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FOURTH QUARTER 1992 AND 1992 SUMMARY

F- AND H-AREA SEWAGE SLUDGE APPLICATION SITES GROUNDWATER MONITORING REPORT (U)

KEY WORDS

FSS wells
HSS wells
iron
lead
tritium

PUBLICATION DATE: APRIL 1993

Authorized Derivative Classifier:

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Abstract

Samples from the four wells at the F-Area Sewage Sludge Application Site (FSS wells) and the three wells at the H-Area Sewage Sludge Application Site (HSS wells) are analyzed quarterly for constituents as required by South Carolina Department of Health and Environmental Control Construction Permit 12,076 and, as requested, for other constituents as part of the Savannah River Site Groundwater Monitoring Program. Annual analyses for other constituents, primarily metals, also are required by the permit. During fourth quarter 1992, the FSS wells also were analyzed for a number of other constituents not required by the permit.

Historically and currently, no permit-required analytes exceed standards at the F- and H-Area Sewage Sludge Application Sites except iron, lead, and manganese, which occur in elevated concentrations frequently in FSS wells. Lead concentrations exceeded the final Primary Drinking Water Standards during fourth quarter 1992, an event that is concurrent with a change in sampling procedures. Tritium is the primary nonpermit constituent that exceeds standards at the F-Area Sewage Sludge Application Site. Other constituents also exceed standards at this site but only sporadically.

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Executive Summary

During fourth quarter 1992, samples from the four monitoring wells at the F-Area Sewage Sludge Application Site (FSS series) and the three monitoring wells at the H-Area Sewage Sludge Application Site (HSS series) were analyzed for constituents required by Construction Permit 12,076 issued by the South Carolina Department of Health and Environmental Control. Samples from the F-Area site also were analyzed for other constituents as part of the Savannah River Site (SRS) Groundwater Monitoring Program. This report describes the monitoring results that exceeded final Primary Drinking Water Standards (PDWS) or SRS flagging criteria.

Lead exceeded the final PDWS in upgradient well FSS 1D at 100 μg/L and in downgradient well FSS 3D at 154 μg/L. The occurrence of elevated lead during fourth quarter 1992 is concurrent with a change in sampling procedures. Downgradient wells FSS 2D and 3D contained elevated activities of tritium, which also occurred in these wells during the three previous quarters of 1992. Iron, manganese, and lead exceeded the SRS Flag 2 criteria in one or more FSS wells, while no constituents exceeded the final PDWS or Flag 2 criteria in HSS wells.

During the fourth quarter, groundwater flow beneath the F-Area Sewage Sludge Application Site was toward the southwest, and flow beneath the H-Area Sewage Sludge Application Site was toward the west-southwest (SRS grid coordinates).

Introduction

The 11 sewage sludge application sites at the Savannah River Site (SRS) were originally the subject of a research program, begun in 1980, using domestic sewage sludge to reclaim borrow pits and to enhance forest productivity at SRS. Sludge was applied to the sites, and hardwoods and pines were then planted to quantify the wood biomass that could be produced using the sludge as a fertilizer and soil conditioner.

The F-Area Sewage Sludge Application Site covers approximately 8 acres south of Road E in the southeastern portion of F Area (Figures 1 and 2, Appendix C). The H-Area Sewage Sludge Application Site includes approximately 13 acres south of Road E in the southeastern portion of H Area (Figures 1 and 3, Appendix C). These sites were permitted to receive sludge from SRS sanitary waste water treatment plants in accordance with Construction Permit 12,076, issued by the South Carolina Department of Health and Environmental Control (SCDHEC) in April 1986. Sewage sludge was disposed of at the F-Area site from 1987 until third quarter 1990. Sludge was disposed of intermittently at the H-Area site from November 1990 through second quarter 1992.

In 1988, SRS determined that new wells were required at the F- and H-Area sites to assess the effects on groundwater of sewage sludge application to these sites. After receiving approval from SCDHEC, SRS installed four new wells at the F-Area site and three new wells at the H-Area site. These wells, designated FSS 1D, 2D, 3D, and 4D and HSS 1D, 2D, and 3D, were first sampled during fourth quarter 1988. All wells monitor the water table.

This report presents data from these wells for fourth quarter 1992 as required by Special Condition 4 of Construction Permit 12,076.

