GROUNDWATER MONITORING

Geological History of the West Valley Site

The West Valley Demonstration Project (WVDP) 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 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 15,000 and 14,200 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.

The 80-hectare (200-acre) WVDP site is contained within the smaller Frank's Creek watershed. Frank's Creek is a tributary of Buttermilk Creek; Buttermilk Creek, a tributary of Cattaraugus Creek, drains most of the WNYNSC and all of the WVDP facilities.

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).

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 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 2 to 4 meters (7 to 13 ft) of the Lavery till is exposed at the ground surface and is weathered and fractured. It is referred to as the weathered Lavery till. The remaining thickness of the Lavery till is unweathered and is called the unweathered Lavery till.

The 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.

Groundwater flow in the unweathered till is predominantly vertically downward at a relatively slow rate, towards the underlying recessional sequence. The hydraulic conductivities of the unweathered till are roughly equal to flow velocities and range 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 consists of alternating deposits of lacustrine clayey silts and 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 bedrock valley intersects the sequence. Groundwater flow is predominantly to the northeast, towards Buttermilk Creek, at an estimated ve-

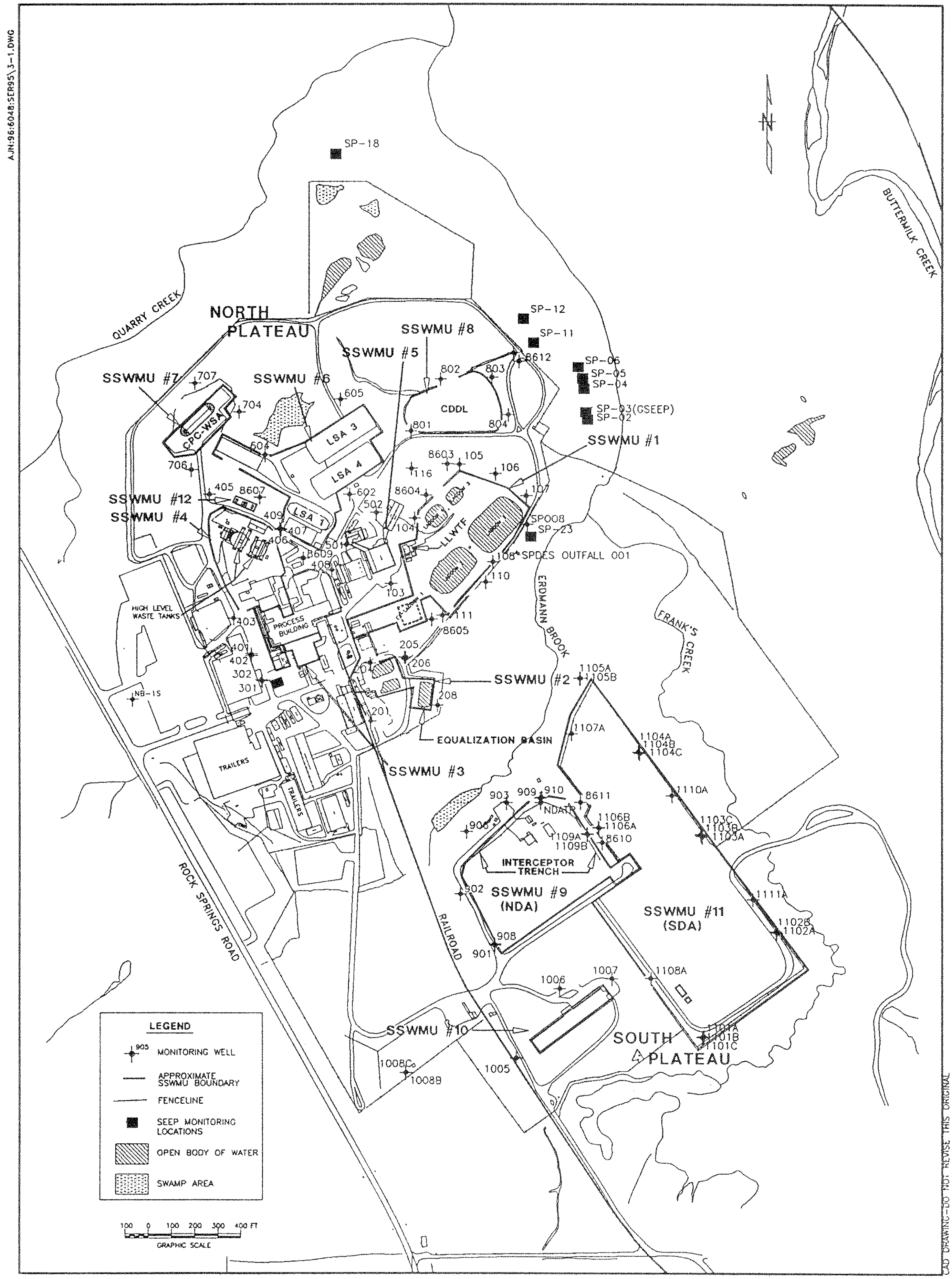


Figure 3-1. Actively Monitored On-Site Groundwater Monitoring Network (Implemented after May 1995).

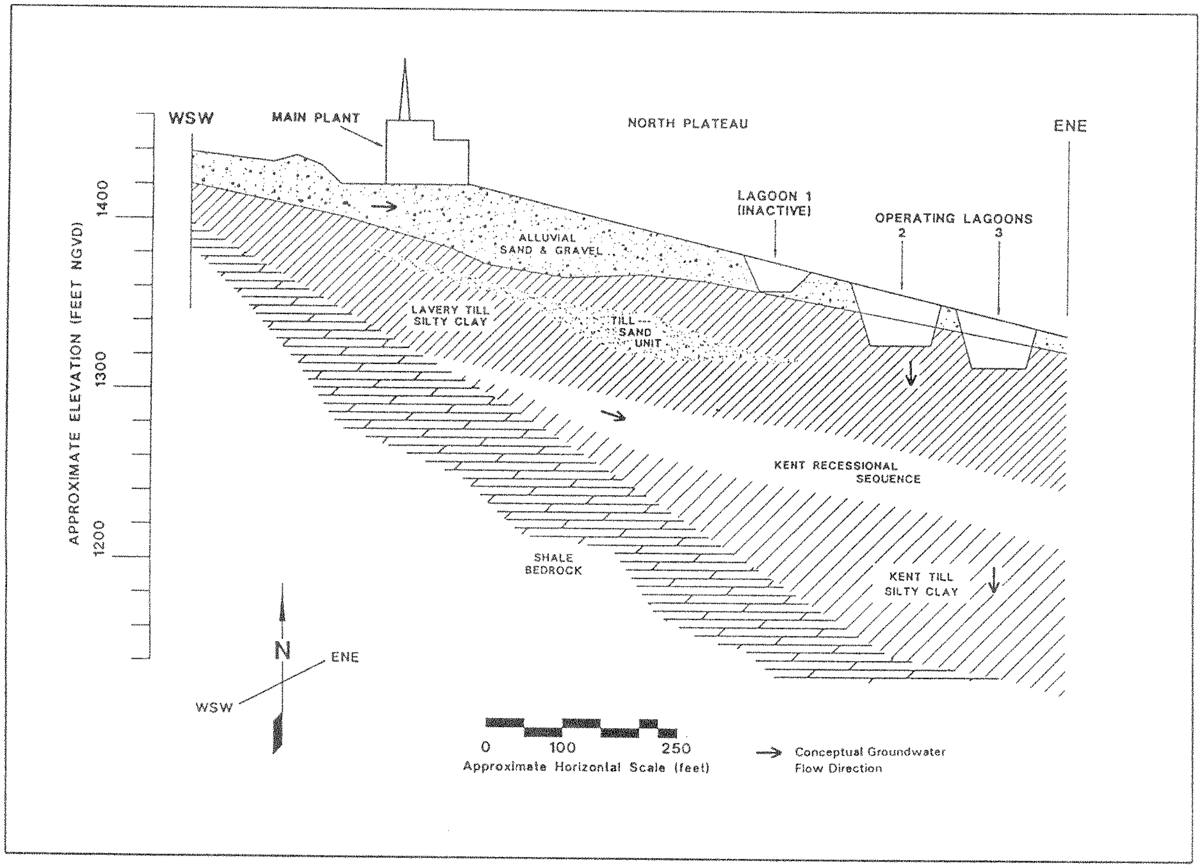


Figure 3-2. Geologic Cross Section through the North Plateau

locity 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

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.

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 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). Based on the testing of forty-one wells in 1995, the geometric mean saturated hydraulic conductivity is 3.1×10^{-4} cm/sec (0.87 ft/day). These new data indicate 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.

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.

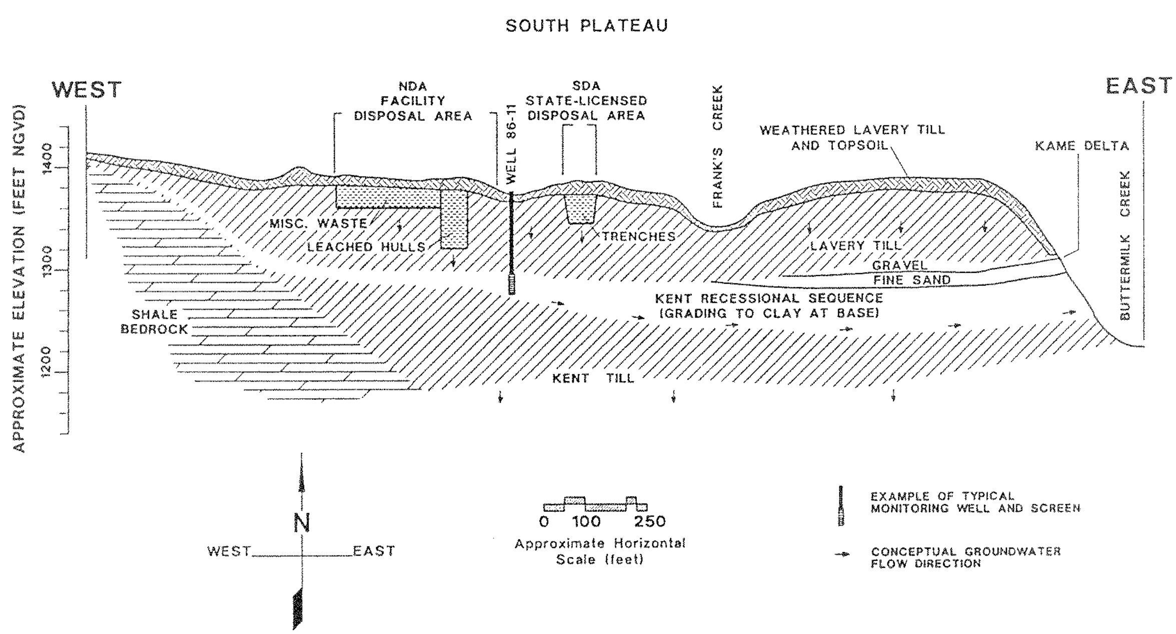


Figure 3-3. Geologic Cross Section through the South Plateau

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 varies from 10^{-8} to 10^{-5} cm/sec (10^{-5} to 10^{-2} ft/day), with the highest conductivities associated with the dense fracture zones (found within the upper 2 meters [7 ft] of the unit).

Groundwater Monitoring Program Overview

Monitoring Well Network

Monitoring provides coverage for 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 (SSWMUs), eleven of which are directly monitored by the well network; the hydraulic position of each well within the waste management unit; the geologic unit monitored; and the depth of each well. Note that monitoring of wells marked by an asterisk is required by the 3008(h) Administrative Order of Consent. (See the *Environmental Compliance Summary: Calendar Year 1995*, **RCRA Facility Investigation [RFI] Program** [p. xlvi] .)

Figure 3-1 (p. 3-3) shows the boundaries of these twelve super solid waste management units at the WVDP. (Twenty-one of the wells are in the SDA and are the responsibility of the New York State Energy Research and Development Authority [NYSERDA]. Although the SDA 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 results for 1995 for the SDA are reported in this document in *Appendix F* [pp. F-1 through F-11].)

Table 3-1 identifies the position of a well relative to the waste management unit monitored. The

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 unit in question.*

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 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 such that the well is neither upgradient nor downgradient of the monitored SSWMU.*

Table 3 - 1

Groundwater Monitoring Network: Super Solid Waste Management Units

SSWMUs and Constituent SWMUs	Well ID Number	Hydrogeologic Unit Monitored[1]	Analytes as of May 1995[2]	Well Position in SSWMU[3]	Well Depth (ft) Below Grade
SSWMU #1 - Low-level Waste Treatment Facilities:					
	103*	S	M	D	21.0
• Former Lagoon 1	104	S	M, SV	U	23.0
• LLWTF Lagoons	105	S	M	D	28.0
• LLWTF Building	106	S	M	D	14.5
• Interceptors	107	T	M	D	28.0
• Neutralization Pit	108	T	M	D	33.0
	109	T	p	D	33.0
	110*	T	M	D	33.0
	111*	S	E, S, SV, M	D	11.0
	114	T	p	D	29.0
	115	T	p	U	28.0
	116*	S	M, S	U	11.0
	8604	S	M	U	22.6
	8605*	S	E, S, SV, M	D	12.0
	WNSP008	Groundwater French Drain Monitoring Point			
SSWMU #2 - Miscellaneous Small Units:					
	201	S	M	U	20.0
• Sludge Ponds	202	TS	p	U	38.0
• Solvent Dike	203	S	p	D	18.0
• Equalization Mixing Basin	204*	TS		U	43.0
• Paper Incinerator	205	S	M	D	11.0
	206	TS		D	37.8
	207	S, (T)	p	D	11.0
	208	TS		D	23.0
	8606	S	p	D	12.1

***** Monitoring for certain parameters is required by the 3008(h) Order on Consent.*

[1] 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 parentheses indicate the hydrogeologic unit is only a secondary monitoring unit.

[2] These parameters are in addition to the contamination indicator parameters, radiological indicator parameters, groundwater quality parameters, and VOCs as scheduled before and after May 1995. p = analytical monitoring discontinued after May 1995; well measured for potentiometric (water-level) data only.
See Table 3-3 for a description of codes and analytes.

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

Table 3 - 1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

SSWMUs and Constituent SWMUs	Well ID Number	Hydrogeologic Unit Monitored[1]	Analytes as of May 1995[2]	Well Position in SSWMU[3]	Well Depth (ft) Below Grade
SSWMU #3 - Liquid Waste Treatment System:					
	301*	S	M	B	16.0
• Liquid Waste Treatment System	302	TS	M	U	28.0
• Cement Solidification System	305	S	p	D	31.0
• Main Process Bldg. (specific areas)	306	K	p	D	81.0
	307	S	p	D	16.0
• Background (north plateau)	NB1S	S, (WT)		B	13.0
SSWMU #4 - HLW Storage and Processing Area:					
	401*	S, (T)	M, R	B	16.0
• Vitrification Facility	402	TS			29.0
• Vitrification Test Tanks	403	S	M	U	13.0
• HLW Tanks	404	TS	P	U	36.5
• Supernatant Treatment System	405	T		C	12.5
	406*	S	M, R	D	16.8
	407	K, (T)		D	75.5
	408*	S	M, R	D	38.0
	409	T		D	55.0
	410	K	p	U	78.0
	411	K, (T)	p	U	66.0
SSWMU #5 - Maintenance Shop Leach Field:					
	501*	S	M, S	U	33.0
• Maintenance Shop Leach Field	502*	S	M, S, SM	D	18.0

** Monitoring for certain parameters is required by the 3008(h) Order on Consent.*

[1] 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 parentheses indicate the hydrogeologic unit is only a secondary monitoring unit.

[2] These parameters are in addition to the contamination indicator parameters, radiological indicator parameters, groundwater quality parameters, and VOCs as scheduled before and after May 1995. p = analytical monitoring discontinued after May 1995; well measured for potentiometric (water-level) data only.
See Table 3-3 for a description of codes and analytes.

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

Table 3 - 1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

SSWMUs and Constituent SWMUs	Well ID Number	Hydrogeologic Unit Monitored[1]	Analytes as of May 1995[2]	Well Position in SSWMU[3]	Well Depth (ft) Below Grade
SSWMU #6 - Low-level Waste Storage Area:					
	601	S	p	D	6.0
• Hardstands (old & new)	602	S	M, S	D	13.0
• Lag Storage	603	S	p	U	13.0
• Lag Storage Additions (LSAs 1, 2, 3, 4)	604	S	M	D	11.0
	605	S, (T)	M, S	D	11.0
	8607*	S	M	U	17.6
	8608	S	p	U	19.0
	8609*	S	M, S	U	24.7
SSWMU #7 - CPC Waste Storage Area:					
	701	TS	p	U	28.0
• CPC Waste Storage Area	702	T	p	C	38.0
	703	T	p	D	21.0
	704	T	M	D	15.5
	705	T	P	C	21.0
	706	S	M	B	11.0
	707	T, (WT)	M	D	11.0
SSWMU #8 - Construction and Demolition Debris Landfill					
	801*	S	M, S	U	17.5
• Former Construction and Demolition Debris Landfill	802*	S, (T)	M	D	11.0
	803*	S	E, M	D	18.0
	804*	S	M	D	9.0
	8603*	S	M, S	U	24.8
	8612*	S	E, M	D	18.1
	WNGSEEP*		M		
		Groundwater Seepage Monitoring Point			
	WNDMPNE		N/A		

** Monitoring for certain parameters is required by the 3008(h) Order on Consent.*

N/A - Not applicable. Monitoring point was discontinued after May 1995.

[1] 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 parentheses indicate the hydrogeologic unit is only a secondary monitoring unit.

[2] These parameters are in addition to the contamination indicator parameters, radiological indicator parameters, groundwater quality parameters, and VOCs as scheduled before and after May 1995. p = analytical monitoring discontinued after May 1995; well measured for potentiometric (water-level) data only.
See Table 3-3 for a description of codes and analytes.

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

Table 3 - 1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

SSWMUs and Constituent SWMUs	Well ID Number	Hydrogeologic Unit Monitored[1]	Analytes as of May 1995[2]	Well Position in SSWMU[3]	Well Depth (ft) Below Grade
SSWMU #9 - NRC-licensed Disposal Area:					
	901*	K, (T)	M	U	136.0
• NRC-licensed Disposal Area	902*	K, (T)	p	U	128.0
• Container Storage Area	903*	K, (T)	M	D	133.0
• Trench Interceptor Project	904	T	p	D	26.0
	905	S	M, R	D	23.0
	906*	WT	M	D	10.0
	907	WT, (T)	p	D	16.0
	908*	WT, (T)	M	U	21.0
	909*	WT, (T)	E, M, R	D	23.0
	910*	T	M	D	29.6
	8610*	K		D	114.0
	8611*	K	M	D	120.0
	WNNDATR		E, R, M Interceptor Trench Manhole Sump		
SSWMU #10 - IRTS Drum Cell:					
	1001	K, (T)	p	U	116.0
• IRTS Drum Cell	1002	K, (T)	p	D	113.0
• Background (south plateau)	1003	K	p	D	138.0
	1004	K, (T)	p	D	108.0
	1005*	WT, (T)	M	U	19.0
	1006*	WT, (T)	M	D	20.0
	1007	WT, (T)	M	D	23.0
	1008B	K, (T)	M	B	51.0
	1008C*	WT, (T)	M	B	18.0

** Monitoring for certain parameters is required by the 3008(h) Order on Consent.*

[1] *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 parentheses indicate the hydrogeologic unit is only a secondary monitoring unit.*

[2] *These parameters are in addition to the contamination indicator parameters, radiological indicator parameters, groundwater quality parameters, and VOCs as scheduled before and after May 1995. p = analytical monitoring discontinued after May 1995; well measured for potentiometric (water-level) data only.*
See Table 3-3 for a description of codes and analytes.

