GROUNDWATER MONITORING

Geological History of the West Valley Site

The West Valley Demonstration Project (WVDP) is located on the dissected and glaciated Allegheny Plateau near the northern border of Cattaraugus County in Western New York. The site is underlain by a thick sequence of Holocene (recent) and Pleistocene (ice age) sediments contained in a steep-sided bedrock valley. From youngest to oldest, these unconsolidated deposits consist of alluvial and glaciofluvial silty coarse-grained deposits, which are found almost exclusively in the northern part of the site, and a sequence of up to three fine-grained glacial tills of Lavery, Kent, and possible Olean age, which are separated by stratified fluvio-lacustrine deposits. These glacial sediments are underlain by bedrock composed of shales and interbedded siltstones of the upper Devonian Canadaway and Conneaut Groups, which dip southward at about 5 m/km (Rickard 1975).

The most widespread glacial unit in the site area is the Kent till, deposited between 18,000 and 24,000 years ago toward the end of the Wisconsin glaciation (Albanese et al. 1984). At that time the ancestral Buttermilk Creek Valley was covered with ice. As the glacier receded, debris trapped in the ice was left behind in the vicinity of West Valley. Meltwater, confined to the valley by the debris dam at West Valley and the ice front, formed a glacial lake that persisted until the glacier receded far enough northward to uncover older drainageways. As the ice continued to melt (between 15,500 and 18,000 years ago), more material was released and deposited to form the recessional sequence (lacustrine and kame delta deposits) that presently overlies the Kent till. Continued recession of the glacier ultimately led to drainage of the proglacial lake and exposure of its sediments to erosion (LaFleur 1979).

Between 15,000 and 15,500 years ago the ice began its last advance (Albanese et al. 1984). Material from this advance covered the recessional deposits with as much as 40 meters (130 ft) of glacial till. This unit, the Lavery till, is the uppermost unit throughout much of the site.

The retreat of the Lavery ice left behind another proglacial lake that ultimately drained, allowing the modern Buttermilk Creek to flow northward to Cattaraugus Creek. Post-Lavery outwash and alluvial fans, including the fan that overlies the northern part of the WVDP, were deposited on the Lavery till between 14,200 and 15,000 years ago (LaFleur 1979). The modern Buttermilk Creek has cut the present valley since the final retreat of the Wisconsin glacier.

Surface Water Hydrology of the West Valley Site

The Western New York Nuclear Service Center (WNYNSC) lies within the Cattaraugus Creek watershed, which empties into Lake Erie about 43 kilometers (27 mi) southwest of Buffalo. Buttermilk Creek, a tributary of Cattaraugus Creek, drains most of the WNYNSC and all of the WVDP facilities.

The 80-hectare (200-acre) WVDP site, located on the WNYNSC, is contained within the smaller Frank's Creek watershed. Frank's Creek is a tributary of Buttermilk Creek.

The WVDP is bounded by Frank's Creek to the east and south and by Quarry Creek (a tributary of Frank's Creek) to the north. Another tributary of Frank's Creek, Erdman Brook, bisects the WVDP into a north and south plateau (Fig. 3-1 [p. 3-3]). 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 on the south plateau.

Hydrogeology of the West Valley Site

The WVDP site area is underlain by glacial tills comprised primarily of clays and silts separated by coarser-grained interstadial layers. The sediments above the second (Kent) till (the Kent recessional sequence, the Lavery till, the Lavery till-sand, and the surficial sand and gravel) are generally regarded as containing all of the potential routes for the migration of contaminants (via groundwater) from the WVDP site. (See Figures 3-2 and 3-3 [pp. 3-4 and 3-5], which show the relative locations of these sediments on the north and south plateaus.)

The Lavery till and the Kent recessional sequence underlie both the north and south plateaus. On the south plateau the upper portion of the Lavery till is exposed at the ground surface and is weathered and fractured to a depth of 0.9 to 4.9 meters (3 to 16 ft). This layer is referred to as the weathered Lavery till.

The remaining thickness of the Lavery till is unweathered. This unweathered Lavery till is predominantly an olive gray, silty clay glacial till with scattered lenses of silt and sand. The till ranges up to 40 meters (130 ft) in thickness beneath the active areas of the site, generally increasing towards Buttermilk Creek and the center of the bedrock valley.

Hydraulic head distributions in the Lavery till indicate that groundwater flow in the unweathered till is predominantly vertically downward at a relatively slow rate, towards the underlying Kent recessional sequence. The mean hydraulic conductivity of the unweathered till, as determined from the most recent testing of sixteen wells in 1996, was 4.2×10^{-8} cm/sec (1.2×10^{-4} ft/day).

The underlying Kent recessional sequence consists of a lower lacustrine unit of interbedded clay and silty clay layers locally overlain by coarse-grained kame delta and outwash sands and gravels. These deposits underlie the Lavery till beneath most of the site, pinching out along the southwestern corner where the shoulder of the bedrock valley intersects the sequence.

Groundwater flow in the Kent recessional sequence is predominantly to the northeast, towards Buttermilk Creek. The hydraulic conductivity, as determined from thirteen wells tested in 1996 and four wells tested in 1997, ranges from approximately 8.4×10^{-9} cm/sec (0.000024 ft/day) to 1.5×10^{-4} cm/sec (0.44 ft/day), with a geometric mean of 4.0×10^{-6} cm/sec (0.01 ft/day). Recharge comes from the overlying till and the

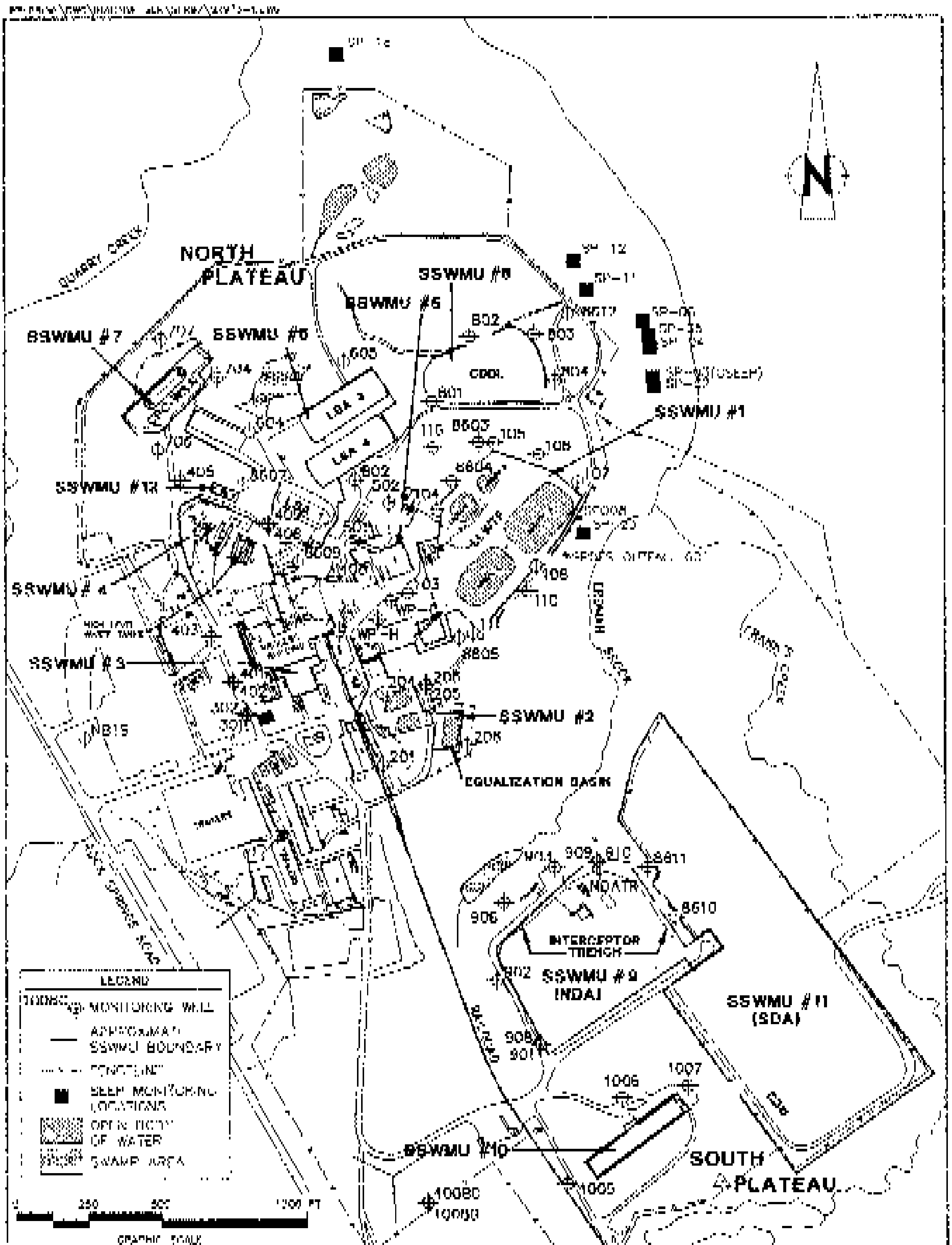


Figure 3-1. WVDP Groundwater Monitoring Program Locations Sampled in 1997.

