U.S. Department of Energy
West Valley Demonstration Project

Phase 1 Decommissioning Plan for the West Valley Demonstration Project

Revision 1

March 2009

Prepared by

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Science Applications International Corporation

The proposed decommissioning approach described in this plan is based on the preferred alternative in 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, which is referred to as the Decommissioning EIS. If changes to that document occur during the course of the National Environmental Policy Act process that affect this plan, such as changes to the preferred alternative, or if a different approach is selected in the Record of Decision, this plan will be revised as necessary to reflect the changes.

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Record of Revisions

No.	Date	Purpose
0	December 2008	Initial issue for U.S. Nuclear Regulatory Commission review.
1	March 2009	(1) Corrected some page numbers in the Contents. (2) Changed the preliminary, order-of-magnitude dose estimate for Waste Management Area 2 on page ES-19 from approximately 0.1 to approximately 0.05 millirem per year. (3) Added report USGS 2007 in the Section 3 reference list. (4) Incorporated radiological data on subsurface soil from the 2008 background and Process Building area north plateau groundwater plume investigations into Section 4. (5) Replaced Figure 5-3 with a modified figure to more accurately show the Lavery till depth where samples were taken. (6) Revised Table 5-1 to reflect the 2008 radiological data. (7) Corrected values in Table 5-10 and Table 5-11 to be consistent with Table C-1. (8) Revised Section 5.4.4 to show a maximum of 1.3 millirem per year for Waste Management Area 1 and 0.04 mrem per year for Waste management Area 2, clarified basis for estimates. (9) Corrected French drain location on Figure 7-10. (10) Corrected soil data reference on Figure 7-11 and modified the figure to more accurately show the Lavery till depth where samples were taken. (This figure is the same as Figure 5-3.) (11) Added WVNSCO 2004 to Section 7 references. (12) Corrected some values in Table 9-1, 9-2, and 9-3. (13) Changed cited page numbers on pages A-12 and A-13. (14) Incorporated radiological data on subsurface soil from the 2008 background and Process Building area north plateau groundwater plume investigations into Appendix B. (15) Revised Table C-4 to add the 2008 data and to clarify the content. (16) Added Appendix C, Attachment 2 to provide another electronic file (Table C-4B Excel spreadsheet for the preliminary, order-of-magnitude dose estimates). (17) Revised Appendix D to describe additional groundwater modeling using revised STOMP model. Corrected French drain location on Figure D-2.

Pages affected by Revision 1 are identified in the list of effective pages that follows. The changed portions of these pages are marked with vertical lines in the right margins. New and revised words appear in blue.

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Note that other tables appear in the Appendix C, Attachment 1 electronic files.

A single Table (C-4B) is included in the Appendix C, Attachment 2 electronic files.

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NOTATION

Acronyms and Abbreviations

AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
BH	bore hole
CG	cleanup goal
DCGL	derived concentration guideline level
$DCGL_W$	derived concentration guideline level, wide
$DCGL_{EMC}$	derived concentration guideline level, elevated measurement concentration
$DCGL_{scan}$	derived concentration guideline level, scan
DOE	Department of Energy
DQO	data quality objective
DSR	dose/source ratio
E	east
EIS	environmental impact statement
EMC	elevated measurement concentration
EPA	U.S Environmental Protection Agency
F	Fahrenheit
FR	Federal Register
HEPA	high-efficiency particulate air
HLW	high-level waste
ICORS	Interagency Steering Committee on Radiation Standards
K	hydraulic conductivity
K_d	distribution coefficient
KRS	Kent recessional sequence
LLW	low-level waste
LTR	License Termination Rule
LTS	Lavery till sand
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
MMI	Modified Mercalli Intensity
N	north
ND	not detected

NOTATION

NDA	NRC-Licensed Disposal Area
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NPR	New Production Reactor
NRC	Nuclear Regulatory Commission
NFS	Nuclear Fuel Services, Inc.
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
PUREX	plutonium uranium refining by extraction
QA	quality assurance
QC	quality control
qtr	quarter
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual radioactivity [computer code]
RFI	RCRA facility investigation
S&G	sand and gravel
SAIC	Science Applications International Corporation
SB	subsurface soil
SD	stream bank sediment
SDA	State-Licensed Disposal Area
SPDES	State Pollutant Discharge Elimination System
SS	surface soil
THOREX	thorium uranium extraction process
TLD	thermoluminescent dosimeter
ULT	unweathered Lavery till
W	west
WLT	weathered Lavery till
WMA	waste management area
WSMS	Washington Safety Management Solutions
WVDP	West Valley Demonstration Project
WVES	West Valley Environmental Services
WVNSCO	West Valley Nuclear Services Company

NOTATION

Units

Ci	curie
cfm	cubic feet per minute
cm	centimeter
cm^2	centimeter squared
cm^3	centimeter cubed
cpm	counts per minute
dpm	disintegrations per minute
g	gram [mass]
g	acceleration due to gravity [in reference to accelerations]
h	hour
kg	kilogram
km	kilometer
L	liter
m	meter
mCi	millicurie
millirem	0.001 Roentgen equivalent man
mL	milliliter
mrem	millirem
mR	milli Roentgen
μCi	0.000001 curie
μR	micro Roentgen
μrem	micro rem
μL	0.000001 liter
pCi	10^{-12} curie
R	Roentgen
rem	Roentgen equivalent man
s	second
y	year

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Since these cleanup goals were developed for individual radionuclides of interest, a sum-of-fractions approach based on radionuclide distributions in different areas would be used to ensure that potential doses from the remediated areas would be no more that the dose from one of the individual radionuclides at the concentration specified in Table ES-2.

Although the subsurface soil cleanup goals in Table ES-2 form the criteria for residual radioactivity in the two large excavations, remediation plans involve excavation at least one foot into the Lavery till and, in Waste Management Area 2, at least one foot below the sediment in the bottoms of Lagoons 2 and 3. This approach is expected to produce residual radioactivity levels well below the cleanup goals, based on limited existing data on residual radioactive contamination in the Lavery till. A preliminary, order-of-magnitude dose analysis using these data suggests that potential futures doses from these excavated areas would be approximately one millirem per year for Waste Management Area 1 and approximately 0.05 millirem per year for Waste Management Area 2.

After additional characterization data become available early in Phase 1 of the decommissioning, the DCGLs and the cleanup goals would be reevaluated using these data and refined as appropriate. After the Phase 1 decommissioning activities have been completed, another dose analysis using Phase 1 final status survey data would be performed to estimate the potential doses from the remediated subsurface areas.

Summary of ALARA Evaluations

DOE has performed a preliminary cost-benefit analysis using NRC methodology to determine whether removal of soil or sediment with radioactivity concentrations below the DCGLs would be consistent with the ALARA principal. These analyses compared the cost of disposal of additional soil or sediment with the reduction in radiation exposure associated with removal of additional soil or sediment below the DCGLs valued at $2000 per person-rem as set forth in NRC guidance. They indicate that removal of soil or sediment with radioactivity concentrations below the DCGLs would not be cost-effective.

DOE would perform another similar analysis when the subsurface soil remediation work is in progress (and when surface soil and streambed sediment remediation is in progress, if that work is done in Phase 1) to confirm the results of the preliminary ALARA evaluation. This second, more-detailed analysis would use updated information and consider other factors such as other societal and socioeconomic considerations and costs related to transportation of additional waste.

Initiation and Completion Dates

Subject to the decision in the Record of Decision for the Decommissioning EIS, expected in 2009, and upon NRC approval of this plan, DOE would begin Phase 1 of the proposed decommissioning in 2011 and it would last until 2018.

Post-Remediation Activities

The proposed post remediation activities fall into two categories: (1) a monitoring and maintenance program and (2) an institutional control program, both of which focus on the project premises.

The monitoring and maintenance program would continue until Phase 2 of the decommissioning starts, when it would be reevaluated. It would include an environmental monitoring program tailored to conditions that would exist at the conclusion of the Phase 1 decommissioning activities. This program would monitor onsite groundwater, storm water, and air, along with onsite and offsite surface water, sediment, and radiation. Groundwater monitoring would be accomplished using approximately 36 monitoring wells.

The monitoring and maintenance program would also ensure that important facilities and systems serve their intended purposes during the period between the completion of Phase 1 of the decommissioning and the start of Phase 2. Facilities and systems within the scope of this program include:

- The subsurface hydraulic barrier wall and French drain to be installed during Phase 1 on the north and east sides of the excavation for removal of the Waste Management Area 1 facilities,
- The subsurface hydraulic barrier wall to be installed during Phase 1 on the northwest and northeast sides of the excavation for removal of key Waste Management Area 2 facilities,
- The tank and vault drying system for the underground waste tanks that is to be installed before Phase 1 of the decommissioning,
- The dewatering well used to minimize in-leakage into the underground waste tank vaults,
- The hydraulic barrier wall and geomembrane cover for the NRC-Licensed Disposal Area, and
- The security features and monitoring systems installed for the new Canister Interim Storage Facility to be established on the south plateau.

Performance of the hydraulic barrier walls would be assessed with hydraulic monitoring piezometers.

Insofar as institutional controls are concerned, DOE would continue control of the project premises during the Phase 1 decommissioning activities and the period between completion of these activities and the start of Phase 2 of the decommissioning. Institutional controls would include security fences and signs along the perimeter of the project premises, a full-time security force, provisions for controlled access through designated gateways, and appropriate security measures for the new Canister Interim Storage Facility on the south plateau, which would be established during Phase 1 of the decommissioning.

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4.2 Radiological Status of Environmental Media

Section 4.2 describes the radiological status of surface soil, sediment, subsurface soil, surface water, and groundwater within the project premises as compared with background.

> NOTE
>
> Environmental media have not been fully characterized and, as a result, certain information normally included in decommissioning plans is not available. Additional characterization is planned in connection with the Phase 1 decommissioning work as described in Sections 7 and 9.
>
> Additional characterization of subsurface soil was performed in 2008. This characterization focused on hazardous contaminants and radionuclides in the area of the north plateau groundwater plume (Michalczak 2007). DOE plans to provide a copy of the summary report of this characterization program to NRC and other involved agencies and to revise this plan to incorporate key data from this program.
>
> The information provided below represents a compilation of environmental radiological data collected as part of the routine WVDP Environmental Monitoring and Groundwater Monitoring programs. It also includes data from nonroutine investigations designed to satisfy regulatory requirements (e.g., RCRA facility investigations) and other focused sampling activities.
>
> Section 2.3 contains information on documented spills of radioactivity that have impacted environmental media on the project premises. These spills include the 1968 airborne radioactivity releases that produced the widespread area of surface contamination northeast of the Process Building known as the cesium prong and the release of radioactive acid under the southwest corner of the Process Building that resulted in the area of subsurface soil and groundwater contamination known today as the north plateau groundwater plume. This section focuses on environmental media conditions that exist today and duplicates information in Section 2.3 only where necessary for clarity.

Information in Section 4.2 is organized as follows:

- Section 4.2.1 identifies data sources used for this evaluation.
- Section 4.2.2 summarizes background levels of (1) radionuclide concentrations in surface soil, subsurface soil, stream sediment, surface water, and groundwater; and (2) environmental radiation.
- Section 4.2.3 summarizes radiological status of surface soil and sediment within the project premises.
- Section 4.2.4 provides the same information on subsurface soil.
- Section 4.2.5 summarizes maximum radionuclide concentrations at locations in each WMA where background levels were exceeded in soil, sediment, and subsurface soil.

- Section 4.2.6 provides information on environmental radiation levels on the project premises.
- Section 4.2.7 provides information on the radiological status of surface water on the project premises.
- Section 4.2.8 addresses the radiological status of groundwater on the project premises and, in particular, the north plateau groundwater plume.

Appendix B, *Environmental Radioactivity Data*, provides the following information:

- A description of how background radionuclide concentrations and environmental radiation levels were estimated;
- Maps showing locations where background data were taken;
- Summary statistics applicable to each medium;
- A description of how data from onsite sampling programs were evaluated to determine if radiological concentrations or environmental radiation levels were above background;
- Tables summarizing the ratios of above-background concentrations of radionuclides with Cs-137 in surface soil, sediment, and subsurface soil;
- Additional summary information about radiological concentrations from routine onsite sampling locations;
- Descriptions of both impacted and non-impacted locations; and
- Tables that list the coordinates and descriptions of groundwater sampling locations, along with the depths and geologic units at which samples were collected.

4.2.1 Data Sources

Radiological data on surface soil, sediment, subsurface soil, surface water, groundwater, and environmental radiation levels were taken from the WVDP Laboratory Information Management System controlled database, which contains environmental data from 1991 through the present. This system is used to manage data from the WVDP Environmental Monitoring and Groundwater Monitoring Programs, as well as data from special sampling activities (e.g., RCRA facility investigations, north plateau groundwater plume investigations).

If necessary (i.e., if only pre-1991 data were available for an area), data were drawn from historical sources or summaries included in reports from previous evaluations.

Previous Evaluations

Radiological data from environmental media have been presented in formal reports, for example:

(1) WVDP Annual Site Environmental Reports (years 1982 through 2007 available on the Internet at www.wv.doe.gov);

(2) Groundwater trend analysis reports;

(3) Reports of RCRA facility investigations of various areas of the WVDP (WVNSCO 1995, WVNSCO 1996, WVNSCO 1997a, WVNSCO 1997b, WVNSCO and Dames & Moore [D&M] 1996a, WVNSCO and D&M 1996b, WVNSCO and D&M 1997a, WVNSCO and D&M 1997b, and WVNSCO and D&M 1997c); and

(4) Results from north plateau groundwater plume investigations (Carpenter and Hemann 1995, WVNSCO 1998, URS 2002, and Klenk 2009). The RCRA Facility Investigations and the north plateau investigations produced a substantial body of soil characterization data, most associated with nonradiological constituents.

Data Quality

WVDP environmental samples evaluated in this plan were collected in accordance with formal sampling plans. Samples were analyzed by onsite and offsite laboratories in accordance with controlled procedures as required by the WVDP quality assurance (QA) program. QA requirements applicable to the sampling programs include documented training of field personnel; controlled collection procedures; using appropriate containers, preservatives, and storage methods to protect samples from contamination and degradation; following appropriate field and analytical quality control guidelines; maintaining and documenting chain-of-custody; and conducting assessments and audits of field and analytical processes to verify compliance.

Data were validated by a separate data validation group, and validation and approval status of sample results were documented in the LIMS.

4.2.2 Background Levels

This subsection addresses background radioactivity in environmental media on the project premises and provides information on background radiation levels.

Background Radionuclide Concentrations in Environmental Media

Radionuclides for which backgrounds were estimated were selected with consideration of (1) radionuclides of interest from the Facility Characterization Project, listed in section 4.1.1, and (2) radionuclides that are routinely monitored in environmental media at the WVDP, for which sufficient data were available to develop a reliable estimate of background.

Background radionuclide concentrations were estimated for soil, sediment, subsurface soil, surface water, and groundwater for the following radionuclides:

Sr-90	U-232	U-235/236	Pu-238	Am-241
Cs-137	U-233/234	U-238	Pu-239/240	

Pu-241, Cm-243, Cm-244, and Np-237, which are radionuclides of interest in the Facility Characterization Project, are not routinely measured in environmental media at the WVDP so were not included in background estimates.

In addition, background concentrations were estimated for surface water and groundwater for the following nuclides that were not routinely analyzed in soil and sediment:

H-3 C-14 Tc-99 I-129

Although tritium (H-3) is not identified in Section 4.1.1 as a radionuclide of interest, it is commonly found in surface water and groundwater samples at the WVDP and so was included in the nuclide listing for environmental media. In addition, gross alpha and gross beta measurements are routinely used as screening (i.e., “surrogate” or “indicator”) parameters for other nuclides, so background concentrations were estimated for gross alpha and gross beta activity. (For instance, gross beta measurements are used as a surrogate for Sr-90 measurements in the WVDP Groundwater Monitoring Program.)

Appendix B provides maps showing locations from which background data were taken and a description of how background concentrations were estimated. Appendix B also includes a table of summary statistics (e.g., number of samples, percentage of nondetect values, average concentrations, medians) for each constituent in each medium.[9] Median and maximum background concentrations are summarized in Table 4-11.

Table 4-11. Median and Maximum(1) Background Concentrations for Environmental Media at the WVDP

Constituent	Surface soil (pCi/g dry)	Subsurface soil (pCi/g dry)(2)	Sediment (pCi/g dry)	Surface water (pCi/L)	Groundwater (pCi/L)
Gross alpha	1.3E+01 (2.7E+01)	1.3E+01 (1.7E+01)	9.2E+00 (2.2E+01)	<9.6E-01 (5.4E+00)	<2.6E+00 (2.2E+01)
Gross beta	2.0E+01 (4.0E+01)	2.9E+01 (6.1E+01)	1.6E+01 (2.7E+01)	2.3E+00 (2.0E+01)	4.6E+00 (2.8E+01)
H-3	NA	NA	NA	<8.2E+01 (6.3E+02)	<8.6E+01 (9.4E+02)
C-14	NA	NA	NA	<1.3E+01 (4.1E+02)	<2.7E+01 (7.4E+00)
Sr-90	9.5E-02 (3.1E+00)	<2.3E-02 (1.2E-01)	<3.4E-02 (1.6E-01)	9.0E-01 (1.2E+01)	2.4E+00 (7.4E+00)
Tc-99	NA	NA	NA	<1.8E+00 (7.3E+00)	<1.8E+00 (4.0E+00)
I-129	NA	NA	NA	<7.9E-01 (2.0E+00)	<6.0E-01 (1.6E+00)
Cs-137	4.2E-01 (1.2E+00)	<2.4E-02 (1.5E-01)	3.8E-02 (7.8E-02)	<4.2E+00 (1.0E+01)	<2.2E+01 (1.9E+01)

[9] Note that if a data set is symmetric, the average (i.e., mean) and the median will be the same. However, if the distribution is skewed to the right (i.e., contains a large number of low values and a few high values), the average will usually be higher than the median. For this reason, the median may be the more reliable estimator of central tendency. In this evaluation, both were estimated and are presented in Appendix B.

Table 4-11. Median and Maximum[(1)] Background Concentrations for Environmental Media at the WVDP

Constituent	Surface soil (pCi/g dry)	Subsurface soil (pCi/g dry)[(2)]	Sediment (pCi/g dry)	Surface water (pCi/L)	Groundwater (pCi/L)
U-232	<2.4E-02 (1.9E-02)	<2.4E-02 (<4.2E-02)	<3.1E-02 (3.9E-02)	<4.3E-02 (2.6E-01)	<4.9E-02 (3.8E-01)
U-233/234	7.9E-01 (9.4E-01)	7.9E-01 (1.1E+00)	6.6E-01 (8.6E-01)	9.9E-02 (3.0E-01)	1.6E-01 (8.2E+00)
U-235/236	5.2E-02 (2.2E-01)	4.2E-02 (1.2E-01)	4.6E-02 (2.8E-01)	<3.3E-02 (1.0E-01)	<5.0E-02 (1.9E-01)
U-238	7.9E-01 (9.3E-01)	8.6E-01 (1.1E+00)	6.5E-01 (9.0E-01)	5.7E-02 (4.0E-01)	1.2E-01 (5.3E+00)
Pu-238	<1.2E-02 (4.0E-02)	<1.2E-02 (<2.4E-02)	<1.4E-02 (1.3E-01)	<3.1E-02 (1.0E-01)	<4.6E-02 (2.2E-01)
Pu-239/240	1.6E-02 (2.3E-01)	<1.0E-02 (<1.9E-02)	<1.2E-02 (6.1E-02)	<2.7E-02 (2.0E-01)	<5.3E-02 (2.7E-01)
Am-241	<1.6E-02 (1.9E-01)	<1.1E-02 (<1.3E-02)	<1.4E-02 (8.6E-02)	<3.3E-02 (2.2E+00)	<3.8E-02 (1.8E-01)

NOTE: (1) Maxima are in parentheses. Maxima were selected from samples in which the radionuclide was detected (i.e., a "nondetect" result, indicated by a "<" sign, was used only if no detectable results were available).

(2) This column was added after sufficient background soil samples were collected in 2008 to allow for comparison purposes.

LEGEND: NA = Not analyzed in this medium

Data on radionuclide concentrations in environmental media on the project premises were evaluated to determine the locations where radionuclide concentrations in excess of site background levels were found. Methods for evaluating sample data with respect to background were dependent on the type of data available for comparison (e.g., a single sample result, a data set encompassing several years). Methods for each are described in Appendix B.

Data evaluated in Section 4.2 were taken from samples collected over several years. While the majority of data points were from 1991 through the present, the earliest was from a sample collected in 1967.[10] In Section 4.1, radionuclide activities in facilities on the project premises were decay-corrected to the year 2011. However, in Section 4.2 no attempt was made to decay-correct results from environmental samples because, unlike process cells or tanks, environmental media are not closed, static systems.

Media such as surface soil, sediment, subsurface soil, surface water, and groundwater are all subject to forces (aside from radioactive decay) with the potential to modify their

[10] Note that historical and current data, which were generated over more than 40 years of NFS and WVDP operations, may not be directly comparable because different sampling and analytical methodologies have been used over the years. Historical and current data were compared with background concentrations using different statistical methods, as described in Appendix B.

radionuclide concentrations. Forces such as weathering, biological activity, atmospheric fallout, surface water runoff, wind erosion, and evaporation may act to deposit or remove radionuclides from a medium. Also, radionuclides are affected differentially by these mechanisms (e.g., Sr-90 is more mobile in water than Cs-137, which is more likely to bind to clay particles in soil and sediment).

Many of the radionuclides considered in this section are long-lived and it is unlikely that decay-correction would have affected the determination of whether or not background concentrations were exceeded. However, it is possible that estimates of radiological concentrations of the shorter-lived radionuclides (i.e., tritium [half-life of 12.3 years], Sr-90 [half-life of 28.9 years], and Cs-137 [half-life of 30 years]) are conservatively high, that is, overestimates.

Background Environmental Radiation Levels

Radiation levels have been measured at the WVDP from 1986 through the present with a network of environmental thermoluminescent dosimeters (TLDs).[11] Average quarterly exposure measurements from four background locations over this time period was 19.3 mR per quarter (about 8.8E-03 mR/h). The maximum for any single quarter was 35 mR/quarter (about 1.6E-02 mR/h).

Background environmental radiation levels were used to evaluate measurements from onsite TLDs near process facilities, waste storage areas, and burial areas. (See Appendix B for a map showing the locations of background TLDs. See section 4.2.6 for a discussion of onsite exposure measurements.)

4.2.3 Radiological Status of Surface Soil and Sediment

Since the facility has operated, numerous soil sampling studies have been conducted on site, not as part of a formal site-wide soil program, but rather as area-specific investigations in response to specific circumstances or events (WVNSCO 1994). In 1993, a site-wide soil sampling program was conducted to obtain additional data to support the EIS and RCRA processes. As part of this program, surface soil, sediment, and subsurface soil samples were collected. Results were summarized in WVNSCO 1994.

NUREG-1757 (NRC 2006) defines surface soil as the soil within the top 15 to 30 cm (six to 12 inches) of the soil column. That definition has been broadened in this plan to include soil within the top 60 cm (0 to two feet) of the soil column. This was done so that available data from the top interval (0 to two-foot depth) from onsite soil-borings collected as part of the 1993 program could be used to assess the radiological status of surface soil. Data from the subsurface portions of the boreholes (i.e., at depths greater than two feet) are discussed in section 4.2.5.

[11] While radiation levels were measured at the WVDP prior to 1986, the current methodology has been used only since 1986. Therefore, for comparability, only data generated from 1986 through the present were used in the background calculation.

Areas With Radionuclide Concentrations in Excess of Site Background Levels

Figure 4-6 shows locations at which radiological concentrations exceeding background were noted in surface soil and sediment for (1) gross alpha or alpha-emitting radionuclides and (2) gross beta or beta-gamma emitting radionuclides.[12]

- The highest radionuclide concentrations were found in sediment from the lagoons in the WMA 2 Low-Level Waste Treatment Facility. See Table 4-14 for a listing of maximum radionuclide concentrations above background noted in the lagoon and drainage system. The highest radionuclide concentrations were noted in sediment from Lagoon 2. (Although higher concentrations are listed for Lagoon 1, the Lagoon 1 sediment was transferred to Lagoon 2 when Lagoon 1 was deactivated in 1984.)
- Cs-137 concentrations in excess of background were found in surface soil samples from all waste management areas at which samples had been collected. Although no surface soil data were available from WMA 1 (the Process Building and Vitrification Facility area), it is suspected that radionuclide concentrations in excess of background would be found here based on proximity to the Process Building and the elevated concentrations observed in adjoining WMAs. The highest levels noted in surface soil from other areas (i.e., 2.8E+02 pCi/g in WMA 2 near the Interceptors, 1.6E+02 pCi/g in WMA 6 near the Fuel Receiving and Storage Area and 2.3E+01 pCi/g in WMA 3 near the Waste Tank Farm) were all from areas in closest proximity to WMA 1. Elevated Cs-137 concentrations are thought to be largely attributable to historical releases and continuing low-level airborne releases from the main stack of the Process Building.
- Surface soil concentrations of Sr-90 exceeding background were noted in several areas, most notably in areas affected by the north plateau groundwater plume, such as WMA 2 (the Low-Level Waste Treatment Facility area) and WMA 4 (the area of the Construction and Demolition Debris Landfill).
- Radionuclide concentrations exceeding background, primarily from Sr-90 and Cs-137, were found in sediment samples from streams and drainage ditches in several waste management areas (WMAs 2, 4, 5, 6, 7, 10, and 12). Concentrations of alpha-emitting radionuclides (i.e., U-232, Pu-238, Pu-239/240, and/or Am-241) in excess of background were also noted in WMAs 2, 4, 5, 7, and 12 downgradient of liquid release points or waste burial areas.

[12] WMA 12 is not labeled on the figures in this section because it extends to the boundaries of the Center. Areas on the project premises (i.e., within the security fence) that are considered to be part of WMA 12 include (1) the area between the north and south plateaus, which contains much of the drainage for Erdman Brook and Franks Creek, and (2) a small area north of WMA 4.

- High radionuclide concentration levels were also associated with soil and sediment from the area of the Old Interceptors, the Solvent Dike, and inactive (filled-in) Lagoon 1 in WMA 2.
- South plateau areas with radionuclide concentrations exceeding background in surface soil include the two former shallow land burial disposal facilities, the NDA (WMA 7) and SDA (WMA 8). Elevated radiological concentrations in the surface and near-surface soils in the vicinities of those facilities is expected due to the nature of their operations. (As noted previously, WMA 8 is not within plan scope.)

Levels at which radionuclide concentrations in excess of background were found in surface soil and sediment are listed by WMA in the tables in section 4.2.5. As shown in Figure 4-6, only one surface soil sampling location (SS-11) had no concentrations exceeding background. All sediment sampling locations had at least one constituent exceeding background.

4.2.4 Radiological Status of Subsurface Soil

Figure 4-7 shows locations at which concentrations of radiological constituents above background were noted in subsurface soil for (1) alpha-emitting radionuclides and (2) beta-gamma emitting radionuclides.

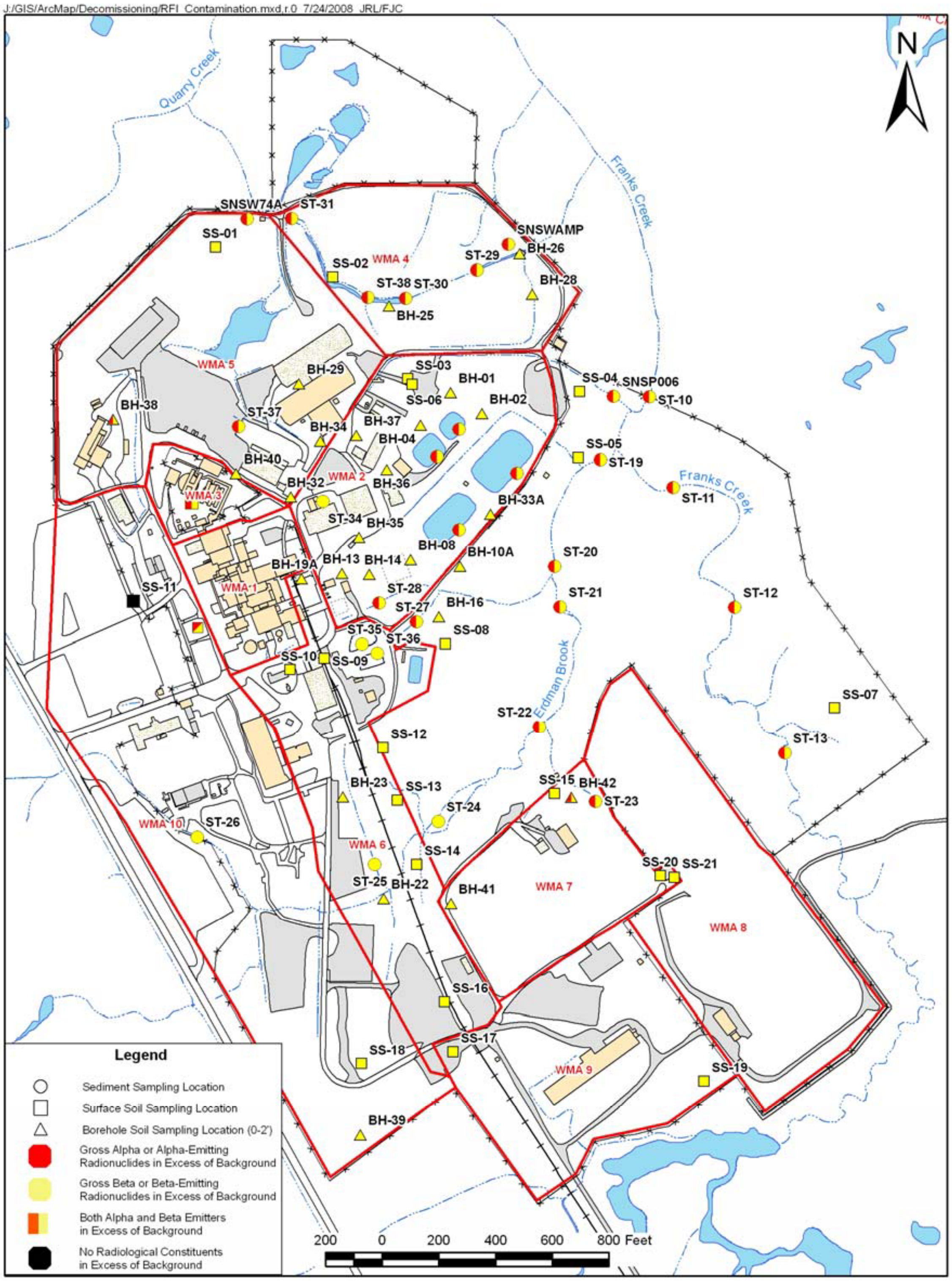

Figure 4-6. Surface Soil and Sediment Locations With Radionuclide Concentrations in Excess of Background

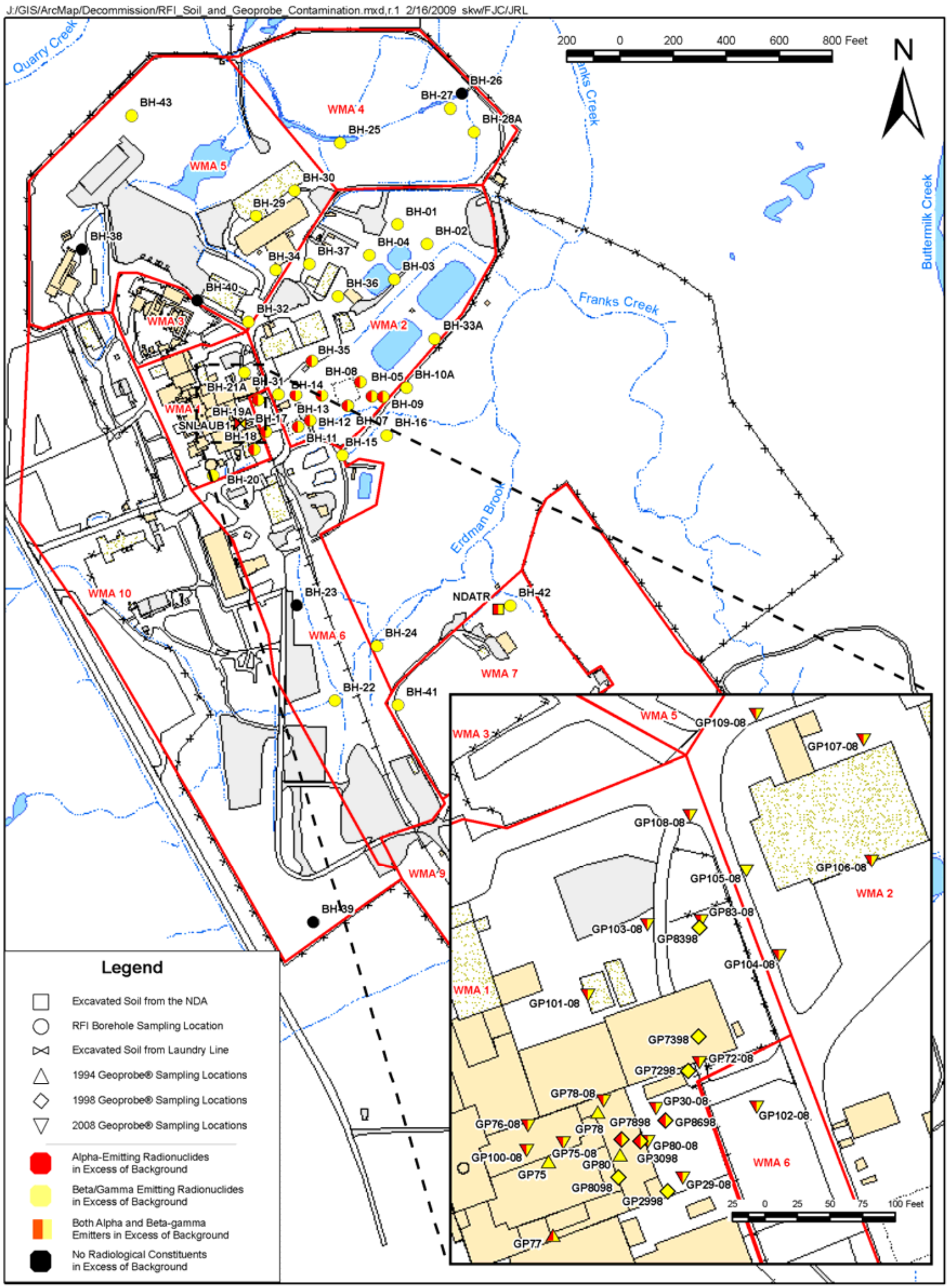

Figure 4-7. Subsurface Soil Locations With Radionuclide Concentrations in Excess of Background

Most subsurface soil data were taken from the 1993 RCRA Facility Investigation sampling program and three Geoprobe® sampling efforts (1994, 1998, and 2008) to better define the origin and extent of the north plateau groundwater plume.

The highest subsurface radiological concentrations on the north plateau were observed in WMA 1 (the Process Building and Vitrification Facility area), WMA 2 (the Low-Level Waste Treatment Facility area), and WMA 6 (the Central Project Premises), downgradient of the Process Building. On the south plateau, highest concentrations were from WMA 7 (the NDA). Subsurface soil concentrations exceeding background were primarily associated with the north plateau groundwater plume (see Section 2) or with former waste processing or burial activities. Figure 4-8 presents a cross-section of Sr-90 concentrations in subsurface soil with depth in the north plateau below the Process Building. Data from this cross-section were taken from samples collected in 1993, 1994, 1998, and 2008 from WMAs 1, 2, and 6. The highest concentrations of Sr-90 were observed in the sand and gravel unit below the water table.

In WMA 1, high levels of Sr-90 were measured during the Geoprobe® investigations near the Process Building. In WMA 2, the highest levels of both beta-gamma and alpha-emitting radionuclides in subsurface soil were observed in sediments from borings taken near the Solvent Dike, the interceptors, and the Maintenance Shop leach field. In WMA 6, elevated subsurface soil concentrations were noted near the Utility Room and the Fuel Receiving and Storage Building. Data from WMA 7 were taken from rolloffs and boxes of excavated soil removed from "special holes" during NDA burial activities and from the Interceptor Trench, immediately downgradient of the NDA, when it was installed in 1990. Although the packaged soil has since been shipped offsite, it is likely that radionuclide concentrations in subsurface soil remaining in the NDA would be similar to those from the excavated soil.

Concentrations of radionuclides observed in excess of background levels in subsurface soils are summarized in Section 4.2.5.

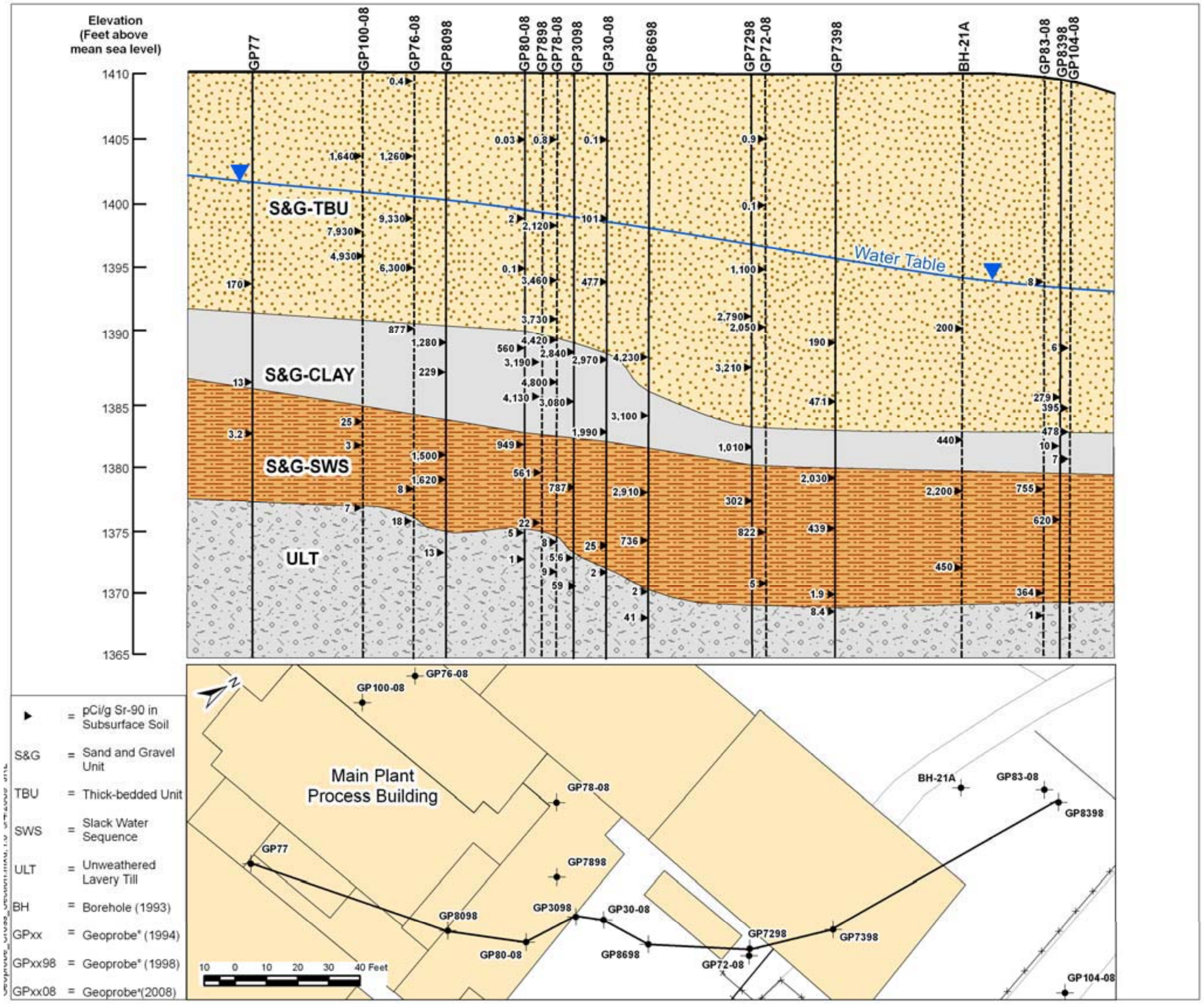

Figure 4-8. Cross-section of Sr-90 Concentrations Versus Depth in Subsurface Soil in WMA 1

4.2.5 Radionuclide Concentrations Exceeding Background in Surface Soil, Sediment, and Subsurface Soil By WMA

The following tables summarize locations in each WMA where radionuclide concentrations were noted in excess of background. (See Table 4-11 and Appendix B for background radionuclide concentrations used to evaluate soil, sediment, and subsurface soil.) Data from surface soil, sediment, and subsurface soil are combined into one table for each WMA, except for WMA 2, where data are presented in three tables due to the large volume of information.

For each area, the maximum concentration at which the radionuclide was found is listed, together with source and location (i.e., reference or specific sample identifier). Identifiers from the 1993 RCRA Facility Investigation sampling program are specified as boreholes ("BH-"), surface soil ("SS-") or stream sediment ("ST-"). Subsurface Geoprobe® soil sample locations are designated "GP." For subsurface soil, the depth at which the maximum was noted (if available) is also provided. Gross alpha and gross beta measurements are not presented because the measurements represent a mix of radionuclides (including those naturally occurring), and because data for specific alpha- and beta-emitting radionuclides were available. Ratios of above-background radionuclide concentrations to Cs-137 are presented in Appendix B in Tables B-9 (Surface Soil), B-10 (Sediment), and B-11 (Subsurface Soil).

WMA 1, Process Building and Vitrification Facility Area

Limited data are available for WMA 1, none for surface soil or sediment. Most subsurface soil data were taken from the Geoprobe® Investigations in 1994, 1998, and 2008 and from three borehole locations from the 1993 RCRA Facility Investigation. Additional data were taken from one sample collected in 2004 near a breach in an underground wastewater line near the laundry.

Above-background concentrations in subsurface soil from WMA 1 were noted for Sr-90, Cs-137, U-232, U-233/234, U-235/236, U-238, Pu-238, Pu-239/240, and Am-241. Maximum radionuclide concentrations are listed in Table 4-12. Except for the Cs-137 and Am-241 maxima observed from the sample near the laundry line breach, all maxima were from samples taken in 2008 under the Process Building. Maxima from Geoprobe® locations were found at depths of 14 to 42 feet in the saturated layer of the sand and gravel unit. High ratios of Sr-90 to Cs-137 observed in WMA 1 (with a median ratio of about 300 to 1 and a maximum ratio of over 63,000 to 1 [see Table B-11 in Appendix B]) reflect the influence of the north plateau groundwater plume. Maximum ratios of other nuclides to Cs-137 in WMA 1 were: U-232 (0.023 to 1), U-233/234 (12 to 1), U-235/236 (1.1 to 1), U-238 (18 to 1), Pu-238 (0.18 to 1), Pu-239/240 (0.80 to 1) and Am-241 (2.7 to 1).

Table 4-12. Above-Background Concentrations of Radionuclides in Subsurface Soil at WMA 1(1)

Location	Maximum Concentration (pCi/g dry)								
	Cs-137	Sr-90	U-232	U-233/ 234	U-235/ 236	U-238	Pu-238	Pu-239/ 240	Am-241
Note (2)	3.3E+03	9.3E+03	5.0E-02	1.9E+00	2.2E-01	1.7E+00	5.6E-01	3.7E+00	8.7E+01

NOTES: (1) See Figure 4-2 for a map of facilities in WMA 1.

(2) Sampling related to laundry line breach in 2004 (Cs-137, Am-241); Geoprobe® sampling underneath Process Building in 2008 (GP7608 at 15-17' depth [Sr-90]; GP10408 at 20-22' depth [U-232]; GP7608 at 38-40' depth [U-233/234]; GP8308 at 40-42' depth [U-235/236]; GP2908 at 14-16' depth [U-238], GP7608 at 19-21' depth [Pu-238, Pu-239/240].

WMA 2, Low-Level Waste Treatment Facility Area

Extensive data, available both electronically and from historical reports, were available for WMA 2. The maximum concentrations observed at each location within WMA 2 are listed below. Due to the large volume, data are presented in three tables: Table 4-13 (surface soil), Table 4-14 (sediment), and Table 4-15 (subsurface soil).

The radionuclides observed above background in surface soil (Table 4-13) were Cs-137 and Sr-90. The maximum ratio of Sr-90 to Cs-137 (about 1.4 to 1) was observed in surface soil north of Lagoons 4 and 5, which is affected by the north plateau groundwater plume. No alpha-emitting radionuclides were observed at concentrations above background in surface soil from WMA 2.

Table 4-13. Above-Background Concentrations of Radionuclides in Surface Soil From WMA 2(1)

Location	Maximum Concentration (pCi/g dry)	
	Cs-137	Sr-90
Surface soil near the Old and New Interceptors (BH-13)	2.8E+02	4.1E+00
Surface soil between the Interceptors and inactive Lagoon 1 (WVNSCO 1994 [Table 3-2] and BH-14)	1.4E+01	1.4E+00
Surface soil between inactive Lagoon 1 and active Lagoon 2 (BH-08)	4.8E+00	1.1E+00
Surface soil from Maintenance Shop Leach Field (WVNSCO 1994 [Table 3-2] and BH-35)	2.1E+01	1.3E+00
Surface soil near the LLW2 Facility (BH-36)	≤Bkg	3.2E-01
Surface soil near the Vitrification Test Facility (BH-37)	6.6E-01	≤Bkg
Surface soil north of Lagoons 4 and 5 (BH-04)	8.5E-01	1.2E+00

Table 4-13. Above-Background Concentrations of Radionuclides in Surface Soil From WMA 2[1]

Location	Maximum Concentration (pCi/g dry)	
	Cs-137	Sr-90
Surface soil between the lagoons and WMA 4 (SS-03, SS-06)	3.6E+00	3.6E-01
Surface soil between the road and Lagoon 2 (BH-33A)	8.9E-01	≤Bkg

LEGEND: "≤Bkg" = Background was not exceeded.

NOTE: (1) See Figure 4-3 for a map of facilities in WMA 2. Facilities not labeled in Fig. 4-3 include the former Maintenance Shop (which was located southwest of the LLW2 Facility), and the Vitrification Test Facility (located northwest of the LLW2 Facility). See Figure 4-6 for a map with the above sampling locations.

Radionuclides observed above background in sediment (Table 4-14) were Cs-137, Sr-90, U-232, U-233/234, U-235/236, U-238, Pu-238, Pu-239/240, and Am-241. Maximum ratios to Cs-137 for each were: Sr-90 (144 to 1), U-232 (0.0054 to 1), U-233/234 (0.056 to 1), U-235/236 (0.011 to 1), U-238 (0.057 to 1), Pu-238 (0.018 to 1), Pu-239/240 (0.019 to 1), and Am-241 (4.2 to 1). (See Appendix B, Table B-10, for a summary of radionuclide ratios in sediment from WMA 2.)

Maximum ratios to Cs-137 were found in sediment from (or downgradient of) the Solvent Dike (Sr-90, U-233/234, U-235/236, Pu-239/240, and Am-241), sediment from Lagoon 3 (U-232 and U-238), and sediment from the Lagoon 2 shoreline (Pu-238). The highest Am-241 to Cs-137 ratio (4.2 to 1) was from one Solvent Dike sediment sample collected in 1986. For comparison, the median Am-241 to Cs-137 ratio in WMA 2 was 0.0019 to 1.

Table 4-14. Above-Background Concentrations of Radionuclides in Sediment From WMA 2

Location	Maximum Concentration (pCi/g dry)								
	Cs-137	Sr-90	U-232	U-233/ 234	U-235/ 236	U-238	Pu-238	Pu-239/ 240	Am-241
Sediment from drainage north of Test and Storage Building (ST-34)	2.0E+00	3.5E-01	NA	NA	NA	NA	NA	NA	NA
Sediment from Solvent Dike (WVNSCO 1994, Table 3-12, 1986 samples)	3.1E+02	1.6E+03	NA	NA	NA	NA	NA	NA	1.1E+03
Sediment from drainage downgradient of Solvent Dike (ST-28)	1.7E+01	2.9E+00	≤Bkg	9.5E-01	≤Bkg	≤Bkg	2.9E-01	3.2E-01	7.1E-01
Sediment from Lagoon 1 (Passuite and Monsalve-Jones 1993, Tables 3-2 [1982 data] and 3-3 [1984 data])	4.7E+05	1.5E+05	NA	NA	NA	NA	3.9E+04	1.8E+04	1.9E+04

Table 4-14. Above-Background Concentrations of Radionuclides in Sediment From WMA 2

Location	Maximum Concentration (pCi/g dry)								
	Cs-137	Sr-90	U-232	U-233/ 234	U-235/ 236	U-238	Pu-238	Pu-239/ 240	Am-241
Sediment from Lagoon 2(1) (WVNSCO 1994, Tables 3-5 [1982 data] and 3-8 [1990 data])	2.7E+05	3.6E+04	NA	NA	6.5E-01	6.2E+00	8.0E+02	6.4E+02	8.3E+02
Sediment from Lagoon 3 (WVNSCO 1994, Tables 3-11 [1990 data], 3-9 [1967 data]; and 1994 Lagoon 3 sampling)	1.1E+04	7.7E+02	7.6E+00	4.5E+00	1.3E+00	8.8E+00	3.1E+00	1.4E+00	5.1E+00
Sediment from Lagoon 4 (1994 sampling)	3.2E+01	7.3E+00	NA	NA	NA	NA	NA	NA	NA
Sediment from Lagoon 5 (1994 sampling)	5.2E+01	4.1E+01	NA	NA	NA	NA	NA	NA	NA

NOTE: (1) In 1984, an estimated 22,400 cubic feet of sediment were pumped from Lagoon 1 to Lagoon 2 (Passuite and Monsalve-Jones 1993) so the 1982 sample results are not necessarily representative of the of the activity in Lagoon 2 sediment.

(2) See Figure 4-3 for a map of facilities in WMA 2. The Test and Storage Building (which was located near the southwestern boundary of WMA 2) is not labeled in Fig. 4-3. See Figure 4-6 for a map with the above sampling locations.

LEGEND: NA = No analysis. "≤Bkg" = Background was not exceeded.

Above-background concentrations in subsurface soil from WMA 2 were noted for Sr-90, Cs-137, U-232, U-233/234, U-235/236, U-238, Pu-238, Pu-239/240, and Am-241. Maximum radionuclide concentrations at various points in WMA 2 are listed in Table 4-15. The highest concentrations of all nuclides were found in saturated soil six-to-eight feet deep from one location (BH-8) downgradient of Lagoon 1. Other maxima were also found in samples taken under the solvent dike and downgradient of the interceptors in saturated soil in the sand and gravel unit.

As noted in the WMA 1 discussion, ratios of Sr-90 to Cs-137 were also elevated in WMA 2, downgradient of the source of the north plateau plume. However, ratios were much lower than in WMA 1 (i.e., a median ratio of 1.9 to 1 and a maximum of 750 to 1 [as compared with the median of about 300 to 1 and the maximum of over 63,000 to 1 in WMA 1). Maximum ratios of other nuclides to Cs-137 in WMA 2, as summarized in Table B-11, were: U-232 (1 to 1), U-233/234 (7 to 1), U-235/236 (1.1 to 1), U-238 (4.4 to 1), Pu-238 (0.089 to 1), Pu-239/240 (0.11 to 1) and Am-241 (0.23 to 1).

Table 4-15. Above-Background Concentrations of Radionuclides in Subsurface Soil From WMA 2[(1)]

Location	Maximum Concentration (pCi/g dry)								
	Cs-137	Sr-90	U-232	U-233/ 234	U-235/ 236	U-238	Pu-238	Pu-239/ 240	Am-241
Downgradient of inactive Lagoon 1 (BH-08 at 6-8' depth)	3.6E+04	1.5E+04	5.8E+02	2.7E+02	4.2E+00	6.8E+01	6.8E+02	1.2E+03	1.7E+03
Near Solvent Dike (BH-11 at 8-10' depth, Cs-137 max at 2-4' depth)	1.8E+02	5.6E+01	≤Bkg	3.6E+00	5.3E-01	2.2E+00	≤Bkg	7.5E-02	1.1E-01
Near the Old and New Interceptors (BH-13, 8-10' depth, U-238 max at 6-8' depth)	5.2E+03	1.9E+02	5.1E+01	2.4E+01	2.0E-01	3.7E+00	6.6E+01	5.1E+01	5.3E+01
Between the Interceptors and inactive Lagoon 1 (BH-14 at 4-6' depth, Pu-238 at 14-16' depth)	6.1E+00	2.8E+01	1.0E-01	≤Bkg	≤Bkg	≤Bkg	1.7E-01	1.9E-01	2.8E-01
East of the former TSB (BH-35, 6-8' depth)	1.6E+01	3.9E+02	1.3E+00	≤Bkg	≤Bkg	≤Bkg	4.6E-01	7.4E-02	1.3E+00
Downgradient of MPPB, near the former TSB [GP10508, 28-30' depth)	≤Bkg	7.6E+02	≤Bkg	≤Bkg	≤Bkg	≤Bkg	≤Bkg	≤Bkg	≤Bkg
Downgradient of MPPB, south of the former Maintenance Shop (GP10608, at 20-22' depth [Sr-90] and at 22-24' depth [Am-241, U isotopes])	≤Bkg	6.6E+01	≤Bkg	9.0E-01	2.2E-01	≤Bkg	≤Bkg	≤Bkg	3.4E-02
Downgradient of MPPB, near Vit Test Facility (GP10708, at 30-32' depth [Sr-90] and at 12-14' depth [U-235/236])	≤Bkg	3.8E+02	≤Bkg	≤Bkg	1.9E-01	≤Bkg	≤Bkg	≤Bkg	≤Bkg
Downgradient of MPPB, near area of the leach field for the former Maintenance Shop (GP10908, at 34-36' depth [Sr-90], and at 36-38' depth [U-232, U-238])	≤Bkg	2.3E+02	1.3E-01	≤Bkg	≤Bkg	1.0E+00	≤Bkg	≤Bkg	≤Bkg

NOTE: (1) See Figure 4-3 for a map of facilities in WMA 2. Facilities not labeled in Figure 4-3 include the former Maintenance Shop (which was located southwest of the LLW2 Facility), and the Vitrification Test Facility (located northwest of the LLW2 Facility). See Figure 4-7 for a map with the above sampling locations.

LEGEND: "≤Bkg" = Background was not exceeded. MPPB = Main Plant Process Building. TSB = Test and Storage Building.

WMA 3. High-level Waste Tank Farm

Minimal data were available for the Waste Tank Farm. Table 4-16 lists maximum concentrations of radionuclides found in surface soil at levels above background. Data were from a 1990 sampling, as summarized in Table 3-2 of WVNSCO 1994. Concentrations in excess of background levels were noted for Cs-137, U-238, and Am-241. The ratios of U-238 and Am-241 to Cs-137 in surface soil from the Waste Tank Farm were 0.047, and 0.011, respectively. No sediment or subsurface soil data were available, although subsurface soil concentrations exceeding background are expected because of leaks or breaches in transfer lines (see Section 2) and because of elevated radionuclide concentrations found in groundwater as discussed below.

Table 4-16. Above-Background Concentrations of Radionuclides in Surface Soil at WMA 3(1)

Location	Maximum Concentration (pCi/g dry)		
	Cs-137	U-238	Am-241
Surface soil at the Waste Tank Farm (WVNSCO 1994, Table 3-2 [1990 data])	2.3E+01	1.1E+00	2.5E-01

NOTE: (1) See Figure 4-4 for a map of facilities in WMA 3 and Figure 4-6 for a map showing areas with above-background levels of radionuclides in surface soil.

WMA 4, Construction and Demolition Debris Landfill Area

Concentrations of radiological constituents measured at levels in excess of background in surface soil, sediment, and subsurface soil from WMA 4 are listed in Table 4-17. Surface soil from WMA 4, a portion of which includes the landfill, was found to contain concentrations of Cs-137 and Sr-90 in excess of background. The maximum ratio of Sr-90 to Cs-137 in surface soil was about 9.5 to 1.

Table 4-17. Above-Background Concentrations of Radionuclides in Surface Soil, Sediment, and Subsurface Soil From WMA 4(1)

Location	Maximum Concentration (pCi/g dry)						
	Cs-137	Sr-90	U-233/ 234	U-238	Pu-238	Pu-239/ 240	Am-241
Surface soil along drainage though CDDL (SS-02 and WVNSCO 1994, Table 3-2 [1990 data])	9.1E+00	1.2E+01	NA	NA	NA	NA	NA
Sediment from drainage through CDDL (ST-31, ST-38)	7.0E+00	8.4E+01	NA	NA	7.3E-02	7.4E-02	1.3E-01
Sediment from Northeast Swamp drainage (SNSWAMP)	3.1E+01	3.0E+01	1.1E+00	1.1E+00	4.3E-01	6.4E-01	1.3E+00
Subsurface soil in CDDL (BH-27 [Cs-137 max at 2-4'], BH-25 [Sr-90 max at 12-14'])	7.3E-01	4.1E+00	NA	NA	NA	NA	NA

LEGEND: CDDL = Construction and Demolition Debris Landfill; NA = No analysis.

NOTE: (1) See Figures 4-6 and 4-7 for maps showing locations with radionuclide concentrations in excess of background.

The highest radionuclide concentrations in surface soil and sediment were from the northern portion of WMA 6, closest to the Process Building. However, elevated concentrations were also found along the rail spur south of the Sewage Treatment Plant. These elevated concentrations may be attributable to events in the 1960s and 1970s (e.g., increased radioactivity in treated effluents or possible line leaks [see further detail in Section 2.3.2]).

Subsurface soil samples – one from near the Utility Room and one from near the Fuel Receiving and Storage Building – contained Cs-137, Sr-90, Pu-238, Pu-239/240, and Am-241 concentrations exceeding background. The highest concentrations were found near the Fuel Receiving and Storage Building at a depth of 22 to 24 feet in the sand and gravel unit below the water table. (See Figure 4-8.) The maximum concentrations near the Utility Room were from 16 to 18 feet below the surface.

Ratios to Cs-137 for Pu-238, Pu-239/240, and Am-241 were similar for subsurface soil samples taken near the Utility Room and the Fuel Receiving and Storage Building (about 0.03 to 1, 0.04 to 1, and 0.2 to 1, respectively). However, the Sr-90 to Cs-137 ratios for each were strikingly different. Near the Utility Room, the ratio was about 1 to 1, but near the Fuel Receiving and Storage Building the ratio was 133 to 1, suggesting that the Fuel Receiving and Storage Building subsurface location was more central to the north plateau groundwater plume.

Sampling of subsurface soil by Geoprobe® in 2008 south of the Fuel Receiving and Storage Area, close to 1993 sampling locations BH-17 and BH-19A, continued to show above-background concentrations of most nuclides. See Figure 4-7. As with WMA 1 and WMA 2, elevated ratios of Sr-90 to Cs-137 in the “tongue” of WMA 6 lying between WMAs 1 and 2 (with a median of 174 to 1 and a maximum of 1115 to 1) reflected the influence of the north plateau groundwater plume. However, maximum concentrations of Cs-137 and Sr-90 in the subsurface saturated layer were lower than those observed in BH-17 and BH-19A in 1993.