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

Table 3 - 1 (continued)

Groundwater Monitoring Network: Super Solid Waste Management Units

SSWMUs and Constituent SWMUs	*Well ID Number*	*Hydrogeologic Unit Monitored[1]*	*Analytes as of May 1995[2]*	*Well Position in SSWMU[3]*	*Well Depth (ft) Below Grade*
SSWMU #11 - State-licensed Disposal Area:					
	1101A	*WT, (T)*	*See*	*U*	*16.0*
• State-licensed Disposal Area	*1101B*	*T*	*Appendix F*	*U*	*30.0*
(SDA)[NYSERDA]	*1101C*	*K*		*U*	*110.0*
NOTE: The SDA is sampled by NYSERDA	*1102A*	*WT, (T)*		*D*	*17.0*
under an independent monitoring program	*1102B*	*T*		*D*	*31.0*
	1103A	*WT, (T)*		*D*	*16.0*
	1103B	*T*		*D*	*26.0*
	1103C	*K*		*D*	*111.0*
	1104A	*WT, (T)*		*D*	*19.0*
	1104B	*T*		*D*	*36.0*
	1104C	*K*		*D*	*114.0*
	1105A	*WT, (T)*		*D*	*21.0*
	1105B	*T*		*D*	*36.0*
	1106A	*K*		*U*	*16.0*
	1106B	*T*		*U*	*31.0*
	1107A	*T*		*D*	*19.0*
	1108A	*WT, (T)*		*U*	*16.0*
	1109A	*T*		*U*	*16.0*
	1109B	*WT, (T)*		*U*	*31.0*
	1110A	*WT, (T)*		*D*	*20.0*
	1111A	*WT, (T)*		*D*	*21.0*

** Monitoring for certain parameters is required by the 3008(h) Order on Consent.*

[1] 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 parentheses indicate the hydrogeologic unit is only a secondary monitoring unit.

[2] These parameters are in addition to the contamination indicator parameters, radiological indicator parameters, groundwater quality parameters, and VOCs as scheduled before and after May 1995. p = analytical monitoring discontinued after May 1995; well measured for potentiometric (water-level) data only.
See Table 3-3 for a description of codes and analytes.

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

Table 3 - 1 (concluded)

Groundwater Monitoring Network: Super Solid Waste Management Units

SSWMUs and Constituent SWMUs	Well ID Number	Hydrogeologic Unit Monitored[1]	Analytes as of May 1995[2]	Well Position in SSWMU[3]	Well Depth (ft) Below Grade
SSWMU #12 - Hazardous Waste Storage Lockers	(No wells installed for SSWMU #12)				
Motor Fuel Storage Area (Monitors underground storage tanks. Not a SSWMU.)	R8613A	S, (T)	p	C	8.0
	R8613B	S	p	C	8.0
	R8613C	S	p	D	6.5

Well ID Number	Hydrogeologic Unit Monitored[1]	Sampling Agenda*	Well Depth (ft) Below Grade
WP-A	S	RI	33
WP-C	S	RI	23
WP-D	S	RI	26
WP-E	S	RI	22
WP-F	S	RI	36
WP-G	S	RI	34
WP-H	S	RI	17

* Monitoring for certain parameters is required by the 3008(h) Order on Consent.

[1] 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 parentheses indicate the hydrogeologic unit is only a secondary monitoring unit.

[2] These parameters are in addition to the contamination indicator parameters, radiological indicator parameters, groundwater quality parameters, and VOCs as scheduled before and after May 1995. p = analytical monitoring discontinued after May 1995; well measured for potentiometric (water-level) data only.
See Table 3-3 for a description of codes and analytes.

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

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, 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.

History of the Monitoring Program

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

Monitoring Program: 1984 - 1994

The WVDP groundwater monitoring program has evolved over the years to meet changing needs: The pre-operational monitoring program began in 1984 with twenty wells located around the main plant and the NDA. In 1986 the program was expanded to accommodate technical requirements for groundwater monitoring at facilities holding RCRA interim status: the areas identified for additional groundwater monitoring were the lagoon system, the waste tank farm, and the NDA. An additional network of fourteen wells, a groundwater seep, and the french drain was designed to monitor the three waste management units.

The groundwater monitoring program was expanded in 1989 and 1990 (Fig. A-3 [p. A-49] in *Appendix A*) in order to provide more detailed characterization of the groundwater and to provide information for the environmental information documents (EIDs). The EIDs were being prepared to support the environmental impact statement (EIS) that would detail possible alternatives for eventual closure of the WVDP site.

The RFI program, established to protect human health and the environment from potential releases of RCRA-regulated hazardous wastes and/or constituents from solid waste management units, focuses on determining the nature and extent of existing releases and evaluating the potential for future releases of RCRA-regulated hazardous waste or constituents from solid waste management units.

Collecting a Soil Core Sample for Analysis

The wells installed in 1989 and 1990 were gradually incorporated into the program during 1991, and the entire network followed full sampling schedules in 1992, 1993, and 1994 except for the two wells that were added to the network in 1992 (wells 909 and 910).

The parameters measured included both chemical and radiological constituents.

Monitoring Program: 1995

Table 3-2 indicates that all the actively monitored locations continued to be sampled routinely in 1995 for indicator parameters (pH and specific conductance) and radiologic indicator parameters (gross alpha, gross beta, and tritium), just as in previous years. All locations were sampled for groundwater quality parameters once during 1995. Samples from selected locations were analyzed for additional parameters such as organics, metals, and radioisotopic analytes during the last two quarters of 1995.

The WVDP is currently continuing the RCRA facility investigations, and reports on each SSWMU are being completed. However, because most of the baseline data has been collected, the groundwater program can now focus on routine, long-term monitoring.

In May 1995, an analysis of the groundwater monitoring program with respect to long-term monitoring indicated that certain well placements and/or monitoring parameters were now redundant. A new program was developed, evolving from one that required an intensive collection of data, as required by the RFIs and EIDs, to one that provides long-term environmental surveillance as required by the DOE 5400-series Orders and agreements with the EPA and NYSDEC. The new program incorporates three major changes:

- The number of wells monitored was reduced. This change was implemented in May 1995. By the end of calendar year 1995 a total of fifty-six groundwater monitoring points were providing radiological and chemical surveillance of both active and inactive SSWMUs and of general site-wide conditions. On-site actively monitored groundwater locations are shown on Figure 3-1 (p. 3-3). The benefits of reducing unnecessary monitoring include the ability to focus more attention on specific areas of interest.

- The analyte list was modified to focus on specific parameters of interest. As the RFIs are reviewed, the list will continue to be modified as necessary.

- Finally, the new program will institute the use of "trigger levels" for all chemical and radiological analytes. These pre-set limits are conservative values for chemical or radiological concentrations that have been developed by the WVDP and entered into a database. Actual measured values are compared to the trigger limits as data are entered into the database. When the actual value exceeds the conservative trigger limit, the data are flagged by the computer and results are investigated. The trigger levels have been entered into the Laboratory Information Management System (LIMS). As new results are entered into the site database, they are electronically compared with these pre-set trigger levels, and ex-

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 annually 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.

Table 3 - 2

1995 Groundwater Monitoring Schedule

Sampling Quarter	1	2	3	4
Sample Date	12/01/94-12/08/94	4/01/95-4/16/95	6/01/95-6/15/95	9/06/95-9/15/95
Contamination Indicators (I) and Radiological Indicators (RI)	✓	✓	*	*
Groundwater Quality Parameters (G)	N/S	✓	N/S	N/S
Volatile Organic Compounds (V)	*	*	*	*
Semivolatile Organic Compounds (SV)	N/A	N/A	*	*
Metals (M)	N/A	N/A	*	*
Strontium-90 (S)	N/A	N/A	*	*
Radioisotopic Parameters (R)	N/A	N/A	*	N/S
Special Monitoring Parameters (SM)	N/A	N/A	*	*

N/S - Not sampled.
N/A - Not applicable.
✓ Analysis performed at all locations.
** Analysis performed at selected monitoring locations only. See Table 3-3 for a description of each analyte group.*

Sampling Methodology

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 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 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 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 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.

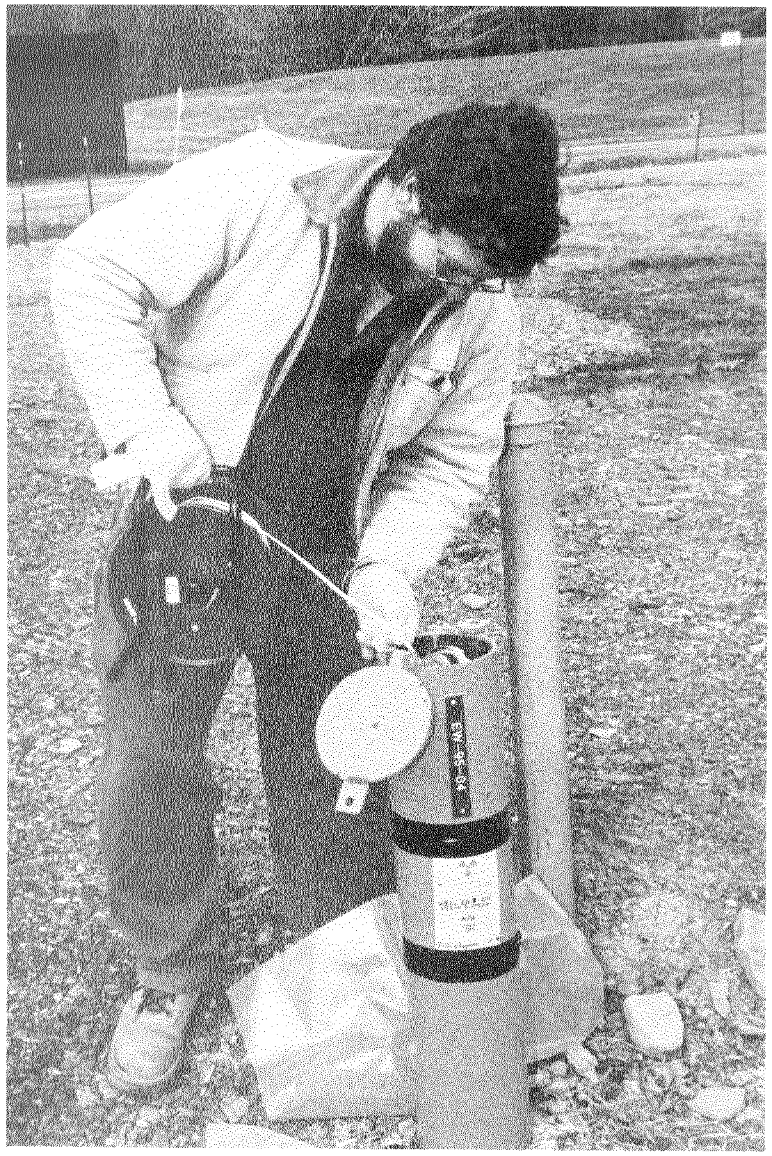
Immediately after the samples are collected they are put into a cooler and returned to the Project's Environmental Laboratory. The samples are then either packaged for expedited delivery to an off-site contract laboratory or put into controlled storage to await on-site testing.

ceedances are flagged for evaluation. (In many cases exceedances are found to be a result of an analytical or data entry error, while other cases of confirmed exceedances are evaluated further.) Using trigger levels allows a prompt focus on any monitoring anomalies.

Groundwater monitoring activities at the WVDP are summarized in two primary documents, the Groundwater Monitoring Plan (West Valley Nuclear Services Co., Inc. December 1995) and the Groundwater Protection Management Program Plan (West Valley Nuclear Services Co., Inc. 1994). The Groundwater Monitoring Plan focuses on long-term monitoring requirements specified under the RCRA and DOE programs. The Groundwater Protection Management Program Plan provides additional information regarding groundwater quality activities in place at the WVDP.

The categories of groundwater sampling parameters collected are noted in Table 3-3 (p. 3-20). Table 3-2 (p. 3-15) indicates the sampling schedule for these parameters during 1995.

Ten off-site water supply wells, sampled for radiological parameters, pH, and conductivity, were also part of the groundwater monitoring program during 1995. These wells are used by site neighbors as sources of drinking water (Fig. 3-4 [p. 3-19]).



Measuring Water Levels in a Groundwater Monitoring Well

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 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 [pp. E-3 through E-10]), groundwater quality parameters (Tables E-6 through E-10 [pp. E-11 through E-18]), and the results of sampling for focused parameters (Tables E-12 through E-16 [pp. E-23 through E-31]). Table E-11 (p. E-19) lists the practical quantitation limits (PQLs) for individual analytes. Analyte groups are described in Table 3-3 (p. 3-20).

The tables in *Appendix E* (pp. E-1 through E-31) present the results of the groundwater monitoring program 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.

The tables summarizing the contamination indicator parameters, the groundwater quality parameters, and the other focused 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 other locations. Downgradient locations are designated B, C, or D to indicate their positions along the groundwater flow path relative to each other. For example, wells denoted as DOWN - C in the sand and gravel unit are downgradient of both UP and DOWN - B wells but are upgradient of DOWN - D wells. Grouping the wells by hydraulic position provides a logical basis for presenting the groundwater monitoring data in the tables and figures in this report.

These tables also list the sample collection periods. Samples were collected each quarter from December 1994 (the first quarter of 1995) through October 1995 (the fourth quarter of 1995). Wells were sampled for the indicator parameters as listed in Table 3-3 (p. 3-20).

Presentation of Results in Graphs

High-low graphs have been prepared to present contamination indicator data for individual locations within the same hydrogeologic unit. All the 1995 results obtained for selected parameters (pH, conductivity, total organic carbon, total organic halogens, gross alpha, gross beta, and tritium) were used to construct the high-low graphs for each well within each hydrogeologic unit. These graphs allow results for wells within a given hydrogeologic unit to be visually compared to each other.

All high-low graphs shown at the end of this chapter 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, conductivity, total organic carbon, and total organic halogens), the upper and lower tick marks on the vertical bar indicate the highest and lowest measurements recorded during 1995. The middle tick represents the arithmetic mean of all 1995 results. The vertical bar thus represents the total range of the data set for each monitoring location.

On radiological graphs (gross alpha, gross beta, and tritium), the upper and lower tick marks on the vertical bar indicate the upper and lower ranges of the pooled error terms. This is a more accurate method of representing radiological data than presenting only the mean, which does not show the whole range of possible values. By displaying the uncertainty together with the mean, a more realistic perspective is obtained. (See also *Chapter 5*, **Data Reporting** [p. 5-7].)

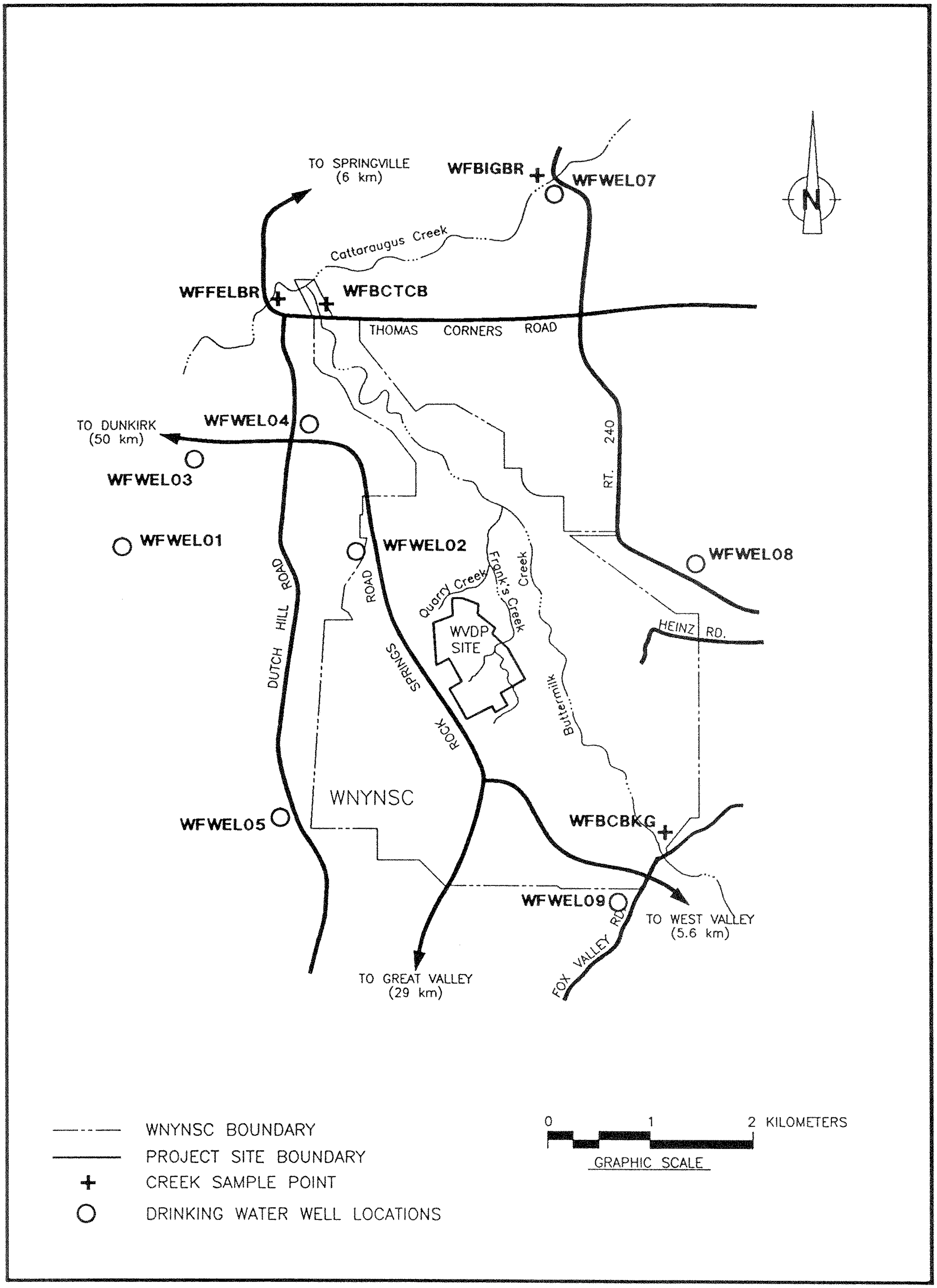


Figure 3-4. Off-site Groundwater Monitoring Wells and Surface Water Samplers.

