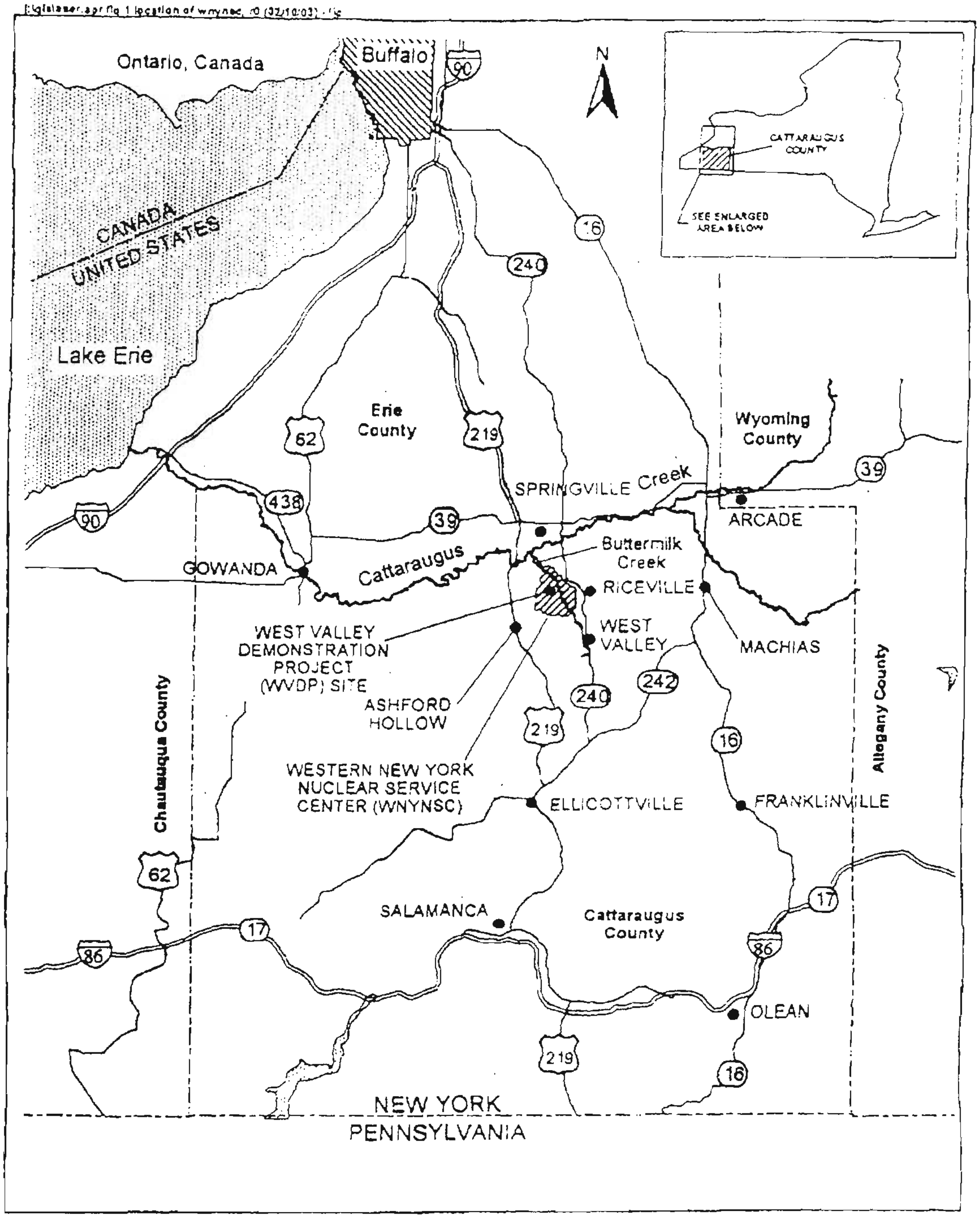


Figure 1. Location of the West Valley Demonstration Project

J:/GIS/ArcMap/ASER/ASER_2006_FigA01.mxd (05/03/07)

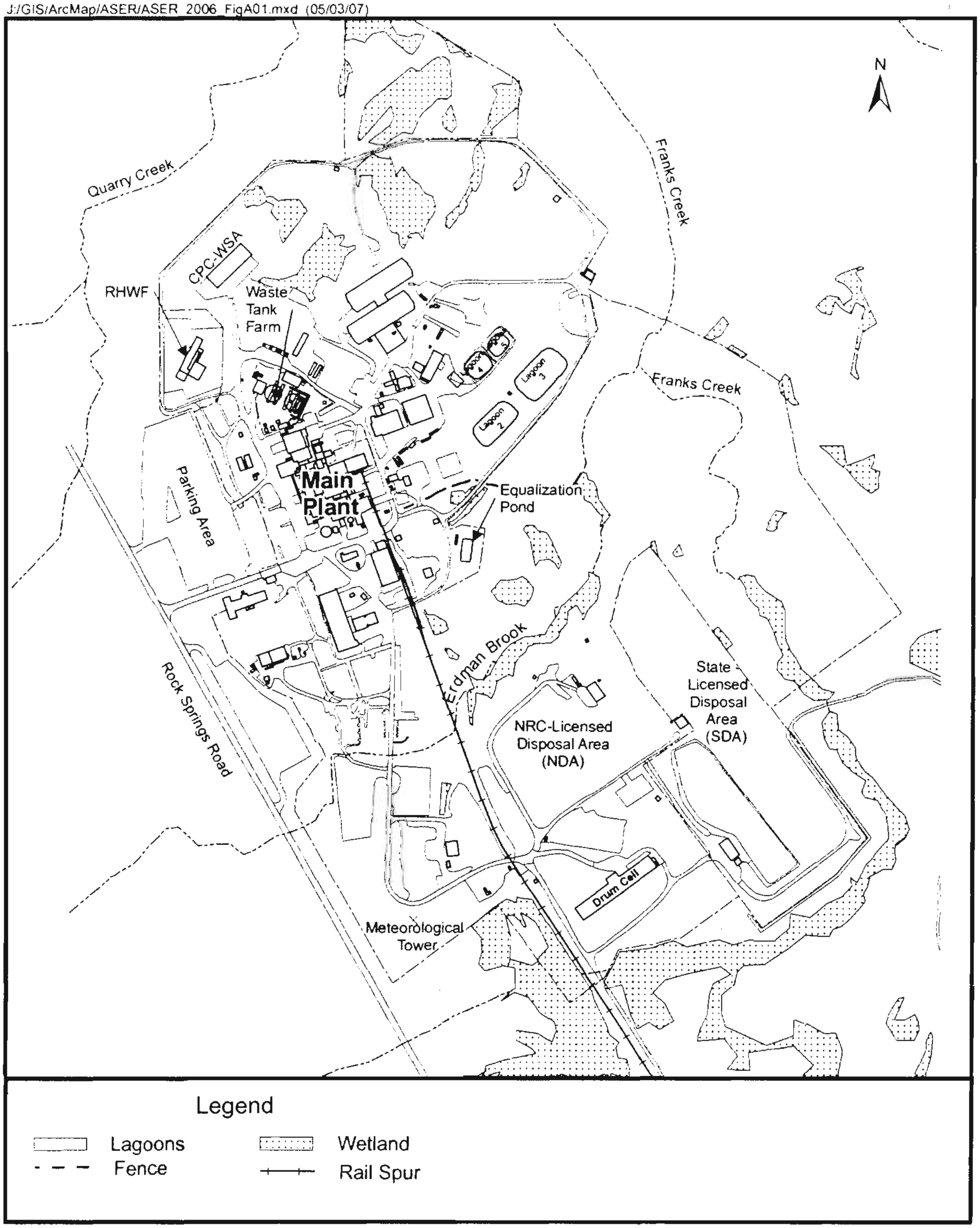


Figure 2. WVDP Project Premises

ATTACHMENT A-3
COPY OF NEW YORK STATE FISH AND WILDLIFE DEPREDATION LICENSE NO. 32
Effective June 30, 2006
U.S. Department of Energy - West Valley Demonstration Project

New York State Department of Environmental Conservation
Division of Fish, Wildlife and Marine Resources - Special Licenses Unit
625 Broadway
Albany, NY 12233-4752
Phone Number (518) 402-8985
Fax Number: (518) 402-8925

NEW YORK STATE FISH AND WILDLIFE LICENSE

License Type: Depredation: General

License Number: 32

Licensee:

MOIRA N MALONEY
U. S. DEPARTMENT OF ENERGY
WVDP 10282 ROCK SPRINGS ROAD
WEST VALLEY, NY 14171-9799

Fee Amount: $.00
Effective Date: 06/30/2006
Expiration Date: 06/30/2007
Region: 9 County: CATTARAUGUS
Home Phone Number:
Business Phone Number: (716) 942-4255

DOB: 3/26/1901

Statutory Authority:

Federal	16 USC 703-712	Federal	50 CFR Part 21.41	Federal	50 CFR Part 13
ECL	11-0505(5)	ECL	11-0521	6NYCRR	Part 175

Conditions:

1. A. Please read all license conditions BEFORE conducting any activity pursuant to this license.

B. The licensee assumes all liability and responsibility for any activities conducted under the authority of this license or any actions resulting from activities authorized by the license.

C. This license may be revoked for any of the following reasons:
i. licensee provided materially false or inaccurate statements in his or her application, supporting documentation or on required reports;
ii. failure by the licensee to comply with any terms or conditions of this license;
iii. licensee exceeds the scope of the purpose or activities described in his or her application for this license;
iv. licensee fails to comply with any provisions of the NYS Environmental Conservation Law, any other State or Federal laws or regulations of the Department directly related to the licensed activity;
v. licensee submits a check, money order or voucher for this license or application for this license that is subsequently returned to the Department for insufficient funds or nonpayment after the license has been issued.

D. The renewal of this license is the responsibility of the licensee. This license is deemed expired on the date of expiration listed on the license unless otherwise notified by the Department.

E. Direct all questions concerning this license to the Special Licenses Unit (518) 402-8985.

2. A. This license is NOT VALID without a corresponding Federal Permit from the US Fish and Wildlife Service.

B. The licensee MUST submit a duplicate set of all reports required under their Federal Permit to the NYS DEC Special Licenses Unit, 625 Broadway, Albany, NY 12233-4752 within 30 days of the expiration of this license (Original reports must be sent to the Federal Permit Office - send ONLY copies to NYS DEC).

3. A. The licensee and/or designated agents are authorized to remove and destroy 15 active Bam Swallow nests, 15 active American Robin nests, 5 active Canada goose nests and 5 active Eastem Phoebe nests at the West Valley Demonstration Project Site, West Valley, NY, pursuant to Federal Permit MB747595-0.

B. All carcasses collected under this license MUST be promptly buried or incinerated.

C. No endangered or threatened species or species of special concern may be collected or possessed pursuant to this license.

D. The licensee and/or designated agents MUST carry a copy of this license when conducting activities authorized by this license and MUST display a copy of this license when requested.

E. The licensee may designate agents to conduct activities authorized by this license. Such designations MUST be made in writing to the NYS DEC Special Licenses Unit by sending a list with the name and address of the person(s) the licensee wishes to designate as an agent. This list MUST be on file at the NYS DEC Special Licenses Unit. The licensee is responsible for all actions take by designated agents under this license.

Department of
Environmental Conservation

Division of Fish, Wildlife & Marine Resources
625 Broadway, Albany, NY 12233-4750
Phone: (518) 402-8924
Fax: (518) 402-9027
Website: www.dec.state.ny.us

General Depredation Permit for Canada Geese and Gulls

(Effective January 1, 2002)

Section 11-0521 of the Environmental Conservation Law (ECL) authorizes the New York State Department of Environmental Conservation (DEC) to "... issue a permit to any person, to take any wildlife at anytime whenever it becomes a nuisance, destructive to public or private property or a threat to public health or welfare...". In the case of migratory birds, the U.S. Fish and Wildlife Service must also issue a permit before any person can take species protected by federal law. The federal permit process, with DEC input, provides adequate protection of the resource and makes review and issuance of individual State permits unnecessary in most cases.

DEC hereby authorizes any person to take Canada geese or gulls **in accordance with a valid federal migratory bird depredation permit, federal depredation order or other federal regulation** permitting the taking of migratory birds in accordance with Title 50, Code of Federal Regulations, Part 21, Subpart D (50 CFR 21D: Control of Depredating Birds), **subject to the following conditions:**

A. Activities carried out under this general permit must be done in accordance with all terms and conditions specified in the federal permit, depredation order or other regulation in 50 CFR 21D.

B. Only the following species may be taken pursuant to this general permit: **Canada goose** (*Branta canadensis*), **ring-billed gull** (*Larus delawarensis*), **herring gull** (*L. argentatus*), and **great black-backed gull** (*L. marinus*), **within limits specified below**. In this permit, the term "gulls" refers only to these three species.

C. **Scaring/herding:** Any person may scare or herd Canada geese or gulls by any means, including pyrotechnics and dogs, as long as Canada geese or gulls are not physically harmed.

D. **Nests and eggs:** Any person may take any number of **nests or eggs of Canada geese found in any place**, and any number of **nests or eggs of gulls found on rooftops or other man-made structures** or along public walkways, in accordance with a valid federal permit, depredation order or other regulation under 50 CFR 21D. Nests or eggs of these species may be disturbed, destroyed, or treated to prevent hatching. This general permit also satisfies the permit requirements of ECL 11-0505(5).

E. **Shooting and euthanasia:** No more than the following numbers of birds may be taken by shooting, live-trapping and euthanasia, or hand capture and euthanasia, from any single property or location:

Canada geese - no more than **2/day** and no more than **20 in any calendar year**; and

Gulls - no more than **15/day** of each species (45 in all) and no more than 250 ring-billed gulls, 250 herring gulls, or 50 great black-backed gulls in any calendar year; **taking of gulls permitted at landfills only**.

F. **Relocation: No** Canada geese or gulls may be relocated (live-trapped and released at a different location) under this general permit.

G. Activities carried out under this general permit must be done in accordance with all applicable local laws and regulations.

H. **Activities not covered by this general permit may be allowed pursuant to an individual permit from DEC**, after the corresponding federal permit or authorization is obtained. For information about federal migratory bird depredation permits, contact: Permit Office, U.S. Fish and Wildlife Service, P.O. Box 779, Hadley, MA 01035-0779, phone (413) 253-8643, fax (413) 253-8424.

ATTACHMENT A-4
COPY OF FEDERAL BIRD DEPREDATION PERMIT
NO. MB747595-0
Effective July 1, 2006
U.S. Department of Energy - West Valley Demonstration Project

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

3-201
(1/97)

FEDERAL FISH AND WILDLIFE PERMIT

1. PERMITTEE

WEST VALLEY DEMONSTRATION PROJECT
U.S. DEPARTMENT OF ENERGY
10282 ROCK SPRINGS ROAD
WEST VALLEY, NY 14171-9799
U.S.A.

2. AUTHORITY-STATUTES
16 USC 703-712

REGULATIONS (*Attached*)
50 CFR Part 13
50 CFR 21.41

3. NUMBER
MB747595-0

4. RENEWABLE
☐ YES
☐ NO

5. MAY COPY
☐ YES
☐ NO

6. EFFECTIVE
07/01/2006

7. EXPIRES
06/30/2007

8. NAME AND TITLE OF PRINCIPAL OFFICER (*If #1 is a business*)
MOIRA N. MALONEY
ENGINEER/SCIENTIST

9. TYPE OF PERMIT
DEPREDATION

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED
200 ACRE PREMISES OF WEST VALLEY DEMONSTRATION PROJECT, WEST VALLEY, NY
TEL: 716-942-4255

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE.

D. Authorized to **remove and destroy all eggs** in up to:
(a) **15 active Barn swallow nests and 15 active American robin nests and**
(b) **5 active Canada goose nests and 5 active Eastern phoebe nests, containing eggs and/or young. Nestlings must be humanely destroyed.**

E. Authorized Subpermittees: **(1) Employees of the U.S. Dept. of Energy assigned to the WVDP; (2) employees of the West Valley Nuclear Services Company (contractor to DOE for WVDP); and, (3) employees of URS (subcontractor to WVNS at WVDP)**

F. Permittee **MUST** also comply with the attached Depredation Permit Standard Conditions.

☐ ADDITIONAL CONDITIONS AND AUTHORIZATIONS ALSO APPLY

12. REPORTING REQUIREMENTS

ANNUAL REPORT DUE WITH NEXT RENEWAL FORM

ISSUED BY	TITLE	DATE
	ARD, MIGRATORY BIRDS & STATE PROGRAMS	06/23/2006

Standard Conditions
Migratory Bird Depredation Permits
50 CFR 21.41

Standard conditions for depredation permits are below. These conditions are in addition to the conditions listed on the face of your permit. All of the governing regulations at 50 CFR Part 13 are also conditions of your permit. Failure to comply with the conditions of your permit could be cause for suspension of the permit. If you have questions regarding the conditions of your permit, refer to the regulations or contact the migratory bird permit office that issued your permit. Regulations and contact information are available on the Internet at: http://www.permits.fws.gov/mbpermits/birdbasics.html

1. You, and any subpermittees, must carry a legible copy of this permit, and display it upon request whenever you are exercising its authority.

2. You may not exercise the authorization granted by this permit contrary to the laws of the applicable state, county, municipal, or tribal government, or any other applicable law.

3. You are not authorized to take, capture, or harass bald or golden eagles or federally listed threatened or endangered species.

