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 period. (The sample collection year is divided into two semiannual periods; each semiannual period is divided into evenly spaced six-week periods, called "reps.") During 1993, the sampling schedule was revised from eight reps per year to four reps per year. The change took place at mid-year, when four six-week reps had already occurred. In the second half of 1993 samples were collected during two quarterly reps, yielding a total of six reps for the 1993 year. (See Table 3-2 and Table 3-3.)

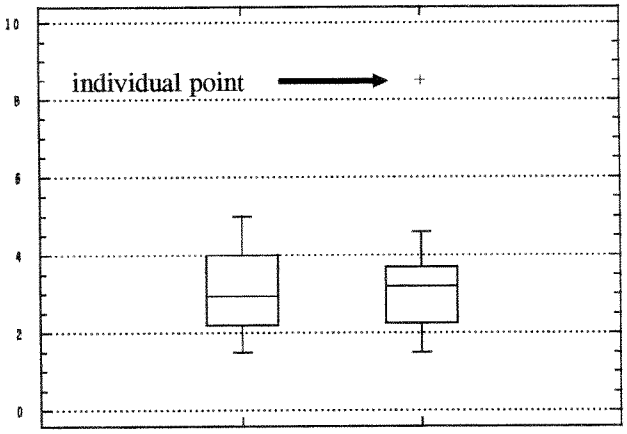


Figure 3-5. Sample Box-and-Whisker Plot

During each of the six reps, all wells were sampled for the contamination indicator parameters listed in Table 3-3. Samples were collected for groundwater quality parameters twice in 1993, during the second and sixth rep. In the sixth rep, fifty-two selected wells were sampled for expanded parameter lists for RFI characterization. (See Table 3-3.)

Presentation of Results in Graphs

A second way in which groundwater monitoring results are presented is through graphs that show relative distributions of the data.

The multiple box-and-whisker plot is used here to present contamination indicator data for individual locations within the same hydrogeologic unit. All the 1993 results obtained for selected parameters (pH, conductivity, total organic carbon, total organic halogens, gross alpha, gross beta, and tritium) were used to construct the box-and-whisker diagrams of each well within a given hydrogeologic unit. Box-and-whisker plots allow results for wells within a hydrogeologic unit to be visually compared to each other.

Figure 3-5 is an example of a multiple box-and-whisker plot.

- The horizontal lines within the small boxes show the median of the data set for a given well.
- The box outline itself shows the range of the middle 50% of the data for a given well (the upper and lower quartiles).
- The whisker extension shows the range of the data for a given well. (Values beyond 1.5 times the length of the box are plotted as individual points.)

The sample counting results for gross alpha, gross beta, and tritium, even if below the minimum detectable concentrations, were used to generate the box-and-whisker plots. Thus, negative values were included. This is most common for the gross alpha analyses, where sample radio-

logical counting results may be lower than the associated instrument background.

All box-and-whisker plots shown at the end of *Chapter 3* present the upgradient wells on the left side of the figure with the upgradient location code prefixed with the letter A. Downgradient locations are plotted to the right and use the letters B through D, as discussed above, to distinguish relative position along the groundwater flow path.

Trend plots or line plots also 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) and dichlorodifluoromethane (DCDFMeth) are plotted using this format. (See Figs. 3-41 and 3-41a.) Long-term and shorter-term trends of gross beta and tritium for selected groundwater monitoring locations are also shown in Figures 3-42 through 3-43a.

Sampling with a Dedicated Bladder Pump

Results of Contamination Indicator Monitoring of the Sand and Gravel Unit

Figures 3-6 through 3-12a are box-and-whisker plots of contamination indicator parameters for the forty-five sample locations monitoring the sand and gravel unit of the north plateau. Background site conditions are monitored by well WNWNB1S (coded ANB1S on the box-and-whisker plots), and upgradient monitoring is provided by wells WNW0301, WNW0401, WNW0403, and WNW0706 (coded A0301, A0401, A0403, and A0706, respectively, in the figures). These wells are shown in the first five positions on the left of the box-and-whisker charts. Tabulated contamination indicator data are presented in *Appendix E*, Table E-1.

Downgradient locations are subdivided into three categories according to the well's general position within the groundwater flow regime. For example, downgradient wells prefixed with B are nearest to the background or upgradient wells (prefixed A), followed by wells prefixed with C, which are located midway along the downgradient flow path. Wells prefixed with a D are farthest downgradient.

Wells monitoring downgradient conditions in the sand and gravel unit constitute the monitoring network for eight SSWMUs. The SSWMUs monitored by wells in the sand and gravel unit are SSWMU #1, the low-level waste treatment facility; SSWMU #2, miscellaneous small units; SSWMU #3, the liquid waste treatment system; SSWMU #4, the high-level waste storage and processing area; SSWMU #5, the maintenance shop leach fields; SSWMU #6, the low-level waste storage area; SSWMU #7, the chemical process cell waste storage area; and SSWMU #8, the construction and demolition debris landfill. (See Table 3-1, which identifies the SSWMUs and associated individual SWMUs, the hydrogeologic unit monitored, and the depth of each well.)

The box-and-whisker plots for the sand and gravel unit show elevated levels of pH and conductivity at well WNW0103 (Figs. 3-6 and 3-7). Well WNW0103 is located in the vicinity of a spill of caustic sodium hydroxide that occurred in 1984. Results of groundwater quality analyses (*Appendix E*, Table E-6) at WNW0103 indicate that elevated levels of sodium and hydroxide have contributed to these elevated levels of conductivity. However, the levels of pH and conductivity at this well have declined in comparison to 1992 values.

Conductivity levels are also elevated in wells WNW0203, WNW0205, and WNW8606 (Fig.3-7). These wells monitor groundwater conditions upgradient and downgradient of the sludge ponds in SSWMU #2. Elevated conductivity values at these locations probably can be attributed to high concentrations of sodium and chloride. This can be seen in *Appendix E*, Table E-6, which shows major cation and anion concentrations for these wells.

The pH and conductivity levels for all other sand and gravel wells appear to lie within normal environmental ranges for this unit.

Figures 3-8 and 3-9 are the box-and-whisker plots for total organic carbon (TOC) and total organic halogens (TOX). Well WNW0103 exhibits elevated levels of TOC and TOX. Wells WNW0111 and WNW8605, both near former lagoon 1, show elevated levels of both TOC and TOX. Wells WNW0203, WNW0205, and WNW8606 also show elevated levels of TOC and TOX. Wells WNW8608 and WNDMPNE show elevated levels of TOC, while well WNW0502 exhibits elevated levels of TOX. The remaining wells display TOC and TOX levels that are similar to background.