Table 3 - 3

Description of 1995 Groundwater Sampling and Analysis Agenda

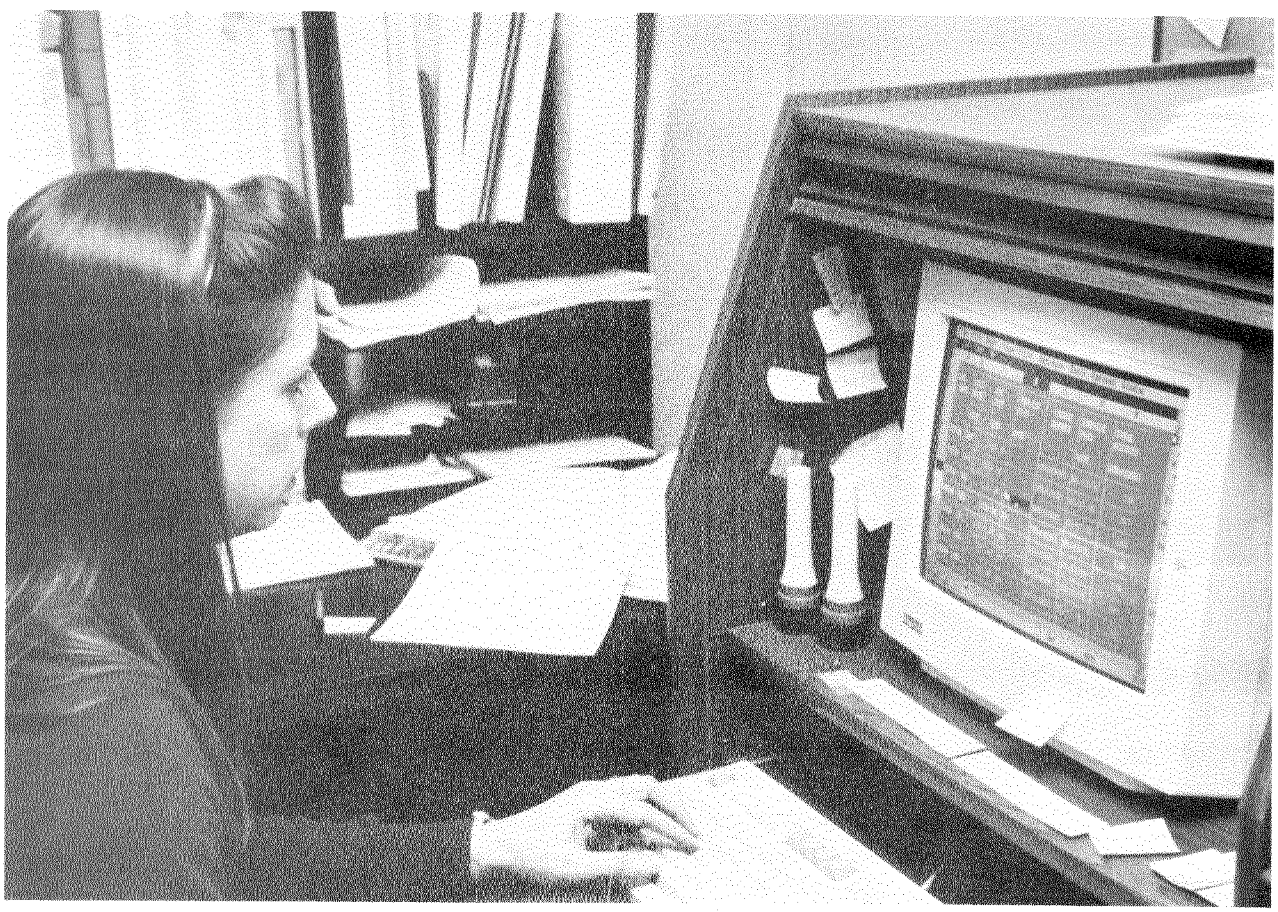
ANALYTE GROUP	DESCRIPTION OF PARAMETERS
Indicator Parameters (I)	pH[1], specific conductance[1], total organic carbon (TOC)[2,3] total organic halogens (TOX)[3], gamma scan[3]
Radiological Indicator Parameters (RI)	Gross alpha, gross beta, tritium
Groundwater Quality Parameters	Alkalinity, aluminum, calcium, chloride, iron, magnesium, manganese, nitrate/nitrite, phosphate, potassium, sodium, silica, sulfate, sulfide
RCRA Hazardous Constituent Metals (M)	Antimony, arsenic, barium, beryllium, cadmium, lead, chromium, mercury, nickel, selenium, silver, thallium
Volatile Organic Compounds (V)	Appendix IX VOCs (see Table E-11)
Semivolatile Organic Compounds (SV)	Appendix IX SVOCs (see Table E-11)
Expanded Compound List: V, SV, and Appendix IX metals (E)	Appendix IX VOCs, SVOCs, and metals (see Table E-11)
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
Strontium-90 (S)	Sr-90
Special Monitoring Parameters (SM)	Arsenic, aluminum, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, vanadium, zinc

[1] *Field measurement.*
[2] *Comprises only nonpurgeable organic carbon (NPOC).*
[3] *Discontinued after second-quarter sampling.*

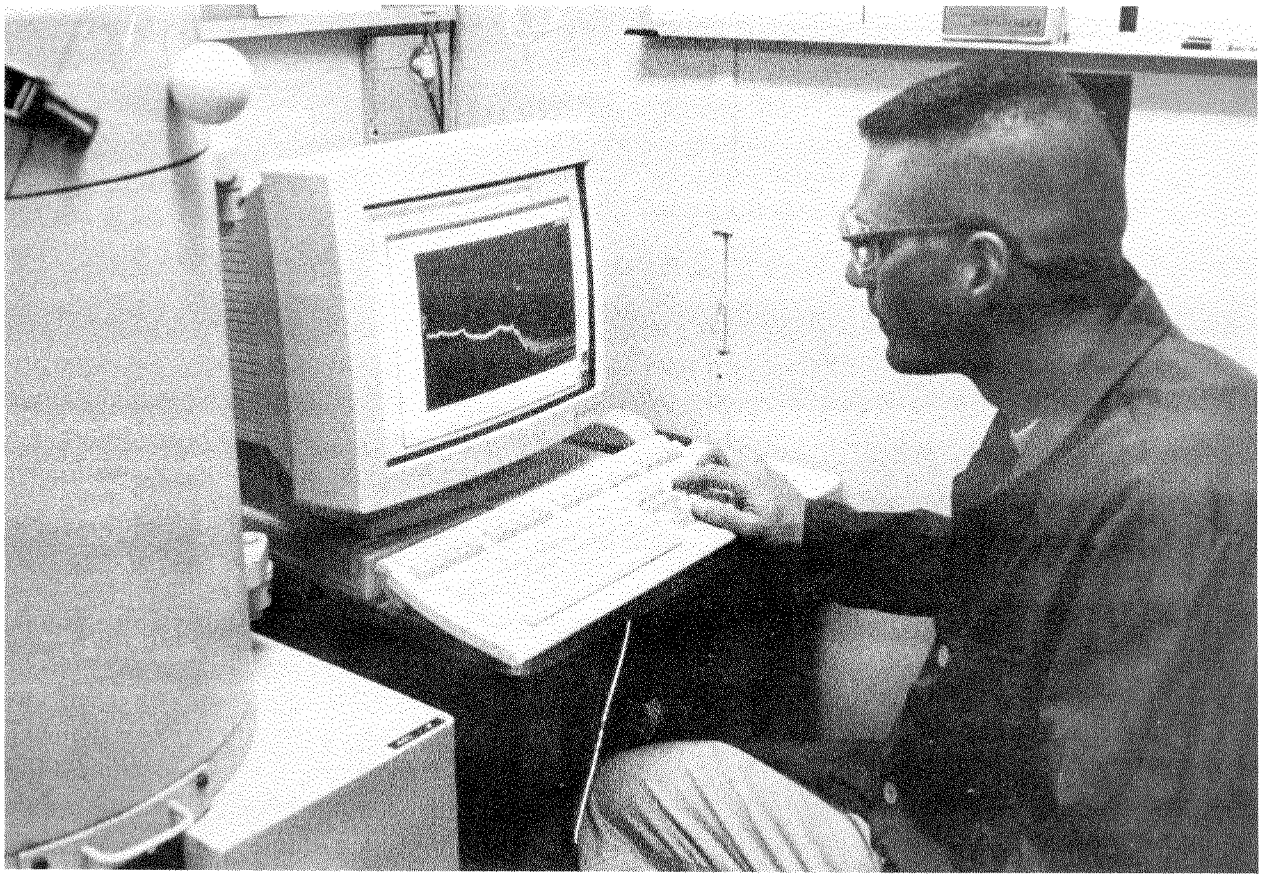
The sample counting results for gross alpha, gross beta, and tritium, even if below the minimum detectable concentrations, were used to generate the high-low graphs. Thus, negative values were included. This is most common for the gross alpha analyses, where sample radiological counting results may be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

Analyses for total organic carbon (TOC) and total organic halogens (TOX) were discontinued after the first two rounds of 1995 because they provided little value in the past and because the program has evolved to comprise analyses of specific organic compounds at selected locations where organic contamination has been detected or locations that are downgradient of suspected sources. As in 1994, low concentrations of acetone (17 µg/L and 21 µg/L on replicate analyses) were detected at well 103. The pH at this location also continues to be elevated.

Trend line graphs have been used to show concentrations of a particular parameter over time at monitoring locations of interest. Results for the volatile organic compounds 1,1-dichloroethane (1,1-DCA) at wells 8609 and 8612, 1,2-dichloroethylene (1,2-DCE) at well 8612, and dichlorodifluoromethane (DCDFMeth) at wells 803 and 8612 are plotted using this format in Figures 3-41 and 3-41a (p. 3-40). See also Tables E-12 and E-13 (p. E-23). Long-term trends (five- and ten-year) of gross beta and tritium for selected groundwater monitoring locations (104, 111, 408, 501, 502, 801, 8603, 8604, 8605, [WN]GSEEP, and [WN]SP008) are also shown in Figures 3-42 through 3-43a (pp. 3-41 and 3-42).



Receiving Groundwater Samples at the Environmental Laboratory Computerized Log-in Station



On-screen Review of a Gamma Count

The 1995 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 are being prepared in accordance with the site's RCRA Facility Investigation Work Plan, as required by the RCRA 3008(h) Order on Consent.)

With the exception of groundwater monitoring results for gross beta on the north plateau, there have been no new developments in 1995. Monitoring results have been consistent with historical levels, which have been discussed in previous site reports. Updated 1995 concentrations are presented in *Appendix E* (pp. E-1 through E-31).

Previous site reports have referred to specific monitoring locations as exhibiting notable concentrations of particular analytes. As a result of the reduction in 1995 in the number of wells monitored, many of these locations previously discussed (as well as others not discussed) are no longer routinely sampled. In every such case, ongoing monitoring coverage of nearby locations provides sufficient surveillance. Wells falling into this category that were previously discussed and are now discontinued are 109, 114, 115, 203, 207, 305, 307, 404, 410, 411, 601, 603, 701, 702, 703, 705, 904, 905, 907, 1001, 1002, 1003, 1004, 8606, 8608, and 8613a, b, and c.

Well 202, previously noted for high pH, is no longer sampled because it has been determined that cement grout used to install the well is responsible for the anomalous pH. The very high pH of samples from that well tended to interfere with other analyses.

Sampling location WNDMPNE was discontinued as a groundwater monitoring location after May 1995 because, as defined in the *Glossary*, it is technically a surface water sampling location. Sampling of WNDMPNE up to May 1995 is reported in *Appendix E*. Groundwater seepage continues to contribute to total discharges at this location. This location, which exhibited the earliest evidence in 1993 that elevated gross beta on the north plateau may have been discharging at the plateau edge, continues to be monitored as surface water location WNSWAMP and is reported in *Appendix C-1*, Table C-1.7 (p. C1-8).

In 1993 and 1994, the expanded characterization of groundwater included sampling and analysis for several radionuclides. Of these radionuclides, strontium-90 was most frequently found to exceed background concentrations. Since concentrations of strontium-90 can be inferred as a percentage of gross beta concentrations, there is no longer a continuing need to analyze for both parameters. Results from the less expensive analyses for gross beta (allowing at least ten days for samples to reach equilibrium with respect to yttrium-90 ingrowth) can be multiplied by 40% to 50% to arrive at an approximation of the strontium-90 concentrations.

Technetium-99, iodine-129, and carbon-14 radionuclides, which were previously noted at several monitoring locations at concentrations above background levels, have been demonstrated to comprise very small percentages of total gross beta concentrations. While elevated levels in 1993 and 1994 were noted at specific locations, none were above DCGs, and gross beta analyses continue to provide surveillance on a quarterly basis.

Elevated alpha-emitting radionuclides such as radium-228, uranium-232, uranium-233/234, and uranium-238 were noted in the 1994 site report for isolated monitoring locations. However, in all cases, these levels were low (far below DCGs) and close to background levels. The site continues to monitor all these areas for gross alpha on a quarterly basis.

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

Trend graphs showing results of groundwater monitoring at monitoring locations 8603, 8604, 8605, WNGSEEP, and WNSP008 from 1986 through 1995 for gross beta (Fig. 3-42 [p. 3-41]) and tritium (Fig. 3-43 [p. 3-42]) were prepared for selected locations in the unit of greatest concern. Results are presented on a logarithmic scale to adequately represent locations of differing concentrations. These specific groundwater monitoring locations in the sand and gravel unit were selected for trending because they have shown elevated or rising levels of these constituents (gross beta) or falling trends (tritium).

The graph of gross beta activity at monitoring locations 8603, 8604, 8605, WNGSEEP, and WNSP008 (Fig. 3-42 [p. 3-41]) indicates steadily rising trends at wells 8603 and 8604. Well 8604 is located to the north of lagoon 4 in SSWMU #1 and extends to 23.0 feet below grade. Results from well 8603, which is north of 8604, at a depth of 25.4 feet, have continued to show a steady upward trend. The source of the increasing gross beta activity is associated with the groundwater plume originating from below the process building.

Lagoon 1, formerly part of the low-level waste treatment facility, was identified as a source of north plateau contamination contributing to the gross beta activity at wells 8605 and 111. The gross beta concentrations at both wells have remained at a steady level over the entire ten-year (well 8605) and five-year (well 111) monitoring periods.

Figure 3-43 (p. 3-42) shows the ten-year trend for tritium concentrations for the same monitoring locations (8603, 8604, 8605, WNGSEEP, and WNSP008). All of these points, with the exception of WNGSEEP, indicate gradually declining trends in tritium.

Figures 3-42a (p. 3-41) and 3-43a (p. 3-42) present gross beta and tritium concentrations for wells 104, 111, 408, 501, 502, and 801 over the five-year period that the WVDP's current groundwater monitoring program has been in place. (For the sake of clarity, these graphs now show annual averages rather than individual results to accommodate the increased amount of data that has been collected.) The wells selected for these five-year trend graphs represent on-site locations with levels of gross beta and/or tritium activity that are elevated above background levels. The two graphs used last year to show trends in beta activity have been merged into one. Monitoring location WNDMPNE has been removed because it is technically a surface water sampling location and is now discussed in *Chapter 2, Environmental Monitoring*. Background well NB1S was also removed from the graph to allow the illustration of additional wells where elevated radiological activity (i.e., wells 104, 111, and 801) may be a concern. However, the average background concentration is plotted on each graph for comparison purposes. All wells shown in these figures monitor the sand and gravel unit. Well 111 exhibits a relatively steady decreasing trend in tritium concentrations. This well is located near former lagoon 1 within SSWMU #1.

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

Although elevated gross beta has been reported historically in localized areas north and east of the process building, 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 which groundwater and soil was sampled using the Geoprobe®, a mobile sampling system, 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 southwest corner of the process building. The maximum activity in groundwater was 3.6E-03 μCi/mL, and the maximum activity in soil reached 2.4E-02 μCi/g. Strontium-90 and its daughter product, yttrium-90, were determined to be responsible for most of the elevated gross beta in the groundwater and soil beneath and downgradient of the process building (West Valley Nuclear Services Co., Inc. 1995).

The interim measure designed to mitigate the gross beta plume on the north plateau is located near the leading edge of a lobe of the plume that is preferentially flowing from the main plume body towards the edge of the plateau (Fig. 3-5). Two extraction wells (RW-01 and RW-02) were installed near the leading edge of the plume.

A pump-and-treat system was installed to treat groundwater extracted from these two wells using an ion-exchange resin column that removes strontium from the groundwater before it is discharged to the low-level waste treatment facility (lagoons 2, 4, or 5). As necessary for treatment in the LLWTF and as required by the current SPDES permit for radiologic species, this pretreatment reduces both the activity and hardness of the groundwater being routed to the LLWTF.

