GROUNDWATER PROTECTION PROGRAM

Groundwater Monitoring Program Overview

Groundwater monitoring at the West Valley Demonstration Project (WVDP or Project) complies with all applicable state and federal regulations and meets the requirements of United States (U.S.) Department of Energy (DOE) Order 450.1. Groundwater monitoring data are used by site managers to determine baseline groundwater conditions, facilitate early detection of existing and potential groundwater contamination sources, provide surveillance of these sources, and provide information for decision-making.

The WVDP's groundwater monitoring program is outlined in the "Groundwater Monitoring Plan" (GMP), which discusses groundwater characterization, the current groundwater sampling agenda, and compliance with long-term monitoring requirements under DOE Orders and the Resource Conservation and Recovery Act (RCRA) §3008(h) Administrative Order on Consent (Consent Order). The "WVDP Groundwater Protection Management Program Plan" documents the Project's approach to the protection of groundwater from on-site activities.

Site groundwater is not used for drinking or operational purposes, nor is effluent discharged directly to groundwater. The majority of the site groundwater eventually flows to Cattaraugus Creek and then to Lake Erie. Surveys have determined that no public water supplies are drawn from Cattaraugus Creek, downstream of the WVDP. Upgradient of the site, groundwater is used as a public and private drinking water supply by local residents.

Surface Water Hydrology

The 167-acre (68-hectare [ha]) Project is located within the Western New York Nuclear Service Center (WNYNSC), which comprises approximately 3,338 acres (1,351 ha) and is located at the northern border of Cattaraugus County. The WNYNSC lies within the watershed of Cattaraugus Creek, which flows northwestward to Lake Erie. Buttermilk Creek, a tributary of Cattaraugus Creek, drains the WNYNSC.

The WVDP is drained by Quarry Creek, Erdman Brook, and Franks Creek, which flow into Buttermilk Creek. (See Figs. A-1 and A-5 in Appendix A.) Erdman Brook bisects the WVDP into the north and south plateaus. The main plant, waste tanks, and lagoons are located on the north plateau. The drum cell, the U.S. Nuclear Regulatory Commission (NRC)-Licensed Disposal Area (NDA), and the New York State-Licensed Disposal Area (SDA) are located on the south plateau.

Geology

The WNYNSC is situated upon a layered sequence of glacial-age sediments that fill a steep-sided bedrock valley that is composed of interbedded shales and siltstones (Rickard, 1975).

The glacial sediments overlying the bedrock consist of a sequence of three glacial tills of Lavery, Kent, and possibly Olean age. The tills are separated by stratified fluvio-lacustrine deposits (silty or silty/sandy lakebed sediments). On the Project's north plateau, the Lavery till is capped by coarse-grained alluvial-fluvial deposits (sandy/silty/gravelly streambed sediments). See Table 4-1 for the descriptions and the geographic distribution of these units.

Hydrogeology

The sediments above the Kent till – the Kent recessional sequence, the weathered and unweathered Lavery till, the intra-Lavery till-sand, and the alluvial sand and gravel – are generally regarded as containing all of the potential routes for contaminant migration from the Project via groundwater. (See Fig. 4-1.) The Kent till has a relatively low permeability and does not provide a pathway for contaminant movement from the WVDP; therefore, it is not discussed here.

Hydrologic conditions of the site are more fully described in "Environmental Information Document, Volume III: Hydrology, Part 4" (West Valley Nuclear Services Co. [WVNSCO], March 1996) and in the "RCRA Facility Investigation Report (RFI) Vol. 1: Introduction and General Site Overview" (WVNSCO and Dames & Moore, July 1997).

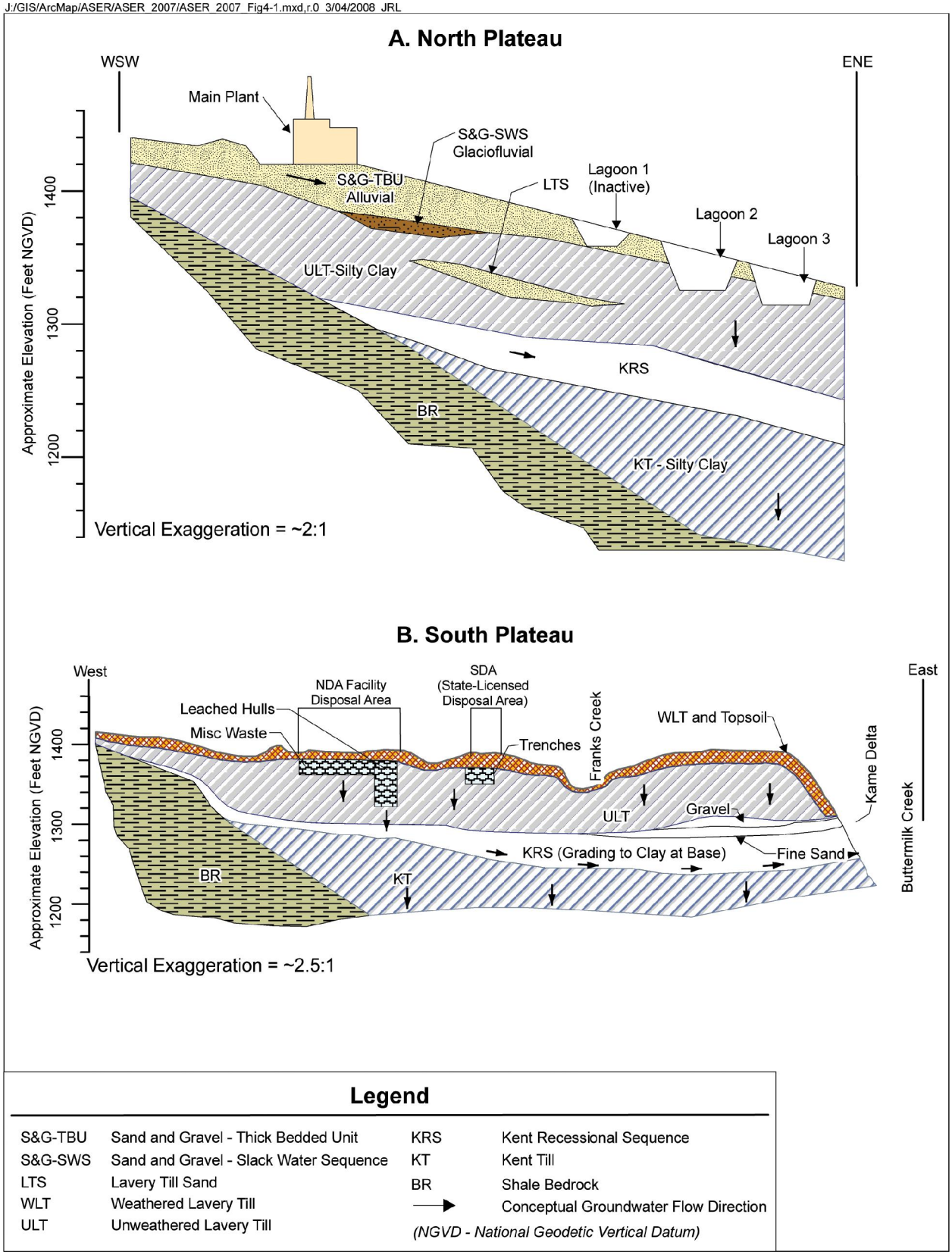
TABLE 4-1
Summary of Hydrogeology at the WVDP