4. You may not use blinds, pits, or other means of concealment, decoys, duck calls, or other devices to lure or entice birds into gun range.

5. Shotguns used to take birds can be no larger than 10 gauge and must be fired from the shoulder. You must use nontoxic shot listed in 50 CFR 20.21(j).

6. To minimize the lethal take of birds, you are required to continually apply non-lethal methods of harassment alternately with lethal control.

7. You are not authorized to take any birds, nests, or eggs, or to release birds on federal or state lands or other public or private property without additional written authorization, permission, or permits from the applicable federal or state agency, landowner, or custodian.

8. Unless otherwise specified on the face of the permit, birds, nests, or eggs taken under this permit must be (1) turned over to the U.S. Department of Agriculture for official purposes, (2) donated to a public educational or scientific institution as defined by 50 CFR 10, or (3) completely destroyed by burial or incineration.

9. You must maintain records of the activities conducted under your permit for a period of 5 years from the date of expiration of the permit (50 CFR 13.46), including the following information: species (common name); date taken; location where taken; number of birds killed or relocated; number of eggs, or nests with eggs, taken or relocated; name of person taking birds; and the final disposition of the birds or eggs.

10. You must keep all records relating to the permitted activities at the location(s) identified in writing by you to the issuing office.

11. Acceptance of this permit authorizes the Fish and Wildlife Service to inspect any wildlife held, and to audit or copy any permits, books, or records required to be kept by the permit and governing regulations.

(9/12/2005)

ATTACHMENT A-5
COMPLETED DEPREDATION ANNUAL REPORT
(FWS Form 3-202-9 (Rev 03/2004))
U.S. Department of Energy - West Valley Demonstration Project

U.S. FISH & WILDLIFE SERVICE - MIGRATORY BIRD PERMIT OFFICE
P.O. Box 779, Hadley, MA 01035
413-253-8642

DEPREDATION - ANNUAL REPORT

PERMITTEE: West Valley Demonstration Project

PERMIT NUMBER: MB747595-0

ADDRESS: 10282 Rock Springs Road

REPORT FOR CALENDAR YEAR: May 1, 2006 through May 1, 2007

West Valley (City) NY (State) 14171-9799 (Zip Code)

REPORT DUE DATE: June 30, 2007

PHONE: (716) 942-4368 Email: Bryan.C.Bower@wv.doe.gov

☐ Check here if reporting a change of name, address, or contact information

INSTRUCTIONS: Type or print the information requested below for all activities conducted under your permit during the year covered by this report, and return the completed report to the above address by the due date. Use of this form is not mandatory, but the same information must be submitted. A supplemental sheet is available if needed. Filing an annual report is a condition of your permit. Failure to file a timely report can result in permit suspension. If you had no activity under your permit during the report year state "No activity" on the form. **MAKE SURE YOU SIGN & DATE THE CERTIFICATION STATEMENT BELOW BEFORE YOU SUBMIT YOUR REPORT.** (50 CFR parts 13, 21, & 22)

☛ **Please provide a total quantity for each species reported. For instance, if 2 Canada geese were killed during each of 5 months, insert a Total of 10 in Killed column for Canada geese.**

Species (Common Name)	Month Taken	Location (Town, county, State)	Number of Birds Killed	Number of Birds Relocated*	Numbers of Eggs Taken**	Numbers of Nests Affected	FINAL DISPOSITION (What you did with the birds, eggs, carcasses, e.g., destroyed, released, transferred to whom)
Canada Goose	05/2006	Ashford, Cattaraugus, NY	0	0	3	1	Nest and eggs destroyed
Barn Swallow	06/2006	Ashford, Cattaraugus, NY	0	0	8	4	Nest and eggs destroyed

* Relocated in the wild. ** Taken = destroyed, addled, oiled, removed from wild.

CERTIFICATION: I certify that the information in this report is true and correct to the best of my knowledge. I understand that any false statement herein may subject me to the criminal penalties of 18 U.S.C. 1001.

Signature: [signature] Date: 06-12-2007

SUPPLEMENTAL SHEET - DEPREDATION ANNUAL REPORT

PERMITTEE: ______________ PERMIT NUMBER: __________ REPORT YEAR: _________ SUPPLEMENTAL PAGE NO: _____

Species (Common Name)	Month Taken	Location (Town, county, State)	Number of Birds Killed	Relocated*	Numbers of Eggs Taken**	Nests Affected	FINAL DISPOSITION (What you did with the birds, eggs, carcasses, e.g., destroyed, released, transferred to whom)

* Relocated in the wild ** Taken = destroyed, addled, oiled, removed from wild. (FWS form 3-202-9(Rev 03/2004))

Department of Energy
West Valley Demonstration Project
10282 Rock Springs Road
West Valley, NY 14171-9799

July 18, 2008

U.S. Fish and Wildlife Service
3817 Luker Road
Cortland, NY 13045

SUBJECT: Rare Species Consultation for the *Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center*

Dear Sir or Madam:

The purpose of this letter is to notify you that the U.S. Department of Energy (DOE) and New York State Energy Research and Development Authority (NYSERDA) are in the process of preparing a revised *Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (see Enclosure 1). NYSERDA is serving as the lead agency for purposes of State Environmental Quality Review Act (SEQR). In support of this effort DOE is requesting information on rare species and significant natural communities that may be impacted by the proposed project.

The West Valley Demonstration Project (WVDP) is a radioactive waste management demonstration site currently operated by the DOE under Act of the U.S. Congress. The WVDP, a largely industrialized area, is located on approximately 63 hectares within the boundaries of the Western New York Nuclear Service Center (WNYNSC), a 1,335-hectare reserve area of fields and woodlands owned by New York State. The WNYNSC is situated partly in the Town of Concord on the southern border of Erie County and mostly in the Town of Ashford on the northern border of Cattaraugus County. A 7.5 minute U.S. Geological Survey topographical map showing the site is presented in Enclosure 2.

While there has been no change in the project impact area since publication of the Notice of Intent in 2003, there has been a change in the alternatives being considered. Following scoping meetings, the alternatives were revised to include: a Site-wide Removal Alternative, Site-wide Close-In-Place Alternative, Phased Decision-making Alternative (the Preferred Alternative), and No-Action Alternative. Each alternative is summarized below.

Under the Site-wide Removal Alternative, all site facilities would be removed, environmental media decontaminated, and waste characterized, packaged, as necessary, and shipped off site for disposal. Under this alternative, the entire WNYNSC could be available for unrestricted release.

Under the Site-wide Close-In-Place Alternative, key site facilities would be closed in place; however, residual radioactivity in facilities with larger inventories of long-lived radionuclides would be isolated by specially-designed closure structures and engineered barriers. Thus, under this alternative, a sizable portion, but not all of the WNYNSC, could be available for unrestricted release.

Under the Phased Decision-making Alternative, a two-phased approach would be undertaken. Phase 1 would entail the removal of a number of key facilities, but would delay a decision on other facilities pending the undertaking of additional studies and evaluations to clarify and possibly reduce uncertainties related to final decommissioning and long-term management. Phase 2 would complete decommissioning, following the approach determined in Phase 1. The amount of land that could be available for unrestricted release would not be fully known until the approach to Phase 2 is determined.

Under the No-Action Alternative, no actions toward decommissioning would be taken; however, a limited portion of the site could be available for unrestricted release.

Please send the requested information to:

Ms. Jennifer M. Dundas
U. S. Department of Energy
10282 Rock Springs Road
West Valley, NY 14171-9799

If you have any questions regarding this inquiry, Jennifer Dundas of my staff may be reached at (716) 942-4287.

Sincerely,

Bryan C. Bower, Director
West Valley Demonstration Project

Enclosures: 1) Notice of Intent to Prepare an *Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center*

2) 7.5 Minute U.S. Geological Survey Topographical Map for Ashford Hollow Quadrangle

cc: J. E. Loving, DOE-HQ, GC-20/FORS, w/o enc.
J. M. Dundas, DOE-WVDP, AC-DOE, w/o enc.
M. N. Maloney, DOE-WVDP, AC-DOE, w/o enc.
P. J. Bembia, NYSERDA, w/o enc.

CMB:99492 - 451.1

CMB/cmb

Department of Energy
West Valley Demonstration Project
10282 Rock Springs Road
West Valley, NY 14171-9799

July 18, 2008

NYSDEC-DFWMR
New York Natural Heritage Program-Information Services
625 Broadway, 5th Floor
Albany, NY 12233-4757

SUBJECT: Rare Species Consultation for the *Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center*

Dear Sir or Madam:

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Under the No-Action Alternative, no actions toward decommissioning would be taken; however, a limited portion of the site could be available for unrestricted release.

Please send the requested information to:

Ms. Jennifer M. Dundas
U. S. Department of Energy
10282 Rock Springs Road
West Valley, NY 14171-9799

If you have any questions regarding this inquiry, Jennifer Dundas of my staff may be reached at (716) 942-4287.

Sincerely,

B. C. B.

Bryan C. Bower, Director
West Valley Demonstration Project

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2) 7.5 Minute U.S. Geological Survey Topographical Map for Ashford Hollow Quadrangle

cc: J. E. Loving, DOE-HQ. GC-20/FORS, w/o enc.
J. M. Dundas, DOE-WVDP, AC-DOE, w/o enc.
M. N. Maloney, DOE-WVDP, AC-DOE, w/o enc.
P. J. Bembia, NYSERDA, w/o enc.

CMB:99493 - 451.1

CMB/cmb

Department of Energy
West Valley Demonstration Project
10282 Rock Springs Road
West Valley, NY 14171-9799

July 21, 2008

Mr. Maurice A. John
President
The Seneca Nation of Indians
P.O. Box 231
Salamanca, New York 14779

ATTENTION: Sylvia Patterson, Environmental Protection Director

SUBJECT: Consultation for the *Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* and Public Meeting

Dear President John:

The U.S. Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA) are jointly preparing a *Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center*. The U.S. Nuclear Regulatory Commission (NRC), the U.S. Environmental Protection Agency (EPA), and the New York State Department of Environmental Conservation (NYSDEC) are participating as cooperating agencies.

This Environmental Impact Statement (EIS) will revise the Draft EIS for Completion of the West Valley Demonstration Project and Closure of Long-Term Management of Facilities at the Western New York Nuclear Service Center (DOE/EIS-0226-D), which was issued in 1996. This EIS will evaluate the range of reasonable alternatives for decommissioning and long-term stewardship of the Western New York Nuclear Service Center (WNYNSC).

While there has been no change in the project impact area since publication of the Notice of Intent in 2003, there has been a change in the alternatives being considered. Following scoping meetings, the alternatives were revised to include: a Site-wide Removal Alternative, Site-wide Close-In-Place Alternative, Phased Decision-making Alternative (the Preferred Alternative), and No-Action Alternative. Each alternative is summarized below.

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Under the No-Action Alternative, no actions toward decommissioning would be taken; however, a limited portion of the site could be available for unrestricted release.

Issuance of a draft EIS is planned for the fall of 2008. We would like to meet with you and/or members of your staff to discuss current planning for the EIS and to hear your issues and concerns.

In 1996, DOE held public meetings on two of your reservations. We would again like to extend an offer to hold public meetings on the two main territories, Cattaraugus and Allegany. Public meetings will likely be held in the March or April 2009 timeframe, during the six-month public comment period, to listen to the views of and gather information from Tribal Governments, regulators, elected officials, stakeholders, and the public, to allow the lead agencies to make effective decisions in regards to this EIS.

If you have any questions regarding this information or to schedule a meeting, please contact:

Ms. Catherine M. Bohan, NEPA Compliance Officer and Tribal Point of Contact
U.S. Department of Energy
West Valley Demonstration Project
10282 Rock Springs Road
West Valley, NY 14171-9799
Phone: (716) 942-4159, E-mail: Catherine.M.Bohan@wv.doe.gov

I look forward to working with you as we move toward completion of this important process.

Sincerely,

Bryan C. Bower, Director
West Valley Demonstration Project

cc: J. E. Loving, DOE-HQ, GC-2/FORS
A. Wickham, DOE-EMCBC
M. N. Maloney, DOE-WVDP, AC-DOE
P. J. Bembia, NYSERDA, AC-NYS
S. C. Crede, SAIC
S. E. Robinson, SAIC

CMB:99524 - 451.1

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New York Field Office
3817 Luker Road
Cortland, NY 13045
Phone: (607) 753-9334 Fax: (607) 753-9699
http://www.fws.gov/northeast/nyfo

Project Number: 80643

To: Bryan Bower

Date: Jul 29, 2008

Regarding: DEIS for decommissioning West Valley Demonstration Site

Town/County: Town of Ashford / Cattaraugus County

We have received your request for information regarding occurrences of Federally-listed threatened and endangered species within the vicinity of the above-referenced project/property. Due to increasing workload and reduction of staff, we are no longer able to reply to endangered species list requests in a timely manner. In an effort to streamline project reviews, we are shifting the majority of species list requests to our website at http://www.fws.gov/northeast/nyfo/es/section7.htm. Please go to our website and print the appropriate portions of our county list of endangered, threatened, proposed, and candidate species, and the official list request response. Step-by-step instructions are found on our website.

As a reminder, Section 9 of the Endangered Species Act (ESA) (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) prohibits unauthorized taking* of listed species and applies to Federal and non-Federal activities. Additionally, endangered species and their habitats are protected by Section 7(a)(2) of the ESA, which requires Federal agencies, in consultation with the U.S. Fish and Wildlife Service (Service), to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. An assessment of the potential direct, indirect, and cumulative impacts is required for all Federal actions that may affect listed species. For projects not authorized, funded, or carried out by a Federal agency, consultation with the Service pursuant to Section 7(a)(2) of the ESA is not required. However, no person is authorized to "take"* any listed species without appropriate authorizations from the Service. Therefore, we provide technical assistance to individuals and agencies to assist with project planning to avoid the potential for "take," or when appropriate, to provide assistance with their application for an incidental take permit pursuant to Section 10(a)(1)(B) of the ESA.

Project construction or implementation should not commence until all requirements of the ESA have been fulfilled. If you have any questions or require further assistance regarding threatened or endangered species, please contact the Endangered Species Program at (607) 753-9334. Please refer to the above document control number in any future correspondence.

Endangered Species Biologist: Sandra Doran *Sandra Doran*

*Under the Act and regulations, it is illegal for any person subject to the jurisdiction of the United States to *take* (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import or export, ship in interstate or foreign commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any endangered fish or wildlife species and most threatened fish and wildlife species. It is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. "Harm" includes any act which actually kills or injures fish or wildlife, and case law has clarified that such acts may include significant habitat modification or degradation that significantly impairs essential behavioral patterns of fish or wildlife.

New York State Department of Environmental Conservation
Division of Fish, Wildlife & Marine Resources
New York Natural Heritage Program
625 Broadway, Albany, New York 12233-4757
Phone: (518) 402-8935 • **FAX:** (518) 402-8925
www.dec.state.ny.us

Alexander B. Grannis
Commissioner

August 6, 2008

Jennifer Dundas
U S Department of Energy
10282 Rock Springs Road
West Valley, NY 14171-9799

Dear Ms. Dundas:

In response to your recent request, we have reviewed the New York Natural Heritage Program database with respect to an Environmental Assessment for the proposed Decommissioning and/or Stewardship at West Valley Demo/Project and Western NY Nuclear Service Center, area as indicated on the map you provided, located partly in the Town of Concord, Erie County; and mostly in the Town of Ashford, Cattaraugus County, New York State.

Enclosed is a report of rare or state-listed animals and plants, significant natural communities, and other significant habitats, which our databases indicate occur, or may occur, on your site or in the immediate vicinity of your site.

The presence of the plants and animals identified in the enclosed report may result in this project requiring additional review or permit conditions. For further guidance, and for information regarding other permits that may be required under state law for regulated areas or activities (e.g., regulated wetlands), please contact the appropriate NYS DEC Regional Office, Division of Environmental Permits, at the enclosed address.

For most sites, comprehensive field surveys have not been conducted; the enclosed report only includes records from our databases. We cannot provide a definitive statement on the presence or absence of all rare or state-listed species or significant natural communities. This information should not be substituted for on-site surveys that may be required for environment impact assessment.

Our databases are continually growing as records are added and updated. If this proposed project is still under development one year from now, we recommend that you contact us again so that we may update this response with the most current information.

Sincerely,
Tara Seoane jp
Tara Seoane, Information Services
New York Natural Heritage Program

cc: Reg. 9, Wildlife Mgr.
Reg. 9, Fisheries Mgr.

Natural Heritage Report on Rare Species and Ecological Communities

NY Natural Heritage Program, NYS DEC, 625 Broadway, 5th Floor, Albany, NY
12233-4757
(518) 402-8935

~This report contains **SENSITIVE** information that should not be released to the public without permission from the NY Natural Heritage Program.
~Refer to the User's Guide for explanations of codes, ranks and fields.
~Location maps for certain species and communities may not be provided 1) if the species is vulnerable to disturbance, 2) if the location and/or extent is not precisely known, 3) if the location and/or extent is too large to display, and/or 4) if the animal is listed as Endangered or Threatened by New York State.