Table 4-19. Above-Background Concentrations of Radionuclides in Surface Soil, Sediment, and Subsurface Soil From WMA 6(1)

Location	Maximum Concentration (pCi/g dry)								
	Cs-137	Sr-90	U-232	U-233/234	U-235/236	U-238	Pu-238	Pu-239/240	Am-241
Surface soil along rail spur south of STP (BH-23, SS-13)	1.8E+00	3.2E-01	NA	NA	NA	NA	NA	NA	NA
Sediment along drainage by rail spur south of STP (ST-25)	2.1E+00	1.3E-01	NA	NA	NA	NA	NA	NA	NA

Table 4-19. Above-Background Concentrations of Radionuclides in Surface Soil, Sediment, and Subsurface Soil From WMA 6(1)

Location	Maximum Concentration (pCi/g dry)								
	Cs-137	Sr-90	U-232	U-233/ 234	U-235/ 236	U-238	Pu-238	Pu-239/ 240	Am-241
Surface soil by FRS (1994 sampling near rail spur)	1.6E+02	1.2E+01	NA	NA	NA	NA	NA	NA	NA
Surface soil by Cooling Tower (SS-10)	1.3E+01	1.4E+00	NA	NA	NA	NA	NA	NA	NA
Surface soil by Old Incinerator (WVNSCO 1994, Table 3-2 [1990 data])	1.9E+01	2.3E+00	NA	NA	NA	NA	NA	NA	NA
Surface soil by Old Warehouse (SS-09)	1.3E+01	9.3E-01	NA	NA	NA	NA	NA	NA	NA
Sediment from North Demineralizer Sludge Pond (WVNSCO 1994 Table 3-18 [1988 data], ST-35)	1.3E+01	7.7E-01	NA	NA	NA	NA	NA	NA	NA
Sediment from South Demineralizer Sludge Pond (WVNSCO 1994 Table 3-19 [1988 data], ST-36)	3.8E+01	3.5E-01	NA	NA	NA	NA	NA	NA	NA
Subsurface soil near the Utility Room (BH-17, 14-16' depth)	2.4E+00	2.7E+00	≤Bkg	≤Bkg	≤Bkg	≤Bkg	6.1E-02	9.7E-02	4.9E-01
Subsurface soil near the FRS (BH-19A, 22-24' depth)	4.3E+00	5.7E+02	≤Bkg	≤Bkg	≤Bkg	≤Bkg	1.5E-01	2.0E-01	8.0E-01
Subsurface soil near rail spur south of the FRS (GP10208, 14-16' depth)	1.1E+00	2.2E+02	9.1E-02	1.3E+00	3.5E-01	1.4E+00	≤Bkg	4.9E-02	1.4E-01

NOTE: (1) See Figure 4-5 for a map showing facilities in the northern portion of WMA 6. See Figures 4-6 and 4-7 for maps showing locations with radionuclide concentrations in excess of background.

LEGEND: NA = Not analyzed. "≤Bkg" = Background was not exceeded. FRS = Fuel Receiving and Storage Building, STP = Sewage Treatment Plant

WMA 7, NDA and Associated Facilities

Concentrations of radiological constituents measured at levels in excess of background in surface soil and sediment from WMA 7 are listed in Table 4-20. Cs-137, Sr-90, and Am-241 were found in concentrations exceeding background in surface soil. Sediment samples collected near the Interceptor Trench contained concentrations of Cs-137, Sr-90, Pu-238, and Am-241 in excess of background. Ratios of Sr-90 to Cs-137 in surface soil ranged from 0.11 to 1 to 8.2 to 1. The Sr-90 to Cs-137 ratio for sediment was about 3.7 to 1. Maximum ratios to Cs-137 for Pu-238, Pu-239/240, and Am-241 in surface soil and sediment were, respectively: 0.096 (sediment), 0.022 (surface soil), and 0.046 (sediment). All were found near the Interceptor Trench.

No concentrations above background were found in boreholes of subsurface soil taken in 1993 at WMA 7. (Note that the two subsurface soil borings done at this location in 1993 were taken from the edges of the burial area, one upgradient of the buried waste and the other on the opposite side of the Interceptor Trench downgradient of the area.) However, analytical results from boxes and rolloffs filled with subsurface soil excavated from "special holes" during burial activities on the NDA or during construction of the Interceptor Trench contained Am-241 concentrations well in excess of background. Ratios of Am-241 to Cs-137 ranged from 0.024 to 0.077 to 1. The excavated soil has been shipped offsite, however, results suggest that subsurface soil remaining in the NDA contains radionuclide concentrations exceeding background.

Table 4-20. Above-Background Concentrations of Radionuclides in Surface Soil, Sediment, and Subsurface Soil at WMA 7[1]

Location	Maximum Concentration (pCi/g dry)				
	Cs-137	Sr-90	Pu-238	Pu-239/ 240	Am-241
Surface soil by the NDA Interceptor Trench (SS-15, BH-42)	4.7E+00	3.3E+00	8.5E-02	9.2E-02	1.5E-01
Surface soil by the NDA Hardstand (SS-20)	6.8E+01	7.7E+00	NA	NA	NA
Surface soil at remainder of NDA (1994 data from special sampling)	3.2E+00	2.1E+01	NA	NA	NA
Sediment from drainage near Interceptor Trench (ST-23)	9.0E-01	3.3E+00	8.6E-02	≤Bkg	4.1E-02
Subsurface soil excavated from "special holes" or Interceptor Trench (1997 sampling of excavated soil in boxes and rolloffs)	3.5E+01	NA	NA	NA	1.8E+00

NOTE: (1) See Figures 4-6 and 4-7 for maps showing locations with radionuclide concentrations in excess of background. Not shown on the map, the Interceptor Trench borders the northeast and northwest boundaries of the NDA. The Trench was installed in 1990 to intercept and collect leaching from the NDA. The NDA Hardstand (not shown on the map) was located at the easternmost point of WMA 7.

WMA 9, Radwaste Treatment Drum Cell Area

Data from only two surface soil samples were available for WMA 9. Although gross beta concentrations exceeded background for both, data for specific beta-emitting radionuclides did not. (See Figure 4-6.) No subsurface soil or sediment data were available for WMA 9.

WMA 10, Support and Services Area

Concentrations of radiological constituents measured at levels in excess of background in surface soil and sediment from WMA 10, the Support and Services Area, are listed in Table 4-21. This area includes support facilities (e.g., administrative buildings, offices, parking lots, the Environmental Laboratory) that are not known to be radiologically contaminated. Note that only one surface soil sample shown on Figure 4-6 did not have concentrations exceeding background: SS-11 on the north plateau, located on the western side of the project premises in WMA 10.

Low-level concentrations of Cs-137 exceeding background were found in surface soil near support trailers close to the Process Building and in sediment from a drainage ditch south of the Environmental Laboratory. Elevated Cs-137 in surface soil is thought to be attributable to airborne releases. Elevated Cs-137 in the drainage ditch could be attributable to runoff from WMA 6 (i.e., possibly related to historical releases or leaks from the old Sewage Treatment Plant that released radionuclides to drainage by the railroad bed, as discussed in Section 2). Although gross alpha and gross beta concentrations slightly above background were noted for certain surface soil samples from WMA 10 (as shown on Figure 4-6), no other concentrations of specific radionuclides above background have been reported.

Table 4-21. Above-Background Concentrations of Radionuclides in Surface Soil and Sediment at WMA 10(1)

Location	Maximum Concentration (pCi/g dry)
	Cs-137
Surface soil by former Trailer City (1998 special soil sampling)	1.0E+00
Sediment samples by drainage south of Environmental Laboratory (ST-26)	1.7E-01

NOTE: (1) See Figure 4-6 for a map showing locations with radionuclide concentrations in excess of background. Not shown on maps, the former Trailer City was located directly opposite the western entrance to the Process Building. The Environmental Laboratory (shown, but not labeled, on Figure 4-6) is located immediately north of sampling point ST-26.

WMA 12, Remainder of the Site

Concentrations of radiological constituents measured at levels in excess of background in surface soil and sediment from WMA 12 are listed in Table 4-22. Only the portion of WMA 12 within the project premises, which includes the onsite segments of Franks Creek and Erdman Brook, is addressed in this evaluation.

Surface soil concentrations of both Cs-137 and Sr-90 were noted in excess of background in WMA 12 (see Figure 4-6). Cs-137 and Sr-90 exceeding background concentrations were also found in sediment samples from both Franks Creek and Erdman Brook, as well as in drainage downgradient of the demineralizer sludge ponds. Sediment samples collected along the lengths of both Franks Creek and Erdman Brook also contained alpha-emitting radionuclides at concentrations in excess of background, although the radionuclides varied in relationship to the stream segment.

In Erdman Brook downstream of drainage from the NDA (locations ST-22 and ST-21), Am-241 and Pu-238 were observed in concentrations greater than background. Further downstream, at point ST-20, after the stream receives inflow from via a drainage from WMA 2, Am-241, Pu-238, and Pu-239/240 concentrations were all above background. At point ST-19, located downstream where the stream receives effluent from Lagoon 3, U-232 (in addition to the other nuclides) was also found above background.

Similarly, sediment at the southernmost segments of Franks Creek (points ST-13, ST-12, and ST-11) contained gross alpha concentrations in excess of background. However, at point ST-10, located downstream of its junction with Erdman Brook, concentrations of Am-241, Pu-238, and Pu-239/240 were found in its sediment in excess of background.

Table 4-22. Above-Background Concentrations of Radionuclides in Surface Soil and Sediment at WMA 12(1)

Location	Maximum Concentration (pCi/g)					
	Cs-137	Sr-90	U-232	Pu-238	Pu-239/ 240	Am-241
Surface soil near borders with WMA 2 and WMA 6 (SS-08 [Cs-137], BH-16 [Sr-90])	8.1E+00	1.3E+00	NA	NA	NA	NA
Surface soil near eastern fence line (SS-07)	1.6E+00	4.4E+00	≤Bkg	≤Bkg	≤Bkg	≤Bkg
Sediment from drainage downgradient of Demineralizer Sludge Ponds (ST-27)	6.0E+00	8.5E-01	≤Bkg	≤Bkg	7.3E-02	1.4E-01
Sediment from Erdman Brook (ST-19 [Cs-137, Sr-90, U-232], ST-20 [Pu-238, Pu-239/240], ST-22 [Am-241])	3.5E+01	1.6E+00	1.1E-01	2.5E-01	7.3E-02	1.4E-01
Sediment from Franks Creek (ST-10 [Cs-137 only], SNSP006)	1.0E+02	1.0E+01	1.4E-01	1.4E-01	1.1E-01	2.4E-01

NOTES: (1) See Figure 4-6 for a map showing locations with radionuclide concentrations in excess of background. The location of the Demineralizer Sludge Ponds is shown in Figure 4-5.

LEGEND: NA = No analysis. "≤Bkg" = Concentrations did not exceed background.

The highest concentrations of all radionuclides (except Pu-238, for which the maximum was found at point ST-20 on Erdman Brook) were observed in sediment from Franks Creek at location SNSP006, where it flows off site at the security fence.[13] As was found with sediment from Erdman Brook, sediment from Franks Creek collected downgradient of the controlled effluent water release point WNSP001 contained U-232 at concentrations exceeding background. (Effluent water discharged from lagoon 3 through WNSP001 often contains measureable quantities of U-232.) Summary statistics for radionuclide concentrations at SNSP006 are presented in Appendix B.

The highest ratio of Sr-90 to Cs-137 (about 3 to 1) in surface soil from WMA 12 was noted for one sample collected near the eastern edge of the fenced area. In sediment, the maximum ratios to Cs-137 for Sr-90 (0.1 to 1), Pu-239/240 (0.012 to 1), and Am-241 (0.023 to 1) were all found downgradient of the Demineralizer Sludge Ponds. The highest ratios to Cs-137 of U-232 (0.003 to 1) and U-238 (0.007 to 1) were found in sediment from Erdman Brook, immediately after the point where it receives Lagoon 3 effluent.

4.2.6 Environmental Radiation Levels

As part of the WVDP Environmental Monitoring Program, since 1986 thermoluminescent dosimeters (TLDs) have been placed in the field to measure levels of integrated gamma radiation exposure. TLDs are placed:

(1) At background locations far from the Center,

(2) At communities near the Center,

(3) At a ring of perimeter locations around the Center, and

(4) At onsite locations near process areas, waste storage areas, and waste burial locations.

Figure 4-9 shows the locations of onsite TLDs.

Note that not all areas on the project premises have environmental TLD monitoring locations, therefore, data are not available for these areas. Average results over the last ten years, in mR/quarter and in mR/h, are summarized in Table 4-23. Onsite results are presented by waste management area. For comparison, measurements from background are included.

Exposure measurements from the ring of TLDs around the perimeter of the Center and at the community locations are evaluated each year as part of preparing the Annual Site Environmental Report. Values from offsite TLDs have consistently been indistinguishable from background.

[13] In 1990, a sample from a hot spot in Erdman Brook that measured 3000 μR/h during the ground-level survey showed 0.01 μCi/g (10,000 pCi/g) Cs-137. (This was a screening analysis that may have been performed on a wet sample; it was not validated.) This area of localized contamination was described as about six inches by six inches located one meter from the edge of the water. Limited investigation indicated that the contamination extended more than seven inches below the streambed surface. (Passuite and Monsalve-Jones 1993, Appendix C)

Results from all onsite TLDs, with the single exception of DNTLD27 located on the eastern border of the security-fenced area, were in excess of background levels. Note that exposure levels in the above table may not be indicative of radionuclides in soil, but of radiation from the wastes being processed and/or stored nearby.

The on-site monitoring point with the highest dose readings was location DNTLD24 on the north plateau (Figure 4-9). Sealed containers of radioactive components and debris from the plant decontamination work are stored nearby in the Chemical Process Cell Waste Storage Area. Exposure rates at this location have been generally decreasing over time because the radioactivity in the materials stored nearby is decaying. This storage area is well within the Center boundary, just inside the WVDP fenced area, and is not accessible by the public.

The maximum quarterly exposure level (1298 mR/qtr [0.59 mR/hr]) was noted at DNTLD35, near the rail spur by the Drum Cell in the second quarter of 2007. This high reading was associated with waste storage and with staging and shipping drums of cement-stabilized waste from the Drum Cell. All remaining drums were shipped from the Drum Cell in 2007, and in the fourth quarter of 2007 the exposure level at DNTLD35 had dropped to 23 mR/qtr (0.011 mR/hr).

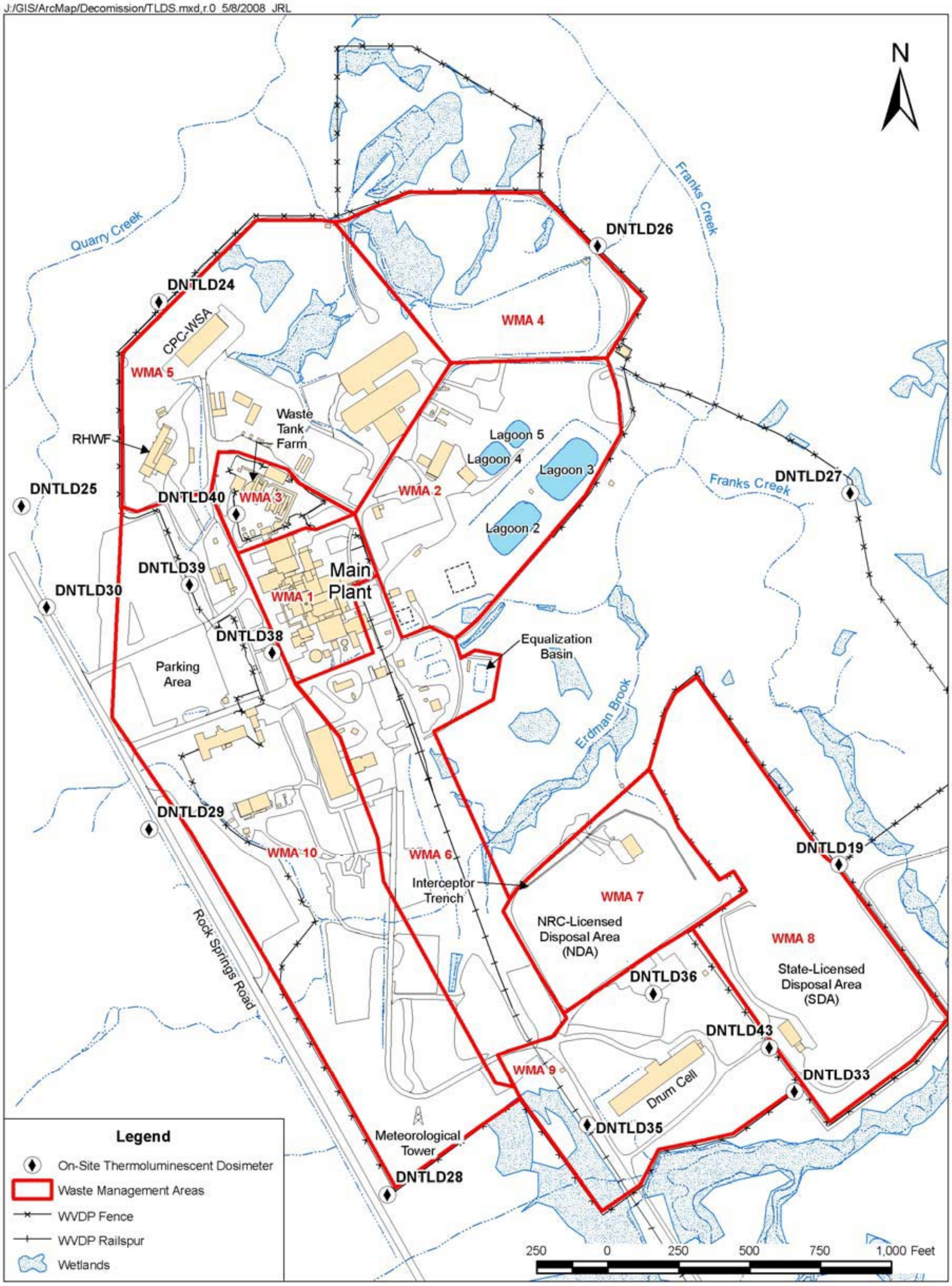

Figure 4-9. Onsite Environmental TLD Locations

Table 4-23. Environmental Radiation Levels on the WVDP Site (1998-2007 data)

TLD (s)	Location	Average mR/qtr	Average mR/h	Maximum mR/qtr	Maximum mR/h	(1)Exceeds Background?
DNTLD40	Waste Tank Farm (WMA 3)	119	0.054	268	0.122	Yes
DNTLD26	Construction and Demolition Debris Landfill fence line (WMA 4)	23	0.011	30	0.014	Yes
DNTLD24	Chemical Process Cell Waste Storage Area fence line (WMA 5)	523	0.239	717	0.327	Yes
DNTLD25	Quarry Creek, between security fence and public road (WMA 5)	23	0.011	31	0.014	Yes
DNTLD30	Northwest parking lot, near public road (WMA 10)	23	0.010	32	0.015	Yes
DNTLD39	On fence between parking lot and Process Building (WMA 10)	49	0.022	70	0.032	Yes
DNTLD38	Nurse's office across Process Building (WMA 10)	34	0.015	55	0.025	Yes
DNTLD29	On fence near Environmental Laboratory (WMA 10)	22	0.010	29	0.013	Yes
DNTLD28	Southwestern corner of Project Premises (WMA 10)	22	0.010	38	0.018	Yes
DNTLD35	(2)Near rail spur by Drum Cell (WMA 9)	109	0.050	1298	0.592	Yes
DNTLD36	(2)Drum Cell north fence (WMA 9)	61	0.028	458	0.209	Yes
DNTLD43	Drum Cell northeastern fence (WMA 9)	31	0.014	69	0.031	Yes
DNTLD33	Drum Cell southeastern corner (WMA 9)	32	0.014	54	0.025	Yes
DNTLD19	Western fence line near waste burial areas (WMA 12)	22	0.010	39	0.018	Yes
DNTLD27	Eastern fence line farthest from process and waste storage areas (WMA 12)	20	0.009	27	0.012	No
Background	Four background locations (map in Appendix B)	19	0.009	35	0.016	NA

NOTE: (1) Data sets from each location were compared with background data sets using one-way analysis of variance (see Appendix B).

(2) Exposure measurements near the Drum Cell have been elevated in the last several years because the area is being used as a storage area for vessels removed from the Process Building and for staging waste for shipping. Waste drums formerly stored in the Drum Cell itself were removed in 2007.

As summarized in WVNSCO 1994, two aerial radiation surveys of the WNYNSC in 1969 and 1979 identified above-background gamma radiation extending from the reprocessing plant in a northwest direction along Buttermilk Creek (1969) and in a prong extending westward offsite across Rock Springs Road (1979). Cs-137 was determined to be the source of the gamma activity. (See Section 2.)

Soil sampling by NYSDEC in 1971 and by WVNSCO in 1982 determined that Cs-137 activity was greater in soil northwest of the plant and that activity was greatest at the soil surface and decreased with depth (WVNSCO 1994). Activity in the cesium prong is attributed to airborne releases from a filter blow-out in 1968, as indicated in Section 2. Elevated radionuclide concentrations in the Buttermilk Creek drainage are attributed to routine radioactive liquid releases.

Posted Radiation Areas

At the WVDP Site, radiation areas are posted if exposure can exceed 5 mrem/hr at 30 centimeters (WVNSCO 2006). Posted radiological control areas on the project premises are shown in Figure 4-10. Posted radiation levels are generally indicative of surface and/or near surface contamination, storage of radioactive waste, and proximity to radiological process areas. Posted areas are delineated in accordance with 10 CFR 835, *Occupational Radiation Protection*.

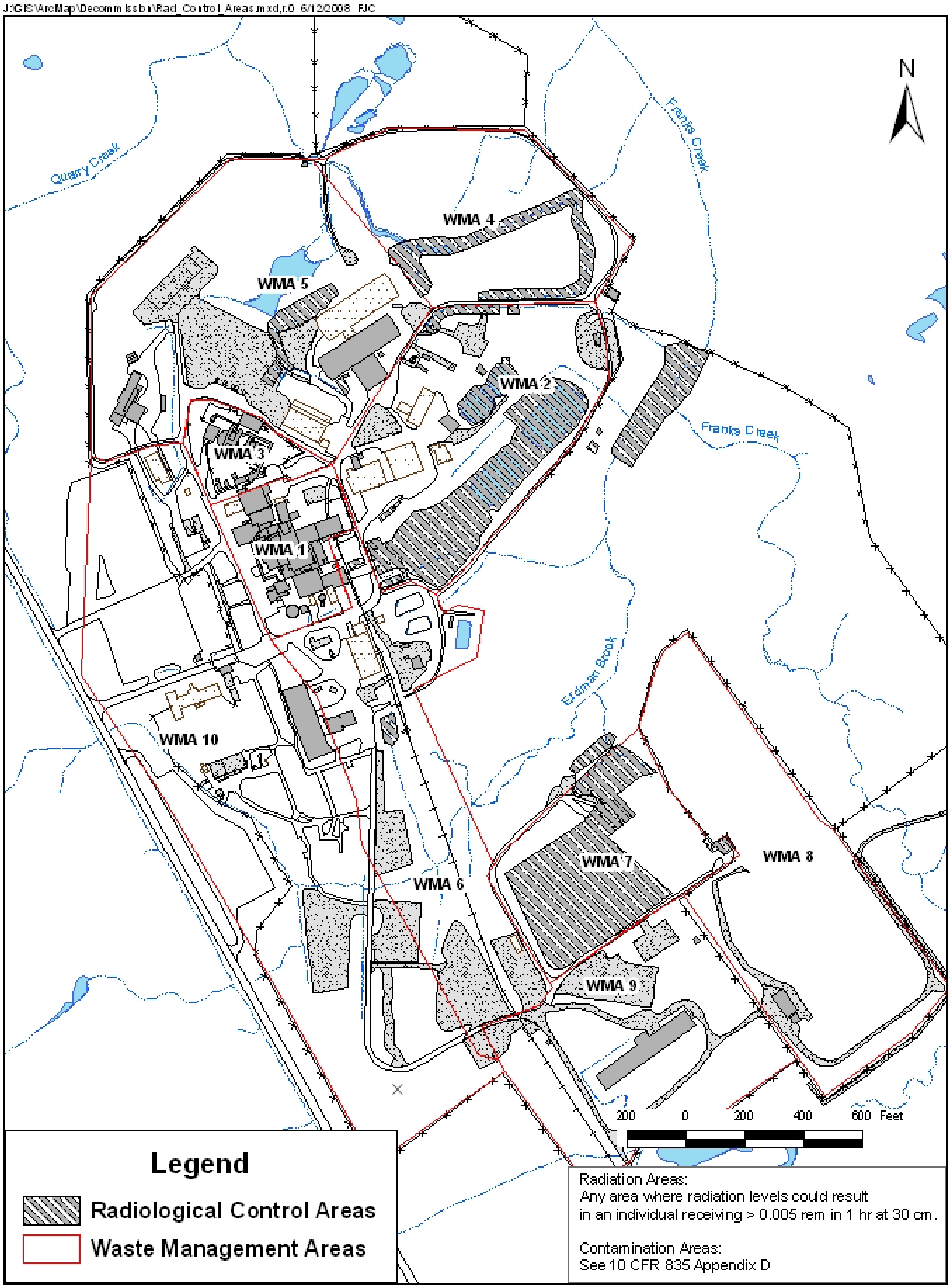

Figure 4-10. WVDP Radiological Control Areas. (Facilities with radiological controlled areas are outlined in black. Radiological Control Areas are current as of June 2008.)

4.2.7 Radiological Status of Onsite Surface Water

The WVDP Environmental Monitoring Program routinely collects surface water samples from the following locations on the project premises:

(1) Two controlled effluent discharges (releases from lagoon 3 through the weir at point WNSP001 and from the Sanitary Waste Treatment Facility at point WNSP007);

(2) Two drainages where water from the North Swamp and the Northeast Swamp leave the site (points WNSW74A and WNSWAMP, respectively);

(3) Facility cooling water from the Cooling Tower (WNCOOLW);

(4) Two drainage ditches (facility drainage [point WNSP005] and NDA surface drainage [point WNNDADR]); and

(5) Three locations on two streams (point WNERB53 on Erdman Brook, point WNFRC67 on Franks Creek, and point WNSP006 where Franks Creek leaves the project premises at the security fence).

Figure 4-11 shows the location of these routine surface water monitoring locations and indicates those with gross alpha (or alpha-emitting radionuclide) concentrations and gross beta (or beta/gamma-emitting radionuclide) concentrations in excess of background. All surface water locations had at least one constituent exceeding background (i.e., no non-impacted locations were noted).

Table 4-24 summarizes median, average, and maximum concentrations of those radionuclides observed to exceed background in surface water over the ten-year period 1998-2007. (For a complete summary of radionuclide concentrations in surface water, including those not detected above background, see Table B-13 of Appendix B.) Note that concentrations of the beta-emitting radionuclide Sr-90 exceeding background were observed in surface water throughout the project premises. (See Appendix B for comparable summary statistics for each radionuclide in surface water from background locations.) The highest Sr-90 concentrations were observed at location WNSWAMP, which is downstream of the point where the leading edge of the north plateau groundwater plume surfaces.

The full suite of radionuclides monitored in surface water was detected at above-background concentrations at the Lagoon 3 discharge point WNSP001. Tritium was detected downstream of the Low-Level Waste Treatment Facility (points WNSP001 and WNSP006), at the Northeast Swamp Discharge Point (WNSWAMP), at a point immediately downstream of the NDA on the south plateau (WNNDADR), and in Erdman Brook and Franks Creek on the south plateau (locations WNERB53 and WNFRC67, respectively).

Alpha-emitting radionuclides at concentrations exceeding background were noted only in surface water from the north plateau, primarily at locations downstream of the Low-Level Waste Treatment Facility discharge, but also at the North (WNSW74A) and Northeast Swamp (WNSWAMP) discharge points.

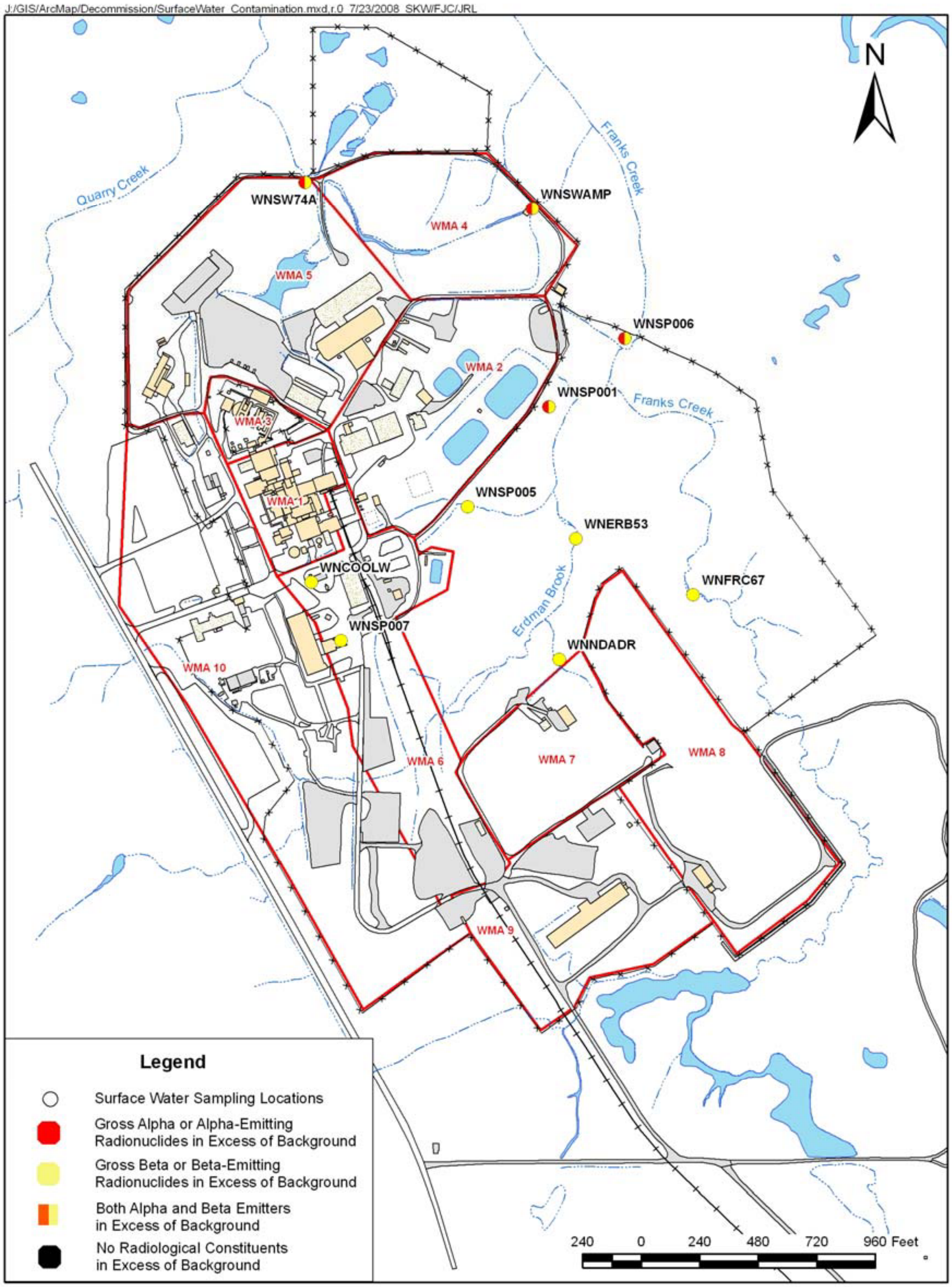

Figure 4-11. Surface Water Locations with Radionuclide Concentrations in Excess of Background

Table 4-24. Radionuclide Concentrations (pCi/L)[1] in Excess of Background in Surface Water[2]

Location	Median	Average			Maximum
		Result	±	Uncertainty	
Lagoon 3 discharge weir (WNSP001), WMA 2					
H-3	2.5E+03	2.8E+03	±	1.4E+02	7.2E+03
C-14	< 2.8E+01	1.4E+01	±	2.2E+01	4.8E+01
Sr-90	9.9E+01	1.2E+02	±	7.4E+00	3.2E+02
Tc-99	6.5E+01	7.9E+01	±	4.8E+01	3.4E+03
I-129	2.1E+00	2.4E+00	±	1.5E+00	1.0E+01
Cs-137	6.1E+01	7.6E+01	±	1.9E+01	3.3E+02
U-232	8.0E+00	9.0E+00	±	9.9E-01	2.1E+01
U-233/234	5.0E+00	5.5E+00	±	6.2E-01	1.4E+01
U-235/236	2.6E-01	2.8E-01	±	1.2E-01	5.8E-01
U-238	3.8E+00	3.8E+00	±	4.9E-01	7.6E+00
Pu-238	6.5E-02	1.5E-01	±	6.8E-02	1.6E+00
Pu-239/240	5.2E-02	1.3E-01	±	6.2E-02	1.4E+00
Am-241	6.8E-02	1.2E-01	±	6.0E-02	9.7E-01
Northeast swamp drainage (WNSWAMP), WMA 4					
H-3	1.1E+02	1.1E+02	±	8.2E+01	5.2E+02
Sr-90	1.5E+03	1.7E+03	±	3.1E+01	5.2E+03
U-233/234	1.7E-01	2.0E-01	±	1.4E-01	9.3E-01
U-238	1.0E-01	1.2E-01	±	1.1E-01	7.2E-01
North swamp drainage (WNSW74A), WMA 5					
Sr-90	5.5E+00	5.5E+00	±	1.8E+00	1.2E+01
U-233/234	1.5E-01	1.6E-01	±	8.4E-02	3.5E-01
U-238	1.0E-01	1.0E-01	±	6.6E-02	2.0E-01
Sanitary waste discharge (WNSP007), WMA 6					
Sr-90	3.1E+00	3.4E+00	±	1.9E+00	1.2E+01
Franks Creek at security fence (WNSP006), WMA 12					
H-3	< 8.5E+01	1.4E+02	±	8.3E+01	2.2E+03
Sr-90	1.9E+01	2.0E+01	±	3.0E+00	5.0E+01
Tc-99	< 2.1E+00	3.3E+00	±	2.1E+00	5.2E+01
Cs-137	< 8.0E+00	6.3E+00	±	9.5E+00	7.3E+01
U-232	3.2E-01	3.2E-01	±	1.3E-01	7.5E-01
U-233/234	3.7E-01	3.7E-01	±	1.3E-01	6.9E-01
U-238	2.5E-01	2.8E-01	±	1.1E-01	7.4E-01

Table 4-24. Radionuclide Concentrations (pCi/L)[1] in Excess of Background in Surface Water[2]

Location	Median	Average			Maximum
		Result	±	Uncertainty	
Pu-238	< 3.4E-02	2.1E-02	±	3.4E-02	1.4E-01
Facility yard drainage (WNSP005), WMA 12					
H-3	< 8.3E+01	3.8E+01	±	8.2E+01	1.2E+03
Sr-90	9.6E+01	1.0E+02	±	6.5E+00	2.0E+02
Drainage between NDA and SDA (WNNDADR), WMA 12					
H-3	1.0E+03	1.1E+03	±	1.0E+02	4.0E+03
Sr-90	8.5E+01	8.4E+01	±	5.4E+00	1.2E+02
Erdman Brook north of disposal areas (WNERB53), WMA 12					
H-3	< 8.3E+01	3.9E+01	±	8.0E+01	4.9E+02
Sr-90	8.2E+00	8.0E+00	±	2.0E+00	9.9E+00
Franks Creek East of SDA (WNFRC67), WMA 12					
H-3	< 8.3E+01	3.1E+01	±	8.1E+01	3.5E+02

NOTES: (1) 1 pCi/L = 3.7E-02 Bq/L
(2) Refer to Table 4-11 for median and maximum background values and to Appendix B for summary statistics of background radionuclide concentrations in surface water.

4.2.8 Radiological Status of Groundwater

Groundwater at the WVDP is routinely monitored in accordance with the WVDP Groundwater Monitoring Program. Although the primary focus of the program is on nonradiological constituents, all wells are monitored for radiological indicator parameters (gross alpha, gross beta, and H-3). Several wells, especially those impacted by the north plateau groundwater plume, are sampled for Sr-90. Select wells are monitored for a full suite of radionuclides. Table 4-25 lists routine groundwater monitoring locations at which radiological concentrations were found at levels exceeding background. Medians, averages, and maximum concentrations (in pCi/L) are presented for each.

For groundwater (unlike the other environmental media discussed in this section), gross alpha and gross beta concentrations exceeding background are presented. This is because limited radionuclide data are available for routinely monitored groundwater locations, and gross alpha and gross beta measurements, taken at all wells, may indicate the presence of other alpha- or beta-emitting radionuclides. For instance, gross beta measurements are used as a surrogate measurement for Sr-90 at monitoring points where the Sr-90-to-gross beta ratio has been determined to be approximately 0.5 to 1.

Locations at which gross alpha (or alpha-emitting radionuclide) concentrations and/or gross beta (or beta-emitting radionuclide, including H-3) concentrations exceeded background are shown on Figure 4-12. Locations at which no radiological constituents were found to exceed background are also shown. For a complete summary of radionuclide data from both impacted and non-impacted routine groundwater monitoring locations, see Appendix B, Table B-14. A listing of supplementary information for each point (e.g., geographical coordinates, well construction, screened interval, geologic unit) is provided in Appendix B, Table B-15.

Table 4-25. Routine Groundwater Monitoring Locations With Radionuclide Concentrations (pCi/L)[(1)] in Excess of Background[(2)]

WMA	Monitoring Point	Constituent	Median	Average			Maximum
				Result	±	Uncertainty	
WMA 1	WP-A	Gross beta	2.4E+01	3.1E+01	±	4.6E+00	5.4E+01
		H-3	1.2E+04	1.1E+04	±	6.2E+02	1.3E+04
WMA 2	WP-C	Gross beta	2.4E+01	4.2E+01	±	5.5E+00	1.2E+02
		H-3	4.9E+04	4.7E+04	±	1.6E+03	6.6E+04
	WP-H	Gross alpha	6.1E+00	7.9E+01	±	2.3E+01	7.4E+02
		Gross beta	7.0E+03	7.2E+03	±	1.9E+02	1.2E+04
		H-3	3.0E+03	3.4E+03	±	5.0E+02	7.4E+03
	WNW0103	Gross beta	1.4E+02	1.8E+02	±	1.9E+01	5.5E+02
	WNW0104	Gross beta	5.9E+04	5.6E+04	±	1.6E+03	1.0E+05
		H-3	3.7E+02	3.9E+02	±	8.6E+01	7.5E+02
	WNW0105	Gross beta	3.9E+04	3.3E+04	±	1.5E+03	1.0E+05
		H-3	3.6E+02	3.7E+02	±	9.1E+01	7.1E+02
	WNW0106	Gross beta	1.6E+01	8.2E+01	±	8.0E+00	5.8E+02
		H-3	9.6E+02	1.0E+03	±	1.0E+02	1.8E+03
	WNW0107	Gross beta	7.0E+00	8.2E+00	±	2.6E+00	2.2E+01
		H-3	3.7E+02	4.8E+02	±	9.0E+01	9.9E+02
	WNW0108	Gross alpha	1.6E+00	1.5E+00	±	1.5E+00	4.3E+00
		H-3	1.2E+02	1.1E+02	±	8.4E+01	2.5E+02
	WNW0110	H-3	1.3E+03	1.3E+03	±	1.1E+02	1.7E+03
	WNW0111	Gross alpha	<4.4E+00	3.2E+00	±	5.1E+00	1.0E+01
		Gross beta	5.6E+03	5.9E+03	±	1.4E+02	1.2E+04
		H-3	2.0E+02	2.3E+02	±	8.4E+01	8.0E+02
	WNW0116	Gross beta	8.7E+02	2.0E+03	±	1.6E+02	9.5E+03
		H-3	1.7E+02	1.9E+02	±	8.2E+01	4.7E+02
	WNW0205	Gross beta	1.6E+01	1.7E+01	±	8.4E+00	4.1E+01
	WNW0408	Gross beta	4.0E+05	4.0E+05	±	3.0E+03	6.3E+05
		H-3	1.5E+02	1.9E+02	±	1.1E+02	2.2E+03
		Sr-90	1.5E+05	1.5E+05	±	1.7E+02	2.5E+05
		Tc-99	1.6E+01	1.7E+01	±	3.3E+00	2.5E+01

Table 4-25. Routine Groundwater Monitoring Locations With Radionuclide Concentrations (pCi/L)[1] in Excess of Background[2]

WMA	Monitoring Point	Constituent	Median	Average Result	±	Uncertainty	Maximum
WMA 2		U-233/234	4.5E-01	5.3E-01	±	2.2E-01	1.3E+00
		U-238	2.9E-01	3.1E-01	±	1.6E-01	4.8E-01
	WNW0501	Gross beta	1.9E+05	1.9E+05	±	2.6E+03	3.2E+05
		H-3	1.4E+02	1.2E+02	±	8.4E+01	3.2E+02
		Sr-90	9.2E+04	9.3E+04	±	2.4E+02	1.5E+05
	WNW0502	Gross beta	1.7E+05	1.6E+05	±	2.8E+03	2.3E+05
		H-3	1.3E+02	1.4E+02	±	8.4E+01	5.0E+02
		Sr-90	8.4E+04	8.3E+04	±	2.1E+02	1.2E+05
	WNW8603	Gross beta	5.7E+04	4.8E+04	±	1.2E+03	9.0E+04
		H-3	3.4E+02	3.4E+02	±	8.8E+01	5.8E+02
	WNW8604	Gross beta	4.1E+04	4.6E+04	±	1.1E+03	1.0E+05
		H-3	3.5E+02	3.8E+02	±	8.4E+01	6.4E+02
	WNW8605	Gross alpha	9.1E+00	8.5E+00	±	7.7E+00	2.1E+01
		Gross beta	1.1E+04	1.1E+04	±	1.7E+02	1.6E+04
		H-3	3.7E+02	4.2E+02	±	8.7E+01	1.3E+03
WMA 3	WNW8609	Gross beta	1.5E+03	1.4E+03	±	4.2E+01	2.3E+03
		H-3	4.5E+02	4.7E+02	±	9.1E+01	7.9E+02
		Sr-90	8.0E+02	7.2E+02	±	2.1E+01	1.1E+03
WMA 4	WNW0801	Gross beta	8.0E+03	8.6E+03	±	2.7E+02	1.5E+04
		H-3	1.5E+02	1.6E+02	±	8.2E+01	3.8E+02
		Sr-90	4.1E+03	4.3E+03	±	4.7E+01	8.0E+03
	WNW0802	Gross beta	9.9E+00	3.5E+01	±	5.1E+00	2.8E+02
		H-3	<1.1E+02	9.0E+01	±	8.0E+01	4.2E+02
	WNW0803	Gross beta	1.5E+01	1.5E+01	±	4.7E+00	2.5E+01
		H-3	1.8E+02	1.6E+02	±	8.5E+01	3.4E+02
	WNW0804	Gross beta	2.6E+02	2.9E+02	±	1.1E+01	6.9E+02
		H-3	1.2E+02	1.1E+02	±	8.0E+01	3.6E+02
	WNW8612	H-3	4.2E+02	4.3E+02	±	8.9E+01	8.5E+02
WMA 5	WNW0406	Gross beta	7.4E+00	8.1E+00	±	3.5E+00	1.7E+01
		H-3	1.2E+02	1.1E+02	±	8.4E+01	4.4E+02
		Tc-99	2.2E+00	2.5E+00	±	1.9E+00	8.5E+00
	WNW0409	Gross alpha	<1.0E+00	9.4E-01	±	9.9E-01	2.3E+00
	WNW0602A	Gross beta	1.2E+01	1.3E+01	±	2.9E+00	3.5E+01

Table 4-25. Routine Groundwater Monitoring Locations With Radionuclide Concentrations (pCi/L)(1) in Excess of Background(2)

WMA	Monitoring Point	Constituent	Median	Average			Maximum
				Result	±	Uncertainty	
WMA 5		H-3	2.2E+02	2.2E+02	±	8.9E+01	4.9E+02
	WNW0604	Gross beta	6.1E+00	6.3E+00	±	3.0E+00	1.3E+01
	WNW0605	Gross beta	4.8E+01	5.1E+01	±	4.0E+00	8.8E+01
	WNW0704	Gross beta	8.0E+00	8.2E+00	±	3.0E+00	1.3E+01
	WNW8607	Gross beta	2.6E+01	2.7E+01	±	5.3E+00	7.6E+01
	WNW1304	U-233/234	2.7E-01	2.9E-01	±	1.3E-01	5.6E-01
		U-238	1.9E-01	2.2E-01	±	1.0E-01	5.8E-01
WMA 7	WNW0902	Gross alpha	1.5E+00	1.3E+00	±	1.3E+00	5.4E+00
	WNW0909	Gross beta	3.7E+02	3.7E+02	±	1.4E+01	6.4E+02
		H-3	8.2E+02	1.5E+03	±	1.2E+02	3.9E+03
		Sr-90	1.9E+02	1.8E+02	±	8.3E+00	2.2E+02
		Tc-99	<1.9E+00	1.3E+00	±	1.8E+00	5.0E+00
		I-129	6.2E+00	6.3E+00	±	1.9E+00	9.7E+00
		U-233/234	6.0E-01	7.4E-01	±	2.4E-01	1.3E+00
		U-238	4.7E-01	5.4E-01	±	2.0E-01	1.0E+00
	WNW0910	Gross alpha	<2.5E+00	1.9E+00	±	2.3E+00	3.4E+00
		Gross beta	3.8E+01	1.5E+02	±	8.5E+01	1.5E+03
	WNNDATR	Gross alpha	2.2E+00	2.1E+00	±	2.1E+00	1.1E+01
		Gross beta	1.5E+02	1.8E+02	±	8.4E+00	5.5E+02
		H-3	3.6E+03	5.0E+03	±	2.3E+02	2.0E+04
		Sr-90	5.8E+01	7.8E+01	±	5.5E+00	2.8E+02
		I-129	<9.1E-01	8.4E-01	±	9.4E-01	7.0E+00
		U-233/234	1.7E+00	1.5E+00	±	2.8E-01	2.1E+00
		U-235/236	1.1E-01	1.4E-01	±	9.5E-02	3.0E-01
		U-238	1.3E+00	1.2E+00	±	2.5E-01	1.7E+00
WMA 9	WNW1006	Gross alpha	<5.1E+00	4.2E+00	±	5.5E+00	1.0E+01

NOTES: (1) 1 pCi/L = 3.7E-02 Bq/L

(2) Refer to Table 4-11 for median and maximum background values and to Appendix B for summary statistics of background radionuclide concentrations in groundwater (Table B-7) and at non-impacted groundwater monitoring locations (Table B-14). Data sets from each location were compared with background data sets using the nonparametric Mann-Whitney "U" test, as described in Appendix B, section 4.3.

As shown in Figure 4-12, elevated gross beta concentrations are evident in groundwater northeast of the Process Building (WVNSCO and URS 2005). The beta activity is primarily found in the surficial sand and gravel unit, and the general direction of flow in this unit is to the northeast. Elevated gross beta concentrations are largely attributed to Sr-90 in the north plateau plume. While concentrations of gross alpha or alpha-emitting radionuclides exceeding background were found at only a few locations, the locations were associated with (or downgradient of) historical waste processing or waste burial activities (i.e., WMAs 1, 2, and 7).

In December 1993, elevated gross beta concentrations were detected in surface water at a former sampling location near the edge of the north plateau. This discovery initiated a subsurface groundwater and soil Geoprobe® investigation in 1994 (Carpenter and Hemann 1995). Two additional Geoprobe® investigations were conducted in 1997 (Hemann and Fallon 1998) and 1998 (Hemann and Steiner 1999).

Groundwater was collected in 2008 in accordance with a sampling and analysis plan (Michalczak 2007) for a Geoprobe® characterization of the north plateau. Data from this sampling program have been included in the tables and figures for this section.

A listing of the Geoprobe® locations, sample depths, and geologic units from which the groundwater was sampled is provided in Appendix B, Table B-16. (NOTE: For completeness, Appendix B, Table B-17, provides a listing of groundwater points — in addition to the routine groundwater monitoring and Geoprobe® locations included in this evaluation — that have been sampled over the years. Table B-17 presents information on the locations and depths of these points, and summarizes the reasons that the points were not included in the current evaluation [dry wells, wells dropped from program, unvalidated data, located in areas outside the scope of the Phase 1 DP, etc.].)

The principal source of the north plateau groundwater plume is believed to be a release of radioactively contaminated acid from the NFS acid recovery system in the 1960s when NFS was reprocessing fuel, during 10 CFR Part 50 licensed activities. A detailed description of the release is provided in Section 2, subsection 2.3.1. See also Table 2-15 for an estimate of radionuclide activity from this release expected to remain in the plume in 2011.

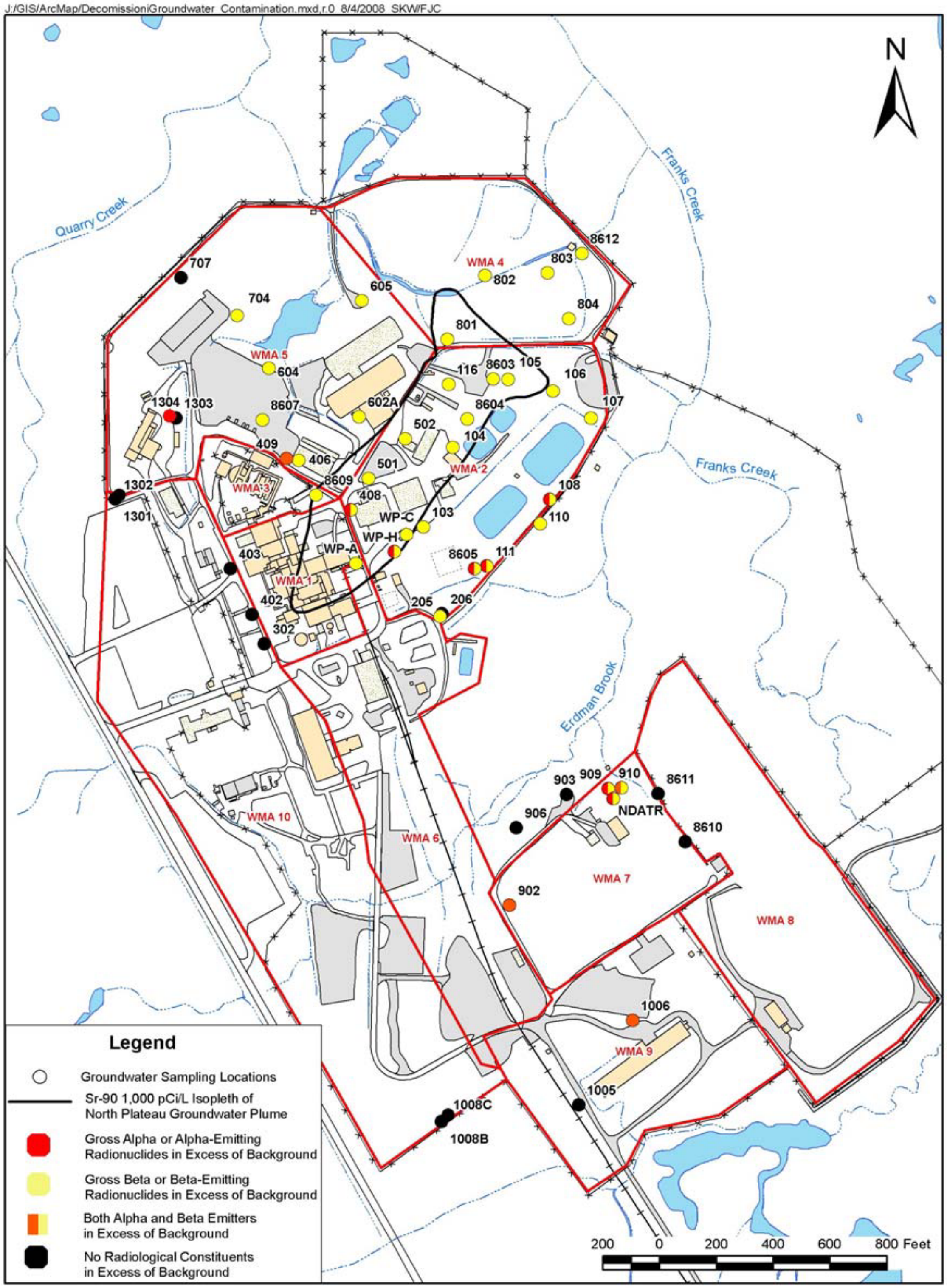

Figure 4-12. Routine Groundwater Monitoring Locations with Radionuclide Concentrations in Excess of Background

The Geoprobe® investigation results were used to estimate the extent of the north plateau groundwater plume beneath and downgradient of the Process Building. As part of the Geoprobe® investigations, a more extensive suite of radionuclides was analyzed in groundwater than was done for routine monitoring. Because the Geoprobe® groundwater samples differed from those taken from routine monitoring locations in that Geoprobe® samples may have been taken from several depths (and even from different geologic units) at a single location, the sample results were not directly comparable and have not been presented in the same table. However, results from the Geoprobe® investigations provide supplemental information about the presence of radionuclides in groundwater on the north plateau.

Geoprobe® locations at which concentrations of alpha-emitting radionuclides or beta/gamma-emitting radionuclides, including H-3, exceeded background are shown on Figure 4-13. The maximum measured radionuclide concentrations are summarized by WMA in Table 4-26. (Since radionuclide data were available for these sampling locations, gross alpha and gross beta data, which could be affected by naturally occurring radionuclides, were not included in Table 4-26 or Figure 4-13).

As can be seen in Figure 4-13, concentrations of beta/gamma-emitting radionuclides exceeding background are evident at most locations downgradient of the Process Building. Most non-impacted points were noted in WMA 5 northwest of the north plateau groundwater plume. Alpha-emitting radionuclide concentrations exceeding background were found immediately downgradient of the Process Building and downgradient of the Interceptors.

Table 4-26. Maximum Above-Background Radionuclide Concentrations (pCi/L) at Groundwater Geoprobe® Points by WMA, Location, and Depth[(1)]

WMA	Point	Constituent	Maximum	Point	Constituent	Maximum
WMA 1	GP8098 (22-24')	H-3	6.4E+04	GP2908 (17-19')	U-232	1.0E+00
	GP29 (27-29')	C-14	2.3E+03	GP2908 (17-19')	U-233/234	1.1E+01
	GP30 (18-20')	Sr-90	1.2E+06	GP2908 (17-19')	U-235/236	4.6E-01
	GP72 (30-32')	Tc-99	1.2E+04	GP2908 (17-19')	U-238	1.2E+01
	GP29 (21-23')	I-129	3.0E+01	GP7608 (20-22')	Pu-239/240	4.5E-01
	GP7608 (20-22')	Cs-137	1.2E+02	GP76 (27-29')	Am-241	4.7E-01
WMA 2	GP47 (11-13')	H-3	3.4E+04	GP44 (14-16')	U-233/234	3.7E+01
	GP66 (30-32')	C-14	4.0E+02	GP44 (14-16')	U-235/236	6.2E-01
	GP8298 (20-24')	Sr-90	2.8E+05	GP60 (12-14')	U-238	1.5E+01
	GP68 (25-27')	Tc-99	5.8E+01	GP59 (17-19')	Pu-238	4.5E+00
	GP47 (11-13')	I-129	8.2E+01	GP59 (17-19')	Pu-239/240	7.9E+00
	GP46 (12-14')	Cs-137	1.5E+02	GP59 (17-19')	Am-241	5.9E+00
	GP44 (14-16')	U-232	7.8E+01	-	-	-
WMA 3	GP20 (15-17')	H-3	1.5E+03	GP20 (15-17')	I-129	2.5E+00
	GP20 (15-17')	Sr-90	5.2E+01	-	-	-
WMA 4	GP32A (5-7')	H-3	1.3E+03	GP8998 (16-18')	Sr-90	6.5E+03
WMA 5	GP43 (12-14')	H-3	2.0E+04	GP53 (14-16')	Tc-99	8.0E+01

Table 4-26. Maximum Above-Background Radionuclide Concentrations (pCi/L) at Groundwater Geoprobe® Points by WMA, Location, and Depth(1)

WMA	Point	Constituent	Maximum	Point	Constituent	Maximum
	GP40 (13-15')	Sr-90	3.8E+03	GP43 (12-14')	I-129	4.6E+00
WMA 6	GP70 (26-28')	H-3	6.8E+03	GP70 (21-23')	Tc-99	3.1E+01
	GP70 (16-18')	C-14	1.4E+02	GP70 (21-28')	I-129	1.1E+01
	GP70 (16-18')	Sr-90	2.8E+04	-	-	-
WMA 12	GP48 (7-9')	H-3	1.5E+03	GP50 (8-10')	U-238	7.2E-01
	GP50 (8-10')	Sr-90	1.3E+01	-	-	-

. NOTE: (1) Points ending with "97," "98," or "08" were collected in 1997, 1998, or 2008, respectively. The remaining points were collected in 1994. Sample results were compared with average background values as described in Appendix B, section 4.2.

The north plateau plume, as delineated by the 1,000 pCi/L isopleth, was approximately 300 feet wide and 800 feet long in 1994. By 2004, the plume area had expanded to approximately 350 feet by 1050 feet, and by 2007 to about 540 feet (at its widest point near the leading edge) by 1300 feet (WVES and URS 2008). (See Figure 4-14.)

The highest gross beta concentrations in groundwater and soil were found near the southeast corner of the Process Building. In the 1994 study, the maximum concentration in groundwater was 3.6E+06 pCi/L, and the maximum concentration in subsurface soil was 2.4E+04 pCi/g. Sr-90 and its progeny, Y-90, were determined to be the isotopes responsible for most of the elevated gross beta activity (WVNSCO and URS 2007).

As a result of recommendations from a 1997 external review of WVDP response actions on the north plateau, more attention was given in 1998 to the core area of the plume, determined to be beneath and immediately downgradient of the Process Building. Results from the 1998 investigation were presented in a summary report (Hemann and Steiner 1999) that compared groundwater and soil sampling data with the 1994 data. Concentrations detected in 1998 samples were generally lower than those in the 1994 samples due to radioactive decay and continuing migration and dispersion of the plume. The study also concluded that Lagoon 1 was a possible contributor of gross beta activity to groundwater downgradient of the Lagoon.

Figure 4-14 shows the 1E+03 pCi/L gross beta contour lines defining the extent of the plume in 1994, 2001, and 2007. (This figure, which duplicates Figure 2-6 in Section 2, is provided here for the sake of completeness.) Figure 4-14 also shows gross beta concentrations at the 12 routine groundwater monitoring locations that define the plume as of the fourth quarter of 2007. Contour lines show a gradual lengthening and expansion of the plume toward the northeast, with the highest concentration (i.e., well 408 at 3.9E+05 pCi/L) near the Process Building and lower concentrations near the leading edge. Further downgradient, the plume appears to be diverging – one prong moving to the north toward the surface drainage north of the CDDL and the other toward the east. Figure 4-14 also shows 1E+03 pCi/L contour lines of gross beta activity in groundwater over time near inactive Lagoon 1. This smaller area of elevated activity, likely associated with contamination remaining in Lagoon 1 sediment and backfill, appears to be migrating slightly eastward over time.