Geologic Unit	*Description*	*Groundwater Flow Characteristics*	*Hydraulic Conductivity* [a]	*Location*
Sand and Gravel; Thick-Bedded Unit	Silty sand and gravel layer composed of younger Holocene alluvial deposits	Flow is generally northeast across the plateau toward Franks Creek, with groundwater near the northwestern and southeastern margins flowing radially outward toward Quarry Creek and Erdman Brook	9.2 ft/day (3.2E-03 cm/sec) or 110 in/day	North plateau
Sand and Gravel; Slackwater Sequence	Interbedded silty sand and gravel layers composed of Pleistocene-age glaciofluvial deposits separated from the sand and gravel thick-bedded unit by a discontinuous clay interval	Flow is to the northeast along gravel layers toward Franks Creek	21.0 ft/day (7E-03 cm/sec) or 2502 in/day	Underlies a portion of the north plateau
Weathered Lavery Till	Upper zone of the Lavery till which has been exposed at the ground surface; weathered and fractured to a depth of 3–16 ft (0.9–4.9 m); brown in color due to oxidation; contains numerous desiccation cracks and root tubes	Flow has both horizontal and vertical components allowing groundwater to move laterally across the south plateau before moving downward into the unweathered lavery till or discharging to nearby incised stream channels	5E-02 ft/day (2E-05 cm/sec) or 0.6 in/day; the highest conductivities are associated with dense fracture zones found within the upper 7 ft (2 m) of the unit	South plateau
Unweathered Lavery Till	Olive gray silty clay with intermittent lenses of silt and sand; ranges up to 130 ft (40 meters) in thickness	Flow is vertically downward at a relatively slow rate; unit is considered an aquatard	2E-03 ft/day (6.4E-07 cm/sec) or 0.02 in/day	Underlies both the north and south plateaus
Lavery Till Sand	Thin, sandy unit of limited areal extent and variable thickness within the Lavery till.	Flow is to the east-southeast toward Erdman Brook	0.26 ft/day (9E-05 cm/sec) or 3 inches/day	Primarily beneath the southeastern portion of the north plateau
Kent Recessional Sequence	Interbedded clay and silty clay layers locally overlain by coarser-grained sands and gravels; pinches out near the east side of Rock Springs Road	Flow is to the northeast; recharge from the overlying till and from bedrock to the southwest; discharges into Buttermilk Creek	1.3E-02 ft/day (4.5-06 cm/sec) or 0.15 in/day	Underlies most of the Project, except areas adjacent to Rock Springs Road

[a] Hydraulic conductivities represent an average of testing results from 1991 through 2007.

FIGURE 4-1
Geologic Cross Sections of the North and South Plateaus at the WVDP

J:/GIS/ArcMap/ASER/ASER_2007/ASER_2007_Fig4-1.mxd,r.0 3/04/2008 JRL



Routine Groundwater Monitoring Program (GMP)

Groundwater Monitoring Program Highlights 1982 Through 2007. Program content is dictated by regulatory requirements in conjunction with current operating practices and historical knowledge of previous site activities.

- Groundwater monitoring at the WVDP began in 1982 and continued to expand through 1992 with the addition of new wells, groundwater seep locations, a french drain outfall, and the NDA interceptor trench sump.

- In 1993, monitoring results indicated elevated gross beta activity in groundwater from the sand and gravel unit on the north plateau. Subsequent investigation of this area delineated a plume of contamination with a southwest to northeast orientation. (See "Groundwater Sampling Observations on the North Plateau" and Figure 4-2 in this chapter for more detail.)

- An RFI expanded characterization program was conducted during 1993 and 1994 to fully assess potential releases of hazardous wastes or constituents from on-site solid waste management units (SWMUs). This investigation, which consisted of two rounds of sampling for a wide range of radiological and chemical parameters, provided valuable information regarding groundwater conditions near each SWMU. Evaluation of these results influenced monitoring program modifications.

- Long-term monitoring needs were the focus of a 1995 groundwater monitoring program evaluation. After a comprehensive assessment, the number of sampling locations was reduced from 91 to 65 and analytical parameters were tailored to each sampling location for a more focused, efficient, and cost-effective program.

- In 1996, several groundwater seep monitoring locations on the northeast edge of the north plateau were added to the monitoring program and the french drain outfall was deleted for groundwater purposes. Five seep locations continue to be monitored.

- Four new groundwater monitoring wells were installed during August 2003 to provide upgradient and downgradient monitoring coverage for the remote-handled waste facility.

- Reductions in analytes or sampling frequencies were implemented at 14 monitoring locations in early 2005.

- The GMP was reviewed in 2007 and recommendations were made to reduce some analytes and sampling frequency at 20 monitoring wells and to discontinue sampling at four wells. These changes were implemented in 2008.

Groundwater is routinely monitored in the six hydrogeologic units described in Table 4-1. (The two sub-units of the sand and gravel are frequently monitored as one unit since many sand and gravel well screens are placed across both units.) In 2007, a total of 69 on-site and one off-site groundwater monitoring locations were sampled. The on-site locations included 63 monitoring wells and well points, five groundwater seepage points, and one sump/manhole. The frequency of monitoring and the constituents measured are a function of regulatory requirements, as well as current operating practices and historical knowledge of previous site activities.

Monitoring Well Network. The WVDP groundwater monitoring network is a vital component of the Environment Protection Program implemented under DOE Order 450.1. Many of the wells were installed to monitor one or more SWMUs on the WVDP in accordance with the Consent Order. Table 4-2 lists the wells in the network, the super solid waste management units (SSWMUs), the geologic units, and the analytes measured in 2007. Table 4-3 defines the analyte groups. (See "RCRA §3008(h) Administrative Order on Consent" in the "Environmental Compliance Summary.") Tables 4-4 and 4-5 provide an overview of groundwater monitoring during 2007 organized by geographic area and by monitoring purpose.

Groundwater Elevation Monitoring. Potentiometric (water level) data are measured at the monitoring network wells in conjunction with the quarterly analytical sampling schedule. (See Figs. A-8 and A-9 in Appendix A.) Groundwater elevation data are used to produce potentiometric surface maps that delineate groundwater flow directions and gradients. Long-term trend graphs are used to illustrate variations in groundwater elevations over time, such as seasonal fluctuations.

Surface water elevations are also measured on the north plateau where the water table in the sand and gravel unit intersects the ground surface, resulting in standing water. These measurements supplement

TABLE 4-2
WVDP Groundwater Monitoring Network Sorted by Geologic Unit

Well ID	SSWMU	Gradient Position	Analytical Parameters in 2007	Well ID	SSWMU	Gradient Position	Analytical Parameters in 2007
Sand and Gravel Wells							
103[a]	1, 3	D	I, RI, V	801[a]	8, 6	U, D	I, RI, S, V
104	1	C	I, RI	802	8	D	I, RI, V
105	1	C	I, RI	803[a]	8	D	I, RI, SV, V
106	1	D	I, RI	804[a]	8	D	I, RI, V
111[a]	1	D	I, RI, M, S, SV, V	1302	NA[b]	D	I, RI, M, R, SV, V
116[a]	1, 8	C, U	I, RI, S, V	1304	NA[b]	U	I, RI, M, R, SV, V
201	2	U	I, RI	8603	8	U	I, RI, S
205	2, 3	D	I, RI	8604	1	C	I, RI
301[a]	3	B	I, RI	8605[a]	1, 2	D	I, RI, M, S, SV, V
302	3	U	I, RI	8607[a]	6, 4	U, D	I, RI, V
401[a]	4, 3	B	I, RI, R	8609[a]	3, 4, 6	D, D, U	I, RI, S, V
402	4	B	I, RI	8612[a]	8	D	I, RI, SV, V
403	4	U	I, RI	NB-1S	NA	B	I, RI
406[a]	4, 6	D, U	I, RI, R, V	WP-A	NA[c]	NA	I, RI
408[a]	4, 3	D	I, RI, R, V	WP-C	NA[c]	NA	I, RI
501[a]	5	U	I, RI, S, V	WP-H	NA[c]	NA	I, RI
502[a]	5	D	I, RI, S, SM, V	SP04	NA[d]	D	RI
602A	6	D	I, RI	SP06	NA[d]	D	RI
604	6	D	I, RI	SP11	NA[d]	D	I, RI
605	6	D	I, RI	SP12[a]	NA[d]	D	I, RI, V
706[a]	7	B	I, RI, M, R, SV, V	GSEEP[a]	NA[d]	D	I, RI, V
Lavery Till Sand Wells							
204[a]	2, 3	D	I, RI	208	2	D	I, RI
206	2	C	I, RI				
Weathered Lavery Till Wells							
906[a]	9	D	I, RI	1005[a]	9, 10	C, U	I, RI
908[a]	9	B	I, RI	1006[a]	9, 10	C, D	I, RI
909[a]	9	D	I, RI, M, R, SV, V	1007	10	D	I, RI
NDATR[a]	9	D	I, RI, M, R, SV, V	1008C[a]	9, 10	U	I, RI
Unweathered Lavery Till Wells							
107	1	D	I, RI, V	704	7	D	I, RI, V
108	1	D	I, RI, V	707	7	C	I, RI
110[a]	1	D	I, RI, V	910[a]	9	D	I, RI
405	4	B	I, RI, M, R, SV, V	1301	NA[b]	D	I, RI, M, R, SV, V
409	4	D	I, RI	1303	NA[b]	U	I, RI, M, R, SV, V
Kent Recessional Sequence Wells							
901[a]	4	B	I, RI	1008B	10	U	I, RI
902[a]	9	U	I, RI	8610[a]	9	D	I, RI
903[a]	9	D	I, RI	8611[a]	9	D	I, RI

Gradient Positions: B (background); C (crossgradient); D (downgradient); U (upgradient)
Analytical Parameters: I (Contamination Indicator Parameters); RI (Radiological Indicator Parameters); V (Volatile Organic Compounds); SV (Semivolatile Organic Compounds); M (Groundwater Metals); SM (Special Monitoring Parameters for early warning wells); R (Radioisotopic Analyses: alpha-, beta-, and gamma-emitters); and S (Strontium-90)

[a] Monitoring for certain parameters is required by the RCRA §3008(h) Consent Order.
[b] Monitor upgradient and downgradient of the remote-handled waste facility.
[c] Monitor north and east of the main plant.
[d] Monitor groundwater emanating from seeps along the edge of the north plateau.