Natural Heritage Report on Rare Species and Ecological Communities

BEETLES

Cicindela ancocisconensis

Office Use
9083

Appalachian Tiger Beetle

NY Legal Status: Unlisted
NYS Rank: S2 - Imperiled
Federal Listing:
Global Rank: G3 - Vulnerable
Last Report: 2000-08-28
EO Rank: Excellent or Good
County: Erie, Cattaraugus
Town: Collins, East Otto, Yorkshire, Otto, Persia, Sardinia, Concord, Ashford
Location: Cattaraugus Creek
Directions: The tiger beetle population occurs along a 25 mile stretch of the Cattaraugus Creek from Gowanda east to the area of Hake Road, approximately 3 miles west of Sillimans Corners. The beetles were found on at least 21 cobble bars and sandy terraces scattered throughout this stretch. Most locations where they have been observed are in the vicinity of the bridges which cross the creek and provide access. A number of locations can be accessed from the Gowanda-Zoar Valley Road and the Zoar Valley Multiple Use Area.

General Quality and Habitat: There are no global rank specifications for this species. All locations are combined as one occurrence based on element occurrence specifications from riparian cicindelidae of 2001-12-06. The "AB: rank is based on the fact that the beetles were found atno less than 17 separate cobble bars or sand/cobble terraces along a 25 mile stretch of a large creek with only one small dam and intact hydrological flow which mainatins the high quality and quantity of habitat present. They undoubtedly occur at many ad The Cattaraugus Creek is a large creek which flows through a rural, agricultural setting and a large steep gorge area known as Zoar Valley. The flow is fast in spring with annual spring flooding. In the eastern portion, the creek has many twists and bends and sand and cobble are deposited at bends in the creek forming large cobble bars and sand/cobble terraces. To the west, where the creek flows through Zoar Valley the creek is bordered by steep, high walls and there are fewer bends in the creek and fewer cobble bars. There is a single small (less than 20 foot in height) dam just west of Route 219 which does not effectively alter the creeks hydrological regime.

Cicindela marginipennis

Office Use
10212

Cobblestone Tiger Beetle

NY Legal Status: Unlisted
NYS Rank: S1 - Critically imperiled
Federal Listing:
Global Rank: G2 - Imperiled
Last Report: 1999-08-10
EO Rank: Excellent or Good
County: Erie, Cattaraugus
Town: Otto, Concord, Collins, Ashford, East Otto
Location: At, or in the vicinity of, the project site.
Directions: **
General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NY Natural Heritage Program Zoologist at 518-402-8939.

IRDS

Spizella pallida

Office Use

Clay-colored Sparrow **NY Legal Status:** Protected **NYS Rank:** S2 - Imperiled 12458

Breeding

Federal Listing:		**Global Rank:**	G5 - Demonstrably secure
Last Report:	2003-06-09	**EO Rank:**	Extant
County:	Cattaraugus		
Town:	Ashford		
Location:	Bond Road Plantation		
Directions:	From the intersection of Route 82 and Cattaragus Street in Springville, travel south on Route 82 (Buffalo Street) for 2.0 mi and turn left onto Thomas Corners Road. Travel east on Thomas Corners Road for 1.3 mi and turn left onto Bond Road. The birds were seen in lilac bushes on the west side of the road.		
General Quality and Habitat:	The birds were observed in lilac (Syringa sp.) bushes in an ornamental shrub plantation.		

COMMUNITIES

Hemlock-northern hardwood forest

This occurrence of Hemlock-Northern Hardwood Forest is considered significant from a statewide perspective by the NY Natural Heritage Program. It is either an occurrence of a community type that is rare in the state or a high quality example of a more common community type. By meeting specific, documented significance criteria, the NY Natural Heritage Program considers this occurrence to have high ecological and conservation value.

Office Use

NY Legal Status: Unlisted **NYS Rank:** S4 8473

Federal Listing:		**Global Rank:**	G4G5
Last Report:	2001-09-01	**EO Rank:**	
County:	Erie, Cattaraugus		
Town:	East Otto, Collins, Concord, Persia, Ashford, Dayton, Otto		
Location:	Cattaraugus Creek Zoar Valley		
Directions:	Take I-90 west past Buffalo and exit to the south on Highway 219. This highway crosses the Cattaraugus River just south of Springville and about 12 miles east of Gowanda. The community occupies the steep slopes and some of the uplands around Zoar Valleywhich surrounds Cattaraugus Creek and the South Branch of Cattaraugus Creek as well as valleys of tributaries including Thatcher Brook, Point Peter Brook, Connoissarauley Creek, Waterman Brook, Utley Brook, Coon Brook, Derby Brook, and Spooner Creek.		
General Quality and Habitat:	The community is a very large, diverse complex of multiple patches, with many mature forest to old-growth patches within an landscape that is moderately large and intact, especially for the High Allegheny Plateau. A hemlock dominated to co-dominated forest primarily on the upper slopes of a deep 12.6-mile long gorge and ravines of the adjacent plateau along the Cattaraugus Creek, a major drainage of Lake Erie. The forest occurs above Cattaraugus Creek with its lining of shale cliff and talus community and shale talus slope woodland and forest forms part of a mature forest complex with beech-maple mesic forest, maple-basswood rich mesic forest, rich mesophytic forest and local, very small patches of Appalachian oak-pine forest. Further upland is an abrupt change to successional hardwood forests, successional old fields, maintained and recovering agricultural land and plantations (mostly pine). Scattered residences and roads are interspersed within the forest.		

4 Records Processed

More detailed information about many of the rare and listed animals and plants in New York, including biology, identification, habitat, conservation, and management, are available online in Natural Heritage's Conservation Guides at www.acris.nynhp.org, from NatureServe Explorer at http://www.natureserve.org/explorer, from NYSDEC at http://www.dec.ny.gov/animals/7494.html (for animals), and from USDA's Plants Database at http://plants.usda.gov/index.html (for plants).

More detailed information about many of the natural community types in New York, including identification, dominant and characteristic vegetation, distribution, conservation, and management, is available online in Natural Heritage's Conservation Guides at www.acris.nynhp.org. For descriptions of all community types, go to http://www.dec.ny.gov/animals/29384.html and click on DRAFT--Ecological Communities of New York State.

USERS GUIDE TO NY NATURAL HERITAGE DATA

New York Natural Heritage Program, 625 Broadway, 5th Floor, Albany, NY 12233-4757 phone: (518) 402-8935

NATURAL HERITAGE PROGRAM: The NY Natural Heritage Program is a partnership between the NYS Department of Environmental Conservation (NYS DEC) and The Nature Conservancy. Our mission is to enable and enhance conservation of rare animals, rare plants, and significant communities. We accomplish this mission by combining thorough field inventories, scientific analyses, expert interpretation, and the most comprehensive database on New York's distinctive biodiversity to deliver the highest quality information for natural resource planning, protection, and management.

DATA SENSITIVITY: The data provided in the report are ecologically sensitive and should be treated in a sensitive manner. The report is for your in-house use and should **not** be released, distributed or incorporated in a public document without prior permission from the Natural Heritage Program.

EO RANK: A letter code for the quality of the occurrence of the rare species or significant natural community, based on population size or area, condition, and landscape context.

A-E = Extant: A=Excellent, B=Good, C=Fair, D=Poor, E=Extant but with insufficient data to assign a rank of A-D.
F = Failed to find. Did not locate species during a limited search, but habitat is still there and further field work is justified.
H = Historical. Historical occurrence without any recent field information.
X = Extirpated. Field/other data indicates element/habitat is destroyed and the element no longer exists at this location.
U = Extant/Historical status uncertain.
Blank = Not assigned.

LAST REPORT: The date that the rare species or significant natural community was last observed at this location, as documented in the Natural Heritage databases. The format is most often YYYY-MM-DD.

NY LEGAL STATUS – Animals:

Categories of Endangered and Threatened species are defined in New York State Environmental Conservation Law section 11-0535. Endangered, Threatened, and Special Concern species are listed in regulation 6NYCRR 182.5.

E - **Endangered Species**: any species which meet one of the following criteria:
- Any native species in imminent danger of extirpation or extinction in New York.
- Any species listed as endangered by the United States Department of the Interior, as enumerated in the Code of Federal Regulations 50 CFR 17.11.

T - **Threatened Species**: any species which meet one of the following criteria:
- Any native species likely to become an endangered species within the foreseeable future in NY.
- Any species listed as threatened by the U.S. Department of the Interior, as enumerated in the Code of the Federal Regulations 50 CFR 17.11.

SC - **Special Concern Species**: those species which are not yet recognized as endangered or threatened, but for which documented concern exists for their continued welfare in New York. Unlike the first two categories, species of special concern receive no additional legal protection under Environmental Conservation Law section 11-0535 (Endangered and Threatened Species).

P - **Protected Wildlife** (defined in Environmental Conservation Law section 11-0103): wild game, protected wild birds, and endangered species of wildlife.

U - **Unprotected** (defined in Environmental Conservation Law section 11-0103): the species may be taken at any time without limit; however a license to take may be required.

G - **Game** (defined in Environmental Conservation Law section 11-0103): any of a variety of big game or small game species as stated in the Environmental Conservation Law; many normally have an open season for at least part of the year, and are protected at other times.

NY LEGAL STATUS – Plants:

The following categories are defined in regulation 6NYCRR part 193.3 and apply to NYS Environmental Conservation Law section 9-1503.

E - **Endangered Species**: listed species are those with:
- 5 or fewer extant sites, or
- fewer than 1,000 individuals, or
- restricted to fewer than 4 U.S.G.S. 7 ½ minute topographical maps, or
- species listed as endangered by U.S. Dept. of Interior, as enumerated in Code of Federal Regulations 50 CFR 17.11.

T - **Threatened**: listed species are those with:
- 6 to fewer than 20 extant sites, or
- 1,000 to fewer than 3,000 individuals, or
- restricted to not less than 4 or more than 7 U.S.G.S. 7 and ½ minute topographical maps, or
- listed as threatened by U.S. Department of Interior, as enumerated in Code of Federal Regulations 50 CFR 17.11.

R - Rare: listed species have:

- 20 to 35 extant sites, or
- 3,000 to 5,000 individuals statewide.

V - Exploitably vulnerable: listed species are likely to become threatened in the near future throughout all or a significant portion of their range within the state if causal factors continue unchecked.

U - Unprotected; no state status.

FEDERAL STATUS (PLANTS and ANIMALS): The categories of federal status are defined by the United States Department of the Interior as part of the 1974 Endangered Species Act (see Code of Federal Regulations 50 CFR 17). The species listed under this law are enumerated in the Federal Register vol. 50, no. 188, pp. 39526 - 39527. The codes below without parentheses are those used in the Federal Register. The codes below in parentheses are created by Heritage to deal with species which have different listings in different parts of their range, and/or different listings for different subspecies or varieties.

(blank) = No Federal Endangered Species Act status.
LE = Formally listed as endangered.
LT = Formally listed as threatened.
C = Candidate for listing.
LE,LT = Formally listed as endangered in part of its range, and as threatened in the other part; or, one or more subspecies or varieties is listed as endangered, and the others are listed as threatened.
LT,PDL = Populations of the species in New York are formally listed as threatened, and proposed for delisting.

GLOBAL AND STATE RANKS (animals, plants, ecological communities and others): Each element has a global and state rank as determined by the NY Natural Heritage Program. These ranks carry no legal weight. The global rank reflects the rarity of the element throughout the world and the state rank reflects the rarity within New York State. Infraspecific taxa are also assigned a taxon rank to reflect the infraspecific taxon's rank throughout the world. ? = Indicates a question exists about the rank. Range ranks, e.g. S1S2, indicate not enough information is available to distinguish between two ranks.

GLOBAL RANK:

G1 - Critically imperiled globally because of extreme rarity (5 or fewer occurrences), or very few remaining acres, or miles of stream) or especially vulnerable to extinction because of some factor of its biology.
G2 - Imperiled globally because of rarity (6 - 20 occurrences, or few remaining acres, or miles of stream) or very vulnerable to extinction throughout its range because of other factors.
G3 – Vulnerable: Either rare and local throughout its range (21 to 100 occurrences), or found locally (even abundantly at some of its locations) in a restricted range (e.g. a physiographic region), or vulnerable to extinction throughout its range because of other factors.
G4 - Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.
G5 - Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.
GH - Historically known, with the expectation that it might be rediscovered.
GX - Species believed to be extinct.

NYS RANK:

S1 - Critically imperiled: Typically 5 or fewer occurrences, very few remaining individuals, acres, or miles of stream, or some factor of its biology making it especially vulnerable in New York State.
S2 – Imperiled: Typically 6 to 20 occurrences, few remaining individuals, acres, or miles of stream, or factors demonstrably making it very vulnerable in New York State.
S3 - Vulnerable: Typically 21 to 100 occurrences, limited acreage, or miles of stream in New York State.
S4 - Apparently secure in New York State.
S5 - Demonstrably secure in New York State.
SH - Historically known from New York State, but not seen in the past 15 years.
SX - Apparently extirpated from New York State.

SxB and SxN, where Sx is one of the codes above, are used for migratory animals, and refer to the rarity within New York State of the breeding (B)populations and the non-breeding populations (N), respectively, of the species.

TAXON (T) RANK: The T-ranks (T1 - T5) are defined the same way as the Global ranks (G1 - G5), but the T-rank refers only to the rarity of the subspecific taxon.
T1 through T5 - See Global Rank definitions above.
Q - Indicates a question exists whether or not the taxon is a good taxonomic entity.

Revised April, 2005

Department of Energy
West Valley Demonstration Project
10282 Rock Springs Road
West Valley, NY 14171-9799
August 26, 2009

Ms. Sandra Doran
U.S. Fish and Wildlife Service
New York Field Office
3817 Luker Road
Cortland, NY 13045

SUBJECT: Request to Complete Endangered Species Act Section 7 Consultation Process

REFERENCE: Letter (101186), A. L. Raddant to C. M. Bohan, "Draft Decommissioning and/or Long-Term Stewardship EIS Comments West Valley Demonstration Project and Western New York Nuclear Service Center Town of Ashford, Cattaraugus County, New York," dated June 8, 2009

Dear Ms. Doran:

The U.S. Department of Energy (DOE) has reviewed the referenced letter which includes comments from both the U.S. Geological Survey and the U.S. Fish and Wildlife Service. While these comments will be addressed in the *Final Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (*Decommissioning and Long-Term Stewardship Draft EIS*), specific comments regarding the need to continue the Endangered Species Act Section 7 consultation process for the clubshell (*Pleurobema clava*) and rayed bean (*Villosa fabalis*) are being addressed in this letter in order to come to timely closure on the process. Two comments in the referenced letter are directed at the following paragraph from the *Decommissioning and Long-Term Stewardship Draft EIS* (page 3-79):

> *The clubshell and rayed bean, although reported in Cattaraugus County, were not found in Buttermilk or Cattaraugus Creeks when those streams were surveyed in 1991 (Doran 2008, WVNS 1992b). Additionally, they were not reported by the New York Natural Heritage Program when that organization was consulted concerning state-listed species potentially present in the vicinity of the site (Seoane 2008).*

Comments received in the referenced letter indicate that the Fish and Wildlife Service (1) is not aware of the referenced West Valley Nuclear Services Company's (WVNS) survey, and (2) suggest that the site should be evaluated for the presence of these two species as the next step in the Section 7 Endangered Species Act consultation process.

The referenced survey (WVNS 1992b) is part of a comprehensive study undertaken in the early 1990s to determine the presence of both vegetation and wildlife, including macrobenthos, present on the West Valley site. This study was issued as *Ecological Resources of the Western New York Nuclear Service Center, West Valley Demonstration Project Environmental Information Document Volume XI*. A copy was transmitted to you electronically on July 8, 2009.

In response to the recommendation that the site be evaluated for suitable habitat for the clubshell and rayed bean, and as described in the following paragraphs, DOE has determined that information from the 1991 survey combined with recent efforts to update that information during preparation of the *Decommissioning and Long-Term Stewardship Draft EIS* have demonstrated the absence of suitable habitat for these species.

Pages 41 and 42 of the study (WVNS 1992) indicate that no mussel species were found in either Buttermilk or Cattaraugus Creeks. The methods used to sample macrobenthos are provided in Appendix A3, Section 4.1 (pages A3-1 – A3-2), and a complete listing of benthic invertebrates sampled during the site surveys is provided in Table.B6 (pages B6-1 through B6-2).

During preparation of the *Decommissioning and Long-Term Stewardship Draft EIS,* DOE requested information on rare species and significant natural communities from both the Fish and Wildlife Service and the New York State Heritage Program. The Natural Heritage Program did not indicate that either the clubshell or rayed bean are known to occur in the site area. However, Ms. Kathy O'Brien of the New York Department of Environmental Conservation, Endangered Species Unit was also contacted with regard to the possibility of the two mussel species being present. She is the state biologist who deals with threatened and endangered mussels. Ms. O'Brien reiterated that the state has no information on locations for the clubshell or rayed bean within the state beyond the Allegheny River basin. She did note that since these species are known from western tributaries to Lake Erie it is not impossible that they could be discovered in New York tributaries to the lake sometime in the future.

Mr. Michael McGarry was also contacted regarding the possible presence of either the clubshell or rayed bean in Buttermilk or Cattaraugus Creeks. Mr. McGarry was a member of the team that conducted the site surveys in the early 1990s (see page 57 of WVNS 1992b). He is a local biologist who has spent much time working in the two creeks and has been involved in mussel surveys himself and through the use of a professional malacologist. He specifically remembered that there were no mussel populations encountered in either creek. He also noted that watersheds within New York such as West Valley's that flow into the Great Lakes do not provide a large reservoir for mussels. Based on the results of the comprehensive site survey and his local knowledge, he did not feel that any additional field work was necessary to conclude that these mussels do not exist in Buttermilk and Cattaraugus Creeks.