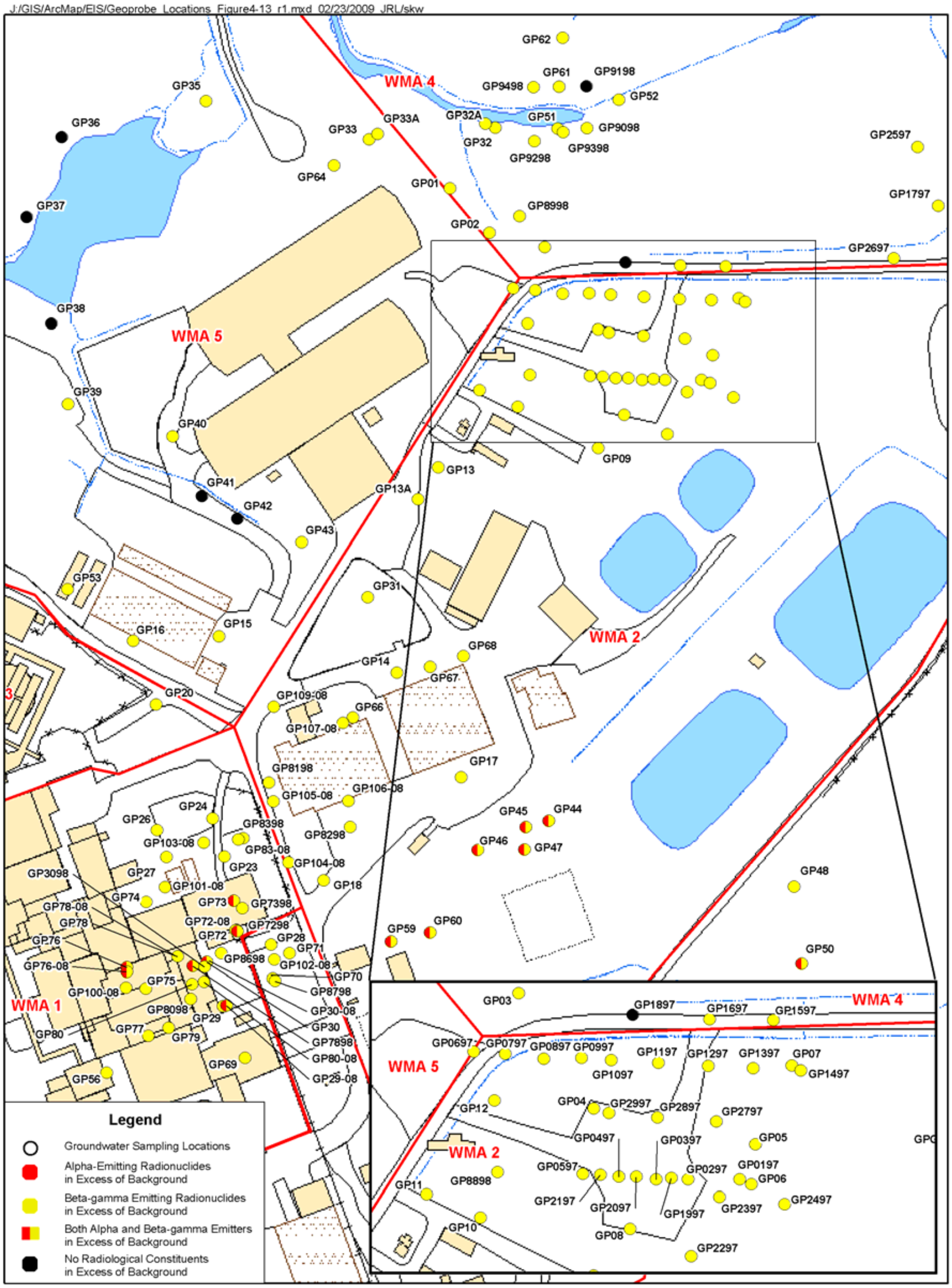

Figure 4-13. Geoprobe® Groundwater Locations with Radionuclide Concentrations in Excess of Background

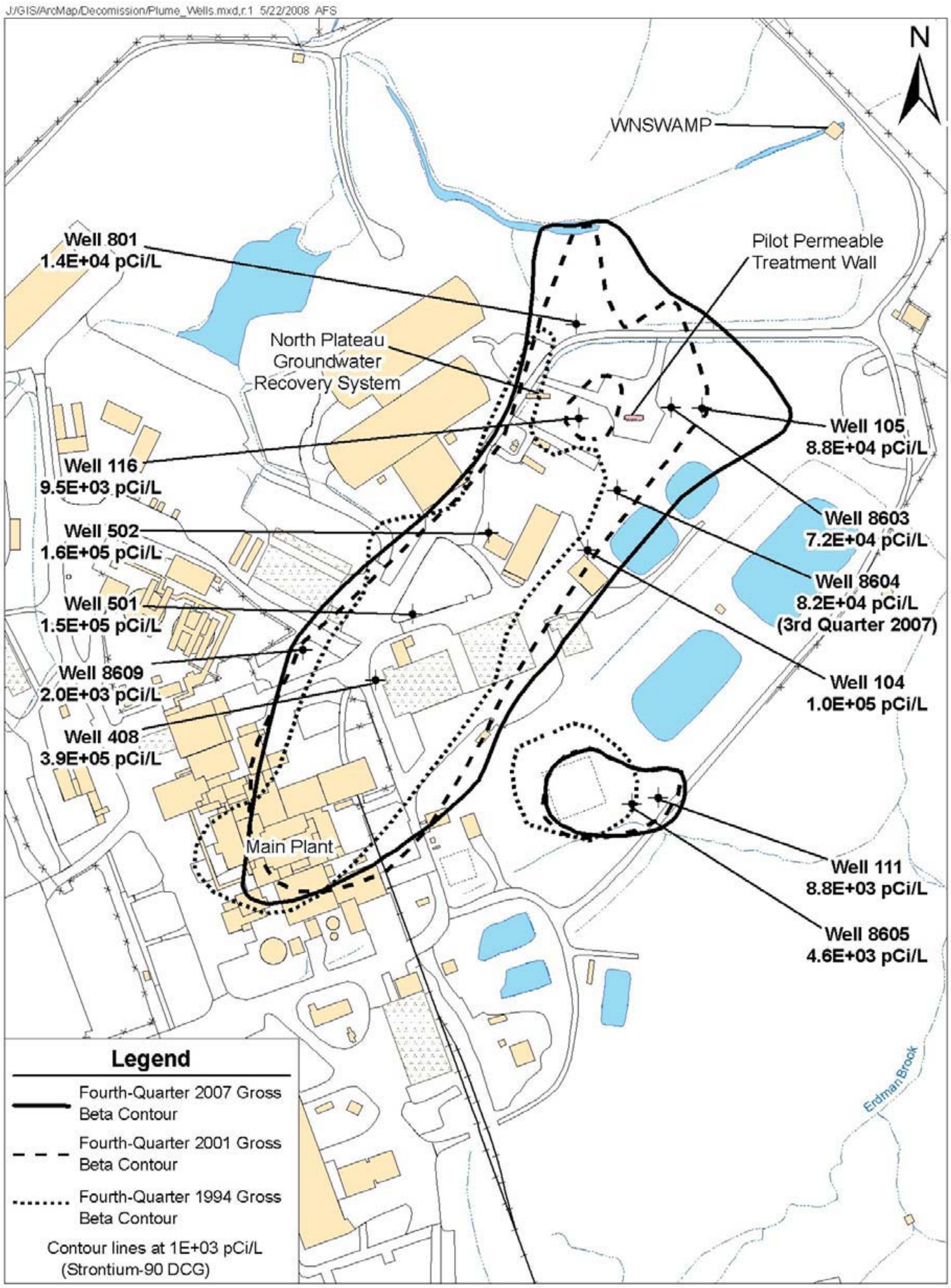

Figure 4-14. North Plateau Groundwater Plume

4.3 References

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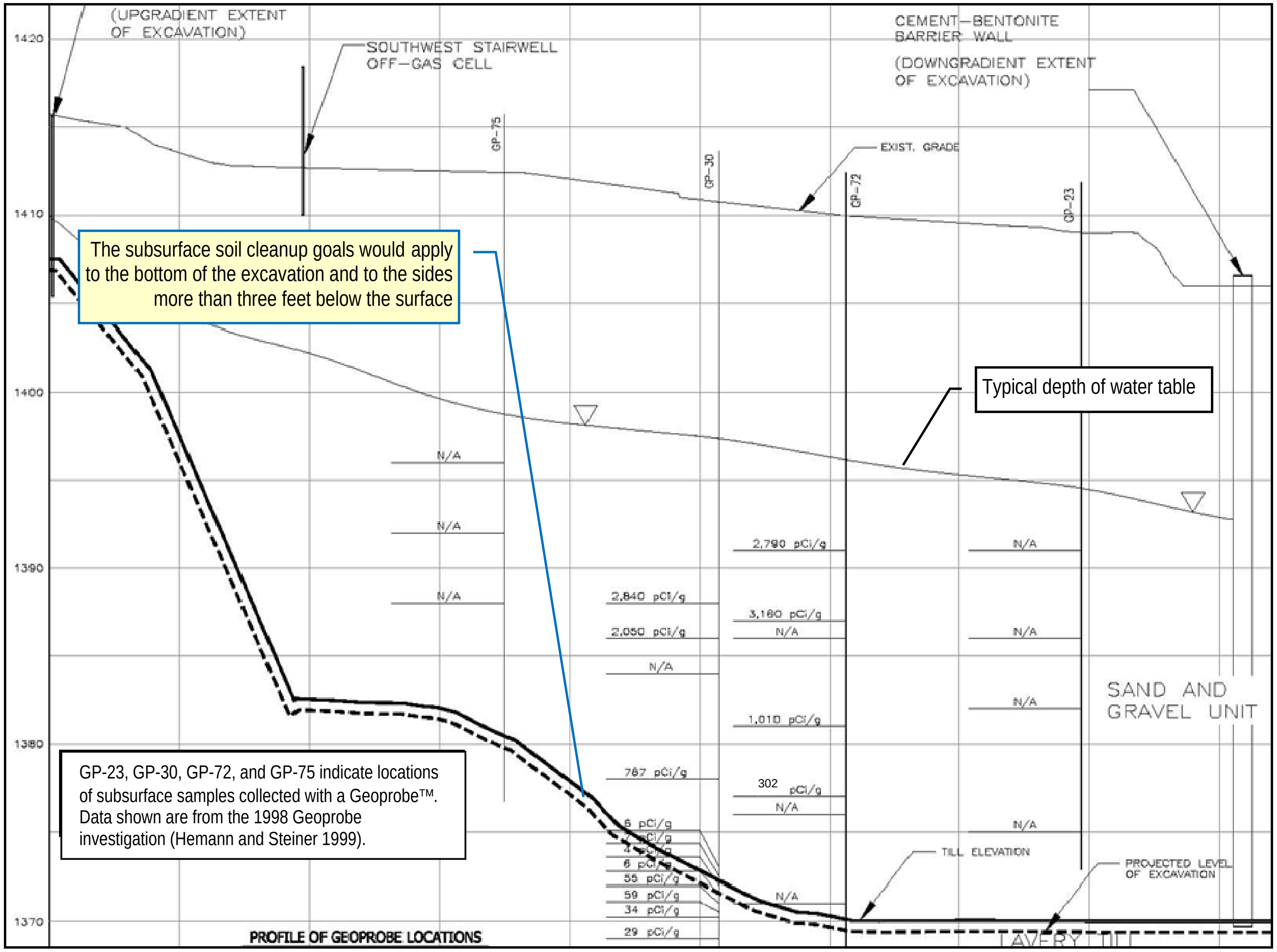

Figure 5-2. Conceptual Cross Section View of WMA 1 Excavation With Representative Data on Sr-90 Concentrations
(See Section 4.2 for more data and 7 for the excavation details.)

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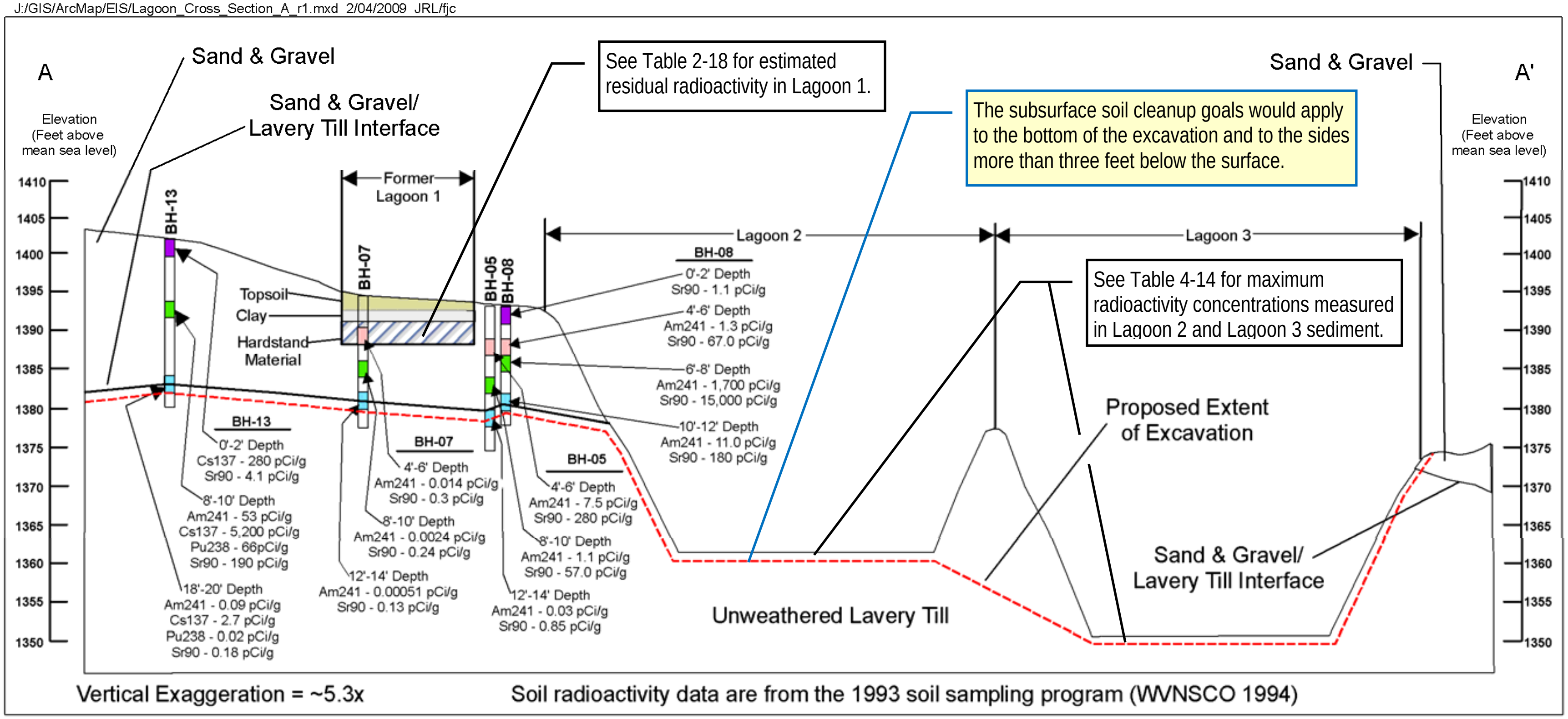

Figure 5-3. Conceptual Cross Section View of WMA 2 Excavation With Representative Data on Subsurface Soil Contamination (See Section 4.2 for more data and 7 for excavation details.

Available data on radioactive contamination in subsurface soil in WMA 1 described in Section 4.2 show Sr-90 to be the dominant radionuclide at depth. Figure 4-8 shows key data, which include three samples from several feet into the unweathered Lavery till that show Sr-90 concentrations of 13 pCi/g, 5.6 pCi/g, and 2.2 pCi/g at depths in the 35 to 40 feet range.

Other radionuclides with measured above-background concentrations in subsurface soil in WMA 1, with their maximum concentrations and the associated sample depth, include: Tc-99 (19 pCi/g at 19-23 feet), Cs-137 (31 pCi/g, at 27 to 29 feet), Pu-241 (15 pCi/g at 21 to 23 feet), and Am-241 (0.1 pCi/g, 19 to 23 feet). Table 5-1 shows the maximum measured radionuclide concentrations in the Lavery till in the areas of the large excavations in WMA 1 and WMA 2. Data in the Lavery till in these areas are limited – the complete set of data is provided in Table C-4 of Appendix C.

Table 5-1. Measured Maximum Lavery Till Radionuclide Concentrations(1)

Nuclide	WMA 1 Excavation Area		WMA 2 Excavation Area	
	Result (pCi/g)	Depth (ft)	Result (pCi/g)(3)	Depth (ft)
C-14	<3.6E-01(2)	24-26	none	none
Sr-90	5.9E+01(4)	38.5-39	8.5E-01	12-14
Tc-99	<5.5E-01(2)	37-39	none	none
I-129	<2.3E-01(2)	38-40	none	none
Cs-137	7.9E+00(2)	38-40	4.5E-01	12-14
U-232	4.1E-02(2)	24-26	1.2E-02	12-14
U-233/234	1.9E+00(2)	38-40	1.8E-01	12-14
U-235	1.4E-01(2)(5)	24-26	<5.9E-03	12-14
Np-237	<3.6E-01(2)	38-40	none	none
U-238	1.4E+00(2)	41-43	1.1E-01	12-14
Pu-238	<3.4E-01(2)	38-40	1.0E-02	12-14
Pu-239/240	<3.1E-01(2)	38-40	<5.9E-03	12-14
Pu-241	<3.4E+01(2)	38-40	<1.3E+00	12-14
Am-241	<2.0E-01(2)	38-40	3.0E-02	12-14
Cm-243/244	<2.2E-01(2)	38-40	none	none

NOTES: (1) See Table C-4 for the complete data set, which includes samples at nine locations entirely within the unweathered Lavery till within the WMA 1 excavation area. Based on boring log data, only one sample (BH-05) taken within the WMA 2 excavation area contained only unweathered Lavery till soil; the others contained some soil from the sand and gravel layer.

(2) Data are from the 2008 north plateau groundwater plume Geoprobe® investigation described in Section 4, with the highest non-detection values recorded (non-detection values, i.e., minimum detectable concentrations, varied widely among different samples).

(3) Data are from sample BH-05 collected during the 1993 RCRA facility investigation described in Section 4.

(4) Data are from point GP3098 from the 1998 north plateau Geoprobe® sampling described in Section 4.

(5) U-235/U-236 result.

Additional Characterization Planned

The characterization program to be undertaken early in Phase 1 of the decommissioning as described in Section 9 would provide additional data on radioactivity in subsurface soil in WMA 1 and WMA 2 and lagoon sediment in WMA 2. As noted in Section 4, additional characterization measurements being taken in 2008 are expected to somewhat better define subsurface contamination in both areas.

The actual depth of the WMA 1 excavation would be based on removal of soil exceeding the subsurface soil cleanup goals, as explained in Section 7. The excavation would extend at least one foot into the Lavery till, as noted previously, and this is the point where the cleanup goals would apply. The configuration of the residual source would therefore be similar to the bottom of the excavation shown in the representative cross section in Figure 5-2.

Figure 5-1 also shows the approximate location of the major excavation in WMA 2. As explained in Section 1 and detailed in Section 7, a single excavation would be made to remove Lagoons, 1, 2, and 3, the interceptors, the Neutralization Pit, and the Solvent Dike. The area of this excavation would be approximately 4.2 acres and its depth would vary from approximately 12 feet on the southwest end to approximately 26 feet on the northeast end.[2]

Figure 5-3 shows a conceptual cross section of the WMA 2 excavation. This figure also shows representative data on subsurface radioactivity. As indicated on the figure, Table 2-18 provides an estimate of residual radioactivity in Lagoon 1 and Table 4-14 shows maximum radionuclide concentrations measured in sediment in Lagoon 2 and Lagoon 3.

As indicated in order-of-magnitude estimates in Table 2-18, Cs-137 (at 510 curies) is expected to dominate the radioactivity in Lagoon 1. Other radionuclides expected to be present include Pu-241 (134 curies), Sr-90 (17 curies), and Pu-238 (6.4 curies). Table 4-14 shows significant concentrations of Sr-90, Cs-137, Pu-238, Pu-239/240, and Am-241 in Lagoon 2 sediment and lower concentrations of these radionuclides in Lagoon 3 sediment.

The actual depth of the WMA 2 excavation would be based on removal of soil exceeding the subsurface soil cleanup goals, as explained in Section 7. The excavation would extend at least one foot into the Lavery till or, in the cases of Lagoon 2 and Lagoon 3, approximately two feet below the bottom the lagoons, which extend into the Lavery till. The configuration of the residual source would therefore be similar to the bottom of the excavation shown in the representative cross section in Figure 5-3.

While the subsurface soil cleanup goals serve as the remediation criteria for the two excavations as specified in Section 7, actual residual contamination levels in the Lavery till are expected to be well below these criteria. The concentrations of Sr-90 and Cs-137 are expected to be of the same order of magnitude as the lower surface soil cleanup goals.

[2] The 26-foot estimate is based on using the ground surface adjacent to Lagoon 3 as a reference point. The excavation is expected to extend several feet below the bottoms of Lagoons 2 and 3 to remove sediment with radioactivity concentrations above DCGLs.

are Sr-90 (due to water independent plant uptake), I-129 (due to water dependent pathways), Cs-137 (external radiation dose), and most uranium radionuclides (water dependent pathways).

The sensitivity analysis of the surface soil model, for these radionuclides, indicates the following:

- A lower indoor exposure fraction results in the largest DCGL decrease for U-232 and no change for I-129. Similarly, a higher indoor exposure fraction results in the largest increase for U-232 and no change for I-129 and U-234. However, it is unlikely that the indoor fraction is too low based on the local climate. The U-232 doses are mainly due to external exposure, which accounts for the relative sensitivity to this parameter.
- Decreasing the source thickness increased the DCGL for all radionuclides and increasing the source thickness resulted in the most significant DCGL decrease for U-235. The sensitivity to this parameter is due to increased/decreased dose from the water ingestion and plant pathways (both water dependent and independent).
- Decreasing the unsaturated zone thickness resulted in an increased DCGL for U-235 and a decrease for U-238. Similarly, increasing the unsaturated zone thickness decreased the U-235 DCGL and increased the U-238 DCGL. Sensitivity to this parameter is mainly due to increased/decreased travel time of contaminants to the saturated zone, resulting in water dependent doses occurring earlier/later with respect to doses from water independent pathways.
- Reducing the irrigation/well pump rate increased the DCGL for I-129 most significantly. Similarly, increasing the pump rate decreased the DCGL for I-129. This is because reducing the pumping rate results in a lower dilution factor, and increasing the pumping rate results in more radionuclide inventory available for exposure.
- The most significant effects of varying the K_d values were observed for Sr-90 and U-234.
- Decreasing the hydraulic conductivity significantly increased the DCGL for I-129 due to increasing the travel time to the well. Increasing the hydraulic conductivity significantly increased the DCGL for U-235 because dilution is greater.
- Variations in the runoff/evapotranspiration coefficients had the greatest effect on U-234 and the least impact on U-232. Radionuclides that are most sensitive to this parameter have doses mainly due to water dependent pathways.
- Decreasing the well intake depth most significantly decreased the DCGL for I-129, while increasing this parameter results in significantly increased the DCGL for I-129, due to increased/decreased dilution in the well water.

- Changes to the parameter for length of contamination parallel to the aquifer flow had the most significant effect on the U-235 DCGL, due to increased/decreased dilution in the aquifer.
- Decreasing/increasing the plant transfer factors significantly increased/decreased the DCGL for Sr-90, as dose is mainly due to ingestion via plant uptake from soil.
- Use of the mass balance groundwater model significantly decreases the DCGL for U-234 but had no effect on U-232. Radionuclides most sensitive to this parameter have doses mainly due to water dependent pathways.

Table 5-10 summarizes the sensitivity analyses performed for the subsurface soil DCGLs, which are detailed in Appendix C.

Table 5-10. Summary of Parameter Sensitivity Analyses – Subsurface Soil DCGLs[1]

Parameter (Base Case)	Run	Change Made	Minimum DCGL Change		Maximum DCGL Change	
			Change	Nuclide(s)	Change	Nuclide(s)
Indoor/Outdoor Fraction (0.66/0.25)	1	-32%	-25%	Cs-137	0.1%	U-234
	2	21%	-1%	U-238	35%	U-232
Source Thickness (1m)	3	-67%	10%	U-238	193%	Sr-90
	4	233%	-66%	Sr-90	-1%	Cs-137
Unsaturated Zone Thickness (2 m)	5	-50%	-1%	U-238	0%	Cs-137, Sr-90, U-232, U-235
	6	150%	0%	Cs-137 Sr-90 U-232 U-235	1%	U-238
Irrigation/Pump Rate (0.5 m/y/ 5720 m³/y)	7	-57%	-36%	I-129	0%	Cs-137
	8	70%	0%	Cs-137	159%	U-238
Soil/Water Distribution Coefficients (K_d) (Table C-2)	9	lower	-85%	U-238	9%	U-232
	10	higher	-27%	U-232	3144%	U-234
Hydraulic Conductivity (1400 m/y)	11	-99%	-1%	U-238	3%	I-129
	12	150%	0%	Cs-137 I-129 Sr-90 U-232 U-233 U-234 U-235 U-238	0%	Cs-137, I-129, Sr-90, U-232, U-233, U-234, U-235, U-238
Runoff/Evapotranspiration Coefficient (0.6/0.55)	13	-69%	-38%	U-234	16%	U-232
	14	64%	-19%	U-232	188%	U-234

Table 5-10. Summary of Parameter Sensitivity Analyses – Subsurface Soil DCGLs(1)

Parameter (Base Case)	Run	Change Made	Minimum DCGL Change		Maximum DCGL Change	
			Change	Nuclide(s)	Change	Nuclide(s)
Plant Transfer Factors (RESRAD defaults)	15	-90%	-0.4%	U-238	574%	Sr-90
	16	900%	-89%	Sr-90	-1%	U-234
Contaminated Layer Area (100 m^2)	-	Various smaller areas	-	-	-	See note (1).

NOTES: (1) Information from the $DCGL_{EMC}$ calculations was used for evaluation of the sensitivity of the contaminated layer area. DCGLs generally increased with smaller areas. Results presented here are for radionuclides considered likely to contribute significantly to the overall subsurface soil dose based on available characterization data.

Discussion of Subsurface Soil Results

The uncertainty results for the subsurface soil source models have been evaluated considering those radionuclides that are the primary dose drivers, i.e., those that are likely to contribute significantly to predicted dose based on available characterization data (see Table 5-1). The radionuclides are Sr-90 (due to water independent plant uptake), I-129 (due to water dependent pathways), Cs-137 (external radiation dose), and uranium radionuclides (water dependent pathways).

The sensitivity analysis of the subsurface soil model for these radionuclides indicates the following:

- A lower indoor exposure fraction results in a DCGL decrease for Cs-137 and no change for U-234. A higher indoor exposure results in a significant increased DCGL for U-232. However, it is unlikely that the indoor fraction is too low based on the local climate. Doses for these isotopes are mainly due to external exposure, which accounts for the relative sensitivity to this parameter.
- The source thickness parameter sensitivity was most significant for Sr-90 The sensitivity to this parameter is due to increased/decreased dose from the water ingestion and plant pathways (both water dependent and independent).
- Decreasing or increasing the unsaturated zone thickness resulted in little change to the DCGLs.
- The I-129 and U-238 DCGLs were sensitive to changes in the irrigation/well pump rate but the Cs-137 DCGL was not. This effect is because reducing the pumping rate results in a lower dilution factor, and increasing the pumping rate results in more dilution for water dependent pathways.
- The most significant effects of varying the K_d values were observed for U-232, U-234, and U-238.
- Decreasing or increasing the hydraulic conductivity resulted in no change to the DCGLs due to use of the mass balance model.

- The U-232 and U-234 DCGLs are sensitive to changes in the runoff/ evapotranspiration coefficient. Radionuclides that are most sensitive to this parameter have doses mainly due to water dependent pathways.
- The plant transfer factor is most sensitive for Sr-90, as the dose is mainly due to ingestion via plant uptake.

Table 5-11 summarizes the sensitivity analyses performed for the streambed sediment DCGLs, which are detailed in Appendix C:

Table 5-11. Summary of Parameter Sensitivity Analyses – Streambed Sediment DCGLs(1)

Parameter (Base Case)	Run	Change Made	Minimum DCGL Change		Maximum DCGL Change	
			Change	Nuclide(s)	Change	Nuclide(s)
Indoor/Outdoor Fraction (0.00/0.012)	1	-50%	3%	Sr-90	86%	Cs-137
	2	100%	-48%	Cs-137	-5%	Sr-90
Source Thickness (1 m)	3	-50%	1%	Cs-137	29%	Sr-90
	4	200%	-0.2%	Sr-90	0%	Cs-137
Unsaturated Zone Thickness (0.0 m)	5	0 m to 1m	0.3%	Cs-137	8%	Sr-90
	6	0 m to 3 m	0.3%	Cs-137	8%	Sr-90
Soil/Water Distribution Coefficients (K_d) (Table C-2)	7	lower	0.5%	Cs-137	12%	Sr-90
	8	higher	0.3%	Cs-137	7%	Sr-90
Runoff/Evapotrans-poration Coefficient (0.6/0.55)	9	-54%	0%	Cs-137	0.4%	Sr-90
	10	78%	-0.3%	Sr-90	0%	Cs-137
Plant Transfer Factors (RESRAD defaults)	11	-90%	1%	Cs-137	82%	Sr-90
	12	900%	-82%	Sr-90	-9%	Cs-137
Fish Transfer Factors (RESRAD defaults)	13	-90%	0.3%	Cs-137	7%	Sr-90
	14	900%	-39%	Sr-90	-3%	Cs-137
Contaminated Layer Area (1000 m^2)	-	Various smaller areas	-	-	-	See note (1).

NOTES: (1) Information from the $DCGL_{EMC}$ calculations was used for evaluation of the sensitivity of the contaminated layer area. DCGLs generally increased with smaller areas. Results presented here are for radionuclides considered likely to contribute significantly to the overall sediment dose based on available characterization data.

radioactivity concentration in the Lavery till for each radionuclide as summarized in Table 5-1, and the results of modeling to develop DCGLs for 25 mrem per year as shown in Table 5-8. The results were as follow:

WMA 1, a maximum of 1.3 mrem a year

WMA 2, a maximum of 0.04 mrem a year

Given the limited data available, these results must be viewed as order-of-magnitude estimates. However, they do suggest that actual potential doses from the two remediated areas are likely to be substantially below 25 mrem per year.

NOTE

The use of maximum rather than average values in these dose estimates adds conservatism, as does including values that are simply the highest minimum detectable concentrations, especially in the case of Np-237. (There was a wide range of several orders of magnitude among the minimum detectable concentrations reported for the 2008 sample data.) As with the DCGLs, decay of Sr-90 and Cs-137 over 30 years is accounted for in the estimate.

5.4.5 Final Dose Assessment

As noted previously, DOE would perform a dose assessment for the residual radioactivity in the WMA 1 and WMA 2 excavated areas using Phase 1 final status survey data. This assessment would use the same methodology used in development of the subsurface soil DCGLs to estimate the potential radiation dose using the actual measured residual radioactivity concentrations. The results of the dose assessment would be made available to NRC and other stakeholders. Note that a more-comprehensive dose assessment that also takes into account the Phase 2 sources may be performed in connection with Phase 2 of the proposed decommissioning, depending on the approach selected for that phase.

5.5 References

Code of Federal Regulations

10 CFR 20, Subpart E, *Radiological Criteria For License Termination (LTR)*.

10 CFR 20.1003, *Definitions.*

DOE Orders

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WVNSCO 1993b, *Environmental Information Document Volume I, Geology,* WVDP-EIS-004, Revision 0. West Valley Nuclear Services Company, West Valley, New York, April 1, 1993.

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Neutralization Pit

The Neutralization Pit would be removed using a process similar to the following:

- Removing any residual water, treating it for disposal via an SPDES-permitted outfall or solidifying it for disposal as LLW; and
- Removing the liner, concrete walls, and floor of the pit.

The underground wastewater lines in the area of the Neutralization Pit would be removed in connection with digging the WMA 2 excavation described in Section 7.4.3. Phase 1 final status surveys, independent confirmatory surveys, and filling the excavation are also addressed in Section 7.4.3.

Old Interceptor

The Old Interceptor would be demolished using a process similar to that used for the Neutralization Pit, with additional radiological controls appropriate to the larger amount of residual radioactivity it contains.

New Interceptors

The New Interceptors would be demolished using a process similar to that used for the Neutralization Pit.

Concrete Floor Slabs and Foundations

The concrete floor slabs of the O2 Building, Test and Storage Building, Vitrification Test Facility, Maintenance Shop, Maintenance Storage Area, and the Vehicle Maintenance Shop would be removed and the building footprints excavated approximately two feet below grade. Phase 1 final status surveys would be performed in the excavated areas, and arrangements made for an independent verification survey if desired by the regulators. After the surveys have been completed, the excavations would be filled with earth.

7.4.3 Decommissioning the Lagoons

Decommissioning of Lagoons 1, 2, and 3 would involve constructing a vertical hydraulic barrier on the northwest side of the lagoons and digging a single large excavation. Lagoons 4 and 5 would be removed separately. Figure 7-10 shows the conceptual plan view of the large excavation and the location of the hydraulic barrier wall. Figure 7-11 shows the conceptual cross section.

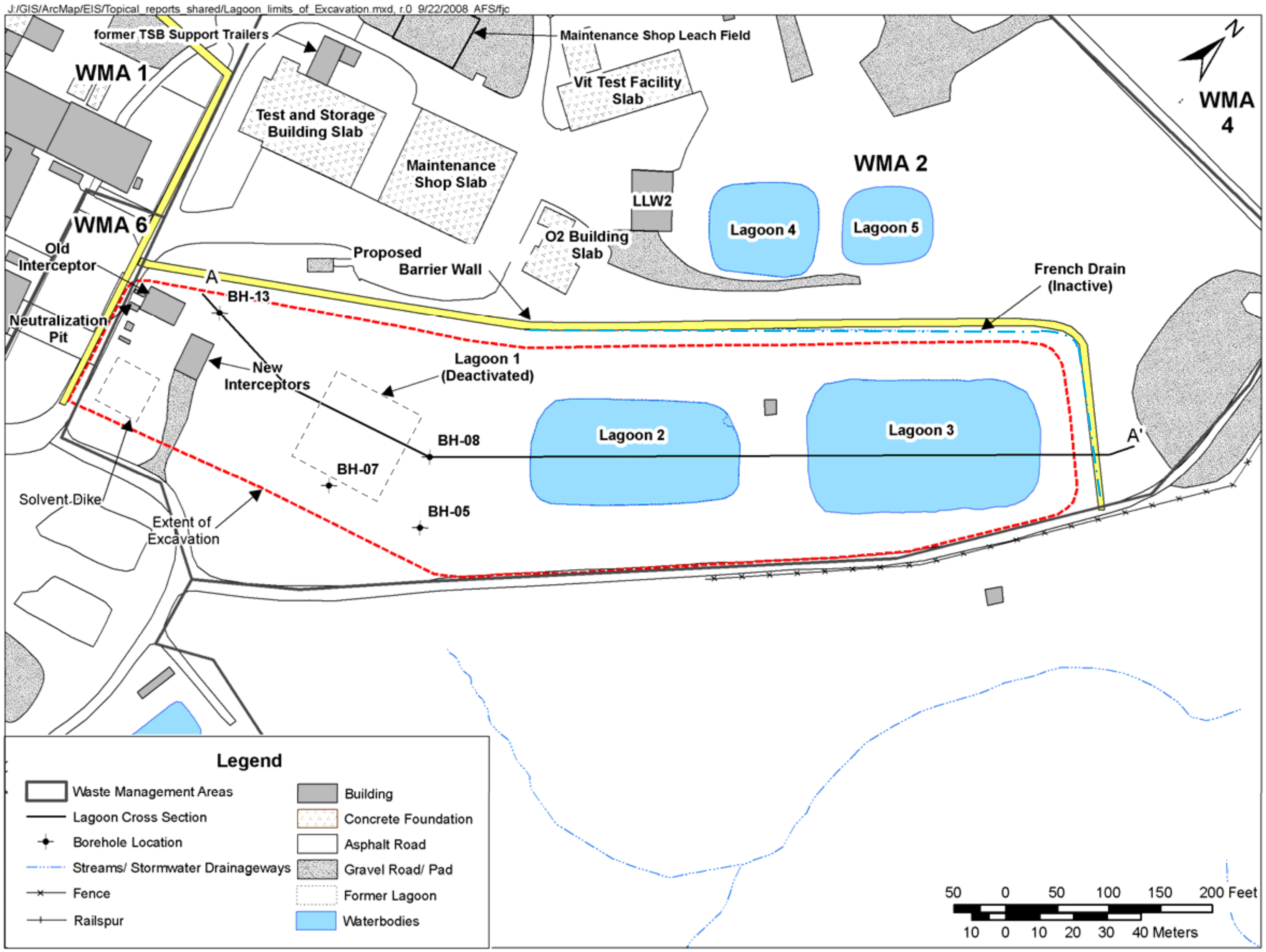

Figure 7-10. Conceptual Arrangement of WMA 2 Excavation, Plan View

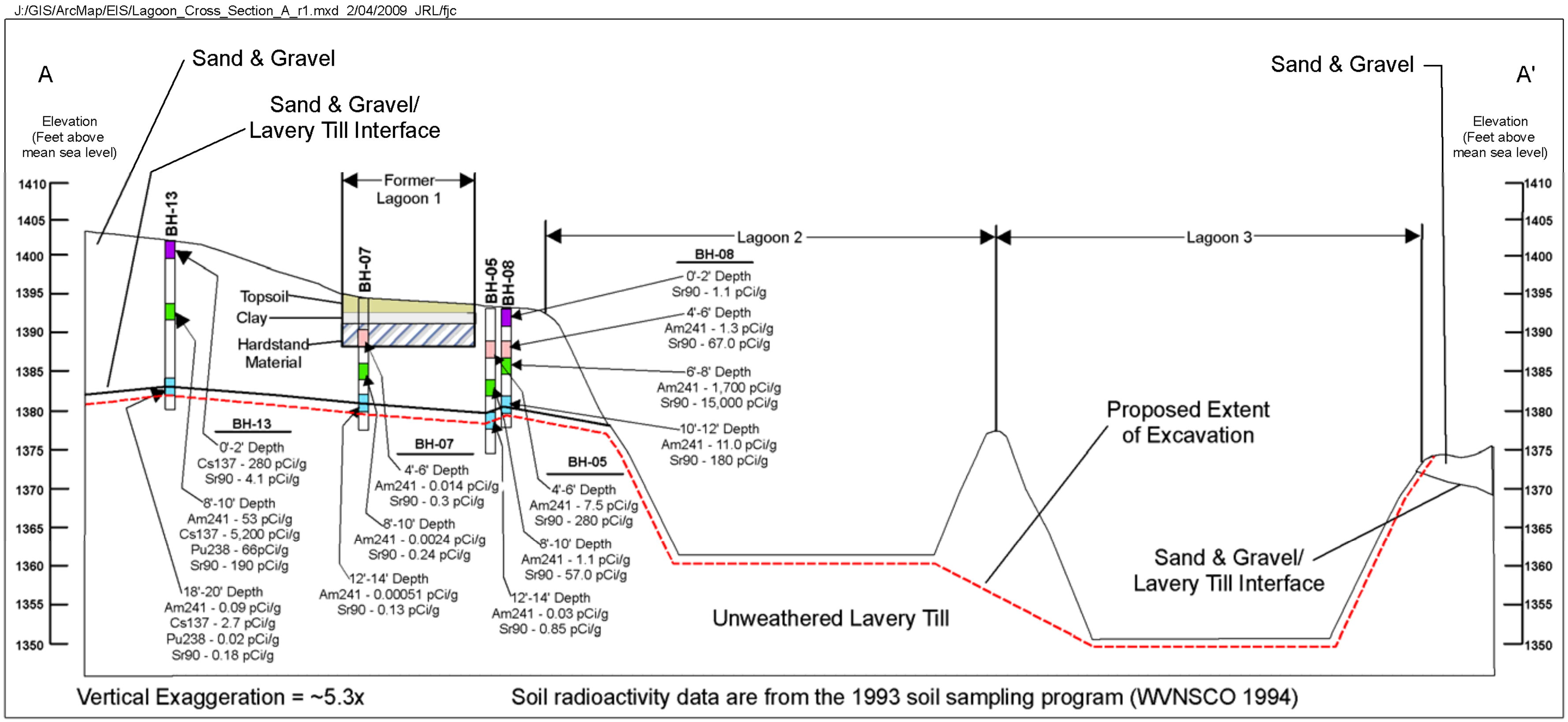

Figure 7-11. Conceptual Arrangement of WMA 2 Excavation, Cross Section

Hydraulic Barrier Wall Installation

To isolate the area of WMA 2 to be excavated from the north plateau groundwater plume, a vertical hydraulic barrier wall would be installed as shown in Figure 7-10. This hydraulic barrier would consist of a soil-cement-bentonite barrier wall that would extend approximately two feet into the Lavery till. It would remain in place after the excavation is backfilled.

Before the hydraulic barrier wall is installed, underground lines in its footprint that carried radioactive liquid would be located. Sections of these lines in the area where the wall would be constructed would be removed in a controlled manner to avoid unnecessary release of contamination. During this process, characterization measurements would be taken in the end of each line that would remain in place and the line capped.

The total length of the barrier wall would be approximate 1100 feet. It would be sufficiently wide to provide the stability necessary to permit excavation up to the base of the wall. This barrier wall would connect with the WMA 1 hydraulic barrier wall as shown in Figure 7-10. It would be constructed in the same manner as the WMA 1 slurry wall and have an in-place maximum saturated hydraulic conductivity of approximately 6E-06 cm/s. It would extend to within about three feet of grade and be topped with excavated material. Sheet piles on the southeastern side of the excavation are not expected to be necessary to control groundwater, except possibly in the Lagoon 1 area as indicated below.

Preparations for Removal of Contaminated Lagoon Sediment and Soil

Detailed planning for the excavation would take into account available information on radioactivity in the lagoon sediment, soil, and groundwater as summarized in Section 4, along with the results of the soil characterization program. The depth of the water table in the area – typically about seven feet below the surface – would also be taken into account.

Preparations, in addition to installation of the hydraulic barrier wall, would include provisions for appropriate radiological controls to minimize airborne radioactivity releases during the excavation work, such as a single-span confinement structure for the Lagoon 1 area.

Removal of Contaminated Soil and Underground Wastewater Lines

Removal of Lagoons 1, 2, and 3 and the facilities within the area to be excavated as described below would be coordinated with removal of soil in other parts of the excavation. Before excavation begins, the hydraulic barrier wall would be 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. It is expected that approximately one-half of the total amount of soil to be removed would be unsaturated.

The second phase would involve removal of soil in the saturated zone. Wastewater piping within the excavated area would be removed. Groundwater accumulating in the excavation would be pumped out, treated using a portable treatment system containing ion exchangers and filters, and discharged to Erdman Brook through an SPDES-permitted outfall.

Figure 7-11 shows the planned depth of excavation. The excavation would extend at least one foot into the Lavery till and one foot below the sediment in the bottoms of Lagoons 2 and 3 as indicated in the figure, with the amount of additional soil removal determined by the use of cleanup

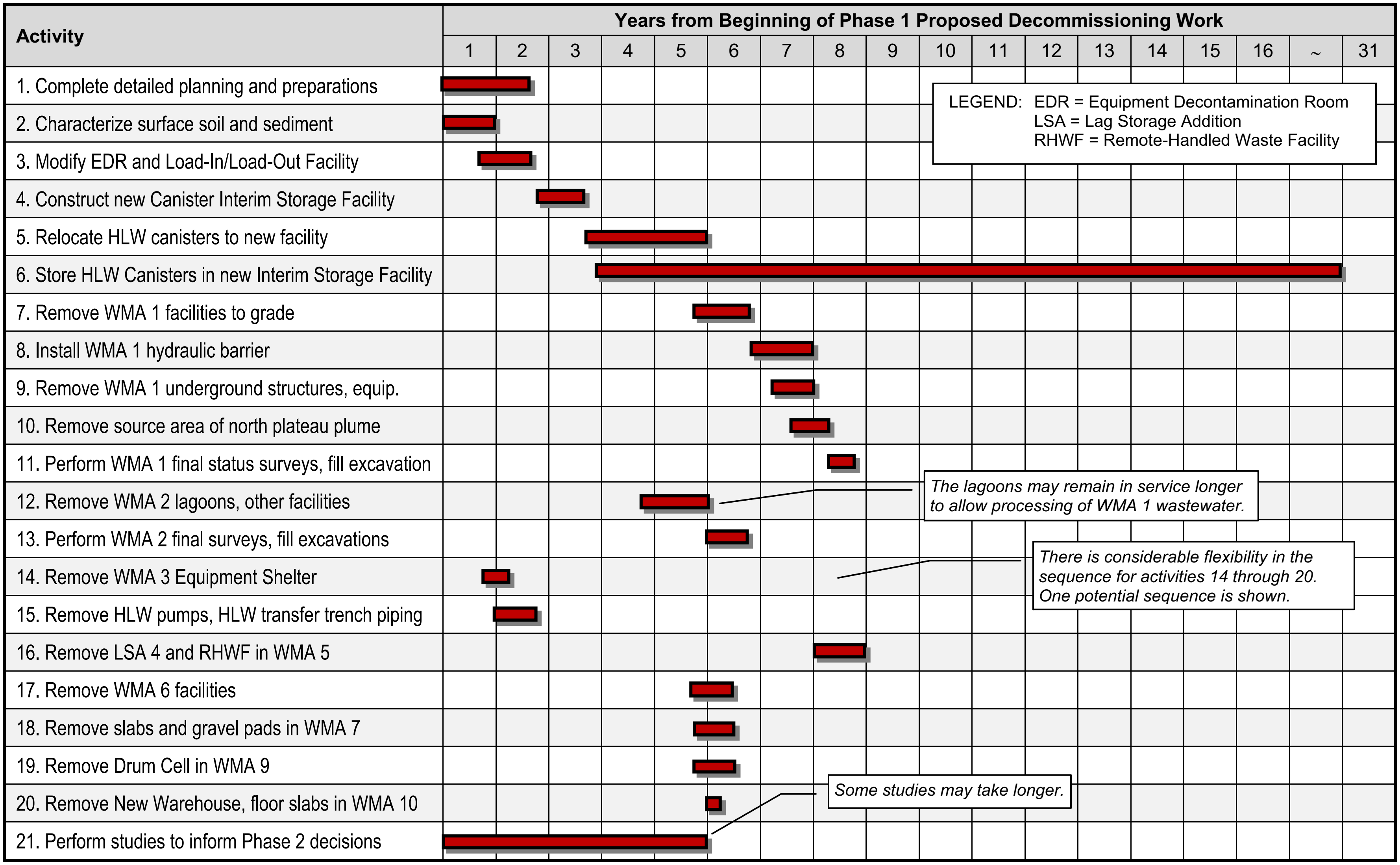

Figure 7-15. Conceptual Schedule of Phase 1 Proposed Decommissioning Activities

7.13 References

Code of Federal Regulations

40 CFR 61, *National Emission Standards for Hazardous Air Pollutants*

DOE Manuals

DOE Manual 435.1-1, Revision 1, *Radioactive Waste Management Manual*

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Table 9-1 Surface Soil Cleanup Goal Area Factors(1)

Nuclide	$DCGL_W$ 10,000 m² (pCi/g)	Area Factors ($DCGL_{EMC}/DCGL_W$)							
		5,000 m²	1,000 m²	500 m²	100 m²	50 m²	10 m²	5 m²	1 m²
Am-241	4.9E+01	1.0E+00	1.0E+00	1.9E+00	7.2E+00	1.1E+01	2.6E+01	3.8E+01	8.1E+01
C-14	3.1E+01	1.7E+00	4.3E+00	1.2E+01	1.2E+02	3.2E+02	2.9E+03	7.0E+03	4.8E+04
Cm-243	4.2E+01	1.0E+00	1.0E+00	1.4E+00	2.3E+00	2.6E+00	4.2E+00	6.3E+00	1.8E+01
Cm-244	9.4E+01	1.0E+00	1.0E+00	2.0E+00	9.2E+00	1.7E+01	5.4E+01	7.8E+01	1.3E+02
Cs-137	2.7E+01	1.1E+00	1.1E+00	1.2E+00	1.5E+00	1.6E+00	2.5E+00	3.8E+00	1.1E+01
I-129	5.8E-01	1.5E+00	3.4E+00	6.1E+00	3.2E+01	6.5E+01	3.2E+02	6.5E+02	3.2E+03
Np-237	9.6E-02	1.3E+00	2.7E+00	4.7E+00	2.4E+01	4.8E+01	2.3E+02	4.6E+02	2.2E+03
Pu-238	5.8E+01	1.0E+00	1.0E+00	2.0E+00	9.3E+00	1.7E+01	5.5E+01	7.9E+01	1.3E+02
Pu-239	5.2E+01	1.0E+00	1.0E+00	2.0E+00	9.3E+00	1.7E+01	5.5E+01	7.9E+01	1.3E+02
Pu-240	5.2E+01	1.0E+00	1.0E+00	2.0E+00	9.3E+00	1.7E+01	5.5E+01	7.9E+01	1.3E+02
Pu-241	1.6E+03	1.0E+00	1.0E+00	1.9E+00	7.3E+00	1.2E+01	2.6E+01	3.8E+01	8.2E+01
Sr-90	8.7E+00	1.1E+00	1.1E+00	2.2E+00	1.1E+01	2.2E+01	1.0E+02	2.0E+02	9.2E+02
Tc-99	2.9E+01	1.3E+00	1.7E+00	3.4E+00	1.7E+01	3.4E+01	1.7E+02	3.4E+02	1.7E+03
U-232	5.6E+00	1.0E+00	1.1E+00	1.1E+00	1.3E+00	1.5E+00	2.3E+00	3.5E+00	1.1E+01
U-233	2.0E+01	1.3E+00	2.6E+00	4.6E+00	2.1E+01	3.9E+01	1.3E+02	2.2E+02	7.1E+02
U-234	2.1E+01	1.3E+00	2.6E+00	4.7E+00	2.4E+01	4.7E+01	2.2E+02	4.2E+02	1.1E+03
U-235	1.4E+01	1.4E+00	2.9E+00	4.8E+00	5.7E+00	6.3E+00	9.8E+00	1.5E+01	4.3E+01
U-238	2.2E+01	1.3E+00	2.6E+00	4.5E+00	1.7E+01	2.0E+01	3.2E+01	4.8E+01	1.4E+02

NOTE: (1) From Table C-16 of Appendix C. The values in the second column are the cleanup goals (CG_W) from Table 5-14.

Table 9-2. Subsurface Soil Cleanup Goal Area Factors(1)

Nuclide	$DCGL_W$ 100 m² (pCi/g)	Area Factors ($DCGL_{EMC}/DCGL_W$)			
		50 m²	10 m²	5 m²	1 m²
Am-241	2.9E+03	1.4E+00	2.5E+00	3.6E+00	7.1E+00
C-14	1.9E+05	2.6E+00	2.3E+01	5.5E+01	3.4E+02
Cm-243	5.1E+02	1.1E+00	1.8E+00	2.7E+00	7.9E+00
Cm-244	8.8E+03	1.7E+00	4.1E+00	5.2E+00	7.5E+00
Cs-137	2.0E+02	1.1E+00	1.8E+00	2.7E+00	8.5E+00
I-129	1.9E+02	2.0E+00	1.0E+01	2.0E+01	1.0E+02
Np-237	1.7E+01	2.0E+00	1.0E+01	2.0E+01	1.0E+02
Pu-238	5.5E+03	1.7E+00	4.1E+00	5.3E+00	7.5E+00
Pu-239	5.0E+03	1.7E+00	4.2E+00	5.3E+00	7.6E+00
Pu-240	5.0E+03	1.7E+00	4.2E+00	5.3E+00	7.6E+00
Pu-241	9.8E+04	1.4E+00	2.6E+00	3.6E+00	7.1E+00

Table 9-2. Subsurface Soil Cleanup Goal Area Factors[1]

Nuclide	$DCGL_W$ 100 m^2 (pCi/g)	Area Factors ($DCGL_{EMC}/DCGL_W$)			
		50 m^2	10 m^2	5 m^2	1 m^2
Sr-90	1.4E+03	1.9E+00	8.1E+00	1.5E+01	6.5E+01
Tc-99	5.0E+03	2.0E+00	9.9E+00	2.0E+01	9.8E+01
U-232	5.3E+01	1.1E+00	1.9E+00	2.8E+00	8.8E+00
U-233	7.5E+02	2.0E+00	1.0E+01	2.0E+01	9.6E+01
U-234	7.7E+02	2.0E+00	1.0E+01	2.0E+01	1.0E+02
U-235	4.3E+02	1.1E+00	1.7E+00	2.6E+00	7.8E+00
U-238	8.2E+02	2.0E+00	4.7E+00	7.0E+00	2.0E+01

NOTE: (1) From Table C-47 of Appendix C. The values in the second column are the cleanup goals (CG_W) from Table 5-14.

Table 9-3. Streambed Sediment Cleanup Goal Area Factors[1]

Nuclide	$DCGL_W$ 1,000 m^2 (pCi/g)	Area Factors ($DCGL_{EMC}/DCGL_W$)					
		500 m^2	100 m^2	50 m^2	10 m^2	5 m^2	1 m^2
Am-241	1.6E+03	1.5E+00	2.9E+00	3.5E+00	5.7E+00	8.5E+00	2.4E+01
C-14	3.4E+02	2.5E+00	2.0E+01	4.5E+01	2.8E+02	6.1E+02	3.3E+03
Cm-243	3.6E+02	1.1E+00	1.2E+00	1.3E+00	2.0E+00	3.1E+00	9.1E+00
Cm-244	4.7E+03	2.0E+00	9.8E+00	1.9E+01	8.5E+01	1.6E+02	6.8E+02
Cs-137	1.3E+02	1.1E+00	1.2E+00	1.3E+00	2.1E+00	3.1E+00	9.4E+00
I-129	3.7E+02	2.0E+00	8.6E+00	1.5E+01	4.6E+01	7.7E+01	2.5E+02
Np-237	5.4E+01	1.6E+00	3.3E+00	4.1E+00	7.1E+00	1.1E+01	3.2E+01
Pu-238	2.0E+03	2.0E+00	9.9E+00	2.0E+01	9.2E+01	1.8E+02	8.1E+02
Pu-239	1.8E+03	2.0E+00	9.8E+00	1.9E+01	8.9E+01	1.7E+02	7.7E+02
Pu-240	1.8E+03	2.0E+00	9.9E+00	2.0E+01	9.3E+01	1.8E+02	8.4E+02
Pu-241	5.2E+04	1.6E+00	3.0E+00	3.6E+00	5.8E+00	8.7E+00	2.4E+01
Sr-90	9.5E+02	1.9E+00	7.2E+00	1.1E+01	2.9E+01	4.6E+01	1.5E+02
Tc-99	2.2E+05	1.8E+00	5.1E+00	7.0E+00	1.4E+01	2.1E+01	6.3E+01
U-232	2.7E+01	1.0E+00	1.2E+00	1.3E+00	2.0E+00	3.0E+00	9.5E+00
U-233	5.8E+03	1.9E+00	3.7E+00	4.0E+00	6.2E+00	9.3E+00	2.8E+01
U-234	6.1E+03	2.0E+00	9.2E+00	1.7E+01	5.2E+01	7.9E+01	2.4E+02
U-235	2.9E+02	1.0E+00	1.2E+00	1.3E+00	1.9E+00	2.9E+00	8.6E+00
U-238	1.3E+03	1.1E+00	1.4E+00	1.5E+00	2.3E+00	3.5E+00	1.1E+01

NOTE: (1) From Table C-75 of Appendix C. The values in the second column are the cleanup goals (CG_W) from Table 5-14.

A *surrogate radionuclide* is a radionuclide in a mixture of radionuclides whose concentration is more easily measured and can be used to infer the concentrations of the other radionuclides in the mixture. If actual radioactive contamination levels are below the specified concentrations of the surrogate radionuclide, then the sum of doses from all radionuclides in the mixture would fall below the dose limit of 25 mrem/y. Tables in Section 5 do not presently show $DCGL_W$ values for a surrogate radionuclide because available data on radionuclide distributions in soil and sediment are not sufficient to support this, but Section 5 may be revised after additional characterization data become available to provide such information.

As characterization and in-process surveys are performed, additional data would become available that could necessitate re-evaluation of the DCGLs, if, for example, assumptions used in development of the DCGLs were found to be incorrect based on the additional data. If such a situation develops, revised DCGLs would be calculated and this plan changed to incorporate the revised DCGLs and any related changes.

9.2 Types of Surveys and Their Purposes

Seven types of radiological surveys are associated with the WVDP Phase 1 proposed decommissioning project: (1) background surveys, (2) scoping surveys, (3) end-of-task surveys taken at the conclusion of deactivation activities, (4) characterization surveys, (5) in-process or remedial action support surveys, (6) Phase 1 final status surveys, and (7) confirmatory surveys. The nature of these surveys and, in some cases, the basic requirements are summarized here; more detail is provided further below on background surveys (9.3), characterization surveys (9.4), in-process surveys (9.5), and Phase 1 final status surveys (9.6).

9.2.1 Background Surveys

Background surveys are performed in non-impacted areas around the facility and in non-impacted buildings of construction similar to those impacted buildings of interest. Background surveys establish the baseline levels of radiation and radioactivity from radionuclides occurring in the environment or incorporated into the structural materials. Requirements for background surveys are summarized in Section 9.3 below.

9.2.2 Scoping Surveys

Scoping surveys are conducted (1) to provide preliminary data to supplement historical site assessment information needed to guide planning of characterization surveys, (2) to identify radionuclide contaminants, (3) to identify relative radionuclide ratios, and (4) to identify the general levels and extent of contaminants. As noted in Section 4, much of the existing radiological data associated with the WVDP proposed decommissioning project falls into the category of scoping survey data, although these data were generally not acquired as scoping survey data but were acquired for other operational needs. Additional scoping surveys are not planned for Phase 1 of the WVDP proposed decommissioning.

9.2.3 End-of-Task Surveys

As explained in Section 1, additional deactivation work will be completed in certain areas of the Process Building during deactivation work to be accomplished before the Phase 1 proposed decommissioning activities begin, and numerous ancillary project facilities will be removed during this period. After each area is deactivated and after each facility is removed, end-of-task or “final radiological characterization” surveys will be performed to define the resulting radiological conditions.

Such surveys are not within the scope of this plan since they will be completed before proposed decommissioning activities begin. However, their results will be considered in connection with defining characterization surveys and Phase 1 final status surveys to be performed during the proposed decommissioning.

9.2.4 Characterization Surveys

Characterization surveys include facility and site sampling, monitoring, and analysis activities to determine the extent and nature of residual contamination. They provide the basis for planning decommissioning actions, and providing technical information to develop, evaluate, and select appropriate remediation techniques. They also provide information for radiation protection purposes and for characterizing waste.

Four WVDP characterization survey programs have been completed: (1) the characterization program for the underground waste tanks, (2) the Facility Characterization Project, (3) a series of Resource Conservation and Recovery Act (RCRA) facility investigations performed in the 1990s, and (4) investigations of the north plateau groundwater plume using a Geoprobe®.[1] Additionally, routine groundwater and other environmental media sampling and analysis are performed as required by DOE Orders for annual monitoring programs. The results of these programs are summarized in Section 4. The approaches used are outlined in Section 9.7 below.

As indicated in Section 4 and Section 7, additional characterization would be performed in connection with proposed decommissioning fieldwork. The requirements for this characterization are addressed in Section 9.4.

9.2.5 In-Process Surveys

In-process surveys, also referred to as remedial action support surveys, include facility and site sampling, monitoring, and analysis activities performed in support of decontamination work. They provide information necessary for radiation protection, for guiding cleanup work, for determining when field decontamination goals have been attained, and to indicate when areas are ready for Phase 1 final status surveys. Requirements for in-process surveys are discussed in Section 9.5 below.

[1] As indicated in Section 4, additional characterization of subsurface soil in the area of the north plateau groundwater plume was accomplished in 2008. The results of this program are summarized in Section 4.