TABLE 4-3
WVDP Groundwater Sampling and Analysis Agenda

Analyte Group	*Description of Parameters*
Contamination Indicator Parameters (I)	pH, specific conductance (field measurements)
Radiological Indicator Parameters (RI)	Gross alpha, gross beta, tritium
Volatile Organic Compounds (V)	6 NYCRR Part 373-2 Appendix 33 Volatile Organic Compounds (VOCs)
Semivolatile Organic Compounds (SV)	6 NYCRR Part 373-2 Appendix 33 Semivolatile Organic Compounds (SVOCs) and tributyl phosphate (TBP)
Groundwater metals (M)	6 NYCRR Part 373-2 Appendix 33 Metals
Special Monitoring Parameters for early warning wells (SM)	Aluminum, iron, manganese
Radioisotopic Analyses: alpha-, beta-, and gamma-emitter (R)	Carbon-14,strontium-90, technetium-99, iodine-129, cesium-137, radium-226, radium-228, uranium-232, uranium-233/234, uranium-235/236, uranium-238, total uranium.
Strontium-90 (S)	Strontium-90

TABLE 4-4
WVDP 2007 Groundwater Monitoring Overview by Geographic Area

Number of…	*Total WVDP*	*North Plateau*	*South Plateau*	*Off-Site Residential*
Monitoring Points Sampled - Analytical[a]	70	54	15	1
Monitoring Points - Water Elevations Only	48	32	16	0
Monitoring Events	5	4	4	1
Analyses	1,254	1,064	184	6
Results	10,314	8,929	1,372	13
Percent of Nondetectable Results	86%	86%	86%	62%
Water Elevation Measurements	437	312	125	0

[a] Total number includes 69 on-site monitoring points and one off-site monitoring point.

TABLE 4-5
WVDP 2007 Groundwater Monitoring Overview by Purpose

Number of…	*Regulatory/ Waste Management*	*Environmental Surveillance*
Monitoring Points Sampled - Analytical[a]	34	36
Monitoring Points - Water Elevations Only	0	48
Monitoring Events	4	5
Analyses	681	573
Results	5,867	4,447
Percent of Nondetectable Results	86%	86%
Water Elevation Measurements	128	309

[a] Total number includes 69 on-site monitoring points and one off-site monitoring point.

TABLE 4-6
Maximum Concentrations of Radiological Parameters in WVDP Wells During 2007

Radionuclide	*Regulatory/Waste Management*		*Environmental Surveillance*	
	Well ID	*Maximun Concentration (µCi/mL)*	*Well ID*	*Maximun Concentration (µCi/mL)*
Gross Beta	Well 408	3.85E-04	Well 104	1.10E-04
Strontium-90	Well 408	1.51E-04	Well 8603	4.09E-05
Tritium	WNNDATR	3.46E-06	WP-C	3.08E-05

groundwater elevations measured at nearby monitoring wells to provide data in areas where monitoring well coverage is sparse or nonexistent.

Analytical Trigger Level Evaluation. A computerized data-screening program uses "trigger levels" – preset conservative values for chemical and radiological concentrations and groundwater elevation measurements – to promptly identify anomalies in monitoring results that may require further investigation. The trigger levels are based on regulatory limits, detection limits, or statistically derived values.

Groundwater Sampling Observations on the North Plateau

The routine GMP network in the sand and gravel unit on the north plateau includes 32 monitoring wells, three well points, and five groundwater seepage locations. A discussion of the significant groundwater quality observations on the north plateau follows.

Gross Beta and the Strontium-90 Plume. In the early 1990s, elevated gross beta activity was detected in groundwater of the sand and gravel unit northeast of the building where Nuclear Fuel Services, Inc. reprocessed nuclear fuel (the "Main Plant" on Fig. 4-2). In 1993, elevated gross beta concentrations were detected in surface water near the northeastern edge of the north plateau. Extensive subsurface investigations characterized the plume, which extends from beneath the main plant process building (MPPB) to the northeast quadrant of the north plateau. Strontium-90 and its daughter product, yttrium-90, were identified as the major isotopic components of the gross beta activity (WVNSCO, 1995). The presumed source of the strontium-90 activity can be traced to soils beneath the southwest corner of the MPPB.

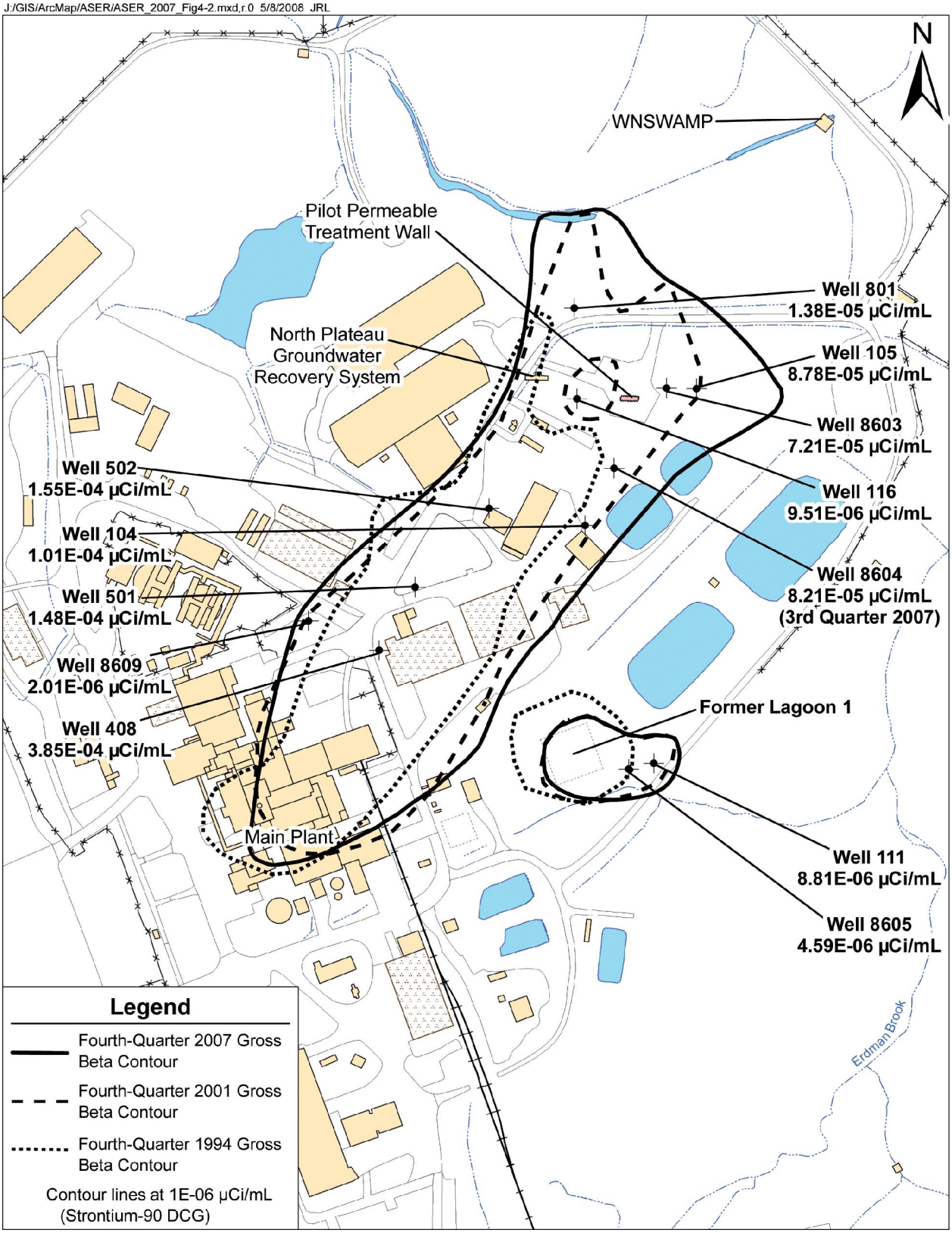
Gross beta activity was also detected in the area of former lagoon 1, which was backfilled in 1984. The source of this gross beta activity was presumed to be radiologically contaminated materials remaining within former lagoon 1. Two wells (8605 and 111) located downgradient of former lagoon 1 continue to exhibit elevated gross beta concentrations.