Based on the results of the site-specific surveys conducted for macrobenthos in the early 1990s, including the work of Mr. McGarry, and the responses from the Natural Heritage Program and Ms. O'Brien, DOE has determined that activities proposed in the *Decommissioning and Long-Term Stewardship Draft EIS* would have <u>no effect</u> on either the clubshell or rayed bean and, therefore, additional studies are not necessary. Accordingly, DOE is requesting acknowledgement from the Fish and Wildlife Service that no further consultation under Section 7 of the Endangered Species Act is required on this matter.

If you have any questions regarding this request, please contact Catherine M. Bohan of my staff at (716) 942-4159.

Sincerely,

Bryan C. Bower, Director
West Valley Demonstration Project

cc: J. T. Dorman, DOE-HQ, GC-20, FORS
M. A. Pearson-Hurley, DOE-HQ, EM-3.3, FORS
C. M. Bohan, DOE-WVDP, AC-DOE
M. N. Maloney, DOE-WVDP, AC-DOE
A. L. Raddant, DOI
K. O'Brien, NYSDEC
P. J. Bembia, NYSERDA, AC-NYS
M. McGarry, Biologist

CMB:101187 - 451.1

CMB/cmb

APPENDIX P
THE SDA QUANTITATIVE RISK ASSESSMENT

APPENDIX P
THE SDA QUANTITATIVE RISK ASSESSMENT

P.1 Introduction

In the Draft Environmental Impact Statement (Draft EIS), the New York State Energy Research and Development Authority's (NYSERDA's) preferred alternative for the State-Licensed Disposal Area (SDA) was to manage the facility in place for up to 30 more years. To meet its requirements under the State Environmental Quality Review Act (SEQR), NYSERDA tasked Dr. B. John Garrick to provide the analysis needed to assess the impacts from NYSERDA's preferred alternative for the SDA. Dr. Garrick, who is the current Chairperson of the U.S. Nuclear Waste Technical Review Board, and a former President of the Society for Risk Analysis, recommended the preparation of a quantitative risk assessment (QRA) for the SDA. At NYSERDA's request, Dr. Garrick assembled a team of highly qualified experts to prepare the QRA.[1]

After considering public comments on the Draft EIS, NYSERDA is assessing whether the duration of in-place management can be reduced. If the time period is reduced to less than 30 years, the QRA, which addresses the impacts from a 30-year management period, will provide a conservative assessment of the integrated SDA risk from in-place management for that shorter time period.

A preliminary draft of the QRA report was made available for public review and comment in October 2008. In parallel, the QRA team also used their insights and results from the draft study (QRA 2008) to identify a number of technical issues that warranted more detailed examination and refinement. The 2009 version of the QRA benefits substantially from this evolution of the SDA risk assessment process. In particular, it accounts for the following enhancements of the 2008 models and supporting analyses.

- More comprehensive analyses of conditions that may cause water to enter the SDA trenches, and refinement of the corresponding trench water level probabilities.
- More comprehensive evaluation of NYSERDA programs for Buttermilk Creek water sampling to detect potential liquid activity releases.
- Improved quantification of uncertainties about radionuclide concentrations in the SDA trench soils and liquids.
- Improved correlations among regional weather data, incident precipitation, trench overflow fluid volumes, and flow rates in the adjacent streams.
- A sensitivity study that examines the potential risk impacts from postulated dramatic climate changes during the 30-year SDA operating period.
- Assessment of specific issues that were raised during public reviews of the 2008 draft study.

The Quantitative Risk Assessment for the State-Licensed Disposal Area (QRA 2009) evaluates the risk to the public from continued operation of the SDA for the next 30 years with its current physical and administrative controls. The QRA includes detailed models for the mobilization, transport, distribution, dilution, and deposition of released radioactive materials throughout the environment surrounding the SDA site, including

[1] *The QRA preparation team includes Dr. B. J. Garrick, Study Director, John W. Stetkar, Principal Investigator, Andrew A. Dykes, Thomas E. Potter, and Stephen L. Wampler.*

the integrated watershed formed by Erdman Brook, Franks Creek and Buttermilk Creek. Exposures to hazardous and toxic chemical impacts are not evaluated as part of the scope of this QRA. Hazardous and toxic chemical impacts are being evaluated as part of the Corrective Measure Study for the SDA being conducted under a RCRA Section 3008(h) Administrative Order on Consent.

This Appendix to the EIS contains a summary of the 2009 QRA for the SDA; the entire QRA report, including supporting models, data, and analyses is available as a separate document from NYSERDA.[2]

P.2 The QRA Framework

The fundamental elements of the QRA process are (1) the "triplet" definition of risk (defined below) to serve as a general framework for the meaning of risk, (2) a scenario approach that clearly links initial (*initiating events or initial conditions*) and final states (*consequences*) with well defined intervening events and processes, (3) the representation of uncertainty by a probability distribution (*the probability of frequency concept*), (4) a definition of probability that measures the *credibility* of a hypothesis based on the supporting evidence, and (5) information processing rooted in the fundamental rules of logic.

The general framework for the QRA is the "set of triplets" definition of risk.

$$R = \{<S_i, L_i, X_i>\}_c,$$

In this format, the brackets denote "the set of," and the subscript c implies that the set is complete. The risk ("R") is a comprehensive answer to the following questions:

- "What can go wrong?" This question is answered by describing a structured, organized, and complete set of possible damage scenarios ("S").
- "What is the likelihood of each scenario?" This question is answered by performing detailed analyses of each risk scenario, using the best available data and engineering knowledge of the relevant processes, and explicitly accounting for all sources of uncertainty that contribute to the scenario likelihood ("L").
- "What are the consequences?" This question is answered by systematically describing the possible end states for each risk scenario, such as different radiation dose levels that may be received by a member of the public ("X").

P.3 The QRA Scope

This study evaluates the risk from continued operation of the SDA for the next 30 years with its current physical and administrative controls. The scope of this risk assessment is limited to quantification of the radiation dose received by a member of the public, represented by two potential receptors.

- A permanent resident farmer located near the confluence of Buttermilk Creek and Cattaraugus Creek
- A transient recreational hiker / hunter who traverses areas along Buttermilk Creek and the lower reaches of Franks Creek

[2] *The complete QRA report (revised August 2009) is available on the Internet at http://www.nyserda.org/publications/ sdaquantitativeriskassessment2009.pdf. Copies on CD can be requested from NYSERDA at END@nyserda.org, or by calling Elaine DeGiglio at (716) 942-9960, extension 2423.*

The study evaluates potential releases of liquid, solid, and gaseous radioactive materials from the 14 waste trenches at the SDA site. It examines a broad spectrum of potential natural and human-caused conditions that may directly cause or contribute to these releases. Threats to the site are grouped into two general categories.

- **Disruptive Events** are unexpected events that cause an immediate change to the site. They are typically characterized by an event occurrence frequency and by directly measurable immediate consequences. Examples are severe storms, tornadoes, earthquakes, fires, and airplane crashes.

- **Nominal Events and Processes** are expected events and natural processes that evolve continuously over the life of the facility. They are typically characterized by a rate, which may be constant or changing over time. The potential consequences from these processes depend on the duration of the exposure period. Examples are groundwater flows, slope subsidence, and the aging of engineered and natural systems.

The QRA includes detailed models for the mobilization, transport, distribution, dilution, and deposition of released radioactive materials throughout the environment surrounding the SDA site, including the integrated watershed formed by Erdman Brook, Franks Creek, and Buttermilk Creek.

This study does not present a quantitative evaluation of the risk from intentional acts of destruction, war, terrorism, or sabotage. Current risk assessment practices for most sensitive facilities in the United States, including nuclear power plants, do not include a quantitative analysis of the risk from these types of threats. Quantifying these risks would require the systematic evaluation of detailed threat scenarios for these sensitive facilities, which would present significant security concerns. While a quantitative assessment of the risk from acts of terrorism on the SDA was not developed for this study, the QRA team did perform limited qualitative and simplified analyses of such threats to provide some insights on this issue (see Section 15.2 of the complete QRA report referenced earlier).

Exposures to hazardous and toxic chemical impacts are not evaluated as part of the scope of this QRA. Hazardous and toxic chemical impacts are being evaluated as part of the Corrective Measure Study for the SDA being conducted under a RCRA Section 3008 (h) Administrative Order on Consent.

P.4 Evaluated Threats

The scope of potential threats considered in this study includes a broad variety of natural phenomena and processes, and human-caused events. Systematic methods were used to examine and screen identified threats for their potential significance to the SDA risk. Table P–1 lists the threats that were retained for explicit evaluation in the QRA models. Table P–2 lists the threats that were evaluated and eliminated from further detailed analysis.

P.5 Release Mechanisms and Scenarios

Five release mechanisms were defined to provide a framework and context for the risk scenarios. Each scenario begins with an initiating disruptive event or an evolving site process, and it results in a release of radioactive materials into the external environment. It then continues through the mobilization and transport elements of the risk models, where the released materials are distributed, diluted, and deposited throughout the area surrounding the site. The scenario finally terminates in a source of radiation exposure and dose to the study receptors.

The five SDA release mechanisms are:

- **Release Mechanism 1** involves liquid releases from the waste trenches via groundwater flows through the Unweathered Lavery Till (ULT) and Kent Recessional Sequence (KRS) soil layers. Four risk scenarios were evaluated for this release mechanism.

- **Release Mechanism 2** involves liquid releases from the waste trenches via groundwater flows through the Weathered Lavery Till (WLT) soil layer. One risk scenario was evaluated for this release mechanism.

- **Release Mechanism 3** involves liquid overflows of the waste trenches and releases via surface water runoff. Nine risk scenarios were evaluated for this release mechanism.

- **Release Mechanism 4** involves physical breaches of the waste trenches and releases of liquid and solid radioactive materials. Sixteen risk scenarios were evaluated for this release mechanism.

- **Release Mechanism 5** involves extensive physical disruption of the SDA site and airborne releases from the waste trenches. One risk scenario was evaluated for this release mechanism.

The release mechanisms and scenarios evaluated are listed in Table P–3.

P.6 Supporting Analyses

Detailed analyses were performed to quantify the frequencies of all threats that are analyzed in the QRA models. In most cases, extensive effort was required to supplement the limited available information and data from previous assessments, to perform a realistic evaluation of the threat frequencies and their associated uncertainties.

Several "fragility analyses" were performed to quantify the conditional likelihood that a disruptive event or natural process will cause a release of radioactive materials from the SDA waste trenches. Members of NYSERDA's Independent Expert Review Team (IERT), for which Dr. Garrick was the chairman, provided technical guidance and input for a number of these analyses, developed some of the analytical models, and performed some of the detailed quantifications. The fragility analyses evaluated the following technical issues:

- Seismic failures of the slopes adjacent to the SDA site

- Failures of the slopes due to landslides that are not related to seismic events or erosion

- Erosion of the waste trench caps

- Erosion and migration of slope gullies

- Groundwater flows through lateral and vertical release pathways

- Trench filling and overflows from water intrusion

NYSERDA engineers provided evaluations of potential intervention efforts to stop or mitigate the consequences of specific radioactive material release scenarios. Analyses were also performed to quantify the effects from conditions that may require extensive repairs or replacement of the geomembranes.

Comprehensive inventories of the SDA waste materials were compiled from existing databases, including the distribution of specific radionuclides at 50-foot intervals in each trench. This information was used to quantify the physical form, quantity, and radioisotopic content of the materials that are released during each risk scenario.

Geohydrologic models were developed for the area surrounding the SDA site, including the integrated drainage basin for Erdman Brook, Franks Creek, and Buttermilk Creek. These models were used to quantify flows and dilution of radioactive liquids that are released into the stream systems, the transport of solids, and the deposition of contaminated material in stream bed sediments. An atmospheric dispersion model was used to quantify flows, transport, and dilution of radioactive aerosols released into the air.

Analyses were performed to evaluate the exposure of each receptor to contaminants that are released during each risk scenario, accounting for the specific form of the material (e.g., liquid, solid, or airborne), its quantity and concentration at the point of exposure, and its radioisotopic content. Potential doses accrue from direct exposure to contaminated creek water, sediments, and airborne species. The analyses also assume that creek water is used for crop irrigation and livestock water supplies, resulting in additional potential doses through these food chain pathways. It is assumed that creek water is not used as a domestic potable water supply. The total effective dose equivalent (TEDE) for each receptor is quantified in terms of millirem (mrem) accumulated in a 1-year period, for comparison with public health standards and other sources of radiation risk.

The QRA contains a sensitivity study that examines the potential risk impacts from postulated dramatic climate changes during the 30-year SDA operating period. The sensitivity analyses account for increased frequencies of severe high winds, tornadoes and precipitation. In particular, the analyses evaluate the effects from postulated conditions that would apply at the site if all meteorological parameters were assumed to persist at the 95th percentiles of their current uncertainty ranges throughout the next 30 years. While these extreme meteorological conditions are not expected to evolve over the 30-year duration of this risk study (based on existing climate data), if the conditions were to occur, the effect would be an increase in the risk over the baseline by a factor of only 2.3. Thus, the sensitivity study confirmed that a release which results in a dose of 100 mrem in 1 year, or more, to an offsite receptor remains very unlikely during the next 30 years of SDA operation.

P.7 The SDA Risk

Figure P–1 shows the integrated risk curves for the SDA site in the "frequency of exceedance" format that is typically used to display QRA results. The following examples illustrate how these curves are interpreted.

Frequency of Dose Exceeding 0.1 mrem in 1 Year

This result is obtained by taking a vertical "slice" through Figure P–1 at the dose value of 1.0E-01 mrem in 1 year. Figure P–2 shows that "slice," in the "probability density" format that displays the calculated uncertainty about the frequency of this dose level.

The mean total frequency of all threats that cause radioactive material releases from the SDA site which result in a total effective dose to all receptors of 0.1 mrem in 1 year, or more, is approximately 7.0E-03 event per year (i.e., one event in 145 years). There is equal probability that the release frequency for this dose is greater than, or less than, the median value of approximately 6.6E-03 event per year (i.e., one event in 150 years). The range of values between the 5th probability percentile and the 95th probability percentile in Figure P–1 is the "90% confidence interval" of the uncertainty about the risk. This means that there is 90% probability that the release frequency for a particular dose level is within this interval. There is 5% probability that the release frequency is less than the lower end of the 90% confidence interval (i.e., lower than the 5th probability percentile), and there is 5% probability that the release frequency is higher than the upper end of the interval (i.e., higher than the 95th probability percentile). For the 0.1-mrem dose "slice" shown in Figure P–2, the QRA authors are 90% confident that the release frequency is between 6.4E-03 event per year and 7.8E-03 event per year (i.e., between one event in 155 years and one event in 130 years). Since the mean value is the "expected" frequency of these releases, the QRA authors do not "expect" to have a release that results in a dose of 0.1 mrem in 1 year, or more, during the next 30 years of SDA operation. However, a complete accounting for the uncertainty in the risk curves concludes that there is approximately a 1% probability that this type of release may occur during the next 30-year operating period.

Frequency of Dose Exceeding 100 mrem in 1 Year

This result is similarly obtained by taking a vertical "slice" through Figure P–1 at the dose value of 1.0E+02 mrem in 1 year. Figure P–3 shows that "slice".

The mean total frequency of all threats that cause radioactive material releases from the SDA site which result in a total effective dose to all receptors of 100 mrem in 1 year, or more, is approximately 5.1E-04 event per year (i.e., one event in 2,000 years). There is equal probability that the release frequency for this dose is greater than, or less than, the median value of approximately 4.8E-04 event per year (i.e., one event in 2,100 years). The QRA authors are 90% confident that the release frequency is between 3.9E-04 event per year and 6.4E-04 event per year (i.e., between one event in 2,600 years and one event in 1,600 years). The QRA results confirm that a release which results in a dose of 100 mrem in 1 year, or more, is extremely unlikely during the next 30 years of SDA operation.

Figure P–4 is another representation of the SDA risk results, with an expanded scale that focuses on the dose range from 10 to 1000 mrem in 1 year. It displays the risk in terms of the number of release events that occur during the SDA 30-year operating period that is covered by this study. It is obtained by multiplying the frequency scale in Figure P–1 by 30 years. The maximum value of the y-axis corresponds to 1 event that results in a release of radioactive material from the SDA during the next 30 years. Figure P–5 shows the uncertainty distribution for the "slice" at the 100 mrem dose level. These results clearly show that it is very unlikely that a release will occur during the next 30 years with the consequences of a 1-year dose of 100 mrem, or more. For example, the 95th probability percentile in Figure P–4 at the 100-mrem vertical "slice" is a factor of approximately 50 times lower than the once-in-30-year release value. This means that the QRA authors are 95% confident that this type of release will occur much less often than once in 30 years. Figure P–5 shows the complete uncertainty distribution for the "slice" at the 100 mrem dose level, further confirming the very high confidence in this conclusion.

Table P–4 lists the mean ("expected") frequency of radioactive material releases for each risk scenario in terms of release events per year, the corresponding mean consequences from that scenario in terms of equivalent mrem dose in 1 year to all exposed receptors, and the product of the scenario frequency and consequences. This tabulation is useful to understand the detailed contributors to the overall SDA risk and their relative importance.