CONTENT	SECTION	PAGE
~~The maximum and average radiation levels in mrem/hr in each room or work area~~	NA	NA
~~A scale drawing or map of the rooms or work areas showing the locations of radionuclide material contamination~~	NA	NA
IV.b. CONTAMINATED SYSTEMS AND EQUIPMENT		
~~A list or description and the location of all systems or equipment at the facility that contain residual radioactive material in excess of site background levels~~	NA	NA
~~A summary of the radionuclides present in each system or on the equipment at each location, the maximum and average radionuclide activities in dpm/100cm^2, and, if multiple radionuclides are present, the radionuclide ratios~~	NA	NA
~~The maximum and average radiation levels in mrem/hr at the surface of each piece of equipment~~	NA	NA
~~A summary of the background levels used during scoping or characterization surveys~~	NA	NA
~~A scale drawing or map of the rooms or work areas showing the locations of the contaminated systems or equipment~~	NA	NA
IV.c. SURFACE SOIL CONTAMINATION *Information provided focuses on the project premises using existing data, which are not available for all locations on the project premises. Contamination in stream sediment is also addressed.*		
A list or description of all locations at the facility where surface soil contains residual radioactive material in excess of site background levels	4.2.3 Figure 4-6	4-29 4-31
A summary of the background levels used during scoping or characterization surveys	4.2.2 Table 4-11 Figure B-1 Table B-1	4-25 4-26 B-3 B-4
A summary of the radionuclides present at each location, the maximum and average radionuclide activities in pCi/gm, and, if multiple radionuclides are present, the radionuclide ratios	4.2.3 4.2.5	4-29 4-35
The maximum and average radiation levels in mrem/hr at each location *[Data are not available at sample locations.]*	4.2.6	4-48

CONTENT	SECTION	PAGE
A scale drawing or map of the site showing the locations of radionuclide material contamination in surface soil	Figure 4-6	4-31
IV.d. SUBSURFACE SOIL CONTAMINATION *Information provided focuses on the project premises using existing data, which are not available for all locations on the project premises.*		
A list or description of all locations at the facility where subsurface soil contains residual radioactive material in excess of site background levels	4.2.4 Figure 4-7 Figure 4-8	4-30 4-32 4-34
A summary of the background levels used during scoping or characterization surveys	4.2.2	4-25
A summary of the radionuclides present at each location, the maximum and average radionuclide activities in pCi/gm, and, if multiple radionuclides are present, the radionuclide ratios	4.2.4 4.2.5	4-30 4-35
The depth of the subsurface soil contamination at each location	Figure 4-8 4.2.5	4-34 4-35
A scale drawing or map of the site showing the locations of subsurface soil contamination	Figure 4-7 Figure 4-8	4-32 4-34
IV.e. SURFACE WATER *[Information provided focuses on the project premises using existing data, which are not available for all locations on the project premises.]*		
A list or description of all surface water bodies at the facility that contain residual radioactive material in excess of site background levels	4.2.7 Figure 4-11	4-54 4-55
A summary of the background levels used during scoping or characterization surveys	Table 4-11	4-26
A summary of the radionuclides present in each surface water body and the maximum and average radionuclide activities in becquerel per liter (Bq/L) (picocuries per liter (pCi/L)	Table 4-24	4-56
IV.f. GROUND WATER *Information provided focuses on the project premises.*		
A summary of the aquifer(s) at the facility that contain residual radioactive material in excess of site background levels	4.2.8	4-57
A summary of the background levels used during scoping or characterization surveys	Table 4-11	4-26

CONTENT	SECTION	PAGE
A summary of the radionuclides present in each aquifer and the maximum and average radionuclide activities in Becquerel per liter (Bq/L) (picocuries per liter (pCi/L))	Table 4-25	4-58
V. DOSE MODELING		
V.a. UNRESTRICTED RELEASE USING SCREENING CRITERIA *Screening criteria are not used.*		
V.a.1. Unrestricted Release Using Screening Criteria for Building Surface Residual Radioactivity		
~~The general conceptual model (for both the source term and the building environment) of the site~~	NA	NA
~~A summary of the screening method (i.e., running DandD or using the look-up Tables) used in the DP~~	NA	NA
V.a.2. Unrestricted Release Using Screening Criteria for Surface Soil Residual Radioactivity		
~~Justification on the appropriateness of using the screening approach (for both the source term and the environment) at the site~~	NA	NA
~~A summary of the screening method (i.e., running DandD or using the look-up Tables) used in the DP~~	NA	NA
V.b. UNRESTRICTED RELEASE USING SITE-SPECIFIC INFORMATION *Although no remediated areas would be released for unrestricted use during Phase 1, information specified in this subsection is provided for development of DCGLs and cleanup goals for surface soil, subsurface soil, and streambed sediment. The level of detail provided is similar to that in the Decommissioning EIS.*		
Source term information including nuclides of interest, configuration of the source, and areal variability of the source	5.1.2	5-2
Description of the exposure scenario including a description of the critical group	5.2.1 Figure 5-7 Figure 5-8 Figure 5-9	5-20 5-20 5-24 5-28
Description of the conceptual model of the site including the source term, physical features important to modeling the transport pathways, and the critical group	5.2.1 Figure 5-7 Figure 5-8 Figure 5-9	5-20 5-20 5-24 5-28
Identification/description of the mathematical model used (e.g., hand calculations, DandD Screen v1.0, and RESRAD v5.81)	5.2.2	5-31

CONTENT	SECTION	PAGE
Description of the parameters used in the analysis	Table C-1	C-3
Discussion about the effect of uncertainty on the results	5.2.4	5-35
Input and output files or printouts, if a computer program was used	App C Related CD	C-1
V.c. RESTRICTED RELEASE USING SITE-SPECIFIC INFORMATION *Although Phase 1 proposed decommissioning activities would not result in a restricted release, this plan provides a limited site-wide integrated dose assessment to help place the Phase 1 proposed decommissioning activities involving remediation of soil in the WMA 1 and WMA 2 excavations into context with regard to supporting potential Phase 2 decommissioning alternatives. Information provided on the topics in this subsection is limited to that necessary to support this assessment. The level of detail is similar to that in the Decommissioning EIS.*		
Source term information including nuclides of interest, configuration of the source, areal variability of the source, and chemical forms	5.1.2	5-2
A description of the exposure scenarios, including a description of the critical group for each scenario	5.2.1 Figure 5-7 Figure 5-8 Figure 5-9	5-20 5-20 5-24 5-28
A description of the conceptual model(s) of the site that includes the source term, physical features important to modeling the transport pathways, and the critical group for each scenario	5.2.1 Figure 5-7 Figure 5-8 Figure 5-9	5-120 5-20 5-24 5-28
Identification/description of the mathematical model(s) used (e.g., hand calculations and RESRAD v5.81)	5.2.2	5-31
A summary of parameters used in the analysis	Table C-1	C-3
A discussion about the effect of uncertainty on the results	5.2.4	5-35
Input and output files or printouts, if a computer program was used	App C Related CD	C-1
V.d. RELEASE INVOLVING ALTERNATE CRITERIA *DOE would not use alternative criteria.*		
~~Source term information including nuclides of interest, configuration of the source, areal variability of the source, and chemical forms~~	NA	NA
~~A description of the exposure scenarios, including a description of the critical group for each scenario~~	NA	NA

APPENDIX B
ENVIRONMENTAL RADIOACTIVITY DATA

PURPOSE OF THIS APPENDIX

The purpose of this appendix is to provide information on radioactivity in environmental media to supplement information in Section 4.2. This appendix discusses how radionuclide-specific and media-specific background values were developed and describes the methods used to determine whether specific areas of the site have been impacted (i.e., contain media with radioactivity concentrations in excess of background).

INFORMATION IN THIS APPENDIX

This appendix identifies locations used in establishing background radioactivity concentrations and methods used for calculating these concentrations. It also provides tables of background summary data for each environmental medium, explains methods used to evaluate concentrations exceeding background in onsite environmental media, provides tables of radionuclide ratios, and provides summary data of radioactivity concentrations and status with respect to background at onsite routine monitoring locations. Supplementary data for groundwater sampling points (e.g., location coordinates, sample depth, geologic unit) are also provided.

RELATIONSHIP TO OTHER PARTS OF THE PLAN

The information in this appendix supplements that provided in Section 4.2 and supports planning for additional characterization of soil and sediment to be performed early in Phase 1 of the proposed decommissioning in accordance with the Characterization Sample and Analysis Plan described in Section 9.

1.0 Locations Used for Background Calculations

Samples of surface soil, sediment, surface water, and groundwater are routinely collected from background locations (i.e., "control" or "rference" locations) as part of the WVDP *Environmental Monitoring Program Plan* (WVES 2008a) and the WVDP *Groundwater Monitoring Plan* (WVES 2008b). Environmental radiation measurements are also taken with thermoluminescent dosimeters (TLDs) at background locations as described in the *Environmental Monitoring Program Plan*. Location designators beginning with a "W" indicate a water sample. Those beginning with an "S" indicate soil or sediment samples. A designator beginning with a "D" indicates direct measurement of environmental exposure.

1.1 Surface Soil

Surface soil samples were collected annually until 2004, when the collection period was reduced to once every three years. (In 2008, the frequency was reduced further to once every five years, and sampling at most locations was discontinued.) Data from only two background locations were available. One (SFGRVAL, located at the air sampling station in Great Valley) is the primary (and current) background location. The other (SFNASHV, located at the former air sampling station at Nashville) was discontinued in 2003. (See Figure B-1.) Therefore, few data points were available to calculate surface soil backgrounds.

To increase the number of data points for estimating background radionuclide concentrations, data from soil collected at other offsite sampling locations (i.e., at perimeter locations and in the nearby communities of West Valley and Springville) were evaluated for the possibility of using data from each in soil background calculations. Data sets for each radionuclide from each soil sampling location (1995-2007) were statistically compared with the comparable data set from the primary background location, SFGRVAL, using the nonparametric Mann-Whitney U-test (Sheskin 1997). The null hypothesis being tested was that the median of the test data set was higher than the median at the reference data set (SFGRVAL) (one-tailed test, $P<0.05$). The results are summarized in Table B-1 below, with the sample locations shown in Figure B-1 or B-2. (Note that, at the 0.05 level, the possibility of making an incorrect decision regarding the status of the location with respect to background could have occurred by chance alone five percent of the time.)

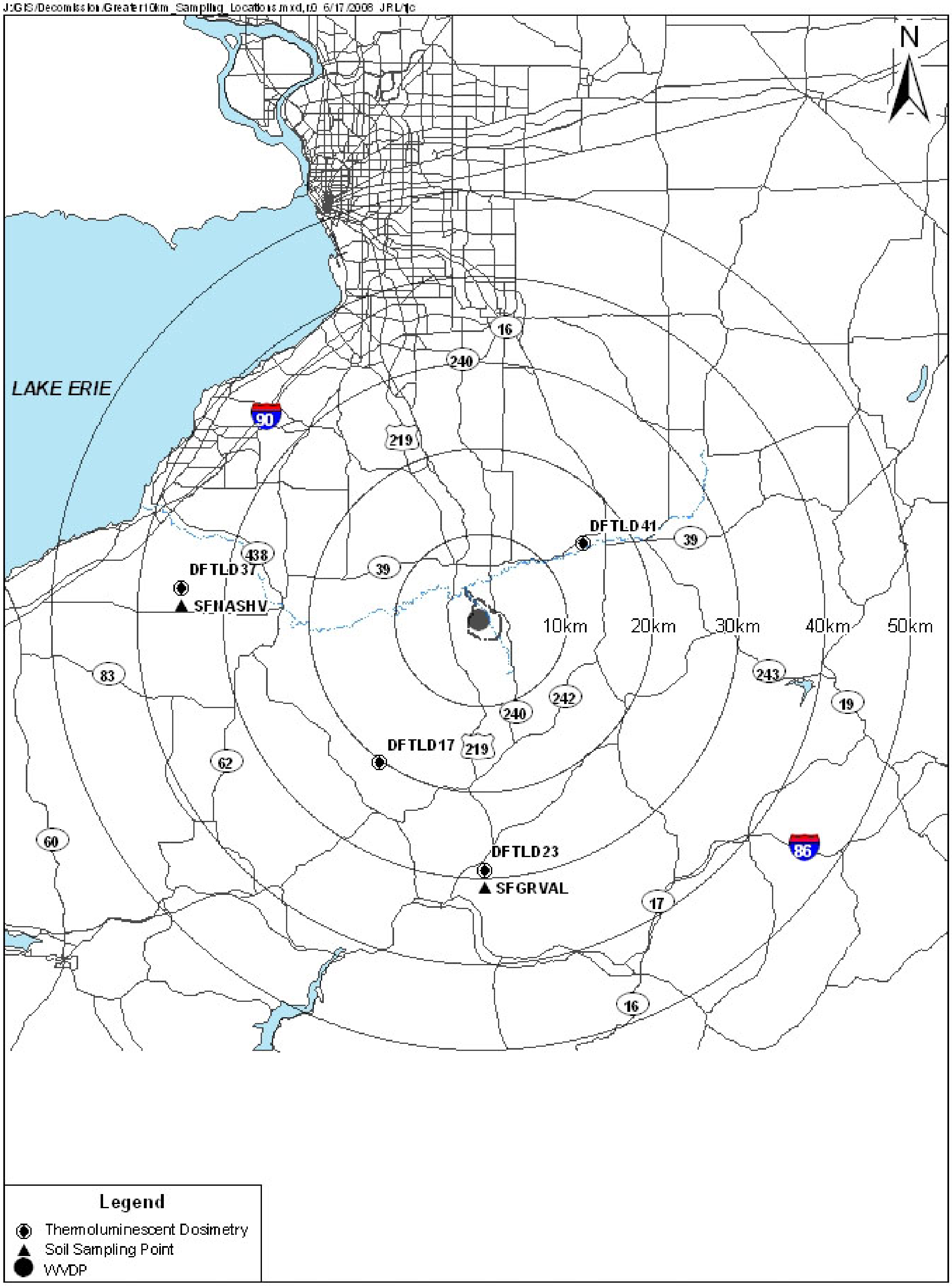

Figure B-1. Background Sampling Locations More Than 10 Kilometers From the WVDP

Table B-1. Summary of Comparisons of Radionuclide Data from Test Surface Soil Locations vs. SFGRVAL Background

Location	Radionuclide Measurement									
	Gross alpha	Gross Beta	Sr-90	Cs-137	U-232	U-233/ 234	U-235/ 236	U-238	Pu-238	Pu-239/ 240	Am-241
SFGRVAL vs.											
SFNASHV	NS	NS	NS	NS	---	---	---	---	NS	NS	NS
SFFXVRD	NS	NS	NS	NS	---	---	---	---	NS	NS	NS
SFTCORD	NS	Higher	NS	NS	---	---	---	---	NS	NS	NS
SFRT240	NS	NS	NS	NS	---	---	---	---	NS	NS	NS
SFSPRVL	NS	NS	NS	NS	---	---	---	---	NS	NS	NS
SFWEVAL	NS	NS	NS	NS	---	---	---	---	NS	NS	NS
SFBOEHN	NS	NS	NS	NS	NS	Higher	NS	NS	NS	NS	NS
SFRSPRD	NS	NS	NS	Higher	NS	NS	NS	NS	NS	NS	NS
SFBLKST	NS	Higher	NS	NS	---	---	---	---	NS	NS	NS

KEY: **Higher** = Null hypothesis was not rejected; results higher than background (P<0.05).
NS = Null hypothesis was rejected; results were not significantly higher than background.
--- = Constituent was not measured at this location.

LOCATION CODES: SFGRVAL = Background at Great Valley;
SFNASHV = Background at Nashville in the town of Hanover;
SFTCORD = Perimeter at Thomas Corners Road;
SFRT240 = Perimeter at Route 240;
SFSPRVL = Community at Springville;
SFWEVAL = Community at West Valley;
SFBOEHN = Perimeter at Boehn Road;
SFRSPRD = Perimeter at Rock Springs Road;
SFBLKST = Perimeter at Bulk Storage Warehouse.
(Location SFNASHV was discontinued in 2003; locations SFTCORD, SFBOEHN, and SFBLKST were discontinued 2005.)
See Figures B-1 and B-2 for sample locations.

If data were determined not to be statistically higher than background (i.e., unlikely to have been impacted by the WVDP, indicated by "NS" results in the above table), the data were pooled with data from Great Valley and included in background calculations.

As discussed in Section 4.2.1 of this plan, data were extracted from the WVDP Laboratory Information Management System. Samples from which the data were taken had been collected and analyzed in accordance with controlled sampling plans and defined quality assurance protocols. All data used for background calculations were independently validated and approved.

Although not all analyses were performed by the same laboratories over the years, before a laboratory was awarded a contract, analytical procedures were reviewed, laboratories were audited by WVDP personnel familiar with radioanalytical methods, and performance on proficiency samples for the radionuclides of interest were examined for acceptability. Analysis of alpha-emitting radionuclides – U-232, U-233/234, U-235/236, U-238, Pu-238, Pu-239/240, and Am-241 – was done by alpha spectrometry to meet contractual detection limits. After contracts were awarded, laboratories were contractually required to participate in formal crosscheck programs and perform acceptably. During the term of the contracts, laboratories were routinely audited by WVDP personnel to ensure that contractually required standards were maintained.

1.2 Subsurface soil

Data from only two boreholes (BH-38 on the north plateau and BH-39 on the south plateau) were available for this calculation when Revision 0 to this plan was prepared. The boreholes were driven into areas of the WVDP classified as non-impacted as part of a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) soil characterization study in 1993. (See Figure B-3.) Although samples were taken from three depths at each borehole, the surficial samples (0-2 feet depth) were classified as surface soil for the purposes of this plan. Therefore, only two samples from each borehole, a total of four samples, were classified as subsurface soil. Although subsurface soil background values were calculated from these four data points, they were not used initially as reference values because there were too few points. Instead, surface soil background results were used to evaluate the presence of radionuclide concentrations in excess of background in subsurface soil samples.

In 2008, subsurface soil background locations in the sand and gravel and unweathered Lavery till geological units underlying the site were sampled as part of the North Plateau Characterization Program (Michalczak 2007, Klenk 2008). Results from the sand and gravel and unweathered Lavery till samples were statistically indistinguishable, so all were combined, together with the 1993 results, to produce a subsurface soil background for the site.

1.3 Surface Water and Sediment

The routine Environmental Monitoring Program background locations were used as the source of background data. Both surface water and sediment background data were taken from samples collected at Buttermilk Creek upstream of the WVDP (surface water monitoring point WFBCBKG and sediment monitoring point SFBCSED) and at Bigelow Bridge on Cattaraugus Creek upstream of the point where Buttermilk Creek, containing effluent from the WVDP, flows into Cattaraugus Creek (surface water point WFBIGBR and sediment point SFBISED). (See Figure B-2.)

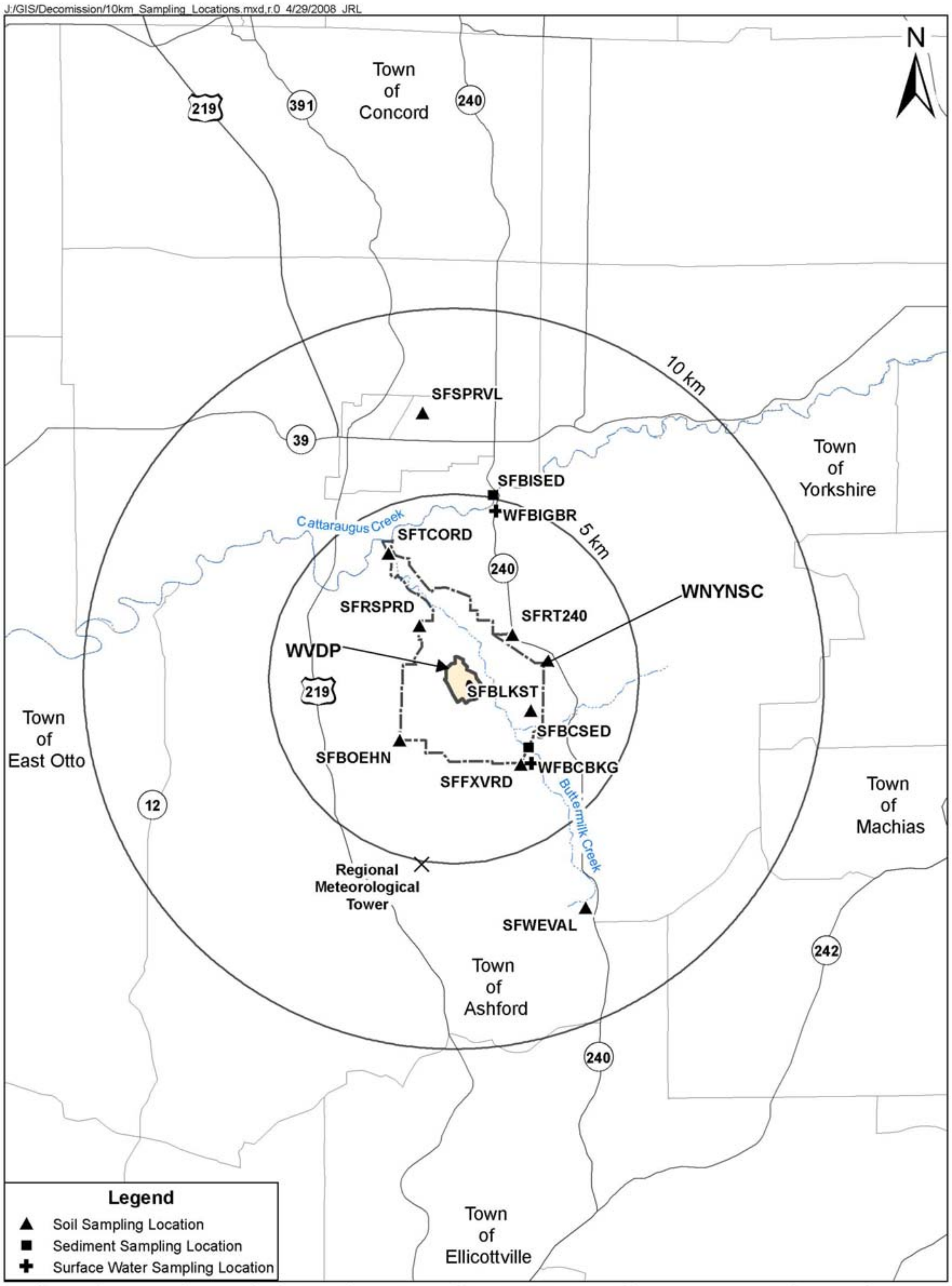

Figure B-2. Sampling Locations Within 10 Kilometers of the WVDP Used for Background Calculations

1.4 Groundwater

The routine background locations from the Groundwater Monitoring Program were used as the source of background data. (See Figure B-3.) Radionuclide concentrations were taken from monitoring wells WNWNB1S, WNW0204, WNW0301, WNW0401, WNW0405, WNW0706, WNW0901, and WNW0908, which serve(d) as upgradient reference locations for the following geologic units: the sand and gravel (S&G) unit (WNWNB1S, WNW0301, WNW0401, and WNW0706); the Lavery till sand (LTS) unit (WNW0204); the unweathered Lavery till (ULT) unit (WNW0405); the Kent recessional sequence (KRS) unit (WNW0901); and the weathered Lavery till (WLT) unit (WNW0908).

Because few background data points were available for most radionuclides in groundwater and no background isotopic data (or very limited data) were available for groundwater from some of the geological units (e.g., the Lavery till sand and the Kent recessional sequence), data sets for the various units were combined to calculate one overall site groundwater background value for each radionuclide. Potential implications of pooling the data were considered to be minimal because most of the data sets were comprised largely of nondetect values as shown in Table B-7, and because, when positive detects were noted (with the exception of naturally occurring radionuclides), they were usually below (or slightly higher than) the contractual detection limits.

1.5 Gamma Radiation Measurements From TLDs

TLD data were taken from four background locations (three no longer active) over the 1986-2007 time period. (See Figure B-1.) Measurements were taken at:

(1) The current background location (DFTLD23), located 18 miles (29 km) south of the WVDP at the Great Valley air sampler;

(2) The five-points landfill (DFTLD17), located 12 miles (19 km) southwest of the Site;

(3) The former air sampling location at Nashville in the town of Hanover (DFTLD37), located 23 miles (37 km) northwest of the Site; and

(4) Sardinia-Savage Road (DFTLD41), 15 miles (24 km) northeast of the Site.

Quarterly exposure rates (in mR/qtr) and hourly exposure rates (in mR/h) were calculated.

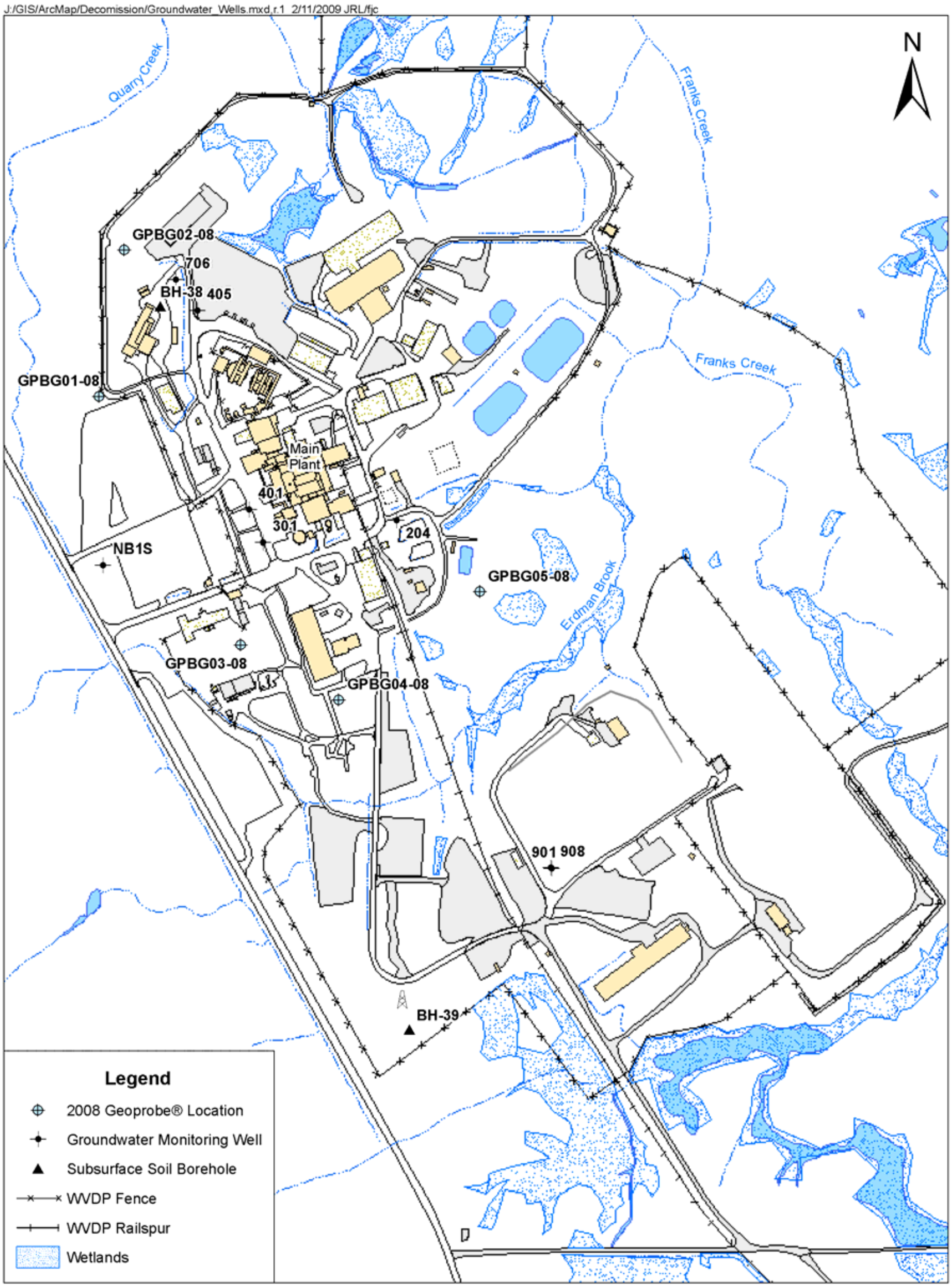

Figure B-3. Onsite Groundwater and Subsurface Soil Locations Used as Background

2.0 Methods Used for Background Calculations

Radionuclides for which backgrounds were estimated were selected with consideration of (1) radionuclides of interest from the Facility Characterization Project, as listed in Decommissioning Plan section 4.1.1, and (2) radionuclides that are routinely monitored in environmental media at the WVDP, for which sufficient data were available to develop a reliable estimate of background. (See Section 4.2.2 of this plan for a more detailed discussion of how background constituents were selected.)

Once radionuclides and locations applicable to each environmental medium had been defined, sample results were extracted from the Laboratory Information Management System database using the Environmental Affairs Trend Tool. As part of the extraction process, data from duplicate samples (i.e., separate samples of one medium collected at the same place and time; co-located samples) were combined into a single result for use in calculations, as were data from replicate samples (i.e., recounts or splits of the same sample). Calculations to combine results from duplicates and replicates, using protocols defined in controlled WVDP Procedure EM-11 (WVNSCO 2004b), were automatically done by the Environmental Affairs Trend Tool during data extraction.

Extracted data files were block copied into Microsoft Excel® spreadsheets and the information identified in Table B-2 was summarized for each environmental medium.

Table B-2. Summary Information for Environmental Medium Background Calculations

Item	Explanatory Notes
Constituent	Gross measurement, radionuclide measurement, or direct radiation measurement
Average result	In the LIMS database, individual radionuclide concentration measurements are represented by a result term plus or minus an associated uncertainty term. The average result is the direct average of result terms from all samples in the data set, including negative numbers and zeros.
Uncertainty associated with the average result	The uncertainty term associated with the average result is calculated from the sample uncertainty terms in accordance with Procedure EM-11 per the following formula: uncertainty = SQRT((uncertainty$_1^2$ + … + uncertainty$_N^2$) / N) where uncertainty$_1$ = the uncertainty term from sample 1 uncertainty$_N$ = the uncertainty term from sample N N = the total number of samples SQRT = square root
Median	To estimate the median of each data set, each sample result±uncertainty was assigned a single result equal to the larger of the result or the uncertainty term. Using the Excel® median function, the median was selected from the set of single values. If more than half the sample results were nondetects, the median was assigned a "<" sign, indicating that the median represented a nondetect value.

Table B-2. Summary Information for Environmental Medium Background Calculations

Item	Explanatory Notes
	Note that if a data set is symmetric, the average and median will be the same. However, if the distribution is skewed to the right (that is, it contains a large number of low values and a few high values), the average will usually be higher than the median. For this reason, with asymmetrically distributed data sets (as is often the case with environmental data) the median may be the more reliable estimator of central tendency.
Maximum	The maximum was selected from only the results indicating that activity had been detected. If no activity had been detected in any of the samples from that data set, the maximum was set equal to the highest uncertainty term and assigned a “<” sign, indicating that it was a nondetect.
N	Total number of samples. (Duplicate samples were counted as one, as were replicate samples.)
% NDs	If the uncertainty term for a sample was larger than the result (i.e., the range around the result term included zero), the radionuclide was considered not detected (ND) in that sample. Total number of ND samples divided by the total number of samples was expressed as a percentage.
Years	The period of years from which the data set was taken.
Data source locations	A listing of the sampling locations from which background data were taken.

Soil and sediment data, as extracted from the Laboratory Information Management System, were in units of µCi/g (dry weight). Surface water and groundwater data were in units of µCi/mL. All calculations were performed in units as extracted from the Laboratory Information Management System. Environmental dosimetry readings were in mR/qtr. For comparisons with onsite sample results, background data were then converted to the units specified in the Decommissioning Plan using the following conversion factors:

Soil and sediment: 1 µCi/g = 1E+06 pCi/g

Water: 1 µCi/mL = 1E+09 pCi/L

3.0 Background Summary Data for Each Environmental Medium

Summary tables of background values (in units of pCi/g per unit dry weight [soil or sediment], pCi/L [surface water and groundwater], or mR/quarter [environmental exposure]) used to evaluate data from onsite sampling locations are presented in the following tables.

Table B-3. Surface Soil Background Radionuclide Concentrations for the WVDP(1),(2)

Constituent	Avg. Concentration (pCi/g) Result	±	Uncertainty		Median (pCi/g)	Maximum (pCi/g)	N	% NDs	Years	Data Source Locations
Gross alpha	1.34E+01	±	3.58E+00		1.29E+01	2.73E+01	104	0%	1995-2007	SFGRVAL, SFNASHV, SFFXVRD, SFTCORD, SFRT240, SFSPRVL, SFWEVAL, SFBOEHN, SFRSPRD, SFBLKST
Gross beta	2.03E+01	±	3.11E+00		2.00E+01	4.00E+01	84	0%	1995-2007	SFGRVAL, SFNASHV, SFFXVRD, SFRT240, SFSPRVL, SFWEVAL, SFBOEHN, SFRSPRD
Sr-90	1.51E-01	±	1.46E-01		9.48E-02	3.10E+00	104	25%	1995-2007	SFGRVAL, SFNASHV, SFFXVRD, SFTCORD, SFRT240, SFSPRVL, SFWEVAL, SFBOEHN, SFRSPRD, SFBLKST
Cs-137	4.50E-01	±	6.68E-02		4.17E-01	1.21E+00	93	0%	1995-2007	SFGRVAL, SFNASHV, SFFXVRD, SFTCORD, SFRT240, SFSPRVL, SFWEVAL, SFBOEHN, SFBLKST
U-232	5.52E-03	±	2.80E-02	<	2.35E-02	1.89E-02	32	97%	1995-2007	SFGRVAL, SFBOEHN, SFRSPRD
U-233/234	7.79E-01	±	1.15E-01		7.88E-01	9.39E-01	22	0%	1995-2007	SFGRVAL, SFRSPRD
U-235/236	5.98E-02	±	3.36E-02		5.24E-02	2.18E-01	32	9%	1995-2007	SFGRVAL, SFBOEHN, SFRSPRD
U-238	7.79E-01	±	1.13E-01		7.87E-01	9.31E-01	32	0%	1995-2007	SFGRVAL, SFBOEHN, SFRSPRD
Pu-238	5.39E-03	±	1.38E-02	<	1.21E-02	4.02E-02	92	86%	1996-2007	SFGRVAL, SFNASHV, SFFXVRD, SFTCORD, SFRT240, SFSPRVL, SVWEVAL, SFBOEHN, SFRSPRD, SFBLKST
Pu-239/240	2.01E-02	±	1.79E-02		1.55E-02	2.34E-01	104	44%	1995-2007	SFGRVAL, SFNASHV, SFFXVRD, SFTCORD, SFRT240, SFSPRVL, SFWEVAL, SFBOEHN, SFRSPRD, SFBLKST
Am-241	1.45E-02	±	1.92E-02	<	1.62E-02	1.93E-01	104	64%	1995-2007	SFGRVAL, SFNASHV, SFFXVRD, SFTCORD, SFRT240, SFSPRVL, SFWEVAL, SFBOEHN, SFRSPRD, SFBLKST

LEGEND: N = Number of samples
ND = Nondetect

NOTES: (1) Soil samples collected at air samplers at background locations (SFGRVAL = Great Valley; SFNASHV = Nashville), perimeter locations (SFFXVRD = Fox Valley Road; SFTCORD = Thomas Corners Road; SFRT240 = Route 240; SFBOEHN = Boehn Road; SFRSPRD = Rock Springs Road; SFBLKST = Bulk Storage Warehouse), and community locations (SFSPRVL = Springville; SFWEVAL = West Valley).

(2) Data from perimeter and community samplers were pooled with data from background locations if they were not statistically higher than background.

Table B-4. Sediment Background Radionuclide Concentrations for the WVDP[1]

Constituent	Average concentration (pCi/g)			Median (pCi/g)		Maximum (pCi/g)	N	% NDs	Years	Data Source Locations
	Result	±	Uncertainty							
Gross alpha	1.02E+01	±	3.28E+00		9.21E+00	2.18E+01	22	0%	1995-2006	SFBCSED, SFBISED
Gross beta	1.74E+01	±	3.01E+00		1.64E+01	2.71E+01	23	0%	1995-2007	SFBCSED, SFBISED
Sr-90	1.49E-02	±	4.91E-02	<	3.35E-02	1.57E-01	23	65%	1995-2007	SFBCSED, SFBISED
Cs-137	3.50E-02	±	2.50E-02		3.75E-02	7.84E-02	23	30%	1995-2007	SFBCSED, SFBISED
U-232	1.15E-02	±	5.50E-02	<	3.10E-02	3.92E-02	23	87%	1995-2007	SFBCSED, SFBISED
U-233/234	5.99E-01	±	1.19E-01		6.59E-01	8.58E-01	23	4%	1995-2007	SFBCSED, SFBISED
U-235/236	5.31E-02	±	3.67E-02		4.57E-02	2.78E-01	23	22%	1995-2007	SFBCSED, SFBISED
U-238	6.11E-01	±	1.19E-01		6.52E-01	9.01E-01	23	4%	1995-2007	SFBCSED, SFBISED
Pu-238	1.67E-02	±	1.79E-02	<	1.41E-02	1.29E-01	23	74%	1995-2007	SFBCSED, SFBISED
Pu-239/240	1.08E-02	±	1.37E-02	<	1.22E-02	6.07E-02	23	83%	1995-2007	SFBCSED, SFBISED
Am-241	1.07E-02	±	1.83E-02	<	1.41E-02	8.60E-02	23	74%	1995-2007	SFBCSED, SFBISED

LEGEND: N = Number of samples
ND = Nondetect

NOTE: (1) Sediment samples were collected at upstream sampling locations on Buttermilk Creek (SFBCSED) and Cattaraugus Creek (SFBISED).

Table B-5. Subsurface Soil Background Radionuclide Concentrations for the WVDP

Constituent	Average concentration (pCi/g) Result	±	Uncertainty	Median (pCi/g)	Maximum (pCi/g)	N	% NDs	Years	Data Source Locations[1]
Gross alpha	1.20E+01	±	4.76E+00	1.26E+01	1.69E+01	18	0%	1993, 2008	BH-38 and 39 (1993); GPBG01-08, GPBG02-08, GPBG03-08, GPBG04-08, and GPBG05-08 (2008)
Gross beta	3.19E+01	±	3.99E+00	2.86E+01	6.10E+01	18	0%	1993, 2008	BH-38 and 39 (1993); GPBG01-08, GPBG02-08, GPBG03-08, GPBG04-08, and GPBG05-08 (2008)
Sr-90	1.80E-02	±	2.59E-02	< 2.30E-02	1.24E-01	18	89%	1993, 2008	BH-38 and 39 (1993); GPBG01-08, GPBG02-08, GPBG03-08, GPBG04-08, and GPBG05-08 (2008)
Cs-137	4.51E-03	±	2.43E-02	< 2.41E-02	1.49E-01	18	94%	1993, 2008	BH-38 and 39 (1993); GPBG01-08, GPBG02-08, GPBG03-08, GPBG04-08, and GPBG05-08 (2008)
U-232	-2.65E-03	±	2.55E-02	< 2.44E-02	< 4.19E-02	18	100%	1993, 2008	BH-38 and 39 (1993); GPBG01-08, GPBG02-08, GPBG03-08, GPBG04-08, and GPBG05-08 (2008)
U-233/234	6.83E-01	±	1.19E-01	7.91E-01	1.08E+00	18	0%	1993, 2008	BH-38 and 39 (1993); GPBG01-08, GPBG02-08, GPBG03-08, GPBG04-08, and GPBG05-08 (2008)
U-235/236	5.14E-02	±	3.47E-02	4.25E-02	1.17E-01	18	33%	1993, 2008	BH-38 and 39 (1993); GPBG01-08, GPBG02-08, GPBG03-08, GPBG04-08, and GPBG05-08 (2008)
U-238	7.19E-01	±	1.22E-01	8.64E-01	1.11E+00	18	0%	1993, 2008	BH-38 and 39 (1993); GPBG01-08, GPBG02-08, GPBG03-08, GPBG04-08, and GPBG05-08 (2008)
Pu-238	4.32E-04	±	1.30E-02	< 1.15E-02	< 2.41E-02	18	100%	1993, 2008	BH-38 and 39 (1993); GPBG01-08, GPBG02-08, GPBG03-08, GPBG04-08, and GPBG05-08 (2008)
Pu-239/240	1.72E-03	±	1.19E-02	< 1.04E-02	< 1.87E-02	18	100%	1993, 2008	BH-38 and 39 (1993); GPBG01-08, GPBG02-08, GPBG03-08, GPBG04-08, and GPBG05-08 (2008)
Am-241	-1.93E-03	±	1.07E-02	< 1.09E-02	< 1.27E-02	18	100%	1993, 2008	BH-38 and 39 (1993); GPBG01-08, GPBG02-08, GPBG03-08, GPBG04-08, and GPBG05-08 (2008)

LEGEND: N = Number of samples
ND = Nondetect

NOTE: (1) Background locations are shown on Figure B-3. After testing to ensure that subsurface soil results for the sand and gravel unit and the unweathered Lavery till were statistically indistinguishable, values were combined into a single subsurface soil background value for each radionuclide.

Table B-6. Surface Water Background Radionuclide Concentrations for the WVDP

Constituent	Average concentration (pCi/L)			Median (pCi/L)		Maximum (pCi/L)	N	% NDs	Years	Data Source Locations
	Result	±	Uncertainty							
Gross alpha	4.74E-01	±	1.28E+00	<	9.55E-01	5.43E+00	387	74%	1991-2007	WFBCBKG, WFBIGBR
Gross beta	2.64E+00	±	1.43E+00		2.34E+00	2.03E+01	388	12%	1991-2007	WFBCBKG, WFBIGBR
H-3	1.35E+01	±	8.43E+01	<	8.21E+01	6.33E+02	388	85%	1991-2007	WFBCBKG, WFBIGBR
C-14	1.19E+01	±	4.44E+01	<	1.33E+01	4.05E+02	68	81%	1991-2007	WFBCBKG
Sr-90	2.00E+00	±	1.61E+00		9.04E-01	1.23E+01	251	47%	1991-2007	WFBCBKG, WFBIGBR
Tc-99	-4.40E-01	±	1.80E+00	<	1.80E+00	7.25E+00	52	85%	1995-2007	WFBCBKG
I-129	1.39E-01	±	8.71E-01	<	7.86E-01	2.02E+00	68	90%	1991-2007	WFBCBKG
Cs-137	6.31E-01	±	5.98E+00	<	4.15E+00	1.01E+01	250	95%	1991-2007	WFBCBKG, WFBIGBR
U-232	1.81E-02	±	8.91E-02	<	4.28E-02	2.60E-01	68	87%	1991-2007	WFBCBKG
U-233/234	1.10E-01	±	7.02E-02		9.94E-02	2.98E-01	61	16%	1992-2007	WFBCBKG
U-235/236	1.71E-02	±	4.07E-02	<	3.28E-02	1.00E-01	67	82%	1991-2007	WFBCBKG
U-238	7.44E-02	±	6.35E-02		5.72E-02	4.00E-01	68	35%	1991-2007	WFBCBKG
Pu-238	1.45E-02	±	6.24E-02	<	3.10E-02	1.02E-01	68	93%	1991-2007	WFBCBKG
Pu-239/240	9.17E-03	±	3.50E-02	<	2.71E-02	1.98E-01	68	91%	1991-2007	WFBCBKG
Am-241	5.42E-02	±	7.15E-02	<	3.27E-02	2.20E+00	68	81%	1991-2007	WFBCBKG

LEGEND: N = Number of samples
ND = Nondetect
WFBCBKG = Buttermilk Creek background; WFBIGBR = Cattaraugus Creek background at Bigelow Bridge.

Table B-7. Groundwater Background Radionuclide Concentrations for the WVDP

Constituent	Average concentration (pCi/L)			Median (pCi/L)		Maximum (pCi/L)	N	% NDs	Years	Data Source Locations
	Result	±	Uncertainty							
Gross alpha	1.06E+00	±	5.69E+00	<	2.59E+00	2.19E+01	566	87%	1991-2007	WNW-NB1S, -0204, -0301, -0401, -0405, -0706, -0901, -0908
Gross beta	6.19E+00	±	5.11E+00		4.56E+00	2.82E+01	566	28%	1991-2007	WNW-NB1S, -0204, -0301, -0401, -0405, -0706, -0901, -0908
H-3	2.11E+01	±	8.55E+01	<	8.58E+01	9.41E+02	566	81%	1991-2007	WNW-NB1S, -0204, -0301, -0401, -0405, -0706, -0901, -0908
C-14	-4.95E+00	±	2.63E+01	<	2.66E+01	7.43E+00	56	98%	1993-2007	WNW-NB1S, -0401, -0405, -0706, -0908
Sr-90	2.69E+00	±	1.35E+00		2.44E+00	7.38E+00	56	16%	1993-2007	WNW-NB1S, -0401, -0405, -0706, -0908
Tc-99	-3.71E-01	±	1.91E+00	<	1.85E+00	3.98E+00	56	96%	1993-2007	WNW-NB1S, -0401, -0405, -0706, -0908
I-129	2.39E-01	±	7.38E-01	<	6.01E-01	1.58E+00	56	86%	1993-2007	WNW-NB1S, -0401, -0405, -0706, -0908
Cs-137	1.75E+00	±	2.39E+01	<	2.22E+01	1.90E+01	258	98%	1991-2007	WNW-NB1S, -0204, -0301, -0401, -0405, -0706, -0901, -0908
U-232	2.28E-02	±	1.00E-01	<	4.92E-02	3.78E-01	56	88%	1993-2007	WNW-NB1S, -0401, -0405, -0706, -0908
U-233/234	4.88E-01	±	1.94E-01		1.60E-01	8.20E+00	56	13%	1993-2007	WNW-NB1S, -0401, -0405, -0706, -0908
U-235/236	4.52E-02	±	6.03E-02	<	5.00E-02	1.93E-01	56	71%	1993-2007	WNW-NB1S, -0401, -0405, -0706, -0908
U-238	3.18E-01	±	1.48E-01		1.21E-01	5.30E+00	56	21%	1993-2007	WNW-NB1S, -0401, -0405, -0706, -0908
Pu-238	5.94E-02	±	9.59E-02	<	4.65E-02	2.20E-01	6	83%	1993-1994	WNW-NB1S, -0405, -0908
Pu-239/240	4.95E-02	±	8.35E-02	<	5.28E-02	2.70E-01	6	83%	1993-1994	WNW-NB1S, -0405, -0908
Am-241	4.32E-02	±	4.76E-02	<	3.81E-02	1.80E-01	6	83%	1993-1994	WNW-NB1S, -0405, -0908

Legend: N = Number of samples

ND = Nondetect

"WNW" locations refer to individual wells that serve as groundwater backgrounds for solid waste management units in the groundwater monitoring program.

Table B-8. Background Environmental Radiation Levels at the WVDP

Constituent	Average (mR/quarter)			Median	Maximum	N	Years	Data Source Locations[1]
	Result	±	Uncertainty					
Environmental radiation	19.3	±	7.1	19.2	35.0	264	1986-2007	DFTLD23, DFTLD17, DFTLD37, DFTLD41

NOTE: (1) Background locations: DFTLD17 (Five Point Landfill); DFTLD23 (Great Valley); DFTLD37 (Dunkirk); DFTLD41 (Sardinia-Savage Road).

4.0 Methods for Evaluating Concentrations Above Background in Onsite Environmental Media

Data from onsite sampling were available in three forms:

(1) Single observations or measurements with no associated uncertainty term (for example, a sediment concentration from 1988 presented in a historical report);

(2) A radionuclide concentration result, plus or minus an associated uncertainty term, from a sample collected as part of a one-time sampling project (i.e., the RFI soil, sediment, and subsurface soil survey done in 1993; Geoprobe® studies done in 1994, 1997, 1998, and 2008); and

(3) Multi-year data sets from samples collected at specified locations as part of the routine Environmental Monitoring or Groundwater Monitoring programs.

4.1 Single-Value Observations

Single-value observations were directly compared with the maximum result from the applicable background radionuclide-medium combination. For example, a Cs-137 concentration from lagoon sediment, as reported in WVNSCO 1994, was compared directly with the maximum Cs-137 concentration observed in background sediment. A value higher than the background result was classified as exceeding background.

4.2 Single Samples With Specified Uncertainty

A single-sample result reported with an associated uncertainty term, such as the result from a sample collected as part of the 1993 RFI investigation, was compared with background using the relative errors ratio test. This test (as described in WVDP procedure EM-74, WVNSCO 2004a) is primarily used as a data validation tool to test the acceptability of results from duplicate samples (i.e., to determine the likelihood that the samples could have come from the same population).

In the relative errors ratio test, one sample result (plus or minus its associated uncertainty term) is compared another sample result (plus or minus its associated uncertainty term). To perform the relative errors ratio calculation, the absolute value of the difference between the two sample results is divided by the sum of the squares of the estimated standard deviations (as based on the error terms) from each. If the result is not greater than 1.96 (approximating a 95 percent confidence interval), the two samples would be considered acceptable as duplicates. In other words, the samples could have been drawn from the same population (the test sample could have been drawn from the background population) if the confidence intervals bracketing the result terms from the two samples overlap.

For purposes of the current evaluation, each onsite sample result was tested against the mean (plus or minus the associated uncertainty term) of the applicable radionuclide/ medium background value. If the test sample result met the three following conditions, the result was classified as exceeding background:

- The radionuclide was detected

- The relative errors ratio value was greater than 1.96, and
- The result term for the sample was higher than the average result term for the background.

Areas with radiological concentrations exceeding background, as determined by the RER calculation, are summarized in Decommissioning Plan Figures 4-6 (surface soil and sediment), 4-7 (subsurface soil), and 4-13 (Geoprobe® groundwater). Maximum above-background concentrations for specific radionuclides at locations in each WMA are summarized in Decommissioning Plan Section 4.2.5, Tables 4-12 through 4-22 (surface soil, sediment, and subsurface soil), and Decommissioning Plan Section 4.2.8, Table 4-26 (Geoprobe® groundwater).

4.3 Data From Routine Monitoring Locations

Radionuclide concentration data sets from routine monitoring locations were compared with applicable background data sets using the nonparametric Mann-Whitney "U" test. As recommended in MARSSIM, a nonparametric test was used because environmental data are usually not normally distributed and because there are often a significant number of results lower than detectable concentrations. Both conditions were true of the WVDP data sets examined in this evaluation.

Because of the larger number of observations available for these comparisons, the "U" test was more sensitive at detecting concentrations exceeding background at a specific location than was the RER test that considered only one measurement. Note that trends (i.e., increasing or decreasing radionuclide concentrations) were not evaluated as part of this exercise, which focused only on comparisons with background. (Data trends at the WVDP are routinely evaluated and conclusions summarized in formal reports associated with the Environmental Monitoring and Groundwater Monitoring Programs.)

The Mann-Whitney U test, similar to the Wilcoxon Rank Sum test used in MARSSIM, is a rank-based test. The null hypothesis being tested was that the median of the tested data set was higher than the median at the background location (one-tailed test, $P<0.05$). To perform the test, data sets were assembled for radionuclide concentrations at each of the onsite routine monitoring points (soil/sediment sampling locations, surface water sampling locations, and routine groundwater sampling locations). So that the data could be ranked, each radionuclide measurement was assigned a single value. All "detect" values (i.e., the result term was larger than the uncertainty term) were set equal to the result term of the measurement; all "nondetect" values (i.e., the uncertainty term was larger than the result term) were set equal to zero. In this way, all nondetect values received the same rank. (Note that summary statistics, such as averages, had already been calculated for each data set. The arbitrarily assigned zero values were used only for ranking purposes.)

The two data sets (test location and background reference location) were then combined into one data set and the results ranked in numerical order from the smallest to the largest. From the assigned ranks, the test statistic (i.e., "U") was calculated for each (Sheskin 1997). The normal approximation for larger sample sizes ("z") was also calculated. Critical values of "U" and "z" were taken from statistical tables in Sheskin 1997.

If the “U” value was lower than the critical value of “U” (or, for larger numbers of samples, if the “z” value exceeded the critical level of “z”), and the mean rank from the test data set was greater than that from the background data set, then the null hypothesis (i.e., that the median of the test data set exceeded that of the background data set) was not rejected. In other words, at a 95% confidence level, it was likely that the median of the test data set exceeded that of the background data set.

Locations where results from routine monitoring locations exceeded background are summarized by waste management area and radionuclide in section 4.2, Table 4-17 (sediment from sampling location SNSWAMP), Table 4-18 (sediment from sampling location SNSW74A), Table 4-22 (sediment from sampling location SNSP006), Table 4-24 (routine onsite surface water monitoring locations), and Table 4-25 (routine groundwater monitoring locations).

Direct onsite measurements of environmental radiation (TLD results), for which the data sets approximate a normal distribution, were compared with background measurements using the one-way analysis of variance (ANOVA) Excel® function ($p<0.05$). If the “F” statistic exceeded the critical value of “F,” and the average from the test data set exceeded the background average, measurements from the test location were determined to exceed background. Results are summarized in section 4.2, Table 4-23.

5.0 Radionuclide Ratios to Cs-137

The concentrations of hard-to-measure radionuclides in a medium are often estimated on the basis of their relationship to a more easily measured nuclide, such as Cs-137, as defined in a well-characterized distribution. As discussed in Section 4.1.4 of this plan, two primary distributions have been identified at the WVDP: (1) the Spent Nuclear Fuel distribution — applicable to nuclear fuel prior to reprocessing, and (2) the Batch 10 distribution — applicable to the high-level waste after the uranium and plutonium had been extracted. Comparable ratios from the two distributions are presented in Table 4-3. As shown in Table 4.3 of this plan, Sr-90 may comprise a larger relative fraction of the total radioactivity in the “feed and waste” category (i.e., before waste reprocessing), while a larger relative fraction of Am-241 may be more characteristic of the “product” category (i.e., after waste reprocessing).

If surface soil, sediment or subsurface soil samples contained both Cs-137 and other radionuclides at above-background concentrations, the ratio of each above-background radionuclide to Cs-137 was calculated. Only data from the same discrete samples were used to calculate ratios. Ratios in surface soil, sediment, and subsurface soil are summarized by WMA in Tables B-9, B-10, and B-11, respectively. For each medium, the following information is listed:

- Number of samples for which each nuclide exceeded background,
- Minimum ratio,
- Median ratio,
- Maximum ratio,

- Concentration of Cs-137 (in pCi/g dry) in the sample with the maximum ratio, and
- Location at which the maximum ratio was observed.

With respect to environmental concentrations exceeding background, the ratio of a radionuclide to Cs-137 may help to better trace the source of the activity. For instance, the area of elevated Sr-90 concentrations on the north plateau downgradient of the Process Building has been traced to a leak of radioactively contaminated acid in the late 1960s. This plume is characterized by high Sr-90-to-Cs-137 ratios.

6.0 Supplementary Data for Onsite Monitoring Locations

Summary statistics were calculated for radiological constituents measured at all routine monitoring locations on the WVDP site, sediment for the years 1995 through 2007, and surface water and groundwater for 1998 through 2007. Constituents exceeding background levels at each location are presented in Section 4.2. Complete results, including those from locations determined to be non-impacted, are presented in the following tables for onsite sediment (Table B-12), surface water (B-13), and groundwater (B-14).

Supplementary information about routine groundwater monitoring locations (i.e., location coordinates, surface elevation, construction material of the well or trench, diameter of the well [if applicable], screened interval, and geologic unit monitored) are summarized in Table B-15. Similar information for special Geoprobe® groundwater sampling points is provided in Table B-16.

Note that only routine monitoring locations included in the current Groundwater Monitoring Program were included in the evaluation presented in Section 4.2.8 of this plan. A large number of points at which groundwater had been sampled in the past were not included in this evaluation. For completeness, information on excluded points is summarized in Table B-17. Reasons for exclusion included:

- The well was dry;
- No radiological data were available;
- Data were not validated (e.g., piezometers, surface elevation points, wells for the north plateau groundwater recovery system, wells used to evaluate the pilot permeable treatment wall);
- Wells had been dropped from the groundwater program because existing coverage was considered sufficient (e.g., more than twenty wells discontinued in 1995); or
- Sampling points were located in areas outside the scope of the Phase 1 Decommissioning Plan (e.g., groundwater seeps outside the process premises, wells from WMA 8 [New York State-Licensed Disposal Area]).

7.0 References

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Table B-9. Radionuclides in Surface Soil: Ratios to Cs-137(1)

Area(2)	Radionuclide	N	Minimum	Median	Maximum	Cs-137 (pCi/g)(3)	Location of Maximum Ratio
WMA 2	Sr-90	5	0.015	0.28	1.4	8.5E-01	Surface soil near Lagoons 4 and 5 (BH-04)
WMA 3	U-238	1	0.047	0.047	0.047	2.2E+01	Surface soil near Waste Tank Farm
	Am-241	1	0.011	0.011	0.011	2.2E+01	Surface soil near Waste Tank Farm
WMA 4	Sr-90	3	0.29	0.96	9.5	1.2E+00	CDDL soil (6-12" depth, 1990)
WMA 5	Sr-90	2	0.019	0.047	0.075	1.1E+01	Surface soil near RHWF (BH-38)
	Pu-238	1	0.0033	0.0033	0.0033	1.1E+01	Surface soil near RHWF (BH-38)
	Pu-239/240	1	0.015	0.015	0.015	1.1E+01	Surface soil near RHWF (BH-38)
	Am-241	4	0.026	0.033	0.073	1.2E+01	LSA 3 & 4 footers (1990)
WMA 6	Sr-90	12	0.036	0.094	1.7	2.9E+00	Rail spur by FRS (1994)
WMA 7	Sr-90	8	0.11	1.9	8.3	1.1E+00	NDA Surface Soil (1994)
	Pu-238	1	0.021	0.021	0.021	4.1E+00	Surface soil by the NDA Interceptor Trench (BH-42)
	Pu-239/240	1	0.022	0.022	0.022	4.1E+00	Surface soil by the NDA Interceptor Trench (BH-42)
	Am-241	1	0.037	0.037	0.037	4.1E+00	Surface soil by the NDA Interceptor Trench (BH-42)
WMA 12	Sr-90	4	0.14	0.25	0.29	4.5E+00	Surface soil near WMA 2 and WMA 6 (BH-16)

NOTES: (1) Ratios were calculated from samples for which both Cs-137 and the nuclide of interest exceeded background, with ratios rounded to two significant digits or nearest integer.

(2) No surface soil data were available for WMA 1. No radionuclides exceeded background in WMA 9. Only Cs-137 exceeded background in WMA 10.

(3) Cs-137 concentration at the location with the maximum ratio.

LEGEND: BH = bore hole CDDL = Construction and Demolition Debris Landfill FRS = Fuel Receiving and Storage LSA = Lag Storage Addition N = number of samples RHWF = Remote-Handled Waste Facility.

Table B-10. Radionuclides in Sediment: Ratios to Cs-137(1)

Area(2)	Radionuclide	N	Minimum	Median	Maximum	Cs-137 (pCi/g)(3)	Location of Maximum Ratio
WMA 2	Sr-90	41	0.0063	0.065	144	1.0E+01	Sediment from the Solvent Dike (1986)
	U-232	1	0.0054	0.0054	0.0054	1.4E+03	Lagoon 3 sediment (1994)
	U-233/234	2	0.0032	0.030	0.056	1.7E+01	Sediment from drainage downgradient of Solvent Dike (ST-28)
	U-235/236	7	0.000010	0.000076	0.011	1.7E+01	Sediment from drainage downgradient of Solvent Dike (ST-28)
	U-238	28	0.000052	0.0014	0.057	2.1E+01	Lagoon 3 sediment (1990)
	Pu-238	10	0.00028	0.0015	0.018	4.4E+04	Lagoon 2 shoreline sediment (1990)
	Pu-239/240	9	0.00051	0.0011	0.019	1.7E+01	Sediment from drainage downgradient of Solvent Dike (ST-28)
	Am-241	29	0.00058	0.0019	4.2	1.0E+01	Sediment from the Solvent Dike (1986)
WMA 4	Sr-90	18	0.041	0.80	16	3.1E+00	Sediment from drainage through CDDL (ST-30)
	U-233/234	9	0.036	0.11	1.4	6.6E-01	Sediment at Northeast Swamp (SNSWAMP)
	U-235/236	2	0.023	0.14	0.27	6.6E-01	Sediment at Northeast Swamp (SNSWAMP)
	U-238	9	0.036	0.12	1.3	6.6E-01	Sediment at Northeast Swamp (SNSWAMP)
	Pu-238	10	0.0057	0.022	0.057	5.2E+00	Sediment at Northeast Swamp (SNSWAMP)
	Pu-239/240	13	0.0089	0.033	0.21	1.1E+01	Sediment at Northeast Swamp (SNSWAMP)
	Am-241	14	0.010	0.056	0.22	2.1E+00	Sediment at Northeast Swamp (SNSWAMP)
WMA 5	Sr-90	15	0.026	0.13	3.3	6.4E-01	Sediment at North Swamp (SNSW74A)
	U-233/234	4	0.12	0.37	0.75	1.1E+00	Sediment at North Swamp (SNSW74A)
	U-235/236	1	0.047	0.047	0.047	2.7E+00	Sediment at North Swamp (SNSW74A)
	U-238	4	0.15	0.34	2.0	4.7E-01	Sediment at North Swamp (SNSW74A)
	Pu-238	1	0.015	0.015	0.015	3.8E+00	Sediment at North Swamp (SNSW74A)
	Pu-239/240	9	0.019	0.035	0.096	4.7E-01	Sediment at North Swamp (SNSW74A)
	Am-241	11	0.0011	0.057	0.087	6.4E-01	Sediment at North Swamp (SNSW74A)

Table B-10. Radionuclides in Sediment: Ratios to Cs-137(1)

Area(2)	Radionuclide	N	Minimum	Median	Maximum	Cs-137 (pCi/g)(3)	Location of Maximum Ratio
WMA 6	Sr-90	3	0.062	0.27	0.59	5.9E-01	Sediment from south Demineralizer Sludge Pond (ST-36)
WMA 7	Sr-90	1	3.7	3.7	3.7	9.0E-01	Sediment from drainage near Interceptor Trench (ST-23)
	Pu-238	1	0.096	0.096	0.096	9.0E-01	Sediment from drainage near Interceptor Trench (ST-23)
	Am-241	1	0.046	0.046	0.046	9.0E-01	Sediment from drainage near Interceptor Trench (ST-23)
WMA 12	Sr-90	33	0.022	0.058	0.59	2.7E-01	Sediment from Franks Creek (ST-13) near burial areas
	U-232	2	0.0010	0.0021	0.0031	3.5E+01	Sediment from Erdman Brook (ST-19) after Lagoon 3 discharge
	U-233/234	3	0.034	0.038	0.075	1.1E+01	Sediment from Franks Creek at fence line (SNSP006)
	U-238	4	0.0094	0.035	0.058	1.4E+01	Sediment from Franks Creek at fence line (SNSP006)
	Pu-238	10	0.00070	0.0034	0.042	5.9E+01	Sediment from Erdman Brook (ST-20) after drainage from WMA 2
	Pu-239/240	7	0.00068	0.0029	0.012	5.9E+01	Sediment from Erdman Brook (ST-20) after drainage from WMA 2
	Am-241	18	0.0012	0.0047	0.033	4.3E+01	Sediment from Erdman Brook (ST-22) downgradient of NDA

NOTES: (1) Ratios were calculated from samples for which both Cs-137 and the nuclide of interest exceeded background, with the ratios rounded to two significant digits or the nearest integer.