At the WVDP, DOE derived concentration guides (DCGs) may be used as a reference for evaluating liquid radionuclide effluents. Because there is no DCG for gross beta in liquid effluents, the strontium-90 DCG (1E-06 µCi/mL) is used as a conservative basis for comparison where beta-emitting radionuclides are detected in groundwater at the WVDP. For the purpose of the following discussions, the strontium-90 DCG is used interchangeably for comparisons with either gross beta or strontium-90. (See the "Useful Information" section at the end of this report for a discussion of the DOE DCGs, and Table UI-4 for a listing of the DCGs for all radionuclides of interest at the WVDP.)

Gross beta activity in groundwater within and around the north plateau plume continues to be monitored closely. Groundwater wells immediately downgradient of the MPPB, in the center of the plume, exhibited the highest gross beta and strontium-90 concentrations reported in the GMP monitoring wells in 2007. The maximum concentrations of gross beta and strontium-90 measured from groundwater wells in CY 2007 are listed in Table 4-6. Ten monitoring wells within the plume exhibited gross beta concentrations above the strontium-90 DCG in 2007. In the spring of 2008, an additional monitoring well (well 106) on the leading edge of the plume, also exceeded the DCG for strontium-90.

Figure 4-2 shows the fourth-quarter 2007 gross beta results from wells within the plume, and plots the outline of the plume where gross beta concentrations in groundwater exceeded the strontium-90 DCG in 1994, 2001, and 2007. A lengthening and shifting of the plume to the northeast over time is shown, indicating migration of the plume in the direction of

FIGURE 4-2
North Plateau Gross Beta Plume: Fourth-Quarter 1994, 2001, and 2007



groundwater flow. (See "Near-Term and Long-Term Plume Management Activities" later in this chapter.)

Groundwater is also monitored along the northeast edge of the north plateau where groundwater seeps from the steep banks of the stream channels incised by Erdman Brook and Franks Creek. (See Figs. A-2 and A-8 in Appendix A.) Gross beta concentrations from seep monitoring locations SP06, SP12, and GSEEP were close to or within background levels during 2007. However, gross beta concentrations at SP11 have increased from near background in 1999 to more than 1E-07 µCi/mL in 2007. The gross beta activity at SP11 is believed to be attributable to re-infiltration of contaminated water that has surfaced from the groundwater plume upgradient of this location. Gross beta concentrations in SP04 increased to approximately twice background in 2007. These levels of gross beta activity remain below the DOE DCG for strontium-90 of 1E-06 microcuries per milliliter (µCi/mL).

Gross beta results from the locations shown in Figure 4-2 are discussed below and gross beta trends over the last 10 years are displayed in Figures 4-3 through 4-5. These graphs are displayed on a log scale where an increase from one y-axis scale division to the next represents a 10-fold increase in concentration.

Figure 4-3 shows gross beta concentrations in wells 104, 408, 501, 502, and 8609 compared with site background concentrations. These wells are centrally located on the north plateau within the main portion of the plume. As in previous years, groundwater from well 408 continues to exhibit the highest gross beta concentrations of all GMP monitoring wells in the plume. Gross beta concentrations in well 408 and wells 104, 501, and 502 increased in 2007 as compared to 2006, after exhibiting steady or decreasing concentrations from 2002 through 2005. The gross beta concentrations measured in well 8609 during 2007 remained consistent with the concentrations reported in 2006.

Figure 4-4 shows gross beta concentrations in wells 105, 116, 801, 8603, and 8604 compared with site background concentrations. These wells are located further northeast than the preceeding group of wells and are further downgradient from the plume's presumed source beneath the MPPB. Figure 4-4 shows that concentrations are increasing in all five wells, indicating that downgradient plume migration continued in 2007. As in the past, groundwater from well 105, on the leading edge of the eastern lobe of the plume, showed the largest overall increase in concentrations from 1998 through 2007.

Figure 4-5 shows gross beta concentrations at wells 111 and 8605, located downgradient of former lagoon 1, compared with site background concentrations. Average concentrations at these two wells have remained relatively steady over time. Gross beta concentrations in well 111 during 2007 were very similar to those in 2006 and concentrations in well 8605 decreased slightly.

Northeast Swamp Drainage Monitoring. Routine radiological sampling continued during 2007 at surface water location WNSWAMP (on the WVDP premises). While gross beta and strontium-90 concentrations continued to fluctuate due to seasonal effects, the annualized average concentration of strontium-90 at this location remained above the DOE DCG throughout 2007. The main source of the elevated strontium-90 is believed to be groundwater from the north plateau plume seeping into the ditch upstream of WNSWAMP. (See Figures 4-2 and 4-6 in this Chapter and Figure A-2 in Appendix A.) An estimated 58 million gallons (219 million L) of water flowed through this monitoring point during 2007.

Monitoring downstream at the first point of public access in Cattaraugus Creek (at Felton Bridge [location code WFFELBR]) continued to show that gross beta concentrations were only slightly higher than those at the Cattaraugus Creek background location (at Bigelow Bridge [WFBIGBR]). (See also "Effluent Monitoring" in Chapter 2.)

Tritium. Residual tritium activity on the WVDP north plateau from previous activities on site during the period of fuel reprocessing operations has decreased as a result of radiological decay, as well as dilution from groundwater recharge and surface water infiltration. Current concentrations are close to or within the background range across most of the north plateau. Tritium concentrations in the seeps along the northeast edge of the north plateau are slightly higher than levels in background wells of the sand and gravel unit, but are still far below the DOE DCG for tritium of 2.0E-03 µCi/mL.

Small isolated areas of higher tritium concentrations still exist adjacent to or downgradient of the lagoon system and adjacent to the hardstand and lag storage areas. Well point WP-C is located in the center of the north plateau downgradient of the main plant, and contains the highest tritium concentrations of

WVDP environmental surveillance wells (see Table 4-6). Tritium concentrations in groundwater from all these areas are steadily decreasing.

Results for Volatile and Semivolatile Organic Compounds (VOCs and SVOCs). Selected wells within the sand and gravel unit continue to be monitored for VOCs and SVOCs, in accordance with the Consent Order. Currently, the only sand and gravel monitoring location with consistent positive detections of VOCs is well 8612, located northeast of the closed construction and demolition debris landfill (CDDL) at the northeast edge of the north plateau. (See Table 4-7 and Figure A-8 in Appendix A.) Figure 4-7 illustrates concentrations of organic compounds at well 8612. Two of these VOCs have been detected above the New York State Groundwater Effluent Limitations (Class GA); however these concentrations are steadily decreasing over time. At nearby well 803, benzene, ethyl benzene, toluene, and xylene were detected at concentrations less than the quantitation limit and below the NYS Class GA Effluent Limitations during one of four sampling events. The presence of VOCs in wells 803 and 8612, both downgradient of the CDDL, is presumed to be the result of wastes buried in the CDDL.

Downgradient of former lagoon 1, the SVOC tributyl phosphate (TBP) was detected when compared to the historic high of 700 micrograms per liter (µg/L) measured in December 1996, at decreasing levels, in groundwater samples from well 8605. TBP has also been detected in well 111, located near well 8605, but at concentrations close to or below the quantitation limit of 10 µg/L. (See Fig. 4-8.) Ongoing detection of TBP in this localized area may reflect residual contamination from liquid waste management activities in the former lagoon 1 area during earlier nuclear fuel reprocessing.

A summary of maximum concentrations of organic compounds detected in WVDP groundwater wells is shown in Table 4-7.

Strontium-90 Plume Remediation Activities

North Plateau Groundwater Recovery System. In 1995, the north plateau groundwater recovery system (NPGRS) was installed to minimize the advance of the strontium-90 plume. (See Fig. 4-2.) The NPGRS consists of three wells that extract contaminated groundwater, which is then treated by ion exchange to remove strontium-90. Treated water is transferred to the lagoon system and is ultimately discharged to Erdman Brook via the SPDES-permitted outfall.