Discussion

Groundwater Monitoring Data

The Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) collects quarterly groundwater samples from wells at the F- and H-Area Sewage Sludge Application Sites as part of the SRS Groundwater Monitoring Program. The EPD/EMS sampling procedure (WSRC, 1992a) requires evacuation of a minimum of two well volumes and stabilization of pH, specific conductance, and turbidity prior to sample collection. Stability is established when a minimum of three successive measurements, taken within a given time period, are within a specified tolerance range.

If a well pumps dry before two well volumes are purged or before stabilization is achieved, it must be revisited within 24 hours for the data to be considered from a single sampling event. On the second visit within 24 hours, samples are taken without purging or stability measurements; thus, these samples may not be representative of groundwater quality. Table 3 (Appendix D) lists the number of well volumes purged from each FSS and HSS well during fourth quarter. Wells FSS 1D, 2D, 3D, and 4D and HSS 1D and 3D went dry during purging. Most of these wells consistently have failed to meet the purging and stabilization criteria. At present, all FSS and HSS wells have single-speed centrifugal downhole pumps.

The quarterly samples from the monitoring wells at the F- and H-Area Sewage Sludge Application Sites are analyzed for the following parameters as required by SCDHEC Construction Permit 12,076:

- Specific conductance and pH (laboratory measurements)
- Water quality indicators: chloride, nitrate, nitrite, sodium, and total dissolved solids

Annually, these wells also are analyzed for cadmium, calcium, copper, iron, lead, magnesium, manganese, nickel, potassium, and total phosphates (as phosphorus) as required by the construction permit. During fourth quarter 1992, FSS wells received additional analyses as part of the SRS Groundwater Monitoring Program.

Monitoring results that exceeded the Safe Drinking Water Act final Primary Drinking Water Standards (PDWS) or drinking water screening levels, as established by the U.S. Environmental Protection Agency (EPA) (Appendix A), the South Carolina final PDWS for lead (Appendix A), or other SRS flagging criteria (Appendix B) are described in this report. Constituent levels that exceed the final PDWS, screening levels, or the Flag 2 criteria are described as *elevated* or as *exceeding* or *above* standards.

The drinking water standard for lead used in this report was changed to the South Carolina final PDWS of 50 μg/L effective fourth quarter 1992. Lead data for the earlier quarters of 1992 were made consistent with the 50 μg/L standard for this annual report. The SRS flagging criteria are based on final and proposed PDWS, Secondary Drinking Water Standards, or constituent detection limits. The final PDWS for individual analytes given in Appendix A may not always match the SRS flagging criteria in Appendix B. The final PDWS are used as guidelines in this compliance report to meet regulatory requirements; the flagging criteria are used by EPD/EMS to identify relative levels of constituents in the groundwater and as guides for scheduling groundwater sampling.

Appendix C provides the locations of the monitored sites at SRS (Figure 1); the individual FSS and HSS monitoring wells (Figures 2 and 3, respectively); the flow directions of the groundwater beneath the sites (Figures 4 and 5); and the tritium activities in the FSS wells compared to the tritium activities in Old Burial Ground wells (Figure 6). Monitoring results tables as well as analyses that exceeded the holding times, final PDWS, and other flagging criteria are in Appendix D. Data quality/useability assessment information is in Appendix E.

Analytical Results Exceeding Standards

Table 1 (Appendix D) summarizes constituents that exceeded the final PDWS during fourth quarter 1992 for the F-Area Sewage Sludge Application Site. Table 2 (Appendix D) summarizes constituents in excess of the final PDWS for the H-Area Sewage Sludge Application Site for the quarter. Tritium exceeded the final PDWS in well FSS 2D at 9.8E+01 pCi/mL and in well FSS 3D at 6.2E+01 pCi/mL. Lead exceeded the final PDWS in wells FSS 1D and 3D at 100 μg/L and 154 μg/L, respectively. No constituents exceeded standards in HSS wells.