(2) No sediment data were available for WMAs 1, 3, or 9. Only Cs-137 exceeded background in WMA 10.

(3) Cs-137 concentration at the location with the maximum ratio.

LEGEND: CDDL = Construction and Demolition Debris Landfill N = number of samples

Table B-11. Radionuclides in Subsurface Soil: Ratios to Cs-137(1)

Area(2)	Radionuclide	N	Minimum	Median	Maximum	Cs-137 (pCi/g)(3)	Location of Maximum Ratio
WMA 1	Sr-90	45	0.31	303	63,419	5.0E-02	Inside MPPB (GP7898, 21-23' depth)
	Tc-99	6	0.0027	2.3	5.6	1.1E-01	Outside MPPB, south of FRS (GP7208, 14-16' depth)
	U-232	1	0.023	0.023	0.023	2.0E+00	Outside southeast corner of MPPB (GP2908, 14-16' depth)
	U-233/234	9	0.0074	0.79	12	7.2E-02	Inside MPPB (GP10008, 30-32' depth)
	U-235/236	5	0.013	0.063	1.1	1.4E-01	Outside eastern wall of MPPB (GP3008, 4-6' depth)
	U-238	7	0.82	6.1	18	7.2E-02	Outside MPPB, north of FRS (GP10108, 20-22' depth)
	Pu-238	5	0.0025	0.019	0.18	1.5E-01	Outside MPPB, south of FRS (GP7208, 4-6' depth)
	Pu-239/240	8	0.015	0.067	0.80	5.5E-02	East of laundry building (BH-18, 14-16' depth)
	Am-241	16	0.025	0.19	2.7	3.6E-02	Inside MPPB (GP77, 19-23' depth)
	Cm-243/244	1	0.015	0.015	0.015	1.0E+01	Inside MPPB (GP8008, 25-27' depth)
WMA 2	Sr-90	27	0.037	1.9	750	4.8E-02	Northwest of Lagoon 1 (BH-09, 10-12' depth)
	U-232	11	0.0050	0.021	1.0	4.8E-02	Northwest of Lagoon 1 (BH-09, 10-12' depth)
	U-233/234	8	0.0046	1.9	7.0	2.7E-01	Solvent dike (BH-11, 10-12' depth)
	U-235/236	7	0.000038	0.55	1.1	2.7E-01	Solvent dike (BH-11, 10-12' depth)
	U-238	7	0.00052	0.052	4.4	2.7E-01	Solvent dike (BH-11, 10-12' depth)
	Pu-238	15	0.0049	0.023	0.089	1.9E+00	Between Interceptors and Lagoon 1 (BH-14, 14-16' depth)
	Pu-239/240	15	0.0046	0.031	0.11	1.6E-01	Maintenance Shop Leach Field (BH-35, 18-20' depth)
	Pu-241	7	0.030	0.11	0.21	1.6E+01	East of Test and Storage Building (BH-35, 6-8' depth)
	Am-241	18	0.010	0.051	0.23	2.7E-01	Solvent dike (BH-11, 10-12' depth)
WMA 4	Sr-90	2	0.73	0.75	0.77	8.8E-02	Southeast corner of CDDL (BH-28, 6-8' depth)
WMA 5	Sr-90	1	6.3	6.3	6.3	4.8E-02	Between LSA 3 and LSA 4 (BH-30, 10-12' depth)
WMA 6	Sr-90	5	1.1	174	1115	1.3E-01	Downgradient of MPPB (GP10208, 16-18' depth)
	U-232	1	0.087	0.087	0.087	1.1E+00	Downgradient of MPPB (GP10208, 14-16' depth)

Table B-11. Radionuclides in Subsurface Soil: Ratios to Cs-137[(1)]

Area[(2)]	Radionuclide	N	Minimum	Median	Maximum	Cs-137 (pCi/g)[(3)]	Location of Maximum Ratio
	U-233/234	2	1.2	4.6	8.0	1.3E-01	Downgradient of MPPB (GP10208, 16-18' depth)
	U-235/236	2	0.33	0.82	1.3	1.3E-01	Downgradient of MPPB (GP10208, 16-18' depth)
	U-238	2	1.3	5.2	9.0	1.3E-01	Downgradient of MPPB (GP10208, 16-18' depth)
	Pu-238	2	0.025	0.030	0.035	4.3E+00	Southeast of FRS (BH-19A, 12-14' depth)
	Pu-239/240	3	0.040	0.047	0.047	1.1E+00	Downgradient of MPPB (GP10208, 14-16' depth)
	Pu-241	1	0.35	0.35	0.35	4.3E+00	Southeast of FRS (BH-19A, 12-14' depth)
	Am-241	4	0.13	0.20	0.33	1.3E-01	Downgradient of MPPB (GP10208, 16-18' depth)
WMA 7	Sr-90	1	2.6	2.6	2.6	5.4E-02	Northern corner of NDA (BH-42, 25-27' depth)
WMA 12	Sr-90	1	1.5	1.5	1.5	4.4E-02	Northwest of the NDA (BH-24, 6-8' depth)

NOTES: (1) Ratios were calculated from samples for which both Cs-137 and the nuclide of interest exceeded background, with ratios rounded to two significant digits or the nearest integer.

(2) No subsurface soil data were available for WMAs 3 and 9. No Cs-137 results exceeding background were found in WMA 10.

(3) Cs-137 concentration at the location with the maximum ratio.

LEGEND: N = Number of Samples; MPPB = Main Plant Process Building; FRS = Fuel Receiving and Storage; CDDL = Construction and Demolition Debris Landfill; LSA = Lag Storage Area; NDA = Nuclear Regulatory Commission Licensed Disposal Area

Table B-12. Summary of Radionuclide Results from Routine Onsite Sediment Monitoring Locations

WMA	Monitoring Point	Constituent	N	Median (pCi/g)	Average (pCi/g) Result	±	Uncertainty	Maximum (pCi/g)	Exceeded Background?(1)
WMA 4	SNSWAMP Sediment at northeast swamp drainage	Gross alpha	13	1.73E+01	1.68E+01	±	3.95E+00	2.26E+01	Yes
		Gross beta	13	5.43E+01	5.51E+01	±	4.66E+00	8.98E+01	Yes
		Sr-90	17	2.35E+00	5.20E+00	±	4.97E-01	2.98E+01	Yes
		Cs-137	17	7.40E+00	9.99E+00	±	1.39E+00	3.14E+01	Yes
		U-232	17	<2.19E-02	9.20E-03	±	3.41E-02	4.79E-02	No
		U-233/234	16	8.21E-01	7.24E-01	±	1.79E-01	1.13E+00	Yes
		U-235/236	16	5.82E-02	5.94E-02	±	5.38E-02	1.76E-01	No
		U-238	16	7.93E-01	7.06E-01	±	1.65E-01	1.14E+00	Yes
		Pu-238	10	2.79E-01	2.62E-01	±	6.87E-02	4.32E-01	Yes
		Pu-239/240	17	2.26E-01	2.58E-01	±	7.10E-02	6.42E-01	Yes
		Am-241	17	4.59E-01	5.13E-01	±	1.22E-01	1.29E+00	Yes
WMA 5	SNSW74A Sediment at north swamp drainage	Gross alpha	13	1.19E+01	1.29E+01	±	3.06E+00	2.20E+01	Yes
		Gross beta	13	2.33E+01	2.35E+01	±	2.97E+00	3.47E+01	Yes
		Sr-90	17	3.28E-01	4.67E-01	±	8.73E-02	2.10E+00	Yes
		Cs-137	17	2.55E+00	2.83E+00	±	2.54E-01	8.82E+00	Yes
		U-232	17	<2.16E-02	8.57E-03	±	2.53E-02	4.23E-02	No
		U-233/234	16	7.18E-01	6.24E-01	±	1.74E-01	1.06E+00	No
		U-235/236	16	5.49E-02	5.59E-02	±	4.05E-02	1.26E-01	No
		U-238	17	6.82E-01	6.36E-01	±	1.80E-01	1.35E+00	No
		Pu-238	10	2.37E-02	2.30E-02	±	1.88E-02	5.59E-02	No
		Pu-239/240	17	6.17E-02	6.52E-02	±	4.13E-02	1.92E-01	Yes
		Am-241	17	6.10E-02	9.01E-02	±	5.09E-02	2.58E-01	Yes

Table B-12. Summary of Radionuclide Results from Routine Onsite Sediment Monitoring Locations

WMA	Monitoring Point	Constituent	N	Median (pCi/g)	Average (pCi/g) Result	±	Uncertainty	Maximum (pCi/g)	Exceeded Background?(1)
WMA 12	SNSP006 Sediment from Franks Creek at security fence	Gross alpha	13	1.10E+01	1.01E+01	±	2.84E+00	1.32E+01	No
		Gross beta	13	4.27E+01	5.01E+01	±	4.09E+00	1.60E+02	Yes
		Sr-90	17	8.38E-01	1.49E+00	±	2.29E-01	9.98E+00	Yes
		Cs-137	17	1.30E+01	2.10E+01	±	2.75E+00	9.76E+01	Yes
		U-232	17	4.07E-02	4.01E-02	±	6.81E-02	1.43E-01	Yes
		U-233/234	16	6.40E-01	6.05E-01	±	1.78E-01	1.02E+00	No
		U-235/236	16	4.56E-02	3.87E-02	±	5.46E-02	1.04E-01	No
		U-238	17	6.07E-01	5.53E-01	±	1.68E-01	9.15E-01	No
		Pu-238	10	3.17E-02	4.29E-02	±	2.58E-02	1.40E-01	Yes
		Pu-239/240	17	2.60E-02	2.97E-02	±	2.54E-02	1.08E-01	Yes
		Am-241	17	4.34E-02	6.51E-02	±	4.78E-02	2.40E-01	Yes

NOTE: (1) Using the nonparametric Mann-Whitney "U" Test, the data set of sediment background results (summarized in Table B-4) was compared with the data set from each of the sampling locations. See Appendix B, Section 4.3.

Table B-13. Summary of Radionuclide Results from Routine Onsite Surface Water Monitoring Locations

WMA	Monitoring Point	Constituent	N	Median (pCi/L)(2)	Average (pCi/L) Result	±	Uncertainty	Maximum (pCi/L)	Exceeded Background?(1)
WMA 2	WNSP001 Lagoon 3 Discharge Weir	Gross alpha	232	1.75E+01	1.92E+01	±	1.32E+01	1.01E+02	Yes
		Gross beta	433	2.56E+02	3.01E+02	±	2.25E+01	8.18E+02	Yes
		H-3	231	2.47E+03	2.75E+03	±	1.42E+02	7.17E+03	Yes
		C-14	62	<2.82E+01	1.35E+01	±	2.24E+01	4.75E+01	Yes
		Sr-90	231	9.88E+01	1.21E+02	±	7.42E+00	3.19E+02	Yes
		Tc-99	197	6.53E+01	7.90E+01	±	4.79E+01	3.36E+02	Yes
		I-129	62	2.13E+00	2.44E+00	±	1.48E+00	1.04E+01	Yes
		Cs-137	231	6.10E+01	7.57E+01	±	1.88E+01	3.29E+02	Yes
		U-232	62	8.02E+00	8.98E+00	±	9.91E-01	2.14E+01	Yes
		U-233/234	62	5.04E+00	5.49E+00	±	6.20E-01	1.36E+01	Yes
		U-235/236	62	2.62E-01	2.75E-01	±	1.21E-01	5.84E-01	Yes
		U-238	62	3.76E+00	3.82E+00	±	4.87E-01	7.57E+00	Yes
		Pu-238	62	6.53E-02	1.53E-01	±	6.78E-02	1.62E+00	Yes
		Pu-239/240	62	5.17E-02	1.34E-01	±	6.19E-02	1.39E+00	Yes
		Am-241	62	6.79E-02	1.18E-01	±	6.01E-02	9.74E-01	Yes
WMA 4	WNSWAMP Northeast Swamp Drainage	Gross alpha	450	<1.87E+00	2.86E-01	±	2.28E+00	7.25E+00	No
		Gross beta	451	3.01E+03	3.24E+03	±	5.33E+01	9.98E+03	Yes
		H-3	451	1.13E+02	1.13E+02	±	8.21E+01	5.20E+02	Yes
		C-14	34	<1.58E+01	2.13E+00	±	2.09E+01	3.72E+01	No
		Sr-90	121	1.52E+03	1.70E+03	±	3.14E+01	5.16E+03	Yes
		I-129	34	<9.05E-01	5.39E-01	±	9.28E-01	1.29E+00	No
		Cs-137	120	<2.43E+00	6.76E-01	±	3.33E+00	5.74E+00	No
		U-232	34	<6.42E-02	7.47E-03	±	1.59E-01	9.76E-02	No
		U-233/234	34	1.73E-01	1.97E-01	±	1.36E-01	9.27E-01	Yes
		U-235/236	34	<4.20E-02	2.54E-02	±	5.77E-02	8.82E-02	No
		U-238	34	1.01E-01	1.21E-01	±	1.07E-01	7.21E-01	Yes
		Pu-238	34	<3.11E-02	1.20E-02	±	9.54E-02	1.50E-01	No
		Pu-239/240	34	<2.90E-02	1.48E-02	±	6.65E-02	1.44E-01	No
		Am-241	34	<3.42E-02	2.86E-02	±	9.57E-02	1.79E-01	No

Table B-13. Summary of Radionuclide Results from Routine Onsite Surface Water Monitoring Locations

WMA	Monitoring Point	Constituent	N	Median (pCi/L)(2)	Average (pCi/L) Result	±	Uncertainty	Maximum (pCi/L)	Exceeded Background?(1)
WMA 5	WNSW74A	Gross alpha	450	<2.17E+00	3.88E-02	±	3.09E+00	7.89E+00	No
	North	Gross beta	450	1.17E+01	1.21E+01	±	4.34E+00	4.24E+01	Yes
	Swamp	H-3	450	<8.18E+01	-2.14E+00	±	8.07E+01	2.80E+02	No
	Drainage	C-14	34	<1.40E+01	-7.72E-01	±	1.94E+01	1.50E+01	No
		Sr-90	120	5.52E+00	5.46E+00	±	1.89E+00	1.25E+01	Yes
		I-129	34	<7.10E-01	2.09E-01	±	7.37E-01	1.31E+00	No
		Cs-137	120	<7.08E+00	1.20E+00	±	8.85E+00	1.18E+01	No
		U-232	34	<4.83E-02	8.38E-03	±	6.79E-02	6.22E-02	No
		U-233/234	34	1.54E-01	1.64E-01	±	8.44E-02	3.54E-01	Yes
		U-235/236	34	<3.70E-02	1.89E-02	±	3.99E-02	1.38E-01	No
		U-238	34	1.01E-01	1.04E-01	±	6.65E-02	2.00E-01	Yes
		Pu-238	34	<2.10E-02	1.43E-02	±	3.36E-02	1.16E-01	No
		Pu-239/240	34	<2.39E-02	4.73E-03	±	2.73E-02	<6.94E-02	No
		Am-241	34	<2.81E-02	1.68E-02	±	3.17E-01	8.63E-02	No
WMA 6	WNSP007	Gross alpha	324	<2.62E+00	1.37E-01	±	3.32E+00	4.80E+00	No
	Sanitary	Gross beta	324	1.45E+01	1.53E+01	±	5.02E+00	4.05E+01	Yes
	Waste	H-3	324	<8.25E+01	2.26E+01	±	8.18E+01	1.53E+03	No
	Discharge	Sr-90	14	3.11E+00	3.38E+00	±	1.75E+00	1.17E+01	Yes
		Cs-137	35	<2.92E+00	8.12E-01	±	3.94E+00	4.44E+00	No
	WNCOOLW	Gross alpha	73	<1.91E+00	5.65E-01	±	2.03E+00	5.81E+00	No
	Cooling	Gross beta	73	6.83E+00	9.05E+00	±	3.64E+00	3.43E+01	Yes
	Tower Water	H-3	73	<8.17E+01	2.86E+00	±	7.94E+01	4.27E+02	No
		Sr-90	10	1.60E+00	1.50E+00	±	1.40E+00	4.68E+00	No
		Cs-137	31	<7.20E+00	8.61E-01	±	8.32E+00	9.15E+00	No

Table B-13. Summary of Radionuclide Results from Routine Onsite Surface Water Monitoring Locations

WMA	Monitoring Point	Constituent	N	Median (pCi/L)(2)	Average (pCi/L) Result	±	Uncertainty	Maximum (pCi/L)	Exceeded Background?(1)
WMA 12	WNSP006 Franks Creek at security fence	Gross alpha	471	<1.50E+00	9.49E-01	±	1.61E+00	1.07E+01	No
		Gross beta	471	3.53E+01	4.44E+01	±	3.99E+00	1.94E+02	Yes
		H-3	471	<8.54E+01	1.36E+02	±	8.33E+01	2.25E+03	Yes
		C-14	40	<1.85E+01	-1.31E+00	±	2.09E+01	2.06E+01	No
		Sr-90	120	1.87E+01	1.98E+01	±	2.99E+00	4.96E+01	Yes
		Tc-99	40	<2.09E+00	3.28E+00	±	2.15E+00	5.24E+01	Yes
		I-129	40	<7.04E-01	3.26E-01	±	7.25E-01	1.65E+00	No
		Cs-137	120	<8.02E+00	6.32E+00	±	9.50E+00	7.33E+01	Yes
		U-232	40	3.17E-01	3.16E-01	±	1.34E-01	7.51E-01	Yes
		U-233/234	40	3.66E-01	3.73E-01	±	1.31E-01	6.87E-01	Yes
		U-235/236	40	<4.41E-02	3.26E-02	±	4.61E-02	9.57E-02	No
		U-238	40	2.54E-01	2.77E-01	±	1.12E-01	7.43E-01	Yes
		Pu-238	40	<3.36E-02	2.14E-02	±	3.39E-02	1.36E-01	Yes
		Pu-239/240	40	<2.79E-02	1.13E-02	±	3.02E-02	6.62E-02	No
		Am-241	40	<3.30E-02	3.23E-02	±	3.69E-02	1.60E-01	No
	WNSP005 Facility yard drainage	Gross alpha	140	<2.71E+00	1.22E+00	±	3.24E+00	1.85E+01	No
		Gross beta	140	1.50E+02	1.63E+02	±	9.11E+00	4.53E+02	Yes
		H-3	140	<8.28E+01	3.78E+01	±	8.23E+01	1.25E+03	Yes
		Sr-90	35	9.61E+01	1.02E+02	±	6.52E+00	1.98E+02	Yes
		Cs-137	14	<1.91E+00	9.28E-01	±	2.19E+00	<3.69E+00	No
	WNNDADR Drainage between NDA and SDA	Gross alpha	130	<1.34E+00	8.22E-01	±	1.40E+00	5.84E+00	No
		Gross beta	136	1.74E+02	1.83E+02	±	6.45E+00	4.06E+02	Yes
		H-3	546	1.00E+03	1.16E+03	±	1.02E+02	4.02E+03	Yes
		Sr-90	41	8.48E+01	8.40E+01	±	5.45E+00	1.22E+02	Yes
		I-129	34	<8.12E-01	2.62E-01	±	8.53E-01	1.15E+00	No
		Cs-137	120	<6.67E+00	5.99E-01	±	8.48E+00	1.86E+01	No

Table B-13. Summary of Radionuclide Results from Routine Onsite Surface Water Monitoring Locations

WMA	Monitoring Point	Constituent	N	Median (pCi/L)[2]	Average (pCi/L)			Maximum (pCi/L)	Exceeded Background?[1]
					Result	±	Uncertainty		
WMA 12	WNERB53 Erdman Brook north of burial areas	Gross alpha	401	<1.45E+00	1.56E-01	±	1.65E+00	2.51E+00	No
		Gross beta	401	1.73E+01	1.81E+01	±	2.92E+00	4.37E+01	Yes
		H-3	403	<8.31E+01	3.08E+01	±	8.11E+01	3.46E+02	Yes
		Sr-90	14	8.23E+00	8.04E+00	±	1.98E+00	9.91E+00	Yes
		Cs-137	14	<2.07E+00	7.52E-01	±	3.96E+00	2.41E+00	No
	WNFRC67 Franks Creek east of burial areas	Gross alpha	99	<7.00E-01	9.41E-02	±	7.56E-01	3.89E+00	No
		Gross beta	99	2.63E+00	2.56E+00	±	1.50E+00	9.00E+00	No
		H-3	99	<8.31E+01	3.08E+01	±	8.11E+01	3.46E+02	Yes
		Sr-90	19	<1.17E+00	5.00E-01	±	1.09E+00	3.42E+00	No
		Cs-137	19	<2.13E+00	5.50E-01	±	2.58E+00	2.26E+00	No

NOTES: (1) Using the nonparametric Mann-Whitney "U" Test, the data set of surface water background results (summarized in Table B-6) was compared with the data set from each of the above sampling locations. See Appendix B, Section 4.3.

(2) 1 pCi/L = 3.7E-02 Bq/L

Table B-14. Summary of Radionuclide Results from Routine Onsite Groundwater Monitoring Locations[1]

WMA	Monitoring Point[2]	Constituent	N	Median (pCi/L)[3]	Average (pCi/L) Result	±	Uncertainty	Maximum (pCi/L)	Exceeded Background?[4]
WMA 1	WP-A S&G	Gross alpha	12	<3.56E-01	1.71E-01	±	2.12E+00	1.82E+00	No
		Gross beta	12	2.41E+01	3.09E+01	±	4.55E+00	5.44E+01	Yes
		H-3	12	1.18E+04	1.12E+04	±	6.24E+02	1.26E+04	Yes
WMA 2	WNW0103 S&G	Gross alpha	40	<7.32E+00	1.06E+00	±	1.01E+01	1.25E+01	No
		Gross beta	40	1.45E+02	1.85E+02	±	1.93E+01	5.53E+02	Yes
		H-3	40	<8.42E+01	5.19E+01	±	8.12E+01	2.02E+02	No
	WNW0104 S&G	Gross alpha	40	<3.86E+00	2.23E-01	±	5.95E+00	5.04E+00	No
		Gross beta	40	5.88E+04	5.63E+04	±	1.64E+03	1.01E+05	Yes
		H-3	40	3.73E+02	3.91E+02	±	8.65E+01	7.53E+02	Yes
	WNW0105 S&G	Gross alpha	41	<4.21E+00	1.04E+00	±	7.17E+00	4.60E+00	No
		Gross beta	41	3.88E+04	3.30E+04	±	1.54E+03	1.02E+05	Yes
		H-3	40	3.57E+02	3.72E+02	±	9.12E+01	7.09E+02	Yes
	WNW0106 S&G	Gross alpha	40	<2.50E+00	1.94E+00	±	3.44E+00	1.31E+01	No
		Gross beta	40	1.64E+01	8.22E+01	±	7.99E+00	5.76E+02	Yes
		H-3	40	9.56E+02	1.04E+03	±	1.00E+02	1.82E+03	Yes
	WNW0107 ULT	Gross alpha	40	<1.85E+00	8.97E-01	±	1.88E+00	5.71E+00	No
		Gross beta	40	7.00E+00	8.23E+00	±	2.63E+00	2.22E+01	Yes
		H-3	40	3.74E+02	4.78E+02	±	9.04E+01	9.85E+02	Yes
	WNW0108 ULT	Gross alpha	40	1.64E+00	1.47E+00	±	1.46E+00	4.31E+00	Yes
		Gross beta	40	2.49E+00	2.42E+00	±	1.90E+00	5.36E+00	No
		H-3	40	1.17E+02	1.10E+02	±	8.38E+01	2.47E+02	Yes
	WNW0110 ULT	Gross alpha	40	<1.49E+00	1.01E+00	±	1.61E+00	4.39E+00	No
		Gross beta	40	2.32E+00	2.23E+00	±	1.95E+00	7.92E+00	No
		H-3	40	1.31E+03	1.28E+03	±	1.08E+02	1.66E+03	Yes
	WNW0111 S&G	Gross alpha	40	<4.38E+00	3.15E+00	±	5.06E+00	1.03E+01	Yes
		Gross beta	40	5.55E+03	5.87E+03	±	1.40E+02	1.18E+04	Yes
		H-3	40	1.97E+02	2.34E+02	±	8.39E+01	7.97E+02	Yes

Table B-14. Summary of Radionuclide Results from Routine Onsite Groundwater Monitoring Locations[1]

WMA	Monitoring Point[2]	Constituent	N	Median (pCi/L)[3]	Average (pCi/L) Result	±	Uncertainty	Maximum (pCi/L)	Exceeded Background?[4]
WMA 2	WNW0116	Gross alpha	40	<3.08E+00	8.94E-01	±	4.35E+00	7.03E+00	No
	S&G	Gross beta	40	8.69E+02	1.98E+03	±	1.55E+02	9.51E+03	Yes
		H-3	40	1.67E+02	1.88E+02	±	8.24E+01	4.66E+02	Yes
	WNW0205	Gross alpha	35	<4.87E+00	4.37E-01	±	7.67E+00	<2.73E+01	No
	S&G	Gross beta	35	1.61E+01	1.66E+01	±	8.39E+00	4.08E+01	Yes
		H-3	35	<8.14E+01	9.44E+00	±	8.02E+01	2.09E+02	No
	WNW0206	Gross alpha	35	<2.47E+00	6.69E-01	±	3.33E+00	5.02E+00	No
	LTS	Gross beta	35	<3.16E+00	1.95E+00	±	3.53E+00	6.11E+00	No
		H-3	35	<8.18E+01	2.94E+01	±	7.96E+01	2.07E+02	No
	WNW0408	Gross alpha	40	<3.58E+00	-7.91E+00	±	9.05E+00	6.44E+00	No
	S&G	Gross beta	39	3.96E+05	4.01E+05	±	3.04E+03	6.28E+05	Yes
		H-3	40	1.52E+02	1.86E+02	±	1.13E+02	2.21E+03	Yes
		C-14	10	<2.16E+01	-7.20E-01	±	2.27E+01	<3.42E+01	No
		Sr-90	10	1.54E+05	1.54E+05	±	1.73E+02	2.53E+05	Yes
		Tc-99	10	1.57E+01	1.70E+01	±	3.28E+00	2.51E+01	Yes
		I-129	10	<9.94E-01	7.65E-02	±	2.53E+00	9.46E-01	No
		Cs-137	10	<4.01E+00	-3.24E-01	±	4.29E+00	<6.72E+00	No
		U-232	10	<6.32E-02	6.31E-02	±	2.04E-01	5.31E-02	No
		U-233/234	10	4.51E-01	5.34E-01	±	2.22E-01	1.27E+00	Yes
		U-235/236	10	<5.44E-02	8.34E-02	±	9.98E-02	3.11E-01	No
		U-238	10	2.87E-01	3.11E-01	±	1.57E-01	4.82E-01	Yes
		Pu-238	2	<6.83E-02	2.09E-02	±	7.45E-02	<9.80E-02	No
		Pu-239/240	2	<6.56E-02	7.70E-03	±	6.65E-02	<7.68E-02	No
		Am-241	2	4.60E-02	3.60E-02	±	4.72E-02	5.90E-02	No
	WNW0501	Gross alpha	40	<4.79E+00	4.82E-01	±	8.34E+00	6.10E+00	No

Table B-14. Summary of Radionuclide Results from Routine Onsite Groundwater Monitoring Locations[1]

WMA	Monitoring Point[2]	Constituent	N	Median (pCi/L)[3]	Average (pCi/L) Result	±	Uncertainty	Maximum (pCi/L)	Exceeded Background?[4]
WMA 2	S&G	Gross beta	40	1.93E+05	1.91E+05	±	2.61E+03	3.24E+05	Yes
		H-3	40	1.35E+02	1.25E+02	±	8.37E+01	3.15E+02	Yes
		Sr-90	10	9.18E+04	9.33E+04	±	2.43E+02	1.48E+05	Yes
	WNW0502	Gross alpha	40	<4.40E+00	7.94E-01	±	8.04E+00	1.46E+01	No
	S&G	Gross beta	40	1.68E+05	1.64E+05	±	2.80E+03	2.33E+05	Yes
		H-3	40	1.33E+02	1.44E+02	±	8.36E+01	4.98E+02	Yes
		Sr-90	10	8.36E+04	8.27E+04	±	2.05E+02	1.16E+05	Yes
	WNW8603	Gross alpha	41	<5.02E+00	3.92E-01	±	7.89E+00	9.30E+00	No
	S&G	Gross beta	41	5.66E+04	4.81E+04	±	1.20E+03	9.01E+04	Yes
		H-3	40	3.37E+02	3.43E+02	±	8.79E+01	5.81E+02	Yes
	WNW8604	Gross alpha	35	<4.68E+00	1.07E+00	±	7.83E+00	9.00E+00	No
	S&G	Gross beta	35	4.12E+04	4.57E+04	±	1.12E+03	1.04E+05	Yes
		H-3	35	3.48E+02	3.76E+02	±	8.38E+01	6.41E+02	Yes
	WNW8605	Gross alpha	40	9.11E+00	8.46E+00	±	7.66E+00	2.08E+01	Yes
	S&G	Gross beta	40	1.09E+04	1.10E+04	±	1.73E+02	1.62E+04	Yes
		H-3	40	3.70E+02	4.19E+02	±	8.68E+01	1.27E+03	Yes
	WP-C	Gross alpha	12	<3.95E-01	9.03E-01	±	2.74E+00	<6.92E+00	No
	S&G	Gross beta	12	2.44E+01	4.16E+01	±	5.48E+00	1.19E+02	Yes
		H-3	12	4.91E+04	4.75E+04	±	1.56E+03	6.61E+04	Yes
	WP-H	Gross alpha	13	6.08E+00	7.90E+01	±	2.33E+01	7.42E+02	Yes
	S&G	Gross beta	13	6.97E+03	7.23E+03	±	1.87E+02	1.25E+04	Yes
		H-3	13	2.99E+03	3.42E+03	±	5.00E+02	7.38E+03	Yes
WMA 3	WNW8609	Gross alpha	40	<3.10E+00	-3.75E-01	±	5.55E+00	3.84E+00	No
	S&G	Gross beta	40	1.51E+03	1.37E+03	±	4.15E+01	2.28E+03	Yes
		H-3	40	4.51E+02	4.66E+02	±	9.10E+01	7.88E+02	Yes
		Sr-90	20	7.99E+02	7.17E+02	±	2.07E+01	1.12E+03	Yes
WMA 4	WNW0801	Gross alpha	40	<3.85E+00	6.31E-02	±	6.49E+00	5.45E+00	No

Table B-14. Summary of Radionuclide Results from Routine Onsite Groundwater Monitoring Locations(1)

WMA	Monitoring Point(2)	Constituent	N	Median (pCi/L)(3)	Average (pCi/L) Result	±	Uncertainty	Maximum (pCi/L)	Exceeded Background?(4)
WMA 4	S&G	Gross beta	40	7.95E+03	8.59E+03	±	2.72E+02	1.46E+04	Yes
		H-3	40	1.51E+02	1.64E+02	±	8.24E+01	3.82E+02	Yes
		Sr-90	40	4.13E+03	4.33E+03	±	4.73E+01	7.99E+03	Yes
	WNW0802 S&G	Gross alpha	40	<1.33E+00	1.05E+00	±	2.03E+00	1.66E+01	No
		Gross beta	40	9.94E+00	3.47E+01	±	5.14E+00	2.84E+02	Yes
		H-3	40	<1.05E+02	9.00E+01	±	8.00E+01	4.20E+02	Yes
	WNW0803 S&G	Gross alpha	40	<3.01E+00	9.79E-01	±	3.38E+00	8.96E+00	No
		Gross beta	40	1.48E+01	1.51E+01	±	4.69E+00	2.50E+01	Yes
		H-3	40	1.84E+02	1.60E+02	±	8.46E+01	3.42E+02	Yes
	WNW0804 S&G	Gross alpha	40	<2.04E+00	6.00E-01	±	2.87E+00	6.54E+00	No
		Gross beta	40	2.58E+02	2.86E+02	±	1.07E+01	6.89E+02	Yes
		H-3	40	1.19E+02	1.14E+02	±	7.98E+01	3.60E+02	Yes
	WNW8612 S&G	Gross alpha	40	<2.62E+00	3.33E-01	±	3.34E+00	4.57E+00	No
		Gross beta	41	<3.58E+00	1.57E+00	±	3.60E+00	5.91E+00	No
		H-3	40	4.21E+02	4.33E+02	±	8.88E+01	8.46E+02	Yes
WMA 5	WNW0406 S&G	Gross alpha	40	<2.22E+00	1.54E-01	±	2.58E+00	4.49E+00	No
		Gross beta	40	7.44E+00	8.08E+00	±	3.49E+00	1.67E+01	Yes
		H-3	40	1.17E+02	1.06E+02	±	8.42E+01	4.38E+02	Yes
		C-14	10	<2.65E+01	-2.04E+00	±	2.36E+01	2.72E+01	No
		Sr-90	10	1.92E+00	2.15E+00	±	1.45E+00	4.57E+00	No
		Tc-99	11	2.19E+00	2.53E+00	±	1.91E+00	8.50E+00	Yes
		I-129	10	<8.91E-01	3.48E-01	±	9.17E-01	1.72E+00	No
		Cs-137	10	<6.41E+00	-9.30E-01	±	7.35E+00	<1.48E+01	No
		U-232	10	<4.55E-02	2.47E-02	±	1.24E-01	<3.59E-01	No
		U-233/234	10	1.37E-01	1.42E-01	±	1.05E-01	2.67E-01	No
		U-235/236	10	<3.97E-02	2.32E-02	±	5.51E-02	6.92E-02	No
		U-238	10	8.08E-02	8.87E-02	±	8.17E-02	1.92E-01	No

Table B-14. Summary of Radionuclide Results from Routine Onsite Groundwater Monitoring Locations[1]

WMA	Monitoring Point[2]	Constituent	N	Median (pCi/L)[3]	Average (pCi/L)			Maximum (pCi/L)	Exceeded Background?[4]
					Result	±	Uncertainty		
WMA 5	WNW0409 ULT	Gross alpha	40	<1.01E+00	9.39E-01	±	9.94E-01	2.32E+00	Yes
		Gross beta	40	2.56E+00	2.36E+00	±	1.37E+00	4.38E+00	No
		H-3	40	<8.01E+01	-3.82E+00	±	7.86E+01	2.10E+02	No
	WNW0602A S&G	Gross alpha	35	<1.37E+00	4.04E-01	±	1.60E+00	2.51E+00	No
		Gross beta	35	1.21E+01	1.32E+01	±	2.87E+00	3.46E+01	Yes
		H-3	35	2.15E+02	2.18E+02	±	8.88E+01	4.88E+02	Yes
	WNW0604 S&G	Gross alpha	41	<2.04E+00	3.35E-01	±	2.45E+00	3.10E+00	No
		Gross beta	41	6.06E+00	6.29E+00	±	2.97E+00	1.29E+01	Yes
		H-3	40	<8.14E+01	1.99E+01	±	8.01E+01	2.07E+02	No
	WNW0605 S&G	Gross alpha	35	<1.54E+00	4.40E-01	±	1.59E+00	1.13E+01	No
		Gross beta	35	4.83E+01	5.07E+01	±	3.98E+00	8.82E+01	Yes
		H-3	35	<8.08E+01	1.59E+01	±	7.86E+01	1.44E+02	No
	WNW0704 ULT/S&G	Gross alpha	40	<1.93E+00	1.75E-01	±	2.25E+00	2.23E+00	No
		Gross beta	40	8.05E+00	8.20E+00	±	3.05E+00	1.34E+01	Yes
		H-3	40	<8.20E+01	-1.69E+01	±	8.24E+01	2.16E+02	No
	WNW0707 ULT/S&G	Gross alpha	40	<1.15E+00	3.09E-01	±	1.35E+00	4.40E+00	No
		Gross beta	40	4.17E+00	4.16E+00	±	1.98E+00	9.85E+00	No
		H-3	40	<8.22E+01	-1.89E+01	±	8.11E+01	1.05E+02	No
	WNW1303 ULT	Gross alpha	19	<9.42E-01	1.19E+00	±	2.06E+00	5.46E+00	No
		Gross beta	19	2.17E+00	2.24E+00	±	2.25E+00	9.38E+00	No
		H-3	19	<8.25E+01	-4.98E+01	±	2.09E+02	1.26E+02	No
	WNW1304 S&G	Gross alpha	19	<6.14E+00	-8.58E-01	±	8.32E+00	6.92E+00	No
		Gross beta	19	<8.20E+00	4.92E+00	±	8.11E+00	1.33E+01	No
		H-3	19	<9.44E+01	2.36E+01	±	2.16E+02	1.60E+02	No
		C-14	18	<3.03E+01	2.02E+00	±	2.92E+01	3.69E+01	No
		Sr-90	18	1.60E+00	1.93E+00	±	1.28E+00	6.33E+00	No
		Tc-99	18	<1.94E+00	1.25E-01	±	1.91E+00	2.62E+00	No

Table B-14. Summary of Radionuclide Results from Routine Onsite Groundwater Monitoring Locations[1]

WMA	Monitoring Point[2]	Constituent	N	Median (pCi/L)[3]	Average (pCi/L)			Maximum (pCi/L)	Exceeded Background?[4]
					Result	±	Uncertainty		
WMA 5		I-129	18	<7.52E-01	3.39E-01	±	1.33E+00	2.83E+00	No
		Cs-137	18	<2.77E+00	7.11E-01	±	4.88E+00	2.52E+00	No
		U-232	18	<3.73E-02	-1.09E-02	±	6.74E-02	<2.17E-01	No
		U-233/234	18	2.66E-01	2.93E-01	±	1.26E-01	5.65E-01	Yes
		U-235/236	18	<4.07E-02	3.85E-02	±	5.31E-02	1.77E-01	No
		U-238	18	1.91E-01	2.15E-01	±	1.05E-01	5.77E-01	Yes
	WNW8607 S&G	Gross alpha	40	<2.36E+00	-7.83E-02	±	4.40E+00	9.45E+00	No
		Gross beta	40	2.57E+01	2.75E+01	±	5.30E+00	7.63E+01	Yes
		H-3	40	<8.47E+01	1.97E+01	±	8.30E+01	2.04E+02	No
WMA 7	WNW0902 KRS	Gross alpha	20	1.46E+00	1.34E+00	±	1.34E+00	5.44E+00	Yes
		Gross beta	20	2.70E+00	2.76E+00	±	1.64E+00	4.92E+00	No
		H-3	20	<8.08E+01	-3.35E+01	±	8.18E+01	1.18E+02	No
	WNW0909 WLT	Gross alpha	26	<3.24E+00	1.16E+00	±	3.83E+00	1.14E+01	No
		Gross beta	34	3.74E+02	3.70E+02	±	1.40E+01	6.44E+02	Yes
		H-3	30	8.23E+02	1.54E+03	±	1.20E+02	3.95E+03	Yes
		C-14	10	<2.49E+01	7.23E+00	±	2.39E+01	3.53E+01	No
		Sr-90	17	1.87E+02	1.83E+02	±	8.33E+00	2.21E+02	Yes
		Tc-99	11	<1.86E+00	1.31E+00	±	1.82E+00	5.01E+00	Yes
		I-129	11	6.21E+00	6.30E+00	±	1.88E+00	9.65E+00	Yes
		Cs-137	10	<5.51E+00	1.09E+00	±	6.42E+00	<1.28E+01	No
		U-232	12	<5.99E-02	6.37E-02	±	1.62E-01	5.26E-01	No
		U-233/234	12	5.97E-01	7.42E-01	±	2.40E-01	1.34E+00	Yes
		U-235/236	11	6.71E-02	7.66E-02	±	7.65E-02	2.48E-01	No
		U-238	12	4.72E-01	5.44E-01	±	1.97E-01	1.03E+00	Yes

Table B-14. Summary of Radionuclide Results from Routine Onsite Groundwater Monitoring Locations[1]

WMA	Monitoring Point[2]	Constituent	N	Median (pCi/L)[3]	Average (pCi/L) Result	±	Uncertainty	Maximum (pCi/L)	Exceeded Background?[4]
WMA 7	WNW0910 ULT	Gross alpha	25	<2.53E+00	1.88E+00	±	2.29E+00	3.45E+00	Yes
		Gross beta	25	3.80E+01	1.46E+02	±	8.51E+00	1.54E+03	Yes
		H-3	24	<8.06E+01	-1.24E+01	±	8.05E+01	2.39E+02	No
	WNNDATR WLT	Gross alpha	160	2.22E+00	2.08E+00	±	2.11E+00	1.06E+01	Yes
		Gross beta	166	1.45E+02	1.75E+02	±	8.36E+00	5.51E+02	Yes
		H-3	164	3.65E+03	5.00E+03	±	2.28E+02	1.99E+04	Yes
		C-14	20	<2.18E+01	3.02E-01	±	2.39E+01	1.33E+01	No
		Sr-90	28	5.84E+01	7.85E+01	±	5.55E+00	2.84E+02	Yes
		Tc-99	21	<1.94E+00	6.32E-01	±	1.89E+00	5.12E+00	No
		I-129	41	<9.14E-01	8.44E-01	±	9.35E-01	7.00E+00	Yes
		Cs-137	140	<6.80E+00	7.20E-01	±	8.88E+00	1.50E+01	No
		U-232	21	<7.12E-02	5.11E-02	±	1.18E-01	4.72E-01	No
		U-233/234	21	1.67E+00	1.51E+00	±	2.81E-01	2.11E+00	Yes
		U-235/236	21	1.06E-01	1.35E-01	±	9.47E-02	3.04E-01	Yes
		U-238	21	1.30E+00	1.22E+00	±	2.50E-01	1.73E+00	Yes
	WNW8610 KRS	Gross alpha	20	<2.21E+00	6.60E-01	±	2.88E+00	6.35E+00	No
		Gross beta	20	4.41E+00	4.79E+00	±	3.09E+00	9.91E+00	No
		H-3	20	<8.17E+01	-3.80E+01	±	7.96E+01	1.46E+02	No
	WNW8611 KRS	Gross alpha	21	<1.98E+00	1.23E+00	±	2.25E+00	4.50E+00	No
		Gross beta	21	<2.71E+00	2.83E+00	±	2.81E+00	1.67E+01	No
		H-3	20	<8.15E+01	-4.98E+01	±	8.08E+01	8.44E+01	No
WMA 9	WNW1005 WLT	Gross alpha	20	<2.49E+00	1.97E+00	±	2.92E+00	4.69E+00	No
		Gross beta	20	<3.52E+00	2.36E+00	±	2.98E+00	5.14E+00	No
		H-3	20	<8.36E+01	1.24E+01	±	8.14E+01	2.01E+02	No

Table B-14. Summary of Radionuclide Results from Routine Onsite Groundwater Monitoring Locations[1]

WMA	Monitoring Point[2]	Constituent	N	Median (pCi/L)[3]	Average (pCi/L) Result	±	Uncertainty	Maximum (pCi/L)	Exceeded Background?[4]
WMA 9	WNW1006 WLT	Gross alpha	20	<5.10E+00	4.24E+00	±	5.50E+00	1.02E+01	Yes
		Gross beta	20	<6.80E+00	4.58E+00	±	5.68E+00	1.03E+01	No
		H-3	20	<8.20E+01	-1.81E+01	±	8.24E+01	1.67E+02	No
WMA 10	WNW0302 S&G	Gross alpha	36	<5.51E+00	8.24E-01	±	9.02E+00	1.55E+00	No
		Gross beta	36	<7.22E+00	4.13E+00	±	8.13E+00	1.27E+01	No
		H-3	36	<8.23E+01	3.72E+01	±	8.11E+01	1.87E+02	No
	WNW0402 S&G	Gross alpha	35	<5.13E+00	5.02E-01	±	6.93E+00	7.45E+00	No
		Gross beta	35	<5.64E+00	2.53E+00	±	6.56E+00	8.33E+00	No
		H-3	35	<8.21E+01	2.73E+01	±	8.05E+01	1.99E+02	No
	WNW0403 S&G	Gross alpha	35	<2.11E+00	3.85E-01	±	2.45E+00	5.94E+00	No
		Gross beta	35	5.76E+00	6.17E+00	±	3.26E+00	1.06E+01	No
		H-3	35	<8.22E+01	2.20E+01	±	7.97E+01	1.92E+02	No
	WNW1008B KRS	Gross alpha	20	<1.08E+00	7.09E-01	±	1.12E+00	3.11E+00	No
		Gross beta	20	2.68E+00	3.15E+00	±	1.46E+00	9.18E+00	No
		H-3	20	<8.04E+01	-2.23E+01	±	7.96E+01	7.81E+01	No
	WNW1008C WLT	Gross alpha	20	<1.51E+00	8.13E-02	±	1.48E+00	<1.89E+00	No
		Gross beta	20	<1.86E+00	1.15E+00	±	2.00E+00	3.03E+00	No
		H-3	20	<8.15E+01	-1.06E+00	±	8.10E+01	1.33E+02	No
	WNW1301 ULT	Gross alpha	1	<1.48E+01	1.43E+01	±	1.48E+01	<1.48E+01	No
		Gross beta	1	<1.02E+01	-1.04E+01	±	1.02E+01	<1.02E+01	No
		H-3	1	<8.61E+02	-6.09E+02	±	8.61E+02	<8.61E+02	No
	WNW1302 S&G	Gross alpha	19	<3.69E+00	1.00E+00	±	5.69E+00	4.88E+00	No
		Gross beta	19	<5.62E+00	2.76E+00	±	6.44E+00	6.47E+00	No
		H-3	19	<9.37E+01	-4.07E+01	±	2.05E+02	1.15E+02	No

Table B-14. Summary of Radionuclide Results from Routine Onsite Groundwater Monitoring Locations[1]

WMA	Monitoring Point[2]	Constituent	N	Median (pCi/L)[3]	Average (pCi/L) Result	±	Uncertainty	Maximum (pCi/L)	Exceeded Background?[4]
WMA 12	WNW0903 KRS	Gross alpha	20	<1.90E+00	3.35E-01	±	2.26E+00	4.29E+00	No
		Gross beta	20	<2.42E+00	2.30E+00	±	2.62E+00	9.21E+00	No
		H-3	20	<8.20E+01	-5.34E+01	±	8.16E+01	1.62E+02	No
	WNW0906 WLT	Gross alpha	20	<1.78E+00	1.47E+00	±	1.72E+00	4.19E+00	No
		Gross beta	20	4.50E+00	4.92E+00	±	2.22E+00	1.41E+01	No
		H-3	20	<8.43E+01	3.80E+00	±	8.23E+01	1.55E+02	No

NOTES: (1) See Figure 4-12 in Section 4 of this plan for the locations of monitoring wells where concentrations exceed background.

(2) Geologic unit is indicated below each monitoring point.

(3) 1 pCi/L = 3.7E-02 Bq/L.

(4) Data sets for radiological constituents in groundwater were compared with data sets from background wells using the nonparametric Mann-Whitney “U” test, as described in Appendix B, Section 4.3.

LEGEND: S&G = Sand and Gravel; ULT = unweathered Lavery till; KRS = Kent Recessional Sequence; WLT = weathered Lavery till; LTS = Lavery till sand.

Table B-15. Groundwater Monitoring Locations: Coordinates, Depth, Screened Interval, and Geologic Unit

Monitoring Location(1)	North Coordinate(2)	East Coordinate(2)	Surface Elevation (ft)	Well Construction Material	Well Diameter (in)	Depth to Screen Top (ft)	Depth to Screen Bottom (ft)	Geologic Unit of Screened Interval
WNW0103	893013.68	1129469.99	1399.99	ST. STL.	2	6	21	S&G-TBU
WNW0104	893295.07	1129574.51	1399.29	ST. STL.	2	8	23	S&G-TBU/SWS
WNW0105	893536.70	1129768.63	1385.59	ST. STL.	2	13	28	S&G-TBU/SWS
WNW0106	893495.37	1129926.24	1383.73	ST. STL.	2	9.5	14.5	S&G-TBU
WNW0107	893399.05	1130060.32	1376.40	ST. STL.	2	8	28	ULT
WNW0108	893110.00	1129915.26	1381.66	ST. STL.	2	13	33	ULT
WNW0110	893024.67	1129881.74	1387.74	ST. STL.	2	13	33	ULT
WNW0111	892874.91	1129694.33	1392.54	ST. STL.	2	6	11	S&G-TBU
WNW0116	893518.81	1129560.10	1387.39	ST. STL.	2	6	11	S&G-TBU
WNW0204	892670.48	1129380.67	1406.83	ST. STL.	2	38	43	LTS
WNW0205	892696.37	1129528.87	1398.32	ST. STL.	2	6	11	S&G-TBU
WNW0206	892705.65	1129535.43	1398.39	ST. STL.	2	32.8	37.8	LTS
WNW0301	892593.20	1128914.31	1418.44	ST. STL.	2	6	16	S&G-TBU
WNW0302	892599.05	1128910.79	1418.46	ST. STL.	2	23	28	S&G-SWS
WNW0401	892708.28	1128864.51	1418.57	ST. STL.	2	6	16	S&G-TBU
WNW0402	892702.84	1128867.50	1419.34	ST. STL.	2	24	29	S&G-SWS
WNW0403	892865.78	1128790.38	1419.66	ST. STL.	2	8	13	S&G-TBU
WNW0405	893405.48	1128685.08	1408.56	ST. STL.	2	7.5	12.5	ULT
WNW0406	893250.04	1128992.47	1405.85	ST. STL.	2	11.8	16.8	S&G-TBU
WNW0408	893074.34	1129214.81	1405.56	ST. STL.	2	28	38	S&G-TBU/SWS
WNW0409	893256.53	1128988.16	1404.34	ST. STL.	2	44	54	ULT
WNW0501	893186.25	1129277.65	1402.18	ST. STL.	2	23	33	S&G-SWS
WNW0502	893325.38	1129406.73	1397.45	ST. STL.	2	8	18	S&G-TBU/SWS
WNW0602A	893403.75	1129244.07	1397.27	PVC	2	5	15	S&G-TBU

Table B-15. Groundwater Monitoring Locations: Coordinates, Depth, Screened Interval, and Geologic Unit

Monitoring Location(1)	North Coordinate(2)	East Coordinate(2)	Surface Elevation (ft)	Well Construction Material	Well Diameter (in)	Depth to Screen Top (ft)	Depth to Screen Bottom (ft)	Geologic Unit of Screened Interval
WNW0604	893576.30	1128926.84	1398.95	ST. STL.	2	6	11	S&G-TBU
WNW0605	893815.08	1129254.11	1383.90	ST. STL.	2	6	11	S&G-TBU
WNW0704	893763.67	1128814.82	1395.36	ST. STL.	2	5.5	15.5	ULT
WNW0706	893512.77	1128608.18	1409.03	ST. STL.	2	6	11	S&G-TBU
WNW0707	893896.47	1128617.53	1396.26	ST. STL.	2	6	11	ULT
WNW0801	893679.20	1129555.29	1383.51	ST. STL.	2	7.5	17.5	S&G-TBU
WNW0802	893904.53	1129687.61	1377.50	ST. STL.	2	6	11	S&G-TBU
WNW0803	893914.79	1129907.88	1370.17	ST. STL.	2	8	18	S&G-SWS
WNW0804	893751.72	1129982.56	1373.04	ST. STL.	2	4	9	S&G-TBU
WNW0901	891449.83	1129923.88	1392.72	ST. STL.	2	121	136	KRS
WNW0902	891671.96	1129774.24	1390.46	ST. STL.	2	118	128	KRS
WNW0903	892064.50	1129974.91	1380.69	ST. STL.	2	118	133	KRS
WNW0906	891945.99	1129796.90	1384.55	ST. STL.	2	5	10	WLT
WNW0908	891453.85	1129920.53	1392.94	ST. STL.	2	6	21	WLT
WNW0909	892085.66	1130121.37	1372.99	ST. STL.	2	8	23	WLT
WNW0910	892088.89	1130128.11	1372.69	PVC	2	25	30	ULT
WNW1005	890964.33	1130017.26	1389.68	ST. STL.	2	9	19	WLT
WNW1006	891264.17	1130206.69	1392.32	ST. STL.	2	10	20	WLT
WNW1008B	890904.46	1129534.09	1402.35	ST. STL.	2	46	51	KRS
WNW1008C	890914.13	1129545.20	1402.43	ST. STL.	2	8	18	WLT
WNW1301	893111.93	1128386.20	1429.49	PVC	2	20	30	ULT
WNW1302	893111.83	1128386.64	1429.47	PVC	2	5	8	S&G-TBU
WNW1303	893400.10	1128599.38	1414.65	PVC	2	23	38	ULT
WNW1304	893405.10	1128595.82	1414.36	PVC	2	6	10	S&G-TBU

Table B-15. Groundwater Monitoring Locations: Coordinates, Depth, Screened Interval, and Geologic Unit

Monitoring Location(1)	North Coordinate(2)	East Coordinate(2)	Surface Elevation (ft)	Well Construction Material	Well Diameter (in)	Depth to Screen Top (ft)	Depth to Screen Bottom (ft)	Geologic Unit of Screened Interval
WNW8603	893537.65	1129716.56	1385.45	PVC	4	8.25	23.25	S&G-TBU/SWS
WNW8604	893396.47	1129624.90	1390.41	PVC	4	6	21	S&G-TBU/SWS
WNW8605	892864.58	1129650.32	1393.19	PVC	4	5.5	10.5	S&G-TBU
WNW8607	893392.16	1128904.17	1405.03	PVC	4	11	16	S&G-TBU
WNW8609	893126.56	1129091.64	1407.07	PVC	4	12.7	22.7	S&G-TBU
WNW8610	891896.52	1130392.29	1376.88	STL.	2	97.33	112.33	KRS
WNW8611	892067.89	1130297.10	1376.34	STL.	2	103.5	118.5	KRS
WNW8612	893983.30	1130028.31	1367.76	PVC	4	6.6	16.6	S&G-TBU/SWS
WNWNB1S	892513.28	1128353.79	1447.08	ST. STL.	2	8	13	S&G-TBU
WNNDATR	892068.35	1130126.06	1374.89	CONCRETE	60	0	0	WLT
WP-A	892883.92	1129232.58	1408.34	IRON	2	29	33	S&G-TBU/SWS
WP-C	892986.95	1129411.57	1400.89	IRON	2	19	23	S&G-TBU
WP-H	892925.41	1129367.85	1405.38	IRON	2	13	17	S&G-TBU

NOTES: (1) Radiological data from the current monitoring locations, as listed in the 2008 Groundwater Monitoring Program, were evaluated for the WVDP Phase 1 DP. Monitoring point WNNDATR is an interceptor trench.

(2) Western New York State Planar Coordinate System

LEGEND: STL = steel, ST.STL = stainless steel, PVC = polyvinyl chloride, S&G = sand and gravel, TBU = thick bedded unit, SWS = slack water sequence, ULT = unweathered Lavery till, LTS = Lavery till sand, KRS = Kent recessional sequence, WLT = weathered Lavery till.