The NPGRS operated with two wells pumping throughout 2007, processing about 2.90 million gallons (gal)

TABLE 4-7
Summary of Maximum Concentrations of Organic Constituents in Selected WVDP Groundwater Wells During 2007

Constituent	*Regulatory/Waste Management Monitoring Program*		*New York State Groundwater Effluent Limitations* [a] *Class GA (µg/L)*
	Well with the Highest Concentration	*Concentration Range (µg/L)*	
1,2-Dichloroethylene (total)	8612	20–26	5.0
1,1,1-Trichloroethane	8612	0.6–1.1 (estimated)	5.0
1,1-Dichloroethane	8612	5.4–8.0	5.0
Dichlorodiflouromethane	8612	2.4–3.7 (estimated)	5.0
Tributyl phosphate	8605	180–270	NA
Benzene	803	ND–0.9 (estimated)	1.0
Ethyl benzene	803	ND–0.6 (estimated)	5.0
Toluene	803	ND–4.2 (estimated)	5.0
Xylene	803	ND–3.5 (estimated)	5.0

Note: Constituents presented as "estimated" were reported at concentrations less than the practical quantitation limit.
NA - Not applicable.
ND - Not detected.
[a] Source: 6 NYCRR Part 703, Division of Water Technical and Operational Guidance Series 1.1.1, NYS Groundwater Effluent Limitations (Class GA).

(11.3 million liters [L]) of water. The system has recovered and processed approximately 49 million gal (186 million L) since November 1995.

North Plateau Groundwater Quality Early Warning Monitoring. Early-warning monitoring of water upgradient of the NPGRS is performed because this water is ultimately discharged off site via the New York State Pollutant Discharge Elimination System (SPDES)-permitted outfall 001. Semiannual monitoring results from well 502, located directly upgradient of the NPGRS, can be used to identify metals concentrations in groundwater that may affect compliance with the SPDES-permitted effluent limits. The levels of metals detected in groundwater from well 502 in CY 2007 were below concentrations likely to affect SPDES permit compliance.

Permeable Treatment Wall. A pilot-scale permeable treatment wall (PTW) was constructed in 1999 within the eastern lobe of the strontium-90 plume to test this passive, in-situ remediation technology. The pilot PTW is a trench that is backfilled with clinoptilolite, a medium selected for its ability to adsorb strontium-90 ions from groundwater. Strontium-90 concentrations are lower in groundwater from wells within the PTW, indicating that strontium-90 is being removed from the water that passes through the wall. However, throughout 2007, strontium-90 concentrations increased in two of the wells within the PTW to levels that may suggest the beginning of some reduction in treatment capacity in that area of the pilot PTW. The complex geology that exists in the vicinity of the pilot PTW is believed to affect the performance of the wall, and the wall itself may be affecting the pattern of groundwater flow in the plume area. The plume has encircled and migrated past the PTW test area. Nevertheless, the data indicate that the PTW technology can be an effective treatment method for strontium-90-contaminated groundwater.

Near-Term and Long-Term Plume Management Activities. Alternatives for management of the plume are currently being evaluated by the DOE. Groundwater monitoring data are being used to evaluate the current conditions of the plume and to model the future plume configuration under differing near-term and long-term management scenarios.

Near-term strategies are focused on ways to reduce migration of the downgradient leading edge of the plume, thereby minimizing expansion beyond its current mapped limits and migration into downgradient surface water and seepage points. The proposed management strategies may include implementation of permeable reactive barrier technology, a full-scale permeable treatment wall, hydraulic barriers such as an interceptor trench, groundwater extraction wells, or a combination of these technologies. The implementation of the near-term plume management strategy is integral to the starting point of the environmental impact statement (EIS) for the WVDP, to manage and minimize the release of contamination off site while the EIS for the Decommissioning and/or Long-Term Stewardship at the WVDP and the WNYNSC is finalized.

Long-term strategies include remedial alternatives that would contain the plume so that it can be effectively removed and/or allowed to decay in-place within the WVDP premises. These strategies will be integrated with the near-term plume management options and will be evaluated in the WVDP Decommissioning EIS.

Sampling projects are planned for 2008 to obtain plume and subsurface characterization data for decision-making for both the near-term and long-term management strategies.

Groundwater Sampling Observations on the South Plateau: Weathered Lavery Till and the NDA

In 1990, a trench system was constructed through the weathered Lavery till along the northeast and northwest sides of the NDA to intercept and collect groundwater that was potentially contaminated with a mixture of radioactive n-dodecane and tributyl phosphate. (See also “Interim Measures; NDA Cap” in the Environmental Compliance Summary and “Nuclear Regulatory Commission [NRC]-Licensed Disposal Area [NDA] Interceptor Trench and Pretreatment System” in Chapter 1.) Monitoring results in 2007 detected no TBP in NDA interceptor trench groundwater. Groundwater elevations are monitored quarterly in and around the trench to ensure that an inward gradient is maintained, thereby minimizing outward migration of potentially contaminated groundwater.

NDA Monitoring. Gross beta and tritium concentrations in groundwater from sampling location WNNDATR, a sump at the lowest point of the interceptor trench, and from well 909, downgradient of WNNDATR (Fig. A-9 in Appendix A), continued to be elevated with respect to concentrations in background monitoring locations on the south plateau. Gross beta concentrations at WNNDATR have increased with time, with even steeper increases ob-

served from 2005 through 2007. Gross beta concentrations at unweathered lavery till well 910 became elevated above the DOE DCG at the end of 2007. This is believed to be caused by a broken well coupling that is allowing shallow contaminated groundwater, and/or surface water that had been previously identified on the surface of the NDA, to enter the well. Following a hydrogeological evaluation, this well was decommissioned and a replacement well was installed to continue monitoring coverage for the unweathered Lavery till in this area.

Residual activity from historical site operations in the NDA is the presumed source of this gross beta activity. Similar to the north plateau, strontium-90 is the predominant contributing radioisotope.

Tritium concentrations at WNNDATR were slightly lower during 2007 than those in 2006, and overall have decreased since 1994. WNNDATR contained the highest tritium concentrations reported in the WVDP regulatory/waste management groundwater monitoring locations (see Table 4-6). Detections of tritium in the NDA are presumed to be the result of residual activity from former burial operations on the south plateau. Tritium concentrations remain well below the DOE DCG for tritium. Currently, groundwater flowing through the NDA is collected at WNNDATR and is transferred to the low-level waste treatment facility for processing.

NDA Interim Measure (IM). An IM work plan for the NDA was completed under the Consent Order in 2007, with the stated goals being to improve the integrity of the earthen cap and to limit water infiltration. The IM, which will be implemented in 2008, will include the installation of a geosynthetic cap over the NDA, a low-permeability subsurface groundwater cutoff wall (slurry wall) upgradient of the NDA, and surface water drainage diversions.

Refer to Environmental Compliance Summary "Interim Measures" under "RCRA §3008(h) Order on Consent" for further discussion of the NDA Cap.

Additional Monitoring and Investigations

Radioisotopic Sampling. In addition to routine sampling of groundwater for gross alpha, gross beta, tritium, and strontium-90 (at specific wells, as indicated in Table 4-2), select groundwater samples from the sand and gravel unit, the weathered Lavery till unit, and the unweathered Lavery till unit are analyzed for a more extensive list of radionuclides (also indicated in Table 4-2). These samples are analyzed for the additional radionuclides carbon-14, technetium-99, iodine-129, cesium-137, radium-226, radium-228, uranium-232, uranium-233/234, uranium-235/236, and uranium-238. (Note that radium-

TABLE 4-8
2007 Maximum Concentrations (µCi/mL) of Radionuclides[a] in Groundwater at the WVDP

Well	*Tc-99*	*I-129*	*Ra-226*	*Ra-228*	*U-233/234*	*U-238*
Sand and Gravel						
WNW0401[b]	--	--	--	9.80±4.13E-10	2.27±1.04E-10	--
WNW0408	1.10±0.28E-08	--	1.06±0.41E-09	3.89±0.82E-09	--	2.90±1.40E-10
WNW0706[b]	--	--	3.59±1.67E-10	--	--	--
WNW1302	--	--	5.86±2.49E-10	--	--	--
WNW1304	--	--	2.18±0.40E-09	--	2.86±1.43E-10	2.21±0.98E-10
Weathered Lavery Till						
WNW0909	--	5.63±1.49E-09	--	--	5.12±1.53E-10	4.48±1.44E-10
WNNDATR	--	1.46±0.55E-09	--	--	1.86±0.36E-09	1.30±0.31E-09
Unweathered Lavery Till						
WNW0405[b]	--	--	5.42±1.99E-10	--	4.72±1.46E-10	3.43±1.53E-10

Note: "--" indicates that the radionuclide was not postively identified at this location.

[a] Results for tritium and strontium-90, discussed earlier, are not included in this summary. Routine monitoring locations with no positive detections of additional radionuclides are not listed, nor are sampled radionuclides that were not positively detected at any of the locations.

[b] Background well

226, radium-228, uranium-234, and uranium-238 occur naturally in the environment.)