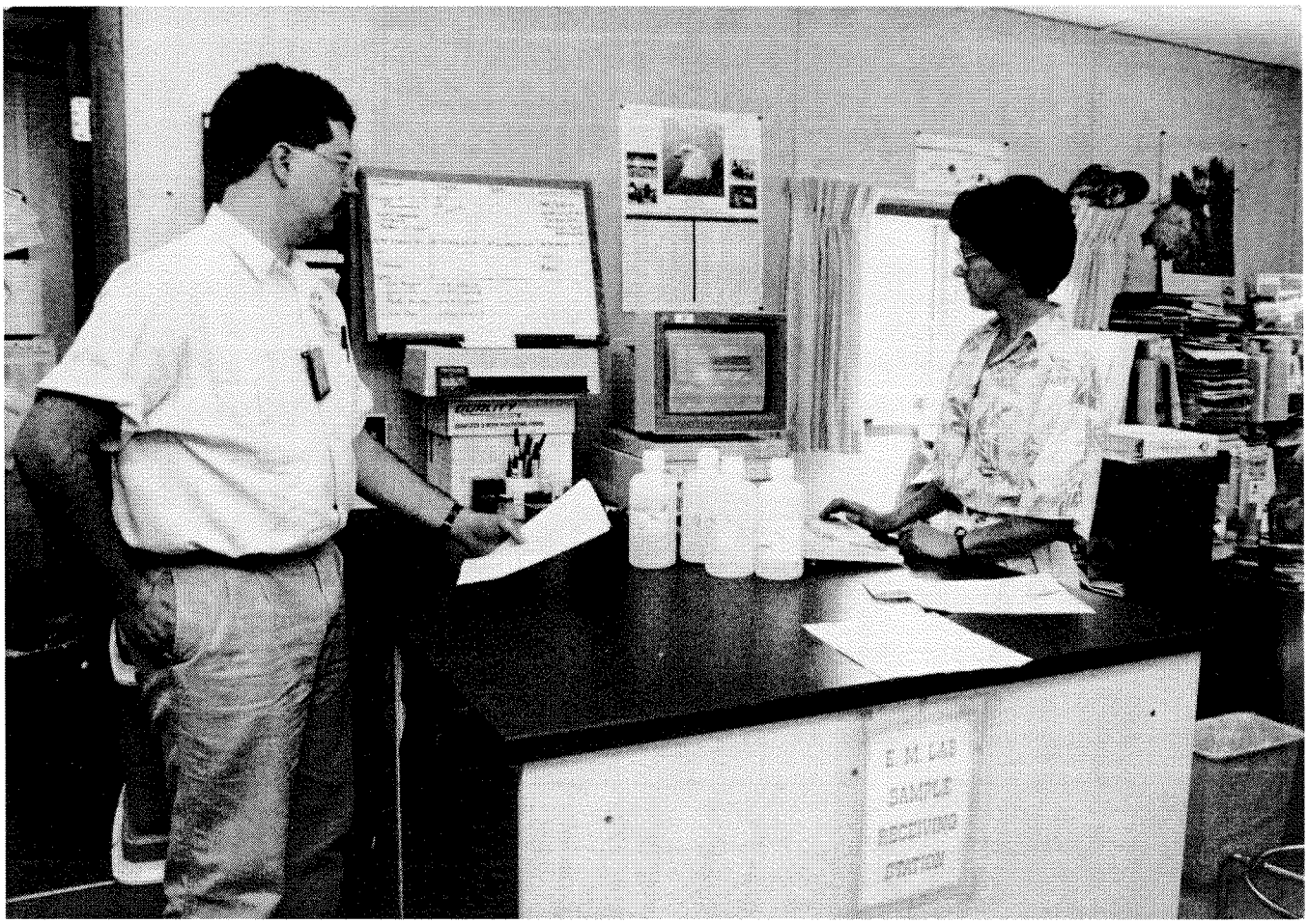
Results of gross alpha activity (Fig. 3-10) are mostly at or below minimum detectable concentrations except at locations WNW0905 and WNW8605, which showed positive results for all six analyses. However, alpha concentrations at WNW8605 are lower this year than in 1992. Wells WNW0103, WNW0111, WNW0501, and WNW0502 showed positive results for at least four of the six analyses. Gross alpha levels at these six locations, although above background, are only marginally above the minimum detectable concentrations.

Gross beta results are shown in Figures 3-11, 3-11a, and 3-11b. The y-axis on these three figures is magnified in order to display the different concentration levels among wells. Figure 3-11 shows the entire range of concentrations: at this scale only the wells with the highest gross beta levels stand out. The wells clearly visible in this figure, WNW0408, WNW0501, WNW0502, and WNW8605, exhibit the highest concentrations of gross beta in on-site groundwater. Beta levels in these wells are slightly higher than last year's values. Three-year and seven-year trends of gross beta concentrations for these and other selected groundwater locations are shown in Figures 3-42, 3-42a, and 3-42b.

Figure 3-11a and 3-11b show gross beta concentrations on a magnified scale to highlight the remainder of the sand and gravel wells. Back-

ground well WNWNB1S had an average gross beta concentration of 2.89E-09μCi/mL for 1993, compared to an average value of 2.83E-04μCi/mL at the well with the highest activity, WNW0408. This represents an approximate 98,000-fold difference in concentration between background and this downgradient location. The available trend data for background well WNWNB1S is included in Figure 3-42a to allow comparison with downgradient trend data. The New York State Class GA groundwater quality standard (applicable to water used for drinking) for gross beta activity (1E-06μCi/mL) was exceeded at wells WNW0104, WNW0111, WNW0408, WNW0501, WNW0502, WNW8604, and WNW8605. Other locations such as WNW0103, WNW0801, WNW8609, and WNDMPNE show elevated concentrations when compared to background wells but are below the groundwater quality standard. The increasing beta activity at location WNDMPNE is the subject of an investigation. (See **Long-term Trends of Gross Beta and Tritium at Selected Groundwater Monitoring Locations**.)

Graphs of tritium concentrations for wells within the sand and gravel unit are presented in Figures 3-12 and 3-12a. Two figures are presented to allow magnification of the y-axis. Wells WNW0602 and WNW8605 contain the highest levels of tritium in the sand and gravel unit. The concentrations observed during 1993 averaged 5.92E-06μCi/mL and 5.21E-06μCi/mL, respectively. This compares to an average of



Receiving Groundwater Samples at the Environmental Laboratory Computerized Receiving Station

4.63E-08μCi/mL for background well WNWNB1S and represents an approximate 100- to 125-fold difference in concentration between background and these downgradient locations. Wells WNW0106, WNW0111, WNW8609, WNW8612, and WNSP008 are slightly elevated above background levels.

In previous annual reports well WNW0408 had been reported to contain elevated levels of tritium that exceeded the EPA primary drinking water standard of 2E-05μCi/mL (which New York State had adopted as its standard for Class GA groundwaters). However, in January 1993 samples collected from the seven wells with known high gross beta concentrations (WNW0104, WNW0111, WNW0408, WNW0501, WNW0502, WNW8604, and WNW8605) were analyzed for tritium with and without first distilling the samples. Lower tritium activities for distilled samples from WNW0408, WNW0501, and WNW0502 were observed, and it was concluded that other, higher energy beta-emitting radionuclides had interfered with the analyses, resulting in an overestimate of the tritium concentration. Distillation removes these interfering radioactivities and yields a more accurate measurement of the tritium activity. (The results from the other four wells revealed less noticeable differences, indicating that interferences were negligible.) It would thus appear that the tritium data for WNW0408, WNW0501, and WNW0502 reported in the 1991 and 1992 Site Environmental Reports actually were artificially elevated and that the standard for tritium, which had been reported in the 1992 Site Environmental Report as having been exceeded at WNW0408, was not exceeded. As a result, this inaccurate data has been deleted from the three-year tritium trend (Fig.3-42a) and should not be used for any other purposes. (Pre-1991 analyses would not have been affected because samples were distilled. All tritium samples collected from the seven contaminated wells and reported in 1993 were distilled before analysis.) There is, however, one routinely monitored well on-site that currently exceeds the standard (WNW1107a).

Monitoring of the wells in the sand and gravel hydrogeologic unit indicates some measurable effects on groundwater, primarily in areas downgradient of the main plant facility and the low-level waste treatment facility. There is no indication that the groundwater from these areas affects human health or the environment because this water is not used for drinking or general facility needs. In addition, the surface water leaving the site, which includes effluent groundwater flow from this surficial sand and gravel unit, meets the appropriate standards.

Comparisons of downgradient location sampling results to both upgradient groundwater monitoring results and groundwater quality standards demonstrate differences that indicate an effect on groundwater, particularly with respect to gross beta activity. The expanded characterization of groundwater for beta-emitting isotopes was implemented to identify the specific radionuclides contributing to the gross beta activity. Strontium-90 has been found to be the primary contributor to gross beta activity, and actions to respond to this finding are being formulated. (See **Discussion of Site Groundwater Monitoring**.)

Results of Contamination Indicator Monitoring of the Lavery Till-Sand Unit

Eight wells monitor groundwater in the Lavery till-sand unit. As noted in the discussion on hydrogeology, the Lavery till-sand unit is limited in its extent and thickness. General upgradient conditions are monitored by wells WNW0302, WNW0402, WNW0404, and WNW0701. Downgradient conditions are monitored by wells WNW0202, WNW0204, WNW0206, and WNW0208. Well WNW0905 has been reclassified this year in the sand and gravel unit following recent geologic interpretation.