Table B-16. Location, Elevation, and Depth of Geoprobe® Groundwater Sampling Points

Location Code	Year Sampled	North Coordinate(1)	East Coordinate(1)	Surface Elevation (ft)	Sample Depths (ft) and Geologic Units(2)
GP01	1994	893754.94	1129433.58	1375.00	04-06
GP0197	1997	893527.20	1129733.08	1382.35	00-04, 04-08, 08-12, 12.5-14, 12-16, 16-20, 17.5-19, 20-24, 22.5-24, 24-28 (ULT)
GP02	1994	893701.98	1129480.46	1378.95	06-08
GP0297	1997	893527.37	1129689.35	1383.08	00-04, 04-08, 08-12, 12.5-14, 12-16, 16-20, 17.5-19, 20-24, 24-28. 25.5-27
GP03	1994	893684.86	1129546.39	1380.07	08-10, 13-15
GP0397	1997	893527.23	1129662.34	1383.08	00-04, 04-08, 08-12, 10.5-12, 12-16, 15.5-17, 16-20, 20.5-22, 20-24, 24.5-26, 24-28, 28-32 (ULT)
GP04	1994	893587.10	1129609.73	1381.96	10-12
GP0497	1997	893529.48	1129630.86	1383.10	08.5-10, 13.5-15, 18.5-20, 23-24.5
GP05	1994	893556.85	1129746.34	1391.59	15-17, 20-22, 25-27
GP0597	1997	893531.83	1129600.53	1383.51	08.5-10, 13.5-15
GP06	1994	893523.31	1129743.01	1382.59	15-17, 20-22, 25-27
GP0697	1997	893635.51	1129508.65	1381.39	08.5-10, 13.5-15, 17.5-19
GP07	1994	893623.69	1129777.03	1378.60	07.5-09.5
GP0797	1997	893633.61	1129535.22	1380.88	08.5-10, 13.5-15, 18.5-20
GP08	1994	893485.68	1129640.70	1384.66	09-11, 14-16, 19-21
GP0897	1997	893629.21	1129567.72	1380.15	08.5-10, 12.5-14.5, 17.5-18.5
GP09	1994	893446.05	1129609.75	1385.81	09-11, 14-16, 19-21
GP0997	1997	893630.01	1129599.46	1379.30	08.5-10, 13.5-15
GP10	1994	893495.08	1129514.19	1386.41	09-11
GP1097	1997	893628.00	1129624.69	1379.01	08.5-10, 13.5-15, 18.5-20
GP11	1994	893514.96	1129468.64	1386.51	08-10
GP1197	1997	893625.73	1129664.22	1378.57	08.5-10, 13.5-15, 17.5-19, 23.4-25
GP12	1994	893594.08	1129526.20	1382.41	07-09
GP1297	1997	893623.09	1129706.63	1378.15	00-04, 04-08, 07.5-09, 08-12, 12.5-14, 12-16, 16-20, 17.5-19, 20-24, 22-23.5, 24-28 (ULT)
GP13	1994	893422.90	1129419.73	1390.67	10-12
GP1397	1997	893621.53	1129744.33	1377.93	09-10.5, 13.5-15, 18.5-20
GP13A	1994	893385.24	1129395.73	1392.97	11-13, 15-17, 16-18
GP14	1994	893179.41	1129370.33	1399.11	15-17, 20-22, 25-27, 30-32
GP1497	1997	893619.43	1129784.76	1378.09	00-04, 04-08, 08-09.5, 08-12, 12-16, 16-20 (ULT)

Table B-16. Location, Elevation, and Depth of Geoprobe® Groundwater Sampling Points

Location Code	Year Sampled	North Coordinate(1)	East Coordinate(1)	Surface Elevation (ft)	Sample Depths (ft) and Geologic Units(2)
GP15	1994	893222.77	1129158.76	1402.57	15-17
GP1597	1997	893662.03	1129761.57	1376.85	08-10, 13-15, 18-20
GP16	1994	893217.10	1129056.60	1402.66	15-17, 20-22
GP1697	1997	893662.85	1129707.70	1377.19	08-10, 12-15, 18-20
GP17	1994	893055.18	1129446.69	1399.01	12-14
GP1797	1997	893733.87	1130014.29	1370.09	08-10, 13-15
GP18	1994	892932.47	1129283.29	1404.16	18-20, 21.5-23.5
GP1897	1997	893666.65	1129642.75	1387.08	08-10, 13-15, 17.5-19.5
GP1898	1998	892929.53	1129281.76	1403.99	12-14, 16-19, 22-24
GP1997	1997	893528.51	1129675.56	1383.27	00-04, 04-08, 08-12, 12-16, 14-16, 16-20, 19-21, 20-22, 22-24, 24-26, 26-28, 28-30
GP20	1994	893141.44	1129083.93	1403.07	15-17
GP2097	1997	893529.48	1129645.74	1383.35	00-04, 04-08, 08-12, 12-14, 12-16, 16-20, 17-19, 20-24, 22-24, 24-28
GP2197	1997	893531.19	1129615.48	1383.43	00-04, 04-08, 08-12, 12-16, 13-15, 16-20, 20-24, 23-25, 24-28 (ULT), 28-32 (ULT), 32-36 (ULT)
GP2297	1997	893462.46	1129692.02	1384.93	12-14, 17-19, 22-24
GP23	1994	892960.50	1129165.19	1409.41	20-22, 22.5-24.5, 27-29, 32-34
GP2397	1997	893512.71	1129715.96	1383.06	12-14, 16-19, 22-24
GP2397	1998	892980.83	1129165.77	1408.96	17-19, 22-24, 25-29, 32-34
GP24	1994	893006.32	1129151.08	1408.99	17-19, 22-24, 26-28, 30-32
GP2497	1997	893506.39	1129771.02	1382.83	00-04, 04-08, 08-12, 12-16, 14-16, 16-20, 19-21, 20-24, 24-26, 24-28, 28-30, 30-32 (ULT)
GP2597	1997	893804.22	1129989.94	1368.40	08-10
GP26	1994	892992.21	1129084.84	1409.63	17-19
GP2697	1997	893671.61	1129961.64	1375.36	04.5-06.5, 09-11, 14-16
GP27	1994	892960.10	1129096.04	1408.86	16-18, 21-23, 26-28
GP2797	1997	893576.18	1129713.16	1381.18	12-14, 16-19, 22-24
GP28	1994	892855.87	1129220.94	1408.08	16-18, 21-23, 26-28, 31-33
GP2897	1997	893579.60	1129663.78	1381.44	12-14, 16-19, 22-24
GP29	1994	892783.34	1129163.61	1410.01	15-17, 21-23, 27-29, 33-35
GP2997	1997	893583.58	1129622.59	1381.56	12-14

Table B-16. Location, Elevation, and Depth of Geoprobe® Groundwater Sampling Points

Location Code	Year Sampled	North Coordinate(1)	East Coordinate(1)	Surface Elevation (ft)	Sample Depths (ft) and Geologic Units(2)
GP2998	1998	892781.53	1129163.00	1409.81	17-19, 19-21, 21-23, 22-24, 23-25, 25-27, 27-29, 29-31, 31-33, 33-35, 34-36, 35-37, 37-38 (ULT), 38-39 (ULT), 39-40 (ULT), 40-41 (ULT)
GP2908	2008	892784.10	1129167.91	1410.50	17-19, 29-31, 35-37
GP30	1994	892835.65	1129144.49	1409.32	18-20, 22-24, 27-29, 32-34
GP3098	1998	892829.94	1129141.96	1409.18	18-20, 20-22, 22-24, 23-27, 23-37, 24-26, 26-28, 28-30, 30-32, 32-34, 34-36, 36-36.5, 36.5-37 (ULT), 37-37.5 (ULT), 37.5-38 (ULT), 38-38.5 (ULT), 38.5-39 (ULT), 39-39.5 (ULT), 39.5-40 (ULT)
GP3008	2008	892837.12	1129147.27	1409.83	20-22, 28-30, 35-37
GP31	1994	893269.27	1129335.71	1396.59	12-14, 17-19
GP32	1994	893827.03	1129487.70	1372.83	05-07
GP32A	1994	893831.75	1129475.59	1372.45	05-07
GP33	1994	893813.09	1129337.41	1375.73	05-07
GP33A	1994	893819.60	1129347.72	1375.24	05-07
GP35	1994	893858.20	1129143.23	1384.48	04-06
GP36	1994	893815.85	1128971.59	1387.17	03.5-05.5
GP37	1994	893720.92	1128930.11	1389.11	05-07
GP38	1994	893594.09	1128959.27	1392.71	06.5-08.5
GP39	1994	893498.24	1128979.05	1396.44	06-08, 10-12
GP40	1994	893459.75	1129103.74	1394.08	08-10, 13-15
GP41	1994	893388.58	1129138.49	1396.59	14-16
GP42	1994	893362.12	1129180.49	1395.96	11-13
GP43	1994	893334.39	1129257.32	1396.17	12-14
GP44	1994	893003.49	1129551.08	1393.29	09-11, 14-16
GP45	1994	892995.79	1129523.66	1394.34	10-12, 15-17, 18.5-20.5
GP46	1994	892968.45	1129466.90	1397.24	12-14, 17-19
GP47	1994	892969.21	1129522.40	1394.24	11-13, 16-18
GP48	1994	892924.74	1129842.93	1386.88	07-09
GP50	1994	892833.51	1129852.05	1384.55	08-10
GP51	1994	893825.87	1129561.74	1374.48	06.5-08.5
GP52	1994	893859.57	1129634.30	1374.21	08-10
GP53	1994	893278.77	1128978.62	1401.62	14-16
GP56	1994	892704.20	1129025.11	1410.49	06-08, 15.5-17.5

Table B-16. Location, Elevation, and Depth of Geoprobe® Groundwater Sampling Points

Location Code	Year Sampled	North Coordinate(1)	East Coordinate(1)	Surface Elevation (ft)	Sample Depths (ft) and Geologic Units(2)
GP59	1994	892859.54	1129363.33	1399.83	09-11, 17-19
GP60	1994	892870.18	1129409.83	1400.01	12-14, 17-19
GP61	1994	893875.01	1129563.26	1372.91	06-08
GP62	1994	893933.30	1129567.59	1371.20	04-06
GP64	1994	893781.92	1129295.55	1379.81	09-11
GP66	1994	893125.94	1129318.33	1403.62	17-19, 22-24, 26-28, 30-32
GP67	1994	893186.02	1129410.00	1399.12	15-17, 20-22, 25-27, 30-32
GP68	1994	893199.21	1129449.59	1398.42	15-17, 20-22, 25-27, 30-32
GP69	1994	892721.81	1129189.75	1410.10	19-21, 29-31, 34-36
GP70	1994	892815.80	1129223.19	1409.19	16-18, 21-23, 26-28
GP71	1994	892845.53	1129242.84	1406.51	16-18, 21-23, 25-27
GP72	1994	892873.33	1129179.42	1409.41	16-18, 21-23, 20-32
GP7298	1998	892873.12	1129178.71	1409.17	17-19, 19-21, 21-23, 22-24, 23-25, 25-27, 27-29, 29-31, 31-33, 32-34, 33-35, 35-37, 37-39 (ULT), 39-41 (ULT)
GP7208	2008	892871.89	1129180.55	1410.07	20-22, 25-27, 31-33, 38-40
GP73	1994	892908.21	1129176.59	1410.51	21-23, 26-28, 30-32
GP7398	1998	892899.43	1129186.81	1410.00	18-20, 20-22, 22-24, 24-26, 25-27, 26-28, 28-30, 30-32, 32-34, 34-36, 35-37, 36-38, 38-40, 40.5-41 (ULT), 40-45.5 (ULT), 41.5-42 (ULT), 41-41.5 (ULT)
GP74	1994	892906.72	1129072.17	1409.69	18-20, 23-25, 28-30
GP75	1994	892804.03	1129071.55	1410.49	19-21, 23-25, 27-29
GP76	1994	892829.00	1129049.17	1414.49	19-21, 23-25, 27-29
GP7608	2008	892824.00	1129049.00	1415.00	20-22, 34-36
GP77	1994	892748.07	1129075.00	1414.49	19-21, 19-23, 27-29, 31-33
GP78	1994	892841.92	1129109.44	1414.48	19-21, 19-23, 23-25, 27-29, 31-33
GP7898	1998	892831.03	1129127.81	1409.70	19-21, 20-22, 21-23, 23-25, 24-27, 25-27, 27-29, 29-31, 30-32, 31-33, 33-35, 35-37
GP7808	2008	892843.00	1129107.00	1410.21	20-22, 28-30, 34-36
GP79	1994	892757.54	1129099.11	1414.49	21-23, 25-27, 29-31
GP80	1994	892809.20	1129126.66	1414.48	25-27, 30-32, 34-39, 35-35, 35-37
GP8098	1998	892792.03	1129125.21	1414.28	22-24, 24-26, 26-28, 27-29, 28-30, 30-32, 32-34, 34-36, 36-38, 38-40, 40-42 (ULT)
GP8008	2008	892812.00	1129141.00	1415.00	25-27, 32-34, 39-41
GP8198	1998	893048.83	1129217.96	1403.98	15-17, 20-22, 25-27, 30-32, 35-37

Table B-16. Location, Elevation, and Depth of Geoprobe® Groundwater Sampling Points

Location Code	Year Sampled	North Coordinate(1)	East Coordinate(1)	Surface Elevation (ft)	Sample Depths (ft) and Geologic Units(2)
GP8298	1998	892996.19	1129315.09	1402.13	12-14, 17-19, 20-24
GP8398	1998	892982.69	1129187.54	1407.43	17-19, 19-21, 20-22, 21-23, 23-25, 25-27, 27-29, 29-31, 31-33, 32-34, 33-35, 35-37
GP8308	2008	892980.71	1129181.86	1409.79	22-24, 30-32, 38-40
GP8698	1998	892845.57	1129161.24	1409.02	18-20, 20-22, 22-24, 24-26, 24-27, 26-28, 28-30, 30-32, 32-34, 34-36, 35-37, 36-38, 38-39, 39-39.5, 39.5-40 (ULT), 40-40.5 (ULT), 40.5-41 (ULT), 41-41.5 (ULT), 41.5-42 (ULT)
GP8798	1998	892813.15	1129225.60	1408.43	15-17, 20-22, 25-27, 28-32
GP8898	1998	893533.28	1129528.60	1384.14	07-09, 12-14
GP8998	1998	893722.00	1129516.58	1379.09	06-08, 11-13, 16-18
GP9098	1998	893826.72	1129596.32	1373.46	03-05, 08-10
GP9198	1998	893875.44	1129596.20	1372.82	03-05
GP9298	1998	893811.26	1129533.79	1373.71	04-06, 09-11, 14-16, 18.5-21
GP9398	1998	893821.48	1129568.33	1372.62	04-06, 09-11, 14-16
GP9498	1998	893874.66	1129532.98	1372.01	03-05, 08-10, 12-15
GP10008	2008	892805.00	1129048.00	1415.00	20-22, 35-37
GP10108	2008	892924.08	1129094.92	1410.30	21-23, 28-30
GP10208	2008	892838.12	1129224.43	1409.11	27-29
GP10308	2008	892977.38	1129140.72	1410.53	21-23, 30-32, 35-37
GP10408	2008	892953.72	1129241.54	1405.91	21-23
GP10508	2008	893026.27	1129223.72	1405.04	16-18, 28-30, 34-36
GP10608	2008	893026.76	1129312.67	1403.39	16-18, 20-22, 28-30
GP10708	2008	893119.33	1129306.52	1403.80	15-17, 22-24, 30-32
GP10908	2008	893138.89	1129224.21	1402.60	14-16, 28-30, 34-36

NOTES: (1) Western New York State Planar Coordinate System

(2) All screened intervals were within the Sand and Gravel (S&G) unit except for those from the Unweathered Lavery Till unit, designated as "ULT."

Table B-17. Groundwater Points Excluded from the Evaluation[1]

Sampling Location	North Coordinate [2]	East Coordinate [2]	Surface Elevation (ft)	Elevation at Top of Screened Interval (ft)	Elevation at Bottom of Screened Interval (ft)	Geologic Unit of Screened Interval
NDA WP-A	892047.61	1130117.37	1375.47	1355.27	1348.77	ULT
NDA WP-B	892045.71	1130112.17	1375.45	1360.25	1357.75	WLT
NDA WP-C	892006.26	1130115.39	1378.47	1367.67	1362.17	WLT
NP0101	893602.56	1129427.10	1386.10	1379.60	1374.60	S&G
NP0102	893577.38	1129428.82	1389.40	1381.90	1376.90	S&G
NP0103	893586.49	1129466.86	1385.10	1376.60	1371.60	S&G
NP0104	893621.36	1129460.64	1384.10	1379.60	1369.60	S&G
NP0105	893528.03	1129853.06	1382.50	1374.50	1359.50	S&G
NP0106	893598.16	1129779.73	1380.70	1369.70	1364.70	S&G
NP0107	893542.52	1129601.69	1384.10	1375.60	1370.60	S&G
NP0108	893518.32	1129601.99	1385.30	1376.30	1371.30	S&G
NP0109	893543.29	1129552.36	1384.30	1376.30	1369.30	S&G
NP0110	893573.10	1129628.57	1383.50	1373.50	1370.50	S&G
NP0111	893609.48	1129621.28	1381.40	1366.40	1363.40	S&G
NP0112	893605.26	1129622.72	1381.50	1373.50	1368.50	S&G
NP0113	893578.74	1129574.71	1383.00	1373.00	1368.00	S&G
NP0114	893564.04	1129564.66	1383.50	1375.50	1370.50	S&G
NP0115	893484.80	1129685.67	1385.60	1366.60	1359.60	S&G
NP0116	893490.96	1129688.62	1385.30	1373.80	1368.80	S&G
NP0117	893446.35	1129634.45	1386.40	1368.40	1363.40	S&G
NP0118	893439.47	1129630.61	1386.60	1375.60	1370.60	S&G
NP0119	893526.14	1129664.12	1385.10	1364.10	1359.10	S&G
NP0120	893526.24	1129655.74	1385.30	1371.30	1366.30	S&G
NP0121	893518.59	1129668.60	1384.60	1373.60	1358.60	S&G
NP0122	893512.26	1129663.29	1384.60	1377.60	1362.60	S&G
NP0123	893513.46	1129649.40	1384.90	1370.90	1365.90	S&G
NP0124	893512.56	1129653.52	1384.70	1365.70	1360.70	S&G
NP0125	893518.72	1129631.75	1384.60	1377.60	1362.60	S&G
NP0126	893513.83	1129634.52	1384.70	1377.70	1362.70	S&G
NP0127	893561.96	1129508.64	1386.10	1379.60	1369.60	S&G
NP0128	893611.18	1129516.76	1382.80	1375.80	1365.80	S&G
NP0129	893585.08	1129529.17	1383.40	1376.40	1366.40	S&G
NP0130	893629.71	1129576.60	1381.00	1374.00	1364.00	S&G
NP0131	893535.80	1129735.81	1383.00	1366.00	1356.00	S&G
NP0132	893556.54	1129690.68	1383.70	1364.70	1360.70	S&G
NP0133	893616.82	1129670.92	1379.90	1364.90	1354.90	S&G
PTWRP	893516.03	1129663.87	1384.88	1380.88	1360.88	S&G

Table B-17. Groundwater Points Excluded from the Evaluation[1]

Sampling Location	North Coordinate [2]	East Coordinate [2]	Surface Elevation (ft)	Elevation at Top of Screened Interval (ft)	Elevation at Bottom of Screened Interval (ft)	Geologic Unit of Screened Interval
PZ01	893501.64	1129644.29	1385.10	1378.10	1363.10	S&G
PZ02	893502.55	1129658.76	1385.10	1378.10	1363.10	S&G
PZ03	893509.15	1129639.29	1384.60	1377.60	1362.60	S&G
PZ04	893508.56	1129664.33	1384.70	1377.70	1362.70	S&G
PZ05	893519.11	1129676.77	1384.40	1377.40	1362.40	S&G
PZ06	893538.60	1129638.19	1384.30	1377.30	1362.30	S&G
PZ07	893537.58	1129663.80	1384.00	1377.00	1362.00	S&G
PZ08	893516.74	1129643.87	1385.40	1368.40	1365.40	S&G
PZ09	893516.34	1129651.79	1385.40	1367.90	1365.40	S&G
PZ10	893521.60	1129632.18	1384.60	1375.60	1372.60	S&G
RW01	893556.21	1129506.87	1384.43	1379.43	1369.43	S&G
RW02	893559.26	1129478.22	1384.38	1380.38	1370.38	S&G
RW03	893565.07	1129493.51	1385.28	1380.28	1370.28	S&G
WNGSEEP	893765.77	1130322.30	1356.89	NA	NA	S&G
WNGSP04	893866.63	1130309.52	NA	NA	NA	S&G
WNGSP06	893960.73	1130283.50	NA	NA	NA	S&G
WNGSP11	894065.05	1130090.45	NA	NA	NA	S&G
WNGSP12	894171.90	1130050.85	NA	NA	NA	S&G
WNNDATR	892068.35	1130126.06	1372.49	NA	NA	WLT
WNSE007	893850.15	1129578.86	1371.11	NA	NA	S&G
WNSE008	893791.04	1130002.44	1368.52	NA	NA	S&G
WNSE009	893683.63	1129699.74	1378.11	NA	NA	S&G
WNSE011	893838.93	1129534.25	1373.08	NA	NA	S&G
WNW0109	892972.05	1129830.09	1386.84	1373.84	1353.84	ULT
WNW0114	893452.77	1129988.66	1377.01	1368.01	1348.01	ULT
WNW0115	893525.49	1129564.84	1384.19	1366.19	1356.19	ULT
WNW0201	892419.73	1129383.16	1408.19	1398.19	1388.19	S&G
WNW0202	892407.19	1129390.47	1407.95	1374.95	1369.95	LTS
WNW0203	892670.42	1129376.09	1404.62	1396.62	1386.62	S&G
WNW0207	892503.34	1129677.53	1396.11	1390.11	1385.11	S&G
WNW0208	892488.90	1129674.25	1396.26	1378.26	1373.26	LTS
WNW0305	892630.33	1129176.24	1410.38	1394.38	1379.38	S&G
WNW0306	892633.70	1129174.87	1410.32	1344.32	1329.32	KRS
WNW0307	892634.87	1129177.55	1410.53	1404.53	1394.53	S&G
WNW0404	892871.77	1128786.30	1416.69	1390.19	1380.19	S&G
WNW0407	893250.92	1128996.78	1402.40	1336.90	1326.90	ULT
WNW0410	892868.61	1128789.26	1416.64	1348.64	1338.64	KRS

Table B-17. Groundwater Points Excluded from the Evaluation(1)

Sampling Location	North Coordinate (2)	East Coordinate (2)	Surface Elevation (ft)	Elevation at Top of Screened Interval (ft)	Elevation at Bottom of Screened Interval (ft)	Geologic Unit of Screened Interval
WNW0411	892694.15	1128869.23	1416.27	1370.27	1350.27	KRS
WNW0601	893810.70	1129256.11	1381.14	1377.14	1375.14	S&G
WNW0603	893519.08	1128736.33	1401.14	1393.14	1388.14	S&G
WNW0701	893501.78	1128611.97	1406.52	1383.52	1378.52	ULT
WNW0702	893775.67	1128516.08	1397.68	1369.68	1359.68	ULT
WNW0703	893887.50	1128622.76	1393.12	1382.12	1372.12	ULT
WNW0705	893779.24	1128509.78	1397.87	1391.87	1376.87	ULT
WNW0904	892066.15	1129984.19	1377.95	1361.95	1351.95	ULT
WNW0905	892131.67	1130069.18	1373.56	1355.56	1350.56	S&G
WNW0907	891901.62	1129774.48	1382.27	1376.27	1366.27	WLT
WNW1001	890969.42	1130010.26	1387.55	1281.55	1271.55	KRS
WNW1002	891267.67	1130208.43	1389.76	1291.76	1276.76	KRS
WNW1003	891303.20	1130437.01	1387.65	1259.65	1249.65	KRS
WNW1004	891085.15	1130459.09	1383.89	1290.89	1275.89	KRS
WNW1007	891306.41	1130433.26	1387.55	1374.55	1364.55	WLT
WNW1101A	891062.41	1130830.41	1379.37	1373.37	1363.37	WLT
WNW1101B	891060.33	1130826.90	1379.42	1359.42	1349.42	ULT
WNW1101C	891058.61	1130823.07	1379.13	1285.13	1270.13	KRS
WNW1102A	891508.74	1131146.27	1382.71	1375.71	1365.71	WLT
WNW1102B	891514.11	1131142.06	1382.59	1361.59	1351.59	ULT
WNW1103A	891925.14	1130822.28	1379.90	1373.90	1363.90	WLT
WNW1103B	891929.54	1130818.73	1379.83	1358.83	1343.83	ULT
WNW1103C	891934.64	1130815.86	1379.51	1273.51	1258.51	KRS
WNW1104A	892289.10	1130545.05	1376.12	1372.12	1357.12	WLT
WNW1104B	892285.42	1130549.21	1376.10	1355.10	1340.10	ULT
WNW1104C	892282.05	1130553.29	1375.96	1261.96	1251.96	KRS
WNW1105A	892608.51	1130294.17	1365.80	1354.80	1344.80	ULT
WNW1105B	892608.20	1130289.77	1366.01	1345.01	1330.01	ULT
WNW1106A	891960.87	1130374.92	1374.36	1368.36	1358.36	WLT
WNW1106B	891964.09	1130372.02	1374.32	1353.62	1343.62	ULT
WNW1107A	892368.58	1130256.16	1377.16	1373.16	1358.16	WLT
WNW1108A	891312.43	1130600.10	1380.93	1374.93	1364.93	WLT
WNW1109A	891929.92	1130329.31	1374.86	1368.86	1358.86	WLT
WNW1109B	891934.27	1130326.01	1374.02	1358.02	1343.02	ULT
WNW1110A	892100.29	1130691.11	1377.05	1367.05	1357.05	WLT
WNW1111A	891654.21	1131042.28	1380.22	1369.22	1359.22	ULT
WNW80-4	893687.98	1129428.98	1386.55	1373.98	1368.98	S&G

Table B-17. Groundwater Points Excluded from the Evaluation[1]

Sampling Location	North Coordinate [2]	East Coordinate [2]	Surface Elevation (ft)	Elevation at Top of Screened Interval (ft)	Elevation at Bottom of Screened Interval (ft)	Geologic Unit of Screened Interval
WNW834D	893670.95	1129435.35	1380.48	1256.18	1249.98	KRS
WNW834E	893670.95	1129435.35	1381.64	NA	NA	BR
WNW8606	892694.89	1129523.46	1396.49	1390.89	1385.89	S&G
WNW8608	893250.67	1128985.62	1401.59	1394.59	1384.59	S&G
WNW90I7	891913.54	1130323.78	NA	NA	NA	WLT
WNW96I1	891991.27	1130117.11	1379.89	1374.89	1369.89	WLT
WNW96I2	891915.18	1130305.03	1380.41	1374.91	1369.91	WLT
WNW96I3	891898.75	1129901.48	1380.32	1372.32	1367.32	WLT
WNW96I4	891872.40	1129910.29	1381.36	1374.36	1369.36	WLT
WNWEW-1	893578.98	1129453.22	1384.91	1379.91	1371.91	S&G
WNWEW-4	893546.14	1129515.19	1384.17	1380.17	1368.17	S&G
WNWWP-4	893486.96	1129473.70	1387.63	1379.63	1377.63	S&G
WP01	893485.51	1129520.87	1386.57	1378.57	1376.57	S&G
WP02	893566.19	1129521.75	1383.10	1376.10	1373.10	S&G
WP03	893513.64	1129490.62	1385.88	1377.88	1375.88	S&G
WP05	893584.51	1129490.37	1383.91	1376.91	1373.91	S&G
WP06	893548.40	1129479.09	1384.94	1377.94	1374.94	S&G
WP07	893520.93	1129467.36	1386.08	1378.08	1376.08	S&G
WP08	893500.03	1129447.32	1387.34	1379.34	1377.34	S&G
WP09	893591.43	1129438.20	1384.81	1377.81	1374.81	S&G
WP10	893533.21	1129414.87	1390.47	1383.47	1380.47	S&G
WP11	893537.89	1129741.98	1382.08	1370.08	1367.08	S&G
WP12	893552.47	1129785.92	1381.68	1369.68	1366.68	S&G
WP13	893603.74	1129840.46	1379.78	1367.78	1364.78	S&G
WP14	893561.33	1129744.79	1381.38	1369.38	1366.38	S&G
WP15	893530.52	1129536.70	1384.08	1377.08	1374.08	S&G
WP16	893591.77	1129669.06	1381.61	1365.61	1362.61	S&G
WP17	893631.05	1129660.29	1379.01	1371.01	1368.01	S&G
WP18	893627.96	1129702.66	1378.66	1370.66	1367.66	S&G
WP20D	892845.95	1129162.30	1409.60	1379.60	1376.6	S&G
WP20S	892844.41	1129162.58	1409.60	1388.60	1385.60	S&G
WP21	893534.74	1129529.93	1384.50	1377.50	1374.50	S&G
WP22	893723.11	1129517.68	1379.80	1365.80	1362.80	S&G
WP23	893809.43	1129533.65	1374.60	1366.60	1363.60	S&G
WP24	893874.64	1129534.13	1372.50	1364.50	1361.50	S&G
WP25	893522.25	1129629.76	1384.70	1377.70	1362.70	S&G
WP26	893511.05	1129650.65	1384.50	1377.50	1362.50	S&G

Table B-17. Groundwater Points Excluded from the Evaluation[1]

Sampling Location	North Coordinate (2)	East Coordinate (2)	Surface Elevation (ft)	Elevation at Top of Screened Interval (ft)	Elevation at Bottom of Screened Interval (ft)	Geologic Unit of Screened Interval
WP27	893519.23	1129672.49	1384.40	1377.40	1362.40	S&G
WP28	893513.60	1129644.17	1384.60	1377.60	1362.60	S&G
WP29	893519.34	1129643.90	1385.10	1378.10	1363.10	S&G
WP30	893526.35	1129644.34	1385.20	1378.20	1363.20	S&G
WP31	893519.50	1129651.73	1385.40	1378.40	1363.40	S&G
WP32	893520.70	1129651.71	1385.40	1378.40	1363.40	S&G
WP33	893522.25	1129651.70	1385.40	1378.40	1363.40	S&G
WP34	893526.13	1129651.67	1385.40	1378.40	1363.40	S&G
WP35	893538.42	1129651.63	1384.00	1377.00	1362.00	S&G
WP36	893513.55	1129659.28	1384.70	1377.70	1362.70	S&G
WP37	893519.29	1129659.11	1385.30	1378.30	1363.30	S&G
WP38	893520.62	1129659.08	1385.40	1378.40	1363.40	S&G
WP39	893522.08	1129659.00	1385.40	1378.40	1363.40	S&G
WP40	893526.27	1129659.35	1385.30	1378.30	1363.30	S&G

NOTES: (1) This table lists points that were not included in the evaluation for DP section 4.2 because: a) no radiological data were available; b) data from that point were not validated (e.g., piezometers, surface elevation points, wells for the north plateau groundwater recovery system, wells for evaluation of the permeable treatment wall); c) sampling was dropped from the groundwater program because coverage was considered sufficient and no additional sampling was required (e.g., several points discontinued in 1995); d) the well was dry; or e) the sampling point was from an area outside the scope of the Phase 1 DP (e.g., groundwater seeps outside the process premises, wells from WMA 8).

(2) Western New York State Planar Coordinate System

LEGEND: S&G = sand and gravel, ULT = unweathered Lavery till, WLT = weathered Lavery till, LTS = Lavery till sand, KRS = Kent recessional sequence, BR = bedrock.

APPENDIX C

DETAILS OF DCGL DEVELOPMENT AND THE INTEGRATED DOSE ASSESSMENT

PURPOSE OF THIS APPENDIX

The purpose of this appendix is to provide supporting information related to development of derived concentration guideline levels (DCGLs) and the limited integrated dose assessment performed to ensure that cleanup criteria for surface soil, subsurface soil, and streambed sediment used in Phase 1 of the proposed decommissioning would support any decommissioning approach that may be selected for Phase 2.

INFORMATION IN THIS APPENDIX

This appendix provides the following information:

- Table C-1 in Section 1 provides a complete list of RESRAD input parameters, except for distribution coefficients, and the bases for these parameters.
- Table C-2 in Section 1 provides a list of distribution coefficients and their bases.
- Table C-3 in Section 1 provides the exposure pathways considered in the analysis.
- Table C-4 in Section 1 provides data on measured radionuclide concentrations in the Lavery till in the area of the large excavations in Waste Management Area 1 and Waste Management Area 2.
- Section 2 describes the information that comprises Attachment 1, which supports the calculation of DCGL and Cleanup Goal values presented in Section 5 of the Decommissioning Plan.
- Attachment 1 provides electronic RESRAD input and output files for the three base cases (surface soil, subsurface soil, and streambed sediment), the limited integrated dose analysis, and the input parameter sensitivity analyses performed, along with the associated Microsoft Excel spreadsheets.
- Attachment 2 provides an additional electronic file (a Microsoft Excel spreadsheet) used in the preliminary dose assessments.

RELATIONSHIP TO OTHER PLAN SECTIONS

This appendix provides supporting information for Section 5. Information provided in Section 5 and in Section 1 on the project background will help place the information in this appendix into context.

1.0 Tabulated Data

Table C-1 identifies input parameters used in the RESRAD models, except for the distribution coefficients, which are included in Table C-2. Input parameters are provided for the three source exposure scenarios: surface soil (SS), subsurface soil (SB), and stream bank sediment (SD). The RESRAD input parameters presented in Table C-1 were selected as discussed in Section 5.

Distribution coefficients (K_d) are presented in Table C-2 for chemical elements of the 18 radionuclides and their decay progeny for each of the three analyses (SS, SB and SD) for each of the modeled media (contaminated zone, unsaturated zone and saturated zone) used in RESRAD. The conceptual models assume the sand and gravel unit is representative of the three RESRAD zones, except that in the SB and SD analyses, the contaminated zone is assumed to be represented by the Lavery till. The table includes the RESRAD default value, the specific value input into the RESRAD model for $DCGL_W$ calculations, either measured site-specific or reference values (as identified in Note 1 to table C-2), and the range of values used in the sensitivity analysis. The K_d values were selected to represent the central tendency of the site-specific data or were based on specific soil strata characteristics where available. Variability/uncertainty in the K_d values was addressed through the sensitivity analysis.

The exposure pathways presented in Table C-3 were based on the critical groups identified for each of the source media. The resident farmer was the critical receptor for soil exposure and the recreationist was identified as the critical receptor for stream bank sediment exposure.

The data in Table C-4 are the basis for the maximum radionuclide concentration data in Table 5-1. These data comprise the available characterization data for radionuclides in the Lavery till within the footprints of the large excavations for the Process Building-Vitrification area and the Low-Level Waste Treatment Facility area that are described in Section 7.

Preliminary dose assessments have been performed for the remediated WMA 1 and WMA 2 excavations. These assessments made use of the maximum measured radioactivity concentration in the Lavery till for each radionuclide as summarized in Table C-4, and the maximum detection level concentration for non-detected radionuclides. (It should be noted that the minimum detection levels for non-detected radionuclides may range several orders of magnitude. Use of the maximum detection level concentration for non-detected radionuclides results in added conservatism in the reported preliminary dose assessment.) The results were as follow:

WMA 1, a maximum of 1.3 mrem a year

WMA 2, a maximum of 0.04 mrem a year

Given the limited data available, these results must be viewed as order-of-magnitude estimates. However, they do suggest that actual potential doses from the two remediated areas are likely to be substantially below 25 mrem per year. Table C-4B in Attachment 2 shows how these doses were estimated.

Table C-2. Soil/Water Distribution Coefficients

Radionuclide	RESRAD Default (mL/g)	Surface Soil DCGL Contaminated Zone (mL/g)	Subsurface Soil DCGL Contaminated Zone (mL/g)	Sediment DCGL Contaminated Zone (mL/g)	Unsaturated(2) Zone (mL/g)	Saturated(3) Zone (mL/g)
Strontium	30	6.16(8) (1 - 32)	15(5) (1 - 32)	15(5) (1 - 32)	6.16(8) (1 - 32)	6.16(8) (1 - 32)
Technetium	0	0.1(4) (0.01 - 4.1)	4.1(7) (1 - 10)	4.1(7) (1 - 10)	0.1(4) (0.01 - 4.1)	0.1(4) (0.01 - 4.1)
Uranium	50	35(4) (15 - 350)	10(7) (1 - 100)	10(7) (1 - 100)	35(4) (15 - 350)	35(4) (15 - 350)
Progeny Elements(9)						
Actinium	20	20	20	20	20	20
Lead	100	100	100	100	100	100
Protactinium	50	50	50	50	50	50
Radium	70	70	70	70	70	70
Thorium	60,000	60,000	60,000	60,000	60,000	60,000

NOTES: (1) Sources of K_d values considered included Table 3-20; NUREG-5512 (Beyeler, et al. 1999), Table 6.7; RESRAD User's Guide (Yu, et al. 2001), Tables E-3, E-4; and Sheppard and Thibault 1990. Values in parentheses are the bounds used in the sensitivity evaluation, selected considering site-specific and literature values to reflect a reasonable range.

(2) Sediment model assumes no unsaturated zone. Values used for surface and subsurface soil evaluation only.

(3) Values presented here are those used for surface soil DCGLs based on the non-dispersion model. Saturated zone distribution coefficients are not utilized by RESRAD for the mass-balance groundwater model.

(4) From Sheppard and Thibault 1990, for sand.

(5) Site specific value for the unweathered Lavery till (see Section 3.7.8, Table 3-20).

(6) RESRAD default for this radionuclide is to allow the code to calculate the distribution coefficient based on correlation with plant root uptake transfer factor.

(7) Site specific value for the Lavery till (see Section 3.7.8, Table 3-20).

(8) Site specific value for the sand and gravel unit (see Section 3.7.8, Table 3-20).

(9) Progeny K_ds were not included in the sensitivity analysis; RESRAD default values were used in all cases.

Table C-3 Scenario exposure pathways for WVDP DCGL development

Exposure Pathways	Resident Farmer (surface soil and Lavery Till source)	Recreationist (sediment source)
Incidental ingestion of source	●	●
External exposure to source	●	●
Inhalation of airborne source	●	○
Ingestion of groundwater impacted by source	●	x
Ingestion of milk impacted by soil and water sources	●	x
Ingestion of beef impacted by soil and water sources	●	x
Ingestion of produce impacted by soil and water sources	●	x
Incidental ingestion of surface water impacted by source	○	●
Ingestion of fish impacted by source	○	●
Ingestion of venison impacted by sediment and water sources	○	●

LEGEND:

● - Pathway is considered complete and is included in DCGL development.

○ - Pathway is considered potentially complete but unlikely, and is not included in DCGL development.

x - Pathway is considered incomplete and is not included in DCGL development.

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas[(1)]

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
BH-17 (WMA 6, 1993) Depth to Lavery till - 27 ft	Sr-90	1.1E-01	26-28
	Cs-137	2.6E-02	26-28
	U-232	< 3.2E-03	26-28
	U-233/234	1.6E-01	26-28
	U-235	< 5.8E-03	26-28
	U-235/236	< 6.9E-03	26-28
	U-238	1.1E-01	26-28
	Pu-238	< 4.3E-03	26-28
	Pu-239/240	< 4.3E-03	26-28
	Pu-241	1.3E+00	26-28
	Am-241	< 9.6E-03	26-28
BH-21A (WMA 1, 1993) Depth to Lavery till - 37.5 ft	Sr-90	4.5E+02	36-38
	Cs-137	< 3.0E-02	36-38
	U-232	< 7.4E-03	36-38
	U-233/234	8.6E-02	36-38
	U-235	< 5.1E-03	36-38
	U-235/236	< 7.2E-03	36-38
	U-238	7.1E-02	36-38
	Pu-238	< 4.8E-03	36-38
	Pu-239/240	< 4.8E-03	36-38
	Pu-241	< 1.1E+00	36-38
	Am-241	< 7.2E-03	36-38
GP3098 (WMA 1, 1998) Depth to Lavery till - 37 ft	Sr-90	6.6E+00	36.5-37
	Sr-90	4.2E+00	37-37.5
	Sr-90	6.3E+00	37.5-38
	Sr-90	5.5E+01	38-38.5
	Sr-90	5.9E+01	38.5-39
	Sr-90	3.4E+01	39-39.5
	Sr-90	2.9E+01	39.5-40
GP3008 (WMA 1, 2008) Depth to Lavery till - 37 ft	C-14	< 3.0E-01	37-39
	Sr-90	1.7E+00	37-39
	Tc-99	< 5.5E-01	37-39
	I-129	< 1.1E-01	37-39
	Cs-137	< 2.0E-02	37-39
	U-232	< 2.2E-02	37-39
	U-233/234	9.7E-01	37-39
	U-235/236	1.3E-01	37-39

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas(1)

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
	U-238	1.1E+00	37-39
	Np-237	< 9.8E-03	37-39
	Pu-238	< 1.1E-02	37-39
	Pu-239/240	< 1.2E-02	37-39
	Pu-241	< 4.8E-01	37-39
	Am-241	< 1.2E-02	37-39
	Cm-243/244	< 1.2E-02	37-39
GP7398 (WMA 1, 1998) Depth to Lavery till - 39 ft	Sr-90	1.9E+00	40-40.5
	Sr-90	1.8E+00	40.5-41
	Sr-90	5.2E+00	41-41.5
	Sr-90	8.4E+00	41.5-42
GP7608 (WMA 1, 2008) Depth to Lavery till - 38 ft	C-14	< 3.4E-01	38-40
	Sr-90	1.8E+01	38-40
	Tc-99	< 3.9E-01	38-40
	I-129	< 2.3E-01	38-40
	Cs-137	7.9E+00	38-40
	U-232	< 2.8E-01	38-40
	U-233/234	1.9E+00	38-40
	U-235/236	< 4.2E-01	38-40
	U-238	8.8E-01	38-40
	Np-237	< 3.6E-01	38-40
	Pu-238	< 3.4E-01	38-40
	Pu-239/240	< 3.1E-01	38-40
	Pu-241	< 3.4E+01	38-40
	Am-241	< 2.0E-01	38-40
	Cm-243/244	< 2.2E-01	38-40
GP7808 (WMA 1, 2008) Depth to Lavery till - 37 ft	C-14	< 2.9E-01	37-39
	Sr-90	8.6E+00	37-39
	Tc-99	< 4.4E-01	37-39
	I-129	< 2.3E-01	37-39
	Cs-137	< 2.2E-02	37-39
	U-232	< 1.3E-02	37-39
	U-233/234	8.2E-01	37-39
	U-235/236	9.2E-02	37-39
	U-238	1.1E+00	37-39
	Np-237	< 2.1E-02	37-39
	Pu-238	< 1.1E-02	37-39
	Pu-239/240	< 1.5E-02	37-39
	Pu-241	< 4.9E-01	37-39
	Am-241	< 1.7E-02	37-39
	Cm-243/244	< 1.6E-02	37-39

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas[1]

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
GP8098 (WMA 1, 1998) Depth to Lavery till - 41 ft	C-14	< 8.6E-02	40-42
	Sr-90	1.3E+01	40-42
	Tc-99	< 2.6E-01	40-42
	I-129	< 2.3E-01	40-42
	Cs-137	< 2.2E-02	40-42
	Pu-241	< 2.1E+00	40-42
GP8008 (WMA 1, 2008) Depth to Lavery till - 40 ft	C-14	< 2.8E-01	39-41
	C-14	< 2.8E-01	41-43
	Sr-90	5.3E+00	39-41
	Sr-90	1.4E+00	41-43
	Tc-99	< 3.4E-01	39-41
	Tc-99	< 3.7E-01	41-43
	I-129	< 1.2E-01	39-41
	I-129	< 1.2E-01	41-43
	Cs-137	< 2.3E-02	39-41
	Cs-137	< 2.8E-02	41-43
	U-232	< 1.0E-02	39-41
	U-232	< 1.3E-02	41-43
	U-233/234	5.2E-01	39-41
	U-233/234	1.1E+00	41-43
	U-235/236	3.9E-02	39-41
	U-235/236	1.1E-01	41-43
	U-238	8.2E-01	39-41
	U-238	1.4E+00	41-43
	Np-237	< 1.1E-02	39-41
	Np-237	< 1.2E-02	41-43
	Pu-238	< 1.5E-02	39-41
	Pu-238	< 1.5E-02	41-43
	Pu-239/240	< 1.6E-02	39-41
	Pu-239/240	< 1.5E-02	41-43
	Pu-241	< 4.4E-01	39-41
	Pu-241	< 5.2E-01	41-43
	Am-241	< 1.2E-02	39-41
	Am-241	< 1.5E-02	41-43
	Cm-243/244	< 1.3E-02	39-41
	Cm-243/244	< 1.6E-02	41-43
GP8308 (WMA 1, 2008) Depth to Lavery till - 41.5 ft	C-14	< 3.5E-01	40-42
	Sr-90	1.5E+00	40-42
	Tc-99	< 3.6E-01	40-42
	I-129	2.4E-01	40-42
	Cs-137	< 2.7E-02	40-42
	U-232	< 2.4E-02	40-42

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas[1]

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
	U-233/234	9.8E-01	40-42
	U-235/236	2.2E-01	40-42
	U-238	1.1E+00	40-42
	Np-237	< 1.3E-02	40-42
	Pu-238	< 1.1E-02	40-42
	Pu-239/240	< 1.1E-02	40-42
	Pu-241	< 2.7E-01	40-42
	Am-241	< 1.2E-02	40-42
	Cm-243/244	< 1.8E-02	40-42
GP8698 (WMA 1, 1998) Depth to Lavery till - 39 ft	Sr-90	2.2E+00	39-39.5
	Sr-90	1.0E+00	39.5-40
	Sr-90	3.0E+00	40-40.5
	Sr-90	1.0E+01	40.5-41
	Sr-90	4.1E+01	41-41.5
	Sr-90	3.0E+01	41.5-42
GP10008 (WMA 1, 2008) Depth to Lavery till - 37 ft	C-14	< 3.0E-01	37-39
	Sr-90	6.7E+00	37-39
	Tc-99	< 4.0E-01	37-39
	I-129	< 1.4E-01	37-39
	Cs-137	< 2.7E-02	37-39
	U-232	< 1.3E-02	37-39
	U-233/234	7.6E-01	37-39
	U-235/236	7.5E-02	37-39
	U-238	9.5E-01	37-39
	Np-237	< 1.2E-02	37-39
	Pu-238	< 2.2E-02	37-39
	Pu-239/240	< 1.1E-02	37-39
	Pu-241	< 4.3E-01	37-39
	Am-241	< 1.4E-02	37-39
	Cm-243/244	< 2.3E-02	37-39
GP10108 (WMA 1, 2008) Depth to Lavery till - 33 ft	C-14	< 3.1E-01	32-34
	Sr-90	6.3E-01	32-34
	Tc-99	< 5.4E-01	32-34
	I-129	< 9.1E-02	32-34
	Cs-137	< 2.6E-02	32-34
	U-232	< 1.6E-01	32-34
	U-233/234	6.0E-01	32-34
	U-235/236	5.0E-02	32-34
	U-238	7.3E-01	32-34
	Np-237	< 1.0E-02	32-34
	Pu-238	< 9.5E-03	32-34

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas[(1)]

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
	Pu-239/240	< 8.8E-03	32-34
	Pu-241	< 4.7E-01	32-34
	Am-241	< 1.1E-02	32-34
	Cm-243/244	< 1.1E-02	32-34
GP10408 (WMA 1, on border of WMA 2) Depth to Lavery till - 24 ft	C-14	< 3.6E-01	24-26
	Sr-90	7.4E+00	24-26
	Tc-99	< 5.1E-01	24-26
	I-129	< 1.1E-01	24-26
	Cs-137	< 5.5E-02	24-26
	U-232	4.1E-02	24-26
	U-233/234	8.8E-01	24-26
	U-235/236	1.4E-01	24-26
	U-238	7.9E-01	24-26
	Np-237	< 6.9E-03	24-26
	Pu-238	< 1.2E-02	24-26
	Pu-239/240	< 1.2E-02	24-26
	Pu-241	< 3.1E-01	24-26
	Am-241	< 1.3E-02	24-26
	Cm-243/244	< 1.4E-02	24-26
BH-05 (WMA 2, 1993), located downgradient of Lagoon 1 Depth to Lavery till - 12 ft	Sr-90	8.5E-01	12-14
	Cs-137	4.5E-01	12-14
	U-232	1.2E-02	12-14
	U-233/234	1.8E-01	12-14
	U-235	< 5.9E-03	12-14
	U-235/236	< 8.3E-03	12-14
	U-238	1.1E-01	12-14
	Pu-238	1.0E-02	12-14
	Pu-239/240	< 5.9E-03	12-14
	Pu-241	< 1.3E+00	12-14
	Am-241	3.0E-02	12-14
BH-07 (WMA 2, 1993) Depth to Lavery till - 13 ft	Sr-90	1.3E-01	12-14
	Cs-137	7.5E-02	12-14
	U-232	< 8.7E-03	12-14
	U-233/234	2.2E-01	12-14
	U-235	< 6.6E-03	12-14
	U-235/236	< 7.6E-03	12-14
	U-238	1.5E-01	12-14
	Pu-238	< 4.7E-03	12-14

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas[1]

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
	Pu-239/240	< 6.2E-03	12-14
	Pu-241	9.5E-01	12-14
	Am-241	< 5.1E-03	12-14
BH-08 (WMA 2, 1993), located downgradient of Lagoon 1 Depth to Lavery till - 11.5 ft	Sr-90	1.8E+02	10-12
	Cs-137	2.5E+02	10-12
	U-232	1.9E+01	10-12
	U-233/234	9.7E+00	10-12
	U-235	3.2E-01	10-12
	U-235/236	5.0E-01	10-12
	U-238	1.3E+01	10-12
	Pu-238	3.9E+00	10-12
	Pu-239/240	7.6E+00	10-12
	Pu-241	2.7E+01	10-12
	Am-241	1.1E+01	10-12
BH-12 (WMA 2, 1993) Depth to Lavery till - 15.5 ft	Sr-90	1.8E-01	14-16
	Cs-137	< 2.2E-02	14-16
	U-232	< 6.0E-03	14-16
	U-233/234	1.1E-01	14-16
	U-235	< 7.0E-03	14-16
	U-235/236	1.3E-02	14-16
	U-238	9.7E-02	14-16
	Pu-238	< 4.9E-03	14-16
	Pu-239/240	< 4.9E-03	14-16
	Pu-241	< 1.0E+00	14-16
	Am-241	< 4.6E-03	14-16
BH-13 (WMA 2, 1993) Depth to Lavery till - 19 ft	Sr-90	1.8E-01	18-20
	Cs-137	2.7E+00	18-20
	U-232	1.6E-02	18-20
	U-233/234	8.5E-02	18-20
	U-235	< 5.1E-03	18-20
	U-235/236	< 8.2E-03	18-20
	U-238	5.3E-02	18-20
	Pu-238	2.4E-02	18-20
	Pu-239/240	2.6E-02	18-20
	Pu-241	< 8.1E-01	18-20
	Am-241	9.5E-02	18-20

Table C-4. Radiological Concentrations from Soil Samples Containing Lavery Till in the WMA 1 and WMA 2 Excavation Areas(1)

Location	Nuclide	Result (pCi/g)	Sample Depth Interval (ft)
BH-14 (WMA 2, 1993) Depth to Lavery till - 15 ft	Sr-90	1.8E+01	14-16
	Cs-137	1.9E+00	14-16
	U-232	2.0E-02	14-16
	U-233/234	1.9E-01	14-16
	U-235	< 7.9E-03	14-16
	U-235/236	< 1.1E-02	14-16
	U-238	2.8E-01	14-16
	Pu-238	1.7E-01	14-16
	Pu-239/240	1.6E-01	14-16
	Pu-241	< 1.1E+00	14-16
	Am-241	1.1E-01	14-16

NOTE: (1) Data are from the 1993 RCRA facility investigation and the other Geoprobe® studies described in Section 4.

2.0 Information Provided in Attachment 1

Other information associated with the dose modeling is provided in Attachment 1. As explained in Section 5, the dose calculations were performed using RESRAD 6.4 and the results were exported to Microsoft Excel for post-processing. Attachment 1 provides:

- RESRAD input files to verify input parameters and model setup,
- RESRAD output files to verify input parameters and results,
- Excel result files containing (1) RESRAD output results (exported from the RESRAD summary report), (2) summaries of data [maximum dose-source ratios (DSRs) and times of maxima], (3) calculation of $DCGL_W$ values from the maximum DSRs, (4) calculation of area factors and $DCGL_{EMC}$ values, and (5) summary of sensitivity results

DCGL development was based on entering unit source concentrations (1pCi/g) for 18 radionuclides into RESRAD to generate DSRs in units of mrem/y per pCi/g (RESRAD output results based on unit concentrations can be interpreted as either the dose or DSR, and the terms are used interchangeably in this document). The individual, peak DSRs are then used to generate DCGLs for each radionuclide based on the following equation:

DCGL (pCi/g) = Dose Limit (mrem/y) / Maximum DSR (mrem/y per pCi/g) (Eq.1)

The dose limit of 25 mrem/y and maximum DSRs were used as the basis for developing the DCGLs. Further details regarding the Attachment 1 files are presented below. Because of the uncertainty in the actual distributions and mixtures of radionuclides in the environmental media, the DCGL for each radionuclide is calculated individually. Following characterization, the working cleanup levels for mixtures can be developed using the sum of fractions method discussed in Chapter 5 of the MARSSIM.

2.1 Input Parameters Tables

The parameters input to the RESRAD model include:

- Base case values for the $DCGL_W$ calculations,
- Modification of source area only for $DCGL_{EMC}$ calculations, and
- Variation of key parameters to evaluate model sensitivity

The Excel file “WV Sensitivity Parameters Table.xls” (Table C.5) provides a summary of the following parameters which were varied to evaluate model sensitivity.

- Surface Soil Sources
  - Indoor/outdoor time fraction
  - Source thickness
  - Unsaturated zone thickness
  - Irrigation/well pumping rate
  - Soil/water distribution coefficients
  - Hydraulic conductivity (Vertical/Horizontal)
  - Runoff/Evapotranspiration coefficients/ Infiltration rate
  - Depth of well intake
  - Length of contaminated area parallel to aquifer flow
  - Plant transfer factors
  - Use of mass balance instead of non-dispersion groundwater model
- Subsurface Soil Sources (subsurface soil distributed on the surface):
  - Indoor/outdoor time fraction
  - Source thickness
  - Unsaturated zone thickness
  - Irrigation/well pumping rate
  - Soil/water distribution coefficients
  - Hydraulic conductivity (Vertical/Horizontal)
  - Runoff/Evapotranspiration coefficients/ Infiltration rate
  - Plant transfer factors
- Stream Bank Sediment sources:
  - Outdoor time fraction
  - Source thickness
  - Unsaturated zone thickness

- Soil/water distribution coefficients
- Runoff/Evapotranspiration coefficients/ Infiltration rate
- Plant transfer factors
- Fish transfer factors

These sensitivity parameters were selected based on preliminary model simulations and consideration of parameter priorities presented in Table 4.2 of NUREG-6697, Attachment B (Yu, et al. 2000). The parameters selected for analysis are discussed further below.

Sensitivity parameter values were selected to represent a reasonable range in order to provide bounds on the uncertainty in the DCGL calculations. The basis for particular parameter values are discussed below.

Indoor/Outdoor fraction – varied from 0.45/0.45 to 0.8/0.1 from the base case values of 0.66/0.25. The lower indoor fraction represents equal time indoors and outdoors, while the higher fraction was selected to represent a farmer spending inordinate amounts of time indoors.

Source thickness – for surface soil and sediment, varied from 0.5 to 3m to bound the base case value of 1m with potential thicknesses resulting from remedial activities and to account for potential source erosion uncertainty. For subsurface soil, varied from 0.1 to 1 m to bound the base case value of 0.3 m. The subsurface source thickness is dependent on the amount of material excavated during well/cistern installation, and depths less than the base case would correspond with a smaller source area for a given excavated volume.

Unsaturated zone thickness – varied from 1 to 5 m to bound the 2 m base case value with the range possible for the site. The range of results also provides an assessment of potential source erosion uncertainty.

Irrigation/well pumping rate - varied from 0.2/2720 to 0.8/8720 (m/y)/(m^3/y) to bound the base case of 0.5/5720 (m/y)/(m^3/y). The irrigation rate and well pump rate are directly related and the range reflects changes in crop irrigation only. For all cases, the assumed household and livestock water ingestion rates were held constant. This parameter is applicable to soil exposure only, not to sediment exposure

Soil/Water distribution coefficients – varied for each radionuclide based on site-specific data where available. If a range of site-specific distribution coefficients was not available (as was the case for the majority of radionuclides), values were selected from the literature to provide a bound on the base case uncertainty. The conceptual models assume the sand and gravel unit is representative of the three RESRAD zones (contaminated, unsaturated and saturated), except that in the SB and SD analyses, the contaminated zone is assumed to be represented by the Lavery till.

Hydraulic conductivity – for the contaminated and unsaturated zone, varied the vertical conductivity from 1 m/y (3.2E-06 cm/s) to 350 m/y (1.1E-03 cm/s) to bound the base case value of 140 m/y (4.4E-04 cm/s) which is the average for the sand and gravel unit divided by 10 to account for anisotropy (DEIS Appendix E, Table E-3).

Similarly for the saturated zone, the horizontal conductivity was varied from 10 to 3500 m/yr from the base case of 1400 m/y. The conceptual model assumes the sand and gravel unit is representative of the unsaturated and saturated zone. The upper bound value is that used in the DEIS and is included for comparison.

Runoff/evapotranspiration coefficient – varied from 0.2/0.5 to 0.8/0.8 to bound the base case of 0.6/0.55. The base case was selected to achieve infiltration rate of 0.42 m/y which corresponds to 25% of the applied water (DEIS Appendix E). The upper bounds are assumed values and the lower bounds for these parameters represent the RESRAD defaults.

Depth of well intake – applicable to non-dispersion model only (surface soil base case). Varied from 3 to 10 m to bound the base case value of 5m. The lower bound represents the minimum for a 1 m contaminated thickness and 2 m unsaturated zone. The upper bound represents the upper end of observed thickness of the saturated zone on site.

Length of contaminated area parallel to aquifer flow - applicable to non-dispersion model only (surface soil base case). Varied from 50 m to 200 m to bound the base case of 100 m.

Plant transfer factors – varied from the constituent specific base cases by increasing and decreasing each parameter an order of magnitude.

Fish transfer factors – applicable for sediment source evaluation. Values varied from the constituent specific base cases by increasing and decreasing each parameter an order of magnitude.

Groundwater model – the surface soil base case non-dispersion model is varied to provide results for the mass balance model for comparison. The RESRAD User's Manual suggests the non-dispersion model for areas >1,000 m^2 (Yu et al. 2001, p.E-18).

2.2 RESRAD Input Files

The following RESRAD input files are provided to allow verification of input parameters and reproduction of the output files and summary graphics:

- $DCGL_W$ input files:
  - WV Surface – 10k Base.RAD (Surface soil source of 10,000 m^2)
  - WV Subsurface – 100 Base.RAD (Subsurface material as a surface source of 100 m^2)
  - WV Sediment - 1k Base.RAD (Sediment source of 1,000 m^2)
- $DCGL_{EMC}$ input files (varying only source area from $DCGL_W$ files):
  - Surface Soil Source
    - WV Surface - 5k EMC.RAD (5,000 m^2 source)
    - WV Surface - 1k EMC.RAD (1,000 m^2 source)

        - WV Surface - 500 EMC.RAD (500 m^2 source)
        - WV Surface - 100 EMC.RAD (100 m^2 source)
        - WV Surface - 50 EMC.RAD (50 m^2 source)
        - WV Surface - 10 EMC.RAD (10 m^2 source)
        - WV Surface - 5 EMC.RAD (5 m^2 source)
        - WV Surface - 1 EMC.RAD (1 m^2 source)
    - Subsurface Source
        - WV Subsurface - 50 EMC.RAD (50 m^2 source)
        - WV Subsurface - 10 EMC.RAD (10 m^2 source)
        - WV Subsurface - 5 EMC.RAD (5 m^2 source)
        - WV Subsurface - 1 EMC.RAD (1 m^2 source)
    - Stream Bank Sediment Source
        - WV Sediment - 500 EMC.RAD (500 m^2 source)
        - WV Sediment - 100 EMC.RAD (100 m^2 source)
        - WV Sediment - 50 EMC.RAD (50 m^2 source)
        - WV Sediment - 10 EMC.RAD (10 m^2 source)
        - WV Sediment - 5 EMC.RAD (5 m^2 source)
        - WV Sediment - 1 EMC.RAD (1 m^2 source)

    Note: sediment source area width was maintained at 3 m when varying areas to represent assumed stream bank configuration.

- Sensitivity analysis input files:
    - Surface soil Source
        - WV Surface - SENS1.RAD (decreased indoor fraction)
        - WV Surface - SENS2.RAD (increased indoor fraction)
        - WV Surface - SENS3.RAD (decreased source layer thickness)
        - WV Surface - SENS4.RAD (increased source layer thickness)
        - WV Surface - SENS5.RAD (decreased unsaturated zone thickness)
        - WV Surface - SENS6.RAD (increased unsaturated zone thickness)
        - WV Surface - SENS7.RAD (decreased well pumping rate)
        - WV Surface - SENS8.RAD (increased well pumping rate)
        - WV Surface - SENS9.RAD (decreased K_d values)
        - WV Surface - SENS10.RAD (increased K_d values)

    - WV Surface - SENS11.RAD (decreased K value)
    - WV Surface - SENS12.RAD (increased K value)
    - WV Surface - SENS13.RAD (decreased runoff/evapotranspiration)
    - WV Surface - SENS14.RAD (increased runoff/evapotranspiration)
    - WV Surface - SENS15.RAD (decreased well intake depth)
    - WV Surface - SENS16.RAD (increased well intake depth)
    - WV Surface - SENS17.RAD (decreased length parallel to flow)
    - WV Surface - SENS18.RAD (increased length parallel to flow)
    - WV Surface - SENS19.RAD (decreased plant transfer factors)
    - WV Surface – SENS20.RAD (increased plant transfer factors)
    - WV Surface - SENS21.RAD (mass balance groundwater model)
- Subsurface Soil Source
    - WV Subsurface - SENS1.RAD (decreased indoor fraction)
    - WV Subsurface - SENS2.RAD (increased indoor fraction)
    - WV Subsurface - SENS3.RAD (decreased source layer thickness)
    - WV Subsurface - SENS4.RAD (increased source layer thickness)
    - WV Subsurface - SENS5.RAD (decreased unsaturated zone thickness)
    - WV Subsurface - SENS6.RAD (increased unsaturated zone thickness)
    - WV Subsurface - SENS7.RAD (decreased well pumping rate)
    - WV Subsurface - SENS8.RAD (increased well pumping rate)
    - WV Subsurface - SENS9.RAD (decreased K_d values)
    - WV Subsurface - SENS10.RAD (increased K_d values)
    - WV Subsurface - SENS11.RAD (decreased K value)
    - WV Subsurface - SENS12.RAD (increased K value)
    - WV Subsurface - SENS13.RAD (decreased runoff/evapotranspiration)
    - WV Subsurface - SENS14.RAD (increased runoff/evapotranspiration)
    - WV Subsurface - SENS15.RAD (decreased plant transfer factors)
    - WV Subsurface – SENS16.RAD (increased plant transfer factors)
- Sediment Source
    - WV Sediment - SENS1.RAD (decreased outdoor fraction)
    - WV Sediment - SENS2.RAD (increased outdoor fraction)
    - WV Sediment - SENS3.RAD (decreased source layer thickness)

- WV Sediment - SENS4.RAD (increased source layer thickness)
- WV Sediment - SENS5.RAD (increased unsaturated zone thickness)
- WV Sediment - SENS6.RAD (largest unsaturated zone thickness)
- WV Sediment - SENS7.RAD (decreased K_d values)
- WV Sediment - SENS8.RAD (increased K_d values)
- WV Sediment – SENS9.RAD (decreased runoff/evapotranspiration)
- WV Sediment – SENS10.RAD (increased runoff/evapotranspiration)
- WV Sediment - SENS11.RAD (decreased plant transfer factors)
- WV Sediment – SENS12.RAD (increased plant transfer factors)
- WV Sediment - SENS13.RAD (decreased fish transfer factors)
- WV Sediment – SENS14.RAD (increased fish transfer factors)

The dose results from the above input files were the basis for calculation of $DCGL_W$ and $DCGL_{EMC}$ values. The DCGLs were calculated in Excel spreadsheets, based on exported data from the RESRAD summary output report. The following section describes the RESRAD output files, which are provided for informational purposes.

