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# GROUNDWATER MONITORING

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## Geology of the West Valley Site

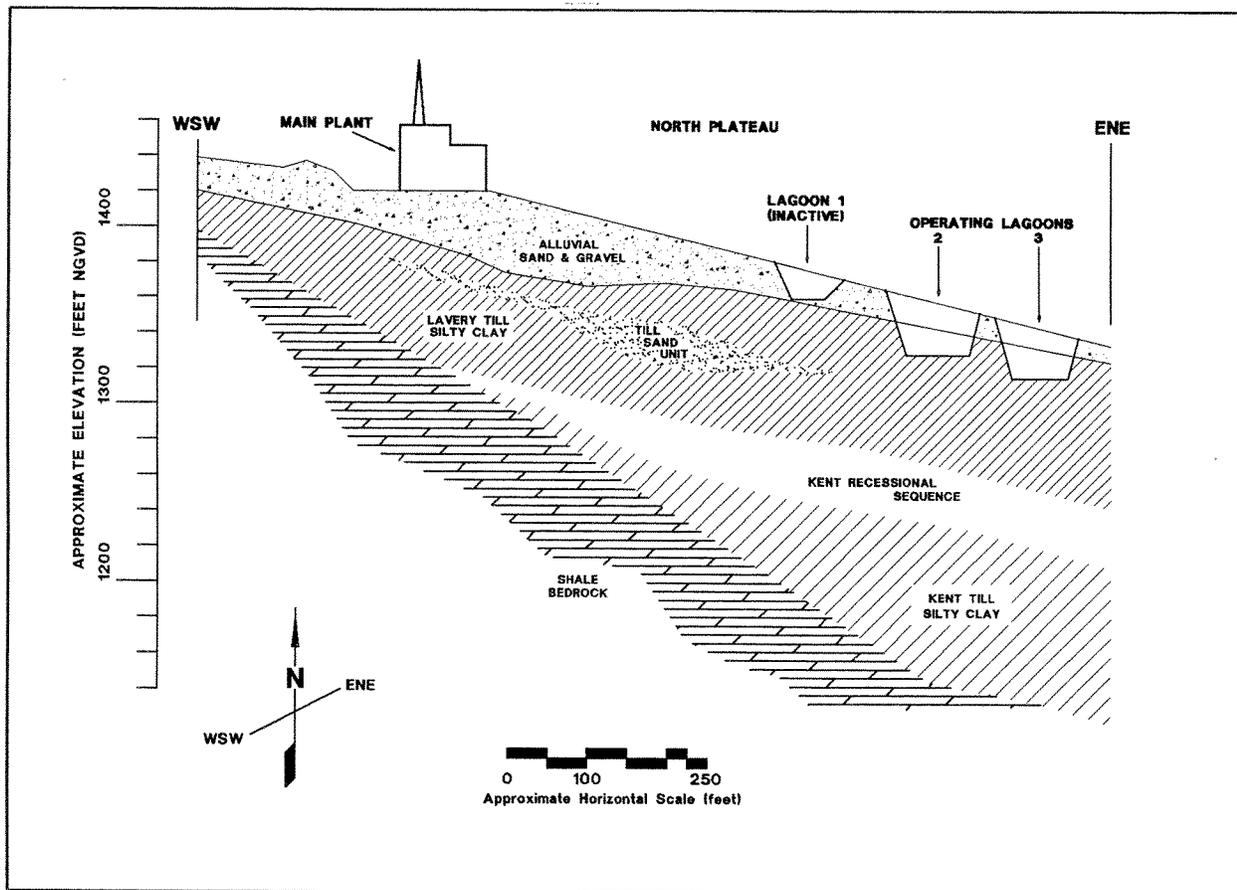
The West Valley Demonstration Project is located on the dissected and glaciated Allegheny Plateau at the northern border of Cattaraugus County in southwestern New York. The site is underlain by a thick sequence of Holocene (recent) and Pleistocene (ice age) sediments contained in a steep-sided bedrock 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 sediments above the second (Kent) till are generally regarded as containing all of the potential routes for the migration of contaminants from the WVDP site. (See **Hydrogeology of the West Valley Site** below for a description of these units. See also Figs. 3-1 and 3-2, which show relative

locations of these sediments on the north and south plateaus.)

The most widespread glacial unit in the site area is the Kent till, deposited between 15,500 and 24,000 years ago toward the end of the Wisconsinan glaciation. At that time the ancestral Butter-milk 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 drainage ways. As the ice continued to melt, 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).

About 15,000 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



**Figure 3-1. Geologic Cross Section Through the North Plateau.**

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 15,000 and 14,200 years ago (LaFleur 1979). The modern Buttermilk Creek has cut the present valley since the final retreat of the Wisconsinan glacier.

## Surface Water Hydrology

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

The WVDP site is contained within the 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. 3-3).

The main plant, waste tanks, and lagoons are located on the north plateau. The drum cell, the NRC-licensed disposal area (NDA), and the state-licensed disposal area (SDA) are on the south plateau.

## Hydrogeology of the West Valley Site

### Unweathered Lavery Till and Recessional Sequence on the North and South Plateaus

The Lavery till is predominantly an olive gray, silty clay glacial till with scattered lenses of silt and sand. The till ranges up to 30 meters (100 ft) in thickness beneath the active areas of the site, generally increasing towards Buttermilk Creek and the center of the bedrock valley. The Lavery till is the surficial unit on the south plateau and is the host formation for wastes buried in the SDA and NDA; on the north plateau the Lavery till is immediately overlain by the surficial sand and gravel layer. Groundwater flow in the unweathered till is predominantly vertically

downward, towards the underlying recessional sequence. The hydraulic conductivity of the unweathered till ranges from  $10^{-8}$  to  $10^{-7}$  cm/sec ( $10^{-5}$  to  $10^{-4}$  ft/day). Values of vertical and horizontal hydraulic conductivity obtained from laboratory analysis of undisturbed cores and field analyses of piezometer recovery data suggest that the unweathered till is essentially isotropic, i.e., it has equal flow properties in both vertical and horizontal directions.

The underlying Kent recessional sequence, formerly called the lacustrine unit, consists of alternating deposits of lacustrine clayey silts and coarsely 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 bedrock valley intersects the sequence. Groundwater flow is predominantly to the northeast, towards Butter-