Historical monitoring of these select wells has resulted in positive detections of carbon-14, technetium-99, iodine-129, radium-226, radium-228, uranium-233/234, and uranium-238. All of these radionuclides, with the exception of carbon-14, were detected in groundwater in 2007. The maximum concentrations of each are presented in Table 4-8. Note that wells 401, 405, and 706 serve as background wells.

As discussed earlier, strontium-90 concentrations were found to be elevated in monitoring wells in the north plateau plume area and also downgradient of the NDA on the south plateau. On the north plateau, in addition to strontium-90, positive concentrations of technetium-99, radium-226, radium-228, and uranium-238 were reported in well 408, the GMP well closest to the strontium-90 plume source and located within the main flow path of the plume. Concentrations of technetium-99 at this well are decreasing over time, while the concentrations of the remaining radionuclides appear consistent with historical results.

Although not included in Table 4-8, special sampling as part of the waste tank farm (WTF) hydrogeologic investigation (discussed later in this chapter) detected technetium-99 and radium-228 at well 8607, located adjacent to the lag storage area. This activity is attributed to residual contamination from historical activities in the vicinity of the WTF.

Radium-226, a decay product of uranium-238, was detected in several of the wells adjacent to the remote-handled waste facility (405, 706, 1302, and 1304). The reported concentration of radium-226 at well 1304 appears to be an outlier, since typical concentrations measured previous to and subsequent to the result reported in Table 4-8 are much lower. Concentrations of radium-226 at the remaining wells adjacent to the RHWF are consistent with historical results.

At location WNNDATR and well 909 on the south plateau, concentrations of iodine-129, uranium-233/234, and uranium-238 were reported above the detection limit and above background levels. The concentrations of iodine-129 remain elevated above background and are consistent with historical results. Elevated radionuclide concentrations in groundwater downgradient of the NDA are presumed to be associated with former burial operations.

Groundwater Monitoring Downgradient of the WTF. The waste in the underground tanks has been solidified through the vitrification process and the tanks remain in place containing residual waste. In 2005, the New York State Department of Environmental Conservation requested that the DOE evaluate the current and historical groundwater conditions in the vicinity of the WTF. Throughout waste processing activities, groundwater controls were in place to (1) reduce the upward hydrostatic pressure on the tanks, and (2) to maintain an inward hydraulic gradient toward the tanks, thereby inhibiting any potential leaks from the tanks. The natural inward hydraulic gradient is influenced by periodically pumping a dewatering well (DWW), located outside the vault, that controls the hydrostatic pressure in the immediate vicinity of the tanks.

Radioactivity in groundwater in the vicinity of the WTF is routinely monitored and evaluated. Elevated gross beta concentrations in groundwater from well 8607 have been observed since 1994, with the maximum concentration measured in 2005. Gross beta activity has also been observed in the DWW and the tank 8D-2 pan. Radionuclide samples from these locations were collected in 2007 to determine the source(s) of the gross beta activity. After evaluating the radiological results, it was concluded that the gross beta activity in well 8607 is most likely attributed to residual contamination from historical events in and around the WTF (i.e., minor leaks from condensate lines or the WTF underdrain) and is not believed to have originated from the tanks themselves.

Investigation of Chromium and Nickel in the Sand and Gravel Unit and Evaluation of Corrosion in Groundwater Monitoring Wells. A 1997 and 1998 study of the effect of modifying sampling equipment and methodology on concentrations of chromium and nickel in groundwater samples from the sand and gravel unit noted that such modifications produced decreases in these concentrations. This finding supported the hypothesis (which is documented in the technical literature) that elevated concentrations of nickel and chromium were not representative of actual groundwater conditions, but were caused by the release of metals from subsurface corrosion of stainless-steel well materials (WVNSCO and Dames & Moore, June 1998).

To ensure that the integrity of the monitoring wells is maintained, and to ensure that samples representative of actual groundwater conditions are collected, wells are periodically inspected for corrosion. Ap-

proximately 75% of the stainless-steel wells monitoring the sand and gravel unit were internally inspected for corrosion during 2001. At that time, wells with corrosion were cleaned and reinspected to verify that corrosion had been removed. Since 2001, select wells have been inspected and cleaned when elevated nickel and chromium were observed. An inspection and cleaning project was planned for CY 2007, but was postponed due to equipment problems. This project will be rescheduled for CY 2009.

Monitoring for Metals. Selected wells in the sand and gravel unit are monitored for metals as required by the RCRA 3008(h) Consent Order. During 2007, a select number of additional wells were sampled for metals analysis to help establish baseline concentrations for metals in groundwater. These data will be evaluated in conjunction with sample data being collected in 2008 to support north plateau background and characterization sampling programs.

Off-Site Groundwater Monitoring. Groundwater is used as a potable water supply at off-site private residences near the WVDP. None of the wells draw from groundwater units that underlie the site. Groundwater samples have been collected routinely from nine off-site residential supply wells within 4.3 miles (7 kilometers [km]) of the Project that represent the closest unrestricted use of groundwater. One additional upgradient well, located 18 miles (29 km) south of the site, was also sampled for background purposes. Sampling of these 10 wells was discontinued since they do not intercept groundwater downgradient of the site. This modification to the monitoring program was presented as part of the 2007 monitoring evaluation. Additional information is provided in "Drinking Water Monitoring" in Chapter 2.

Fuel Receiving and Storage (FRS) Pool Water Infiltration. During mid-2005, water was found trickling into the empty FRS pool during a quarterly inspection. The water had accumulated to approximately four to six inches. The water is directed by a slope in the floor to a deeper stainless-steel-lined cask unloading pool (CUP). Analytical data for the FRS CUP water indicate that groundwater seepage is the source of the water. During periods of high precipitation or snow melt, slight seepage has entered along the south wall. The elevated cesium-137 concentrations are believed to be from residuals that adhered to the FRS walls when the pool was full. Groundwater seepage into the pool is thought to have dissolved some of the cesium. Since the water does not pose operational or safety concerns, it has been left in the CUP under routine monitoring. Currently, the water level in the CUP is measured daily by facility operators and samples of the water are analyzed periodically.

FIGURE 4-3
Average Annual Gross Beta Concentrations
at Monitoring Wells Centrally Located Within the North Plateau Plume

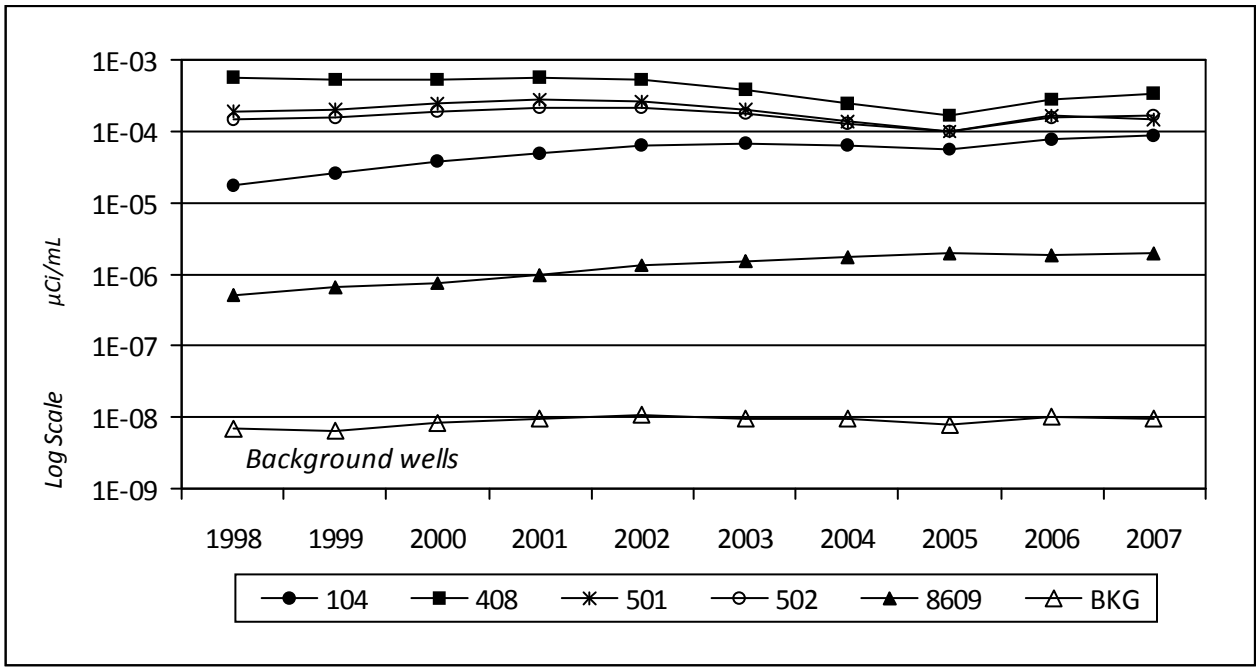


FIGURE 4-4
Average Annual Gross Beta Concentrations
at Monitoring Wells Near the Leading Edge of the North Plateau Plume