Only nine scenarios individually account for more than 1% of the total SDA risk, and these nine scenarios collectively account for almost 99% of the total. Each of the remaining 22 scenarios contributes less than 1% of the overall risk, and the 22 scenarios collectively account for just slightly more than 1% of the total. The top six scenarios for total SDA risk are:

- **Scenario 1 – 2** is the second scenario defined for Release Mechanism 1. It accounts for approximately 30% of the total SDA risk. The scenario involves lateral groundwater flows through the ULT soil layer. These releases occur when water levels in the waste trenches are at or near the interface between the ULT and WLT soil layers.

- **Scenario 4 – 1c** involves physical breaches of the waste trenches nearest to the East side and North end of the SDA. It accounts for approximately 23% of the total SDA risk. The trench breaches are caused by localized landslides or seismic events that destabilize the adjacent slopes. Scenario 4 – 1c evaluates the doses from liquid releases that occur when water levels in the waste trenches are at their current elevations, or lower.

- **Scenario 4 – 1** is similar to Scenario 4 – 1c. It also involves physical breaches of the waste trenches nearest to the East side and North end of the SDA that are caused by localized landslides or seismic events. It accounts for approximately 12% of the total SDA risk. Scenario 4 – 1 evaluates the doses from contaminated solids that are released from the damaged trenches.

- **Scenario 2 – 1** is the only scenario for Release Mechanism 2. It accounts for approximately 10% of the total SDA risk. The scenario involves lateral groundwater flows through the WLT soil layer near the surface of the SDA site. These releases can occur only when the water levels in the waste trenches are high, and the trenches are nearly full of water.

- **Scenario 1 – 3** is the third scenario defined for Release Mechanism 1. It accounts for approximately 7% of the total SDA risk. The scenario involves lateral groundwater flows through the ULT soil layer. These releases occur when water levels in the waste trenches are at their current elevations.

- **Scenario 3 – 4** is the fourth scenario defined for Release Mechanism 3. It accounts for approximately 6% of the total SDA risk. The scenario involves initial site conditions when the geomembranes are not intact, and the trench compacted clay caps are in their normal state. Water levels in the waste trenches are at or near the interface between the ULT and WLT soil layers. Total precipitation during a 14-day period exceeds 9 inches, including at least one storm with rainfall intensity that is severe enough to erode the trench caps and allow water intrusion to fill the trenches. The trenches overflow, and contaminated liquid enters the adjacent streams through surface runoff.

Table P-4 shows that seismic damage, gully erosion, and landslide scenarios in Release Mechanism 4 contribute increasingly to the "low frequency / high consequence" end of the risk profile in Figure P–1. The table shows that the mean doses from some of these scenarios can be quite significant. However, the release frequencies are extremely small, resulting in negligible contributions to overall site risk. "Intermediate frequency / intermediate consequence" scenarios in Release Mechanism 3 also contribute to the middle range of the risk spectrum.

The approximate fractional risk contribution from each major release mechanism is:

Release Mechanism 1:	Groundwater flows through the ULT	45%
Release Mechanism 2:	Groundwater flows through the WLT	10%
Release Mechanism 3:	Trench overflows and surface water runoff	9%
Release Mechanism 4:	Trench breaches by erosion, landslides, and earthquakes	36%
Release Mechanism 5:	Airborne releases from SDA physical impacts	<< 0.1%

P.8 Conclusions

The QRA results confirm that the public health risk from operating the SDA for the next 30 years is well below widely applied radiation dose limits, such as the 100 mrem per year limit specified under "Radiation Dose Limits for Individual Members of the Public" in Part 380 of the State of New York Codes, Rules, and Regulations (6 NYCRR Part 380) and in Part 20 of Title 10 of the Code of Federal Regulations (10 CFR 20).

There is extremely high confidence that potential releases of radioactive materials from the SDA which may result in a 1-year dose to any member of the public of 100 mrem, or more, will occur much less often than once in 30 years.

These results should not be interpreted to mean that a release of this magnitude is impossible. They simply indicate that a release with these consequences is extremely unlikely during the next 30 years. If the SDA site could be maintained in its current state in perpetuity (including all geohydrologic and meteorological conditions) it would be expected that this type of event would occur only once in approximately 2,000 years.

This low level of risk will be maintained only if NYSERDA continues to operate the SDA according to its current physical and administrative controls.

The quantified risk from the SDA is dominated by a small number of event scenarios. A total of nine scenarios accounts for almost 99 percent of the overall risk. Five of these scenarios involve releases of radioactive liquids from the waste trenches through groundwater flow paths. Two scenarios involve trench overtopping and radioactive liquid releases via surface runoff during heavy precipitation that occurs while the geomembranes are not intact. Two scenarios are caused by localized landslides or seismic events that result in partial breaching of waste trenches near the site boundaries, with subsequent releases of contaminated solids and liquids.

There is very large uncertainty about several of the most important risk contributors identified in this study. The three most significant sources of uncertainty are:

- Models and analyses for the groundwater release pathways. Substantial reduction of these uncertainties may be achieved by extensive refinements to the groundwater flow models, supporting data, and analyses.

- Estimation of radionuclide concentrations in the trench leachate. These uncertainties may be reduced by further refinements to the QRA evaluations of the distribution coefficients for liquid concentrations of the most risk-sensitive radionuclides. Additional sampling of the trench leachate may also reduce these uncertainties. However, each trench contains a small number of sample points, and large variability has been observed in previously measured nuclide concentrations. Therefore, limited benefit may be realized from additional sampling with the sole purpose to reduce uncertainties in the estimated average nuclide concentrations in the trench leachate. Nonetheless, consideration of periodic monitoring of trench leachate concentrations for this and other purposes, such as assessment of trench water turnover rates, may be warranted.

- Evaluation of SDA slope stabilities and non-seismic slope failures. It is likely that these uncertainties can be reduced through further refinements to the slope failure models and the trench intersection probabilities.

The first two sources of uncertainty have compound effects for the liquid release scenarios in Release Mechanisms 1 and 2. The second source of uncertainty also affects all other liquid release scenarios. The third source of uncertainty affects the most important risk contributors from Release Mechanism 4. Relatively small reductions in the uncertainties may have a rather significant impact on the quantified risk, due to the numerical effects from low probability "tails" of the uncertainty distributions.

P.9 Recommendations

Apart from decisions regarding possible refinements to the QRA models, data, and analyses, it is recommended that NYSERDA:

- Continue to actively maintain trench water levels below the ULT / WLT interface level, regardless of the status of the geomembranes and other activities at the site.

- Minimize the amount of time that the geomembrane covers are not intact, and the surface of the trench caps is exposed. This includes expedited repairs or replacement of damaged geomembrane sections, and minimizing the time and extent of surface uncovery during planned geomembrane replacements.

- Formalize emergency preparedness plans and guidelines for responses to the types of release scenarios that are evaluated in this study. The risk from specific scenarios is affected significantly by the credit that has been applied for these intervention and mitigation responses.

- Consider the benefits from a program to periodically sample the water in each trench and monitor the concentrations of radionuclide species.

Table P–1 Threats Included in the SDA Risk Assessment

Disruptive Events

- Aircraft Crashes
  - Commercial
  - General aviation
  - Military
- Erosion
  - Local streams
  - Trenches
- Extraterrestrial Impacts (meteorites)
- Fires
  - Offsite (e.g., grass fires, forest fires)
- Flooding Events
  - Extreme precipitation
  - Rapid snow melt
- High Wind Events
  - Extreme sustained winds
  - Wind gusts
  - Tornadoes
- Landslides
- Pipeline Accidents
  - Site natural gas supply pipe
- Seismic Events
  - Direct seismic failures
- Severe Storms (snow)

Nominal Events and Processes

- Corrosion / Deterioration / Decomposition
  - Geomembrane covers
  - Crates, boxes
  - Steel drums
- Groundwater Intrusion
  - Historic intrusion
  - Rapid intrusion (“bath-tubbing”)
- Soil Shrink / Swell / Consolidation

Table P–2 Potential SDA Threats that were Evaluated and Eliminated from further Detailed Analysis

- Avalanches
- Biological Events
- Drought
- Erosion
  - Coastal/lake shore erosion
  - River bank erosion
- Excavation of Contaminated Stream Sediments
- Explosions
- Extraterrestrial Impacts (involving meteorites greater than 1 meter in diameter)
- Extreme Temperatures (heat, cold)
- Fires
  - Onsite facilities ("internal fires")
- Flooding Events
  - Onsite facilities ("internal flooding")
  - Dam failure
  - Site water supply pipe failure
  - Seiche
  - Storm surge
  - Tsunami
- Fog
- Frost
- High Tides
- Hurricanes
- Ice Cover
- Lightning
- Loss of External Power Supplies
- Low Lake or River Water Level
- Nearby Facility Accidents
  - Industrial
  - Chemical
  - Military
- NRC-Licensed Facility Decommissioning Activities
  - Direct accident impacts on SDA
  - Effects on site grading, surface water runoff, erosion
- Radiolytic/Chemical Interactions
- River Diversion
- Seismic Events
  - Seismic-induced fires
  - Seismic-induced flooding (e.g., piping failures)

- Severe Storms
  - Hail
  - Sand storms
  - Dust storms
- Sinkholes
- Site Intrusions (direct intrusion into the SDA during the 30-year period of this study)
- Toxic Gas Releases
- Transportation Accidents
  - Rail
  - Highway
  - Shipping (by navigable waterway)
- Volcanic Activity

Table P–3 Release Mechanisms and Scenarios

Release Mechanism	***Scenario***	***Threat Condition – Damage Scenario***
1 Liquid Releases from Waste Trenches via Groundwater through the Unweathered Lavery Till (ULT) and Kent Recessional Sequence (KRS) Soil Layers	1 – 1	Initial trench water level high; Lateral flow through ULT; NYSERDA detection via stream water sampling; NYSERDA mitigation
	1 – 2	Initial trench water level at the WLT/ULT interface; Lateral flow through ULT; NYSERDA detection via stream water sampling; NYSERDA mitigation
	1 – 3	Initial trench water at the current level; Lateral flow through ULT; NYSERDA detection via stream water sampling; NYSERDA mitigation
	1 – 4	Vertical flow through ULT and lateral flow through KRS; All trench water levels; NYSERDA detection via Buttermilk Creek sediment sampling; External intervention to limit receptor exposure
2 Liquid Releases from Waste Trenches via Groundwater through the Weathered Lavery Till (WLT) Soil Layer	2 – 1	Initial trench water level high; Lateral flow through WLT; NYSERDA detection via stream water sampling; NYSERDA mitigation
3 Liquid Overflows of the Waste Trenches and Releases via Surface Water Runoff	3 – 1	Initial trench water level high; Geomembranes unavailable; Trench caps intact; Severe precipitation (24- or 48-hour precipitation event) erodes caps
	3 – 2	Initial trench water level high; Geomembranes initially in place; Trench caps intact; Severe storm destroys geomembranes and erodes caps
	3 – 3	Initial trench water level high; Geomembranes damaged; Trench caps disrupted; Precipitation $\geq$ 1 inch in 14 days
	3 – 4	Initial trench water level at the WLT/ULT interface; Geomembranes unavailable; Trench caps intact; Precipitation $\geq$ 9 inches in 14 days (assumed to erode caps)
	3 – 5	Initial trench water level at the WLT/ULT interface; Geomembranes intact; Trench caps intact; Severe storm (Wind or Tornado) destroys geomembranes and erodes caps; Precipitation $\geq$ 9 inches total accumulation in 14 days
	3 –6	Initial trench water level at the WLT/ULT interface; Geomembranes unavailable; Trench caps disrupted; Precipitation $\geq$ 9 inches in 14 days
	3 – 7	Initial trench water at the current level or lower; Geomembranes unavailable; Trench caps intact; Precipitation $\geq$ 25 inches in 14 days (assumed to erode caps)
	3 – 8	Initial trench water at the current level or lower; Geomembranes initially in place; Trench caps intact; Severe storm (Wind or Tornado) destroys geomembranes and erodes caps; Precipitation $\geq$ 25 inches accumulation in 14 days
	3 – 9	Initial trench water at the current level or lower; Geomembranes unavailable; Trench caps disrupted; Precipitation $\geq$ 25 inches in 14 days

Release Mechanism	***Scenario***	***Threat Condition – Damage Scenario***
4 Physical Breaches of the Waste Trenches and Releases of Liquid and Solid Radioactive Material	4 – 1	Localized landslide or seismic-induced slope failure Damage Condition 1[a]; Solid releases
	4 – 1a	Initial trench water level high; Localized landslide or seismic-induced slope failure Damage Condition 1; Liquid releases
	4 – 1b	Initial trench water level at the WLT/ULT interface; Localized landslide or seismic-induced slope failure Damage Condition 1; Liquid releases
	4 – 1c	Initial trench water at current level or lower; Localized landslide or seismic-induced slope failure Damage Condition 1; Liquid releases
	4 – 2	Geomembranes unavailable; Gully erosion; Solid releases
	4 – 2a	Initial trench water level high; Geomembranes unavailable; Gully erosion; Liquid releases
	4 – 2b	Initial trench water level at the WLT/ULT interface; Geomembranes unavailable; Gully erosion; Liquid releases
	4 – 2c	Initial trench water at current level or lower; Geomembranes unavailable; Gully erosion; Liquid releases
	4 – 3	Seismic – induced slope failure Damage Condition 2[b]; Solid releases
	4 – 3a	Initial trench water level high; Seismic-induced slope failure Damage Condition 2; Liquid releases
	4 – 3b	Initial trench water level at the WLT/ULT interface; Seismic-induced slope failure Damage Condition 2; Liquid releases
	4 – 3c	Initial trench water at the current level or lower; Seismic-induced slope failure Damage Condition 2; Liquid releases
	4 – 4	Regional/Global landslide; Solid releases
	4 – 4a	Initial trench water level high; Regional/Global landslide; Liquid releases
	4 – 4b	Initial trench water level at the WLT/ULT interface; Regional/Global landslide; Liquid releases
	4 – 4c	Initial trench water at current level or lower; Regional/Global landslide; Liquid releases
5 Extensive Physical Disruption of the SDA Site and Airborne Releases from the Waste Trenches	5 – 1	Aircraft crash or meteorite; Geomembranes damaged and surface disturbed; Airborne releases

[a] Damage Condition 1 – Slope failures intersect Trenches 1/2, Trench 8 and 125 feet of the north ends of Trenches 3, 4 and 5.
[b] Damage Condition 2 – Slope failures intersect Trenches 1/2, Trench 3, 8 and 9, and 250 feet of the north ends of Trenches 4 and 5.

Table P–4 SDA Risk Scenarios

Scenario	*Mean Frequency (event / year)*	*Mean Dose (mrem in 1 year)*	*Mean Frequency x Dose [(mrem in 1 year) / year]*	*Fraction of Total Risk*	*Cumulative Fraction of Total Risk*	*Contributing Conditions*
1 – 2	4.57E-04	174.95	7.99E-02	2.97E-01	0.297	Groundwater, Level = ULT / WLT, ULT Lateral
4 – 1c	5.84E-05	1096.01	6.11E-02	2.27E-01	0.524	Local Landslide or Seismic Damage 1, Level = Current / Low, Liquids
4 – 1	5.93E-05	539.60	3.18E-02	1.18E-01	0.643	Local Landslide or Seismic Damage 1, Solids
2 – 1	4.00E-05	683.01	2.73E-02	1.02E-01	0.744	Groundwater, Level = High, WLT Lateral
1 – 3	3.12E-02	0.59	1.85E-02	6.88E-02	0.813	Groundwater, Level = Current, ULT Lateral
3 – 4	2.51E-04	69.66	1.73E-02	6.44E-02	0.877	Overflow, Level = ULT / WLT, > 9 inches in 14 days
1 – 4	3.33E-02	0.35	1.17E-02	4.36E-02	0.921	Groundwater, ULT-KRS
1 – 1	4.00E-05	290.64	1.16E-02	4.32E-02	0.964	Groundwater, Level = High, ULT Lateral
3 – 3	2.01E-05	294.57	5.44E-03	2.02E-02	0.985	Overflow, Level = High, Surface Disturbed, > 1 inch in 14 days
4 – 1b	8.13E-07	2283.36	1.77E-03	6.58E-03	0.991	Local Landslide or Seismic Damage 1, Level = WLT / ULT, Liquids
4 – 3c	8.65E-07	1187.35	1.17E-03	4.35E-03	0.995	Seismic Damage 2, Level = Current / Low, Liquids
4 – 1a	7.12E-08	4749.39	3.23E-04	1.20E-03	0.997	Local Landslide or Seismic Damage 1, Level = High, Liquids
4 – 3	8.79E-07	361.82	3.21E-04	1.19E-03	0.998	Seismic Damage 2, Solids
3 – 5	9.93E-07	171.28	1.67E-04	6.22E-04	0.999	Overflow, Level = ULT / WLT, Wind or Tornado, > 9 inches in 14 days
3 – 7	4.79E-06	34.78	1.49E-04	5.56E-04	0.999	Overflow, Level = Current / Low, > 25 inches in 14 days
4 – 2c	6.89E-08	1096.01	7.92E-05	2.95E-04	0.999	Gully Erosion, Level = Current / Low, Liquids
3 – 6	9.75E-07	69.46	6.23E-05	2.32E-04	1.000	Overflow, Level = ULT / WLT, Surface Disturbed, > 9 inches in 14 days
4 – 2	7.00E-08	539.60	3.81E-05	1.42E-04	1.000	Gully Erosion, Solids
4 – 3b	1.20E-08	2740.03	3.75E-05	1.40E-04	1.000	Seismic Damage 2, Level = WLT / ULT, Liquids
4 – 4c	4.95E-09	2557.37	1.35E-05	5.00E-05	1.000	Global Landslide, Level = Current / Low, Liquids
4 – 3a	1.05E-09	5662.74	6.79E-06	2.53E-05	1.000	Seismic Damage 2, Level = High, Liquids
5 – 1	3.69E-07	18.18	6.66E-06	2.48E-05	1.000	Aircraft crash or meteorite
3 – 2	1.97E-07	14.38	2.79E-06	1.04E-05	1.000	Overflow, Level = High, Wind or Tornado
4 – 2b	9.58E-10	2283.36	2.30E-06	8.54E-06	1.000	Gully Erosion, Level = WLT / ULT, Liquids
3 – 1	1.99E-08	28.60	6.32E-07	2.35E-06	1.000	Overflow, Level = High, 24- or 48-Hour Storm