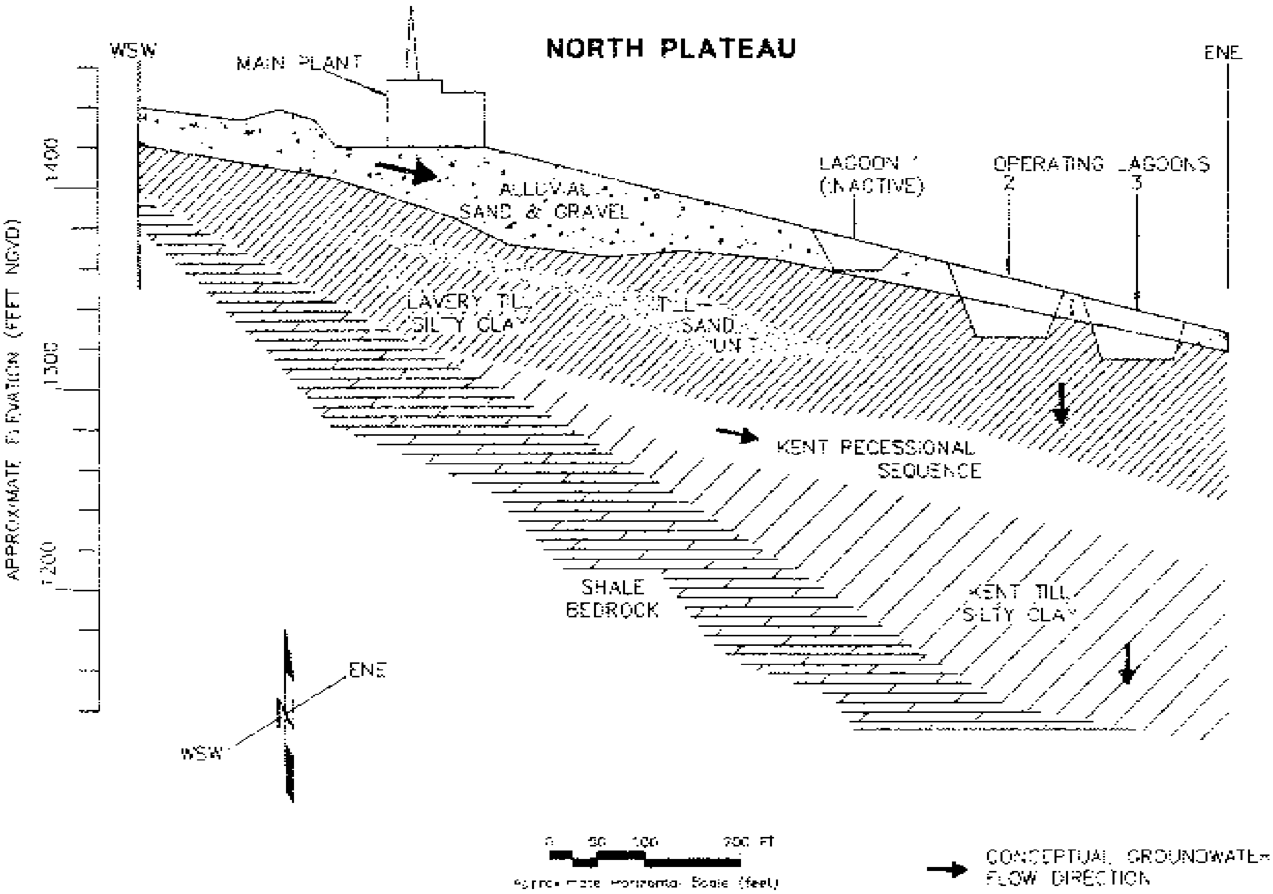


Figure 3-2. Geologic Cross Section through the North Plateau

bedrock in the southwest, and discharge is to Buttermilk Creek.

Underneath the Kent recessional sequence is the less permeable Kent till, which does not provide a pathway for contaminant movement from the WVDP and so is not discussed here.

North Plateau

On the north plateau, where the main plant, waste tanks, and lagoons are located, the unweathered Lavery till is immediately overlain by the surficial sand and gravel layer. Within the Lavery till on the north plateau is another unit, the till-sand. A geologic cross section of the north plateau is shown on Figure 3-2 (above).

Surficial Sand and Gravel Layer

The surficial sand and gravel is a silty sand and gravel layer composed of younger Holocene alluvial deposits that overlie older Pleistocene-age glaciofluvial deposits. Together these two layers range up to 12.5 meters (41 ft) in thickness near the center of the plateau and pinch out along the northern, eastern, and southern edges of the plateau, where they have been truncated by the downward erosion of stream channels. Depth to groundwater within this layer varies from 0 meters to 5 meters (0 ft to 16 ft), being deepest generally beneath the central north plateau (beneath the main plant facilities) and intersecting the surface farther north towards the security fence. Groundwater in this layer generally flows across the north plateau from the southwest (near Rock Springs

Road) to the northeast (towards Frank's Creek). Calculations based on the testing of twenty wells and five well points in 1997 indicate that hydraulic conductivity ranged from 6.4 x 10^{-6} cm/sec (0.2 ft/day) to 3.1 x 10^{-3} cm/sec (8.8 ft/day), with a geometric mean hydraulic conductivity of 2.8 x 10^{-4} cm/sec (0.79 ft/day). These new data show higher velocities than noted in earlier site reports, which used a smaller data set of twenty-one wells. Groundwater near the northwestern and southeastern margins of the sand and gravel layer flows radially outward toward Quarry Creek and Erdman Brook, respectively. There is minimal groundwater flow downward into the underlying Lavery till.

Lavery Till-sand

On-site investigations from 1989 through 1990 identified a lenticular sandy unit of limited areal extent and variable thickness within the Lavery till, primarily beneath the north plateau. Groundwater flow through this unit apparently is limited by the cross sectional area of the unit's erosional exposure, and surface discharge locations have not been observed. Results of the most recent hydraulic testing in 1996 of seven wells screened in this unit indicated that hydraulic conductivity ranged from 4.8 x 10^{-8} (0.00014 ft/day) to 2.5 x 10^{-3} cm/sec (7.1 ft/day), with a mean conductivity of 1.1 x 10^{-3} cm/sec (3.1 ft/day).

South Plateau

A geological cross section of the south plateau is shown on Figure 3-3 (below). The uppermost geologic unit, the weathered Lavery till, is discussed below. The other units (the unweathered Lavery till, the Kent recessional sequence, and the Kent till) were discussed above.

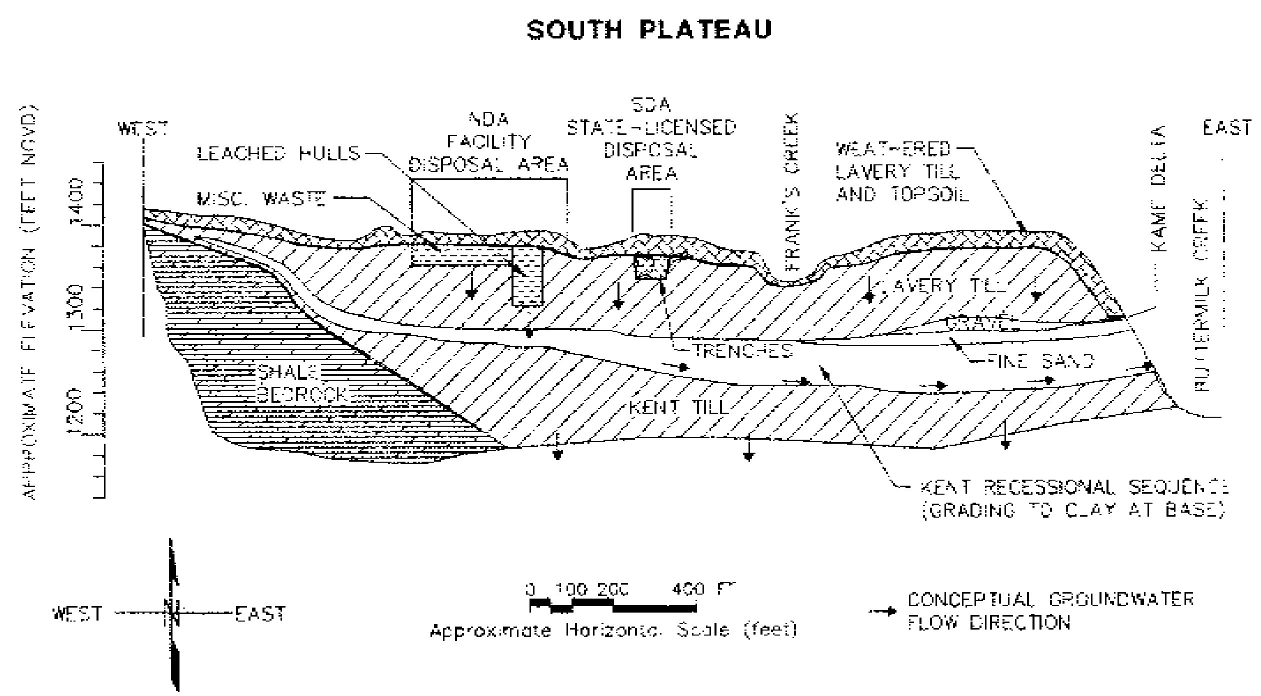


Figure 3-3. Geologic Cross Section through the South Plateau

Weathered Lavery Till

On the south plateau, the upper portion of Lavery till exposed at the surface is referred to as the weathered till. It is physically distinct from the underlying unweathered till: it has been oxidized to a brown color and contains numerous fractures and root tubes. The thickness of this layer generally varies from 0.9 meters to 4.9 meters (3 ft to 16 ft). On the north plateau, the weathered till layer is much thinner or nonexistent.

Groundwater flow in the weathered till that occurs in the upper 4.9 meters (16 ft) has both horizontal and vertical components. This enables the groundwater to move laterally across the plateau before moving downward into the unweathered Lavery till or discharging to nearby incised stream channels. The hydraulic conductivity of the weathered till as determined from the testing of eight wells in 1997 ranges from 9.1×10^{-8} cm/sec (0.00026 ft/day) to 3.5×10^{-5} cm/sec (0.1 ft/day), with a geometric mean of 1.5 x 10-6 cm/sec (.004 ft/day). The highest conductivities are associated with the dense fracture zones (found within the upper 2 meters [7 ft] of the unit).

Routine Groundwater Monitoring Program Overview

Groundwater Monitoring Activities

Current groundwater monitoring activities at the WVDP are summarized in two primary documents, the Groundwater Monitoring Plan (West Valley Nuclear Services Co., Inc. December 1996) and the Groundwater Protection Plan (West Valley Nuclear Services Co., Inc. April 1997). The Groundwater Monitoring Plan outlines the WVDP's plans for groundwater characterization, current groundwater monitoring, and support of long-term monitoring requirements specified under the RCRA facilities investigation and DOE programs. The Groundwater Protection Plan provides additional information regarding protection of groundwater from on-site activities.

The categories of groundwater analytical parameters and the 1997 sampling schedule for these parameters are noted in Table 3-1 (p.3-7). Potentiometric (water level) measurements also are collected from the wells listed in Table E-1 (*Appendix E,* p. E-3) in conjunction with the quarterly analytical sampling schedule. Water-level data are used to determine groundwater flow directions and gradients.

Monitoring Well Network

The purpose of groundwater monitoring is to detect changes in groundwater quality within the five different hydrogeologic units discussed above: the sand and gravel unit, the weathered Lavery till, the unweathered Lavery till, the Lavery till-sand unit, and the Kent recessional sequence.