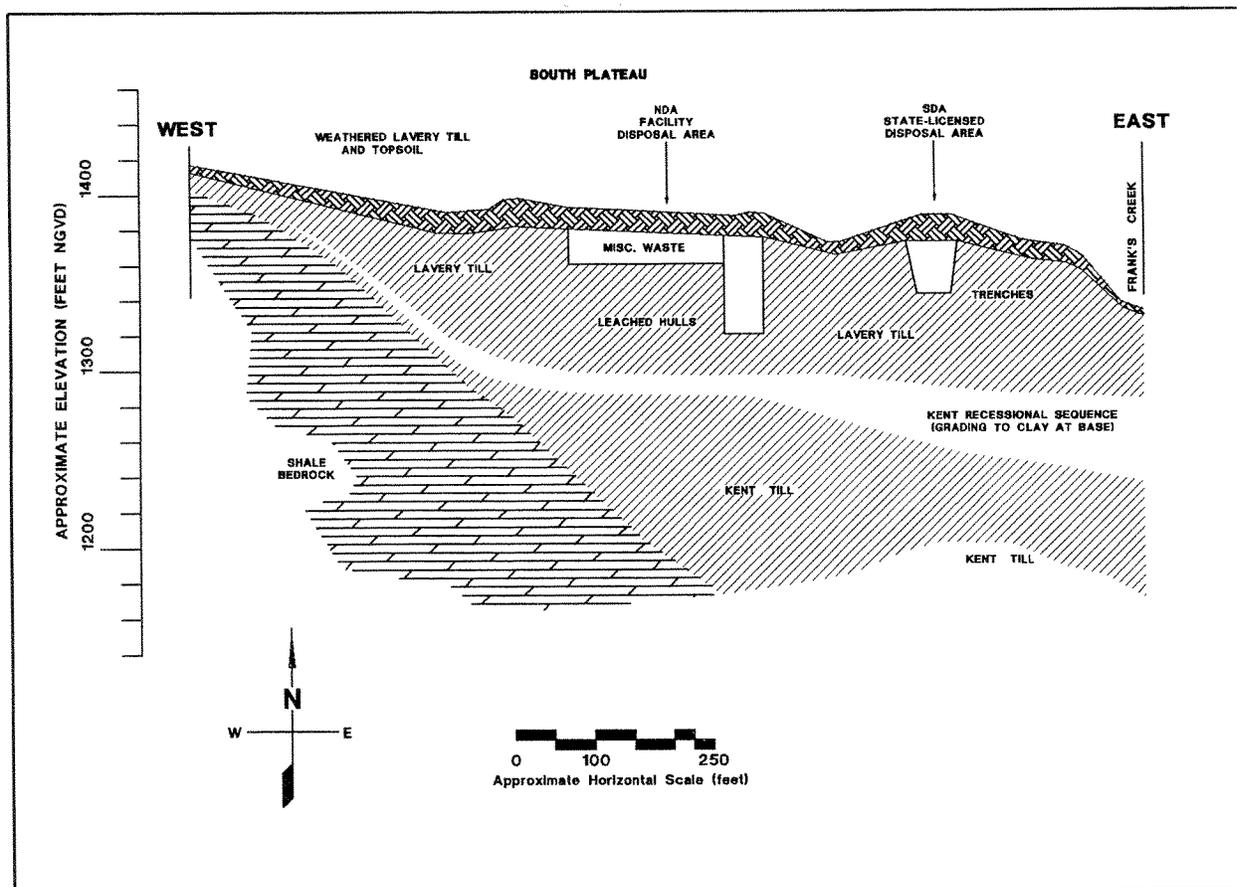


Figure 3-2. Geologic Cross Section Through the South Plateau.

WYDPA\_3.DWG

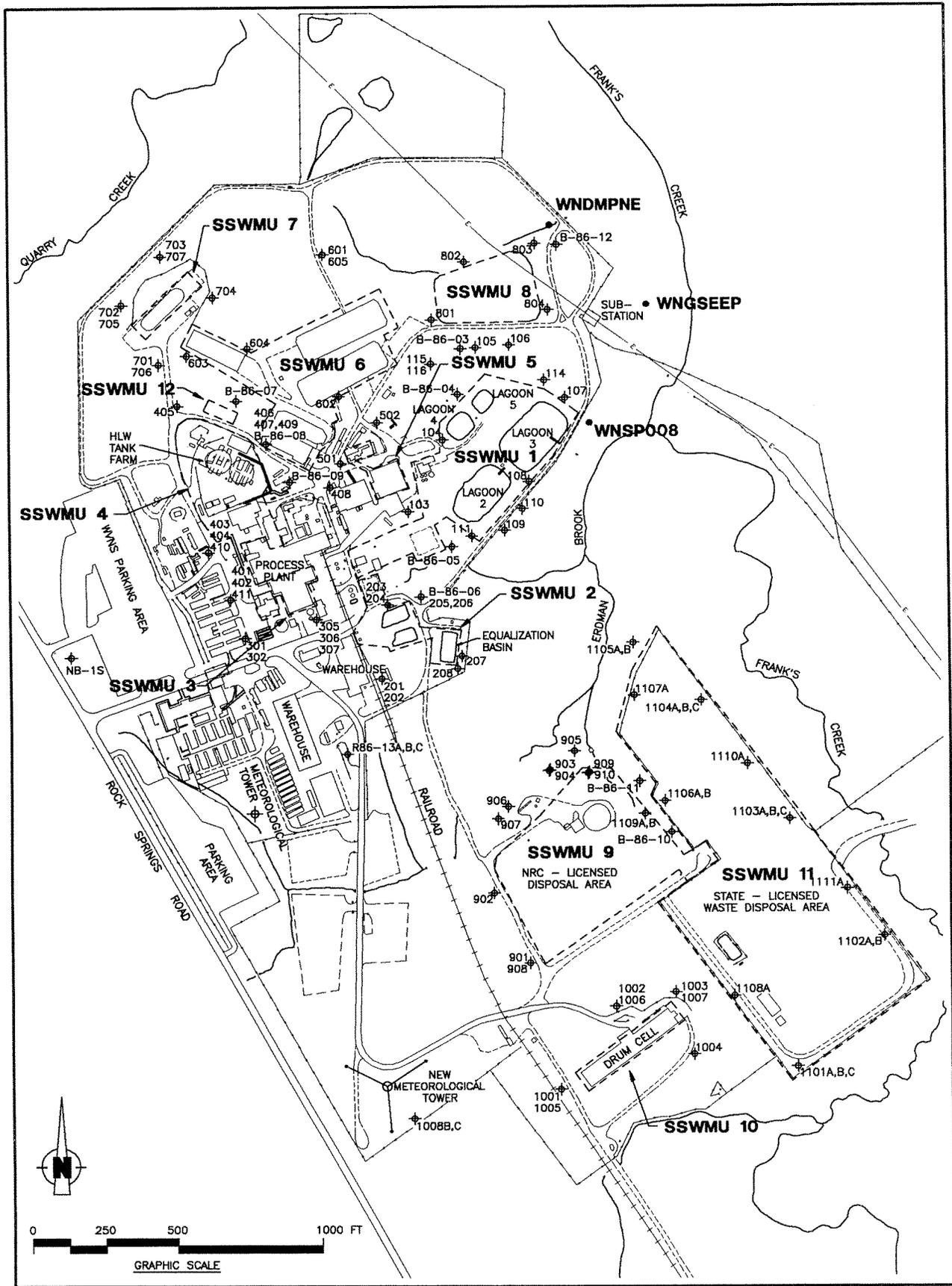


Figure 3-3. Location of On-site Groundwater Monitoring Network Wells.

milk Creek, at an estimated velocity of 13 cm/year (0.4 ft/yr). The hydraulic conductivity is approximately  $10^{-6}$  cm/sec ( $10^{-3}$  ft/day). Recharge comes from the overlying till and the bedrock in the southwest, and discharge is to Buttermilk Creek. Underneath the 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 further.

## **North Plateau**

### *Surficial Sand and Gravel Layer*

The north plateau is covered by 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 gullies.