An ongoing analysis of water-level data obtained during the operation of these two wells indicates that they capture a majority of the gross beta lobe. A third extraction well will be positioned between

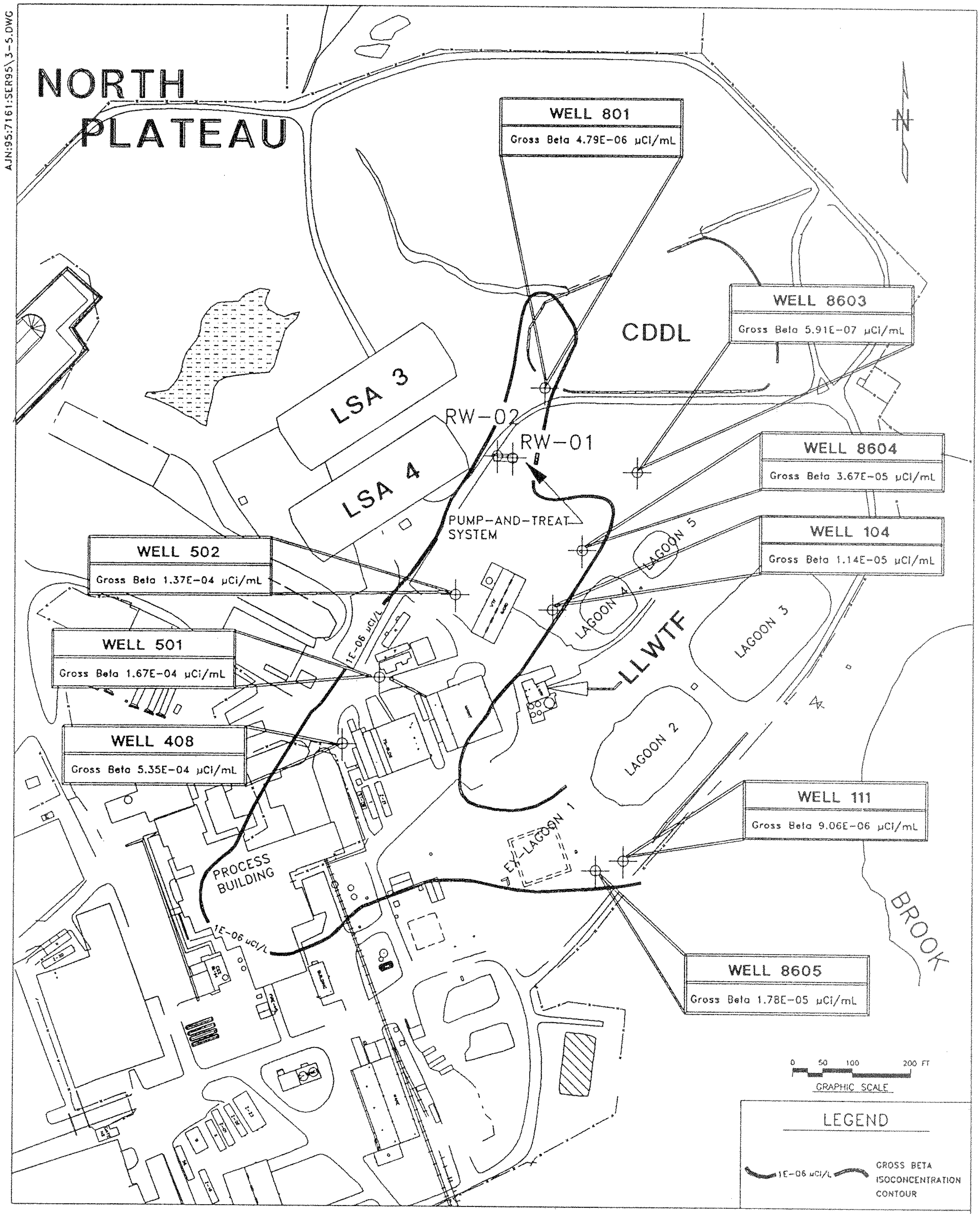


Figure 3-5. North Plateau Gross Beta Plume Area Illustrating the Fourth-Quarter 1995 Results and the Location of the Pump-and-Treat System.

the two current wells to increase the groundwater capture zone and intercept a greater volume of the groundwater plume in order to decrease the amount of contaminated water flowing towards the edge of the plateau.

Discussion of Site Groundwater Monitoring

The groundwater monitoring program was considerably revised in 1995. Revisions were aimed at using the knowledge gained from recent characterization efforts to focus the overall program. By the end of 1995, fewer wells were sampled and, in many cases, fewer parameters were analyzed than in 1994. This reflects the expected transition of the program from one dominated by data collection needs for adequate characterization to one more focused on providing efficient ongoing monitoring surveillance. Data collection needs are expected to further decrease as the RCRA facility investigation reports are made final.

Off-site Groundwater Monitoring Program

During 1995 all of the off-site groundwater residential wells were sampled for radiological constituents, pH, and conductivity. 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. C1-21) in *Appendix C-1*.

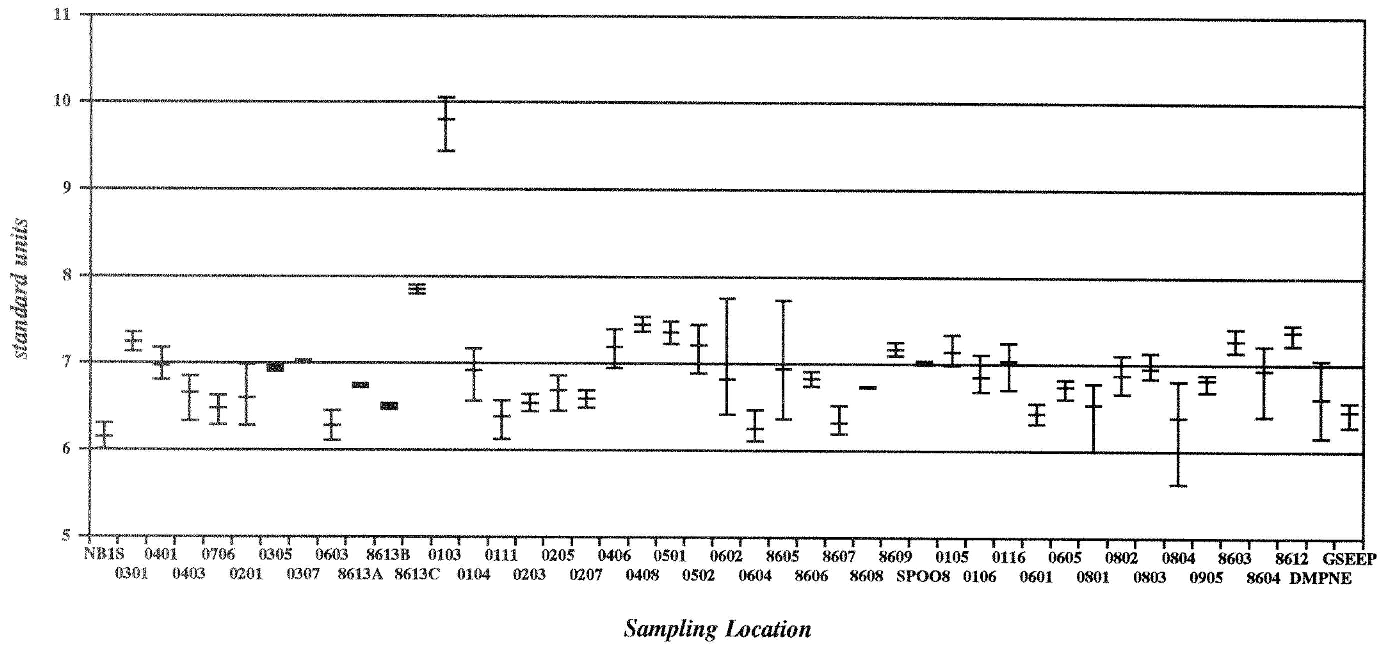


Figure 3-6. pH in Groundwater Samples from the Sand and Gravel Unit

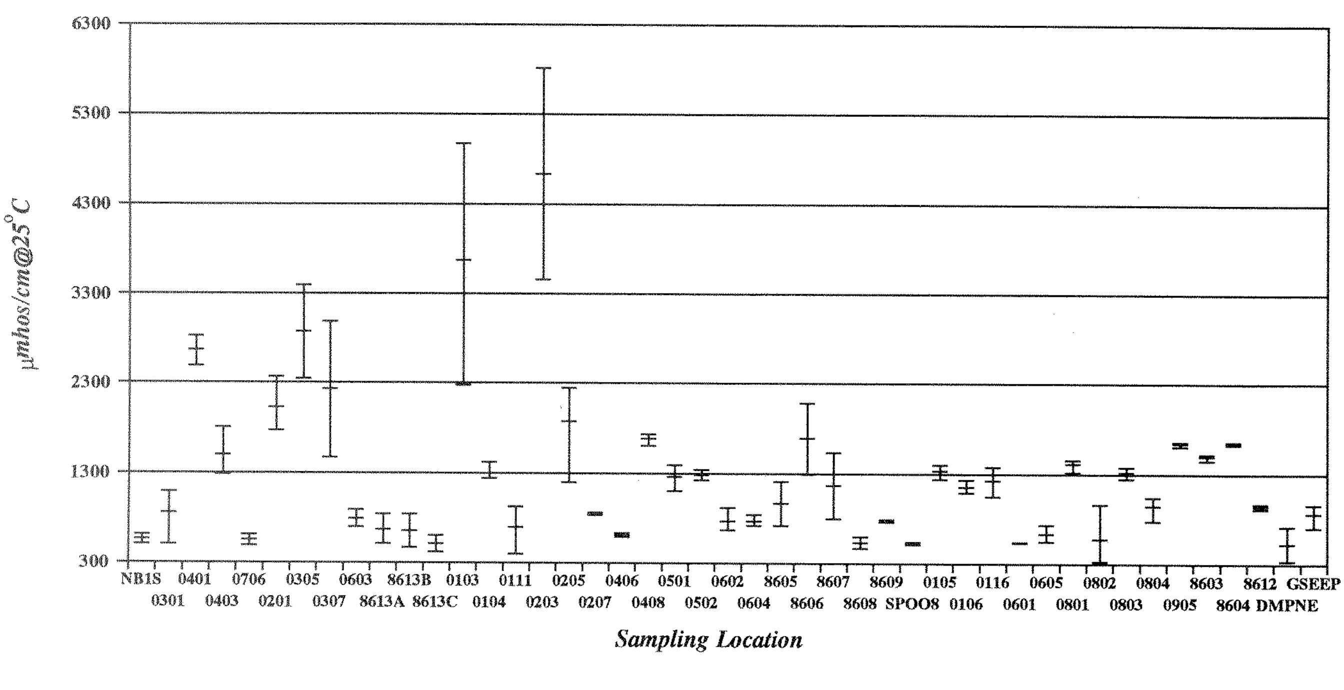


Figure 3-7. Conductivity (μmhos/cm@25°C) in Groundwater Samples from the Sand and Gravel Unit

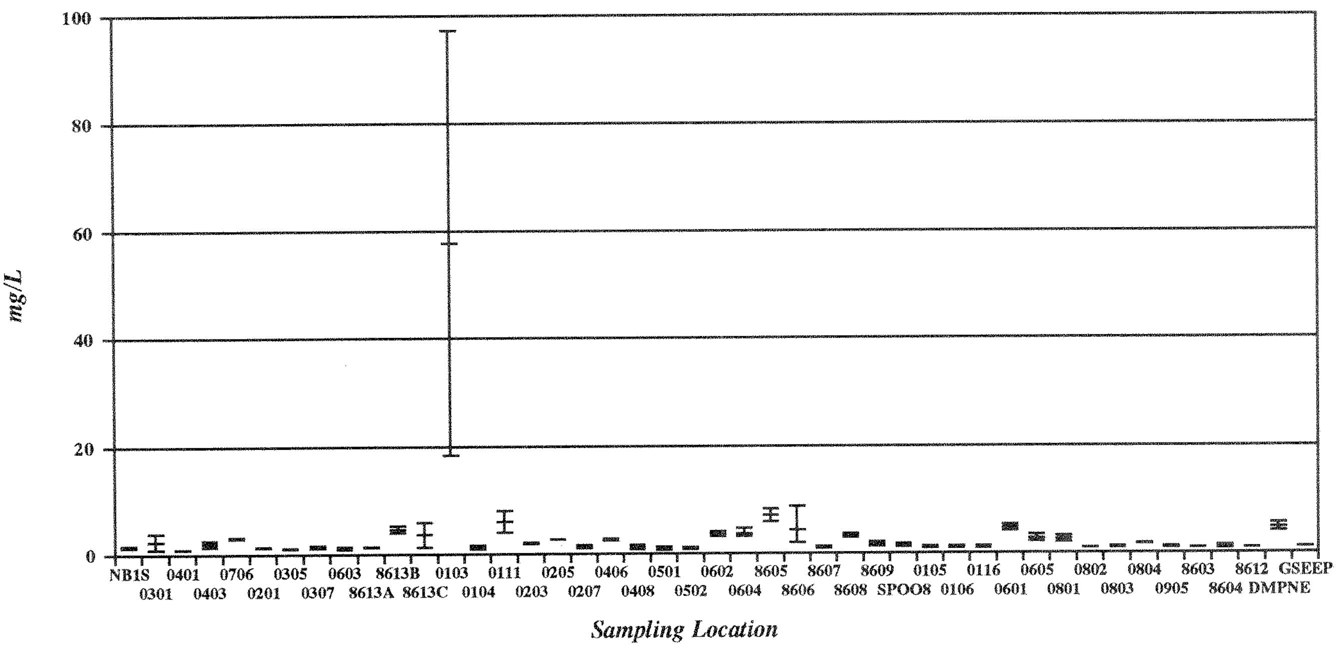


Figure 3-8. Total Organic Carbon (mg/L) in Groundwater Samples from the Sand and Gravel Unit

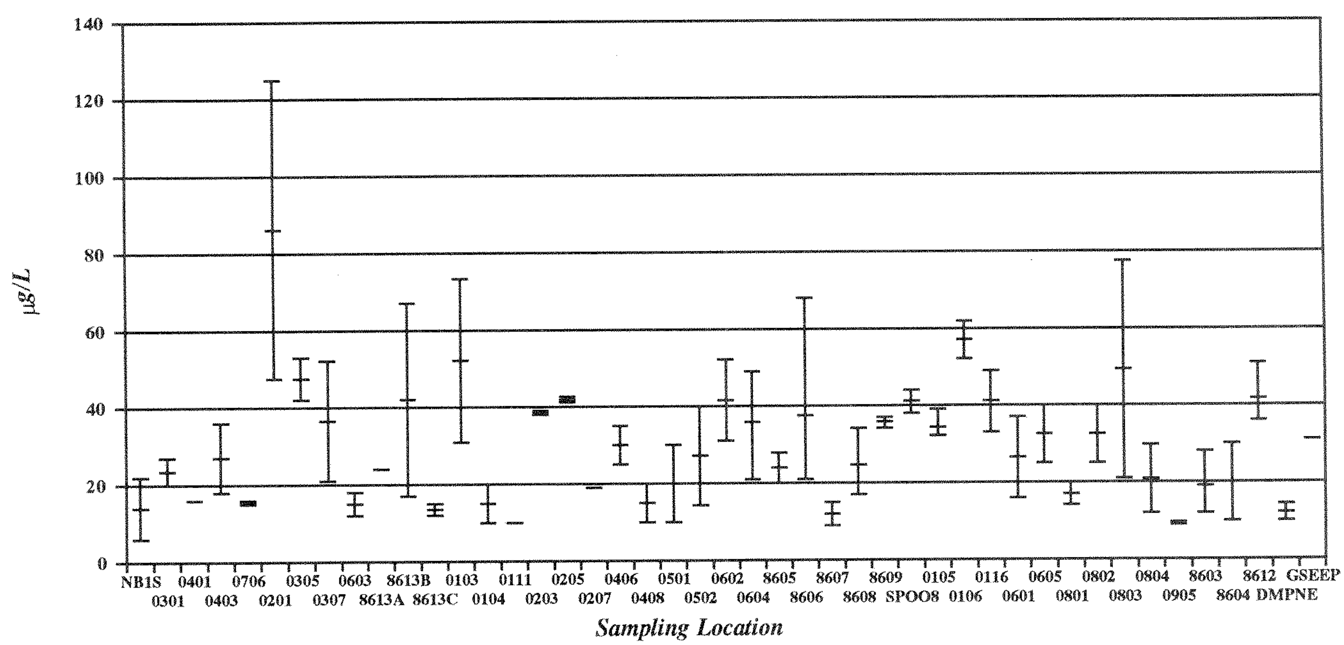


Figure 3-9. Total Organic Halogens (μg/L) in Groundwater Samples from the Sand and Gravel Unit

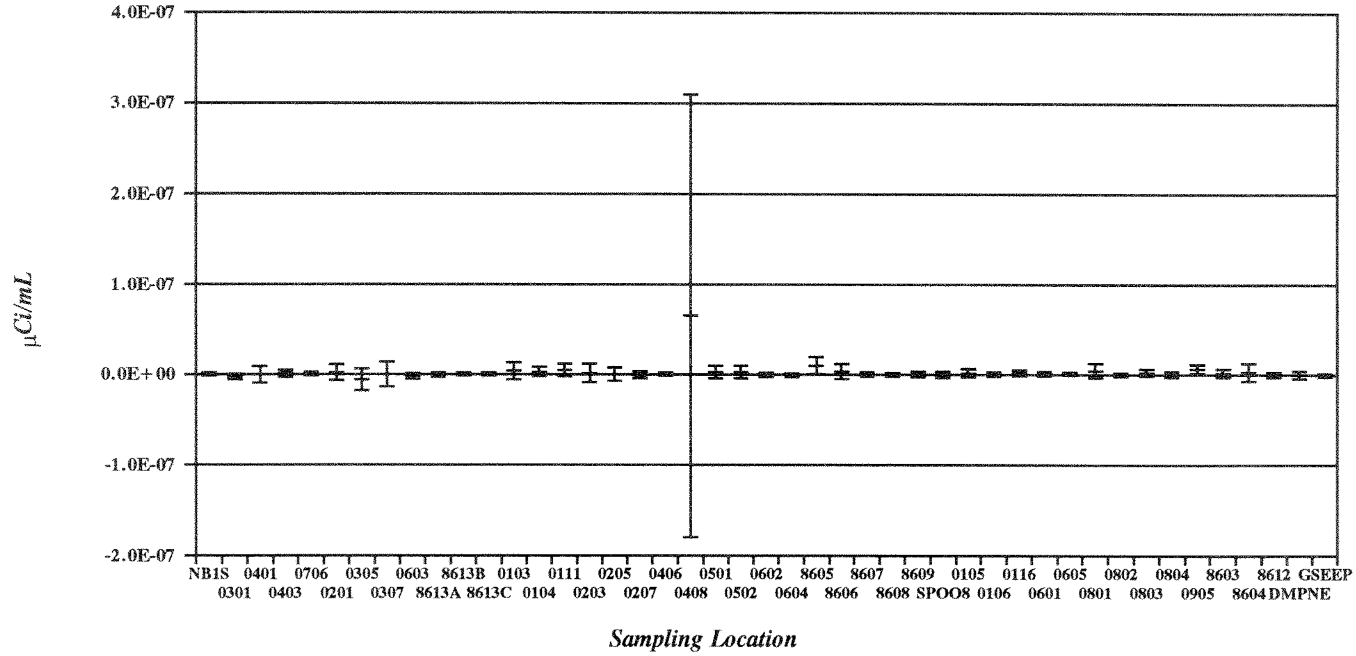


Figure 3-10. Gross Alpha (µCi/mL) in Groundwater Samples from the Sand and Gravel Unit

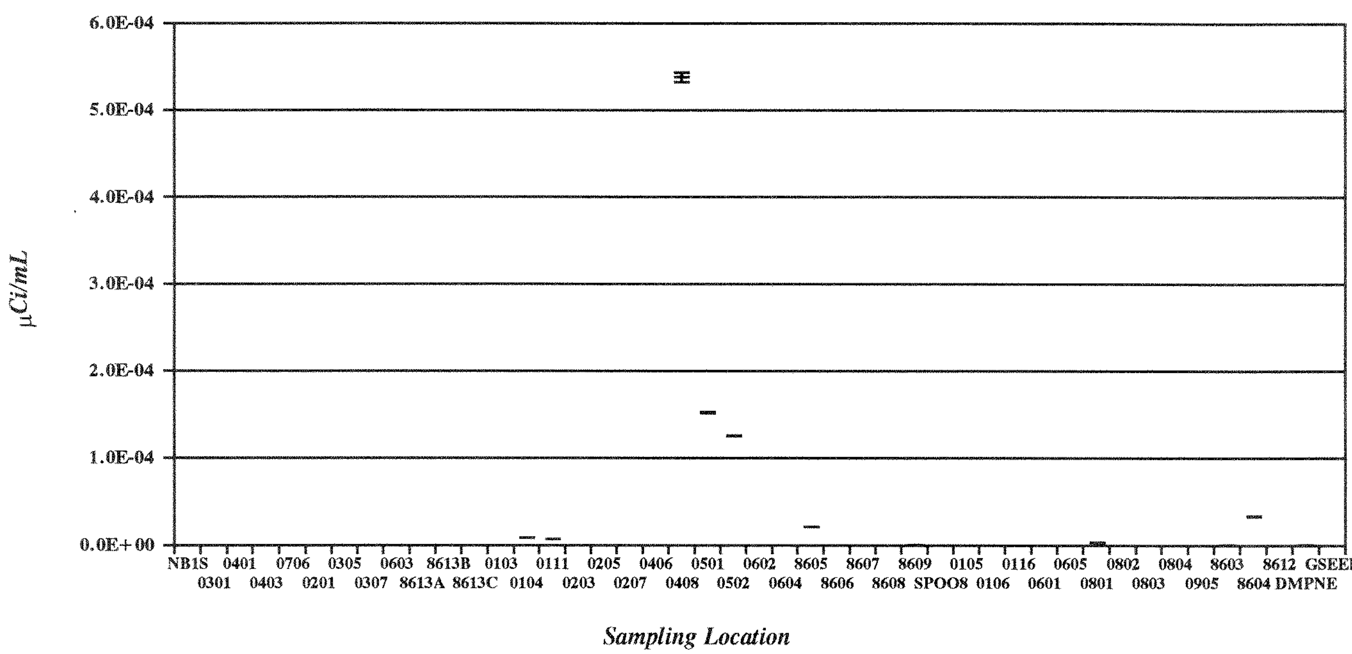


Figure 3-11. Gross Beta (µCi/mL) in Groundwater Samples from the Sand and Gravel Unit (Figs. 3-11a and 3-11b follow with magnified scales.)