Scenario	Mean Frequency (event / year)	Mean Dose (mrem in 1 year)	Mean Frequency x Dose [(mrem in 1 year) / year]	Fraction of Total Risk	Cumulative Fraction of Total Risk	Contributing Conditions
3 – 9	2.07E-08	34.78	5.57E-07	2.07E-06	1.000	Overflow, Level = Current / Low, Surface Disturbed, > 25 inches in 14 days
3 – 8	1.93E-08	34.78	5.33E-07	1.98E-06	1.000	Overflow, Level = Current / Low, Wind or Tornado, > 25 inches in 14 days
4 – 4b	6.89E-11	6028.08	4.41E-07	1.64E-06	1.000	Global Landslide, Level = WLT / ULT, Liquids
4 – 2a	8.39E-11	4749.39	4.18E-07	1.56E-06	1.000	Gully Erosion, Level = High, Liquids
4 – 4	5.03E-09	24.95	1.17E-07	4.34E-07	1.000	Global Landslide, Solids
4 – 4a	6.03E-12	9772.79	6.26E-08	2.33E-07	1.000	Global Landslide, Level = High, Liquids

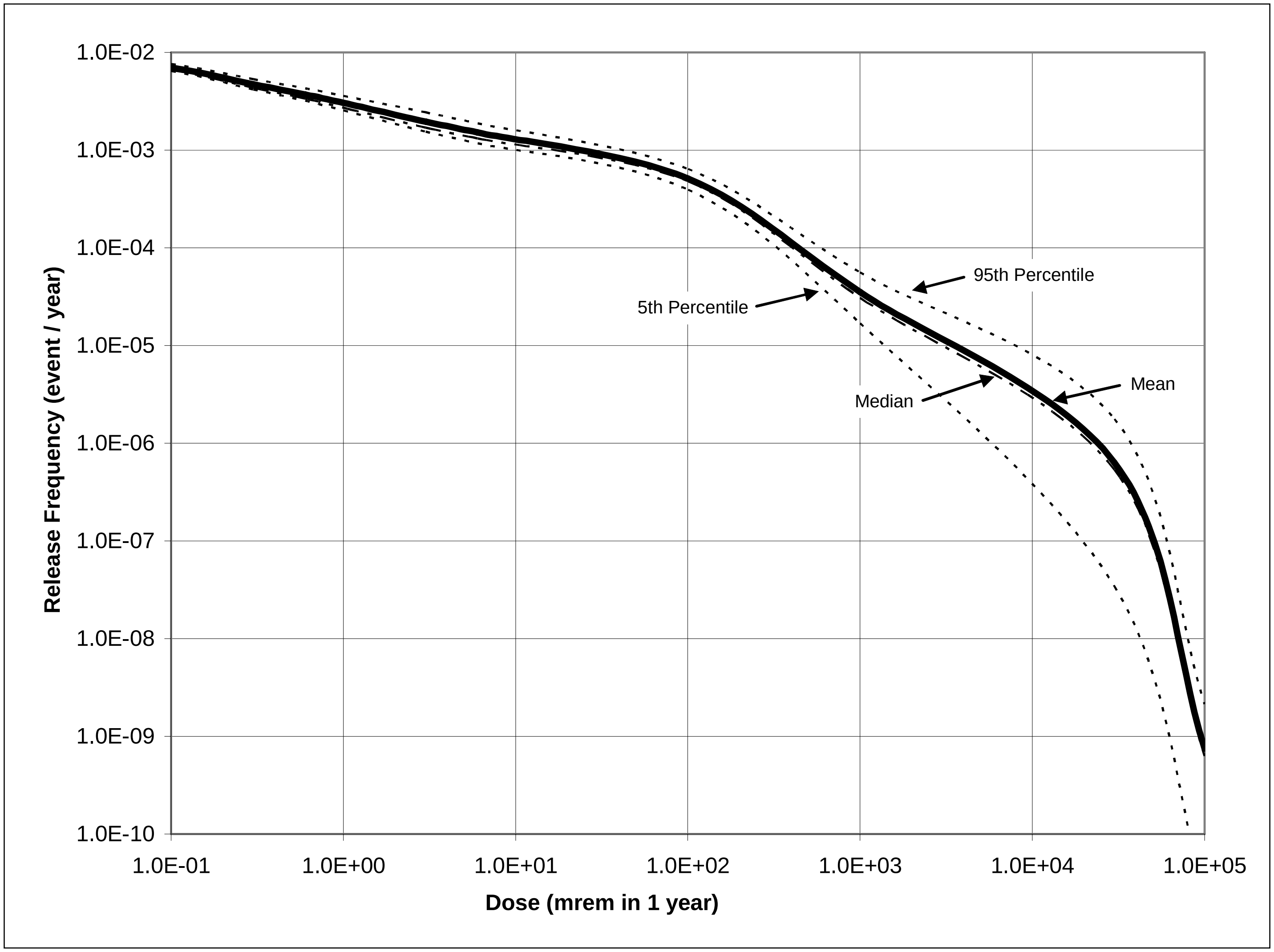

Figure P–1 SDA Risk Curves, Exceedance Frequency Format

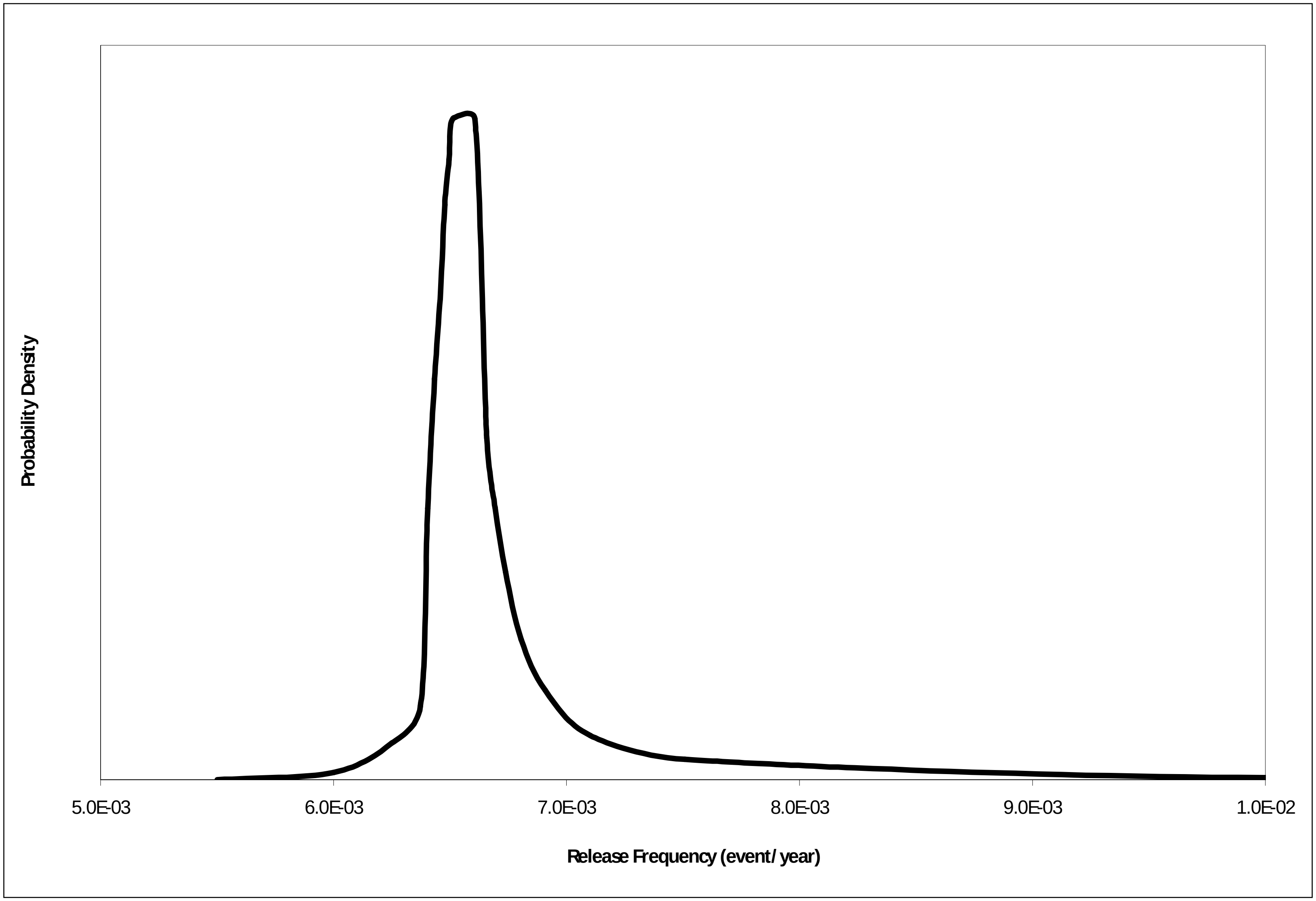

Figure P–2 Release Frequency for Exceeding a Dose of 0.1 mrem in 1 Year, Probability Density Format

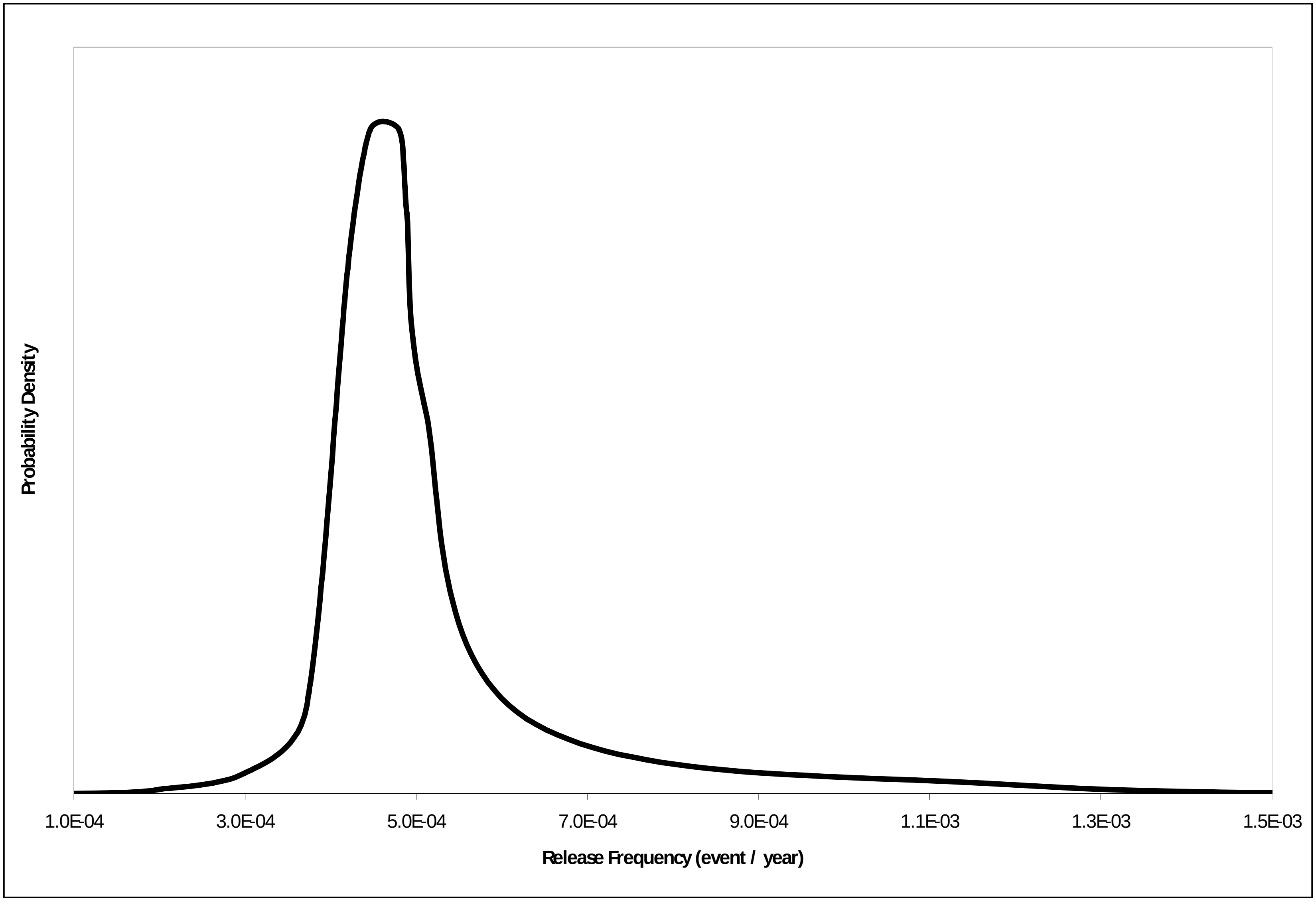

Figure P–3 Release Frequency for Exceeding a Dose of 100 mrem in 1 Year, Probability Density Format

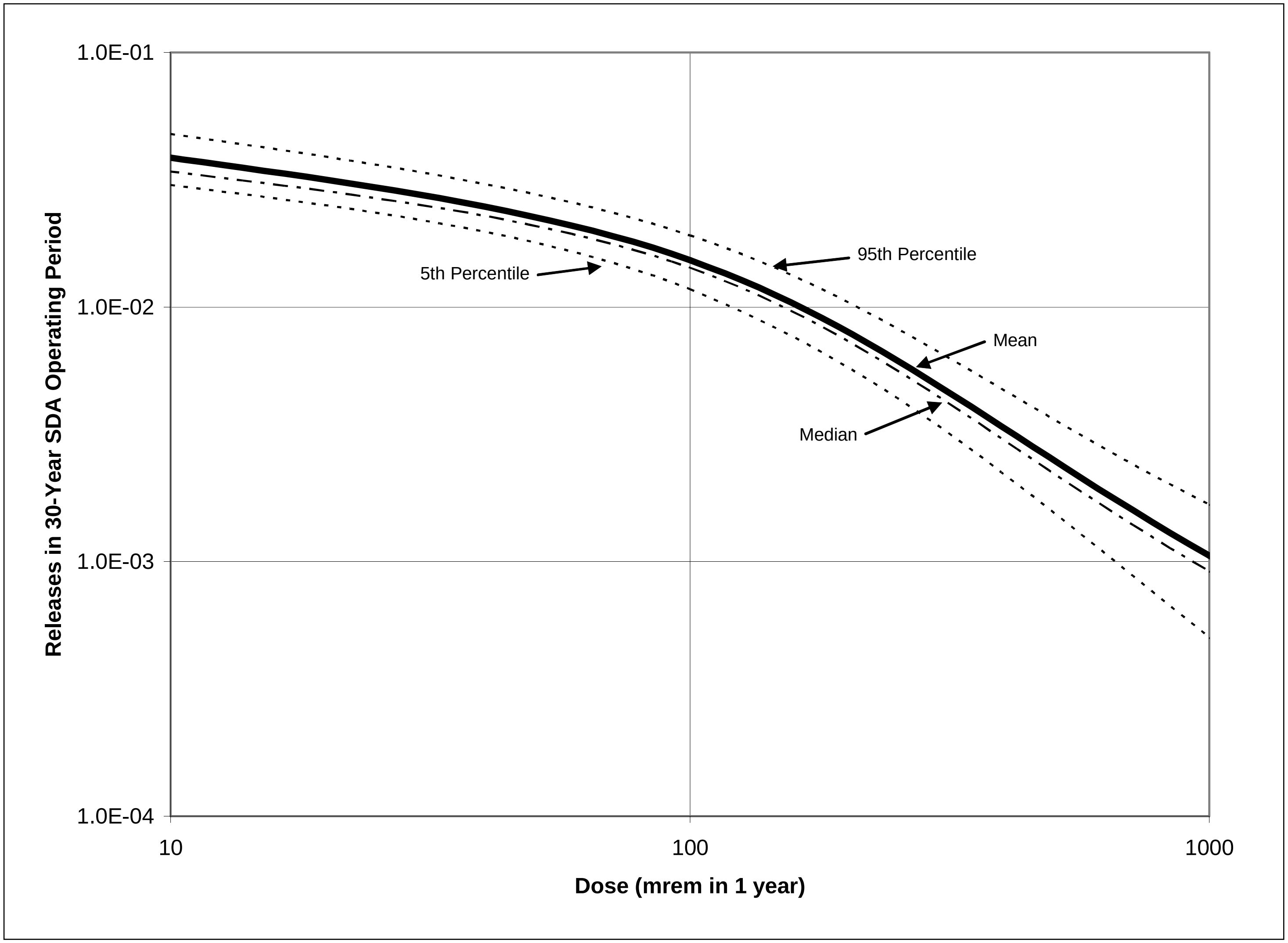

Figure P–4 SDA Risk Curves, 30-Year Operation Period Exceedance Format (Expanded Scale)