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) under an average velocity of 18.6 m/yr (61 ft/yr). The mean hydraulic conductivity is  $1.5 \times 10^{-4}$  cm/sec (0.43 ft/day). Groundwater near the northwestern and southeastern margins of the sand and gravel layer flows radially outward toward Quarry Creek and Erdman Brook, respectively. A very small percentage of groundwater flows downward into the underlying Lavery till.

### *Lavery Till-sand*

On-site investigations from 1989 through 1990 have identified a lenticular sandy unit of limited areal extent and variable thickness within the Lavery till, primarily beneath the north plateau. This unit, called the till-sand, was not specifically identified in previous studies as a hydrologic unit. Groundwater flow through this unit is limited, and surface discharge locations have not been observed.



*Measuring a Soil Core Sample*

## 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 as 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 in the weathered till that occurs in the upper 4.5 meters (15 ft) flows both horizontally and vertically. 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 varies from  $10^{-8}$  to  $10^{-5}$  cm/sec ( $10^{-5}$  to  $10^{-2}$  ft/day), with the highest conductivities associated with dense fracture zones.

## Groundwater Monitoring Program Overview

Currently, 108 groundwater monitoring points provide radiological and chemical surveillance of both active and inactive super solid waste management units (SSWMUs) and of general site-wide conditions. A full schedule of monitoring for all points was in effect for all of 1993. One additional sampling point, WNNATR, was added during the second half of the year. On-site groundwater monitoring locations are shown on Figure 3-3. (See **Special Monitoring** in *Chapter 2*.)

Monitoring includes 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 3-1 lists

the twelve identified super solid waste management units, the hydraulic position of each well within the waste management unit, the geologic unit monitored, and the depth of each well. Figure 3-3 shows the boundaries of these twelve super solid waste management units at the WVDP. (Twenty-one of the wells are in the state-licensed disposal area [SDA] and are the responsibility of the New York State Energy Research and Development Authority [NYSERDA]. Although the state-licensed disposal area is a closed radioactive waste landfill contiguous with the Project premises, the WVDP is not responsible for the facilities or activities relating to it. Under a joint agreement with NYSERDA, however, the Project provides specifically requested technical support to NYSERDA in SDA-related matters.)

Groundwater monitoring fulfills multiple technical and regulatory requirements, which are summarized in the site's Environmental Monitoring Program Plan (West Valley Nuclear Services 1993), the draft Sampling and Analysis Plan for the Groundwater Monitoring Network (West Valley Nuclear Services 1990), the site Groundwater Protection Management Program Plan (West Valley Nuclear Services 1993), and the draft RCRA Facility Investigation Work Plan (West Valley Nuclear Services December 1993).

The data generated as part of the groundwater monitoring program also will be used to support preparation of an environmental impact statement (EIS) that will assess the effect of Project completion and site closure or long-term management.

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

*Upgradient well.* A well installed hydraulically upgradient of the SSWMU under study that is capable of yielding groundwater samples that are representative of local conditions and that are not affected by the unit in question.

Table 3-1

Groundwater Monitoring Network: Super Solid Waste Management Units

| SSWMUs and Constituent SWMUs                               | Well Identification Number | Expanded Characterization Schedule (Table 3-3) | Hydrogeological Unit Monitored | Positive Quarterly Volatile Organic Analyses | Well Position in SSWMU | Depth (ft) Below Grade |       |
|--|----------------------------|--|--------------------------------|--|------------------------|------------------------|-------|
| <i>SSWMU No. 1 - Low-level Waste Treatment Facilities:</i> |                            |  |                                |  |                        |                        |       |
| • Former Lagoon 1  | WNW0103                    | A  | S                              |  | U                      | 21.00                  |       |
| • LLWTF Lagoons  | WNW0104                    | A  | S                              |  | U                      | 23.00                  |       |
| • LLWTF Building   | WNW0105                    | A  | S                              |  | D                      | 28.00                  |       |
| • Interceptors   | WNW0106                    | A  | S                              |  | D                      | 14.50                  |       |
| • Neutralizer Pit  | WNW0107                    | A  | T                              |  | D                      | 28.00                  |       |
|  | WNW0108                    |  | T                              |  | D                      | 33.00                  |       |
|  | WNW0109                    | A  | T                              |  | D                      | 33.00                  |       |
|  | WNW0110                    | A  | T                              |  | D                      | 33.00                  |       |
|  | WNW0111                    | I  | S                              |  | D                      | 11.00                  |       |
|  | WNW0114                    |  | T                              |  | D                      | 29.00                  |       |
|  | WNW0115                    | A  | T                              |  | U                      | 28.00                  |       |
|  | WNW0116                    | A  | S                              |  | U                      | 11.00                  |       |
|  | WNW8603                    | A  | S                              |  | D                      | 24.80                  |       |
|  | WNW8604                    | A  | S                              |  | U                      | 22.60                  |       |
|  | WNW8605                    | A  | S                              |  | D                      | 12.00                  |       |
|  | WNW8606                    | A  | S                              |  | D                      | 12.10                  |       |
|  |                            | WNW0108  |                                | T  |                        | D                      | 33.00 |
|  |                            | WNW0109  | A                              | T  |                        | D                      | 33.00 |
|  |                            | WNW0110  | A                              | T  |                        | D                      | 33.00 |
|  | WNW0111                    | I  | S                              |  | D                      | 11.00                  |       |
|  | WNW0114                    |  | T                              |  | D                      | 29.00                  |       |
|  | WNW0115                    | A  | T                              |  | U                      | 28.00                  |       |
|  | WNW0116                    | A  | S                              |  | U                      | 11.00                  |       |
|  | WNW8603                    | A  | S                              |  | D                      | 24.80                  |       |
|  | WNW8604                    | A  | S                              |  | U                      | 22.60                  |       |
|  | WNW8605                    | A  | S                              |  | D                      | 12.00                  |       |
|  | WNW8606                    | A  | S                              |  | D                      | 12.10                  |       |
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|  | WNW0109                    | A  | T                              |  | D                      | 33.00                  |       |
|  | WNW0110                    | A  | T                              |  | D                      | 33.00                  |       |
|  | WNW0111                    | I  | S                              |  | D                      | 11.00                  |       |
|  | WNW0114                    |  | T                              |  | D                      | 29.00                  |       |
|  | WNW0115                    | A  | T                              |  | U                      | 28.00                  |       |
|  | WNW0116                    | A  | S                              |  | U                      | 11.00                  |       |
|  | WNW8603                    | A  | S                              |  | D                      | 24.80                  |       |
|  | WNW8604                    | A  | S                              |  | U                      | 22.60                  |       |
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|  | WNW0110                    | A  | T                              |  | D                      | 33.00                  |       |
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|  | WNW0114                    |  | T                              |  | D                      | 29.00                  |       |
|  | WNW0115                    | A  | T                              |  | U                      | 28.00                  |       |
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|  | WNW0110                    | A  | T                              |  | D                      | 33.00                  |       |
|  | WNW0111                    | I  | S                              |  | D                      | 11.00                  |       |
|  | WNW0114                    |  | T                              |  | D                      | 29.00                  |       |
|  | WNW0115                    | A  | T                              |  | U                      | 28.00                  |       |
|  | WNW0116                    | A  | S                              |  | U                      | 11.00                  |       |
|  | WNW8603                    | A  | S                              |  | D                      | 24.80                  |       |
|  | WNW8604                    | A  | S                              |  | U                      | 22.60                  |       |
|  | WNW8605                    | A  | S                              |  | D                      | 12.00                  |       |
|  | WNW8606                    | A  | S                              |  | D                      | 12.10                  |       |
|  | WNW0108                    |  | T                              |  | D                      | 33.00                  |       |
|  | WNW0109                    | A  | T                              |  | D                      | 33.00                  |       |
|  | WNW0110                    | A  | T                              |  | D                      | 33.00                  |       |
|  | WNW0111                    | I  | S                              |  | D                      | 11.00                  |       |
|  | WNW0114                    |  | T                              |  | D                      | 29.00                  |       |
|  | WNW0115                    | A  | T                              |  | U                      | 28.00                  |       |
|  | WNW0116                    | A  | S                              |  | U                      | 11.00                  |       |
|  | WNW8603                    | A  | S                              |  | D                      | 24.80                  |       |
|  | WNW8604                    | A  | S                              |  | U                      | 22.60                  |       |
|  | WNW8605                    | A  | S                              |  | D                      | 12.00                  |       |
|  | WNW8606                    | A  | S                              |  | D                      | 12.10                  |       |
|  | WNW0108                    |  | T                              |  | D                      | 33.00                  |       |
|  | WNW0109                    | A  | T                              |  | D                      | 33.00                  |       |
|  | WNW0110                    | A  | T                              |  | D                      | 33.00                  |       |
|  | WNW0111                    | I  | S                              |  | D                      | 11.00                  |       |
|  | WNW0114                    |  | T                              |  | D                      | 29.00                  |       |
|  | WNW0115                    | A  | T                              |  | U                      | 28.00                  |       |
|  | WNW0116                    | A  | S                              |  | U                      | 11.00                  |       |
|  | WNW8603                    | A  | S                              |  | D                      | 24.80                  |       |
|  | WNW8604                    | A  | S                              |  | U                      | 22.60                  |       |
|  | WNW8605                    | A  | S                              |  | D                      | 12.00                  |       |
|  | WNW8606                    | A  | S                              |  | D                      | 12.10                  |       |
|  | WNW0108                    |  | T                              |  | D                      | 33.00                  |       |
|  | WNW0109                    | A  | T                              |  | D                      | 33.00                  |       |
|  | WNW0110                    | A  | T                              |  | D                      | 33.00                  |       |
|  | WNW0111                    | I  | S                              |  | D                      | 11.00                  |       |
|  | WNW0114                    |  | T                              |  | D                      | 29.00                  |       |
|  | WNW0115                    | A  | T                              |  | U                      | 28.00                  |       |