Figures 3-13 through 3-19 are box-and-whisker plots for selected contamination indicator parameters for the Lavery till-sand unit. Tabulated data for these parameters are presented in *Appendix E*,

On-screen Review of a Tritium Sample Count

Table E-2. Well WNW0202 continues to show elevated levels of pH. This elevated pH condition reflects the presence of measurable hydroxide alkalinity. Levels of conductivity in well WNW0202 also appear slightly elevated. All other wells appear to lie within normal ranges of pH and conductivity for this unit.

The box-and-whisker plots for TOC and TOX (Figs. 3-15 and 3-16) exhibit no clear distinctions between upgradient and downgradient locations.

Radiological constituents are at or below minimum detectable concentrations in all wells monitoring the till-sand unit (Figs. 3-17 through 3-19), with the exception of well WNW0202. Well WNW0202 shows marginally elevated concentrations of gross beta and tritium. However, these wells were below the New York State groundwater quality standards for these constituents (1.0E-06μCi/mL and 2E-05μCi/mL, respectively).

Results of Contamination Indicator Monitoring of the Unweathered Lavery Till Unit

Twenty-three wells monitor the unweathered Lavery till unit, which extends beneath both the north and south plateaus of the WVDP. General upgradient conditions of the unweathered till are monitored by well WNW0405.

Wells monitoring the unweathered Lavery till are part of the monitoring network for several SSWMUs: SSWMU #1, SSWMU #4, SSWMU #7, SSWMU #9, and SSWMU #11, the SDA, for which NYSERDA is responsible. In addition, most of the wells monitoring SSWMU #10 may provide useful information about this unit even though they are classified as monitoring primarily the weathered Lavery till or the Kent recessional unit. Results of groundwater contamination indicator monitoring for the unweathered Lavery till geologic unit are shown in box-and-whisker Figures 3-20 through 3-26a. Tabulated data are presented in *Appendix E*, Table E-3.

Levels of pH (Fig. 3-20) at well WNW0409 appear to be slightly higher than background and upgradient wells in this unit, while wells WNW0704 and WNW0707 appear to be slightly lower. However, they all lie within normal environmental ranges. Levels of conductivity (Fig. 3-21) appear to be slightly elevated in well WNW0910, which is located downgradient of the NDA and interceptor trench.

Concentrations of both total organic carbon (Fig. 3-22) and total organic halogens (Fig. 3-23) are elevated at well WNW0704. This is a downgradient well located in SSWMU #7. Levels of TOC and TOX for all other wells are similar to or lower than background.

Results of radiological monitoring of unweathered Lavery till wells are shown in Figures 3-24 through 3-26. Results for gross alpha analyses (Fig. 3-24) are mostly at or below the minimum detectable concentration. Results for gross beta (Fig. 3-25) indicate that concentrations at wells WNW0704 and WNW0910 are slightly elevated when compared to other wells in this unit. Gross beta results for these two wells are slightly higher than last year's values. Figure 3-26 shows results of tritium measurements for wells monitoring the unweathered Lavery till. Wells WNW0107, WNW0109, WNW0110, WNW0114, and WNW0115 of SSWMU #1 showed slightly elevated results for tritium. Well WNW1109B, which monitors SSWMU #11 (NYSERDA's SDA) also showed slightly elevated tritium concentrations. Well WNW1109B is located between NYSERDA's SDA and the NDA. (See Fig. 3-3.)

The concentrations of gross beta and tritium detected in these unweathered Lavery till wells are below the applicable standard of 1E-06μCi/mL for gross beta and 2E-05μCi/mL for tritium. Although some above-background results are reported for gross beta and tritium, concentrations are relatively low and indicate a negligible effect on groundwater within the unit.

Results of Contamination Indicator Monitoring of the Kent Recessional Sequence

Seventeen wells monitor groundwater conditions within the recessional sequence. However, several of these wells are consistently dry and therefore can not be sampled on a regular basis. The water-bearing wells are all situated on the site's south plateau and represent the deepest groundwater monitoring points on-site.

Background conditions are monitored by well WNW1008B, which is 51 feet below grade. Three additional wells, WNW0901, WNW0902, and WNW1001, provide upgradient monitoring of the unit. These wells range in depth from 116 to 136 feet below grade. General downgradient monitoring is provided by eight wells that range in depth from 108 to 138 feet.

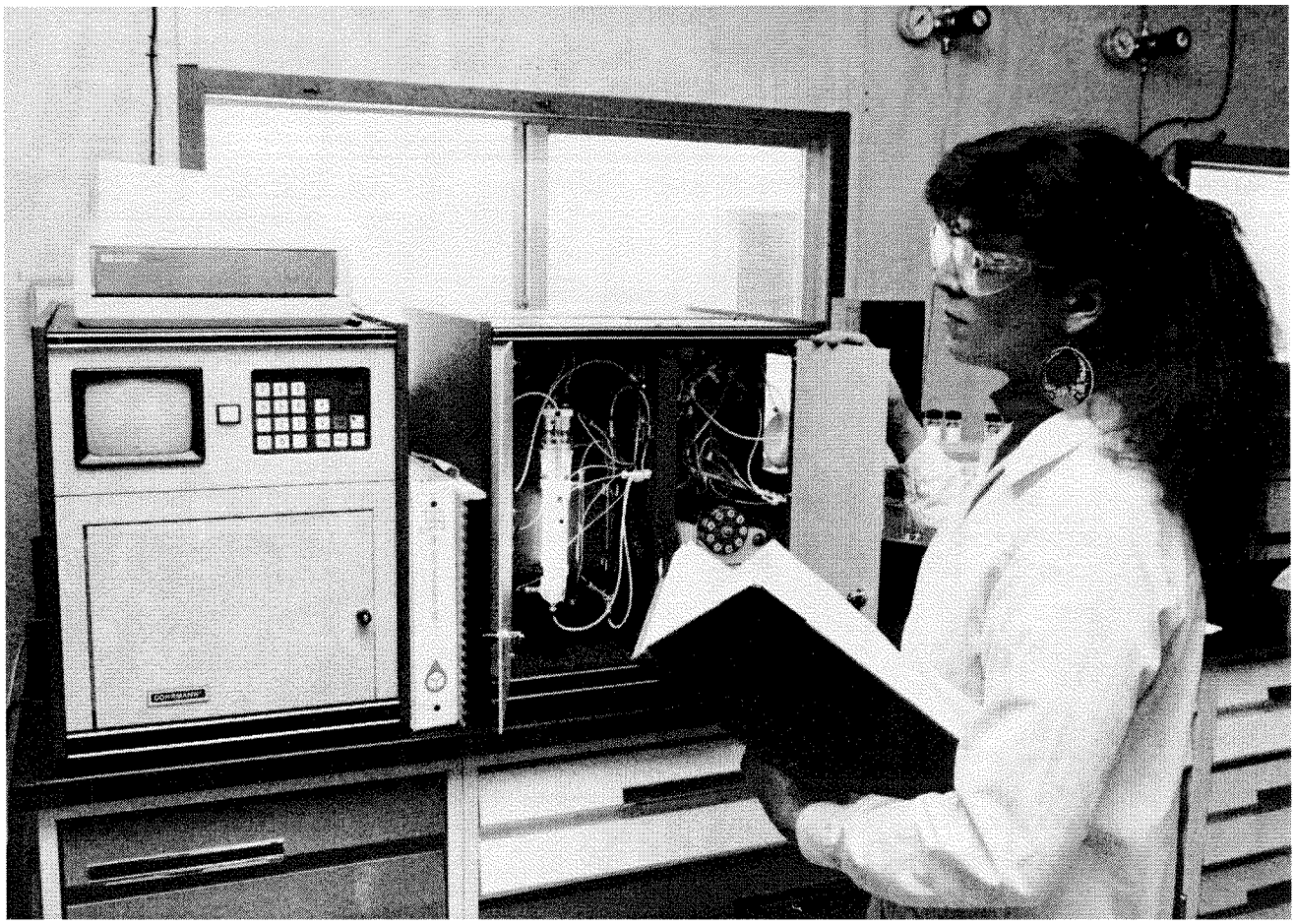
The Kent recessional sequence is monitored as part of the groundwater monitoring program associated with SSWMU #9, SSWMU #10, and SSWMU #11.