2.3 RESRAD Output Files

The RESRAD output files are provided to allow review of results without running the simulations. For the $DCGL_W$ simulations, summary, detailed, daughter, and concentration reports are included in the QA files. The summary report is also available for the $DCGL_{EMC}$ simulations. As indicated in the previous section, DCGL calculations are based on data exported from the RESRAD summary output report. RESRAD output files generated are as follows;

- $DCGL_W$ output files:
  - Surface Soil Source
    - WV Surface – 10k Base_sum.TXT (summary report)
    - WV Surface – 10k Base_ det.TXT (detailed report)
    - WV Surface – 10k Base _dtr.TXT (daughter report)
    - WV Surface – 10k Base _conc.TXT (concentration report)
  - Subsurface Soil Source
    - WV Subsurface – 100 Base_sum.TXT (summary report)
    - WV Subsurface – 100 Base_det.TXT (detailed report)
    - WV Subsurface – 100 Base_dtr.TXT (daughter report)
    - WV Subsurface – 100 Base_conc.TXT (concentration report)

- Sediment Source
  - WV Sediment – 1k Base_sum.TXT (summary report)
  - WV Sediment – 1k Base_det.TXT (detailed report)
  - WV Sediment – 1k Base_dtr.TXT (daughter report)
  - WV Sediment – 1k Base_conc.TXT (concentration report)

- $DCGL_{EMC}$ output files (varying only source area from $DCGL_w$ files):
  - Surface Soil Source
    - WV Surface - 5k EMC_sum.TXT (5,000 m^2 source)
    - WV Surface - 1k EMC_ sum.TXT (1,000 m^2 source)
    - WV Surface - 500 EMC_sum.TXT (500 m^2 source)
    - WV Surface - 100 EMC_sum.TXT (100 m^2 source)
    - WV Surface - 50 EMC_sum.TXT (50 m^2 source)
    - WV Surface - 10 EMC_sum.TXT (10 m^2 source)
    - WV Surface - 5 EMC_sum.TXT (5 m^2 source)
    - WV Surface - 1 EMC_sum.TXT (1 m^2 source)
  - Subsurface Soil Source
    - WV Subsurface - 50 EMC_sum.TXT (50 m^2 source)
    - WV Subsurface - 10 EMC_sum.TXT (10 m^2 source)
    - WV Subsurface - 5 EMC_sum.TXT (5 m^2 source)
    - WV Subsurface - 1 EMC_sum.TXT (1 m^2 source)
  - Sediment Source
    - WV Sediment - 500 EMC_sum.TXT (500 m^2 source)
    - WV Sediment - 100 EMC_sum.TXT (100 m^2 source)
    - WV Sediment - 50 EMC_sum.TXT (50 m^2 source)
    - WV Sediment - 10 EMC_sum.TXT (10 m^2 source)
    - WV Sediment - 5 EMC_sum.TXT (5 m^2 source)
    - WV Sediment - 1 EMC_sum.TXT (1 m^2 source)

- Sensitivity analysis output files:
  - Surface Soil Source
    - WV Surface - SENS1_sum.TXT (decreased indoor fraction)
    - WV Surface - SENS2_sum.TXT (increased indoor fraction)
    - WV Surface - SENS3_sum.TXT (decreased source layer thickness)

- WV Surface - SENS4_sum.TXT (increased source layer thickness)
- WV Surface - SENS5_sum.TXT (decreased unsaturated zone thickness)
- WV Surface - SENS6_sum.TXT (increased unsaturated zone thickness)
- WV Surface - SENS7_sum.TXT (decreased well pumping rate)
- WV Surface - SENS8_sum.TXT (increased well pumping rate)
- WV Surface - SENS9_sum.TXT (decreased K_d values)
- WV Surface - SENS10_sum.TXT (increased K_d values)
- WV Surface - SENS11_sum.TXT (decreased K value)
- WV Surface - SENS12_sum.TXT (increased K value)
- WV Surface - SENS13_sum.TXT (decreased runoff/evapotranspiration)
- WV Surface - SENS14_sum.TXT (increased runoff/evapotranspiration)
- WV Surface - SENS15_sum.TXT (decreased well intake depth)
- WV Surface - SENS16_sum.TXT (increased well intake depth)
- WV Surface - SENS17_sum.TXT (decreased length parallel to flow)
- WV Surface - SENS18_sum.TXT (increased length parallel to flow)
- WV Surface - SENS19_sum.TXT (decreased plant transfer factors)
- WV Surface – SENS20_sum.TXT (increased plant transfer factors)
- WV Surface - SENS21_sum.TXT (mass balance groundwater model)

– Subsurface Soil Source

- WV Subsurface - SENS1_sum.TXT (decreased indoor fraction)
- WV Subsurface - SENS2_sum.TXT (increased indoor fraction)
- WV Subsurface - SENS3_sum.TXT (decreased source layer thickness)
- WV Subsurface - SENS4_sum.TXT (increased source layer thickness)
- WV Subsurface - SENS5_sum.TXT (decreased unsaturated zone thickness)
- WV Subsurface - SENS6_sum.TXT (increased unsaturated zone thickness)
- WV Subsurface - SENS7_sum.TXT (decreased well pumping rate)
- WV Subsurface - SENS8_sum.TXT (increased well pumping rate)
- WV Subsurface - SENS9_sum.TXT (decreased K_d values)
- WV Subsurface - SENS10_sum.TXT (increased K_d values)
- WV Subsurface - SENS11_sum.TXT (decreased K value)
- WV Subsurface - SENS12_sum.TXT (increased K value)

    - WV Subsurface - SENS13_sum.TXT (decreased runoff/evapotranspiration)
    - WV Subsurface - SENS14_sum.TXT (increased runoff/evapotranspiration)
    - WV Subsurface - SENS15_sum.TXT (decreased plant transfer factors)
    - WV Subsurface – SENS16_sum.TXT (increased plant transfer factors)
- Stream Bank Sediment Source
    - WV Sediment - SENS1_sum.TXT (decreased outdoor fraction)
    - WV Sediment - SENS2_sum.TXT (increased outdoor fraction)
    - WV Sediment - SENS3_sum.TXT (decreased source layer thickness)
    - WV Sediment - SENS4_sum.TXT (increased source layer thickness)
    - WV Sediment - SENS5_sum.TXT (increased unsaturated zone thickness)
    - WV Sediment - SENS6_sum.TXT (largest unsaturated zone thickness)
    - WV Sediment - SENS7_sum.TXT (decreased K_d values)
    - WV Sediment - SENS8_sum.TXT (increased K_d values)
    - WV Sediment – SENS9_sum.TXT (decreased runoff/evapotranspiration)
    - WV Sediment – SENS10_sum.TXT (increased runoff/evapotranspiration)
    - WV Sediment - SENS11_sum.TXT (decreased plant transfer factors)
    - WV Sediment – SENS12_sum.TXT (increased plant transfer factors)
    - WV Sediment - SENS13_sum.TXT (decreased fish transfer factors)
    - WV Sediment – SENS14_sum.TXT (increased fish transfer factors)

The following section presents the methods used to generate DCGLs from the RESRAD model output previously described.

2.4 Excel Result Files

The outputs of the RESRAD simulations (the DSR for each of the radionuclides at various future times) were exported to Excel from the RESRAD summary output report (specifically, the DSR values in the table presented at the bottom of page 45 of each RESRAD summary report). For each simulation, dose results were exported for each of the 18 radionuclides, which includes the simulation year and dose (for that year) for each radionuclide. These have been generated for $DCGL_W$, $DCGL_{EMC}$, and sensitivity simulations for each source media and isotope. The peak dose for each radionuclide is identified and used as the basis for the DCGL calculation as follows;

$DCGL_w$ = Dose Limit / Peak radionuclide DSR (Eq.2)

Specific Excel result files are described below.

2.4.1 Surface Soil DCGLs

Surface soil DCGLs were calculated to conform with the annual dose limit for large areas ($DCGL_W$), smaller areas of elevated concentrations ($DCGL_{EMC}$), and to evaluate the sensitivity of the model to variations in specific parameters. The files associated with these calculations are described below.

Surface Soil $DCGL_W$ Values

The soil $DCGL_W$ values were calculated based on resident farmer exposure for a 10,000 m^2 source area and results from the RESRAD summary output report are presented in the Excel file "WVDP Surface DCGLs.XLS" in the sheet "Base" (Table C-6). The input files for the surface soil evaluation are presented in Section 2.2. These surface soil $DCGL_W$ values are the basis for calculation of surface soil area factors and $DCGL_{EMC}$ values.

Surface Soil $DCGL_{EMC}$ Values

The $DCGL_W$ values calculated on the Excel summary sheet previously discussed serve as the base case for subsequent $DCGL_{EMC}$ development; $DCGL_{EMC}$ values are based on varying the source area from the 10,000 m^2 value used for the $DCGL_W$ as discussed in Chapter 5 of the MARSSIM. The Excel file "WVDP Surface DCGLs.XLS" has sheets for each of the source areas used to generate the $DCGL_{EMC}$ (Tables C-7 to C-14). The sheet "Summary" in the Excel file "WV Surface DCGLs.XLS" summarizes the $DCGL_{EMC}$ (Table C-15) and Soil Area Factors (TableC-16) for each of the 18 radionuclides and selected source areas (ranging from 1 to 10,000 m^2).

Surface Soil $DCGL_W$ Sensitivity Analysis

The surface soil $DCGL_W$ sensitivity to key parameters was assessed by varying the input values for specific parameters and tabulating the results. The Excel file "WV Surface DCGL Sensitivity.XLS" contains the DSRs and DCGLs for each of 18 radionuclides from the RESRAD summary report output for each of the sensitivity simulations. Results of each run are in sheets SENS1 through SENS21 (Tables C-17 to C-37). Also included in the file are a summarization of the calculated DCGLs (Table C-38) and a summary of the percent change from the base case (Table C-39) for each of the sensitivity runs (also presented in Table 5-9). Table C-40 below presents a summary of the surface soil sensitivity results.

Table C-40 Summary of Surface Soil DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
Indoor/Outdoor Fraction	1	-32%	-23%	U-232	0%	C-14 I-129 Np-237 Tc-99
	2	21%	0%	C-14 I-129 Np-237 Tc-99 U-234	30%	U-232
Source Thickness	3	-50%	9%	Cs-137	238%	C-14
	4	200%	-58%	C-14	0%	Am-241 Cm-243 Cm-244 Pu-239 Pu-240
Unsaturated Zone Thickness	5	-50%	-10%	Tc-99	6%	U-235
	6	150%	-4%	U-235	10%	Tc-99

Table C-40 Summary of Surface Soil DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
Irrigation/Pump Rate	7	-57%	-1%	U-232	52%	I-129
	8	70%	-31%	I-129	2%	U-232
Distribution Coefficients (Kd)	9	lower	-100%	Pu-239	6%	U-232
	10	higher	-4%	U-232	1146%	U-234
Hydraulic Conductivity	11	-99%	0%	Sr-90	1873%	I-129
	12	150%	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Sr-90 U-232	122%	U-235
Runoff/Evapo-transporation Coefficient	13	-69%	-28%	U-234	3%	U-232
	14	64%	-3%	U-232	123%	Np-237
Depth of Well Intake	15	-40%	-42%	I-129	0.1%	U-232
	16	100%	0%	Am-241 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240	93%	Np-237
Length Parallel to Aquifer Flow	17	-50%	0%	Am-241 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240	78%	U-235
	18	100%	-44%	U-235	0.1%	U-232
Plant Transfer Factors	19	-90%	-4%	I-129	387%	Sr-90
	20	900%	-90%	Sr-90	-6%	I-129
Mass Balance Model	21	-69%	-81%	U-234	0%	U-232

2.4.2 Subsurface Soil (Lavery till) DCGLs

To evaluate an excavation that would expose the resident farmer to subsurface material, DCGLs were developed to address this potential future source. It is possible that a farmer may install a cistern or well to access groundwater, and in the excavation process, contaminated Lavery till material from the subsurface may be spread on the ground surface and be a source of exposure. The following subsections discuss the files associated with this calculation.

Subsurface Soil $DCGL_W$ Values

The subsurface $DCGL_w$ values are presented in the Excel file “WV Subsurface DCGLs.XLS” in the sheet “Base” (TableC-41), and are based on the RESRAD input file

"WV Subsurface – 100 Base.RAD" and results from page 45 of the RESRAD summary output report "WV Subsurface – 100 Base.TXT".

For calculation of the distributed soil, $DCGL_W$ values for a 100 m^2 source area of Lavery till on the surface were increased by a factor of 10 to account for an assumed blending of residually contaminated till with clean overlying soil in the excavation process (assuming 0.5 m of till for each 5 m of total excavation). This factor is applied to the final RESRAD generated DCGLw as presented in the overall summary table (See "DCGL Summary" section).

The input files for the subsurface soil evaluation are discussed in Section 2.2. These Lavery Till $DCGL_W$ values are used as the basis for calculation of the subsurface soil $DCGL_{EMC}$ values and for sensitivity analysis as described below.

Subsurface Soil $DCGL_{EMC}$ Values

Calculation of $DCGL_{EMC}$ values for the subsurface Lavery till was based on the base case area of 100 m^2 used for development of the $DCGL_W$ values (after accounting for blending). The $DCGL_{EMC}$ values were generated by varying the source area. The RESRAD output for these simulations are presented and summarized in the Excel file "WV Subsurface DCGLs.XLS". The results for each source area are presented in individual sheets (Tables C-42 to C-45). The sheet "Summary" presents the $DCGL_{EMC}$ values (Table C-46) and subsurface soil area factors (Table C-47) for each of the 18 radionuclides and selected source areas (ranging from 1 to 100 m^2).

Subsurface Soil Sensitivity Analysis

The subsurface soil $DCGL_W$ sensitivity to key parameters was assessed by varying the input values for specific parameters and tabulating the results. The Excel file "WV Subsurface DCGL Sensitivity.XLS" contains the DSRs and DCGLs for each of 18 radionuclides from the RESRAD summary report output for each of the sensitivity simulations. Results of each run are in sheets SENS1 through SENS16 (Tables C-48 to C-63). Also included in the file is a summarization of the calculated DCGLs (Table C-64) and a summary of the percent change from the base case (Table C-65) for each of the sensitivity runs (also presented in Table 5-10). Table C-66 below presents a summary of the subsurface soil sensitivity results.

Table C-66 Summary of Subsurface Soil DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
Indoor/Outdoor Fraction	**1**	-32%	-25%	Cs-137	0.1%	U-234
	2	21%	-1%	U-238	35%	U-232
Source Thickness	**3**	-67%	10%	U-238	255%	Tc-99
	4	233%	-90%	C-14	-1%	Cs-137
Unsaturated Zone Thickness	**5**	-50%	-3%	Tc-99	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Pu-241 Sr-90 U-232 U-235

Table C-66 Summary of Subsurface Soil DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
	6	150%	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240 Pu-241 Sr-90 Tc-99 U-232 U-235	1%	U-238
Irrigation/Pump Rate	**7**	-57%	-36%	I-129	0%	Am-241 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240
	8	70%	0%	Cm-243 Pu-238 Pu-239 Pu-240	159%	U-238
Distribution Coefficients (K_d)	**9**	lower	-99%	Pu-239	16%	Tc-99
	10	higher	-27%	U-232	3144%	U-234
Hydraulic Conductivity	**11**	-99%	-1%	U-238	3%	I-129
	12	150%	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 I-129 Np-237 Pu-238 Pu-239 Pu-240 Pu-241 Sr-90 Tc-99 U-232 U-233 U-234 U-235 U-238	0%	Am-241 C-14 Cm-243 Cm-244 Cs-137 I-129 Np-237 Pu-238 Pu-239 Pu-240 Pu-241 Sr-90 Tc-99 U-232 U-233 U-234 U-235 U-238
Runoff/Evapo-transporation Coefficient	**13**	-69%	-38%	U-234	16%	U-232
	14	64%	-19%	U-232	188%	U-234
Plant Transfer Factors	**15**	-90%	-0.4%	U-238	574%	Sr-90
	16	900%	-90%	Tc-99	-1%	U-234

2.4.3 Streambed Sediment DCGLs

DCGLs were also developed to account for potential exposure associated with stream bank sediment (including direct pathways, fish ingestion, and venison ingestion). The stream bank rather than the streambed was the focus of the analysis because the recreationist is assumed to be in direct contact with the stream bank, and not the stream bed.

Files associated with the calculations are discussed below and presented in the files attachment.

Streambed Sediment $DCGL_W$ Values

The sediment $DCGL_W$ values were calculated based on a recreationist exposure for a 1,000 m^2 source area and results from the RESRAD summary output report are presented in the Excel file "WVDP Surface DCGLs.XLS" in the sheet "Base" (Table C-67). The input files for the sediment evaluation are discussed in Section 2.2. These sediment $DCGL_W$ values are the basis for calculation of Sediment Area Factors and $DCGL_{EMC}$ values.

Streambed Sediment $DCGL_{EMC}$ Values

The $DCGL_W$ values calculated on the Excel summary sheet previously discussed serve as the base case for subsequent $DCGL_{EMC}$ development, which are based on varying the source area from the 1,000 m^2 value used for the $DCGL_W$ values. The RESRAD output for these simulations are presented and summarized in the Excel file "WV Sediment DCGLs.XLS". The results for each source area are presented in individual sheets (Tables C-68 to C-73). The sheet "Summary" presents the $DCGL_{EMC}$ values (Table C-74) and sediment area factors (Table C-75) the 18 radionuclides and selected source areas (ranging from 1 to 1,000 m^2).

Streambed Sediment Sensitivity Analysis

The sediment $DCGL_W$ sensitivity to key parameters was assessed by varying the input values and tabulating the results. The Excel file "WV Sediment DCGL Sensitivity.XLS" contains the RESRAD summary report output for each of the sensitivity simulations. Results of each run are in sheets SENS1 through SENS14 (Tables C-76 to C-89). Also included in the file is a summarization of the calculated DCGLs (Table C-90) and percent change from the base case (Table C-91) for each of the sensitivity runs (also presented in Table 5-11). Table C-92 below presents a summary of the sediment sensitivity analysis.

Table C-92 Summary of Sediment DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
Outdoor Fraction	1	-50%	0%	C-14	97%	U-232
	2	100%	-50%	Cm-243	0%	C-14
Source Thickness	3	-50%	0%	Cm-243	157%	C-14
	4	200%	-52%	C-14	0%	Am-241 Cm-243 Cm-244 Cs-137 Pu-238 Pu-239 Pu-240
Unsaturated Zone Thickness	5	0 m to 1m	0.3%	Cs-137	83%	U-234
	6	0 m to 3 m	0.3%	Cs-137	83%	U-234
Soil/Water Distribution Coefficients (Kd)	7	lower	-90%	Pu-239	47%	Pu-241
	8	higher	-59%	U-233	127%	Np-237

Table C-92 Summary of Sediment DCGL Sensitivity Analysis

Parameter	Run	Change in Sensitivity Parameter	Minimum		Maximum	
			Change	Nuclide(s)	Change	Nuclide(s)
Runoff/Evapotranspiration Coefficient	**9**	-54%	0%	Am-241 Cm-243 Pu-238 Pu-239 Pu-240	8%	U-232
	10	78%	-29%	U-233	0%	Am-241 Cm-243 Cm-244 Pu-238 Pu-239 Pu-240
Plant Transfer Factors	**11**	-90%	-29%	U-233	82%	Sr-90
	12	900%	-82%	Sr-90	-1%	U-235
Fish Transfer Factors	**13**	-90%	-28%	U-233	99%	Np-237
	14	900%	-84%	Np-237	-3%	Cs-137

Consideration of Subsurface Lavery till as a Continuing Source to Groundwater

An evaluation of the potential for the Lavery till to act as a continuing source to groundwater was conducted and concluded the following (See section 3.7 and Table 3-19 of the body of the plan):

- A well screened entirely in the Lavery Till could not produce enough groundwater for the resident farmer scenario.
- A well screened in both the sand and gravel unit and Lavery till would likely pump mostly groundwater from the sand and gravel unit due to the much higher relative hydraulic conductivity and subsequent development of preferential flowpaths, and contain highly diluted contributions of contaminated groundwater from the Lavery Till.
- Advective movement from the Lavery Till to the overlying Sand and Gravel Unit is unlikely considering the vertical downward groundwater gradient.
- Diffusive movement from the Lavery Till to the Sand and Gravel Unit is unlikely considering the very low diffusion coefficients for radionuclides.
- Migration vertically upward from the till through the aquifer and into a well that is screened several meters above the till is unlikely.

DCGL Summary

The Excel File “WV DCGL Summary Tables.xls” (Table C-93) summarizes the DCGLs for the surface soil, subsurface soil and sediment, and presents $DCGL_W$ and $DCGL_{EMC}$ for a 1 m^2 area (also presented in Table 5-8).

Integrated Dose Assessment

In order to account for potential exposure to multiple sources, a combined dose assessment was conducted. The assessment considered which combination of exposures was likely, and concluded that the resident farmer may also spend time in recreation along the stream bank.

The Excel File "WV DCGL Summary Tables.xls" presents the calculated $DCGL_W$ and $DCGL_{EMC}$ values when considering the combined doses from surface soil (90% x 25 mrem/yr = 22.5 mrem/y) and sediment sources (10% x 25 mrem/y = 2.5 mrem/y), which are summarized in Tables C-94, C-95, and C-96 (also presented in Table 5-13). In the same Excel file, Table C-96 presents the cleanup goals to be used as the criteria for the proposed remediation activities. Values in Table C-97 represent the $DCGL_W$ and $DCGL_{EMC}$ values for surface soil and sediment (considering the combined dose), as well as cleanup goals for subsurface soil (which are 50% of the $DCGL_W$ and $DCGL_{EMC}$ values adjusted to provide a margin of confidence/safety factor for excavation success for each radionuclide (also presented in Table 5-12).

Evaluation of Institutional Control Period

After Phase 1 proposed remediation there is assumed to be a 30 year period of institutional controls (associated with storage of the HLW canisters until 2041), prior to site access by the critical receptors. During this period, radionuclide inventories will be subject to decay and leaching, which will result in site concentrations at the time of exposure that are reduced from the initial concentrations left at the time of proposed remediation. With the exception of Sr-90 and Cs-137, DCGLs were developed neglecting the effects of decay and leaching from the source during the 30 year institutional control period. The ratio of the initial concentrations in soil to the RESRAD generated soil concentration after a 30 year simulation was used to provide an evaluation of uncertainty associated with the assumption of neglecting decay/leaching. A RESRAD simulation was run using the surface soil base case without irrigation, well pumping, or plant/animal/human uptake from soil (see RESRAD input file "WV SURFACE – 10k – LCH_DCAY.RAD" and output file "WV SURFACE – 10k – LCH_DCAY_sum.txt". The RESRAD concentration output summary file (see page 8 of the file "WV SURFACE – 10k – LCH_DCAY_conc.txt") provides the soil concentration at year 30, which is then related to the initial soil concentration to quantify the effects of leaching/decay (see Excel file "WV Institutional Control.xls" Table C-98).

Evaluation of Potential Dose Drivers and Sensitivity Parameters

The impact of specific sensitivity parameters is dependent on the radionuclides that contribute the majority of the dose to the receptor. Due to limited site data, a full evaluation can not be performed until additional site characterization data is available. In the interim, Table C-99 presented below identifies the primary dose pathways for each radionuclide and indicates which of the sensitivity parameters have significant impact on the dose. This evaluation would be refined as additional site data are collected.

Table C-99 Summary of Primary Dose Pathways

Nuclide	Primary Pathway for Dose	Key Parameters(1)	Year of Peak Dose
Surface Soil			
Am-241	Water independent (plant uptake)	plant transfer factors, source thickness	0.00E+00
C-14	Water independent (plant uptake)	source thickness	0.00E+00
Cm-243	External Exposure, Water independent (plant uptake)	plant transfer factors, source thickness	0.00E+00
Cm-244	Water independent (plant uptake)	plant transfer factors, source thickness	0.00E+00
Cs-137	External Exposure	outdoor fraction, plant transfer factors	0.00E+00
I-129	Water dependent (water ingestion, plant and milk uptake)	K, Kd, runoff/evap coefficients, well intake depth, groundwater model	9.21E+00
Np-237	Water dependent (water ingestion, plant uptake)	hydraulic conductivity, Kd, runoff/evap coefficients, well intake depth, groundwater model	2.01E+01
Pu-238	Water independent (plant uptake)	Kd, plant transfer factors	0.00E+00
Pu-239	Water independent (plant uptake)	Kd, plant transfer factors	0.00E+00
Pu-240	Water independent (plant uptake)	Kd, plant transfer factors	0.00E+00
Pu-241	Water independent (plant uptake)	Kd, plant transfer factors	5.52E+01
Sr-90	Water independent (plant uptake)	source thickness, plant transfer factors, Kd, groundwater model	0.00E+00
Tc-99	Water dependent (water ingestion, plant uptake), independent (plant uptake)	source thickness, well intake depth, plant transfer factors, length parallel to flow, Kd, K, groundwater model	1.54E+00
U-232	External Exposure	outdoor fraction, plant transfer factors	8.17E+00
U-233	Water dependent (water ingestion, plant uptake)	irrigation/pump rate, Kd, runoff/evap coefficients, groundwater model	2.96E+02
U-234	Water dependent (water ingestion, plant uptake)	irrigation/pump rate, Kd, runoff/evap coefficients, groundwater model	2.96E+02
U-235	Water dependent (water ingestion, plant uptake)	irrigation/pump rate, Kd, runoff/evap coefficients, groundwater model	2.96E+02
U-238	Water dependent (water ingestion, plant uptake)	irrigation/pump rate, Kd, runoff/evap coefficients, groundwater model	2.96E+02
Subsurface Soil			
Am-241	External Exposure, Water independent (plant uptake)	source thickness, plant transfer factors	0.00E+00
C-14	Water independent (plant uptake)	source thickness	0.00E+00
Cm-243	External Exposure	outdoor fraction, source thickness	0.00E+00
Cm-244	Water independent (plant uptake)	source thickness, plant transfer factors	0.00E+00
Cs-137	External Exposure	outdoor fraction, source thickness	0.00E+00

Table C-99 Summary of Primary Dose Pathways

Nuclide	Primary Pathway for Dose	Key Parameters(1)	Year of Peak Dose
I-129	Water dependent (water ingestion)	source thickness, irrigation/pump rate, Kd, runoff/evap coefficients	6.32E+00
Np-237	Water independent (soil ingestion, plant uptake)	source thickness, Kd, runoff/evap coefficients	1.37E+01
Pu-238	Water independent (plant uptake, soil ingestion and inhalation)	source thickness, Kd, plant transfer factors	0.00E+00
Pu-239	Water independent (plant uptake, soil ingestion and inhalation)	source thickness, Kd, plant transfer factors	0.00E+00
Pu-240	Water independent (plant uptake, soil ingestion and inhalation)	source thickness, Kd, plant transfer factors	0.00E+00
Pu-241	Water independent (plant uptake)	source thickness, Kd, plant transfer factors	6.14E+01
Sr-90	Water independent (plant uptake)	source thickness, Kd, plant transfer factors	0.00E+00
Tc-99	Water dependent (plant uptake)	source thickness, plant transfer factors	0.00E+00
U-232	External Exposure	outdoor fraction, source thickness	4.60E+00
U-233	Water dependent (water ingestion)	Kd, runoff/evap coefficients	1.97E+02
U-234	Water dependent (water ingestion)	Kd, runoff/evap coefficients	1.97E+02
U-235	External Exposure	outdoor fraction, source thickness, Kd	0.00E+00
U-238	Water dependent (water ingestion)	source thickness, irrigation/pump rate, Kd, runoff/evap coefficients, groundwater model	1.98E+02
Sediment			
Am-241	External Exposure, Soil ingestion, Water independent (meat uptake)	outdoor fraction	0.00E+00
C-14	Water independent (meat uptake), Water dependent (fish uptake)	source thickness, unsaturated thickness, Kd	0.00E+00
Cm-243	External Exposure	outdoor fraction	0.00E+00
Cm-244	Soil ingestion	outdoor fraction	0.00E+00
Cs-137	External Exposure	outdoor fraction	0.00E+00
I-129	Water independent (meat uptake), Water dependent (fish uptake)	unsaturated thickness, Kd, fish transfer factors	0.00E+00
Np-237	External Exposure, Water independent (meat uptake), Water dependent (fish uptake)	unsaturated thickness, Kd, fish transfer factors	0.00E+00
Pu-238	Water independent (meat uptake), Soil ingestion	outdoor fraction, Kd	0.00E+00
Pu-239	Water independent (meat uptake), Soil ingestion	outdoor fraction, Kd	2.82E-01
Pu-240	Water independent (meat uptake), Soil ingestion	outdoor fraction, Kd	1.18E-01

Table C-99 Summary of Primary Dose Pathways

Nuclide	Primary Pathway for Dose	Key Parameters(1)	Year of Peak Dose
Pu-241	External Exposure, Water independent (meat uptake), Soil ingestion	outdoor fraction, Kd	5.78E+01
Sr-90	Water independent (meat uptake)	plant and fish transfer factors	0.00E+00
Tc-99	Water independent (meat uptake)	Kd, plant and fish transfer factors	0.00E+00
U-232	External Exposure	outdoor fraction, Kd	7.72E+00
U-233	External Exposure, Water independent (meat uptake), Water dependent (fish uptake)	outdoor fraction, unsaturated thickness, Kd, plant and fish transfer factors	1.56E-01
U-234	Water independent (meat uptake), Water dependent (fish uptake)	outdoor fraction, unsaturated thickness, Kd, fish transfer factors	1.81E-01
U-235	External Exposure	outdoor fraction	0.00E+00
U-238	External Exposure	outdoor fraction, fish transfer factors	0.00E+00

NOTE: (1) Key parameters identified in sensitivity runs. As additional site characterization data becomes available, the radionuclides driving dose and parameters most critical to calculating dose can be used to refine the sensitivity analysis.

3.0 References

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Attachments

1. Electronic Files Described in Section 2 (provided separately)
2. Electronic File Described in Section 1 (provided separately)

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permanent hydraulic barrier of slurry wall type construction would be installed on the downgradient side of the excavation in soil contaminated by the north plateau groundwater plume to act as an intrusion barrier to prevent the migration of Sr-90 contaminated groundwater from the non-source area of the north plateau groundwater plume into the WMA 1 excavation.

The permanent downgradient hydraulic barrier would:

- Prevent recontamination of the remediated and backfilled WMA 1 excavation from the non-source area of the plume until a Phase 2 decommissioning decision is made, and
- Minimize groundwater recharge to the non-source area of the plume, thereby minimizing hydraulic heads and groundwater velocity.

A French drain system would be installed adjacent and hydraulically upgradient of the permanent hydraulic barrier wall once the WMA 1 excavation has been backfilled to maintain groundwater elevations near there current levels. The French drain system would:

- Prevent groundwater mounding against, and potential overtopping of, the permanent downgradient hydraulic barrier wall;
- Maintain hydraulic heads on the upgradient side of the barrier wall that coincide with the elevation of the French drain system, that are higher than groundwater levels downgradient of the barrier wall. This would create a hydraulic gradient towards the non-source area of the north plateau groundwater plume, preventing seepage from the plume through the wall into the backfilled excavation; and
- In conjunction with the permanent downgradient hydraulic barrier, minimize groundwater recharge to the non-source area of the North Plateau Plume thereby minimizing hydraulic heads and groundwater velocity across the North Plateau.

1.1.2 Hydraulic Barrier Walls and French Drain System

The WMA 1 excavation would require the installation of approximately 2,250 linear feet of subsurface hydraulic barrier wall comprised of temporary interlocking steel sheet piling on the upgradient and cross-gradient sides of the excavation and a permanent hydraulic barrier wall on the downgradient side of the excavation before excavation begins as shown on Figure D-1.

Temporary Sheet Pile Barrier Walls

Approximately 1,500 feet of conventional interlocking sheet piles would be installed in uncontaminated soils along the upgradient and cross-gradient sides of the excavation boundary before excavation begins (Figure D-1). The piles would be driven a minimum of two feet into the underlying Lavery till to prevent groundwater from migrating beneath the piles into the WMA 1 excavation.

Contaminated soil exceeding the subsurface soil cleanup criteria specified in Section 5 would be excavated leaving a soil cut-back slope against the sheet pile walls containing soil with radionuclide concentrations below the subsurface soil clean-up criteria.[2] The soil cut-backs along the sheet pile walls would be surveyed during the Phase 1 final status surveys as specified in Sections 7 and 9 of this plan. The sheet pile barrier wall would be removed as

[2] Figure 7-8 in Section 7 of this plan shows typical excavation slopes.

specified in Section 7 once the final status survey, the independent verification survey, and backfilling of the WMA 1 excavation is completed to allow a return to typical groundwater flow patterns within the sand and gravel unit.

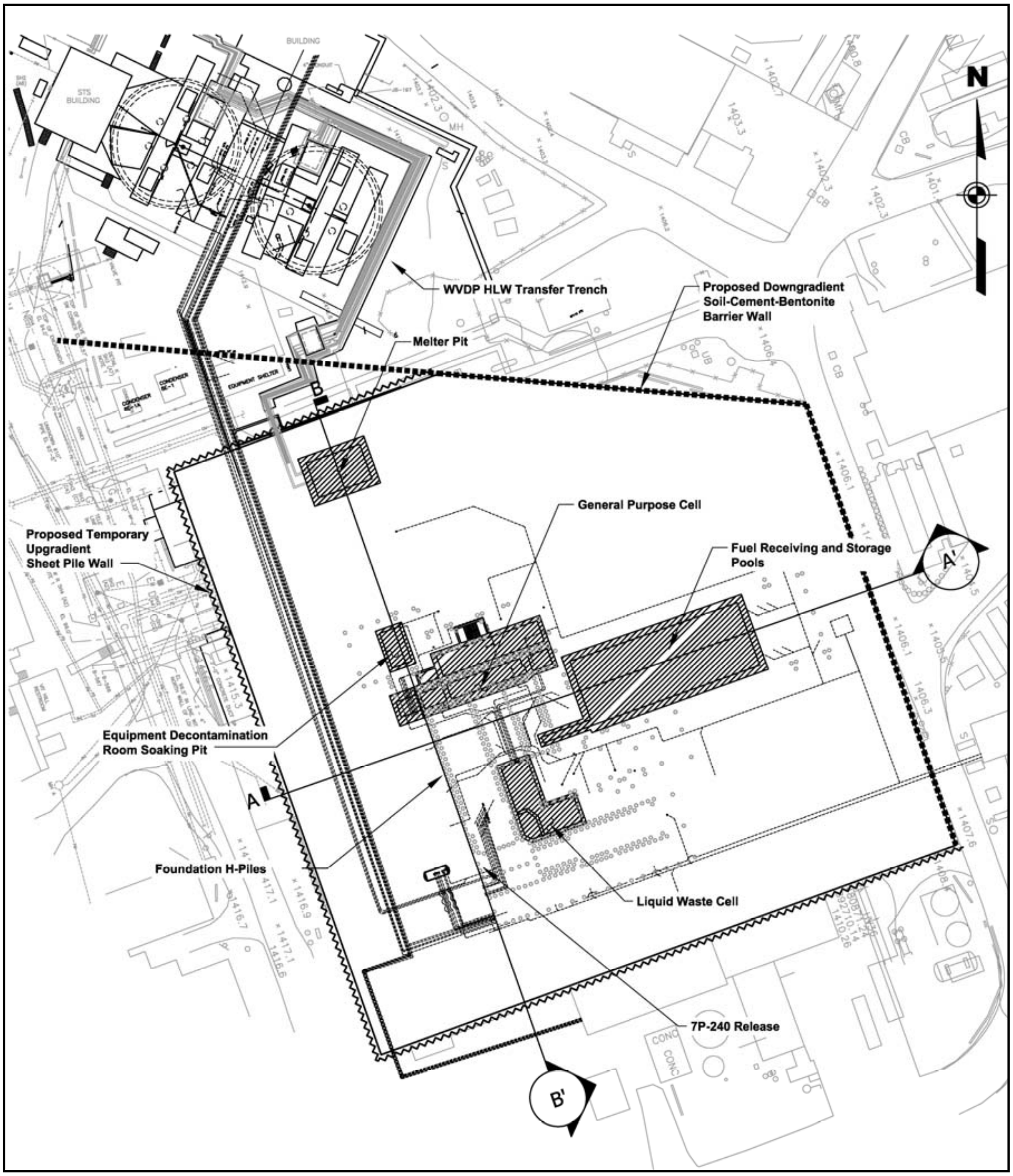

Figure D-1. Plan View of the WMA 1 Excavation

Permanent Downgradient Hydraulic Barrier Wall

The permanent hydraulic barrier wall constructed on the downgradient side of the WMA 1 excavation (Figure D-1) would be a vertical soil-cement-bentonite slurry wall installed using slurry wall trenching technology. This hydraulic barrier technology was selected because of its long history of successful usage. This wall would prevent migration of Sr-90 contaminated groundwater from the non-source area of the North Plateau Plume into the WMA 1 excavation both during excavation and after backfilling the excavation with clean fill.

The hydraulic barrier wall downgradient of the WMA 1 excavation would be installed under a carefully planned and rigorous quality control-quality assurance program as described in Section 8.

The soil-cement-bentonite barrier wall would be a mixture of 85 percent soil, five percent Portland cement, and 10 percent bentonite. The Portland cement would provide internal stability to the barrier wall and it would have an initial maximum design hydraulic conductivity of 6.0 E-06 cm/s.

The soil-cement-bentonite barrier wall would be approximately 750 feet long, two to 13 feet wide, and would be up to 50 feet deep with an average depth of 27 feet. The wall would extend through the sand and gravel unit and a minimum of two feet into the Lavery till to minimize groundwater flow beneath the bottom of the wall.

Approximately 225 feet of barrier wall outside of the excavation boundary would be two to three feet thick. The remaining 525 feet of barrier wall within the boundary of the excavation would be at least 13 feet thick to allow the excavation of subsurface soils up to and into the barrier wall. The proposed thickness would allow an excavation cut back slope of 1:2 (horizontal to vertical), which is typical of what can be achieved in most stiff clayey soils. The barrier wall material within the excavation cut-back slope would be surveyed during the Phase 1 final status survey.[3]

The upper three feet of the barrier wall would be constructed of clean backfill similar to the surrounding sand and gravel unit. This material would allow vehicular traffic over the barrier wall without damaging the underlying barrier wall.

French Drain System

A French drain system would be installed upgradient of the permanent hydraulic barrier wall during the backfilling of the WMA 1 excavation (Figure D-1). The French drain would be installed to keep groundwater levels at their current level on the upgradient side of the barrier wall to prevent groundwater mounding against the wall, prevent potential overtopping of the wall, and promote groundwater flow towards the non-source area of the north plateau groundwater plume.

The French drain would be constructed by excavating a trench, approximately four feet wide and 10 feet deep, placing perforated pipe into the bottom of the trench, and backfilling the trench with permeable granular materials. The northwest and southeast portions of the French drain would meet at a concrete manhole located near the mid-point of the barrier wall. The French drain would be sloped to the southeast to discharge by gravity flow to a surface water drainage discharging to Erdman Brook.

[3] As explained in Section 7 of this plan, any soil found to exceed cleanup goals would be removed only within the confines of the planned excavation, that is, within the confines of the downgradient hydraulic barrier wall and the sheet piles.

1.2 Waste Management Area 2

The Phase 1 proposed decommissioning activities in WMA 2 would include the removal of Lagoons 1 through 3, the Neutralization Pit, Interceptors, Solvent Dike, and surrounding contaminated soils within a single excavation down into the underlying Lavery till. Most of this excavation is cross gradient to the non-source area of the North Plateau Plume (Figure D-2). The removal of the lagoons, sub-grade structures, and surrounding soils would require the installation of a permanent subsurface hydraulic barrier wall prior to excavation to facilitate removal activities and to prevent potential recontamination of the area from the non-source area of the north plateau groundwater plume as described in Section 7. The barrier wall for WMA 2 is described in greater detail below.

1.2.1 Need for Subsurface Engineered Barriers

Lagoons 1 through 3, sub-grade structures, and surrounding contaminated vadose and saturated soils would be removed to a depth of approximately 14 feet to meet the unrestricted release criteria in 10 CFR 20.1402. Most of the WMA 2 excavation may be impacted by migration of Sr-90 contaminated groundwater from the adjacent non-source area of the north plateau groundwater plume. The need for a subsurface hydraulic barrier wall for the 4.2-acre excavation area across WMA 2 is the same as the rationale described earlier in Section 1.1.1 of this Appendix for the excavation of WMA 1.

A permanent hydraulic barrier of slurry wall type construction would be installed on the northwest side of the WMA 2 excavation to act as an intrusion barrier to prevent the migration of Sr-90 contaminated groundwater from the non-source area of the north plateau groundwater plume into the WMA 2 excavation. This permanent downgradient hydraulic barrier would prevent recontamination of the remediated and backfilled WMA 2 excavation from the non-source area of the north plateau plume until a Phase 2 decommissioning decision is made.

1.2.2 Hydraulic Barrier Wall

Before excavation activities begin in WMA 2 a permanent subsurface hydraulic barrier wall would be installed on the northwest side of the WMA 2 excavation as shown on Figure D-3.

Permanent Hydraulic Barrier Wall

The permanent hydraulic barrier wall constructed on the northwest side of the WMA 2 excavation would be a vertical soil-cement-bentonite slurry wall installed using slurry wall trenching technology. This hydraulic barrier technology was selected because of its long history of successful usage. This wall would prevent migration of Sr-90 contaminated groundwater from the non-source area of the north plateau plume into the WMA 2 excavation both during excavation and after the excavation has been backfilled with clean fill.

The hydraulic barrier wall installed northwest of the WMA 2 excavation would be installed under a carefully planned and rigorous quality control-quality assurance program as described in Section 8. The barrier wall would be approximately 1,100 feet long, sufficiently wide to provide the stability necessary to permit excavation close to the edge of the excavation, and up to 20 feet deep, with an average depth of 16 feet. The wall would extend through the sand and gravel unit and a minimum of two feet into the Lavery till to minimize groundwater flow beneath the bottom of the wall.

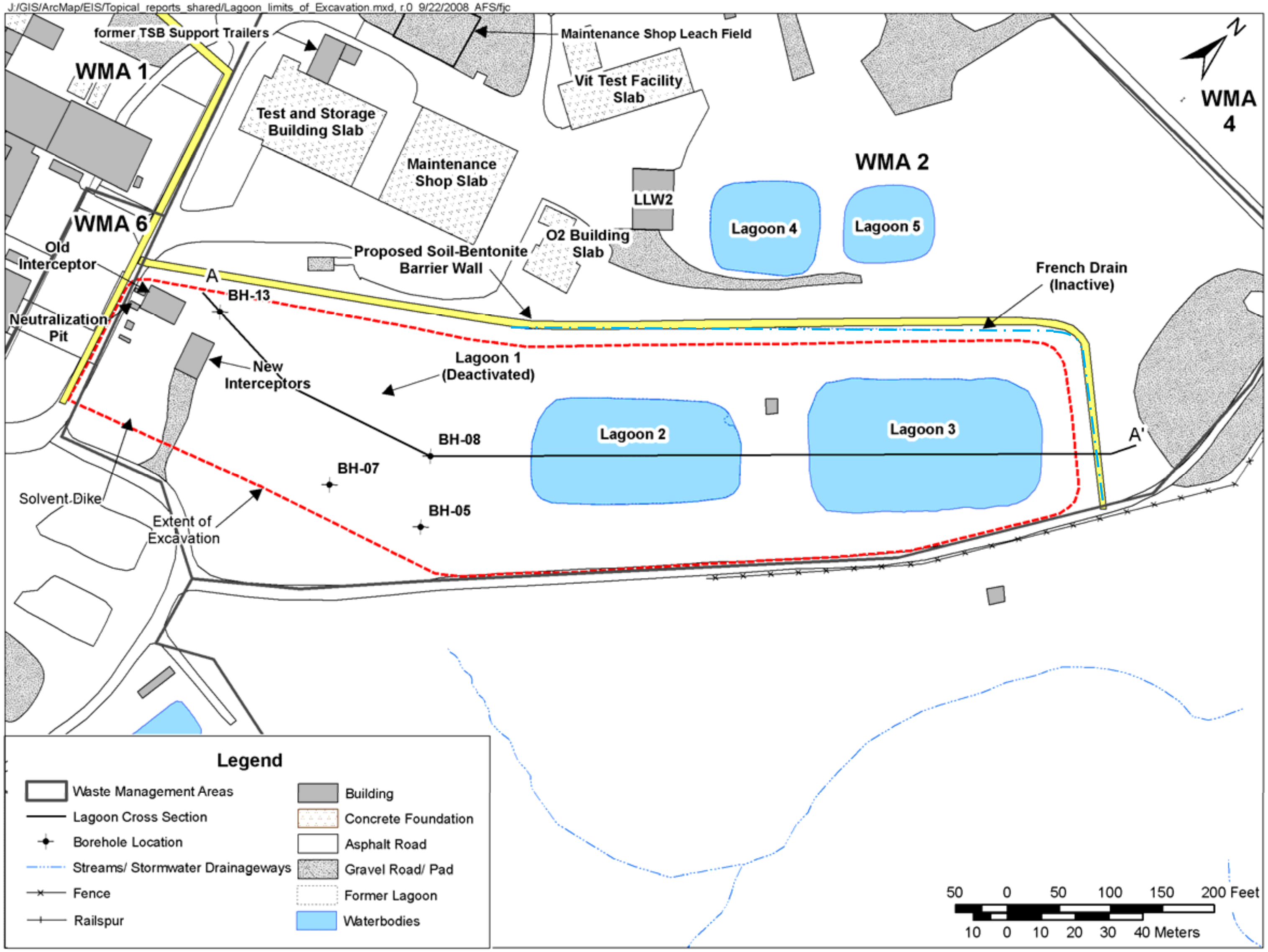

Figure D-2. Plan View of the WMA 2 Excavation

The upper three feet of the barrier wall would be constructed of clean backfill similar to the surrounding sand and gravel unit. This material would allow vehicular traffic over the barrier wall without damaging the underlying barrier wall.

1.3 Durability of Engineered Barriers

The materials used in the construction of the soil-cement-bentonite slurry walls are common natural geologic construction materials that exhibit long-term durability within the natural environment. The engineered barriers are expected to retain their design effectiveness until the start of Phase 2 of the decommissioning at a minimum. Their continued use would be among the factors evaluated in determining the approach to Phase 2 of the decommissioning.

The low-permeability bentonite used in the slurry wall construction is a natural geologic material exhibiting demonstrated long-term mineralogical and geologic stability (Mitchell 1986 and Mitchell 1993). Chemical contaminants that might degrade the physical characteristics and/or compromise the hydraulic conductivity of soil-bentonite slurry walls include:

- Concentrated solutions of organic fluids (Mille, et al. 1992 and Khera and Tirumala 1992),
- Organic groundwater contaminants (Evans, et al. 1985b and Grube 1992), and
- Acidic or highly alkaline solutions (Evans, et al. 1985a and Fang et al. 1992).

However, these conditions are not present within the project premises.

The backfill to be used for slurry wall construction would be a mixture of soil, Portland cement, and commercial sodium bentonite. The soil can be any material that could be classified as CL, CL/ML or ML/CL by the Unified Soil Classification System. The soil backfill would be natural geologic materials similar to the sand and gravel unit in the North Plateau. Uncontaminated sand and gravel from the trench excavation may also be used as soil backfill for the slurry wall. The sodium bentonite would be added at a rate recommended by the vendor to achieve a hydraulic conductivity on the order of 1 E-08 to 1 E-06 cm/s.

The geotechnical stability of the soil-cement-bentonite slurry wall has been evaluated under combined static and seismic loading conditions. The evaluation results indicate that the proposed soil-cement-bentonite slurry wall would provide the necessary strength to withstand damage from static and seismic loads predicted to occur during a hypothetical earthquake generating a horizontal acceleration of 0.20 g in the soil, with an approximate factor of safety of greater than 1.3 to greater than 3.0 (URS 2000).

The French drain would be constructed of natural (stone backfill) and man-made (perforated drain pipe, geotextile) materials. The French drain trench backfill would be designed to minimize silting of the drainpipe. The French drain would be periodically monitored and maintained until the start of Phase 2 decommissioning to ensure it is functioning properly.

1.4 Engineered Barriers and Groundwater Flow

Groundwater flow in the sand and gravel unit is currently to the northeast across the north plateau through WMA 1 and parallel to WMA 2 (Figure D-2). The permanent hydraulic barrier wall and French drain to be installed on the downgradient side of the WMA 1 excavation would be nearly perpendicular to the current groundwater flow path in the sand and gravel unit in the north plateau.

1.4.1 Conceptual Model

A three-dimensional near-field groundwater model was developed to simulate groundwater flow conditions near the engineered barriers installed at WMA 1 and WMA 2 using the STOMP computer code (Nichols, et al. 1997)[4]. This model is a revised version of the near-field model described in Appendix E to 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*. Figure D-3 shows the boundaries of the north plateau near-field model.

Figure D-3. North Plateau Groundwater Flow Model Boundary

The north plateau model mimics the shape of the lateral extent of the sand and gravel unit. It is oriented from the southwest to the northeast and extends downward from the ground surface to the top of the Kent Recessional Sequence.

Hydrogeologic 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 comprise the surficial sand and gravel unit. The thick-bedded unit comprises glaciofluvial gravel and alluvial deposits that range from one to five 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. The slack-water sequence varies in thickness from zero to five meters with the thickest portions beneath the Process Building. The unweathered Lavery

[4] STOMP (Subsurface Transport Over Multiple Phases) solves the relevant conservation equations for the flow of both liquid and gas (air with water vapor) phases in a porous matrix confined in a cylindrical shape. This computer code was developed by DOE's Pacific Northwest National Laboratory.

till is a glacial till with a thickness range of 10 to 17 meters in the model volume.

The hydrogeologic units incorporated into the north plateau near-field flow model are represented in Figures D-4 through D–8. The slack-water sequence appears in the northeastern portion of the model as shown in Figures D-6 through D–8. The hydraulic conductivities of these units are assumed constant over the model domain with values of 2.5 E-03, 5.3 E-03, and 6.0 E-08 centimeters per second for the thick-bedded unit, slack-water sequence, and unweathered Lavery till, respectively. Two variants of the north plateau near-field model were developed to simulate current north plateau groundwater flow conditions and to evaluate north plateau groundwater flow conditions associated with the proposed hydraulic barriers to be installed during Phase 1.

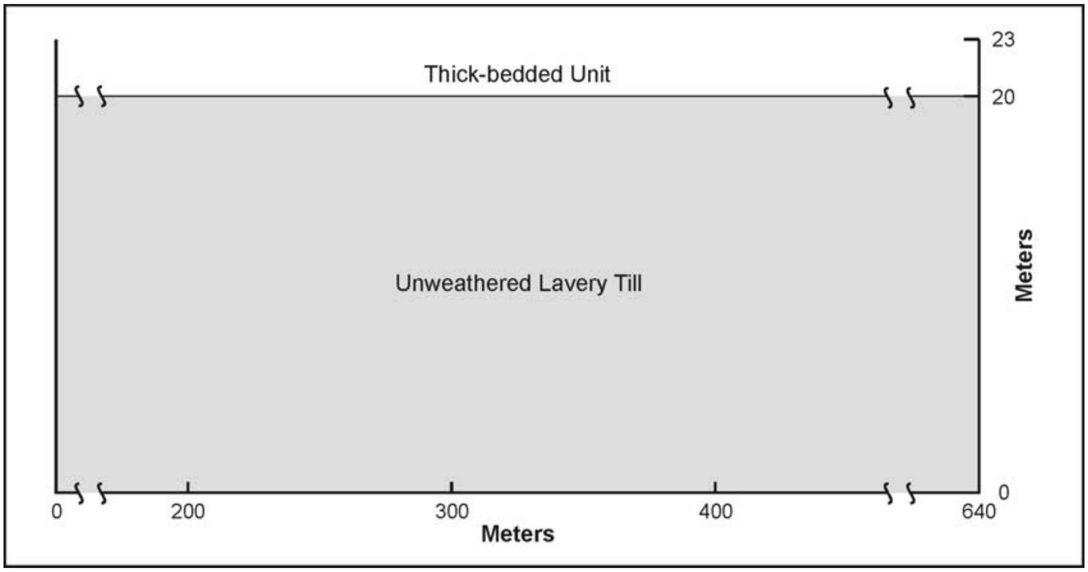

Figure D-4. Cross Section of North Plateau Near-Field Model – Northwest to Southeast, Distance of 0 to 80 Meters

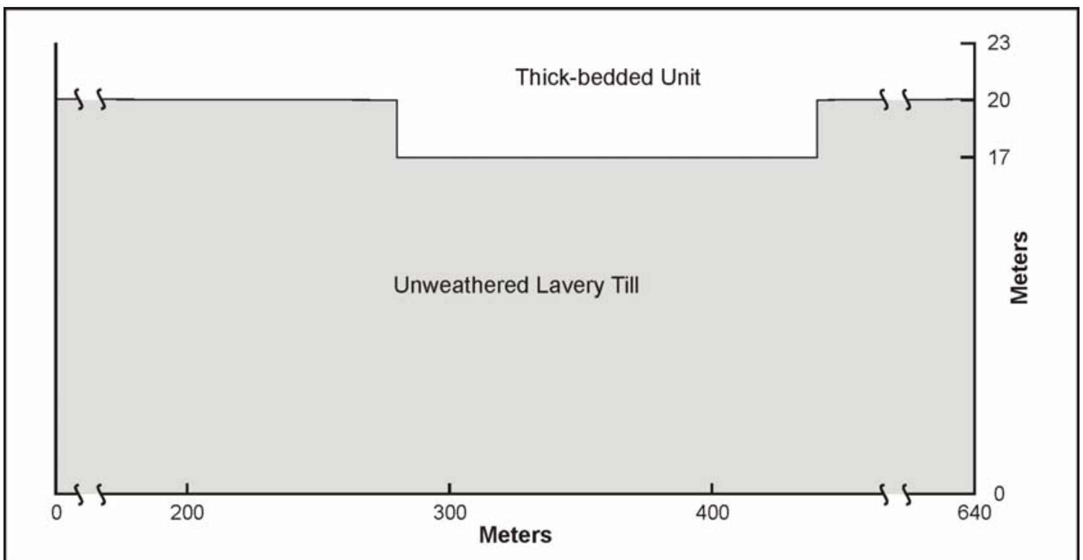

Figure D-5. Cross Section of North Plateau Near-Field Model – Northwest to Southeast, Distance of 80 to 120 Meters

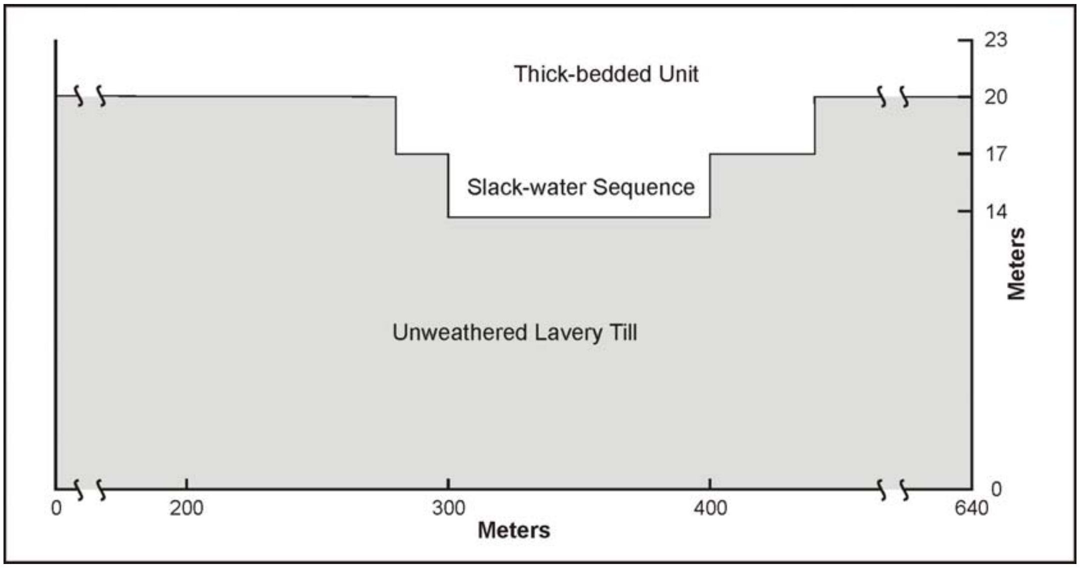

Figure D-6. Cross Section of North Plateau Near-Field Model – Northwest to Southeast, Distance of 120 to 250 Meters

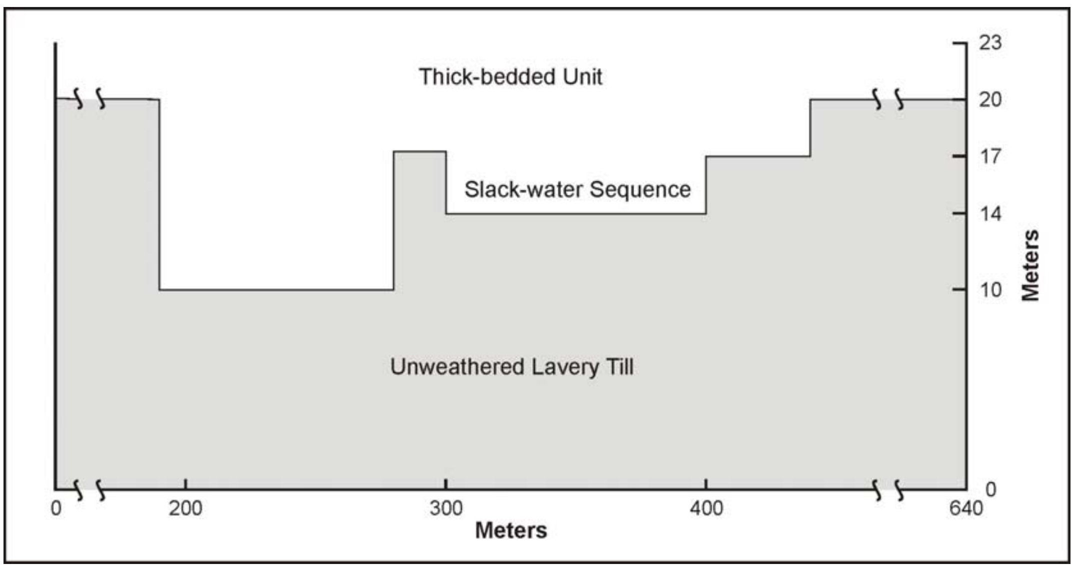

Figure D-7. Cross Section of North Plateau Near-Field Model – Northwest to Southeast, Distance of 250 to 310 Meters

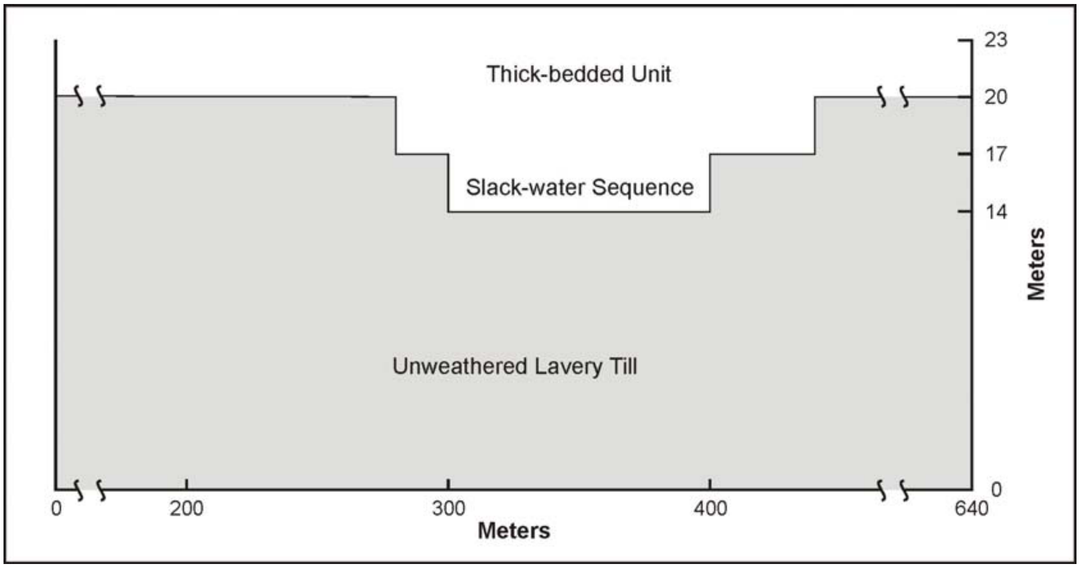

Figure D-8. Cross Section of North Plateau Near-Field Model – Northwest to Southeast, Distance of 310 to 820 Meters

1.4.2 Modeling Current Conditions

To simulate current conditions, the horizontal portion of the near-field groundwater model grid comprised rectangular blocks with 81 blocks in the northwest-to-southeast direction and 64 blocks in the southwest-to-northeast direction. Grid blocks with horizontal dimension as large as 50 meters were used along the west and north boundaries while grid block horizontal dimensions range from 1 to 10 meters over most of the model domain. For the vertical direction, the upper three meters were represented using 15 0.2-meter-thick layers, the next three meters were represented using six 0.5-meter-thick layers, and the bottom 17 meters were represented using 17 1.0-meter-thick layers. With these dimensions, the model utilized approximately 200,000 grid blocks.