Table 3-1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

| SSWMUs and Constituent SWMUs                          | Well Identification Number | Expanded Characterization Schedule (Table 3-3) | Hydrogeological Unit Monitored | Positive Quarterly Volatile Organic Analyses | Well Position in SSWMU | Depth (ft) Below Grade |
|---|----------------------------|--|--------------------------------|--|------------------------|------------------------|
| <b>SSWMU No. 3 - Liquid Waste Treatment System:</b>   |                            |  |                                |  |                        |                        |
| • Liquid Waste Treatment System                       | WNW0301                    |  | S                              |  | U                      | 16.00                  |
| • Cement Solidification System                        | WNW0302                    |  | TS                             |  | U                      | 28.00                  |
| • Main Process Bldg. (specific areas)                 | WNW0305                    | A  | S                              |  | D                      | 31.00                  |
| • Background (north plateau)                          | WNW0306                    |  | K                              |  | D                      | 81.00                  |
|   | WNW0307                    |  | S                              |  | D                      | 16.00                  |
|   | WNWNB1S                    | A  | S <sub>1</sub> (WT)            |  | B                      | 13.00                  |
| <b>SSWMU No. 4 - HLW Storage and Processing Area:</b> |                            |  |                                |  |                        |                        |
| • Vitrification Facility                              | WNW0401                    |  | S <sub>1</sub> (T)             |  | U                      | 16.00                  |
| • Vitrification Test Tanks                            | WNW0402                    | A  | TS                             |  | U                      | 29.00                  |
| • HLW Tanks   | WNW0403                    |  | S                              |  | U                      | 13.00                  |
| • Supernatant Treatment System                        | WNW0404                    |  | TS                             |  | U                      | 36.50                  |
|   | WNW0405                    | A  | T                              |  | C                      | 12.50                  |
|   | WNW0406                    | A  | S                              |  | D                      | 16.80                  |
|   | WNW0407                    |  | K <sub>1</sub> (T)             |  | D                      | 75.50                  |
|   | WNW0408                    | A  | S                              |  | D                      | 38.00                  |
|   | WNW0409                    | A  | T                              |  | D                      | 55.00                  |
|   | WNW0410                    |  | K                              |  | U                      | 78.00                  |
|   | WNW0411                    |  | K <sub>1</sub> (T)             |  | U                      | 66.00                  |
|   | WNW8607                    |  | S                              |  | D                      | 17.60                  |
|   | WNW8608                    |  | S                              |  | D                      | 19.00                  |
| WNW8609   | B                          | S  |                                | V  | D                      | 24.70                  |
| <b>SSWMU No. 5 - Maintenance Shop Leach Field:</b>    |                            |  |                                |  |                        |                        |
| • Maintenance Shop Leach Field                        | WNW0501                    | A  | S                              | V  | U                      | 33.00                  |
|   | WNW0502                    | A  | S                              |  | D                      | 18.00                  |

Well position in SSWMU: U = upgradient; D = downgradient; B = background; C = crossgradient.

Hydrogeologic units monitored are: WT = weathered Lavery till; T = unweathered Lavery till; S = sand and gravel; K = Kent recessional sequence; TS = till-sand. Units enclosed in brackets indicate the hydrogeologic unit is only a secondary monitoring unit.

V = quarterly volatile sampling. A, B, C, I = expanded characterization parameters for RFI. (See Table 3-3 for parameter list.)

R = annually for limited radiological sampling.

\* Location added to program during rep 6, 1993.