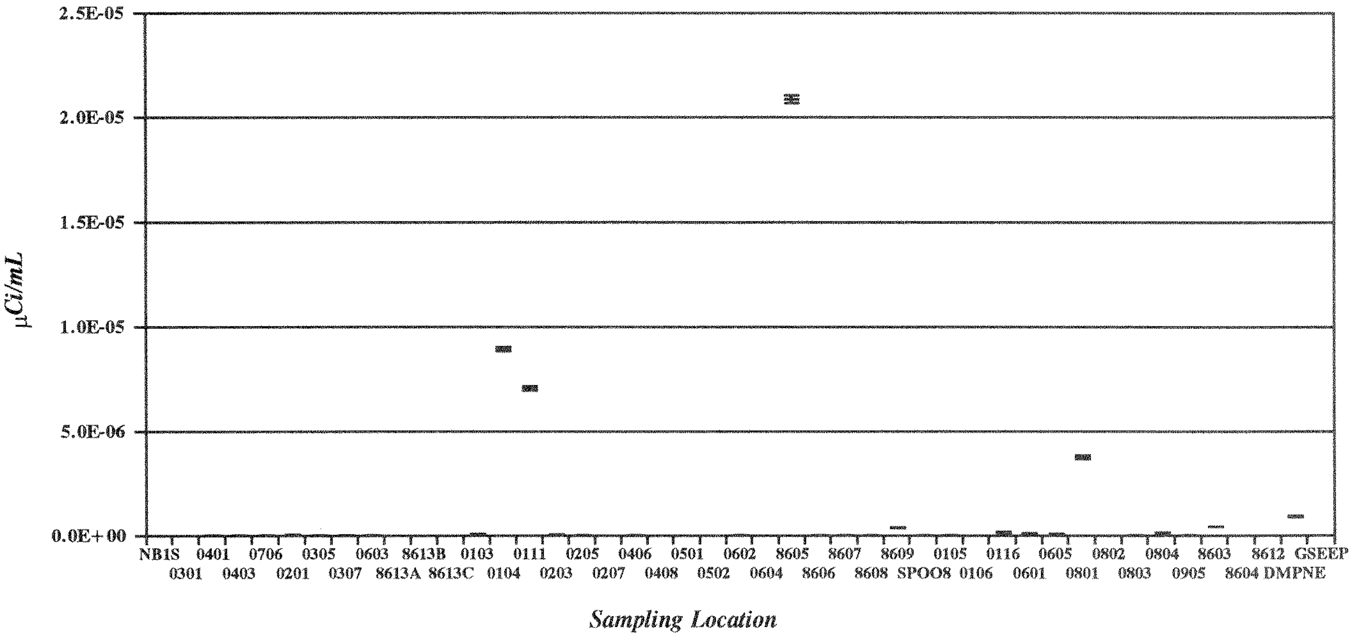


Figure 3-11a. Gross Beta (μCi/mL) in Groundwater Samples from the Sand and Gravel Unit (magnified scale of Fig. 3-11)

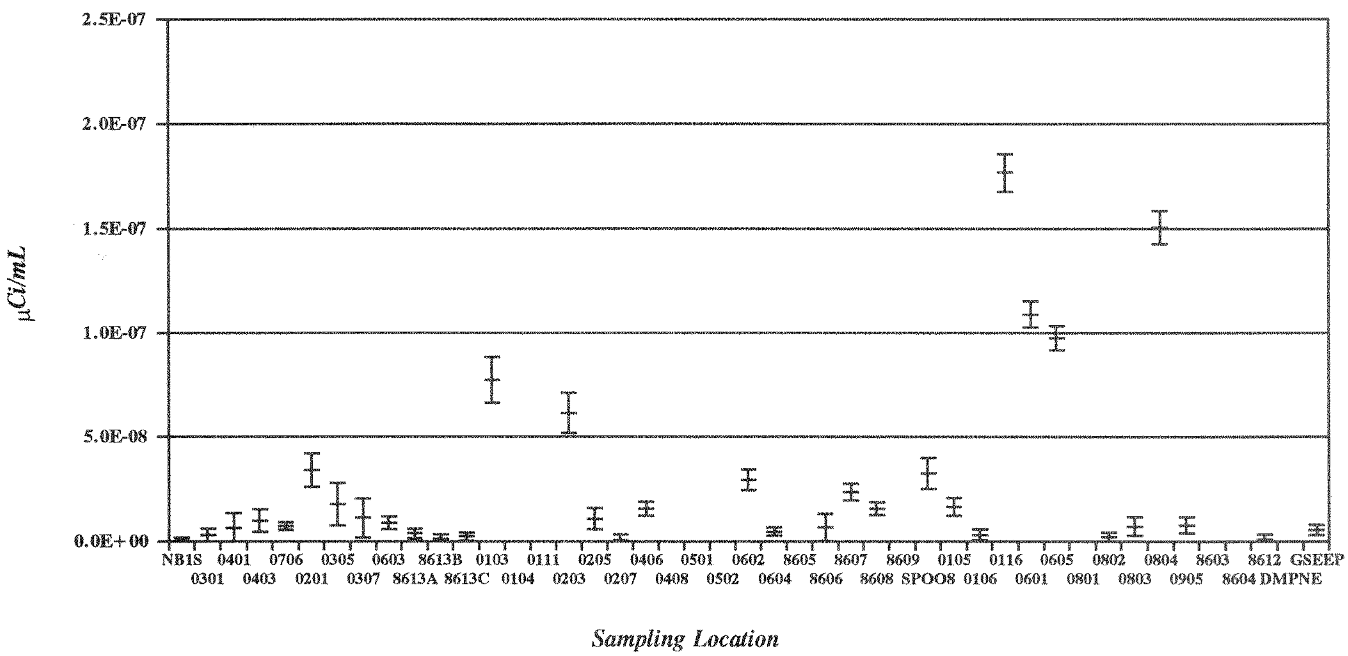


Figure 3-11b. Gross Beta (μCi/mL) in Groundwater Samples from the Sand and Gravel Unit (magnified scale of Fig. 3-11a)

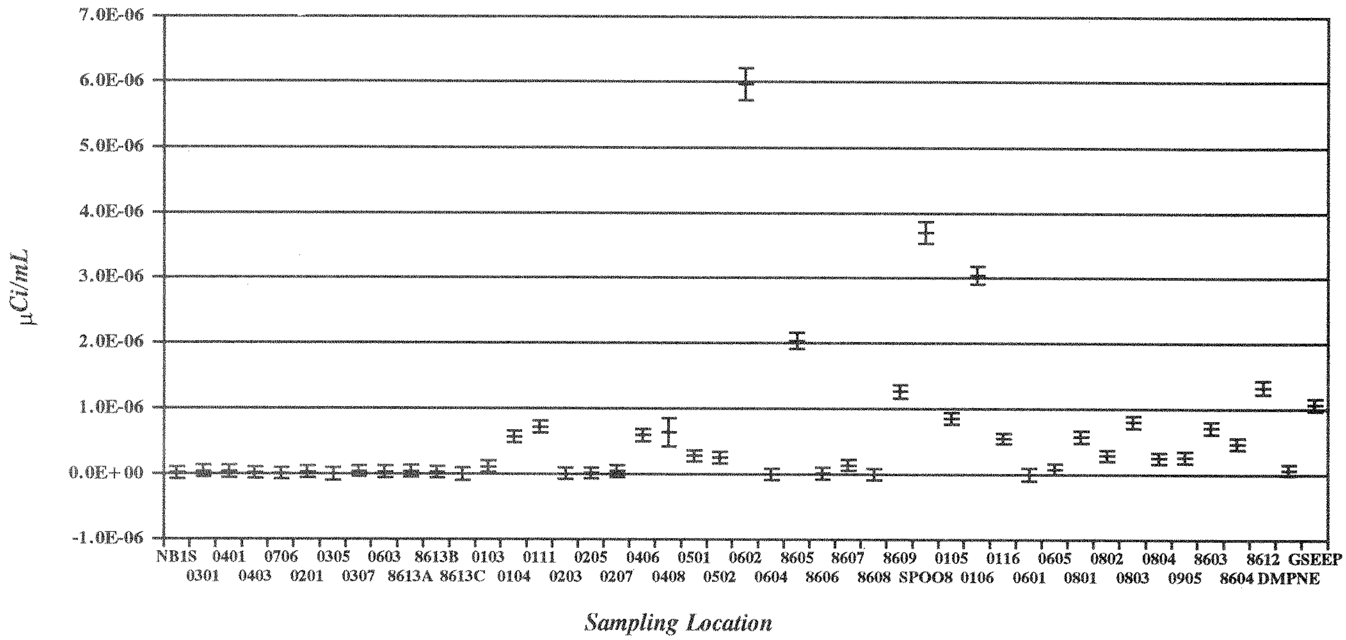


Figure 3-12. Tritium Activity (μCi/mL) in Groundwater Samples from the Sand and Gravel Unit (Fig. 3-12a follows with magnified scale.)

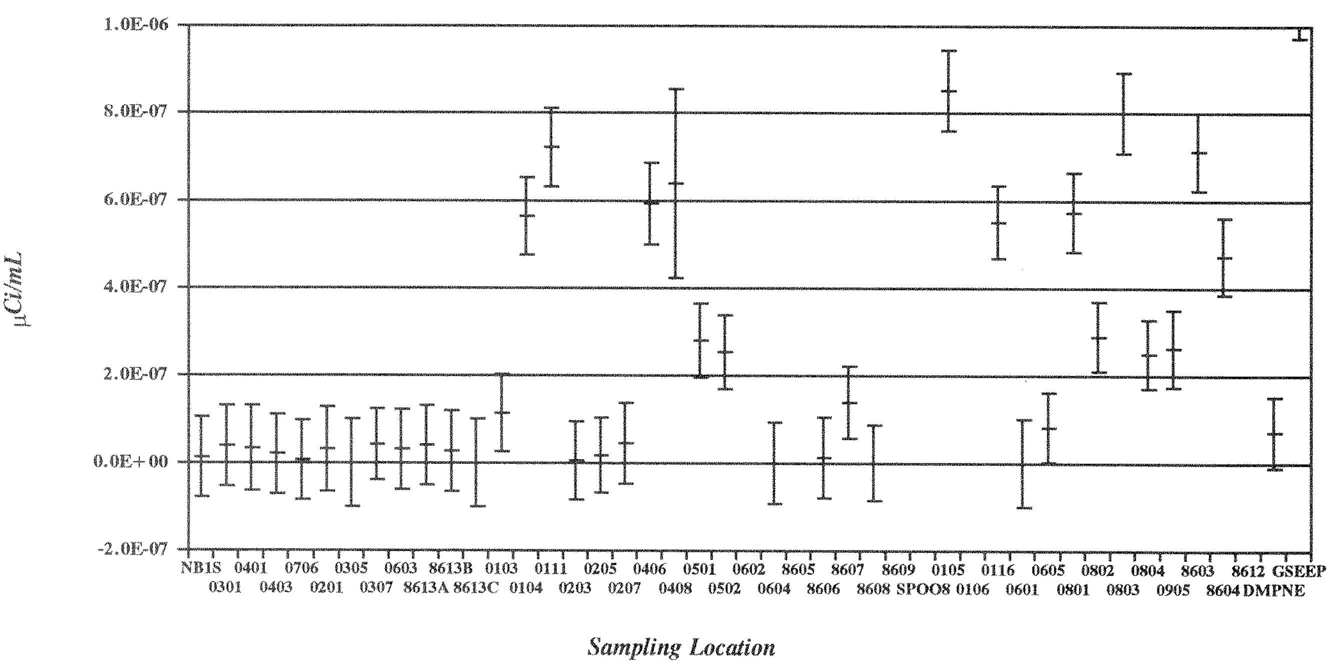


Figure 3-12a. Tritium Activity (μCi/mL) in Groundwater Samples from the Sand and Gravel Unit (magnified scale of Fig. 3-12)

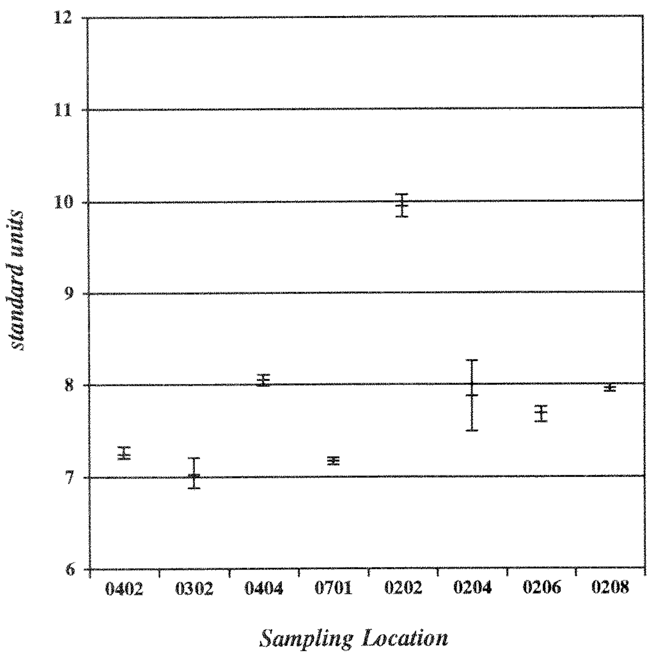


Figure 3-13. pH of Groundwater Samples from the Till-Sand Unit

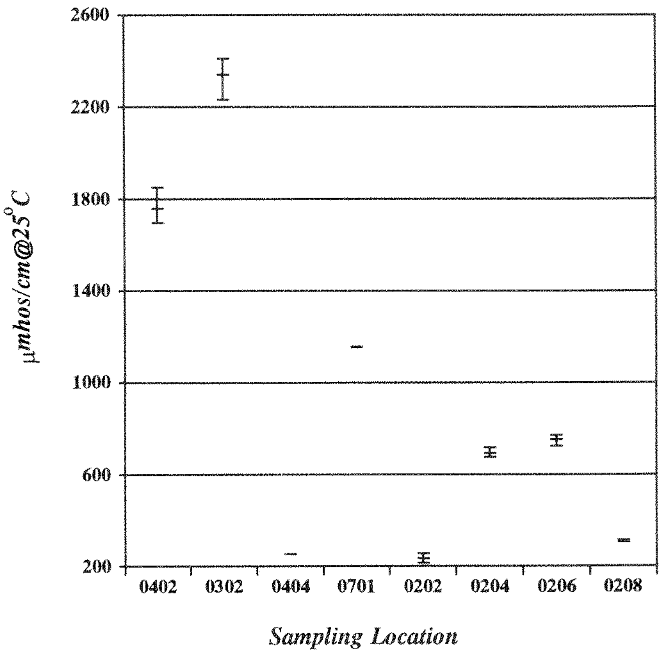


Figure 3-14. Conductivity (μmhos/cm@25°C) of Groundwater Samples from the Till-Sand Unit

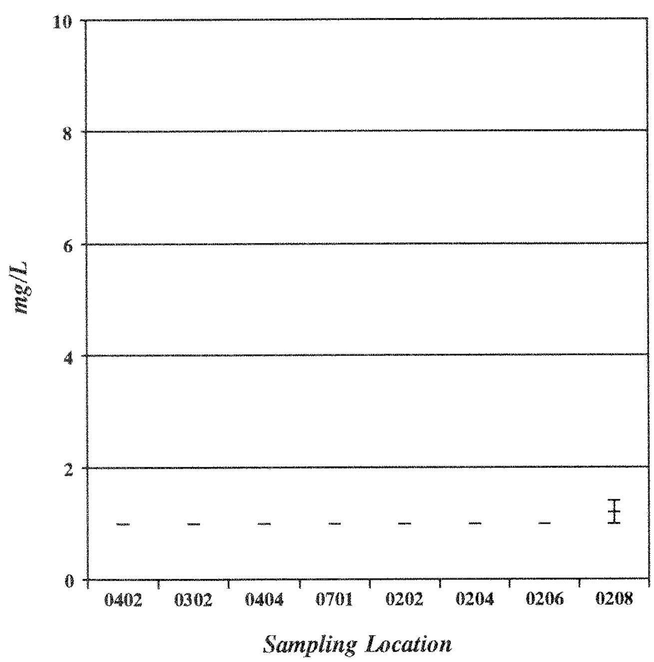


Figure 3-15. Total Organic Carbon (mg/L) in Groundwater Samples from the Till-Sand Unit