Results of contamination indicator monitoring of the Kent recessional sequence are shown in Figures 3-27 through 3-33. The box-and-whisker plots of pH and conductivity show some vari-

ations across well locations. Values of pH (Fig. 3-27) at WNW1002 appear slightly lower than background and upgradient wells, while pH at WNW8610 appears slightly higher. However, all values lie within normal ranges of environmental variability. Conductivity values (Fig. 3-28) appear slightly elevated at wells WNW0903, WNW1002, WNW1104C, WNW8610, and WNW8611. Because of dryness, well WNW1104C could be sampled only once in 1993. TOC values (Fig. 3-29) appear to be slightly elevated in downgradient locations when compared to the background and upgradient locations. TOX values (Fig. 3-30) show no apparent differences between upgradient and downgradient locations.

Results of sampling for radiological contamination indicator parameters (Figs. 3-31 through 3-33) suggest the lack of any direct site-induced effects on the waters of the recessional sequence. Gross alpha concentrations in all wells are at or below the minimum detectable levels. NYSERDA's SDA wells WNW1103C and WNW1104C contain marginally elevated levels of gross beta activity. Tritium concentrations at well WNW8610 appear to be marginally above the minimum detectable concentrations.

All levels of radioactivity measured within the recessional sequence are well below applicable groundwater standards. These results indicate



Checking a Total Organic Carbon Analyzer Run

that little, if any, effect on the groundwater in this unit has occurred through site operations.

Results of Contamination Indicator Monitoring of the Weathered Lavery Till Unit

Eighteen wells are used to monitor groundwater in the weathered Lavery till unit, which is the surficial hydrogeologic unit on the site's south plateau. Three SSWMUs are monitored as part of groundwater monitoring in the weathered Lavery till: SSWMU #9, SSWMU #10, and SSWMU #11.

Well WNW1008C monitors background conditions in the weathered Lavery till. Wells WNW0908 and WNW1005 monitor general upgradient conditions. Wells monitoring this unit range in depth from 10 to 23 feet below grade.

The results of monitoring of pH (Fig. 3-34) fall within a range of about 6.5 to 8.0 for wells within this geologic unit. The range of conductivity is relatively wide across this unit, with background and upgradient locations ranging from low to high values. Downgradient values for conductivity are within the ranges of the upgradient and background results (Fig. 3-35).

Results for total organic carbon and total organic halogens (Figs. 3-36 and 3-37) indicate elevated levels of these constituents at wells WNW0909 and WNW1107A. Levels of TOC also appear slightly elevated at well WNW0906.

Gross alpha concentrations (Fig. 3-38) for downgradient wells are similar to upgradient wells for this unit. Gross beta concentrations (Fig. 3-39) at well WNW0909 appear elevated and at wells WNW1007 and WNW1107A appear to be marginally elevated. Several of the wells within the unit, including WNW0906, WNW0907, WNW0908, and WNW1108A, exhibit very limited recharge rates, making it difficult to obtain sufficient volumes for sampling. The variation in gross alpha levels indicated in Figure 3-38 for WNW0908 represents a range of below minimum detectable concentrations that are associated with elevated levels of dissolved solids in the samples. The positive results of gross beta activity in upgradient well WNW0908 may also be related to the elevated levels of dissolved solids for gross alpha activity. All gross beta results are well below the groundwater quality standard of 1.0E-06μCi/mL.

Several wells monitoring the weathered Lavery till exhibited detectable levels of tritium activity (Figs. 3-40 and 3-40a). Levels of tritium in well WNW1107A are slightly above the EPA primary drinking water standard of 2.0E-05μCi/mL. Several other wells (WNW0909, WNW1102A, WNW1103A, WNW1104A, WNW1106A, and WNW1109A) consistently had above-background levels of tritium.

Results of Sampling for Groundwater Quality Parameters

Results of the two rounds of sampling for groundwater quality parameters are in *Appendix E*, Tables E-6 through E-10. The results for the major cations (calcium, magnesium, and sodium) and anions (chloride, sulfate, bicarbonate/carbonate) indicate that the major constituents of the groundwater beneath the site are essentially calcium and bicarbonate ions. Magnesium, sodium, chloride, and sulfate are secondary constituents. Small localized areas in each of the geologic units contain high sulfide or chloride concentrations.

Concentrations of sodium and chloride are high in sand and gravel wells WNW0103, WNW0210, WNW0203, WNW0205, WNW0305, WNW0307, WNW0401, WNW0408, and WNW8606. Several of these wells are located downgradient of Rock Springs Road, which is salted during the winter months. Wells

WNW0205 and WNW8606 are located downgradient of the sludge pond in SSWMU #2. Background well WNWNB1S nearly exceeded the nitrate+nitrite-nitrogen quality standard of 10.0 mg/L by exhibiting a mean 1993 concentration of 9.85 mg/L. High bicarbonate concentrations were observed in wells WNW0207, WNW0603, WNW0803, WNW0905, and WNW8605.

Concentrations of sodium and chloride are slightly elevated in Lavery till-sand wells WNW0302 and WNW0402. Concentrations of chloride in wells WNW0208, WNW0404, and WNW0701 are very low compared to the rest of the wells. The concentration of sulfate is high in well WNW0701. This well is located in the northwestern portion of the north plateau, where many wells are high in sulfate. This may be due to variations in the natural geochemistry of that portion of the site. The high pH found at well WNW0202 is the cause of the dissimilarity of its chemistry to the rest of the till-sand wells. Bicarbonate concentration is low in this well as the high pH has caused it to be converted to carbonate. Concentrations of iron, manganese, and magnesium are lower, while sodium and potassium appear higher. This may be related to changes in the solubility of these ions in a high pH environment.

The majority of wells in the unweathered till are low in chloride, with the exception of WNW0405. South plateau well WNW0910 contains a high concentration of sulfate. This well is located downgradient of the NDA and interceptor trench.

Several wells in the recessional sequence (WNW1002, WNW1003, WNW1101C, WNW8610, and WNW8611) contain high levels of sulfate, while others (WNW0901, WNW0902, WNW1001) contain high levels of chloride. These differences might be attributable to variations in the natural geochemistry of the geologic unit.

Weathered till well WNW1008C, which is representative of background conditions, contains the highest levels of chloride in this unit. This relatively high concentration may be influenced by road salting in the winter along Rock Springs Road, which is located not far from this well. WNW0909 also contains relatively high concentrations of chloride and ammonia. Several wells (WNW0908, WNW1006, WNW1007, WNW1107A, WNW1108A, and WNW1110A) contain high concentrations of sulfate. Well WNW1006 also contains a high concentration of sulfide.

Results of Sampling for Appendix IX and Target Compound List Metals

The sampling program for RFI characterization included analyzing samples from selected Project wells for total metals. The analytical techniques used included methods from SW-846, Test Methods for Evaluating Solid Waste (U.S. Environmental Protection Agency November 1986). The results of this sampling are tabulated in *Appendix E*, Table E-14. The results may be compared to New York State groundwater quality standards for Class GA groundwater. (See *Glossary*.) These standards are derived from Title 6 of the New York Code of Rules and Regulations (NYCRR), Chapter X, Part 703.5. Groundwater meeting these standards is best suited for a source of drinking water. In the absence of Class GA standards for specific constituents, New York State draft guidelines are used (New York State Department of Environmental Conservation 1991). The groundwater action levels determined by the WVDP media policy document, the Environmental Media Management Plan (West Valley Nuclear Services Co., Inc. January 1992), are also used if they are more stringent than the above. These standards provide a conservative reference for comparison to site groundwater sampling results, even though site groundwater is not used for either on- or off-site drinking water.