Table 3-1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

| SSWMUs and Constituent SWMUs                                     | Well Identification Number | Expanded Characterization Schedule (Table 3-3) | Hydrogeological Unit Monitored        | Positive Quarterly Volatile Organic Analyses | Well Position in SSWMU | Depth (ft) Below Grade |
|--|----------------------------|--|---------------------------------------|--|------------------------|------------------------|
| <b>SSWMU No. 6 - Low-level Waste Storage Area:</b>               |                            |  |                                       |  |                        |                        |
| • Hardstands (old & new)   | WNW0601                    | A  | S                                     |  | D                      | 6.00                   |
| • Lag Storage  | WNW0602                    | A  | S                                     |  | D                      | 13.00                  |
| • Lag Storage Additions  | WNW0603                    |  | S                                     |  | U                      | 13.00                  |
|  | WNW0604                    | A  | S                                     |  | D                      | 11.00                  |
|  | WNW0605                    |  | S,(T)                                 |  | D                      | 11.00                  |
|  | WNW8607                    |  | S                                     |  | U                      | 17.60                  |
|  | WNW8608                    |  | S                                     |  | U                      | 19.00                  |
| <b>SSWMU No. 7 - CPC Waste Storage Area:</b>                     |                            |  |                                       |  |                        |                        |
| • CPC Waste Storage Area   | WNW0701                    |  | TS                                    |  | U                      | 28.00                  |
|  | WNW0702                    |  | T                                     |  | C                      | 38.00                  |
|  | WNW0703                    |  | T                                     |  | D                      | 21.00                  |
|  | WNW0704                    | A  | T                                     |  | D                      | 15.50                  |
|  | WNW0705                    |  | T                                     |  | C                      | 21.00                  |
|  | WNW0706                    |  | S                                     |  | U                      | 11.00                  |
|  | WNW0707                    |  | T,(WT)                                |  | D                      | 11.00                  |
| <b>SSWMU No. 8 - Construction and Demolition Debris Landfill</b> |                            |  |                                       |  |                        |                        |
| • Former Construction and Demolition Debris Landfill             | WNW0801                    | A  | S                                     |  | U                      | 17.50                  |
|  | WNW0802                    | A  | S,(T)                                 |  | D                      | 11.00                  |
|  | WNW0803                    | B  | S                                     | V  | D                      | 18.00                  |
|  | WNW0804                    | A  | S                                     |  | D                      | 9.00                   |
|  | WNGSEEP                    | B  | Groundwater Seepage Monitoring Points |  | V                      |                        |
|  | WNDMPNE                    | A  |                                       |  |                        |                        |
|  | WNW8612                    | B  | S                                     | V  | D                      | 18.10                  |

Well position in SSWMU: U = upgradient; D = downgradient; B = background; C = crossgradient.

Hydrogeologic units monitored are: WT = weathered Lavery till; T = unweathered Lavery till; S = sand and gravel; K = Kent recessional sequence; TS = till-sand. Units enclosed in brackets indicate the hydrogeologic unit is only a secondary monitoring unit.

V = quarterly volatile sampling. A,B,C,I = expanded characterization parameters for RFI. (See Table 3-3 for parameter list.)

R = annually for limited radiological sampling.

\* Location added to program during rep 6, 1993.

Table 3-1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

| SSWMUs and Constituent SWMUs                     | Well Identification Number | Expanded Characterization Schedule (Table 3-3) | Hydrogeological Unit Monitored  | Positive Quarterly Volatile Organic Analyses | Well Position in SSWMU | Depth (ft) Below Grade |
|--|----------------------------|--|---------------------------------|--|------------------------|------------------------|
| <b>SSWMU No. 9 - NRC-licensed Disposal Area:</b> |                            |  |                                 |  |                        |                        |
| • NRC-licensed Disposal Area                     | WNW0901                    |  | K,(T)                           |  | U                      | 136.0                  |
| • Container Storage Area                         | WNW0902                    |  | K,(T)                           |  | U                      | 128.0                  |
| • Trench Interceptor Project                     | WNW0903                    |  | K,(T)                           |  | D                      | 133.0                  |
|  | WNW0904                    | A  | T                               |  | D                      | 26.00                  |
|  | WNW0905                    | A  | S                               |  | D                      | 23.00                  |
|  | WNW0906                    | I  | WT                              |  | D                      | 10.00                  |
|  | WNW0907                    | A  | WT,(T)                          |  | D                      | 16.00                  |
|  | WNW0908                    | A  | WT,(T)                          |  | U                      | 21.00                  |
|  | WNW0909                    | C  | WT,(T)                          | V  | D                      | 23.00                  |
|  | WNW0910                    | A  | T                               |  | D                      | 29.60                  |
|  | WNW8610                    |  | K                               |  | D                      | 114.0                  |
|  | WNW8611                    |  | K                               |  | D                      | 120.0                  |
|  | WNNDATR*                   | C  | Interceptor Trench Manhole Sump |  |                        |                        |
| <b>SSWMU No. 10 - IRTS Drum Cell:</b>            |                            |  |                                 |  |                        |                        |
| • IRTS Drum Cell                                 | WNW1001                    |  | K,(T)                           |  | U                      | 116.0                  |
|  | WNW1002                    |  | K,(T)                           |  | D                      | 113.0                  |
|  | WNW1003                    |  | K                               |  | D                      | 138.0                  |
|  | WNW1004                    |  | K,(T)                           |  | D                      | 108.0                  |
|  | WNW1005                    |  | WT,(T)                          |  | U                      | 19.00                  |
|  | WNW1006                    | I  | WT,(T)                          |  | D                      | 20.00                  |
|  | WNW1007                    | A  | WT,(T)                          |  | D                      | 23.00                  |
| • Background (south plateau)                     | WNW1008B                   |  | K,(T)                           |  | B                      | 51.00                  |
|  | WNW1008C                   | A  | WT,(T)                          |  | B                      | 18.00                  |

Well position in SSWMU: U = upgradient; D = downgradient; B = background; C = crossgradient.

Hydrogeologic units monitored are: WT = weathered Lavery till; T = unweathered Lavery till; S = sand and gravel; K = Kent recessional sequence; TS = till-sand. Units enclosed in brackets indicate the hydrogeologic unit is only a secondary monitoring unit.

V = quarterly volatile sampling. A,B,C,I = expanded characterization parameters for RFI. (See Table 3-3 for parameter list.)

R = annually for limited radiological sampling.

\* Location added to program during rep 6, 1993.

Table 3-1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

| SSWMUs and Constituent SWMUs  | Well Identification Number                   | Expanded Characterization Schedule (Table 3-3) | Hydrogeological Unit Monitored | Positive Quarterly Volatile Organic Analyses | Well Position in SSWMU | Depth (ft) Below Grade |
|---|--|--|--------------------------------|--|------------------------|------------------------|
| <i>SSWMU No. 11 - State-licensed Disposal Area:</i>                               |  |  |                                |  |                        |                        |
| • <i>State-licensed Disposal Area (SDA)[NYSERDA]</i>                              | WNW1101A                                     |  | WT,(T)                         |  | U                      | 16.00                  |
|   | WNW1101B                                     |  | T                              |  | U                      | 30.00                  |
|   | WNW1101C                                     |  | K                              |  | U                      | 110.0                  |
|   | WNW1102A                                     |  | WT,(T)                         |  | D                      | 17.00                  |
|   | WNW1102B                                     |  | T                              |  | D                      | 31.00                  |
|   | WNW1103A                                     |  | WT,(T)                         |  | D                      | 16.00                  |
|   | WNW1103B                                     |  | T                              |  | D                      | 26.00                  |
|   | WNW1103C                                     |  | K                              |  | D                      | 111.0                  |
|   | WNW1104A                                     |  | WT,(T)                         | V  | D                      | 19.00                  |
|   | WNW1104B                                     |  | T                              |  | D                      | 36.00                  |
|   | WNW1104C                                     |  | K                              |  | D                      | 114.0                  |
|   | WNW1105A                                     |  | T                              |  | D                      | 21.00                  |
|   | WNW1105B                                     |  | T                              |  | D                      | 36.00                  |
|   | WNW1106A                                     |  | WT,(T)                         |  | U                      | 16.00                  |
|   | WNW1106B                                     |  | T                              |  | U                      | 31.00                  |
|   | WNW1107A                                     |  | WT,(T)                         | V  | D                      | 19.00                  |
|   | WNW1108A                                     | A  | WT,(T)                         |  | U                      | 16.00                  |
|   | WNW1109A                                     |  | WT,(T)                         |  | U                      | 16.00                  |
|   | WNW1109B                                     | A  | T                              |  | U                      | 31.00                  |
|   | WNW1110A                                     |  | WT,(T)                         |  | D                      | 20.00                  |
| WNW1111A  |  | T  |                                | D  | 21.00                  |                        |
| <i>SSWMU No. 12 - Hazardous Waste Storage Lockers</i>                             | <i>(No wells installed for SSWMU No. 12)</i> |  |                                |  |                        |                        |
| <i>Motor Fuel Storage Area (Monitors underground storage tanks. Not a SSWMU.)</i> | R8613A                                       |  | S,(T)                          |  | C                      | 8.00                   |
|   | R8613B                                       |  | S                              |  | C                      | 8.00                   |
|   | R8613C                                       |  | S                              |  | D                      | 6.50                   |