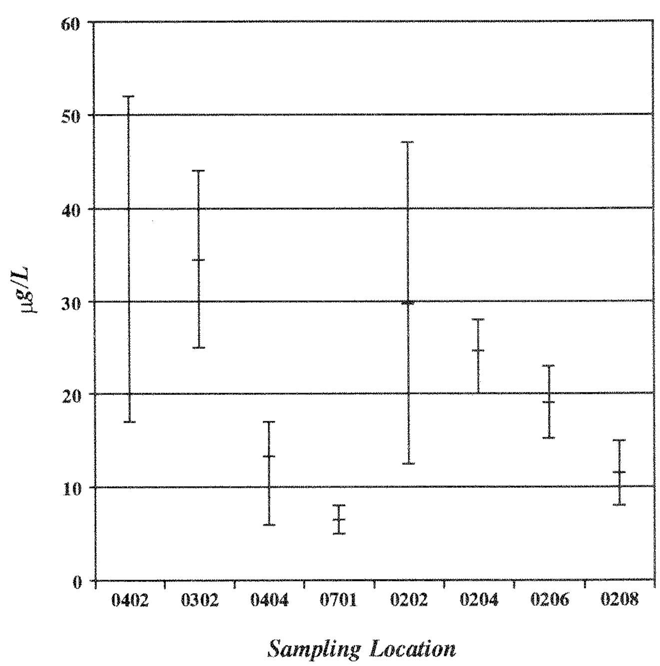


Figure 3-16. Total Organic Halogens (μg/L) in Groundwater Samples from the Till-Sand Unit

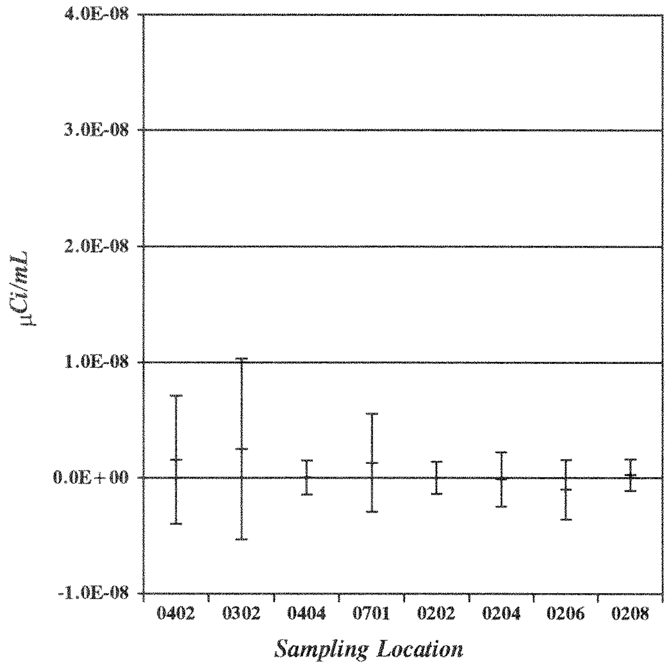


Figure 3-17. Gross Alpha (μCi/mL) in Groundwater Samples from the Till-Sand Unit

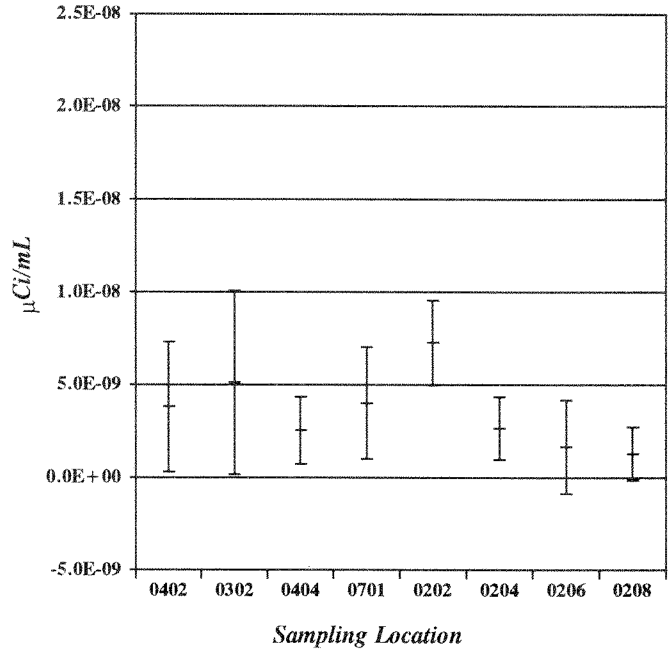


Figure 3-18. Gross Beta (μCi/mL) in Groundwater Samples from the Till-Sand Unit

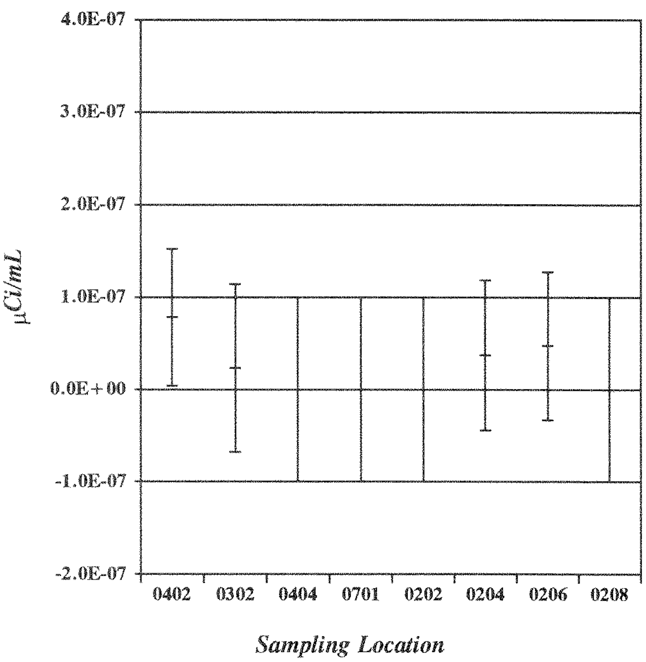


Figure 3-19. Tritium Activity (μCi/mL) in Groundwater Samples from the Till-Sand Unit

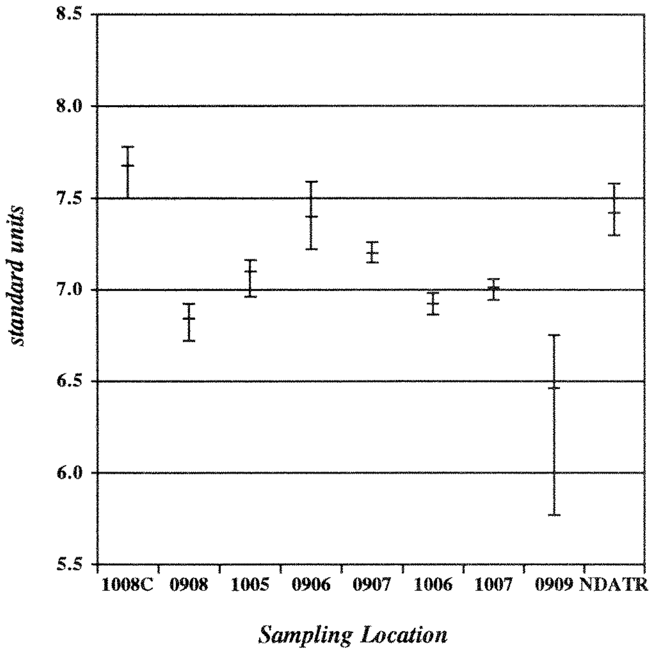


Figure 3-20. pH of Groundwater Samples from the Weathered Lavery Till Unit

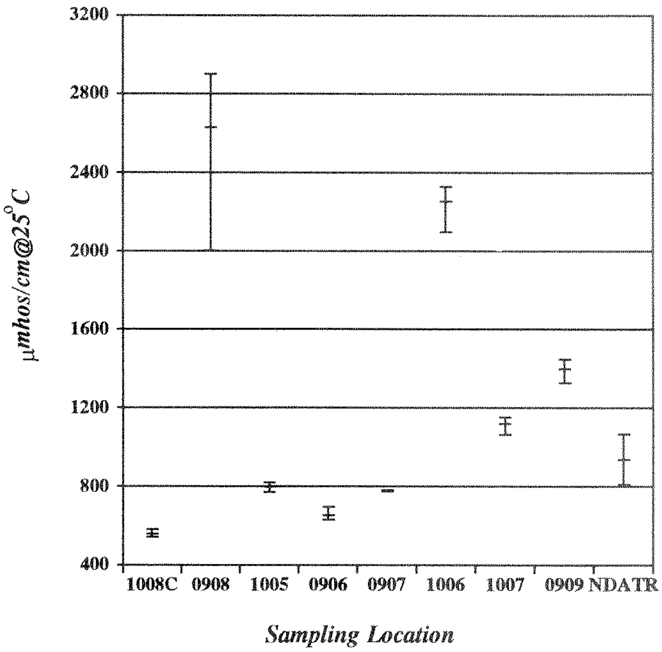


Figure 3-21. Conductivity (µmhos/cm@25°C) of Groundwater Samples from the Weathered Lavery Till Unit

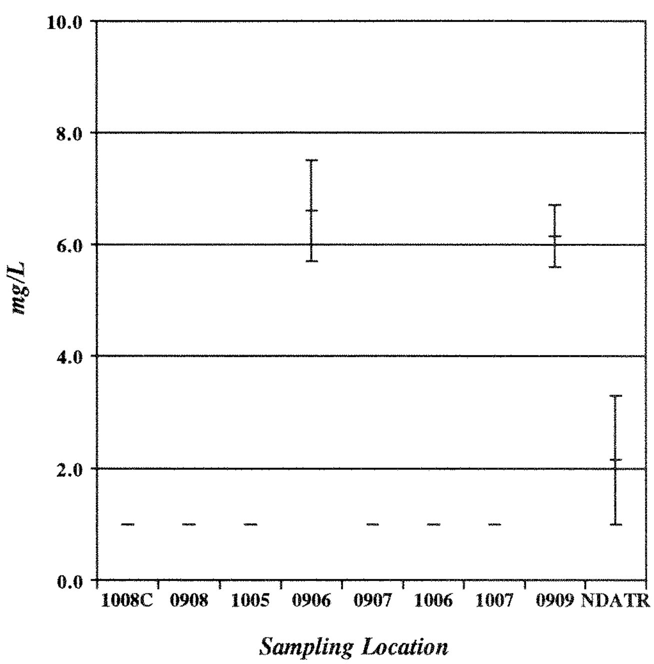


Figure 3-22. Total Organic Carbon (mg/L) in Groundwater Samples from the Weathered Lavery Till Unit

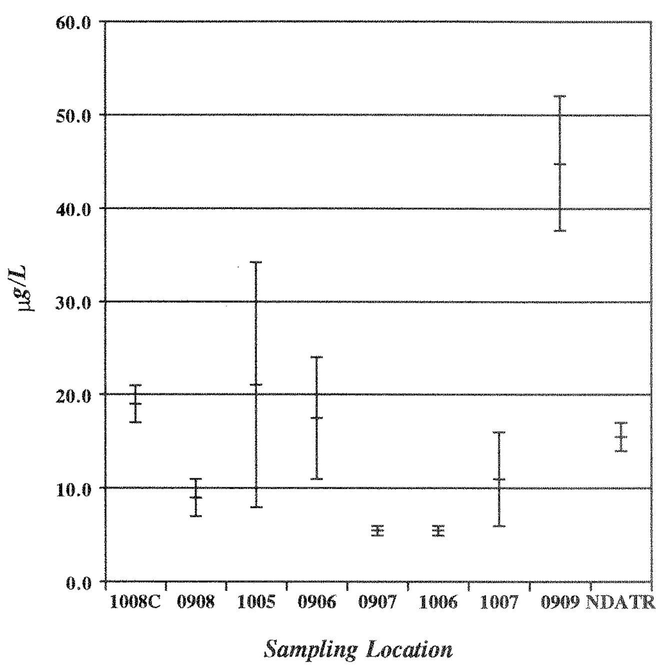


Figure 3-23. Total Organic Halogens (µg/L) in Groundwater Samples from the Weathered Lavery Till Unit

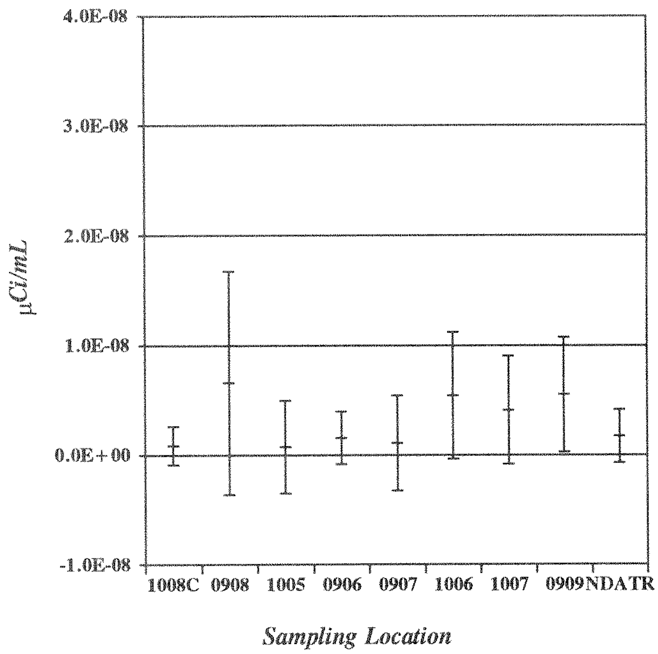


Figure 3-24. Gross Alpha (μCi/mL) in Groundwater Samples from the Weathered Lavery Till Unit

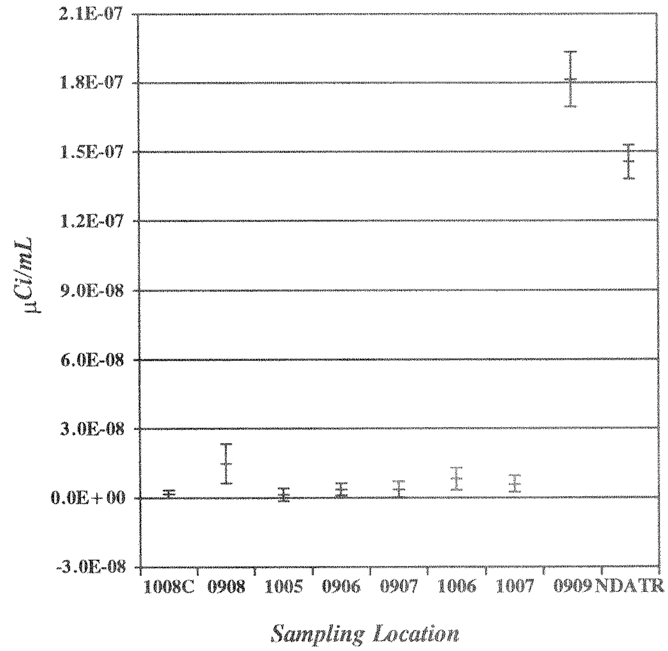


Figure 3-25. Gross Beta (μCi/mL) in Groundwater Samples from the Weathered Lavery Till Unit

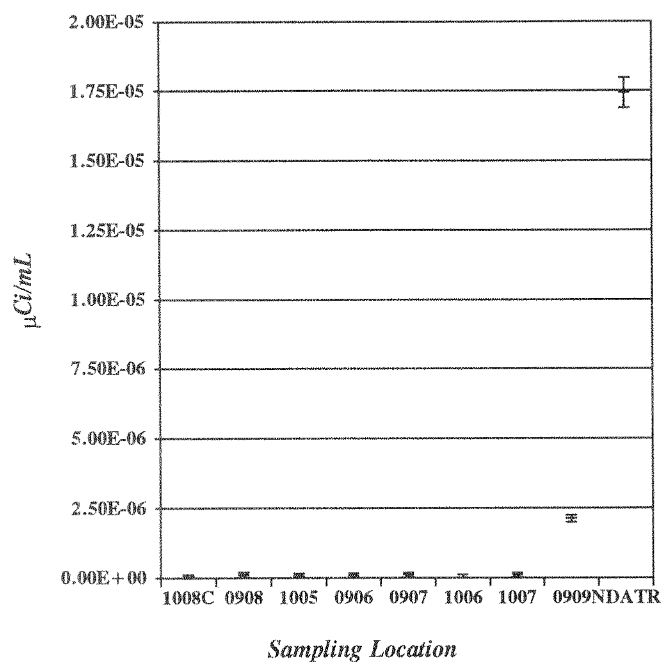


Figure 3-26. Tritium Activity (μCi/mL) in Groundwater Samples from the Weathered Lavery Till Unit (Fig. 3-26a follows with magnified scale.)