Comparison of the New York State Class GA standards for metals concentrations in groundwater to site groundwater results indicates several instances in which metal concentrations in site groundwater exceeded the respective quality standards:

Sand and gravel wells exceeded the standards for arsenic (WNW0105), chromium (WNW0106, WNW0116, WNW0203, WNW0502, WNW0601), lead (WNW0105, WNW0106, WNW0116, WNW0601, WNW0602, WNW0803, WNW0804, WNW8604), and copper (WNW0205). It is interesting to note that background well WNWNB1S contains relatively high concentrations of chromium and copper when compared to the New York State Class GA standard and to other wells in the hydrogeologic unit. New York State guideline standards for antimony were exceeded at WNW0501, WNW0502, WNW8604, and WNW8605.

Sand and gravel monitoring location WNSP008 closely approaches the New York State Class GA standards for mercury, while well WNW0601 is slightly below the New York State guidelines for nickel and zinc. Four wells (WNW0406, WNW0408, WNW0501, WNW8612) contain lead levels above the WVDP Media Management Plan action levels but below the New York State Class GA standard.

New York State Class GA standards for arsenic were exceeded in the weathered Lavery till well WNW0907. New York State Class GA standards for lead were exceeded in unweathered Lavery till well WNW0904; samples from well WNW0115 appear elevated and are slightly below the lead standard.

Concentrations of barium, beryllium, cadmium, cobalt, selenium, silver, tin, and vanadium are below detection limits or well below the New York State Class GA standards and guidelines in all hydrogeologic units.

Results of Routine and Expanded RFI Sampling for Organic Compounds

All wells in the groundwater monitoring program are analyzed routinely for volatile organic compounds (VOCs) from Appendix IX 40 CFR Part 264 as part of the contamination indicator parameter sampling. (See Table 3-3, which summarizes the 1993 sampling schedule.) Groundwater collected for routine VOC sampling is analyzed by off-site contract laboratories according to method 8240 (Test Methods for Evaluating Solid Waste, SW-846 [U.S.EPA 1986]). The routine analysis of VOCs for contamination indicator parameter sampling generated data on fifty-eight volatile organic compounds.

During the expanded RFI characterization, selected Project wells exhibiting statistical significance for indicator parameters with respect to background were sampled. Data was generated for approximately 200 organic compounds, including volatile organics, semivolatile organics, pesticides, and PCBs from Appendix IX (40 CFR Part 264). Compounds on the Target Compound List (TCL) also were chosen for sampling of the majority of well locations because the list focuses on compounds that are most commonly associated with hazardous waste sites and that represent the greatest threat to human health and the environment. The full Appendix IX list, excluding two families of compounds (PCDDs and PCDFs), was used for five well locations where VOCs have previously been detected and for the NDA interceptor trench sump manhole (WNNDATR). The analytical methodologies in SW-846, Test Methods for Evaluating Solid Waste, used to analyze the RFI sampling data were volatile organic compounds — method 8240, semivolatiles — method 8270, pesticides/PCBs — method 8080, and cyanide — method 9010.

Table E-11 in *Appendix E* lists the individual compounds and the practical quantitation limit

(PQL) for compounds in Appendix IX and the TCL. The practical quantitation limit is the lowest concentration of the compound that can be reliably determined within the method-specified level of precision and accuracy under routine laboratory conditions. The PQLs used here include those that are specified by contract with the vendor laboratories and are more stringent than those listed in Appendix IX and reproduced in Table E-11.

The results of routine and RFI groundwater sampling for volatile organic compounds during 1993 reveal continued positive detections of 1,1-dichloroethane (1,1-DCA) and dichlorodifluoromethane (DCDFMeth) at well WNW8612. The concentrations of 1,1-DCA in well WNW8612 in 1993 increased from those seen in 1992, ranging from approximately 30 μg/L to 36 μg/L during the year. The concentration of DCDFMeth at WNW8612 during 1993 is similar to that of 1992, maintaining a level between approximately 4.5 μg/L and 9.5 μg/L during the year.

The compound DCDFMeth has continued to be detected at well WNW0803. First detected in August 1992, the concentration has fluctuated between 5 μg/L and 32 μg/L during 1993.

Tributyl phosphate (TBP) was detected in well WNW8605 at 280 μg/L. Repeat analysis of the same sample showed 300 μg/L, but this is considered an estimated value because re-analysis occurred after the acceptable holding time. This well is located downgradient of the former lagoon 1 in SSWMU #1 and historically has been characterized by elevated levels of beta and tritium activity. While not of particular importance to the RCRA-regulated efforts to identify hazardous wastes or constituents, the detection of TBP probably indicates contaminant migration related to wastes generated by the NFS solvent extraction process.

Acetone has been detected at well WNW0909. However, this detection is considered speculative because this compound commonly appeared as a laboratory contaminant and because positive detections have been separated by periods of reporting below the PQL of 5 μg/L.

The compound 1,1,1-trichloroethane (1,1,1-TCA), first detected at WNGSEEP in 1990, has remained below the PQL since mid-1992 and during all of 1993. The same is true for 1,1-DCA at well WNW8609, which was also first detected in 1990 and which declined to less than the PQL of 5 μg/L in 1992 and has remained below the PQL during 1993.

The compounds 1,1,1-TCA and 1,1-DCA are solvents commonly used by industry for degreasing processes, although their origins at the WVDP have not been specifically identified. DCDFMeth is also known as Freon-12, a coolant widely used for air conditioning and refrigeration. Tributyl phosphate was the organic solvent used by NFS during fuel reprocessing activities. Analytical results of sampling for these compounds at the above locations are shown in *Appendix E*, Table E-12.

Groundwater wells WNW8612 and WNW0803 and monitoring point WNGSEEP are located on the northeastern edge of the Project premises, downgradient of the main plant and the former construction and demolition debris landfill (CDDL). The detection of 1,1,1-TCA at WNGSEEP is the subject of the Groundwater Seep Investigation Report: 1,1,1-Trichloroethane Detection (West Valley Nuclear Services 1992), which was prepared to fulfill the RCRA 3008(h) Order on Consent.

Analysis of volatile organic compounds by method 8240 uses an instrument known as a gas chromatograph/mass spectrometer (GC/MS). This instrument has the ability to identify the presence of compounds below the PQLs listed in Table E-11. Such detections, taken on an individ-

ual basis, must be viewed with caution since they may be false. However, when the same compound is repeatedly detected at levels below the PQL at the same groundwater location, it may actually indicate the presence of that compound, but at levels below that which can be accurately measured. The repeated detection of compounds below their associated PQLs has occurred at the following groundwater monitoring locations:

- WNW0202: toluene below its PQL of 5 µg/L and acetone below its PQL of 10 µg/L.
- WNW0803: 1,1-DCA below its PQL of 5 µg/L and chloroethane below its PQL of 10 µg/L.
- WNW1002: Toluene below its PQL of 5 µg/L and benzene below its PQL of 5 µg/L.
- WNW8609: 1,1,1-TCA below its PQL of 5 µg/L.
- WNW8612: 1,1,1-TCA below its PQL of 5 µg/L.
- WNW1104A: toluene below its PQL of 5 µg/L, benzene below its PQL of 5 µg/L, and total xylene below its PQL of 5 µg/L.
- WNNDATR: 1,4-dioxane (1,4-diethylene dioxide) below its PQL of 150 µg/L.

In addition to analyzing for compounds below their PQL, the GC/MS can also detect the presence of compounds for which it has not been calibrated. When this occurs, the unknown substance can be tentatively identified by performing a library scan of all known organic compounds to find the one that best fits the data. The tentatively identified compounds reported during the RFI sampling in the sixth rep are as follows:

- WNW0803: chlorodifluoromethane at 18 µg/L.
- WNW0909: chloroiodomethane at 5.9 µg/L.

Further sampling and analysis for VOC analytes will continue at all of the locations mentioned above to track the detection of these compounds. (See Tables 3-2 and 3-3 for the groundwater sampling and analysis schedule.) Figures 3-41 and 3-41a are trend plots for selected VOCs.