Table E-1 (p. E-3) lists the eleven super solid waste management units (SSWMUs) monitored by the well network; the hydraulic position of each well relative to the waste management unit; the geologic unit monitored; and the analytes measured in 1997. Note that monitoring of wells marked by an asterisk is required by the RCRA 3008(h) Administrative Order on Consent. (See the ***Environmental Compliance Summary: Calendar Year 1997***, *RCRA Facility Investigation [RFI] Program* [p. xlvi].)

Figure 3-1 (p. 3-3) shows the boundaries of these eleven super solid waste management units at the WVDP. (Twenty-one additional wells monitor the SDA and are the responsibility of the New York State Energy Research and Development Authority [NYSERDA]. Locations of NYSERDA wells are shown on Fig. A-3, p. A-47 in *Appendix A*.) Although the SDA is a closed radioactive waste landfill contiguous with the Project premises, the

Table 3-1
1997 Groundwater Sampling and Analysis Agenda

Analyte Group	*Description of Parameters* [1]	*Location of Sampling Results in Appendix E*
Contamination Indicator Parameters (I)	pH, specific conductance (field measurement)	Tables E-2 through E-6 (pp. E-7 through E-14)
Radiological Indicator Parameters (RI)	Gross alpha, gross beta, tritium	Tables E-2 through E-6 (pp. E-7 through E-14)
RCRA Hazardous Constituent Metals (M +)	Antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, nickel, selenium, silver, thallium	Table E-11 (pp. E-17 through E-23)
Appendix IX Metals (M9)	Metals listed above plus cobalt, copper, tin, vanadium, zinc	Table E-11 (pp. E-17 through E-23)
Volatile Organic Compounds (V)	Appendix IX VOCs (See Table E-13[p.E-24])	Table E-9 (p. E-16)
Semivolatile Organic Compounds (SV)	Appendix IX SVOCs (See Table E-13 [p.E-24])	Table E-10 (p. E-16)
Radioisotopic Analyses: alpha- , beta- , and gamma-emitters (R)	C-14, Cs-137, I-129, Ra-226, Ra-228, Sr-90, Tc-99, U-232, U-233/234, U-235/236, U-238, total uranium	Table E-13 (pp. E-24 through E-25)
Strontium-90 (S)	Sr-90	Table E-13 (pp. E-24 through E-25)
Pilot Program for Investigating Chromium and Nickel Concentrations (M)	Chromium, nickel	Table E-11 (pp. E-17 through E-23)
Special Monitoring Parameters for Early Warning Wells (SM)	Aluminum, iron, manganese	Table E-12 (p. E-24)

1997 Quarterly Sampling Schedule:
1st Qtr - December 2, 1996 to December 12, 1996
2nd Qtr - March 3, 1997 to March 12, 1997
3rd Qtr - June 2, 1997 to June 18, 1997
4th Qtr - September 2, 1997 to September 18, 1997

[1]*Analysis performed at selected active monitoring locations only. See Table E-1 (p. E-3) for the analytes sampled at each monitoring location.*

Four designations are often used to indicate a well's function within the groundwater monitoring program:

Upgradient well. *A well installed hydraulically upgradient of a SSWMU that is capable of yielding groundwater samples that are representative of local conditions and that are not affected by the SSWMU being monitored.*

Downgradient well. *A well installed hydraulically downgradient of a SSWMU that is capable of detecting the migration of contaminants from the SSWMU.*

Background well. *A well installed hydraulically upgradient of all SWMUs and SSWMUs that is capable of yielding groundwater samples that are representative of conditions not affected by site activities. In some cases upgradient wells may be downgradient of other SSWMUs or SWMUs, which makes them unsuitable for use as true background wells. However, they are still useful for providing upgradient information about the waste management unit under study.*

Crossgradient well. *A well installed to the side of the major downgradient flow path such that the well is neither upgradient nor downgradient of the monitored SSWMU.*

WVDP is not responsible for the facilities or activities relating to it. Under a joint agreement with the DOE, NYSERDA contracts with the Project to obtain specifically requested technical support in SDA-related matters. The 1997 groundwater monitoring results for the SDA are reported in this document in *Appendix F* [pp. F-3 through F-10] but are not discussed here.

Table E-1 (p. E-3) identifies the position of a monitoring location relative to the waste management unit. The wells monitoring a given hydrogeologic unit (e.g., sand and gravel, weathered Lavery till) also may be arranged in a generalized upgradient to downgradient order based upon their location within the entire hydrogeologic unit. The hydraulic position of a well relative to a SSWMU, i.e., upgradient or downgradient, does not necessarily match that same well's position within a hydrogeologic unit. For example, a well that is upgradient in relation to a SSWMU may be located at any position within a hydrogeologic unit within the boundaries of the WVDP, depending on the geographic position of the SSWMU relative to the hydrogeologic unit. In general, the following text and graphics refer to the hydraulic position of monitoring wells within their respective hydrogeologic units, thus providing a site-wide hydrogeologic unit perspective.

History of the Monitoring Program

The groundwater monitoring program is designed to support DOE Order 5400.1 requirements and the RCRA 3008(h) Administrative Order on Consent. In general, the content of the program is dictated by these requirements in conjunction with current operating practices and historical knowledge of previous site activities.

Groundwater Monitoring Program Highlights 1982 to 1997

WVDP groundwater monitoring activities began in 1982 with the monitoring of tritium in the sand and gravel unit in the area of the lagoon system.

- By 1984 twenty wells in the vicinity of the main plant and the NDA provided monitoring coverage.

- Fourteen new wells, a groundwater seep location, and the french drain outfall were added in 1986 to provide monitoring of additional site facilities.

• Ninety-six new wells were installed in 1990 to support data collection for the environmental impact statement and RCRA facility investigations.

• A RCRA facility investigation expanded characterization program was conducted during 1993 and 1994 to fully assess potential releases of hazardous wastes or constituents from on-site SSWMUs. This investigation, which consisted of two rounds of sampling for a wide range of radiological and chemical parameters, yielded valuable information regarding the presence or absence of groundwater contamination near each SSWMU and was also used to guide later monitoring program modifications.

• In 1993 monitoring results indicated elevated gross beta activity in groundwater in 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 *Special Groundwater Monitoring*, p. 3-15, for more detail.)

• Long-term monitoring needs were the focus of 1995 groundwater monitoring program evaluations. A comprehensive assessment reduced the number of sampling locations from ninety-one to sixty-five, for a more efficient and cost-effective program.

• Wells, analytes, and sampling frequencies continued to be modified in 1997 in response to DOE and RCRA monitoring requirements.

Annual Analytical Trigger Limit Review

A computerized data evaluation program using "trigger limits" for all chemical and radiological analytes was instituted in 1995. These preset limits are conservative values for chemical or radiological concentrations that were developed to expedite a prompt focus on any monitoring anomalies. Early in 1997 these statistically derived trigger limits were updated by incorporating data collected during 1996.

1997 Groundwater Monitoring Results

Successful implementation of the WVDP's groundwater monitoring program includes proper placement of groundwater monitoring wells, using appropriate methods of sample collection, reviewing analytical data and quality assurance information, and presenting, summarizing, and evaluating the resulting data appropriately. Data are presented in this report through tables and graphs.

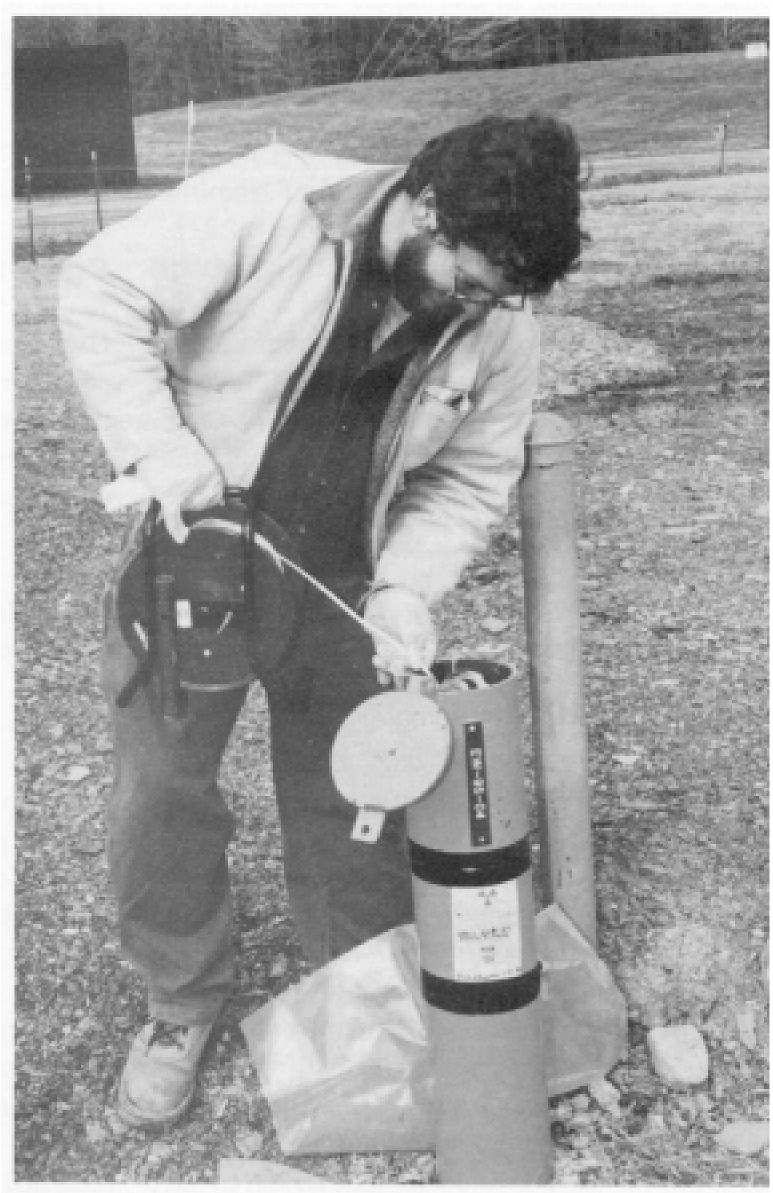
Presentation of Results in Tables

The tables in *Appendix E* (pp. E-7 through E-25) present the results of groundwater monitoring grouped according to the five hydrogeologic units monitored: the sand and gravel unit, the Lavery till-sand unit, the weathered Lavery till unit, the unweathered Lavery till unit, and the Kent recessional sequence.

These tables contain the results of 1997 sampling for the radiological and nonradiological analyte groups noted on Table 3-1 (p. 3-7). Table E-14 (pp. E-26 through E-28) lists the practical quantitation limits (PQLs) for individual analytes. *Appendix E* tables also display each well's hydraulic position relative to other wells within the same hydrogeologic unit.