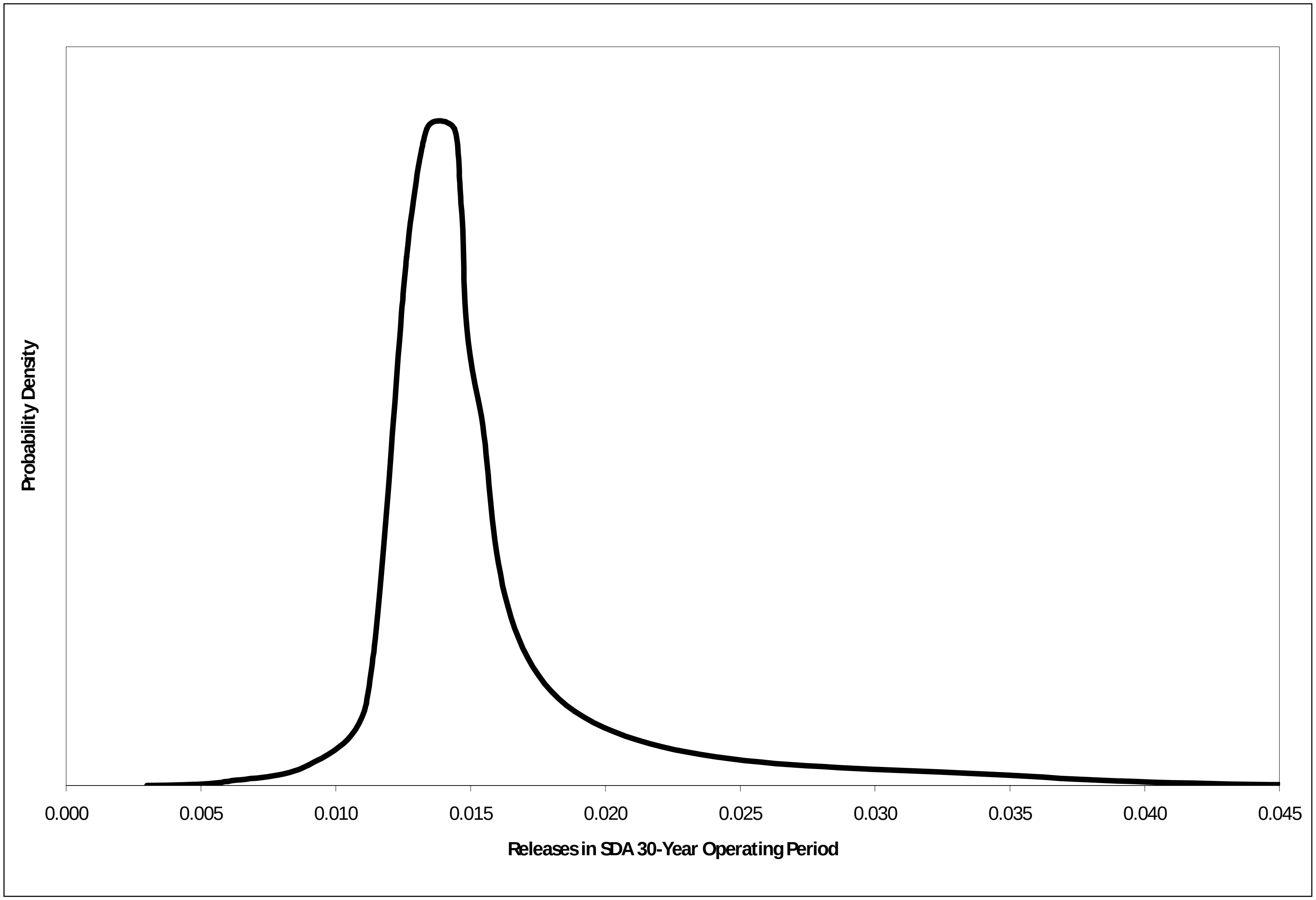

Figure P–5 Releases in SDA 30-Year Operation Period with Doses that Exceed 100 mrem in 1 Year

APPENDIX Q
CONCURRENCE LETTERS

NYSERDA New York State Energy Research and Development Authority

Vincent A. DeIorio, Esq., *Chairman*
Toll Free: 1 (866) NYSERDA
www.nyserda.org • info@nyserda.org

October 14, 2008

James A. Rispoli
Asst. Secretary for Environmental Management
EM-1/Forrestal Building
U.S. Department of Energy
1000 Independence Ave., S.W.
Washington, DC 20585

SUBJECT: Acknowledgment of Agency Concurrence to Release the *Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (DOE/EIS-0226-R) to the Public

Dear Mr. Rispoli:

The U. S. Department of Energy prepared the *Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (DOE/EIS-0226-R) (DEIS) for issuance to the public after receiving extensive comments from the New York State Energy Research and Development Authority (NYSERDA) and other governmental agencies. NYSERDA strongly supports the preferred cleanup alternative identified in the DEIS because it calls for near-term removal of significant site facilities and areas of contamination such as the Main Plant Process Building, the low-level waste treatment system lagoons, and the source area of the North Plateau groundwater plume. As you know, NYSERDA has expressed concerns about the long-term performance assessment contained in the DEIS. Given our agreement that NYSERDA's "View" statement[1] will be published in the Foreword to the Revised DEIS, NYSERDA recommends issuance of the Revised DEIS for public review.

We look forward to working with you as our agencies proceed toward a final EIS.

---

[1] "The View of the New York State Energy Research and Development Authority on the Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center"

PJB/08end083.end

Sincerely,

WEST VALLEY SITE MANAGEMENT PROGRAM

Paul J Bembia

Paul J. Bembia, Director

PJB/end

cc: C. M. Borgstrom, DOE-HQ, GC-20/FORS.
E. B. Cohen, DOE-HQ, GC-20/FORS.
B. M. Diamond, DOE-HQ, GC-51/FORS.
J. E. Loving, DOE-HQ, GC-20/FORS.
F. Marcinowski, DOE-HQ, EM-10/FORS.
B. C. Bower, DOE-WVDP, AC-DOE
C. M. Bohan, DOE-WVDP, AC-DOE
M. N. Maloney, DOE-WVDP, AC-DOE
File #60416

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 15, 2008

Mr. James Rispoli, Assistant Secretary
Office of Environmental Management
EM-1/Forrestal Building
U. S. Department of Energy
1000 Independence Ave., S.W.
Washington, D.C. 20585

SUBJECT: ACKNOWLEDGMENT OF AGENCY CONCURRENCE TO RELEASE THE *REVISED DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR DECOMMISSIONING AND/OR LONG-TERM STEWARDSHIP AT THE WEST VALLEY DEMONSTRATION PROJECT AND WESTERN NEW YORK NUCLEAR SERVICE CENTER* (DOE/EIS-0226-R) TO THE PUBLIC

Dear Mr. Rispoli:

The U.S. Department of Energy and the New York State Energy Research and Development Authority have been jointly preparing the *Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (DOE/EIS-0226-R) (EIS) for release to the public. As a cooperating agency on this EIS, the U.S. Nuclear Regulatory Commission (NRC) has participated in multi-agency concurrence meetings related to the development of the draft EIS for the West Valley project. Based on the agency's participation in this process, the NRC concurs in release of the draft EIS for public comment.

NRC appreciates the opportunity to be involved in this EIS, and reserves the right to further comment on the draft EIS during the public comment period. We look forward to working with you as you proceed toward a final EIS.

Sincerely,

Larry W. Camper, Director
Division of Waste Management
and Environmental Protection
Office of Federal and States Materials
and Environmental Management Programs

cc: See next page

cc:

C. M. Borgstrom, DOE-HQ, GC-20/FORS.
E. B. Cohen, DOE-HQ, GC-20/FORS.
B. M. Diamond, DOE-HQ, GC-51/FORS.
J. E. Loving, DOE-HQ, GC-20/FORS.
F. Marcinowski, DOE-HQ, EM-10/FORS.
B. C. Bower, DOE-WVDP, AC-DOE.
C. M. Bohan, DOE-WVDP, AC-DOE
M. N. Maloney, DOE-WVDP, AC-DOE
G. Baker, NYSDOH
P. Bembia, NYSERDA
P. Giardina, USEPA
E. Dassatti, NYSDEC
M. John, Seneca Nation of Indians

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

James Rispoli, Assistant Secretary
Office of Environmental Management
EM-1/Forrestal Building
U. S. Department of Energy
1000 Independence Ave., S.W.
Washington, D.C. 20585

SUBJECT: Acknowledgment of Agency Concurrence to Release the *Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (DOE/EIS-0226-R) to the Public

Dear Mr. Rispoli:

The U. S. Department of Energy and the New York State Energy Research and Development Authority have been jointly preparing the revised *Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (DOE/EIS-0226-R) (DEIS) for release to the public. As a cooperating agency on this DEIS, the U.S. Environmental Protection Agency (EPA) has reviewed the concurrence draft of this document. EPA concurs that the draft represents an adequate compilation of relevant information, has not ignored pertinent data, and that the information has been analyzed reasonably. Therefore, EPA recommends release of the revised DEIS for public review.

However, we want to point out that our participation as a cooperating agency and our recommendation to release the DEIS neither precludes our review under the National Environmental Policy Act nor negates our comment authority under Section 309 of the Clean Air Act.

EPA thanks you for the opportunity to be involved in the preparation of this DEIS. We look forward to working with you as you proceed toward a final EIS.

Sincerely yours,

John Filippelli

John Filippelli, Chief
Strategic Planning Multi-Media Programs Branch

New York State Department of Environmental Conservation
Division of Solid and Hazardous Materials, 9th Floor
625 Broadway, Albany, New York 12233-7250
Phone: (518) 402-8651 • **FAX:** (518) 402-9024
Website: www.dec.ny.gov

Alexander B. Grannis
Commissioner

OCT 14 2008

Mr. James Rispoli
Assistant Secretary, Office of Environmental Management
EM-1/Forrestal Building
U.S. Department of Energy
1000 Independence Ave., S.W.
Washington, D.C. 20585

Dear Mr. Rispoli:

RE: Concurrence Meeting Letter for the Revised Draft Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Services Center (DEIS)

At the end of August, the New York State Departments of Environmental Conservation and Health (the Departments) received your letter inviting their management and technical staff to the West Valley DEIS Concurrence Review Meeting at the U.S. Department of Energy (DOE) Headquarters in Washington, D.C., from October 6-10. While we regret that we were not able to physically attend the meeting, staff from the Departments did participate via teleconference.

The Departments have received and reviewed the proposed resolutions provided by DOE in response to comments made by the Departments during the "Fatal Flaw" review of the DEIS. Based on these responses and proposed resolutions, the Departments agree that the DEIS is acceptable for release to the public. This does not constitute the Departments' concurrence with the DEIS, but that it is sufficiently complete for release for public review and comment. As staffs have repeatedly stated, in person during Core Team meetings, in writing in our August 22 letter, and during our Concurrence meeting opening remarks, the full and detailed review of the DEIS by both Departments will take place during the public comment period.

If you have any questions, please do not hesitate to contact either Robert Phaneuf or Lynn Winterberger, of the New York State Department of Environmental Conservation (518-402-8594), or Gary Baker, of the New York State Department of Health (315-477-4884).

Sincerely,

Edwin Dassatti, P.E.
Director
Division of Solid and Hazardous Materials
New York State Department of
Environmental Conservation

for G. Anders Carlson, Ph.D.
Director
Division of Environmental Health Investigation
New York State Department of Health

cc: C. M. Borgstrom, DOE-HQ, GC-20/FORS
E. B. Cohen, DOE-HQ, GC-20/FORS
B. M. Diamond, DOE-HQ, GC-51/FORS
J. E. Loving, DOE-HQ, GC-20/FORS
F. Marcinowski, DOE-HQ, EM-10/FORS
B. C. Bower, DOE-WVDP, AC-DOE
C. M. Bohan, DOE-WVDP, AC-DOE
M. N. Maloney, DOE-WVDP, AC-DOE
V. Washington, NYSDEC Central Office
A. Crocker, NYSDEC Central Office
K. McConnell, NRC
P. Bembia, NYSERDA
J. Reidy, US EPA
P. Giardina, US EPA
S. Gavitt, NYSDOH
G. Baker, NYSDOH

New York State Department of Environmental Conservation
Division of Solid and Hazardous Materials, 9th Floor
625 Broadway, Albany, New York 12233-7250
Phone: (518) 402-8651 • **FAX:** (518) 402-9024
Website: www.dec.ny.gov

Alexander B. Grannis
Commissioner

November 30, 2009

Dr. Inés R. Triay, Assistant Secretary
Office of Environmental Management
EM-1/Forrestal Building
U.S. Department of Energy
1000 Independence Ave., S.W.
Washington, D.C. 20585

Dear Dr. Triay:

Re: Concurrence Review Meeting Letter for the Final Environmental Impact Statement (FEIS) for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center

The New York State Departments of Environmental Conservation and Health (Departments) appreciate the opportunity for our managerial and technical staff to participate in the Concurrence Review Meeting at the U.S. Department of Energy (DOE) Headquarters, in Washington D.C., from November 17-20. While we regret that we were not able to physically attend the meeting, staff from the Departments were able to participate via teleconference.

The Departments recognize the efforts put forward by the stakeholders and all agencies involved in this EIS process, and applaud the progress made to date toward the decommissioning of the Western New York Nuclear Service Center (WNYNSC). The Departments have received and reviewed the draft of the FEIS and participated in discussions during Core Team Meetings, Interagency Roundtable Meetings and during the Concurrence Review Meeting, and provided written comments during the public comment period. We continue to support the Phased Decommissioning Alternative; however, we are unable to concur with all aspects of this FEIS and are concerned for the pressures that may be imposed by the accelerated Phase 2 decision timeline. We strongly encourage making the Phase 2 decision by the end of Phase 1 in order to allow site remedial work to continue uninterrupted, as a goal of the Preferred Alternative. However, understanding the scope of this project and the long history involved in finally getting an FEIS to this point, we would hope that the schedule does not overtake events and force inappropriate remedial or decommissioning decisions at this important site.

The Departments want to emphasize that the ultimate Phase 2 decision will need to be supported by technologically and scientifically defensible data. Furthermore, we strongly recommend that both the DOE and the New York State Energy Research & Development Authority (NYSERDA) should begin immediately to compile and analyze the necessary information for the Phase 2 decision. Additionally, due to the contiguous nature of the DOE and NYSERDA sites at the WNYNSC, we also strongly encourage the agencies to make a coordinated decision for all units/areas at the site by the end of Phase 1. The Departments will continue to exercise their regulatory authorities to ensure protection of the environment and public health and safety.

If you have any questions, please do not hesitate to contact either Robert Phaneuf, of the New York State Department of Environmental Conservation (518-402-8594), or Robert Snyder, of the New York State Department of Health (518-402-7550).

Sincerely,

Ed Dassatti

Edwin Dassatti, P.E.
Director
Division of Solid & Hazardous Materials
New York State Department
of Environmental Conservation

Ed Dassatti
for Adele Salame-Alfi, Ph.D.
Assistant Director
Division of Environmental Health Investigation
New York State Department of Health

ecc: B. C. Bower, DOE-WVDP, AC-DOE
C. M. Bohan, DOE-WVDP, AC-DOE
K. McConnell, NRC
P. Bembia, NYSERDA
P. Giardina, USEPA
R. Snyder, NYSDOH

'NMENTAI
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

NOV 3 0 2009

COPY

Dr. Inés R. Triay, Assistant Secretary
Office of Environmental Management
EM-1/Forrestal Building
U.S. Department of Energy
1000 Independence Ave., S.W.
Washington, DC 20585

SUBJECT: Acknowledgement of Agency Concurrence to Release the Final Environmental Impact Statement of Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center (DOE/EIS-0226) to the Public.

Dear Dr. Triay:

The U.S. Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA) have finalized the Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center (DOE/EIS-0226) for release to the public. As a cooperating agency on the Final Environmental Impact Statement (FEIS), the U.S. Environmental Protection Agency (EPA) has reviewed the concurrence draft of this document. While EPA is concerned that NYSERDA, a co-lead agency, has several points of disagreement with the DOE and some of the findings within the document, we can concur that the FEIS can be released to the public.

I am also taking this opportunity to note that EPA's participation as a cooperating agency and our recommendation to release the FEIS neither precludes Agency review under the National Environmental Policy Act nor negates our authority to comment on the FEIS as mandated by Section 309 of the Clean Air Act. Accordingly, EPA will prepare a comment letter on the document during the review period following its release.

We appreciate the opportunity to work with the DOE, NYSERDA, and the other cooperating agencies involved in this effort.

Sincerely,

John Filippelli, Chief
Strategic Planning and Multi-Media Programs Branch

NYSERDA **New York State Energy Research and Development Authority**

Vincent A. DeIorio, Esq., ***Chairman***
Toll Free: 1 (866) NYSERDA
www.nyserda.org • info@nyserda.org

December 3, 2009

Dr. Inés R. Triay
Asst. Secretary for Environmental Management
EM-1/Forrestal Building
U.S. Department of Energy
1000 Independence Ave., S.W.
Washington, DC 20585

Dear Dr. Triay:

SUBJECT: Release of the *Final Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (DOE/EIS-0226-R) to the Public

The U. S. Department of Energy is now in the final stages of preparing the *Final Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center* (DOE/EIS-0226-R) (FEIS) for issuance to the public. As part of the process for completing the FEIS, DOE has requested each participating agency, including NYSERDA, the joint lead, provide a letter of concurrence in regard to issuance of the FEIS. While we do concur with issuing the FEIS to the public, we do wish to make you aware of some important issues surrounding the FEIS.