Semivolatile organic compounds, pesticides, and PCB analyses for the remainder of the forty-nine selected Project wells were all reported as non-detectable.

It should be pointed out that the VOC detections mentioned above have been compared with relevant New York State groundwater quality standards. This comparison has been performed for VOCs appearing both above and below their appropriate PQLs. In summary, positive detections of 1,1-DCA and DCDFMeth, identified as principle organic contaminants, have exceeded the 5 µg/L limit for Class GA groundwaters. There is no indication that the groundwater from these areas affects human health or the environment because this water is not used for drinking or general facility needs. Other VOC detections on-site show concentrations below the applicable groundwater quality standards.

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

Trend graphs showing results of groundwater monitoring from 1986 through 1993 for gross beta (Fig. 3-42) and tritium (Fig. 3-43) were prepared for selected locations. These graphs show annual averaged results for these constituents over a seven-year period. Results are presented on a logarithmic scale to adequately represent locations of differing concentrations. These specific groundwater monitoring locations were selected for trending because they have shown elevated or rising levels of these constituents (WNW8605 and WNW8604, Fig. 3-42), or falling trends (Fig. 3-43).

The results for gross beta activity (Fig. 3-42) indicate a steadily rising trend for location WNW8604. Well WNW8604 is located to the north of lagoon 4 in SSWMU #1 and is 23.0 feet below grade. Well WNW8603, which is north of WNW8604, at a depth of 25.4 feet, shows much lower levels of gross beta activity and a more gradual upward trend. Although the specific source of the increasing gross beta activity at WNW8604 has not been identified, this well is positioned downgradient of wells with higher levels of activity (WNW0408 and WNW0502, both downgradient of the main plant facility) and is crossgradient to the low-level waste treatment facility. Lagoon 1, formerly part of the low-level waste treatment facility, was previously identified as a source of contamination and is believed to be contributing to the gross beta activity at wells WNW8605 and WNW0111. The concentration of gross beta activity at location WNW8604 is lower than that measured for WNW8605. Identification, continued monitoring, and follow-up evaluation of this area will provide the information necessary for either near-term response or eventual facility closure.

Monitoring point WNDMPNE, located in the swamp drainage ditch northeast of the CDDL, has been added to the trend graph this year to chart rising gross beta activity observed during 1993. The stream that flows past this point conveys groundwater baseflow, surface runoff, and spring seepage to Frank's Creek and is adjacent to surface monitoring point WNSWAMP. (See Fig. A-2 or Fig. 2-3.) In July 1993 the beta activity at this point was 9.21E-07μCi/mL. Field investigations in the area of WNDMPNE identified a small seep located between the CDDL and the former NFS hardstand area that was feeding into the swamp drainage ditch. It was determined that the small seep was the contributor to the beta activity. Since the radioisotopic composition is significantly reduced before discharge from the WVDP premises, it was concluded that there was no threat to human health and the environment. However, the frequency of sampling was increased from monthly to weekly to more closely monitor the activity at the location. Investigation will continue in order to determine the extent and source of the radioactivity. Beta concentrations in November 1993 for WNDMPNE decreased from July, but this may simply be evidence of seasonality.

Monitoring point WNGSEEP, which has shown elevated levels of some VOCs, as discussed above, exhibits a fairly level long-term trend for gross beta activity (Fig. 3-42).

Figure 3-43 shows the seven-year trend for tritium concentrations for the same monitoring points presented in Figure 3-42. All points, including WNW8604, which show rising beta activity, indicate a gradually declining trend for tritium.

Figures 3-42a and 3-43a present gross beta and tritium concentrations for selected wells over the three-year period that the WVDP's current groundwater monitoring program has been in place. (The results presented in these two figures are individual sample results rather than the annual averages presented in Figs. 3-42 and 3-43.) Well WNWNB1S is a site background well that is included in the figures as a point of reference. The wells selected for these three-year trend graphs represent on-site locations with elevated levels of gross beta and tritium activity. All wells shown in these figures monitor the sand and gravel hydrogeologic unit.

Gross beta and tritium concentrations at these locations are generally consistent, with a slightly rising trend noted for gross beta. Well WNW0111 shows a relatively large degree of variability of tritium concentrations. This well is located near former lagoon 1 and well WNW8605 in SSWMU #1. Concentrations shown in these two figures are above the background concentrations shown for well WNWNB1S.

Results of Expanded Characterization for Radiological Parameters

To provide information concerning possible sources of contamination and contaminant migration pathways, samples from downgradient wells in each geologic unit were first analyzed for gross alpha, gross beta, and tritium. If any of these indicators showed statistically significant differences in comparison to the background samples, the wells were sampled and analyzed for additional parameters. Where high activity or alpha activity was encountered, samples were analyzed for a full set of radiological isotopes. (See Table E-15.) Where nominal levels of beta-emitting activity were encountered, samples were analyzed only for beta-emitting isotopes. (See Table E-16.) Samples from background wells for each geologic unit were all analyzed for the full list of isotopic parameters in order to provide a comparison with the downgradient wells. Table 3-5 summarizes the results of the expanded isotopic characterization compared to background values.

Sand and Gravel

Nine locations in the sand and gravel unit were analyzed for the full list of isotopes (Table E-15), and twenty-one wells were analyzed for the beta-emitting isotopes (Table E-16).

The background well for the sand and gravel unit, WNWNB1S, generally exhibited the lowest radioisotopic activity and thus indicates that higher radioisotopic values in downgradient wells probably can be attributed to environmental and manmade sources.

Strontium-90 (Sr-90)

The data in Table E-16 indicate that, with the exception of wells WNW0106 and WNW8612, Sr-90 was higher than background levels in samples from all wells and discharge points in the sand and gravel unit that were analyzed for this expanded characterization. The two groups of wells and discharge points with Sr-90 activities of two or more orders of magnitude greater than background (WNW0104, WNW0111, WNW0116, WNW8604, WNW8605, WNDMPNE, WNW0408, WNW0501, WNW0502, WNW0601, WNW8609, and WNW0801) are located northeast of the main plant, the old hardstand area, and inactive lagoon 1. These same wells show elevated levels of tritium.

Strontium-90 in sand and gravel wells and discharge points with levels between one to two orders of magnitude above background (WNW0103, WNW8603, WNW0602, WNW0201, WNSP008, WNW0203, WNW0804) are usually found east and northeast of the main plant, in the french drain northwest of lagoons 2 and 3, an area around the demineralization basin, and east of the CDDL. All other locations (WNGSEEP, WNW0105, WNW0205, WNW0305, WNW0406, WNW0604, WNW0803, and WNW0802) exhibited Sr-90 levels that are less than one order of magnitude of background.

The elevated level of Sr-90 in WNW0408 and WNW0502 is the major contributor to the elevated gross beta levels in these wells.