Boundary conditions applied for the near-field model are consistent with site observations and with those applied for the site-wide 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 the sides 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 northwest, southeast, and northeast sides of the model, atmospheric pressure conditions were applied for the thick-bedded unit and slack-water sequence to represent seepage to Quarry Creek, Erdman Brook, and Franks Creek.

Evaluation of simulated pressures and measured conditions in target groundwater wells showed that a uniform recharge of 26 centimeters per year produced the closest match to existing conditions. Table D-1 compares measured hydraulic heads in wells screened in the sand and gravel unit from the north plateau with predicted hydraulic heads generated by the near-field model for three different recharge rates. Figure D-9 shows the resulting plot of water table elevation in the thick bedded unit for a recharge of 26 centimeters per year. These water table elevations are consistent with the measured heads and the predictions of the site-wide groundwater model described in Appendix E to 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*. Table D-2 shows the modeled flow balance.

Table D-1. North Plateau Near-field Flow Model Calibration for Head(1)

Groundwater Well	Measured Head (ft)	Predicted Head (ft) at Specified Recharge		
		18 cm/y	26 cm/y	34 cm/y
103	1391.4	1386.8	1391.6	1394.5
104	1385.5	1379.6	1383.1	1385.7
116	1380.5	1372.4	1376.8	1379.4
203	1394.4	1400.2	1401.6	1404.2
205	1393.1	1397.9	1399.2	1401.2
301	1410.7	1401.9	1406.8	1410.6
401	1410.3	1401.5	1406.4	1409.5
406/86-08	1393.45	1394.1	1397.4	1400.0
601	1377.3	1376.9	1378.9	1380.9
603	1391.9	1395.0	1397.0	1399.6
604	1391.6	1389.7	1391.9	1394.6
86-09	1391.8	1391.6	1396.5	1399.8
86-12	1364.8	1343.6	1345.2	1346.8
408	1391.8	1391.0	1394.8	1398.4
501	1391.3	1386.8	1391.5	1394.5
403	1408.0	1401.1	1405.8	1409.1
801	1376.6	1369.3	1373.1	1375.7
804	1369.9	1391.6	1396.5	1399.8
Sum of Squared Residuals (ft^2)(2)		1111.4	730.1	831.4

NOTES: (1) This specified recharge is the net inflow at the ground surface that results from the balance of precipitation, evapotranspiration, and run-off.

(2) Sum of squared residuals = (Measured Head – Predicted Head)^2 for each location, then summed.

Table D-2. Summary of Sand and Gravel Unit Flow Balance[(1)]

Inflow		Outflow	
Location	**Rate (m^3/y)**	**Location**	**Rate (m^3/y)**
Ground Surface	107,624	Down to ULT	9,060
Bedrock leakage	7,304	Quarry Creek	8,456
		Erdman Brook	15,238
		Frank's Creek	66,713
		North Plateau Ditch	15,445
Totals	114,928		114,912

NOTE: (1) For a recharge rate of 26 centimeters per year
LEGEND: ULT = unweathered Lavery till

The relationship between rate of flow 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 location of the Process Building to the north plateau ditch. Average linear velocities predicted by the near-field model for this path are presented in Table D-3. An effective porosity value of 0.225 was used for the thick-bedded unit and an effective porosity value of 0.35 for the slack-water sequence. 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 2.26 years and 141 meters per year and 3.07 years and 104 meters per year, respectively.

Table D-3. Average Linear Velocity for Flow Path Originating at the Process Building

Distance Along Flow Path (m)	Average Linear Velocity (m/y)	
	Slack-water Sequence	**Thick-bedded Unit**
0 to 40	107.4	78.6
40 to 80	117.7	86.6
80 to 120	127.9	96.5
120 to 160	139.8	102.5
160 to 200	150.4	110.3
200 to 240	161.5	118.4
240 to 280	174.9	128.5
280 to 320	191.8	140.9

NOTE: To convert meters per year to feet per year, multiply by 3.2803.

1.4.3 Modeling Conditions Following Phase 1 of the Decommissioning

The near-field groundwater flow model developed to assess current groundwater flow conditions was used to evaluate groundwater flow following the installation of the Phase 1 hydraulic barriers and WMA 1 French drain. The WMA 1 and WMA 2 slurry walls are modeled as one-meter thick extending downward to the unweathered Lavery till with a hydraulic conductivity of 1.0 E-06 cm/s. The WMA 1 hydraulic barrier wall downgradient of the Process

Building is oriented parallel to the groundwater elevation contours and perpendicular to groundwater flow as shown in Figure D-9. The segment of barrier wall between the Process Building and the Waste Tank Farm has been modeled parallel to groundwater flow due to the model constraints. The French drain for WMA 1 was modeled as one-meter thick with a depth of three meters and a hydraulic conductivity of 10 cm/s.

The cross-sectional structure of the aquifer is that represented in Figures D-4, D-5, D-6, D-7, and D-8 with the same vertical discretization as the current conditions case.

Figure D-9 shows the distribution of hydraulic heads predicted following completion of Phase 1 of the decommissioning. The results indicate an overall increase of approximately four feet in water table elevation across the large backfilled WMA 1 and WMA 2 excavations formerly occupied by the Process Building and the lagoons, respectively.

The higher groundwater elevations in the backfilled WMA 1 excavation suggest that groundwater would flow through the WMA 1 slurry wall to the northwest, towards the Waste Tank Farm, and to the northeast, towards the non-source area of the north plateau groundwater plume. However, a significant volume of this flow would be diverted by the French drain and discharged to Erdman Brook (Table D-4).

Groundwater elevations coincide with the bottom of the French drain near the WMA 1 barrier wall. Groundwater elevations on the downgradient side of the WMA 1 barrier wall are over 10 feet lower than on the upgradient side, resulting in a steep hydraulic gradient across the barrier wall and a shallower gradient along the non-source area of the north plateau groundwater plume.

Groundwater levels in the backfilled WMA 2 excavation are several feet higher than modeled in the current conditions scenario and would be below grade across the backfilled WMA 2 excavation. Groundwater elevations are up to 10 feet lower on the north plateau plume side of the WMA 2 barrier wall, suggesting groundwater flow to the northwest and northeast through the WMA 2 slurry wall towards the non-source area of the north plateau groundwater plume and to the southeast towards Erdman Brook.

Table D-4 summarizes the modeled flow balance. Table D-5 shows the average linear velocities predicted by the near-field model for conditions after Phase 1.

Table D-4. Summary of Sand and Gravel Unit Flow Balance After Phase 1(1)

Inflow		Outflow	
Location	**Rate (m^3/y)**	**Location**	**Rate (m^3/y)**
Ground Surface	107,624	Down to ULT	8,884
Bedrock leakage	7,304	Quarry Creek	8,659
		Erdman Brook (TBU)	14,881
		Erdman Brook (French drain)	21,700
		Frank's Creek	47,117
		North Plateau Ditch	13,664
Total	114,928		114,905

NOTE: (1) For a recharge rate of 26 centimeters per year.

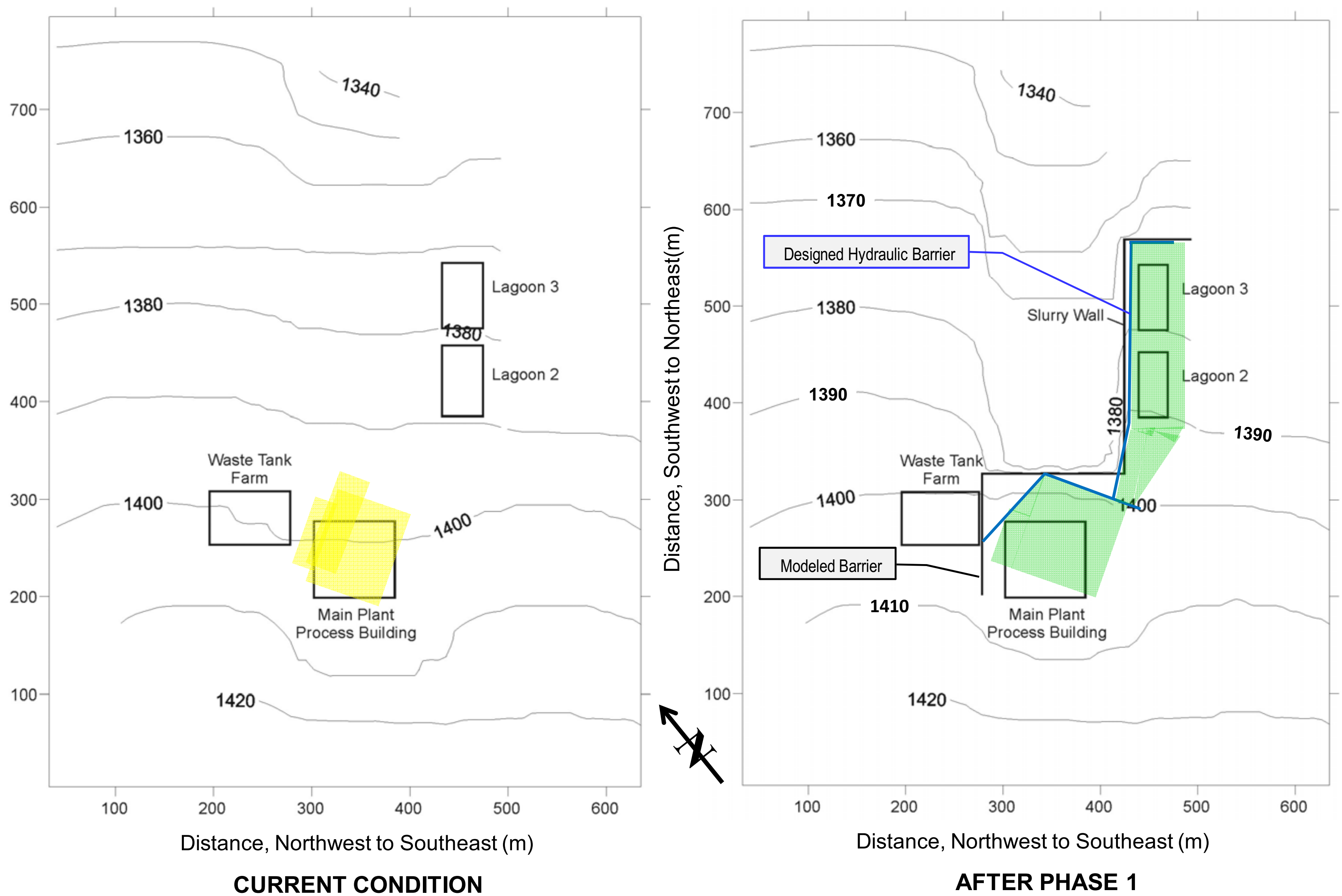

Figure D-9. Groundwater Flow Associated with the WMA 1 and WMA 2 Engineered Barriers

Table D-5. Average Linear Velocity for Flow Path Originating at the Process Building Area After Phase 1

Distance Along Flow Path (m)	Average Linear Velocity (m/y)	
	Slack-water Sequence	Thick-bedded Unit
0 to 40	89.5	65.9
40 to 80	84.6	67.8
80 to 120	13.1	1.9
120 to 160	45.3	1.8
160 to 200	73.5	2.0
200 to 240	99.0	7.6
240 to 280	115.4	88.2
280 to 320	133.3	119.0

NOTE: To convert meters per year to feet per year, multiply by 3.2803.

In calculation of linear velocities shown in Table D-5, the value of effective porosity of 0.35 was used for the slack-water sequence while the moisture content of the thick-bedded unit was used to reflect unsaturated conditions that develop along the flow path north of the location of the slurry wall. 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 6.37 years and 50 meters per year and 70 years and 4.6 meters per year, respectively.

1.4.4 Groundwater Modeling Predictions for Conditions Following Phase 1

The revised near-field groundwater model for the north plateau suggests that the engineered barriers to be installed during Phase 1 decommissioning would have the following effect on groundwater flow in the north plateau:

- Groundwater flow patterns upgradient of the WMA 1 barrier wall and French drain would be similar to current flow patterns in the sand and gravel unit shown in Figure D-9.
- Water table elevations in WMA 1 would be approximately 15 feet higher on the upgradient side of the WMA 1 barrier wall compared to water levels immediately downgradient of the wall.
- This steep hydraulic gradient suggests that groundwater would preferentially flow from the backfilled WMA 1 excavation across the barrier wall into the non-source area of the north plateau plume, rather than from the non-source area of the plume into the backfilled WMA 1 excavation.
- Higher groundwater elevations would also be found on the upgradient side of the barrier wall separating the WMA 1 excavation from the Waste Tank Farm, suggesting potential flow from WMA 1 into the Waste Tank Farm area.
- Flow contours southeast of the WMA 1 barrier wall suggest that groundwater would flow to the east into the area of the backfilled WMA 2 excavation, as discussed in Section 1.4.3 of this appendix.

- Downgradient of the WMA 1 barrier wall groundwater flow in the sand and gravel unit would continue to the northeast across the north plateau. However, the upgradient diversion of groundwater flow by the barrier wall system would result in an overall reduction in the hydraulic gradient of the non-source area of the north plateau groundwater plume.
- Groundwater elevations in the backfilled WMA 2 excavation are expected to be up to 10 feet higher than present in the non-source area of the north plateau groundwater plume.
- Higher groundwater elevations within the backfilled WMA 2 excavation suggests groundwater would flow across the WMA 2 barrier wall to the northwest and northeast toward the non-source area of the north plateau groundwater plume and also to the southeast toward Erdman Brook.

2.0 Post-Remediation Site Monitoring and Maintenance

This section describes the post-remediation site monitoring and maintenance program to be implemented by the DOE at the project premises following the completion of Phase 1 of the proposed decommissioning. The program would include monitoring and maintenance associated with engineered barriers installed within the project premises and monitoring of environmental media within and outside the project premises. This monitoring and maintenance program would continue until the start of Phase 2 of the decommissioning, when the program requirements would be re-evaluated. DOE concludes that this program would be adequate to control and maintain the project premises because it is similar to the successful program currently in use and because it appropriately addresses all facilities of importance.

2.1 Monitoring and Maintenance of Engineered Barriers and Systems

The performance of the engineered barriers installed at WMA 1 and WMA 2 during Phase 1 proposed decommissioning would be routinely monitored up to the start of Phase 2 of the decommissioning to ensure they function as designed. Systems and engineered barriers installed during work leading to the interim end state, such the Tank and Vault Drying System at WMA 3 and the geomembrane cover and slurry wall at WMA 7, would also be routinely monitored and maintained as part of the DOE monitoring and maintenance program. Corrective actions would be implemented to correct any observed defects or irregularities with these engineered barrier and systems.

2.1.1 North Plateau Subsurface Barrier Walls and French Drain

The monitoring and maintenance program would monitor the performance and condition of the subsurface hydraulic barriers installed at WMA 1 and WMA 2, and the French drain at WMA 1. This program would include routine inspections of these systems for signs of degradation or loss of performance.

Hydraulic Barrier Walls

Piezometers would be installed upgradient and downgradient of the permanent hydraulic barrier walls installed downgradient of the WMA 1 and northwest of the WMA 2 excavations (Figure D-10). These piezometers would be spaced at intervals at least equal to the maximum lateral spacing recommended by the U.S. Environmental Protection Agency (EPA 1998). Water levels in these piezometers would be routinely monitored to evaluate the performance of these hydraulic barriers. Groundwater would be sampled and analyzed semi-annually for the radiological indicator parameters (gross alpha, gross beta, tritium) and for Sr-90 to evaluate the effectiveness of the barrier walls in preventing recontamination of WMA 1 and WMA 2.

If groundwater monitoring suggests repairs to the walls are required, these repairs would be accomplished through grouting, consistent with past industry experience and practice (e.g., EPA 1998).

French Drain

Monitoring and maintenance activities associated with the French drain installed upgradient of the WMA 1 hydraulic barrier wall would include monitoring of groundwater levels in piezometers installed on the upgradient and downgradient sides of the French drain following installation.

The need for and extent of repairs to the French drain, if any, would be determined based on analysis of the groundwater level data, which would be evaluated to identify evidence for any localized defect(s) in the French drain.

2.1.2 Waste Tank Farm Tank and Vault Drying System

The Tank and Vault Drying System installed in WMA 3 during the work to establish the interim end state would be routinely monitored and maintained during the Phase 1 period to ensure its continued operation as designed. The major components of the system – such as the blowers, heaters, and dehumidifier units – would be inspected and repaired or replaced as necessary to ensure continued operation of the system.

2.1.3 Waste Tank Farm Dewatering Well

As specified in Section 7 of this plan, the existing dewatering well would continue to be used to artificially lower the water table to minimize in-leakage of groundwater into the tank vaults. The water from this well would be collected, sampled, treated if necessary using a portable wastewater treatment system, and released to Erdman Brook through a State Pollutant Discharge Elimination System-permitted outfall.

2.1.4 NRC-licensed Disposal Area Engineered Barriers

The geomembrane cover and the hydraulic barrier wall installed at the NDA during work to establish the interim end state would be routinely monitored and maintained throughout Phase

Geomembrane Cover

The geomembrane cover would be routinely inspected for signs of deterioration or damage to the membrane. The seams connecting the geomembrane panels would be inspected to evaluate their condition. The geomembrane cover would be repaired to remedy any defects or irregularities identified during these inspections.

Hydraulic Barrier Wall

A monitoring and maintenance program similar to that described for the barrier walls installed at WMA 1 and WMA 2 would be implemented for the hydraulic barrier wall installed upgradient of the NDA. Twenty-one piezometers were installed upgradient and downgradient of the barrier wall during its construction. Water levels in these piezometers would be routinely monitored during Phase 1 to evaluate the performance of the barrier wall in limiting groundwater flow into the NDA.

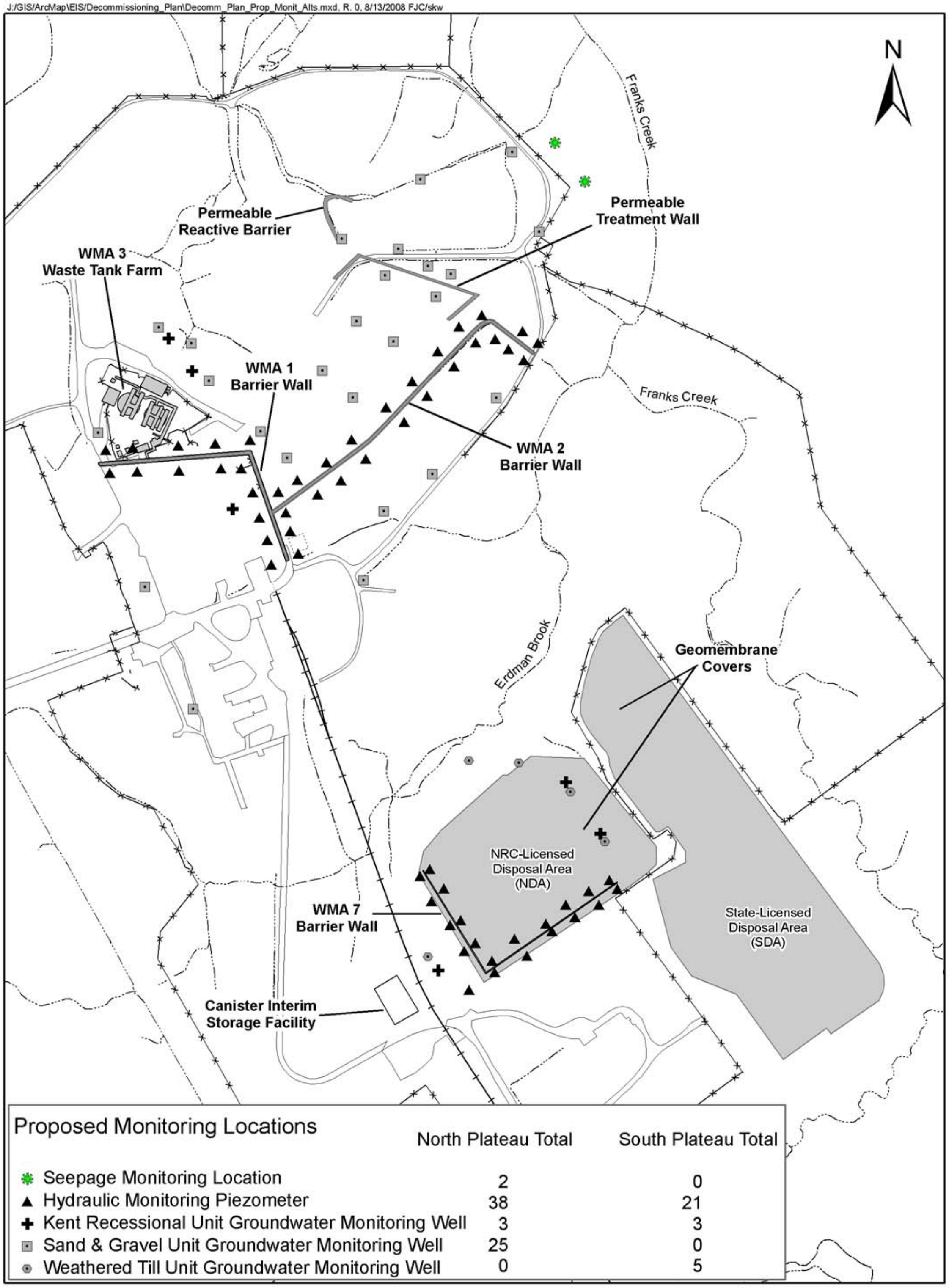

Figure D-10. Groundwater Monitoring Locations within the Project Premises during the Phase 1 Institutional Control Period

2.1.4 Security Features

The features important to security on the project premises and to security of the new Canister Interim Storage Facility during the period before Phase 2 of the decommissioning would be periodically inspected and maintained in good repair. These features include the security fences, signs, and security lighting described in Section 3.2 of this appendix.

2.2 Environmental Monitoring

The Phase 1 proposed decommissioning activities would include the removal of the following facilities:

- Above-ground and below-grade facilities in WMA 1 and the underlying source area of the north plateau groundwater plume within a single excavation down into the underlying Lavery till;
- Lagoons 1, 2, and 3, the Neutralization Pit, Interceptors, Solvent Dike, and surrounding contaminated soils in WMA 2 within a single excavation down into the underlying Lavery till; and
- Most remaining facilities and concrete slabs down to a maximum depth of two feet.

The following facilities and contamination areas within the project premises would not be considered during Phase 1 of the proposed decommissioning but would be addressed during Phase 2:

- The Waste Tank Farm in WMA 3, including the Permanent Ventilation System Building and the Supernatant Treatment System Support Building;
- The Construction Demolition Debris Landfill in WMA 4;
- The NDA in WMA 7; and
- The non-source area of the north plateau groundwater plume.

The DOE would implement an environmental monitoring program to monitor closed and remaining facilities and the non-source area of the north plateau groundwater plume as part of its management of the project premises during the Phase 1 institutional control period. Environmental monitoring would include onsite groundwater, storm water, and air monitoring, and both onsite and offsite surface water, sediment, and radiation monitoring as described below. Annual reports would be issued summarizing the monitoring results. These reports would include analyses of the data collected, along with conclusions about trends and compliance with regulatory limits.

2.2.1 Groundwater Monitoring Within the Project Premises

Groundwater within the project premises would be monitored during the Phase 1 institutional control period in accordance with the DOE WVDP Groundwater Monitoring Plan in effect at the time. Offsite groundwater monitoring would not be performed as this monitoring program was discontinued in 2007. The onsite grounding monitoring program for the project premises is described below and shown on Figure D-4. A total of 36 groundwater wells would be routinely monitored along with 59 piezometers.

WMA 1 - Process Building and Vitrification Facility Area

Groundwater in the sand and gravel unit in the backfilled WMA 1 excavation would be monitored using the network of piezometers installed to monitor the effectiveness of the hydraulic barrier wall and French drain described in Section 2.1.1 of this Appendix. A monitoring well screened in the sand and gravel unit would also be installed in the upgradient portion of the WMA 1 excavation to provide information on groundwater quality flowing into the backfilled excavation.

An additional monitoring well screened in the Kent Recessional Sequence would be installed immediately upgradient of the WMA 1 hydraulic barrier wall to monitor groundwater in this unit and to evaluate potential migration of groundwater from the source area of the north plateau groundwater plume that was removed during Phase 1 of the proposed decommissioning.

Groundwater from these piezometers and monitoring wells would be sampled semiannually for radiological indicator parameters (gross alpha, gross beta, and tritium) and for Sr-90 during the Phase 1 institutional control period.

WMA 2 - Low-Level Waste Treatment Facility Area

Groundwater in the sand and gravel unit in the backfilled WMA 2 excavation would be monitored using the network of piezometers installed to monitor the effectiveness of the hydraulic barrier wall and French drain described in Section 2.1.1 of this Appendix. Three monitoring wells screened in the sand and gravel unit would also be installed on the southeastern boundary of the WMA 2 excavation to provide information on groundwater flow and quality in this area.

Groundwater from these piezometers and monitoring wells would be sampled semiannually for radiological indicator parameters (gross alpha, gross beta, and tritium) and for Sr-90 during the Phase 1 institutional control period.

WMA 3 - Waste Tank Farm Area

Groundwater in the sand and gravel unit and the Kent Recessional Sequence would be routinely monitored at WMA 3 during the Phase 1 institutional control period. Four wells would be screened in the sand and gravel unit with one well upgradient and three wells downgradient of the Waste Tank Farm. Two wells screened in the Kent Recessional Sequence would be installed downgradient of the Waste Tank Farm.

Groundwater from these wells would be sampled semiannually for radiological indicator parameters (gross alpha, gross beta, and tritium) and for Sr-90 during the Phase 1 institutional control period.

WMA 4 - Construction Demolition Debris Landfill Area

Groundwater in the sand and gravel unit at WMA 4 would be routinely monitored at six locations, including four monitoring wells around the Construction and Demolition Debris Landfill, and at two groundwater seep locations along the edge of the north plateau outside of the WVDP fence line.

Groundwater at WMA 4 would be sampled semiannually for radiological indicator parameters (gross alpha, gross beta, and tritium) and for Sr-90.

WMA 6 - Central Project Premises

Groundwater in the sand and gravel unit at WMA 6 would be routinely monitored at two well locations, including one well upgradient of the rail spur and the other well downgradient of the rail spur and the removed Demineralizer Sludge Ponds and Equalization Basin.

Groundwater at these locations would be sampled semiannually for radiological indicator parameters (gross alpha, gross beta, and tritium).

WMA 7 – NDA

Groundwater in the weathered Lavery till and Kent recessional unit at WMA 7 would be routinely monitored by five wells screened in the weathered Lavery till and three wells screened in the Kent Recessional Sequence. One well cluster would be located upgradient of the NDA and would include a well screened in the weathered Lavery till and one screened in the Kent Recessional Sequence. Two well clusters, each with a well screened in the weathered Lavery till and Kent Recessional Sequence, would be located downgradient of the burial area. The two remaining wells screened in the weathered Lavery till would be located downgradient of the burial area.

Groundwater at WMA 7 would be sampled semiannually for radiological indicator parameters (gross alpha, gross beta, and tritium) and annually for specific radionuclides (Cs-137, Sr-90, Am-241, and Pu isotopes).

Non-Source Area of the North Plateau Plume

Groundwater in the sand and gravel unit would be routinely monitored at 11 well locations within the non-source area of the north plateau groundwater plume. These wells are located along the length of the plume from the WMA 1 barrier wall to the Construction and Demolition Debris Landfill in WMA 4. Three wells are located downgradient of the Permeable Treatment Wall to evaluate its effectiveness in reducing Sr-90 concentrations in groundwater from the sand and gravel unit.

Groundwater in the non-source area of the north plateau groundwater plume would be sampled semiannually for radiological indicator parameters (gross alpha, gross beta, and tritium) and for Sr-90.

2.2.2 Surface Water, Sediment, and Storm Water Monitoring

Surface water and associated stream sediments would be routinely monitored both within and outside the project premises during the Phase 1 institutional control period. The proposed monitoring locations are currently part of the DOE WVDP annual environmental monitoring program. These locations have been uniquely sited to monitor surface water releases from the WVDP and the Center. Several of the locations have been actively monitored since the implementation of the program in 1982 providing a significant historical record of surface waters leaving the WVDP and the Center.

Eight surface water-sampling locations within the project premises would be routinely monitored during the Phase 1 institutional control period (Figure D-11). These locations monitor streams both within (WNDNKEL, WNSP005, WNNDADR, WNFRC67, WNERB53) and leaving the project premises (WNSW74A, WNSWAMP, and WNSP006). Sediment samples would be collected from three locations where surface waters leave the project premises (SNSW74A, SNSWAMP, and SNSP006).

Surface water would be routinely collected and analyzed from three sampling locations outside of the project premises (Figure D-12). These locations would monitor surface water quality in Buttermilk Creek and Cattaraugus Creek where these streams leave the Center (WFFELBR, WFBCTCB) and where Buttermilk Creek enters the Center (WFBCBKG). Sediment samples would be collected from all three off-site locations (SFBCSED, SFTCSED, SFCCSED).

Surface water and sediment samples would be collected from these locations semi-annually and would be analyzed for radiological indicator parameters (gross alpha, gross beta, and tritium).

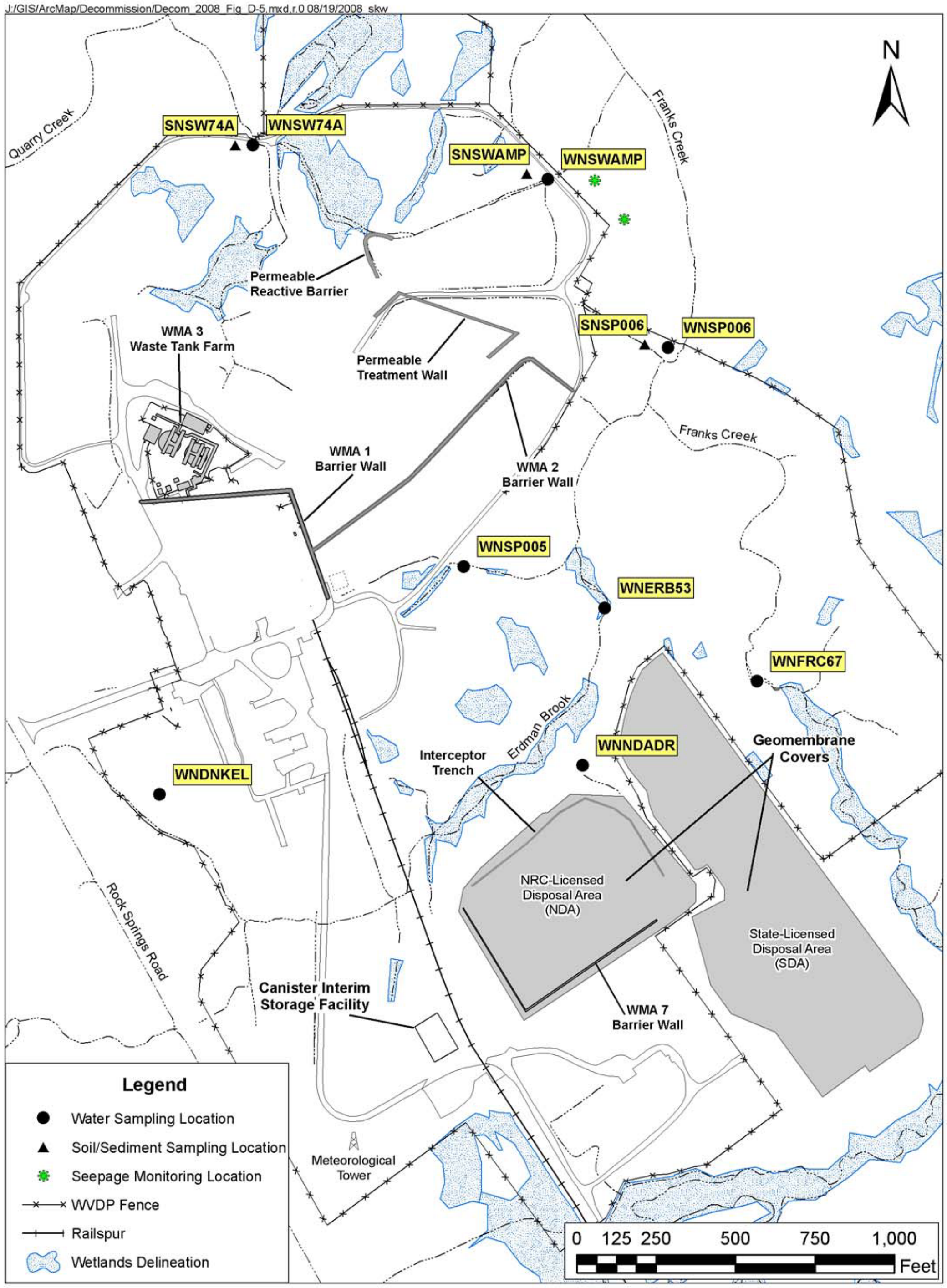

Figure D-11. Surface Water and Sediment Sampling Locations on the Project Premises during the Phase 1 Institutional Control Period

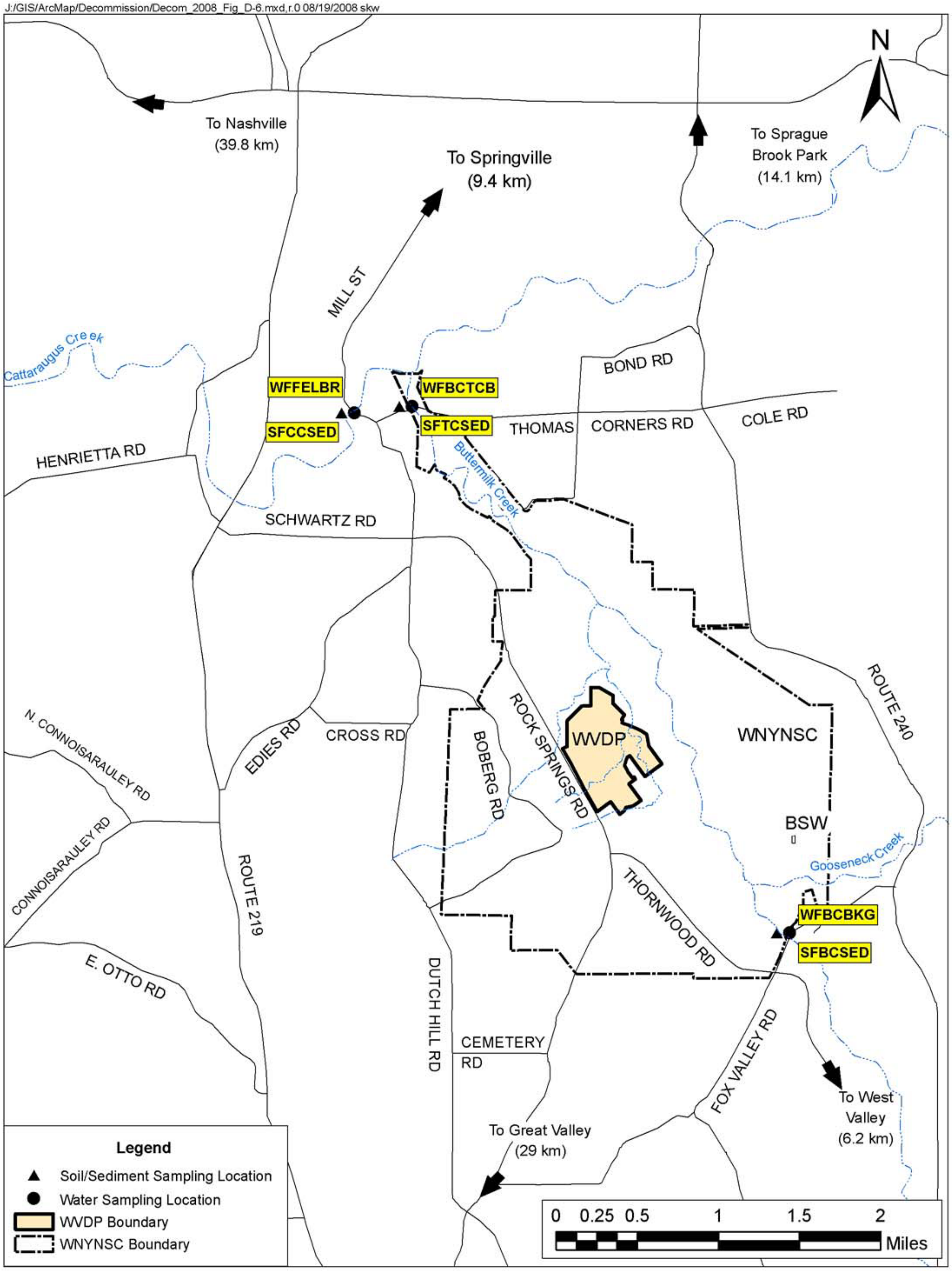

Figure D-12 – Offsite Surface Water and Sediment Sampling Locations during the Phase 1 Institutional Control Period

The New York State Pollutant Discharge Elimination System permit issued to the DOE WVDP requires periodic sampling from storm water outfalls located within the project premises. Sampling from these outfalls during storm events is designed to assess specific chemicals in storm water discharges that may originate from industrial or construction activity runoff from locations within the project premises. The planned storm water sampling locations are identified on Figure D-13. Sampling would be performed semi-annually for the non-radiological parameters specified in the New York State Pollutant Discharge Elimination System permit.

2.2.3 Air Monitoring

The stack discharge from the Permanent Ventilation System Building in the Waste Tank Farm in WMA 3 would be the only air monitoring location to be routinely monitored within and outside of the project premises during the Phase 1 institutional control period (Figure D-14).

The Permanent Ventilation System ventilates the Supernatant Treatment System Valve Aisle and Tanks 8D-1, 8D-2, 8D-3, and 8D-4 in WMA 3. The air discharged from these facilities passes though high-efficiency particulate air filters before discharge through the Permanent Ventilation System Building stack. Air discharged from the Tank and Vault Drying System would also be treated in the Permanent Ventilation System Building.

Air discharges from this location would be analyzed for radiological indicator parameters (gross alpha, gross beta, and tritium) and specific radionuclides (Cs-137, Sr-90, I-129, Am-241, and U and Pu isotopes).

2.2.4 Direct Radiation Monitoring

Direct radiation monitoring using thermoluminescent dosimeters would be performed at 19 locations within and outside of the project premises. These monitoring locations are currently part of the DOE WVDP annual environmental monitoring program and were sited to monitor both on-site and off-site radiation exposure from facilities within the project premises and the State-Licensed Disposal Area. Several of these locations have been actively monitored since 1982.

Eight monitoring locations would be within the project premises (Figure D-15) and eleven stations would be located on the perimeter of the Center (Figure D-16). All locations would be routinely monitored for gamma radiation exposure on a quarterly monitoring schedule.

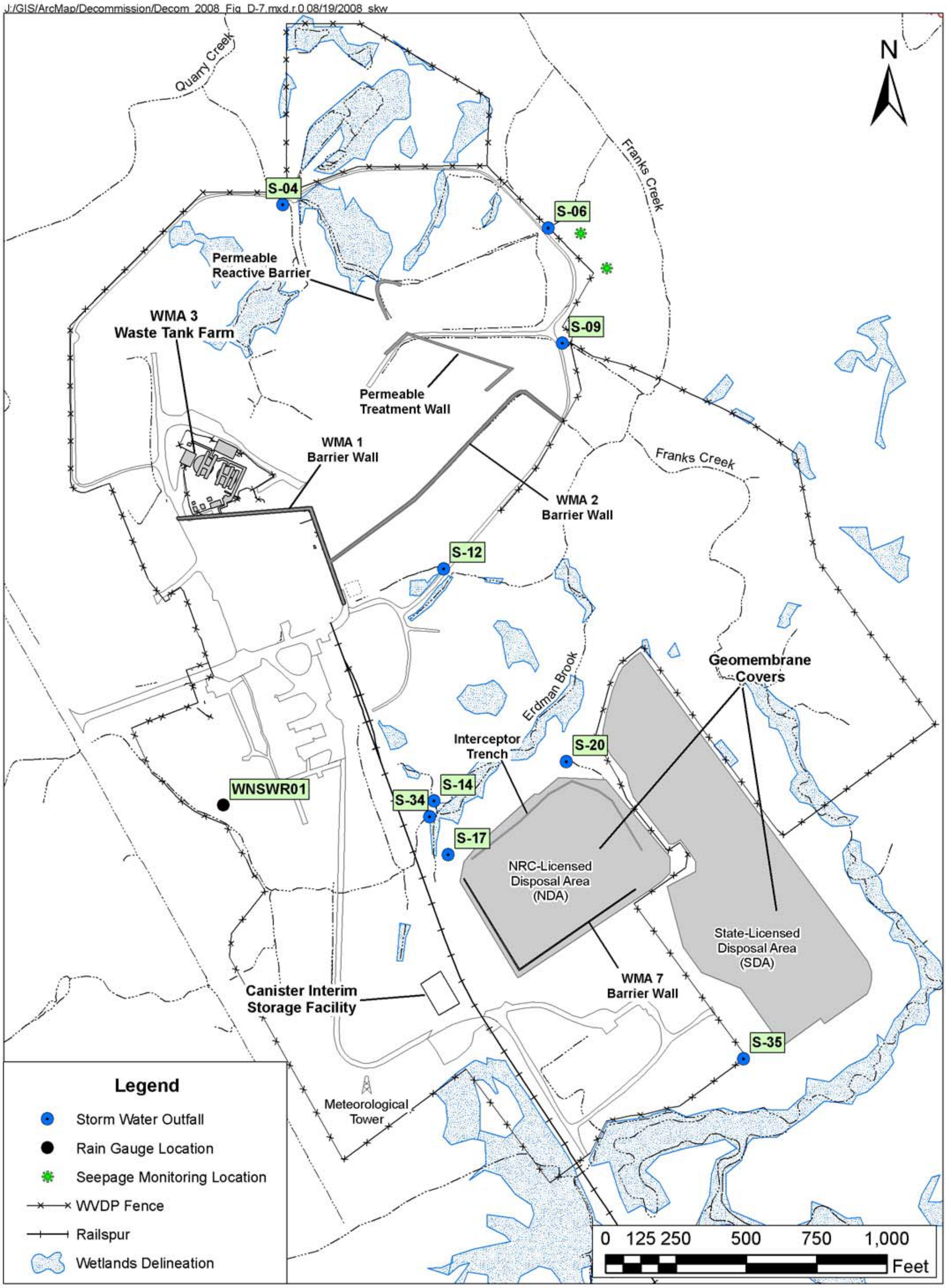

Figure D-13. Storm Water Sampling Locations on the Project Premises during the Phase 1 Institutional Control Period

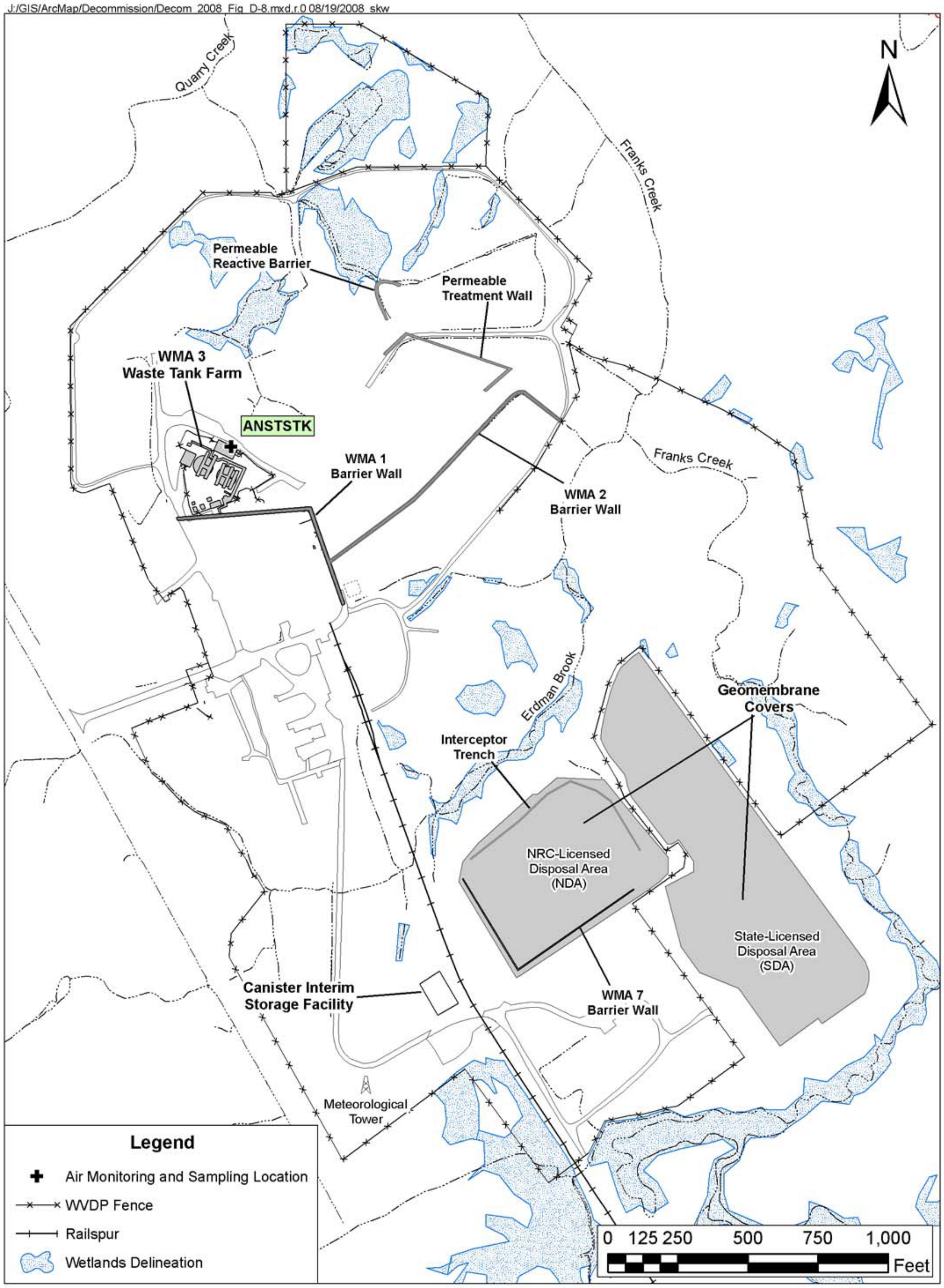

Figure D-14. Air Monitoring Locations on the Project Premises during the Phase 1 Institutional Control Period

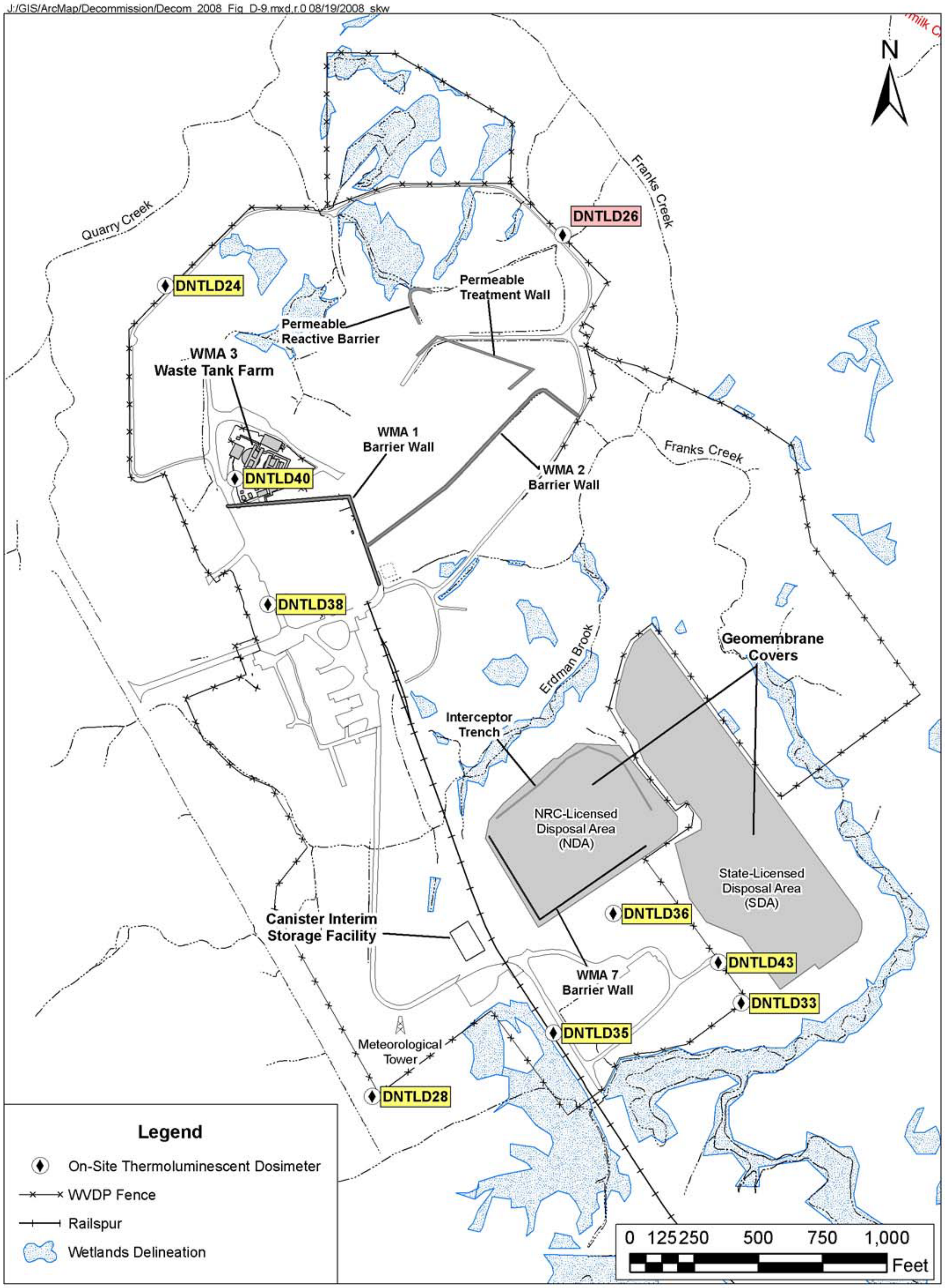

Figure D-15 – Direct Radiation Monitoring Locations on the Project Premises during the Phase 1 Institutional Control Period

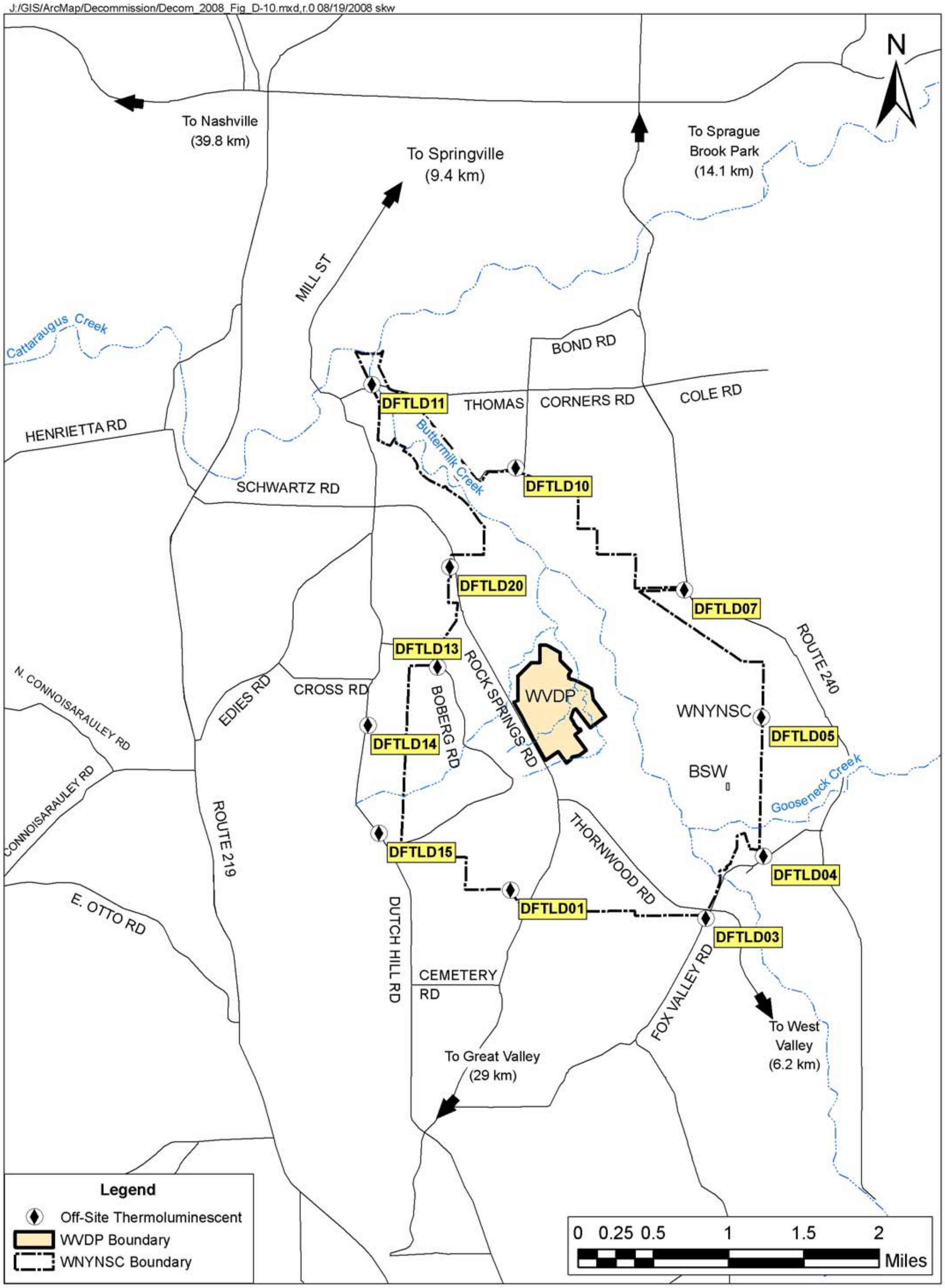

Figure D-16. Offsite Direct Radiation Monitoring Locations during the Phase 1 Institutional Control Period

3.0 Phase 1 Institutional Control Program

This section describes the institutional control program that would be implemented for the project premises following the completion of the Phase 1 remedial activities.

3.1 Government Control of the Project Premises

NYSERDA is the current owner of the project premises property and would remain owner following Phase 1 activities. As stipulated in the Cooperative Agreement with NYSERDA, DOE shall remain in exclusive use and possession of the project premises and project facilities throughout the remainder of the project term (DOE and NYSERDA 1981). DOE would therefore continue control of the project premises during the implementation of the Phase 1 proposed decommissioning activities and during the Phase 1 institutional control period. In this capacity, DOE carries the full authority of the federal government in enforcing institutional controls over the project premises.

DOE would be responsible for operating and maintaining facilities within the project premises such as the Waste Tank Farm, the NDA, and the non-source area of the north plateau groundwater plume in a safe manner. DOE would continue to implement the environmental radiation protection program for the project premises as required by DOE Order 5400.5*, Radiation Protection of the Public and the Environment*. NRC would also be involved in a regulatory oversight capacity over the project premises, which would remain under NRC license.

3.2 Institutional Control Design Features

The institutional control program for the project premises would prevent its unacceptable use and protect against inadvertent intrusion into the site. DOE in its capacity as the steward of the site would ensure that institutional controls are maintained at the project premises during Phase 1 proposed decommissioning and during the Phase 1 institutional control period. These institutional controls would include:

- Security fencing and signage along the perimeter of the project premises to prevent inadvertent intrusion into the site and to notify individuals that access is forbidden without permission from the DOE,
- A full time security force to prevent unauthorized access into the project premises,
- Authorized personnel and vehicle access into the project premises would be limited to designated gateways through the perimeter security fence
- The environmental monitoring program implemented at the project premises during the Phase 1 institutional control period would ensure that operations at the site protect members of the public and the environment from radiation risk.

Additional institutional controls would be provided for the new Canister Interim Storage Facility on the south plateau. These would include measures such as security fencing around the area and appropriate security lighting.

4.0 References

Code of Federal Regulations and Federal Register Notices

10 CFR 20 Subpart E, *Radiological Criteria for License Termination*.

67 FR 22, *Decommissioning Criteria for the West valley Demonstration Project (M-32) at the West Valley Site; Final Policy Statement*, U.S. Nuclear Regulatory Commission, Washington, D.C., February 1, 2002.

DOE Orders

DOE Order 5400.5, Change 2, *Radiation Protection of the Public and the Environment*. U.S. Department of Energy, Washington, D.C., January 7, 1993.

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URS 2000, *Evaluation of Stability of Proposed WMA1&3/WMA7 Slurry Walls Under Hypothetical Seismically-induced Horizontal Acceleration of 0.2g*, Calculation BUF-2000-069, Rev. 0. URS Corp., Orchard Park, New York, July 17, 2000.