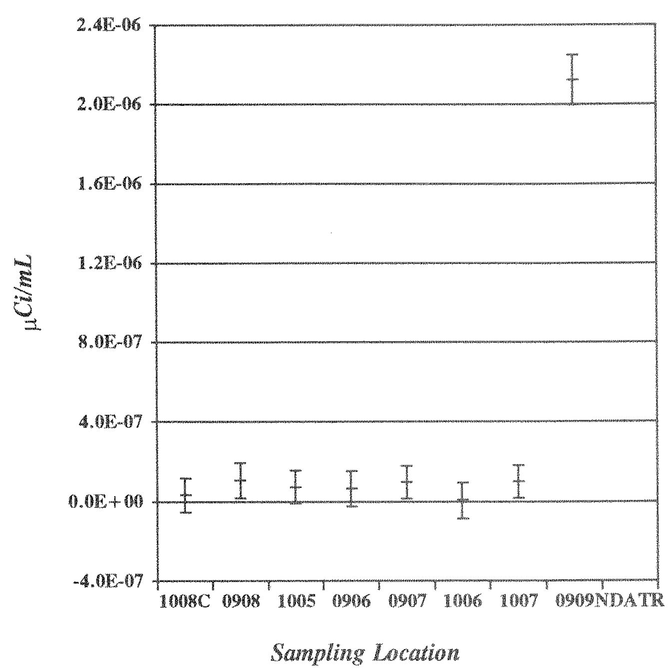


Figure 3-26a. Tritium Activity (μCi/mL) in Groundwater Samples from the Weathered Lavery Till Unit (magnified scale of Fig. 3-26)

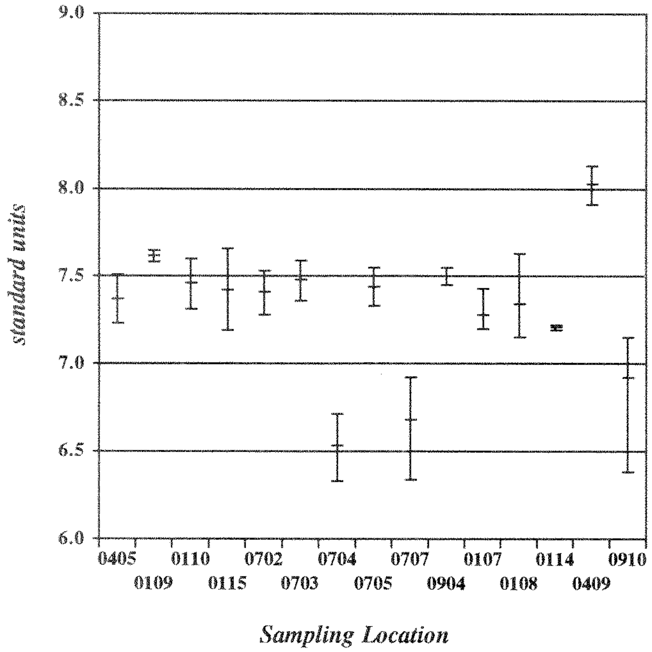


Figure 3-27. pH of Groundwater Samples from the Unweathered Lavery Till Unit

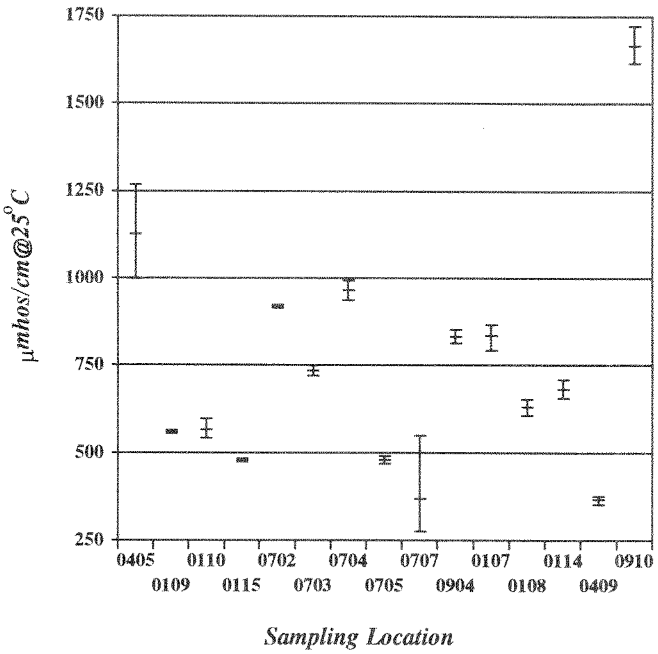


Figure 3-28. Conductivity (μmhos/cm@25°C) of Groundwater Samples from the Unweathered Lavery Till Unit

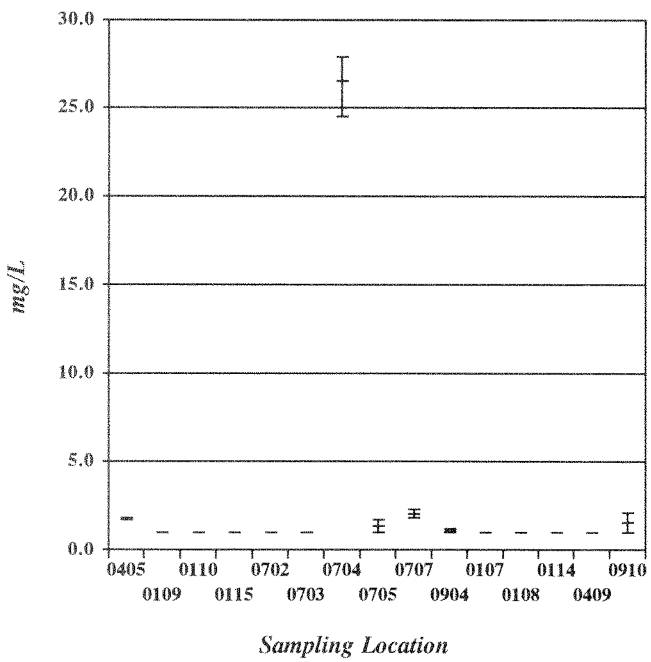


Figure 3-29. Total Organic Carbon (mg/L) in Groundwater Samples from the Unweathered Lavery Till Unit

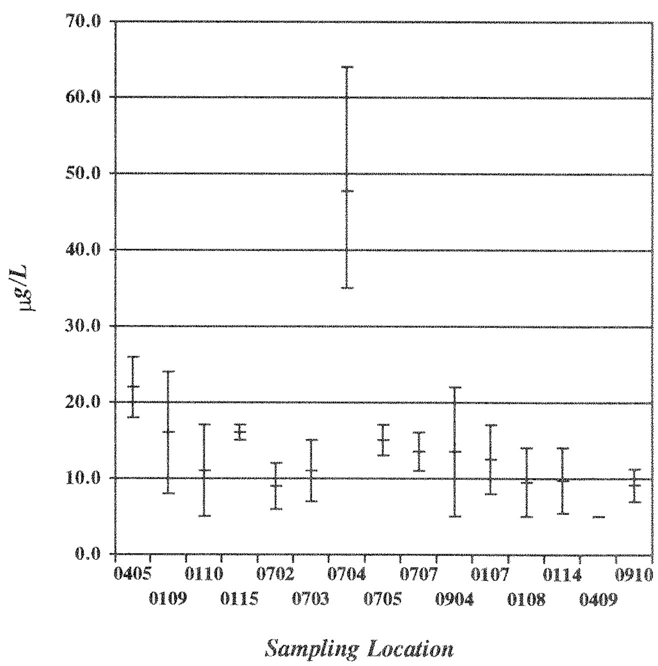


Figure 3-30. Total Organic Halogens (μg/L) in Groundwater Samples from the Unweathered Lavery Till Unit

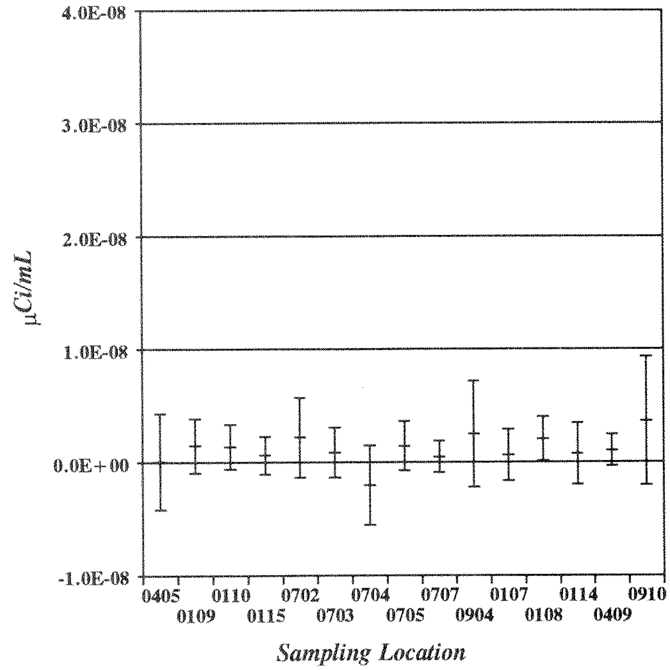


Figure 3-31. Gross Alpha (µCi/mL) in Groundwater Samples from the Unweathered Lavery Till Unit

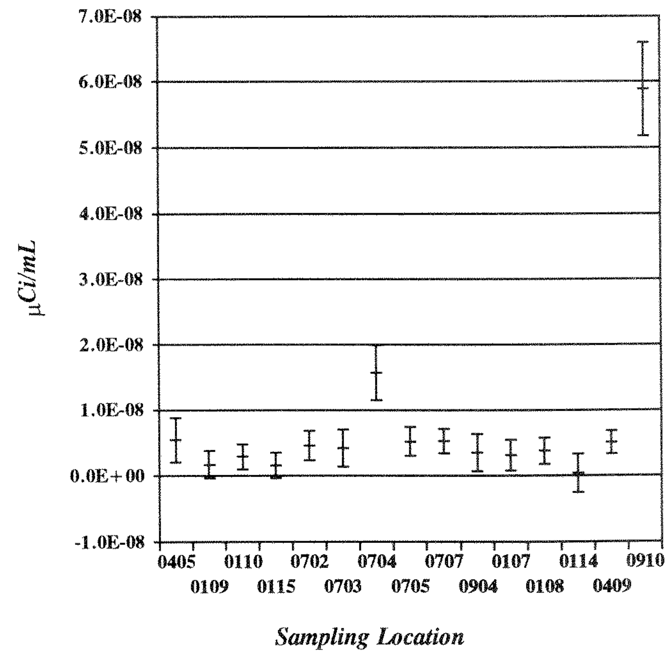


Figure 3-32. Gross Beta (µCi/mL) in Groundwater Samples from the Unweathered Lavery Till Unit

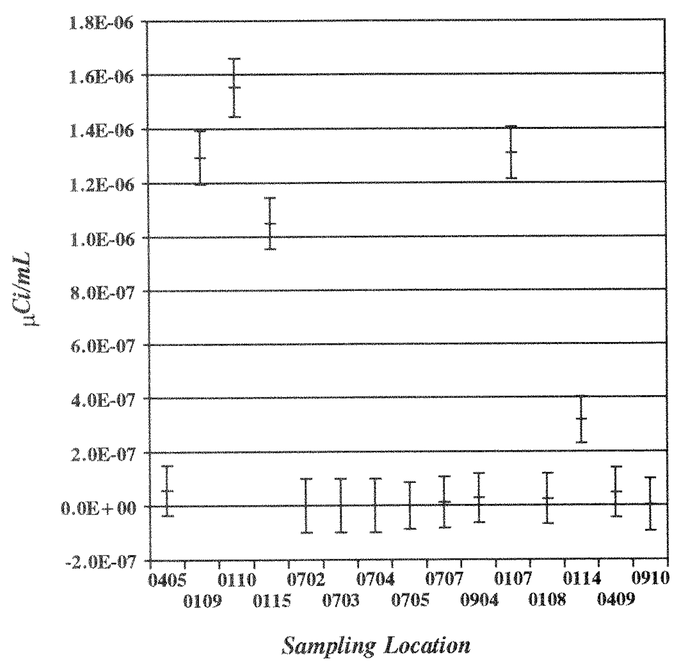


Figure 3-33. Tritium Activity (µCi/mL) in Groundwater Samples from the Unweathered Lavery Till Unit

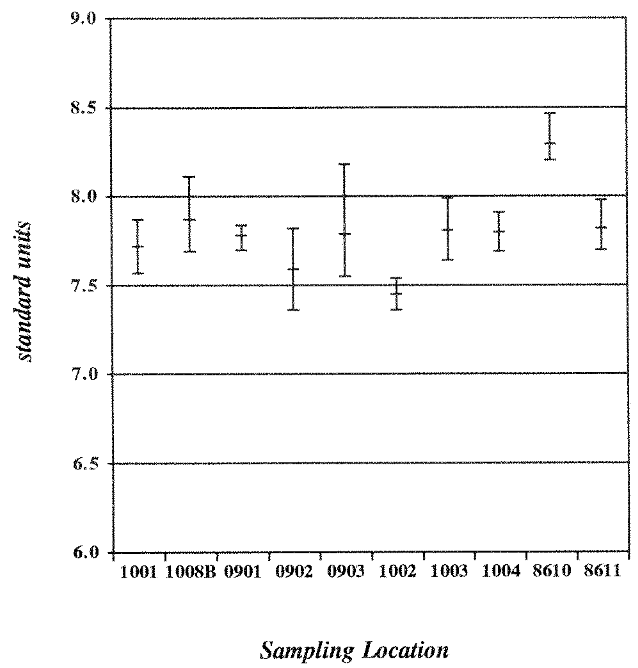


Figure 3-34. pH of Groundwater Samples from the Kent Recessional Sequence

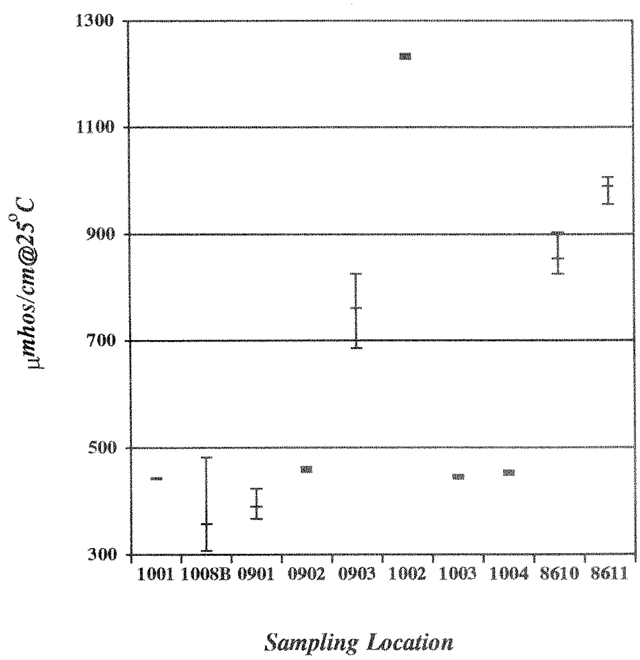


Figure 3-35. Conductivity (µmhos/cm@25°C) of Groundwater Samples from the Kent Recessional Sequence

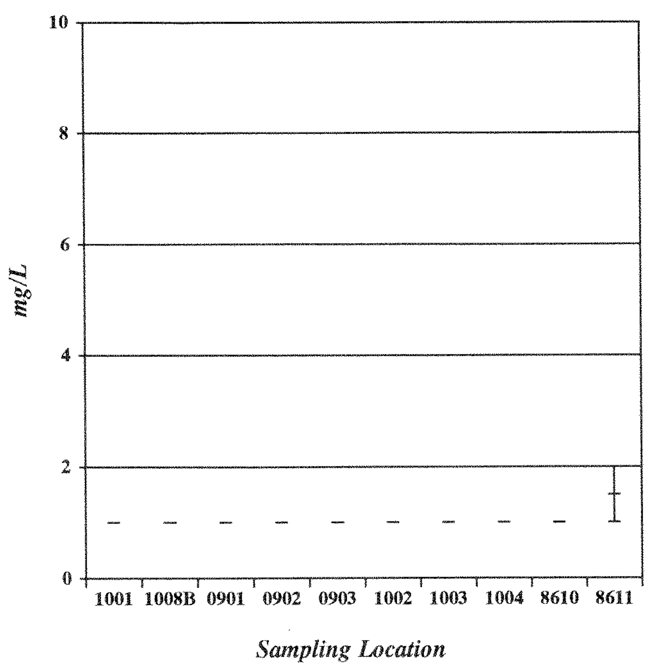


Figure 3-36. Total Organic Carbon (mg/L) in Groundwater Samples from the Kent Recessional Sequence

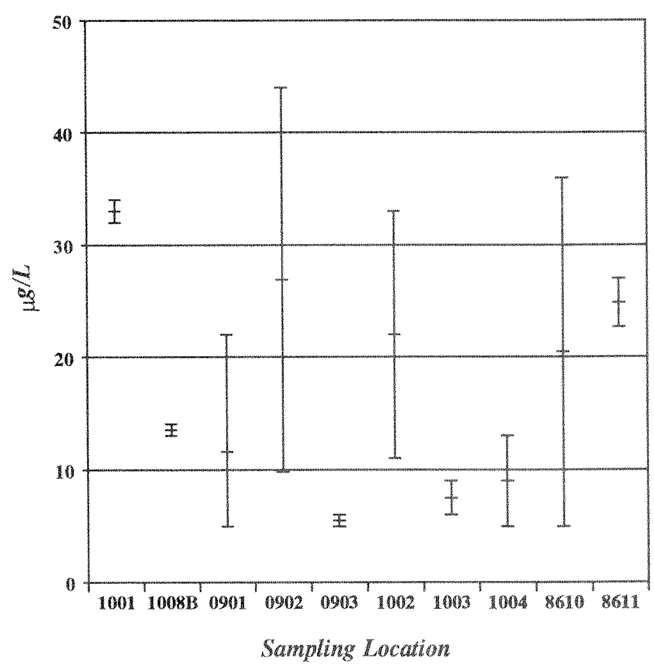


Figure 3-37. Total Organic Halogens (µg/L) in Groundwater Samples from the Kent Recessional Sequence

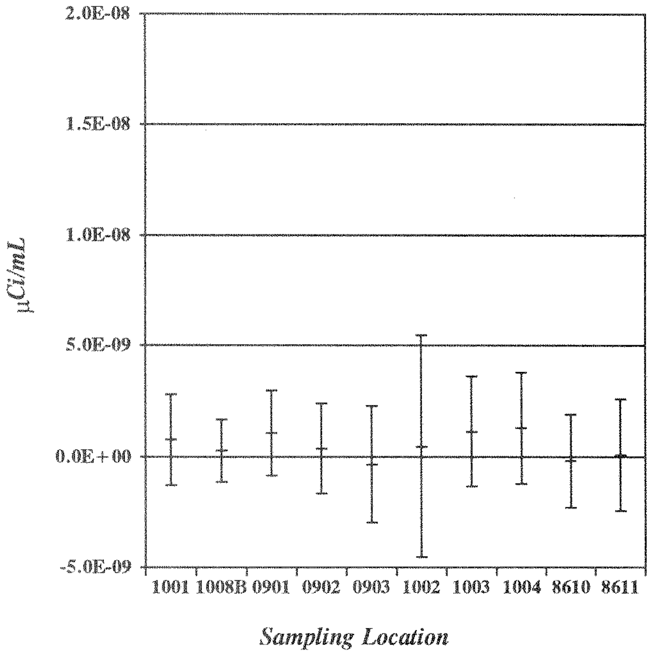


Figure 3-38. Gross Alpha (μCi/mL) in Groundwater Samples from the Kent Recessional Sequence

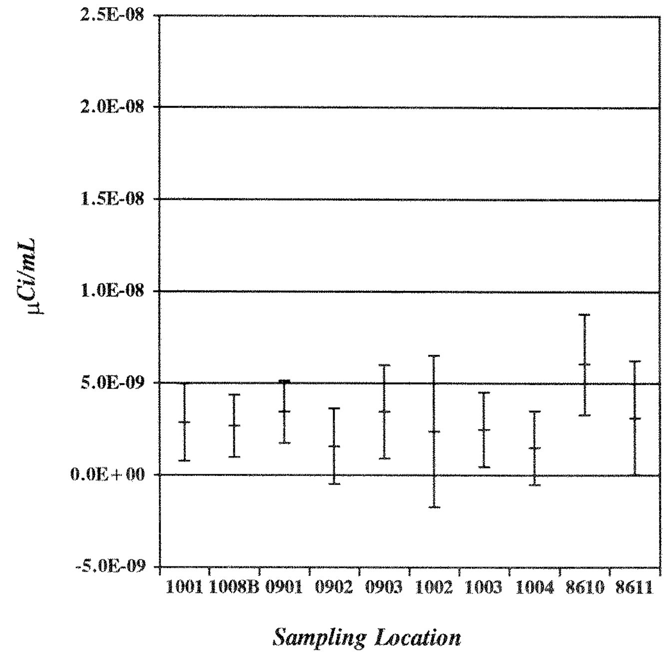


Figure 3-39. Gross Beta (μCi/mL) in Groundwater Samples from the Kent Recessional Sequence