Iodine-129 (I-129)

Iodine-129 was the third most abundant radioisotope in the sand and gravel unit. Well WNW8605, located near lagoon 1, showed I-129 levels between one and two orders of magnitude above background, while wells WNW0103, WNW0104, WNW0105, WNW0106, WNW0111, WNW0116, WNW0406, WNW8604, WNW0502, WNW0602, WNW0802, WNW0803, WNW0905, WNW8612, and discharge point WNSP008, located northeast of the main plant, exhibited levels of less than one order of magnitude above background. All other wells sampled had I-129 activities very close to background. The activities

Table 3-5

Expanded Groundwater Characterization: Number of Wells and Discharge Points in Hydrogeologic Units Exceeding Background Values by Orders of Magnitude

Alpha-emitting Isotopes

Hydrogeologic Unit	OMAB	Am-241	Ra-228	Ra-226	U-232	U-233	U-235	U-236	U-238	Total U	Pu-238	Pu-239
Sand and Gravel Unit	0-1	9	4	9	5	7	6	9	3	1	9	9
	1-2	0	3	0	4	2	3	0	4	7	0	0
	>2	0	2	0	0	0	0	0	2	1	0	0
Weathered Lavery Till	0-1	4	1	3	4	1	1	4	1	1	4	4
	1-2	0	3	0	0	3	3	0	3	3	0	0
	>2	0	0	1	0	0	0	0	0	0	0	0
Unweathered Lavery Till	0-1	1	1	1	1	1	1	1	1	1	1	1
	1-2	0	0	0	0	0	0	0	0	0	0	0
	>2	0	0	0	0	0	0	0	0	0	0	0
Lavery Till-sand Unit	0-1	1	1	1	1	1	1	1	1	1	1	1
	1-2	0	0	0	0	0	0	0	0	0	0	0
	>2	0	0	0	0	0	0	0	0	0	0	0

Beta-emitting Isotopes

	OMAB	C-14	Cs-137	Co-60	I-129	Sr-90	Tc-99
Sand & Gravel Unit	0-1	30	31	31	30	12	25
	1-2	1	0	0	1	7	6
	>2	0	0	0	0	12	0
Weathered Lavery Till	0-1	9	9	9	9	7	9
	1-2	0	0	0	0	1	0
	>2	0	0	0	0	1	0
Unweathered Lavery Till	0-1	10	10	10	8	10	10
	1-2	0	0	0	2	0	0
	>2	0	0	0	0	0	0
Lavery Till-sand Unit	0-1	2	2	2	2	2	2
	1-2	0	0	0	0	0	0
	>2	0	0	0	0	0	0

OMAB = Orders of magnitude above background.
Note: Only the background wells for the unweathered Lavery till and the Lavery till-sand unit were analyzed for alpha-emitting isotopes.

measured in WNW0201, WNW0203, WNW0205, WNW0601, and WNW0604 were less than the activities measured in background wells.

Technetium-99 (Tc-99)

Technetium-99, the second most abundant isotope, was evident in activities between one and two orders of magnitude greater than background in wells WNW0104, WNW0105, WNW8603, WNW8605, WNW0408, and WNW0502. Wells WNW0106, WNW0116, WNW0406, WNW0501, WNW0801, WNW0802, WNW0905, WNW8604, WNW8612, and discharge points WNSP008 and WNDMPNE exhibited Tc-99 activities within one order of magnitude above background, with the remaining analyzed wells being below background. All wells and discharge points with Tc-99 greater than background are generally located in the areas northeast of the main plant, north of the construction and demolition debris landfill (CDDL), or near lagoon 1, indicating that Tc-99 also partly contributes to the elevated gross beta in this area.

Cesium-137 (Cs-137)

Cesium-137 was not encountered at activities above background in any of the tested wells. However, Cs-137 in wells WNW0103, WNW0104, WNW0111, WNW0203, WNW0601, WNW8605, WNW8612, and discharge points WNDMPNE and WNGSEEP did approach background activities, only surpassing it when analysis uncertainties were accounted for.

Cobalt 60 (Co-60)

Cobalt-60 also was not evident at above-background activities in any wells but did approach background in wells WNW0104, WNW0201, WNW0601, WNW8605, and discharge points WNDMPNE and WNGSEEP. These points slightly surpassed background only when uncertainties were added to mean activity values.

Carbon-14 (C-14)

Carbon-14 was encountered in well WNW0408 at activity levels between one and two orders of magnitude above background and in well WNW0502 at activities within one order of magnitude of background. The remaining twenty-eight samples all exhibited activities below background even after accounting for analytic uncertainties. The activity of C-14 in the above-background samples indicates that the associated gross beta in the two affected wells is partly due to C-14. Background well WNWNBIS exhibited C-14 activities below the detection limit of 7.0E-08 μCi/mL, so the detection limit was used as the screening criteria.

Americium-241 (Am-241)

Americium-241 was not found above background activity in any well finished in the sand and gravel unit. It approached background in well WNW8605 but this was determined to be not significant.

Radium-228 (Ra-228)

Radium-228 was found at activities between one and two orders of magnitude above background in wells WNW0104, WNW0111, and WNW0905 and at activities greater than two orders of magnitude above background in wells WNW8604 and WNW8605, which are near lagoons 4 and 1, respectively.

Uranium-232 (U-232)

Uranium-232 was encountered at activities between one and two orders of magnitude above background in wells WNW0111 and WNW8605. The elevated U-232 activity in well WNW8605 is probably due to earlier releases from lagoon 1 during previous fuel reprocessing activities.

Uranium-234 (U-234)

Uranium-234 was encountered in above-background activities in eight sand and gravel unit wells (WNW0104, WNW0111, WNW8604, WNW8605, WNW0408, WNW0501, WNW0502, and WNW0905). Wells WNW8605 and WNW0905 exhibited activities between one and two orders of magnitude above background. These are probably due to releases from lagoon 1 during earlier fuel reprocessing activities and past NDA disposal activities, respectively. The activity in wells WNW0104, WNW0111, WNW8604, WNW0408, WNW0501, and WNW0502 was within one order of magnitude above background and is probably associated with earlier fuel reprocessing plant activities.

Uranium-235 (U-235)

Uranium-235 was encountered in above-background activity in wells WNW8605, WNW0408, WNW0502, and WNW0905, with well WNW0502 being within one order of magnitude above background and the other three wells between one and two orders of magnitude above background. The above-background activities in wells WNW0408 and WNW0502 are probably associated with past fuel reprocessing activities; well WNW8605 activity is probably associated with discontinued lagoon 1 activities and well WNW0905 possibly with past NDA disposal activities.

Uranium-236 (U-236)

Uranium-236 was found within one order of magnitude above background in wells WNW0104, WNW8604, WNW8605, WNW0408, WNW0502, and WNW0905; all other sand and gravel wells exhibited lower than background activities. As with U-234, the U-235 activities are probably associated with discontinued main plant, lagoon 1, and past NDA activities.

Uranium-238 (U-238)

Uranium-238 was found at greater than two orders of magnitude above background in wells WNW0111, WNW0905, WNW8605, and WNW0408, while wells WNW0104, WNW8604, WNW0501, and WNW0502 exhibited activities between one and two orders of magnitude above background. The elevated activity in these wells is probably due to main plant, lagoon 1, and past NDA activities that involved fuel storage, reprocessing, and burial.

Total uranium (total U), which is reported in μg/mL, is found in these same wells at concentrations between one and two orders of magnitude above background (wells WNW0104, WNW0111, WNW8604, WNW8605, WNW0408, WNW0501, WNW0502) and greater than two orders of magnitude above background in well WNW0905. These concentrations are similarly associated with fuel storage reprocessing and burial activities. Uranium-234, -235, -236, -238, and total U were not tested for in any other sand and gravel wells.

Plutonium-238 (Pu-238)/Plutonium-239 (Pu-239)

Plutonium-238 was not found above background activity in any well finished in the sand and gravel unit. Plutonium-239 showed activities within one order of magnitude above background in wells WNW0104, WNW8604, WNW8605, WNW0408, and WNW0501. This activity probably is associated with main plant and lagoon 1 activities during earlier fuel storage and reprocessing. No other sand and gravel wells exhibited activities above background.

Alpha radiation at activities above the usual norm of very low activities in the sand and gravel wells is probably attributable to the above-background activities of uranium isotopes that may be a product of fuel storage and reprocessing activities. (See Fig. 3-10.)

Weathered Lavery Till

Eight weathered Lavery till wells were statistically significant with respect to background well WNW1008C and thus were analyzed for additional parameters. WNW0906, WNW0908, WNW1006, and WNW1008C were sampled for the full radioisotopic set of parameters. The NDA interceptor trench sump manhole (WNNDATR) and wells WNW0907, WNW0909, WNW1007, and WNW1108A were sampled for beta-emitting isotopes.

The weathered Lavery till background well, WNW1008C, was analyzed for the full set of isotopic parameters for comparison with the downgradient wells and the sump. Well WNW1008C exhibited very low radioisotope activities and thus indicates that higher radioisotopic activity values probably can be attributed to environmental and manmade sources.