Wells identified as UP refer to either background or upgradient wells that are upgradient of all other wells in the same hydrogeologic unit.

Downgradient locations are designated B, C, or D to indicate their positions along the groundwater flow path relative to each other. Wells denoted as DOWN - B are closest to the UP wells. Wells de-



Measuring Water Levels in a Groundwater Monitoring Well

These tables also list the sample collection periods. The 1997 sampling year covers the period from December 1996 (the first quarter of 1997) through September 1997 (the fourth quarter of 1997).

Presentation of Results in Graphs

High-Low Graphs

Graphs showing the 1997 measurements for contamination and radiological indicator parameters (pH, conductivity, gross alpha, gross beta, and tritium) have been prepared for all active monitoring locations in each geologic unit. (See pp. E-29 through E-38). These graphs allow results for all wells within a given hydrogeologic unit to be visually compared to each other. All the high-low graphs present the upgradient wells on the left side of the figure. Downgradient locations are plotted to the right according to their relative position along the groundwater flow path.

On the nonradiological graphs (pH and conductivity), the upper and lower tick marks on the vertical bar indicate the highest and lowest measurements recorded during 1997. The middle tick represents the arithmetic mean of all 1997 results. The vertical bar thus represents the total range of the data set for each monitoring location.

noted as DOWN-C are downgradient of DOWN - B wells but are upgradient of DOWN-D wells. DOWN-D wells are downgradient of all other wells on-site.

Grouping the wells by hydraulic position provides a logical basis for presenting the groundwater monitoring data in the tables and figures in this report.

On the radiological graphs (gross alpha, gross beta, and tritium), the middle tick is again used to represent the arithmetic mean of all 1997 results. However, the upper and lower tick marks on the vertical bar indicate the upper and lower ranges of the pooled error terms for all 1997 results. This format illustrates the relative amount of uncertainty associated with the radiological measurements. By displaying the uncertainty together with the mean, a more realistic perspective is obtained. (See also *Data Reporting* [p. 5-7] in ***Chapter 5, Quality Assuranc***e .)

The sample counting results for gross alpha, gross beta, and tritium, even if below the minimum detectable concentrations, were used to generate the high-low graphs. Thus, negative values were included. This is most common for the gross alpha analyses, where sample radiological counting results may be lower than the associated instrument background.

The wells used to provide background values are noted on each graph. All the geologic units except the sand and gravel unit use a single well for background, and in previous years well NB1S was used as the background reference well for the sand and gravel unit. However, the collective monitoring results from three upgradient wells (301, 401, and 706) currently are used for comparison with other sand and gravel wells as a way of better representing the natural spatial variability within the geologic unit. Both DOE and NYSDEC have accepted the use of this collective background reference instead of well NB1S.

Trend-Line Graphs

Trend-line graphs (pp. 3-21 through 3-24) have been used to show concentrations of a particular parameter over time at monitoring locations that have historically shown concentrations above background values: the volatile organic compounds 1,1-dichloroethane (1,1-DCA) at wells 8609 and 8612; dichlorodifluoromethane (DCDFMeth) at wells 803 and 8612; 1,2-dichloroethylene (1,2-DCE) and 1,1,1-trichloroethylene (1,1,1-TCA) at well 8612 (see *Volatile and Semivolatile Organic Compounds* below [p. 3-14]); and gross beta and tritium at selected groundwater monitoring locations (104, 111, 408, 501, 502, 801, 8603, 8604, 8605, and GSEEP).

Results of Radiological Analyses

Long-term Trends of Gross Beta and Tritium at Selected Groundwater Monitoring Locations

Figures 3-6 through 3-9 (pp. 3-21 through 3-24) show the trends of gross beta activity and tritium at selected monitoring locations. These specific groundwater monitoring locations in the sand and gravel unit were selected for trending because they have shown elevated or rising levels of gross beta activity or steady or falling levels of tritium. Results are presented on a logarithmic scale to adequately represent locations of differing concentrations.

The average background concentration is plotted on each graph for comparison purposes. All wells shown in these figures monitor the sand and gravel unit.

Gross Beta

The groundwater plume of gross beta activity in the sand and gravel unit on the north plateau (Fig. 3-4 [p. 3-12]) continues to be monitored closely. The source of the plume's activity can be traced to a subsurface area beneath the former process building. Nine wells (104, 111, 408, 501, 502, 801, 8603, 8604, and 8605) contain elevated levels of gross beta activity, i.e., greater than 1.0E-06μCi/mL, the DOE DCG for strontium-90. Gross beta results for wells 804 and 105 were one and two orders of magnitude less than the DOE DCG, respectively, thereby indicating the downgradient limits of the plume.

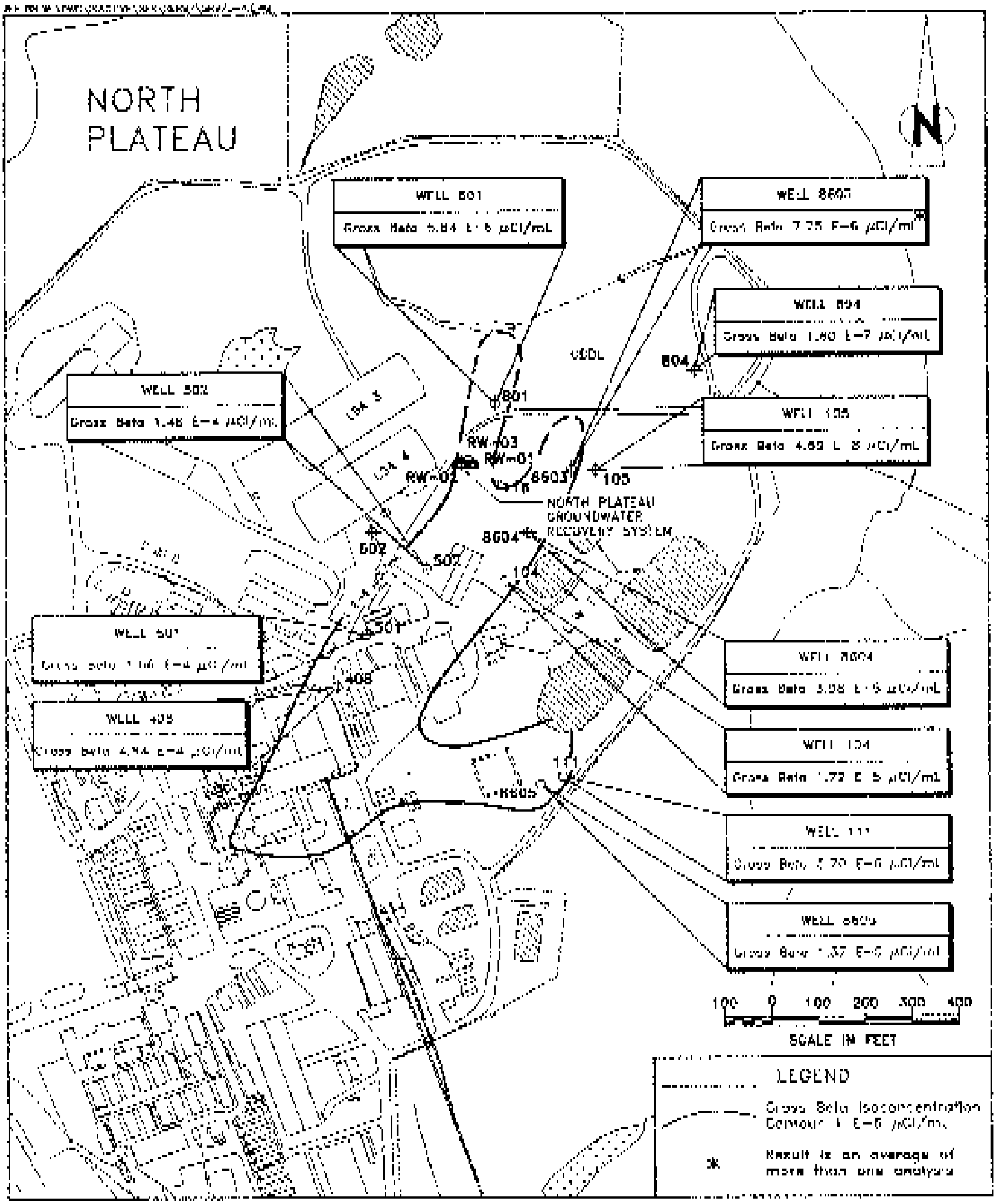


Figure 3-4. North Plateau Gross Beta Plume Area Fourth-Quarter 1997 Results.

• Figure 3-6 (p. 3-21) shows gross beta concentrations in wells 104, 111, 408, 501, 502, and 801 over the seven-year period that the WVDP's current groundwater monitoring program has been in place.

As in previous years, well 408 continued to contain the highest gross beta levels of all the wells within the north plateau gross beta plume area. The yearly average gross beta concentration at well 408 decreased slightly in 1997 as compared to levels in 1995 and 1996. The gross beta concentrations in wells 501 and 502 have remained relatively consistent over the last several years. Concentration trends for wells 104 and 801 are continuing to increase but at a slower rate than in previous years.

• Figure 3-7 (p. 3-21) is a graph of gross beta activity at monitoring locations 8603, 8604, 8605, and GSEEP. The trend at 8604 appears to have leveled off after several years of steep increases. Results from well 8603 have continued to show a steady upward trend, apparently due to migration of the eastern lobe of the north plateau plume.

Lagoon 1, formerly part of the low-level waste treatment facility, has been identified as a source of the gross beta activity at wells 8605 and 111. The gross beta concentrations at both wells have remained relatively steady over most of the twelve-year monitoring period (well 8605) and seven-year monitoring period (well 111), but are now starting to show decreasing trends.

Tritium

• Figure 3-8 (p. 3-22) shows the tritium concentrations in wells 104, 111, 408, 501, 502, and 801 over the seven-year period that the WVDP's current groundwater monitoring program has been in place. The figure shows that tritium concentrations in well 111 apparently have decreased over recent years. Other monitoring points show slight decreases or steady concentration trends.

• Figure 3-9 (p.3-22) shows the twelve-year trend of tritium concentrations at monitoring locations 8603, 8604, 8605, and GSEEP. Wells 8603 and 8604 indicate gradually declining trends in tritium, and 8605 shows a significant decrease over time.