Well position in SSWMU: U = upgradient; D = downgradient; B = background; C = crossgradient.

Hydrogeologic units monitored are: WT = weathered Lavery till; T = unweathered Lavery till; S = sand and gravel; K = Kent recessional sequence; TS = till-sand. Units enclosed in brackets indicate the hydrogeologic unit is only a secondary monitoring unit.

V = quarterly volatile sampling. A,B,C,I = expanded characterization parameters for RFI. (See Table 3-3 for parameter list.)

R = annually for limited radiological sampling.

\* Location added to program during rep 6, 1993.

*Table 3-1 (concluded)*

*Groundwater Monitoring Network: Super Solid Waste Management Units*

| <i>Well Point Identification</i> | <i>Special Sampling Protocol</i> | <i>Year Installed</i> | <i>Well Depth</i> |
|----------------------------------|----------------------------------|-----------------------|-------------------|
| <i>WP-A</i>                      | <i>R</i>                         | <i>1990</i>           | <i>33</i>         |
| <i>WP-C</i>                      | <i>R</i>                         | <i>1990</i>           | <i>23</i>         |
| <i>WP-D</i>                      | <i>R</i>                         | <i>1990</i>           | <i>26</i>         |
| <i>WP-E</i>                      | <i>R</i>                         | <i>1990</i>           | <i>22</i>         |
| <i>WP-F</i>                      | <i>R</i>                         | <i>1990</i>           | <i>36</i>         |
| <i>WP-G</i>                      | <i>R</i>                         | <i>1990</i>           | <i>34</i>         |
| <i>WP-H</i>                      | <i>R</i>                         | <i>1990</i>           | <i>17</i>         |

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*Well position in SSWMU: U = upgradient; D = downgradient; B = background; C = crossgradient.*

*Hydrogeologic units monitored are: WT = weathered Lavery till; T = unweathered Lavery till; S = sand and gravel; K = Kent recessional sequence; TS = till-sand. Units enclosed in brackets indicate the hydrogeologic unit is only a secondary monitoring unit.*

*V = quarterly volatile sampling. A,B,C,I = expanded characterization parameters for RFI. (See Table 3-3 for parameter list.)*

*R = annually for limited radiological sampling.*

*\* Location added to program during rep 6, 1993.*

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

*Background well.* A well installed hydraulically upgradient of all waste management units 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 units, which makes them unsuitable for use as true background wells. However, they are still useful for providing upgradient information about the unit under study.

*Crossgradient well.* A well installed to the side of the major downgradient flow path.

Table 3-1 identifies the position of a well relative to the waste management unit monitored. 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 hydrogeologic unit. The hydraulic position of a well relative to a super solid waste management unit (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, depending on the geographic position of the SSWMU within 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.

Initial sampling of wells in the current monitoring network began in 1990. All wells were gradually incorporated into the program during 1991, and the entire network followed full sampling schedules in 1992 and 1993 (Table 3-2) except for the two wells that were added to the network in 1992 (WNW0909 and WNW0910).

The wells were sampled routinely for indicator and groundwater quality parameters. The planned one-year sampling for U.S. EPA interim primary drinking water standards to establish a baseline for water quality was completed in 1992.

### **Routine Groundwater Sampling**

The two categories of groundwater sampling parameters, collected as noted in Table 3-3, are contamination indicator parameters and groundwater quality parameters. Table 3-2 indicates the sampling schedule for these parameters during 1993. Parameters constituting the indicator and groundwater quality lists have been developed to satisfy the requirements of 40 CFR, Part 265, Subpart F, which governs groundwater monitoring at interim status facilities. Indicator parameters are used as indicators of groundwater contamination while the groundwater quality parameters are used to establish groundwater quality.

*Contamination indicator parameters:* Samples were collected six times in 1993. Monitoring the contamination indicator parameters helps to identify any potential effect of past or present site operations.

*Groundwater quality parameters:* Samples were collected twice in 1993. The groundwater quality parameters selected provide information on the major chemical constituents of the groundwater.

The following changes to the 1993 WVDP groundwater monitoring program were phased in beginning with the October 1993 sampling:

- A baseline for groundwater quality was established during the past two years with an intensive eight-times-per-year sampling schedule under the expanded well-monitoring program, which was developed to support site closure and the EIS. Sampling for indicator parameters on a quarterly basis will now allow long-

term trending and characterization of seasonal changes.

- All wells have been monitored for volatile organic compounds (VOCs) approximately sixteen times during the past two years, with the vast majority of the wells showing no detection of any of the fifty-eight compounds on the parameter list. All routine groundwater locations that have not shown positive detections will now be sampled annually for VOCs.

A small group of wells consistently show positive detections of very low concentrations of one to a few compounds. Those wells that showed positive detections in 1991 and 1992 and wells at selected locations downgradient of positive detections will be sampled quarterly for VOCs to evaluate possible contaminant migration.

- Wells will continue to be sampled semiannually for groundwater quality constituents. Sampling for aluminum, phosphate, silicon, and hydrogen sulfide were added to the sampling parameters to help determine ion mass balance, which will support groundwater modeling efforts.

### **Expanded Characterization Sampling**

The WVDP RCRA Facility Investigation (RFI) Work Plan commits the WVDP to providing an expanded characterization of the groundwater in order to more fully assess potential releases of hazardous wastes and/or constituents from SSWMUs on the Project premises. This expanded characterization will consist of two rounds of site-wide sampling of selected wells for full suites of both radiological and nonradiological parameters. The first round in this expanded sampling and analysis occurred during the fourth-quarter sampling in 1993. The second round will occur in the second quarter of 1994.

An evaluation of 1991 and 1992 indicator parameter results identified fifty-two groundwater monitoring locations requiring further chemical and radiological characterization. The evaluation used analysis of variance techniques to statistically assess downgradient locations for significant differences with respect to background values. All fifty-two locations were characterized radiologically. Forty-nine of the fifty-two locations were also characterized for chemical parameters.