Tables 3 and 4 (Appendix D) summarize constituents exceeding half the final PDWS or other Flag 1 or Flag 2 criteria during fourth quarter 1992 for the F-Area Sewage Sludge Application Site and H-Area Sewage Sludge Application Site, respectively. Iron and manganese exceeded their Flag 2 criteria in wells FSS 1D, 2D, and 3D, with concentrations in well FSS 2D up to 10,300 μg/L and 104 μg/L, respectively. Lead exceeded the Flag 2 criterion at 41 μg/L in well FSS 2D. No constituents exceeded Flag 2 criteria in HSS wells during the quarter.

Fourth quarter 1992 results for all analyzed constituents for the FSS and HSS wells are presented in Tables 5 and 6, respectively (Appendix D). Results as they appear in the database are compared with the final PDWS. The database results are reported with more significant digits than the results given in these reports. Thus, constituent results in Tables 5 and 6 that appear to equal the final PDWS but are not marked in the *D* column are below the final PDWS in the database.

Presently, SRS sets no flagging criteria for alkalinity. In the FSS wells, alkalinity ranged up to 30 mg/L (well FSS 1D). In the HSS wells, alkalinity ranged up to 2 mg/L (well HSS 1D).

Water Elevations and Groundwater Flow Directions

Water-table elevations at the F-Area Sewage Sludge Application Site indicate that the groundwater flow direction is toward the southwest (SRS grid coordinates), discharging into Fourmile Branch. During fourth quarter 1992, groundwater from well FSS 1D, upgradient of the F-Area Sewage Sludge Application Site, contained lead in excess of the final PDWS, as did a sample from downgradient well FSS 3D. Tritium activities exceeded PDWS in downgradient wells FSS 2D and 3D.

The nearly linear orientation of the wells at the H-Area Sewage Sludge Application Site and the fact that wells HSS 1D and 2D are screened well below the water table make the determination of groundwater flow direction difficult. Available data, including water-level elevations from the three wells, indicate that groundwater flow is generally toward the west-southwest (SRS grid coordinates) (Figure 5, Appendix C). Well HSS 3D is upgradient of the H-Area Sewage Sludge Application Site, and wells HSS 1D and HSS 2D are downgradient.

Conclusions

- During fourth quarter 1992, upgradient well FSS 1D contained iron, lead, and manganese concentrations that exceeded the final PDWS or the SRS Flag 2 criteria. Downgradient wells contained elevated levels of iron, lead, manganese, and tritium.

- Elevated lead concentrations did not occur in FSS wells during the first three quarters of 1992; the occurrence of elevated lead during fourth quarter 1992 is concurrent with the change to analyses of unfiltered metals samples.

- Generally, elevated levels of constituents found in downgradient wells but not in upgradient wells at a waste management unit are considered products of that waste management unit. However, the historical records for the F- and H-Area Sewage Sludge Application Sites indicate that no radionuclides were disposed of in the immediate area. The source of the tritium in the FSS wells is believed to be the Old Burial Ground (Figure 6, Appendix C); the source of the other elevated constituents in these wells is uncertain.

- Groundwater flow beneath the F- and H-Area Sewage Sludge Application Sites is toward the southwest (SRS grid coordinates).

- In the FSS wells, alkalinity ranged up to 30 mg/L (well FSS 1D). In the HSS wells, alkalinity ranged up to 2 mg/L (well HSS 1D). These results are similar to those of previous quarters.

- The wells that pumped dry during purging, FSS 1D, 2D, 3D, and 4D and HSS 1D and 3D, may have yielded unrepresentative groundwater samples.

Summary 1992

As in 1991, tritium exceeded the final PDWS in downgradient wells FSS 2D and 3D during each quarter. Maximum tritium activity during 1992 occurred in well FSS 2D during third quarter at 1.1E+02 pCi/mL.

Elevated concentrations of mercury and lead occurred sporadically during the year in FSS wells. Mercury was elevated during third quarter 1992 in well FSS 2D; this result is considered anomalous because reanalysis of the same sample yielded a result below the detection limit and because historical data show no previous mercury result above the final PDWS. Lead was elevated in upgradient well FSS 1D and downgradient well FSS 3D during fourth quarter 1992; these results are concurrent with the change to analyses of unfiltered metals samples.

Total alpha-emitting radium activity occurred occasionally in the FSS and HSS wells during 1991; during 1992, this constituent was analyzed only during first quarter in well HSS 2D. That result did not exceed the final PDWS for total radium.