North Plateau Seeps

Analytical results of semiannual sampling of the sand and gravel unit seepage locations for radiological parameters were time-trended and compared to the results from GSEEP, a seep monitored since 1991 that apparently exhibits no influences from the gross beta plume. (See Fig. 3-1 [p. 3-3].) Two rounds of routine samples to be analyzed for VOCs were collected at SP-12 in 1997. (See *Volatile and Semivolatile Organic Compounds* [p. 3-14].) Results were compared to concentrations in wells downgradient of the CDDL. Seep SP-23 could not be sampled in 1997 because it was dry.

Gross alpha and gross beta concentrations at the seeps remained similar in magnitude to GSEEP. There were a few minor fluctuations, but these did not appear to indicate elevated radiological activity or increasing trends. Gross alpha and gross beta results at all monitored seeps (including GSEEP) generally remained at background levels.

Tritium concentrations at the seeps remained similar in magnitude or were less than concentrations at GSEEP. Minor seasonal fluctuations over time also are apparent. Concentrations at all the seeps are slightly above background but are generally consistent with tritium levels seen in sand and gravel wells on the north plateau.

Results thus far appear to indicate that gross beta activity from the north plateau plume has not migrated as far as these seepage areas.

North Plateau Well Points

Seven well points were installed in 1990 downgradient of the process building and were sampled annually between 1993 and 1997 for radiological indicator parameters. These well points were used to supplement data collected from groundwater monitoring wells.

An evaluation concluded that gross alpha concentrations were at or near background levels at all well points. While gross beta concentrations were elevated, they were within historical ranges in wells downgradient of the process building.

Well points A, C, and H (Fig. 3-1 [p. 3-3]) have yielded samples with elevated concentrations of tritium with respect to historical monitoring of wells in the area. However, the tritium concentrations are well below the DOE derived concentration guide of 2.0E-03μCi/mL. Data from downgradient monitoring wells have not indicated similarly elevated levels of tritium.

This area east of the process building and west of lagoon 1 may be an area of localized contamination, and it will continue to be monitored annually for contamination indicator and radiological indicator parameters in the future. Well points D, E, F, and G will no longer be sampled because adequate coverage is provided by active monitoring wells. Sampling will continue at well points A,C, and H to further evaluate the presence of tritium in this localized area.

Results of Monitoring at the NDA

Gross beta and tritium concentrations in samples from well 909 and location NDATR (Fig. 3-1[p. 3-3]) continued to be elevated with respect to other locations monitoring the NDA but remained well below the DCGs. Radiological indicator results have historically fluctuated at these locations, but, in general, upward trends in gross beta and tritium are discernible at well 909. Gross beta concentrations from well 909 are considerably higher than at NDATR; residual soil contamination near this well is the suspected source. There were no monitoring results in 1997 that indicated the presence of TBP, confirming historical results.

Results of Radioisotopic Sampling

Groundwater samples for radioisotopic analyses are collected regularly from fifteen monitoring points in the sand and gravel unit and the weathered Lavery till. (See Table E-2 [pp. E-7 through E-10] and Table E-4 [p. E-12].) Results from 1997 generally confirmed historical findings. Strontium-90 remained the major contributor to elevated gross beta activity in the plume on the north plateau.

Technetium-99, iodine-129, and carbon-14 radionuclides, which were previously noted at several monitoring locations at concentrations above background levels (at specific wells within the gross beta plume and downgradient of inactive lagoon 1), have been demonstrated to contribute very small percentages of total gross beta concentrations. None of these concentrations have been above DCGs, and gross beta analyses continue to provide surveillance on a quarterly basis.

Volatile and Semivolatile Organic Compounds

Volatile and semivolatile organic compounds were sampled at specific locations (wells 8612, 8609, 803, and 111 [Fig. 3-1, p. 3-3]) that have shown historical results above their respective practical quantitation levels (PQLs). (The PQL is the lowest level that can be measured within specified limits of precision during routine laboratory operations on most matrices. [New York State Department of Environmental Conservation 1991]. See Table E-14 [pp. E-26 through E-28] for a list of PQLs.) Other monitoring locations are sampled for volatile and semivolatile organic compounds because they are downgradient of locations showing positive results.

The 1991 through 1997 trends in concentrations of the compound 1,1-dichloroethane (1,1-DCA) are illustrated in Figure 3-10 (p.3-23). Concentrations of 1,1-DCA at well 8612 remained consistent with results from previous years. The compound 1,1-DCA was not detected at wells 8609 and 803 during 1997. At groundwater seep SP-12 the compound was reported at estimated concentrations below the PQL. (See Table E-9 [p. E-16].)

Trends of dichlorodifluoromethane (DCDFMeth) concentrations are shown in Figure 3-11 (p.3-23). The concentrations of DCDFMeth at well 8612 remained at low levels in 1997 — near the detection limit. DCDFMeth was identified at well 803 at concentrations below the PQL. DCDFMeth was not detected at SP-12 during 1997.

Another positive VOC detection (Fig. 3-12 [p. 3-24]) was 1,2-dichloroethylene (1,2-DCE) at well 8612, which showed an increasing trend during 1997. (This compound was first detected in 1995.) Concentrations of the compound 1,1,1- trichloroethane (1,1,1-TCA) also were detected at well 8612 at or below the PQL.

The VOCs 1,1-DCA, DCDFMeth, and 1,1,1-TCA are often found in combination with each other and with 1,2-DCE. In well 8612 each of these three compounds first exhibited an increasing trend that, over the past few years, was then followed by a decreasing trend. It is expected that 1,2-DCE will exhibit similar behavior, and continued routine monitoring will evaluate future trends.

Aqueous concentrations of tributyl phosphate (TBP) were detected at well 8605, near lagoon 1, at higher concentrations than in 1996. Current results are closer to the levels reported in 1994 and 1995. TBP was not detected in well 111, which is next to and downgradient of well 8605, although positive detections of TBP have been reported in the past.

The ongoing detection of TBP in this localized area may be related to previously detected low, positive concentrations of iodine-129 and uranium-232 in wells 111 and 8605, as noted in previous annual Site Environmental Reports. The presence of all three contaminants indicates that these results reflect residual contamination from previous waste disposal activities in the former lagoon 1 area during historical fuel reprocessing. TBP concentrations detected in groundwater in this area during 1997 were limited to well 8605. Future trends of TBP will be evaluated as part of the routine groundwater monitoring program.

Special Groundwater Monitoring

Interim Mitigative Measures Near the Leading Edge of the Gross Beta Plume on the North Plateau

Elevated gross beta activity has been detected in groundwater from the surficial sand and gravel unit in localized areas north and east of the former process building (Fig. 3-4 [p. 3-12]). The most likely source of the gross beta activity is previous fuel reprocessing activities by NFS. In December 1993 elevated gross beta concentrations were detected in surface water at former sampling location WNDMPNE, located at the edge of the plateau. This detection initiated a subsurface investigation, in 1994, of groundwater and soil using the Geoprobe®, a mobile sampling system. The investigation was used to define the extent of the gross beta plume beneath and downgradient of the process building. The gross beta plume delineated was approximately 300 feet wide and 800 feet long.

The highest gross beta concentrations in groundwater and soil were located near the southeast corner of the process building. The maximum activity in groundwater was 3.6E-03μCi/mL, and the maximum activity in soil reached 2.4E-02μCi/g. Strontium-90 and its daughter product, yttrium-90, were determined to be the isotopes responsible for most of the elevated gross beta activity in the groundwater and soil beneath and downgradient of the former process building (West Valley Nuclear Services Co., Inc. 1995). In 1995 the north plateau groundwater recovery system (NPGRS) was installed as a mitigative measure for minimizing the spread of the gross beta plume. The NPGRS was located near the leading edge of the main lobe of the plume where groundwater flows preferentially towards the edge of the plateau. The NPGRS initially consisted of two extraction wells (RW-01 and RW-02) to recover the contaminated groundwater. In September 1996 a third well (RW-03) was added to the NPGRS along with other system upgrades. The upgraded recovery system more effectively captures the contaminant plume in this area.

Water recovered by the NPGRS is treated by ion exchange to remove strontium-90. Treated water is transferred to lagoon 4 or 5 and then to lagoon 3 for ultimate discharge to Erdman Brook.

The radionuclides present at the WVDP site are residues from the reprocessing of commercial nuclear fuel during the 1960s and early 1970s. A very small fraction of these radionuclides is released off-site during the year through ventilation systems and liquid discharges and makes a negligible contribution to the radiation dose to the surrounding population through a variety of exposure pathways.

The north plateau groundwater recovery system operated successfully throughout 1997, recovering and processing approximately 5.5 million gallons of water, a total of about 10 million gallons since November 1995.

Improvements to the site's north parking lot to divert surface water runoff away from the north plateau minimized groundwater recharge upgradient of the former process building and also reduced the amount of water needing to be recovered and processed by the NPGRS.

1997 Geoprobe® Investigation on the North Plateau

During the summer and fall of 1997, a second investigation was conducted using a Geoprobe® unit to provide additional characterization of the northeast leading edge of the north plateau gross beta groundwater plume. It was known that the main lobe of the plume was migrating northward, in the general direction of well 801. (See Fig. 3-4 [p. 3-12].) Recent groundwater sampling results northeast of the main lobe had indicated a second lobe of elevated gross beta activity migrating to the northeast, in the direction of well 8603. The objectives of the 1997 investigation included three-dimensional characterization of the second lobe and an evaluation of the geology of the soils within that area.

Investigation activities consisted of sampling soil and groundwater in the areas of interest. Three well points also were installed to provide additional groundwater sampling locations (West Valley Nuclear Services Co., Inc. June 1997). A summary report is being prepared, with completion scheduled for the first quarter of 1998.