### **Expanded Chemical Characterization**

Of the forty-four monitoring locations and five background wells sampled for chemical characterization, thirty are screened in the sand and gravel unit of the north plateau. The weathered till on the south plateau was characterized at eight locations that provide comprehensive coverage, particularly of the NDA. The NDA interceptor trench area was characterized by analyzing samples from the NDA sump manhole (WNNDATR) and from well WNW0909, which is approximately 25 feet downgradient of the trench.

The unweathered Lavery till was characterized at nine locations, seven on the north plateau and two on the south plateau.

The Lavery till-sand was characterized at background well WNW0402 and well WNW0202, which persistently indicates a high pH. No other locations in the Lavery till-sand were judged to require further characterization. No further chemical or radiological characterization was recommended for the Kent recessional sequence because nonradiological indicators were consistent with naturally occurring conditions and none of the radiological parameters showed statistical significance.

To provide the most conservative results, samples from most locations were analyzed for chemicals on the Target Compound List (U.S. Environmental Protection Agency 1991) because these analytes are most commonly associated with haz-

**Table 3-2**  
**1993 Groundwater Monitoring Schedule**

| <i>Date</i>                                | <i>Sample Rep*</i> | <i>Contamination Indicator Parameters Scheduled and Collected</i> | <i>Groundwater Quality Parameters Scheduled and Collected</i> | <i>Expanded Characterization of Project Monitoring Locations**</i> |
|--|--------------------|---|---|--|
| 1/11/93 - 2/9/93                           | 1                  | F   |   |  |
| 2/16/93 - 3/26/93                          | 2                  | F   | F   |  |
| 4/19/93 - 5/13/93                          | 3                  | F   |   |  |
| 5/24/93 - 6/22/93                          | 4                  | F   |   |  |
| 7/12/93 - 8/9/93***                        | 5                  | F   |   |  |
| 10/29/93 - 12/31/93                        | 6                  | S   | F   | E  |
| <b>Total Sample Sets per Well in 1993:</b> |                    | <b>6</b>  | <b>2</b>  | <b>1</b>   |

*Key:*

\* *Sample rep is a 6-week period within a semiannual sampling period.*

\*\* *The RCRA Facility Investigation (RFI) Work Plan calls for two rounds of sampling. See Expanded Characterization Sampling in text.*

\*\*\* *This sampling period marked the transition from sampling eight times per year to sampling four times per year.*

*F = All wells sampled for full parameters.*

*S = Contamination indicator parameter analyses included Appendix IX volatile compounds at only nine selected locations.*

*E = This sample rep was chosen, together with the second rep of 1994, to further characterize selected Project monitoring locations for full suites of expanded radiological and chemical parameters. (See Tables 3-1 and 3-3 for details of locations and parameters.)*

**Table 3-3**  
**1993 Schedule of Groundwater Sampling and Analysis**

**Contamination Indicator Parameters**  
(Completed six times in 1993)

*pH*<sup>1</sup>  
*Conductivity*<sup>1</sup>  
*Total Organic Carbon (TOC)*<sup>2</sup>  
*Total Organic Halogens (TOX)*  
*Gross Alpha*  
*Gross Beta*  
*Tritium*  
*Gamma Isotopic Scan*  
*Appendix IX Volatile Organic Analysis (VOAs)*

**Groundwater Quality Parameters**  
(Completed two times in 1993)

|                               |                             |
|-------------------------------|-----------------------------|
| <i>Aluminum</i> <sup>3</sup>  | <i>Silica</i> <sup>3</sup>  |
| <i>Ammonia</i>                | <i>Sodium</i>               |
| <i>Bicarbonate/Carbonate</i>  | <i>Sulfate</i>              |
| <i>Calcium</i>                | <i>Sulfide</i> <sup>3</sup> |
| <i>Chloride</i>               |                             |
| <i>Iron</i>                   |                             |
| <i>Magnesium</i>              |                             |
| <i>Manganese</i>              |                             |
| <i>Nitrate + Nitrite-N</i>    |                             |
| <i>Phenols</i>                |                             |
| <i>Phosphate</i> <sup>3</sup> |                             |
| <i>Potassium</i>              |                             |

**Expanded Characterization Parameters for  
Project Monitoring Locations Only**  
(Completed one time in 1993)

*Schedule A (43 locations)*  
*Target Compound List (TCL)*  
*Radioisotopic*

*Schedule B (6 locations)*  
*Modified Appendix IX*<sup>4</sup> (40 CFR Part 264)  
*Radioisotopic*

*Schedule C (2 locations)*  
*Modified Appendix IX*<sup>4</sup>  
*Radioisotopic*  
*Tributyl phosphate (TBP)*  
*N-dodecane*

*Schedule I (3 locations)*  
*Radioisotopic only*

<sup>1</sup> Field measurement.

<sup>2</sup> Includes nonpurgeable organic carbon (NPOC) only.

<sup>3</sup> Analyses performed only once during 1993 because parameters were added to the schedule at mid-year.

<sup>4</sup> Does not include polychlorinated dibenzo-p-dioxins (PCDDs) or polychlorinated dibenzofurans (PCDFs).

ardous waste sites and represent the greatest threat to human health and the environment.

Samples from five locations where volatile organic compounds have been previously detected and samples from the NDA trench sump manhole were analyzed for compounds from a modified Appendix IX list from 40 CFR 264 (U.S. Environmental Protection Agency 1992). Analyses were not performed for polychlorinated dibenzodioxins (PCDDs) or polychlorinated dibenzofurans (PCDFs). All volatile and semivolatile organic analyses have included a library scan for tentative identification of undetermined peaks.

### ***Expanded Radiological Characterization***

Table 3-4 lists the radioisotopes that best represent potential radiological contaminants encountered on the WVDP site. The first column — full radioisotopic — is appropriate for areas where high activity or alpha activity is encountered. The second column — beta-emitting — establishes analytical parameters for areas where nominal levels of beta-gamma activity are encountered.

During this first round of sampling all fifty-two locations that had been identified as requiring further characterization under the expanded monitoring program were characterized for the beta-emitting radioisotopes listed on Table 3-4. The analyses for the full radioisotopic list was used at fifteen locations: four wells with gross alpha significance, i.e., with a statistically significant difference from background value (WNW0905, WNW1006, WNW0908, and WNW0906); seven wells exceeding the New York State Class GA (see *Glossary*) radiological water quality standard for gross beta activity (WNW0408, WNW0111, WNW0501, WNW0502, WNW0104, WNW8604, and WNW8605); and four background wells (WNWNB1S, WNW1008c, WNW0402, and WNW0405). Three of these fifteen wells

(WNW1006, WNW0906, and WNW0111) were sampled only for expanded radiological characterization because they exhibited significance only for radiological indicators.

### **Sampling Methodology**

Samples are collected from monitoring wells using either Teflon well bailers or bladder pumps. (All nylon leaders on dedicated bailers were replaced with Teflon-coated stainless steel leaders in midsummer 1993 in order to comply with applicable regulations.)

The method of collection used depends on well construction, water depth, and the water-yielding characteristics of the well. Teflon bailers are used in wells with low standing water volume; 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 achieves the same results. Conductivity and pH are measured before and after sampling to help determine if the quality of the groundwater changed while samples were being collected.

The Teflon bailer, a tube with a check valve at the bottom and the top, is lowered into the well until it reaches the desired point in the water column. The bailer is lowered slowly to ensure that the water column is not agitated 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 used exclusively for that well at all times.