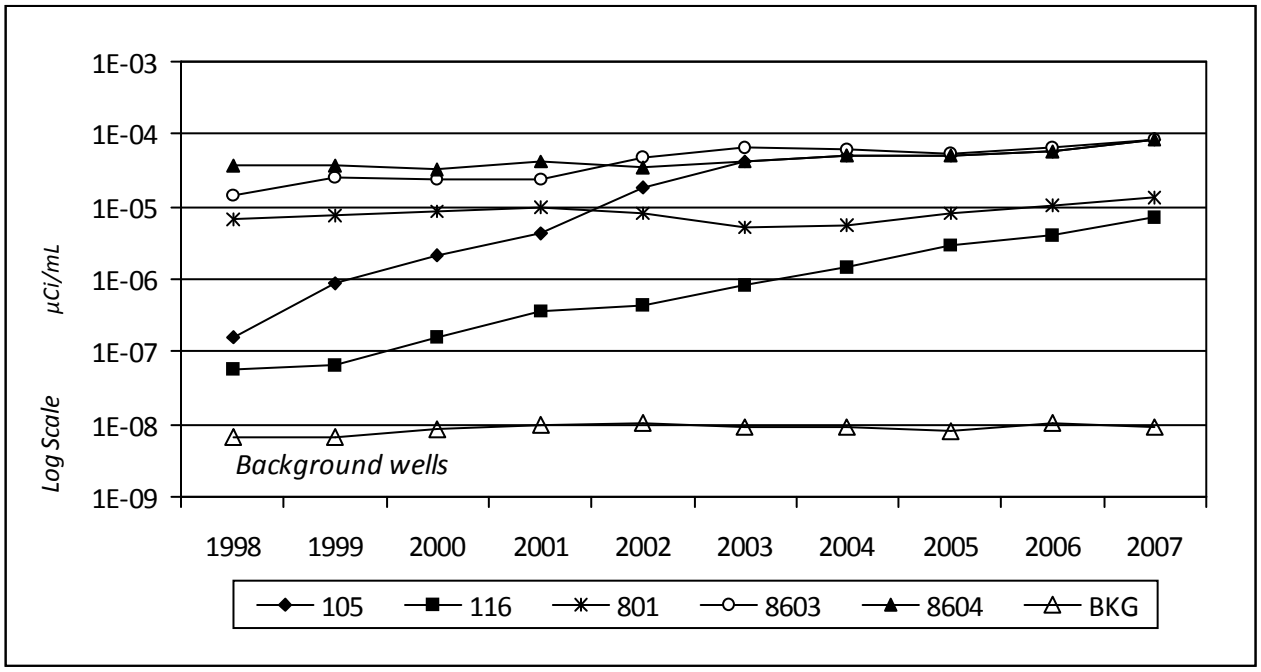


FIGURE 4-5
Average Annual Gross Beta Concentrations at Monitoring Wells Near Former Lagoon 1

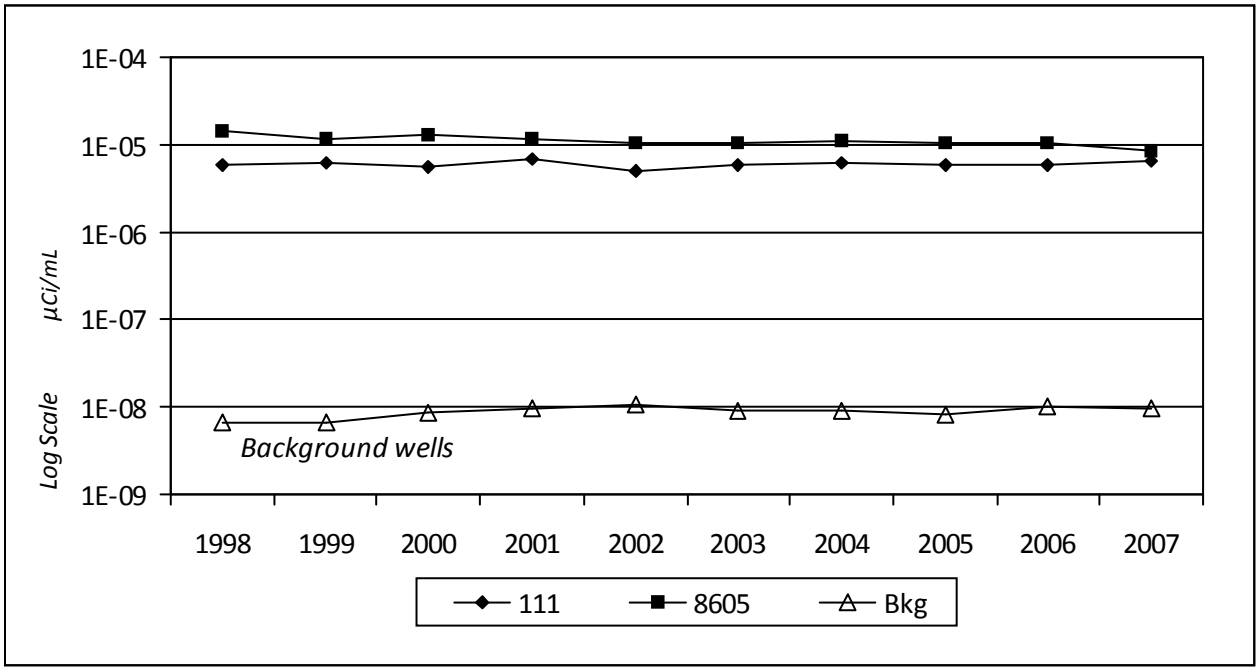
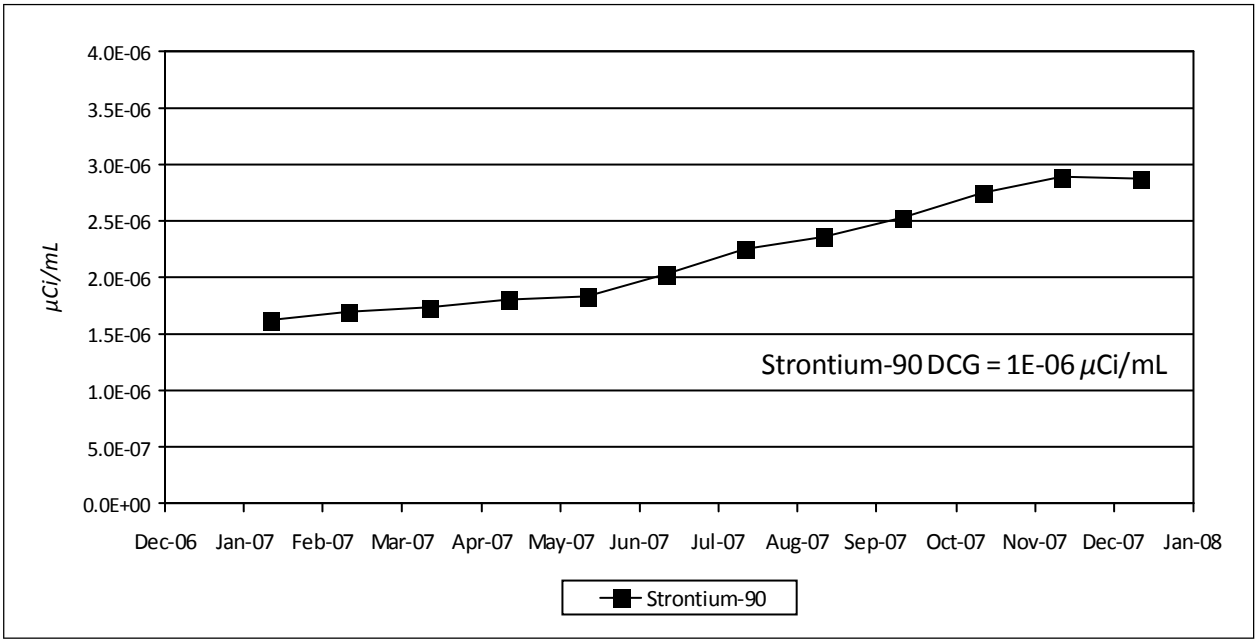


FIGURE 4-6
2007 Annualized Average Strontium-90 Concentrations at WNSWAMP



Note: DCGs are used as an evaluation tool for results from on-site locations as part of the routine environmental monitoring program. However, DOE DCGs are applicable only at locations accessible to members of the public. The WNSWAMP location is not accessible to the public.