Preliminary results of the 1997 Geoprobe® investigation provided improved definition of the eastern lobe of the plume and indicated that the main (western) lobe of the plume remains the primary route

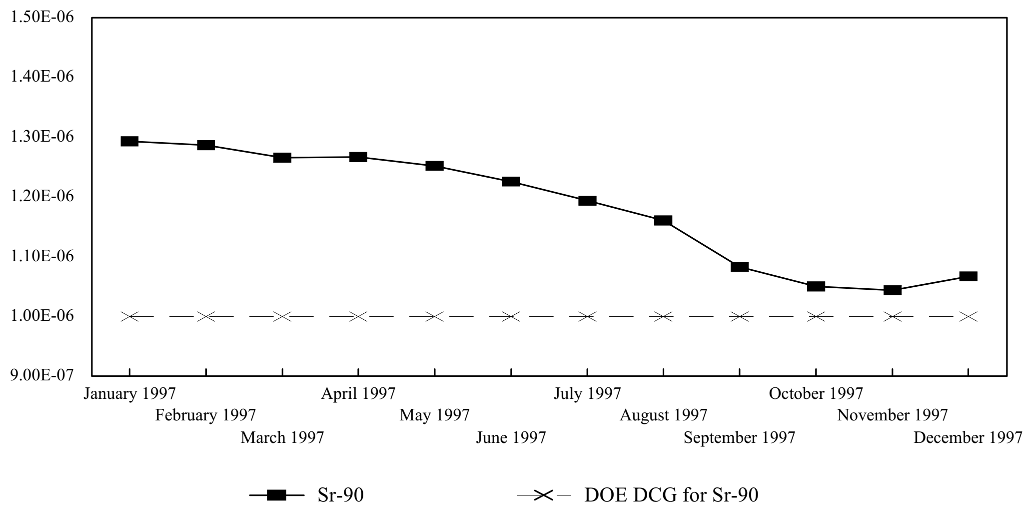


Figure 3-5. Annualized Average Strontium-90 Concentrations at Sampling Location WNSWAMP

of strontium-90 migration. Minor gross beta activity near well 804 appears to be related to residual soil contamination rather than plume migration.

Northeast Swamp Drainage Monitoring

In 1993 trend analyses of surface and groundwater monitoring results indicated increasing gross beta concentrations in waters discharged through the northeast swamp drainage as monitored at sampling points WNDMPNE and WNSWAMP, as discussed above. (WNDMPNE and WNSWAMP monitored the same location; samples collected as part of the groundwater program were identified as WNDMPNE, since discontinued, and surface water samples were identified as WNSWAMP.)

Routine surface water sampling during 1997 continued to monitor radiological discharges through the northeast swamp drainage. (See *Appendix C-1*, Table C-1.7 [p. C1-8]). Gross beta and strontium-90 concentrations continued to fluctuate due to seasonal effects. The annualized average strontium-90 concentrations trended downward during 1997 (see Fig. 3-5 above), which may be an indication of the effectiveness of the groundwater recovery system. WNSWAMP concentrations tend to decrease during periods of rainfall or snowmelt and to increase during dry weather.

The maximum average monthly gross beta concentration observed at WNSWAMP in 1997 was 3.22 ± 0.03E-06μCi/mL (119 ± 1.11 Bq/L), observed during July. The average minimum monthly gross beta concentration was 1.49 ± 0.02E-06μCi/mL (55 ± 0.74 Bq/L), observed in January.

Strontium-90 values ranged from a low of 6.82 ± 0.2E-07μCi/mL (25 ± 0.7Bq/L) in January to a high of 1.60 ± 0.02E-06μCi/mL (59 ± 0.74 Bq/L) in July. The strontium-90 DOE DCG, 1.0E-06μCi/mL (37 Bq/L), pertains to an annualized rolling average, which currently (January 1997 to December 1997) is 1.07 ± 0.02E-06μCi/mL (107% of the DOE DCG). This value is down from the 1996 level of 133%. It is probable that the operation of the groundwater recovery system has contributed to this decrease.

Although the annualized averaged concentration of strontium-90 in surface water exceeded the DOE DCG at sampling location WNSWAMP (on the WVDP premises), monitoring downstream at the first point of public accesss (WFFELBR) continued to show strontium-90 concentrations to be nearly indistinguishable from background (WFBIGBR) concentrations. (See *Off-site Surface Water Sampling*, p. 2-12, in ***Chapter 2, Environmental Monitoring***.

Special Monitoring for the North Plateau Groundwater Quality Early Warning Evaluation

An early warning evaluation of selected monitoring well data was devised to identify possible changes in groundwater quality recovered by the NPGRS that might affect compliance with site effluent limitations on pollutants specified in the SPDES permit for outfall 001. This monitoring is important because water recovered by the NPGRS ultimately is discharged through outfall 001.

The early warning system compares quarterly monitoring results from three wells (116, 602, and 502) in the vicinity of the NPGRS to early warning levels (multiples of the SPDES permit levels) in order to identify concentrations that may affect compliance with SPDES effluent limits. Two of the wells, 116 and 602, are used to monitor groundwater in the area affected by NPGRS drawdown. The third well, 502, is directly upgradient of the NPGRS and is sampled for additional parameters (mostly total and dissolved metals) not routinely analyzed under the groundwater monitoring program.

Evaluation of 1997 early warning data indicated one exceedance during the third quarter. Metallic cobalt was detected at a concentration of 0.024 mg/L; the early warning level is 0.015mg/L. However, no associated exceedance of the SPDES permit limit for cobalt (0.005mg/L) occurred at outfall 001. No other early warning level exceedances occurred during 1997.

Pilot Program Investigating Chromium and Nickel in the Sand and Gravel Unit

Long-term groundwater monitoring results have shown a wide range of chromium and nickel concentrations in the sand and gravel unit, both spatially and over time. The randomness of elevated concentrations indicated that the source probably was not related to a release from an on-site facility.

However, a possible source of elevated metals in groundwater samples is corrosion of stainless steel monitoring well screens and casings: Metals leached from the well materials can adsorb to sediment particles within the well and these particles can then become entrained in the groundwater sample by vigorous purging and sampling techniques, which are known to agitate the water and suspend sediment particles in a well.

A study was initiated in 1997 to determine the effect of modifying sampling equipment and methodology on the concentrations of chromium and nickel in the groundwater. Twelve sand and gravel wells were selected for the investigation. The equipment and sampling methods for six of the wells were left unchanged and these wells were sampled according to routine procedures. The sampling equipment and methodology of the other six wells were modified in order to minimize the amount of solids collected during sampling.

Test results are being evaluated, and a final report will be issued in June 1998. A preliminary evaluation of the data results indicates that the modified sampling equipment and methodology may contribute to lower measured chromium and nickel concentrations, which are believed to be more representative of actual groundwater conditions.

Results of Off-Site Groundwater Monitoring

Ten off-site wells, used by site neighbors as sources of drinking water, were sampled for radiological parameters, pH, and conductivity as part of the groundwater monitoring program during 1997. (See Fig. A-5 [p. A-49].) Sampling and analysis indicated no evidence of contamination by the WVDP of these off-site water supplies. Analytical results are found in Table C-1.26 (p. C1-20) in *Appendix C-1*.

Summary of Site Groundwater Monitoring

One of the primary functions of routine groundwater monitoring at the WVDP is to provide timely detection of contaminant release, if any, from SSWMUs to site groundwater. Program specifications, such as monitoring well locations and selected analytes, were designed for this purpose. Groundwater monitoring data collected during 1997 did not indicate new releases from SSWMUs or any other new groundwater concerns.

Groundwater seep samples from the sand and gravel unit are collected quarterly from several points near the northeast corner of the north plateau. These points are hydraulically downgradient of the site. Analytical results from seep samples obtained during 1997 indicated no concentrations of radiological or chemical parameters above regulatory guidelines.

The 1997 groundwater monitoring program reflects continuous refinements of a systematic routine based on historic groundwater data, site-use information, and recent trends. These data and information are also used to make responsible, proactive decisions such as the Geoprobe® investigations to better define the north plateau gross beta plume and installation and operation of the NPGRS. The pilot study to investigate chromium and nickel in groundwater, discussed earlier in this chapter, is another example of an action resulting from historic data evaluation. Sample collection methods may be permanently modified, depending on this study's conclusions.

Groundwater monitoring will continue on a quarterly basis during 1998. If and when items of concern are discovered, they will be addressed in order to protect groundwater resources in the vicinity of the WVDP.

Groundwater Sampling Methodology

Groundwater samples are collected from monitoring wells using either dedicated Teflon® well bailers or bladder pumps. (Dedicated bailers are equipped with Teflon®-coated stainless steel leaders.)

The method of collection depends on well construction, water depth, and the water-yielding characteristics of the well. Bailers are used in low-yield wells; bladder pumps are used in wells with good water-yielding characteristics.

To ensure that only representative groundwater is sampled, three well volumes are removed (purged) from the well before the actual samples are collected. If three well volumes cannot be removed because of limited recharge, purging the well to dryness provides sufficient purging. Conductivity and pH are measured before sampling and after sampling, if sufficient water is still available, to confirm the geochemical stability of the groundwater during sampling.

The bailer, a tube with a check valve at the bottom, is lowered into the well until it reaches the desired point in the water column. The bailer is lowered slowly to minimize agitation of the water column and is then withdrawn from the well with a sample and emptied into a sample container. The bailer, bailer line, and bottom-emptying device used to drain the bailer are dedicated to the well, i.e., are not used for any other well.

Bladder pumps use compressed air to gently squeeze a Teflon® bladder that is encased in a stainless steel tube located near the bottom of the well. When the pressure is released, new groundwater flows into the bladder. A series of check valves ensures that the water flows only in one direction. The operating air is always separated from the sample and is expelled to the surface by a separate line.

Bladder pumps reduce mixing and agitation of the water in the well. Each bladder pump system is dedicated to an individual well to reduce the likelihood of sample contamination from external materials or cross contamination. The air compressor and pump control box can be used from well to well because they do not contact the sample.

Immediately after the samples are collected they are put into a cooler and returned to the Project's Environmental Laboratory. The samples are preserved with chemicals, if necessary, and stored under controlled conditions to minimize chemical and/or biological changes after sample collection. The samples are then either packaged for expedited delivery to an off-site contract laboratory or kept in controlled storage to await on-site testing. A strict chain-of-custody protocol is followed for all samples.