When the Draft EIS was issued for public review in December 2008, it was issued with a NYSERDA-prepared "Foreword" that documented eight major concerns with the analyses presented in the DEIS. While NYSERDA and DOE have reached agreement on one of these concerns (the analytical approach for calculating rail transportation fatalities), the remainder of NYSERDA's concerns are unresolved and now carry over into the FEIS. Although we continue to have significant technical concerns with the FEIS, NYSERDA recommends issuance of the FEIS to the public because: 1) DOE and NYSERDA have agreed that NYSERDA's view on the FEIS will be published in a "Foreword" to the FEIS; 2) DOE and NYSERDA have agreed to work together to identify a suite of additional studies that will be targeted to address the outstanding technical concerns; and 3) implementation of the Preferred Alternative does not hinge on the analyses that we believe to be problematic. Both agencies have also agreed that the additional technical studies will be conducted concurrently with the Phase 1 decommissioning work, allowing the cleanup to move directly from Phase 1 to Phase 2. This will allow us to maintain funding, momentum on the cleanup, and our trained workforce.

PJB/09amd055.pjb

We look forward to working with DOE on the remainder of the West Valley Demonstration Project.

Sincerely,

WEST VALLEY SITE MANAGEMENT PROGRAM

Paul J. Bembia

Paul J. Bembia, Director

PJB/amd

cc: C. M. Borgstrom, DOE-HQ, GC-20/FORS.
B. M. Diamond, DOE-HQ, GC-51/FORS.
F. Marcinowski, DOE-HQ, EM-10/FORS.
B. C. Bower, DOE-WVDP, AC-DOE
C. M. Bohan, DOE-WVDP, AC-DOE
H. Brodie, NYSERDA-Albany
D. A. Munro, NYSERDA-Albany
J. C. Kelly, NYSERDA-WV
L. M. Gordon, NYSERDA-WV
File #60416

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 3, 2009

Dr. Inés R. Triay, Assistant Secretary
Office of Environmental Management
EM-1/Forrestal Building
U. S. Department of Energy
1000 Independence Ave., S.W.
Washington, D.C. 20585

SUBJECT: PUBLIC RELEASE OF FINAL ENVIRONMENTAL IMPACT STATEMENT FOR DECOMMISSIONING AND/OR LONG-TERM STEWARDSHIP AT THE WEST VALLEY DEMONSTRATION PROJECT AND WESTERN NEW YORK NUCLEAR SERVICE CENTER (DOE/EIS-0226-R)

Dear Dr. Triay:

The U.S. Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA) have prepared a Final Environmental Impact Statement (DOE/NYSERDA EIS) for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center (DOE/EIS-0226-R) for release to the public. As a cooperating agency on this DOE/NYSERDA EIS, the U.S. Nuclear Regulatory Commission (NRC) has participated in multi-agency concurrence meetings related to the development of the final DOE/NYSERDA EIS. Based on the agency's participation in this process, NRC concurs that the DOE/NYSERDA EIS as modified by NRC comments is acceptable for publication.

Sincerely,

Larry W. Camper

Larry W. Camper, Director
Division of Waste Management
and Environmental Protection
Office of Federal and States Materials
and Environmental Management Programs

cc: See next page

cc:
C. M. Borgstrom, DOE-HQ, GC-20/FORS.
E. B. Cohen, DOE-HQ, GC-20/FORS.
B. M. Diamond, DOE-HQ, GC-51/FORS.
J. E. Loving, DOE-HQ, GC-20/FORS.
F. Marcinowski, DOE-HQ, EM-10/FORS.
B. C. Bower, DOE-WVDP, AC-DOE.
C. M. Bohan, DOE-WVDP, AC-DOE
M. N. Maloney, DOE-WVDP, AC-DOE
G. Baker, NYSDOH
P. Bembia, NYSERDA
P. Giardina, USEPA
E. Dassatti, NYSDEC

APPENDIX R
CONTRACTOR DISCLOSURE STATEMENTS

NEPA DISCLOSURE STATEMENT FOR THE INTEGRATION AND EXECUTION OF THE WEST VALLEY ENVIRONMENTAL IMPACT STATEMENT AND DECOMMISSIONING PLAN

The Council on Environmental Quality (CEQ) Regulations at Title 40 of the *Code of Federal Regulations* (CFR) Section 1506.5(c), which have been adopted by the U.S. Department of Energy (10 CFR 1021), require contractors and subcontractors who will prepare an environmental impact statement to execute a disclosure specifying that they have no financial or other interest in the outcome of the project.

"Financial or other interest in the outcome of the project" is defined as any direct financial benefit such as a promise of future construction or design work in the project, as well as indirect financial benefits the contractor is aware of.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows, to the best of their actual knowledge as of the date set forth below:

(a) X Offeror and any proposed subcontractors have no financial or other interest in the outcome of the project.

(b) __ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract, or agree to the attached plan to mitigate, neutralize or avoid any such conflict of interest.

Financial or Other Interests

1.
2.
3.

Certified by:

Sandra L. Reid

Signature

Sandra L. Reid

Name

Senior Contracts Representative

Title

Science Applications International Corporation

Company

January 25, 2005

Date

ORGANIZATIONAL CONFLICT OF INTEREST

I. INSTRUCTIONS

Read Part II carefully. If a disclosure statement is required, complete Part III. If a representation is submitted, complete Part IV. Complete Part V in every case.

II. ORGANIZATIONAL CONFLICT OF INTEREST DISCLOSURE OR REPRESENTATION

It is Department of Energy (DOE) policy to avoid situations which place an offeror in a position where its judgment may be biased because of any past, present, or currently planned interest, financial or otherwise, the offerer may have which relates to the work performed pursuant to this solicitation or where the offerors performance of such work may provide it with an unfair competitive advantage. (As used herein, an offeror means the proposer or any of its affiliates or proposed consultants or subcontractors of any tier.)

Therefore:

(a) The offeror shall provide a statement which describes in a concise manner all relevant facts concerning any past, present or currently planned interest (financial, contractual, organizational, or otherwise) relating to the work to be performed hereunder and bearing on whether the offeror has a possible organizational conflict of interest with respect to (1) being able to render impartial, technically sound, and other objective assistance or advise, or (2) being given an unfair competitive advantage. The offeror may also provide relevant facts that show how possible organizational conflict of interest relating to other divisions or sections of the organizations and how that structure or system would avoid or mitigate such organizational conflict.

(b) In the absence of any relevant interest referred to above, the offeror shall submit a statement certifying that to its best knowledge and belief no such facts exist relevant to possible organizational conflicts of interest. Proposed consultants and subcontractors are responsible for submitting information and may submit it directly to the DOE Contract Representative.

(c) DOE will review the statement submitted and may require additional relevant information from the offeror. All such information, and any other relevant information will be used by DOE to determine whether an award to the offeror may create an organizational conflict of interest. If found to exist, DOE may direct the offeror to (1) impose appropriate conditions which avoid such conflict, (2) disqualify the offeror, or DOE may determine that it is otherwise in the best interest of the United States for DOE to contract with the offeror by including appropriate conditions mitigating such conflict in the contract awarded.

(d) The refusal to provide the disclosure or representation of any additional information as required shall result in disqualification of the offeror for award. The nondisclosure or misrepresentation of any relevant interest may also result in the disqualification of the offeror for award, or if such nondisclosure or misrepresentation is discovered after award, DOE may terminate the contract for default, recommend that the offeror be disqualified from subsequent related contracts, or be subject to such other remedial actions as may be permitted or provided by law. The attention of the offeror in complying with this provision is directed to 18 U.S.C. 1001 and 31 U.S.C. 3802(a)(2).

(e) Depending on the nature of the contract activities, the offeror may, because of possible organizational conflicts of interest, propose to exclude specific kinds of work from the statement, unless the solicitation specifically prohibits such exclusion. Any such proposed exclusion by an offeror shall be considered by DOE in the evaluation of proposals, and if DOE considers the proposed excluded work to be an essential or integral part of the required work, the proposal may be rejected as unacceptable.

(f) No award shall be made until the disclosure or representation has been evaluated by DOE. Failure to provide the disclosure or representation will be deemed to be a minor informality and the offeror or contractor shall be required to promptly correct the omission.

III. DISCLOSURE STATEMENT
(attach additional pages if more space is needed)

IV. REPRESENTATION

The offeror, Washington Safety Management Solutions LLC hereby represents that it is aware of no past, present, or currently planned interest (financial, contractual, organizational, or otherwise) relating to the work to be performed under the contract resulting from Request for Proposal No. 44001084ll that would indicate any impingement upon its ability to render impartial, technically sound, and objective assistance or advice or result in it being given an unfair competitive advantage. This representation applies to all affiliates of the offeror and its proposed consultants or subcontractors of any tier.

V. SIGNATURE

Offeror's Name Washington Safety Management Solution LLC

RFP/Contract No. 44001084ll

Signature [signature]

Title Manager, Contracts and Procurement

Date 1/28/08

(e) Depending on the nature of the contract activities, the offeror may, because of possible organizational conflicts of interest, propose to exclude specific kinds of work from the statement, unless the solicitation specifically prohibits such exclusion. Any such proposed exclusion by an offeror shall be considered by DOE in the evaluation of proposals, and if DOE considers the proposed excluded work to be an essential or integral part of the required work, the proposal may be rejected as unacceptable.

(f) No award shall be made until the disclosure or representation has been evaluated by DOE. Failure to provide the disclosure or representation will be deemed to be a minor informality and the offeror or contractor shall be required to promptly correct the omission.

III. DISCLOSURE STATEMENT
(attach additional pages if more space is needed)

IV. REPRESENTATION

The offeror, Gregory E. Tucker, hereby represents that it is aware of no past, present or currently planned interest (financial, contractual, organizational, or otherwise) relating to the work to be performed under the contract resulting from the Department of Energy's December 3,2004 Request for Proposal titled "Integration and Execution of the Environmental Impact Statement and Decommissioning Plan Preparation Efforts". That would indicate any impingement upon its ability to render impartial, technically sound, and objective assistance or advice or result in it being given an unfair competitive advantage. This representation applies to all affiliates of the offeror and its proposed consultants or subcontractors of any tier.

V. SIGNATURE

Offeror's Name: Gregory E. Tucker

RFP/Contract: Department of Energy's December 3, 2004 Request for Proposal titled "Integration and Execution of the Environmental Impact Statement and Decommissioning Plan Preparation Efforts".

Signature:

Title: Consultant

Date: 10/23/08

APPENDIX R
CONTRACTOR DISCLOSURE STATEMENTS

NEPA DISCLOSURE STATEMENT FOR THE INTEGRATION AND EXECUTION OF THE WEST VALLEY ENVIRONMENTAL IMPACT STATEMENT AND DECOMMISSIONING PLAN

The Council on Environmental Quality (CEQ) Regulations at Title 40 of the *Code of Federal Regulations* (CFR) Section 1506.5(c), which have been adopted by the U.S. Department of Energy (10 CFR 1021), require contractors and subcontractors who will prepare an environmental impact statement to execute a disclosure specifying that they have no financial or other interest in the outcome of the project.

"Financial or other interest in the outcome of the project" is defined as any direct financial benefit such as a promise of future construction or design work in the project, as well as indirect financial benefits the contractor is aware of.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows, to the best of their actual knowledge as of the date set forth below:

(a) X Offeror and any proposed subcontractors have no financial or other interest in the outcome of the project.

(b) __ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract, or agree to the attached plan to mitigate, neutralize or avoid any such conflict of interest.

<u>Financial or Other Interests</u>

1.
2.
3.

Certified by:

Sandra L. Reid
Signature

Sandra L. Reid
Name

Senior Contracts Representative
Title

Science Applications International Corporation
Company

January 25, 2005
Date

ORGANIZATIONAL CONFLICT OF INTEREST

I. INSTRUCTIONS

Read Part II carefully. If a disclosure statement is required, complete Part III. If a representation is submitted, complete Part IV. Complete Part V in every case.

II. ORGANIZATIONAL CONFLICT OF INTEREST DISCLOSURE OR REPRESENTATION

It is Department of Energy (DOE) policy to avoid situations which place an offeror in a position where its judgment may be biased because of any past, present, or currently planned interest, financial or otherwise, the offerer may have which relates to the work performed pursuant to this solicitation or where the offerors performance of such work may provide it with an unfair competitive advantage. (As used herein, an offeror means the proposer or any of its affiliates or proposed consultants or subcontractors of any tier.)

Therefore:

(a) The offeror shall provide a statement which describes in a concise manner all relevant facts concerning any past, present or currently planned interest (financial, contractual, organizational, or otherwise) relating to the work to be performed hereunder and bearing on whether the offeror has a possible organizational conflict of interest with respect to (1) being able to render impartial, technically sound, and other objective assistance or advise, or (2) being given an unfair competitive advantage. The offeror may also provide relevant facts that show how possible organizational conflict of interest relating to other divisions or sections of the organizations and how that structure or system would avoid or mitigate such organizational conflict.

(b) In the absence of any relevant interest referred to above, the offeror shall submit a statement certifying that to its best knowledge and belief no such facts exist relevant to possible organizational conflicts of interest. Proposed consultants and subcontractors are responsible for submitting information and may submit it directly to the DOE Contract Representative.

(c) DOE will review the statement submitted and may require additional relevant information from the offeror. All such information, and any other relevant information will be used by DOE to determine whether an award to the offeror may create an organizational conflict of interest. If found to exist, DOE may direct the offeror to (1) impose appropriate conditions which avoid such conflict, (2) disqualify the offeror, or DOE may determine that it is otherwise in the best interest of the United States for DOE to contract with the offeror by including appropriate conditions mitigating such conflict in the contract awarded.

(d) The refusal to provide the disclosure or representation of any additional information as required shall result in disqualification of the offeror for award. The nondisclosure or misrepresentation of any relevant interest may also result in the disqualification of the offeror for award, or if such nondisclosure or misrepresentation is discovered after award, DOE may terminate the contract for default, recommend that the offeror be disqualified from subsequent related contracts, or be subject to such other remedial actions as may be permitted or provided by law. The attention of the offeror in complying with this provision is directed to 18 U.S.C. 1001 and 31 U.S.C. 3802(a)(2).

(e) Depending on the nature of the contract activities, the offeror may, because of possible organizational conflicts of interest, propose to exclude specific kinds of work from the statement, unless the solicitation specifically prohibits such exclusion. Any such proposed exclusion by an offeror shall be considered by DOE in the evaluation of proposals, and if DOE considers the proposed excluded work to be an essential or integral part of the required work, the proposal may be rejected as unacceptable.

(f) No award shall be made until the disclosure or representation has been evaluated by DOE. Failure to provide the disclosure or representation will be deemed to be a minor informality and the offeror or contractor shall be required to promptly correct the omission.

III. DISCLOSURE STATEMENT
(attach additional pages if more space is needed)

IV. REPRESENTATION

The offeror, Washington Safety Management Solutions LLC hereby represents that it is aware of no past, present, or currently planned interest (financial, contractual, organizational, or otherwise) relating to the work to be performed under the contract resulting from Request for Proposal No. 44001084ll that would indicate any impingement upon its ability to render impartial, technically sound, and objective assistance or advice or result in it being given an unfair competitive advantage. This representation applies to all affiliates of the offeror and its proposed consultants or subcontractors of any tier.

V. SIGNATURE

Offeror's Name Washington Safety Management Solution LLC

RFP/Contract No. 44001084ll

Signature

Title Manager, Contracts and Procurement

Date 1/28/08

(e) Depending on the nature of the contract activities, the offeror may, because of possible organizational conflicts of interest, propose to exclude specific kinds of work from the statement, unless the solicitation specifically prohibits such exclusion. Any such proposed exclusion by an offeror shall be considered by DOE in the evaluation of proposals, and if DOE considers the proposed excluded work to be an essential or integral part of the required work, the proposal may be rejected as unacceptable.

(f) No award shall be made until the disclosure or representation has been evaluated by DOE. Failure to provide the disclosure or representation will be deemed to be a minor informality and the offeror or contractor shall be required to promptly correct the omission.

III. DISCLOSURE STATEMENT
(attach additional pages if more space is needed)

IV. REPRESENTATION

The offeror, Gregory E. Tucker, hereby represents that it is aware of no past, present or currently planned interest (financial, contractual, organizational, or otherwise) relating to the work to be performed under the contract resulting from the Department of Energy's December 3,2004 Request for Proposal titled "Integration and Execution of the Environmental Impact Statement and Decommissioning Plan Preparation Efforts". That would indicate any impingement upon its ability to render impartial, technically sound, and objective assistance or advice or result in it being given an unfair competitive advantage. This representation applies to all affiliates of the offeror and its proposed consultants or subcontractors of any tier.

V. SIGNATURE

Offeror's Name: Gregory E. Tucker

RFP/Contract: Department of Energy's December 3, 2004 Request for Proposal titled "Integration and Execution of the Environmental Impact Statement and Decommissioning Plan Preparation Efforts".

Signature: [signature]

Title: Consultant

Date: 10/23/08