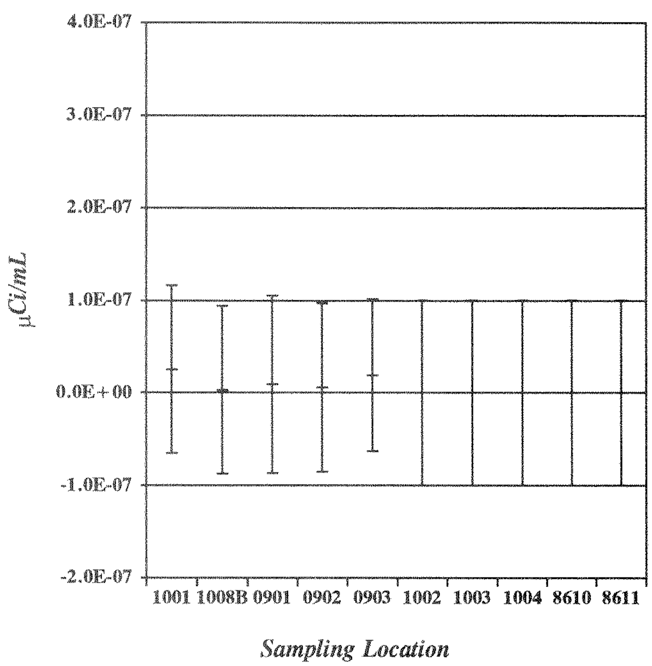


Figure 3-40. Tritium Activity (μCi/mL) in Groundwater Samples from the Kent Recessional Sequence

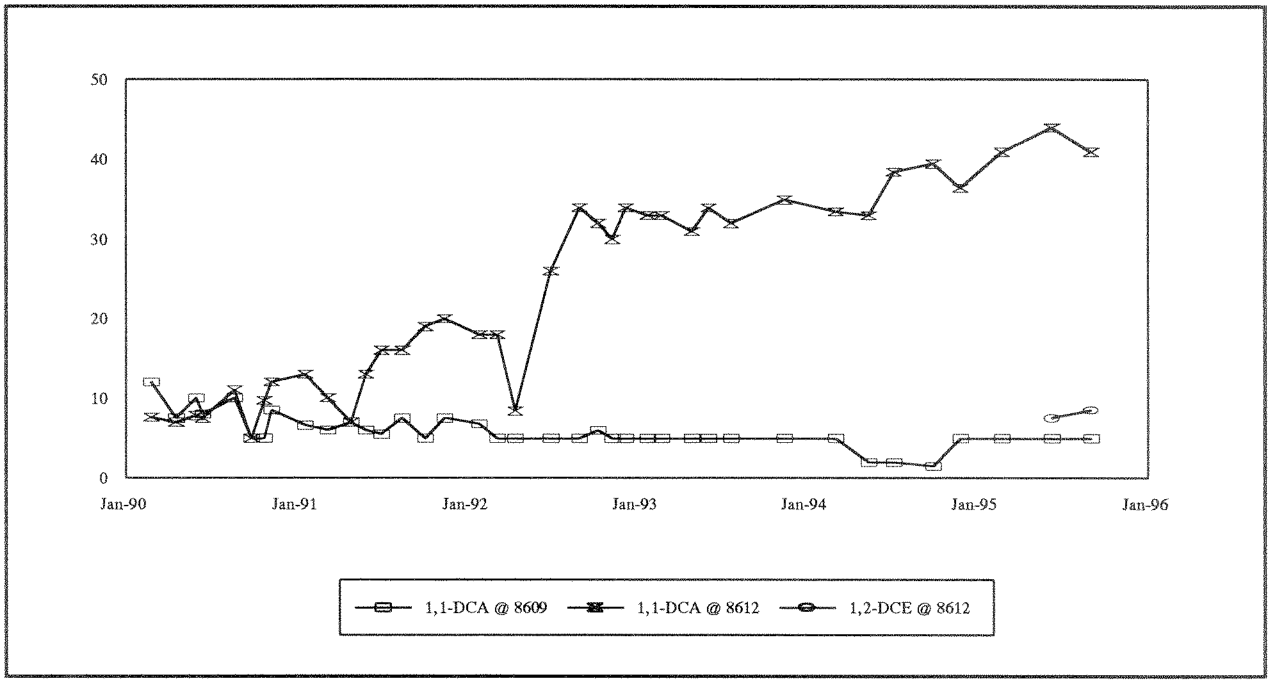


Figure 3-41. Six-Year Trends (1990 through 1995) of 1,1-DCA and 1,2-DCE (μg/L) at Selected Groundwater Locations

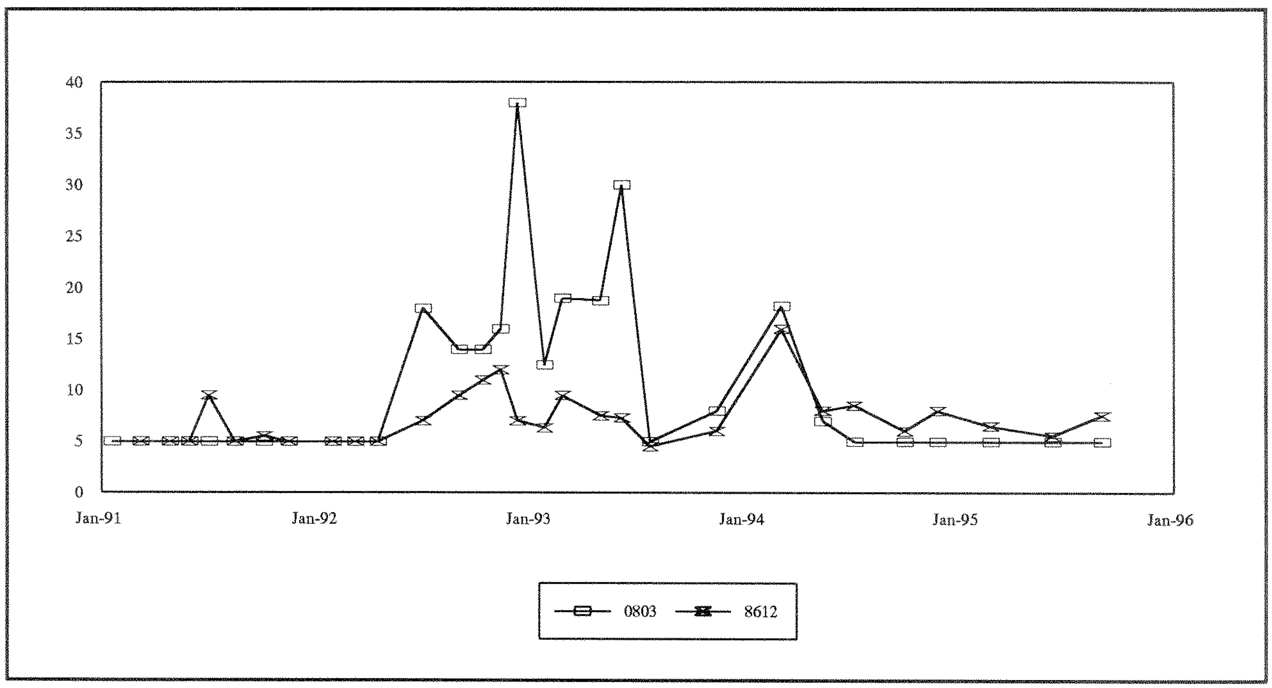


Figure 3-41a. Five-Year Trends (1991 through 1995) of Dichlorodifluoromethane (DCDFMeth) (μg/L) at Selected Groundwater Locations

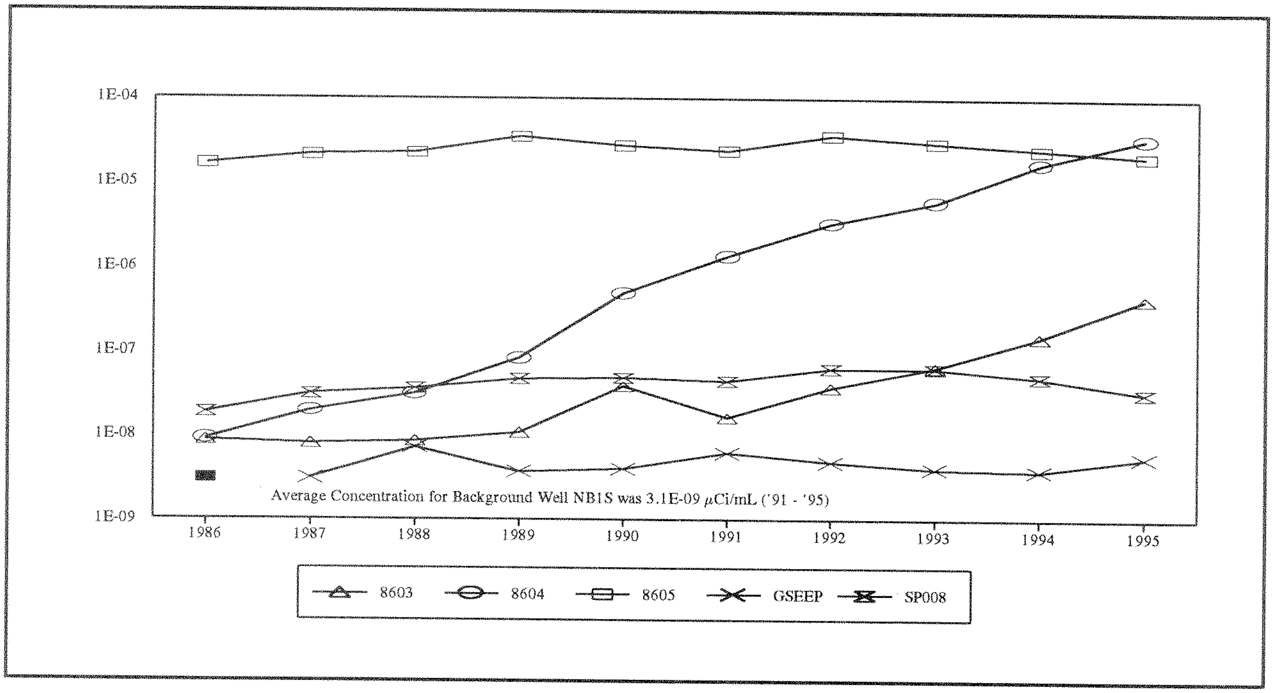


Figure 3-42. Ten-Year Trends of Averaged Gross Beta Activity (µCi/mL) at Selected Locations in the Sand and Gravel Unit

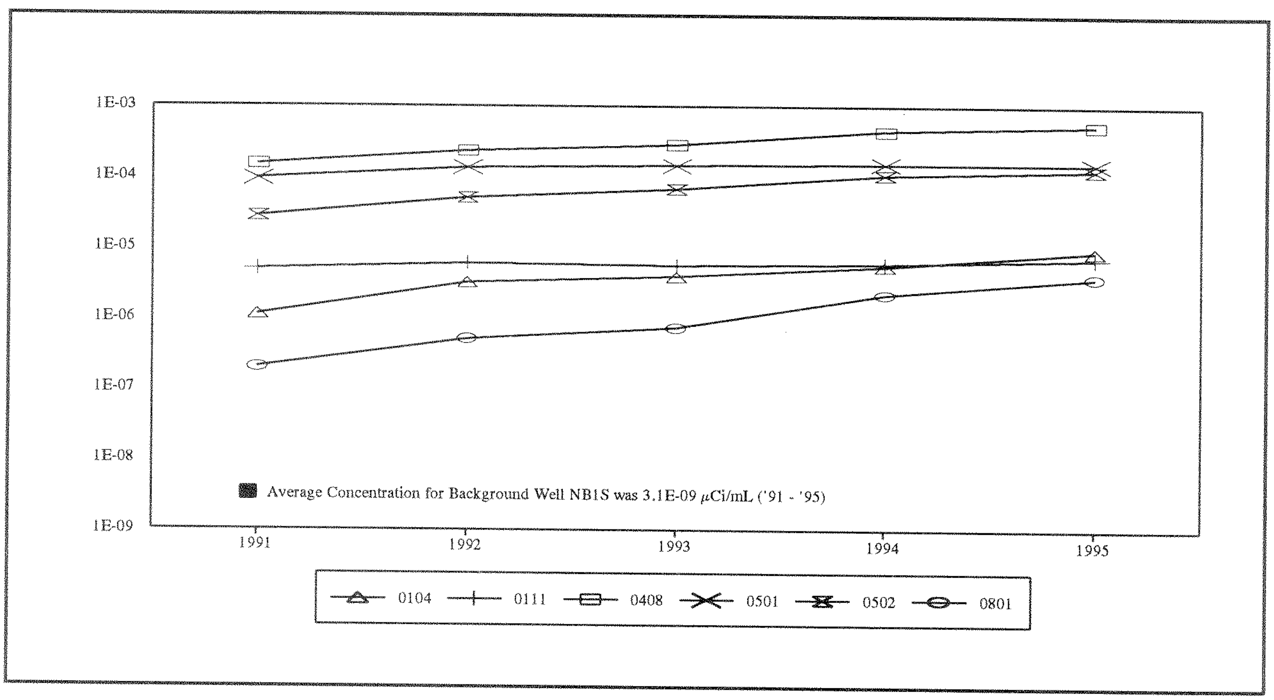


Figure 3-42a. Five-Year Trends of Gross Beta Activity (µCi/mL) at Selected Locations in the Sand and Gravel Unit

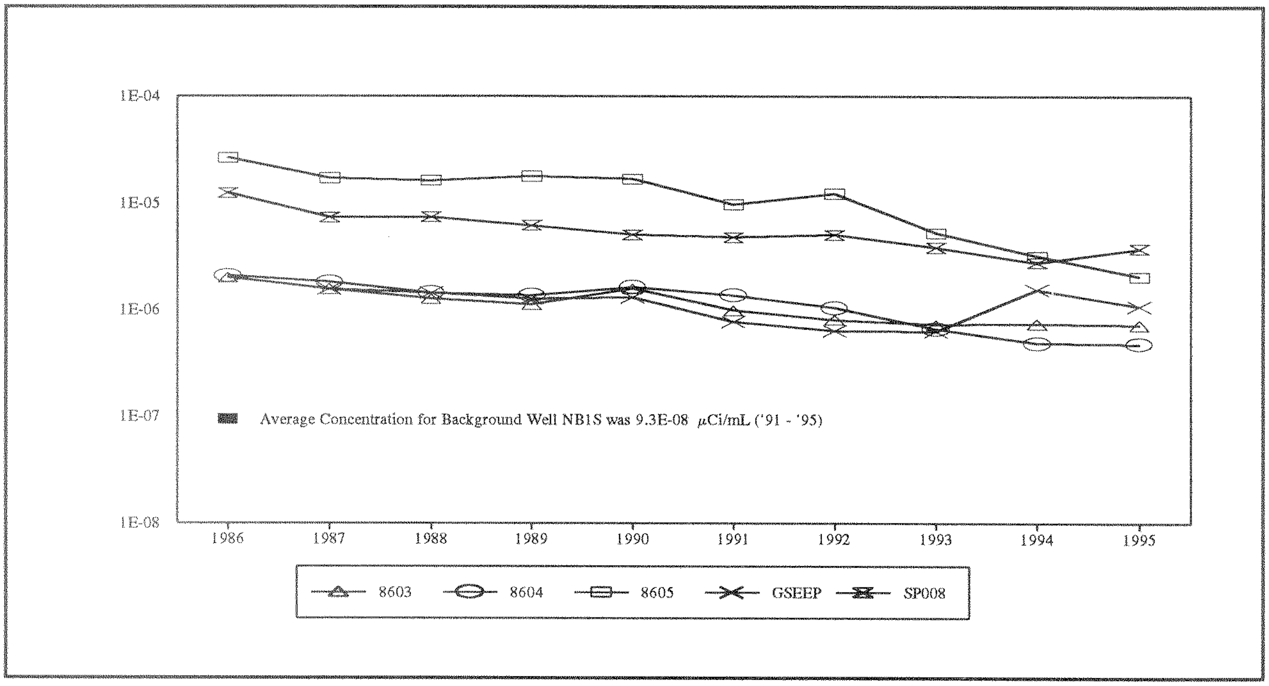


Figure 3-43. Ten-Year Trends of Averaged Tritium Activity (μCi/mL) at Selected Locations in the Sand and Gravel Unit

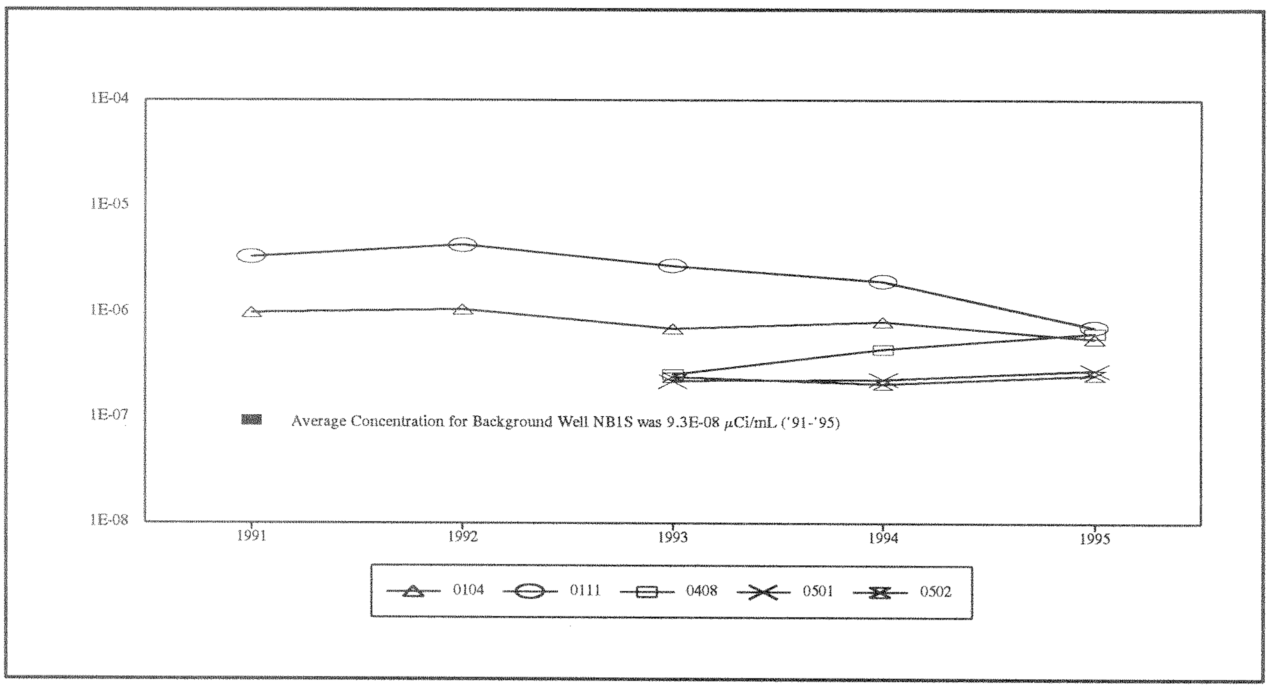


Figure 3-43a. Five-Year Trends of Tritium Activity (μCi/mL) at Selected Locations in the Sand and Gravel Unit