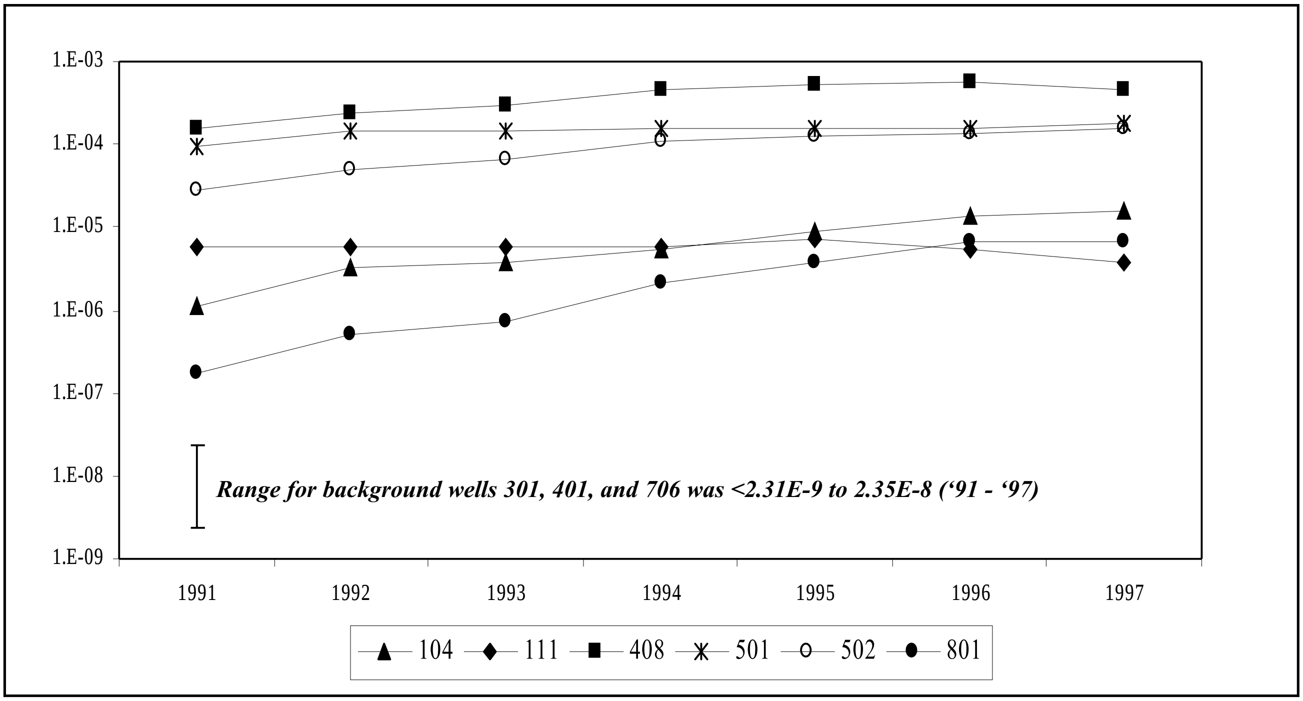


Figure 3-6. Seven-Year Trends of Averaged Gross Beta Activity (µCi/mL) at Selected Locations in the Sand and Gravel Unit

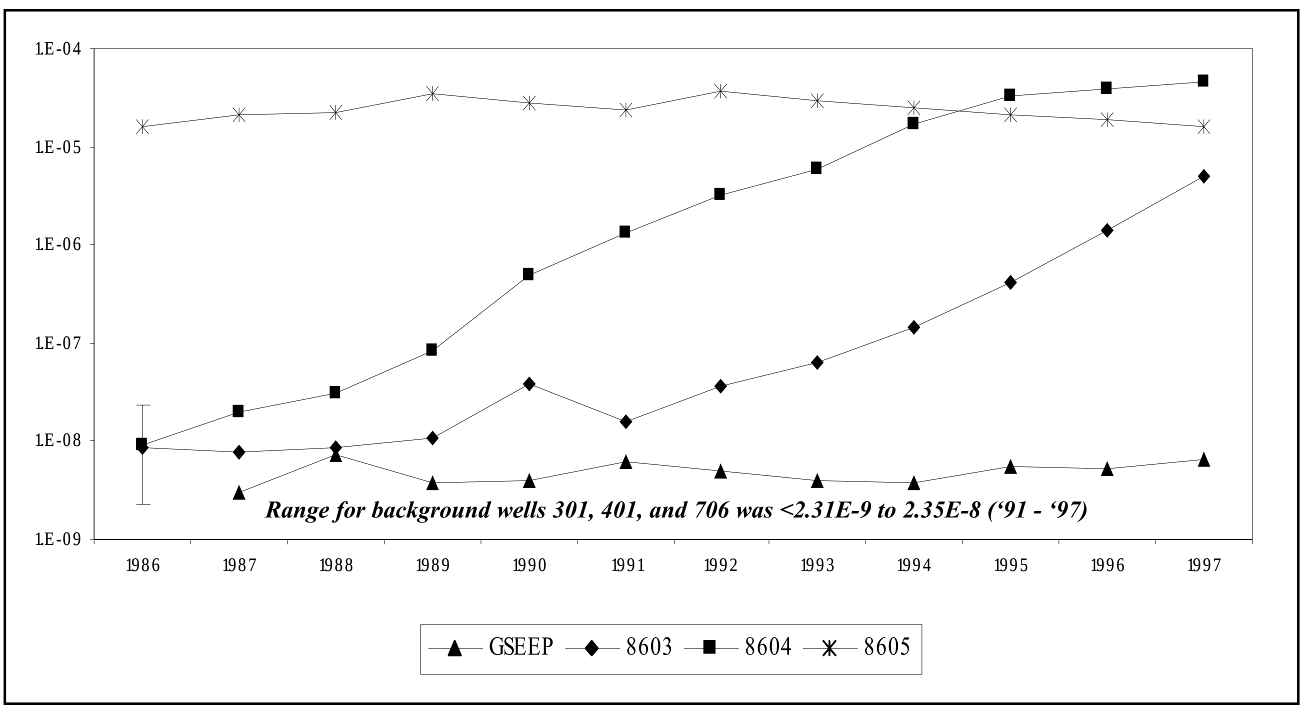


Figure 3-7. Twelve-Year Trends of Averaged Gross Beta Activity (µCi/mL) at Selected Locations in the Sand and Gravel Unit

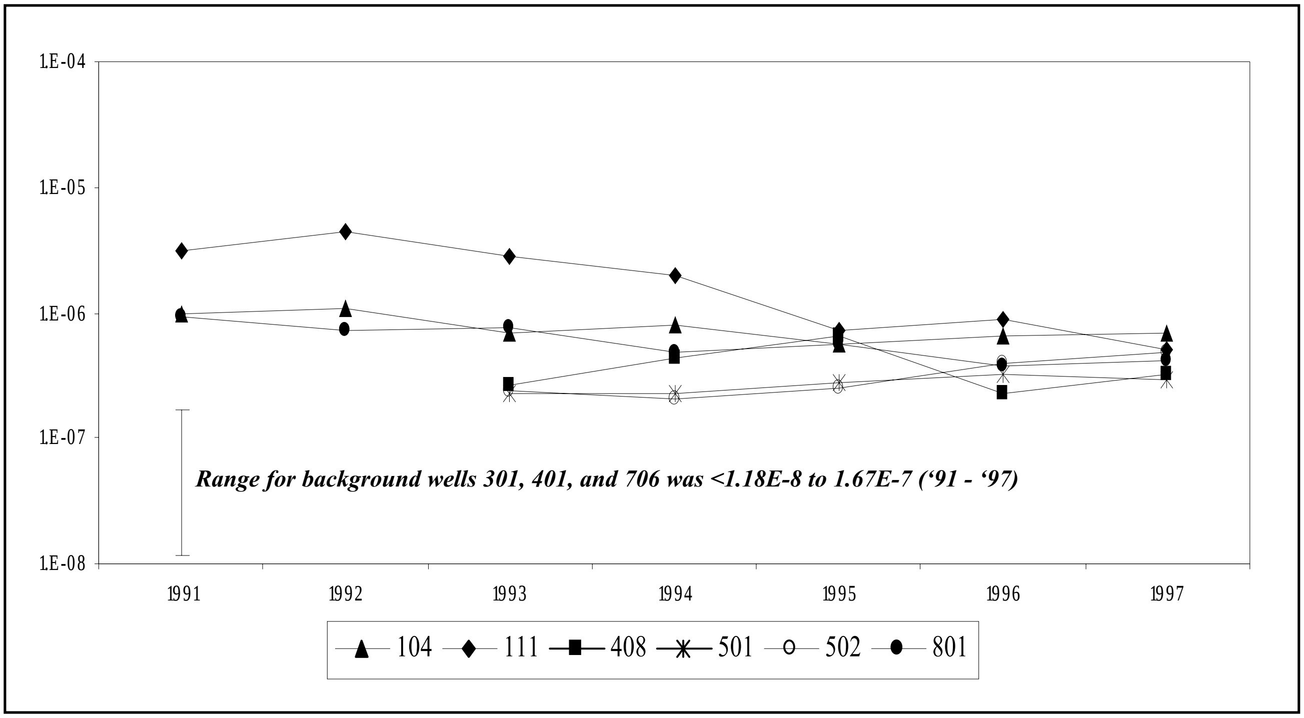


Figure 3-8. Seven-Year Trends of Averaged Tritium Activity (µCi/mL) at Selected Locations in the Sand and Gravel Unit

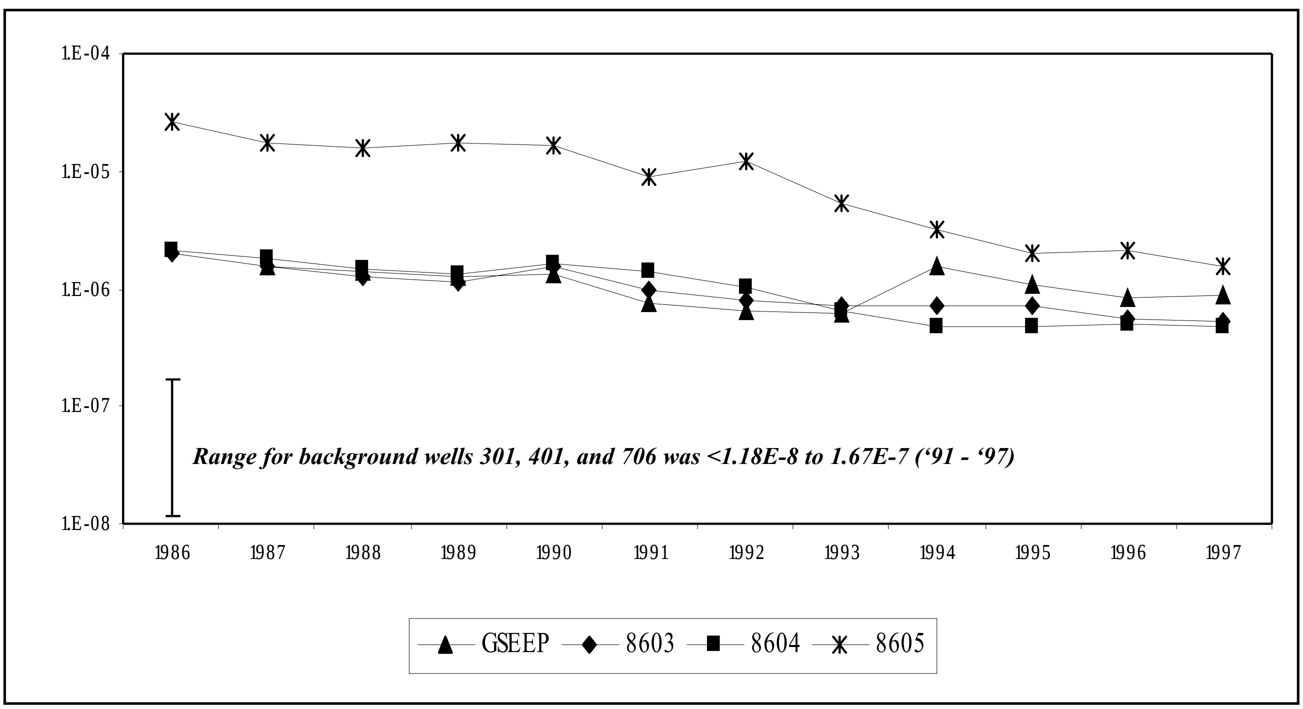


Figure 3-9. Twelve-Year Trends of Averaged Tritium Activity (µCi/mL) at Selected Locations in the Sand and Gravel Unit