FIGURE 4-7
Concentrations of 1,2-DCE-t, 1,1,1-TCA, 1,1-DCA, and DCDFMeth at Well 8612 in the Sand and Gravel Unit

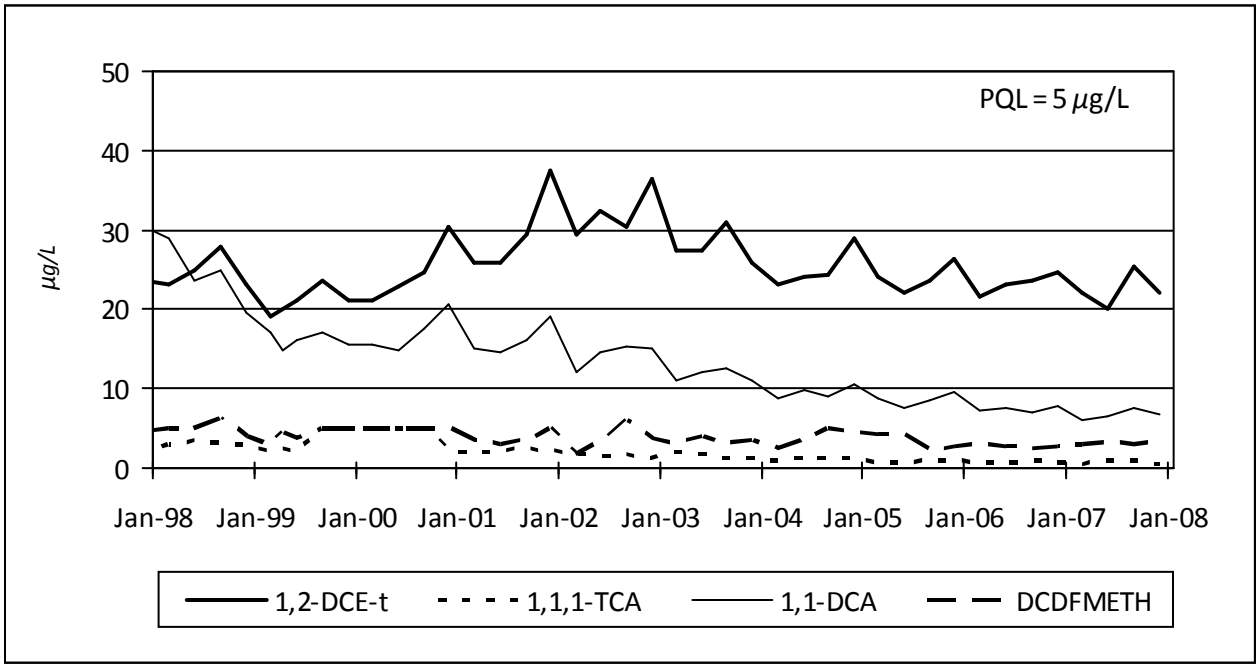


FIGURE 4-8
Concentrations of Tributyl Phosphate at Monitoring Wells Near Former Lagoon 1 in the Sand and Gravel Unit

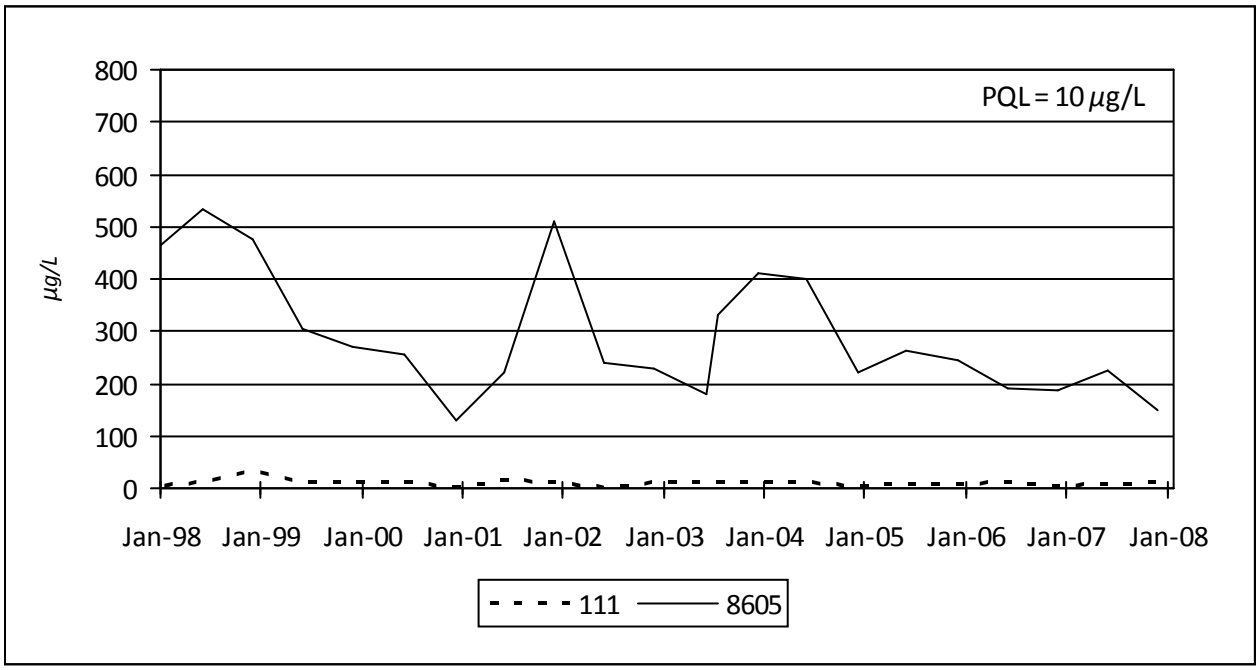
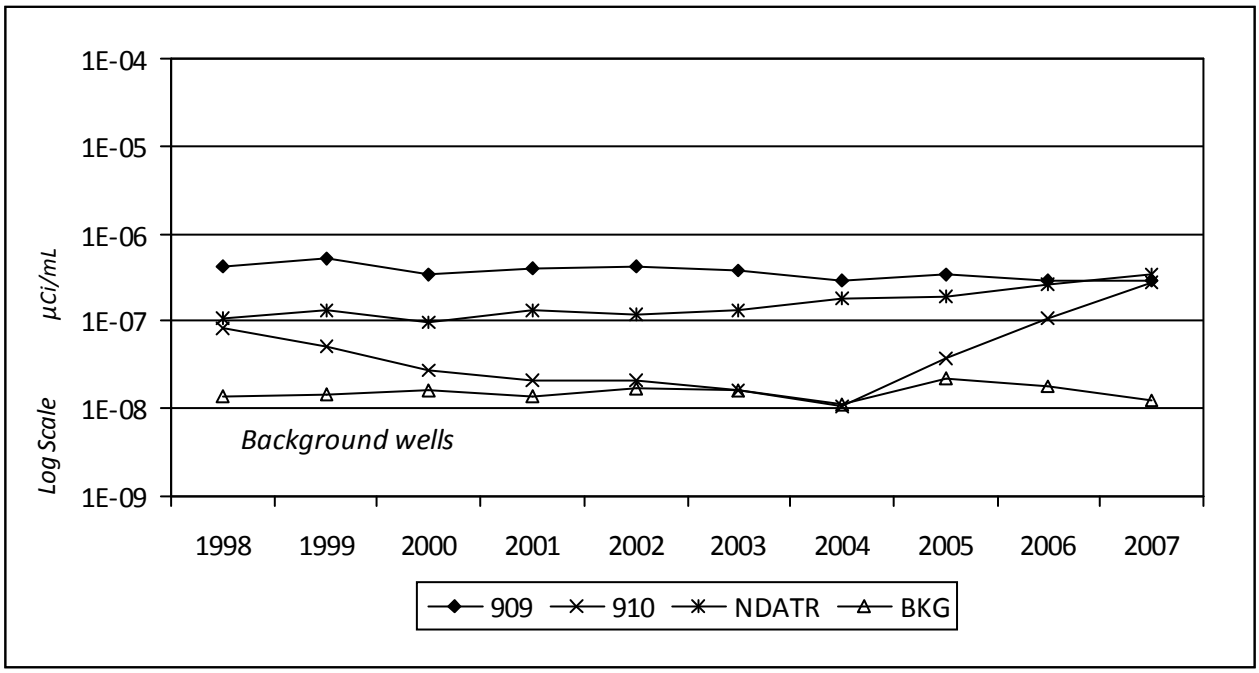



FIGURE 4-9
Average Annual Gross Beta Concentrations
at Monitoring Wells Downgradient of the NDA