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

**Table 3-4**  
**Radioisotopic Parameter List**

| <i>Isotope</i>   | <i>Full<br/>Radioisotopic<br/>List</i> | <i>Beta-emitting<br/>Radioisotopic<br/>List</i> |
|--|--|---|
| <b>C-14</b>  | X                                      | X   |
| <b>Cs-137</b>  | X                                      | X   |
| <b>Co-60</b>   | X                                      | X   |
| <b>I-129</b>   | X                                      | X   |
| <b>Am-241</b>  | X                                      |   |
| <b>Sr-90</b>   | X                                      | X   |
| <b>Ra-228</b>  | X                                      |   |
| <b>Ra-226</b>  | X                                      |   |
| <b>H-3</b>   | X                                      | X   |
| <b>Tc-99</b>   | X                                      | X   |
| <b>U-232, U-233/234, U-235/236,<br/>U-238, Total U</b> | X                                      |   |
| <b>Pu-238, Pu-239/240</b>                              | X                                      |   |

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 drive air is always kept separate 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 its individual well to reduce the likelihood of sample contamination from external materials or cross contamination. The compressor and air 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 then either packaged for overnight delivery to an off-site contract laboratory or put into controlled storage to await on-site testing.

Ten off-site wells, sampled for radiological parameters, pH, and conductivity, were also part of the groundwater monitoring program during 1993. These wells are used by site neighbors as sources of drinking water (Fig. 3-4).

## Groundwater Monitoring Results

**R**esults of the 1993 groundwater monitoring program and the expanded RCRA characterization program are summarized below. (Complete data are tabulated in *Appendix E*.) The 1993 sampling results are grouped and summarized according to the five hydrogeologic units in order to present the results of the groundwater monitoring program on a site-wide basis and to provide intra-unit comparisons. (More detailed assessments of potential releases from SSWMUs will be prepared in accordance with the site's RCRA Facility Investigation Work Plan, as required by the RCRA 3008 (h) Order on Consent.)

Successful implementation of the WVDP's groundwater monitoring program includes proper placing of groundwater monitoring wells, using appropriate methods of sample collection, reviewing analytical data and quality control 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

*Appendix E* tables contain the results of sampling for contamination indicator parameters (Tables E-1 through E-5), groundwater quality parameters (Tables E-6 through E-10), and the results of expanded characterization sampling (Tables E-12 through E-17). Individual analytes within each group of parameters are listed in Table 3-3. Expanded characterization sampling includes Target Compound List (TCL) and Appendix IX volatile organic compounds (Table E-12); n-dodecane and tributyl phosphate (Table E-13); TCL and Appendix IX metals (Table E-14); full (alpha and beta) radioisotopic analyses (Table E-15); beta-emitting radioisotopic analyses (Table E-16), and radiologic analyses of north plateau well points (Table E-17).

The tables in *Appendix E* present the results of the groundwater monitoring program grouped according to the five different 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.

The tables summarizing the contamination indicator parameters, the groundwater quality parameters, and the expanded characterization parameters also display each well's hydraulic position relative to other wells within the same hydrogeologic unit. These positions are identified as UP, which refers to either background or upgradient wells, and DOWN - B, DOWN - C, and DOWN - D. Upgradient locations are designated UP because they are upgradient of all the

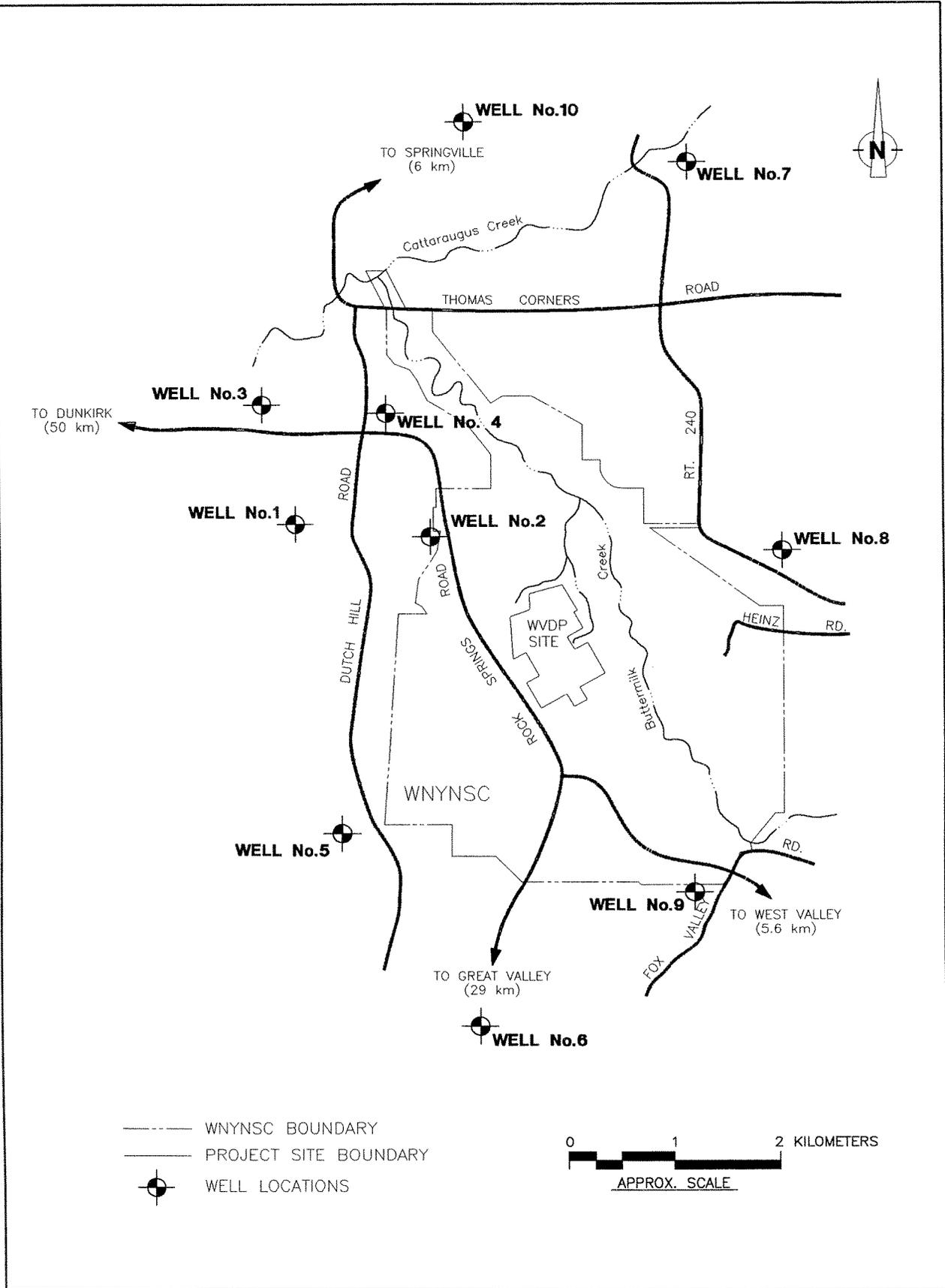


Figure 3-4. Off-site Groundwater Monitoring Points.