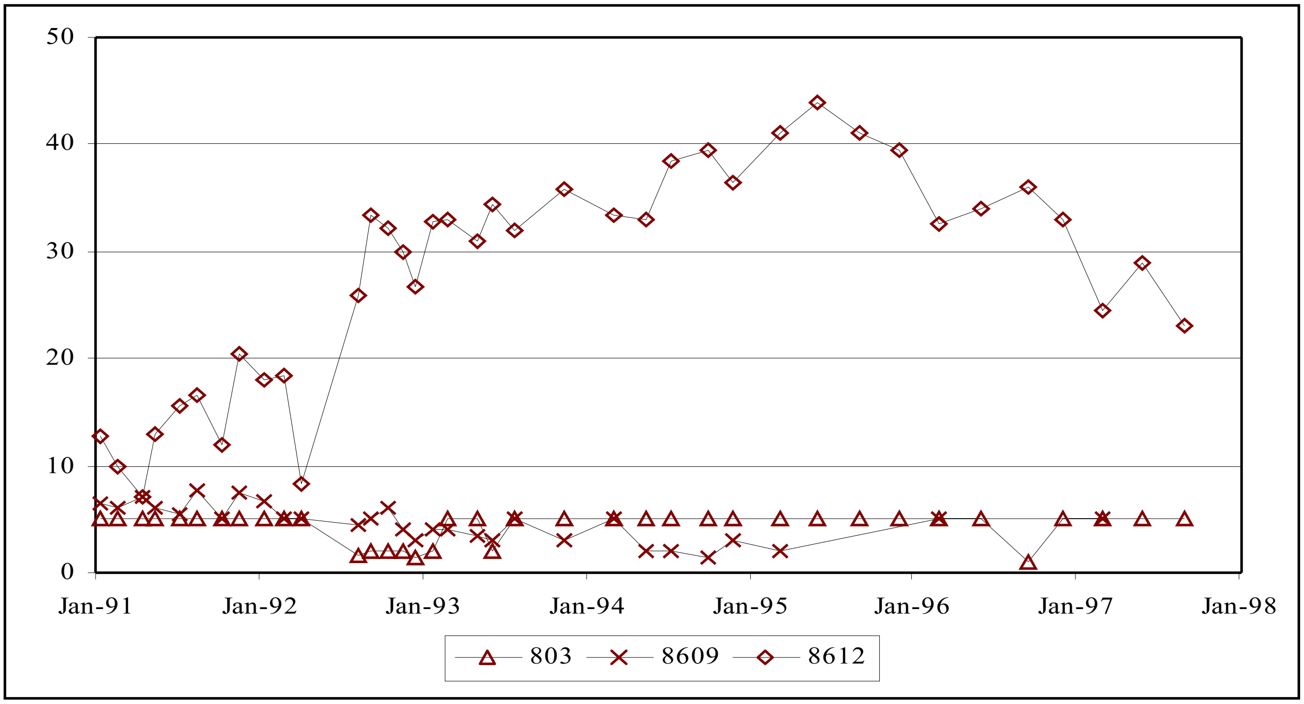


Figure 3-10. Eight-Year Trends (1991 through 1997) of 1,1-DCA (µg/L) at Selected Monitoring Locations

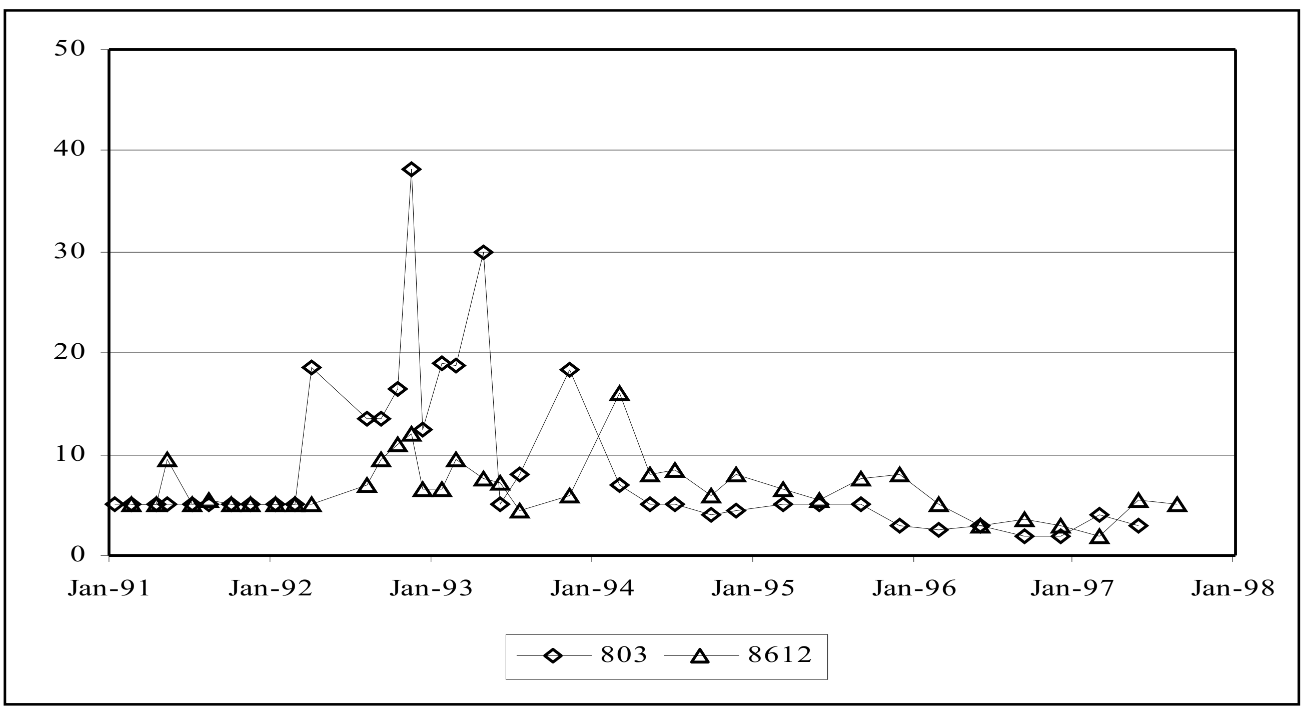


Figure 3-11. Seven-Year Trends (1991 through 1997) of Dichlorodifluoromethane (DCDFMeth) (µg/L) at Selected Groundwater Locations

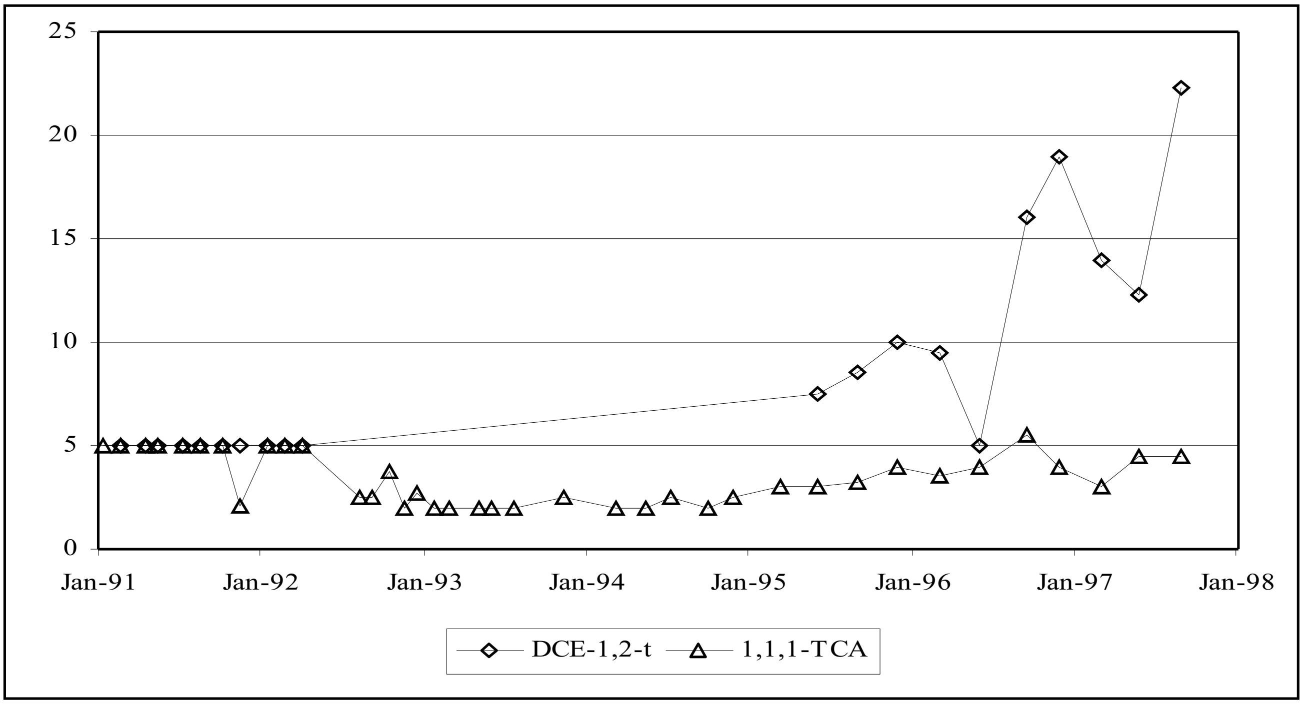


Figure 3-12. Seven-Year Trends of 1,2-DCE and 1,1,1-TCA (µg/L) (1991 through 1997) at Well 8612