Carbon-14 (C-14)

Carbon-14 was evident in wells WNW0907, WNW0909, and WNW1006 at activities less than one order of magnitude above background and may be partly responsible for the slightly elevated gross beta in these wells. The remaining wells exhibited activities below background levels.

Cesium-137 (Cs-137)

Cesium-137 was not above background in any wells tested in the weathered till. Cesium-137 did surpass background activities in all wells only when analytic uncertainties were added to the mean values. However, these values were very close to background.

Cobalt-60 (Co-60)

Cobalt-60 also did not exhibit above background activities in any tested wells, and, as with Cs-137, only slightly surpassed background when analytic uncertainties were added to mean values.

Iodine-129 (I-129)

Iodine-129 was encountered in wells WNW0907, WNW0908, and WNW0909 as well as discharge sump WNNDATR at activities of less than one order of magnitude above background. No other tested wells exhibited activities above background.

Americium-241 (Am-241)

Americium-241 exhibited activities within one order of magnitude above background in wells WNW0906, WNW0908, and WNW1006.

Strontium-90 (Sr-90)

Strontium-90 was evident in wells WNW1007 and WNW1108A at activities of less than one order of magnitude above background. Well WNW0909 exhibited activity greater than two orders of magnitude above background, and discharge point WNNDATR exhibited activities between one and two orders of magnitude above background. No other tested wells exhibited activities above background, although some activities approached background. The elevated Sr-90 in well WNW1007 may be partly responsible for the elevated gross beta in this well. While well WNW1108A did not show highly elevated gross beta, it was above background, and thus Sr-90 may also be partly responsible for these beta activities.

Radium-226 (Ra-226)

Radium-226 was evident in well WNW0908 at activities of more than two orders of magnitude above background, while wells WNW0906 and WNW1006 exhibited activities of less than one order of magnitude above background. The elevated Ra-226 in well WNW0908 is partly responsible for the elevated gross alpha activity in this well and also contributes to the above-background alpha activity in wells WNW0906 and WNW1006.

Radium-228 (Ra-228)

Radium-228 was evident in wells WNW0906, WNW0908, and WNW1006 at activities between one and two orders of magnitude above background. The Ra-226 and Ra-228 activities may be partly due to the clayey composition of the till, which contains natural sources of radium. Both Ra-226 and Ra-228 contribute to the above-background gross alpha activities in these wells.

Technetium-99 (Tc-99)

Technetium-99 is found in wells WNW0907, WNW0908, WNW0909, WNW1007, and WNW1108A, and in discharge sump WNNDATR at activities within one order of magnitude above background. Technetium-99 partly contributes to the elevated gross beta in wells WNW0908 and WNW1007 and may be a product of discontinued waste transport and past burial practices associated with the NDA.

Plutonium-238/239 (Pu-238/239)

Plutonium-238 and -239 were not evident in any tested wells at activities above background. Pu-238 and -239 activities did approach background but did not surpass it.

Uranium Isotopes

Uranium-232, -234, -235, -238, and total U are evident in wells WNW0906, WNW0908, and WNW1006 at between one and two orders of magnitude above background. These uranium isotopes are responsible for the above-background gross alpha in wells WNW0906, WNW0908, and WNW1006.

Unweathered Lavery Till

The sample results from nine unweathered Lavery till wells exhibited statistically significant differences with respect to background well WNW0405 and thus were analyzed for additional parameters. Samples from background well WNW0405 were analyzed for the full radioisotopic set of parameters; the nine downgradient wells (WNW0107, WNW0109, WNW0110, WNW0904, WNW0115, WNW0409, WNW0704, WNW0910, and WNW1109B) were sampled for only the beta-emitting isotopes. Well WNW0405 generally exhibited the lowest radioisotopic values in this geologic unit and thus indicates that higher radioisotopic activity values in downgradient wells probably can be attributed to environmental and manmade sources.

Carbon-14 (C-14)

Carbon-14 is not evident in any tested wells at activities above background. Carbon-14 activities in wells WNW0107 and WNW0910 approached background activities but did not surpass them. Carbon-14 activities may be partly derived from naturally occurring C-14 that may be incorporated into the till, itself derived from pre-Lavery lacustrine sediments that may have been rich in organic material and thus a source of carbon.

Iodine-129 (I-129)

Iodine-129 is evident in wells WNW0107, WNW0110, WNW0115, WNW0704, WNW0904, and WNW0910 at activities within one order of magnitude above background; wells WNW0109 and WNW1109B are between one and two orders of magnitude above background activities. The I-129 contamination in wells WNW0109 and WNW1109B may be caused partly by past wastewater management activities and and discontinued NDA burial activities, respectively.

Strontium-90 (Sr-90)

Strontium-90 showed activity within one order of magnitude above background in well WNW0704 and is probably responsible for the elevated gross beta in this well. No other tested wells show Sr-90 activities above background, although WNW1109B did approach background but did

not surpass it. One possible source for this isotope at well WNW0704 would be the chemical processing cell waste storage area (CPCWSA). However, no release from this storage area has ever been documented.

Technetium-99 (Tc-99)

Technetium-99 was encountered in wells WNW0107 and WNW1109B at activities within one order of magnitude above background. Possible sources of Tc-99 in WNW1109B might be attributable to NDA/SDA disposals. No other tested well exhibited Tc-99 activities above background.

Cesium-137 (Cs-137)

Cesium-137 was not found above background activities in any tested wells. However, it did slightly surpass background in all wells except WNW0910 and WNW1109B when analytic uncertainties were accounted for.

Cobalt-60 (Co-60)

Cobalt-60 also did not exhibit above-background activities in any tested wells. However, it did slightly surpass background in all wells except WNW0910 when analytic uncertainties were accounted for.

Lavery Till-sand

The sample results from well WNW0202 in the Lavery till-sand unit exhibited statistically significant differences from background well WNW0402 and so samples were analyzed for beta-emitting isotopes.

Well WNW0202 exhibited activity levels within one order of magnitude above background for only I-129, Sr-90, and Tc-99. These beta-emitting isotopes are responsible for the elevated gross beta that is evident in this well with respect to background.

Discussion of Site Groundwater Monitoring

Significant achievements were made in characterizing the site groundwaters in 1993. Beginning with a statistical analysis of 1991 and 1992 indicator parameters, further characterization for wider suites of radiological and nonradiological parameters was conducted at nearly 50% of the monitoring locations in an effort to better understand the apparent differences in water quality with respect to background values. Results of the first round of this expanded characterization have indicated that issues of radiological water quality deserve the most attention. Although several metals and organic compounds exceeded drinking water standards, these part-per-billion concentrations pose less serious potential threats to the environment than the elevated beta-emitting isotopes.

Strontium-90 in localized areas north and east of the main plant in the uppermost, water-bearing sand and gravel unit has been implicated as being the isotope primarily responsible for the elevated gross beta reported historically in those areas. Figure 3-44 illustrates the strong influences of strontium-90 concentrations on gross beta radioactivities. Understanding that this isotope is relatively mobile (less attenuated by soil interaction), recent efforts have begun to focus on the issues of defining a source (or sources) and on understanding the present extent of migration. An example of these recent efforts was illustrated when an increasing trend of gross beta was observed at location WNDMPNE in December 1993. Follow-up sampling and analysis in that vicinity has led to the identification of an upgradient groundwater seepage location that appeared to be a major contributor to the radioactivity. In response to this finding, short-term remedial alternatives are being considered together with a long-term assessment plan that would coincide with the timetable already in place for the RCRA

facility investigations. Assessment of the radiological doses associated with this elevated activity is expected to be a key element in the development of media-specific cleanup levels for such radioisotopes as strontium-90. In the meantime, the Department of Energy is committed to reducing the potential off-site migration of radiological contaminants by treating discharges, if necessary, to safeguard the public. The potential hazards associated with metals and organic compounds in the site groundwater will continue to be pursued under the terms of the RCRA 3008 (h) Administrative Order on Consent.

Off-site Groundwater Monitoring Program

During 1993 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-1.8 in *Appendix C-1*.