Iron and manganese concentrations exceeding their SRS Flag 2 criteria occurred sporadically in FSS wells during 1992 as well as during 1991. None of the constituents analyzed exceeded Flag 2 criteria in HSS wells during the past two years.

Groundwater flow beneath the F- and H-Area Sewage Sludge Application Sites was consistently to the southwest during 1991 and 1992.

Errata

The results of analyses performed using EPA Method 900.1 have been incorrectly referred to in the past as total radium results and have been inappropriately evaluated against the drinking water standard for combined radium-226 and radium-228. EPA Method 900.1 measures radium-223, -224, and -226 and should be considered a gross radium alpha screening procedure; it may be used to screen drinking water for the necessity of performing a specific radium-226 analysis, but it gives no indication of the presence or quantity of radium-228 in the sample. This analysis is now referred to as total alpha-emitting radium.

First through Third Quarters 1992:

- Chlordane analysis was requested as part of the Base/Neutral/Acid suite of analyses as described in the Environmental Protection Department/Environmental Monitoring Section contract with the analytical laboratory. However, Roy F. Weston, Inc., which conducted the analyses for first through third quarters 1992, does not include chlordane in its Base/Neutral/Acid suite of analyses. Chlordane analysis was conducted by General Engineering Laboratories for fourth quarter 1992.

First through Fourth Quarters 1992:

- Some results for earlier quarters of 1992 that are presented in the results tables of the fourth quarter 1992 report may differ from the results presented in the earlier reports, and reported results may not match reported sample dates. These differences arise from the following: (1) the computer program that creates the results tables was revised beginning second quarter 1992 to present the highest value for analytes with more than one result (previously, the program presented the first value encountered in the database); (2) a new computer program, which rounds numbers differently from the former computer program, was first used during third quarter 1992; and (3) some reanalyses may have been performed by the laboratories after the quarterly reports had gone to press. The sample dates in the tables are the dates when the field data were collected. These dates may differ from the dates of the laboratory analyses if the highest results were obtained for samples collected on different dates.

Appendix A – Final Primary Drinking Water Standards

Final Primary Drinking Water Standards

Analyte	Unit	Level	Status	Reference
Arsenic	µg/L	50	Final	CFR, 1991
Barium	µg/L	2,000	Final	CFR, 1991
Benzene	µg/L	5	Final	CFR, 1991
Bromodichloromethane	µg/L	100[a]	Final	CFR, 1991
Bromoform	µg/L	100[a]	Final	CFR, 1991
Cadmium	µg/L	5	Final	CFR, 1991
Carbon tetrachloride	µg/L	5	Final	CFR, 1991
Chlordane	µg/L	2	Final	CFR, 1991
Chloroethene (Vinyl chloride)	µg/L	2	Final	CFR, 1991
Chloroform	µg/L	100[a]	Final	CFR, 1991
Chromium	µg/L	100	Final	CFR, 1991
Copper	µg/L	1,300	Final	CFR, 1991
Dibromochloromethane	µg/L	100[a]	Final	CFR, 1991
Dibromochloropropane	µg/L	0.2	Final	CFR, 1991
1,2-Dichlorobenzene	µg/L	600	Final	CFR, 1991
1,4-Dichlorobenzene	µg/L	75	Final	CFR, 1991
1,2-Dichloroethane	µg/L	5	Final	CFR, 1991
1,1-Dichloroethylene	µg/L	7	Final	CFR, 1991
cis-1,2-Dichloroethylene	µg/L	70	Final	CFR, 1991
trans-1,2-Dichloroethylene	µg/L	100	Final	CFR, 1991
2,4-Dichlorophenoxyacetic acid	µg/L	70	Final	CFR, 1991
1,2-Dichloropropane	µg/L	5	Final	CFR, 1991
Endrin	µg/L	0.2	Final	CFR, 1991
Ethylbenzene	µg/L	700	Final	CFR, 1991
Fluoride	µg/L	4,000	Final	CFR, 1991
Gross alpha[b]	pCi/L	1.5E+01	Final	CFR, 1991
Heptachlor	µg/L	0.4	Final	CFR, 1991
Heptachlor epoxide	µg/L	0.2	Final	CFR, 1991
Lead	µg/L	50	Final	SCDHEC, 1981
Lindane	µg/L	0.2	Final	CFR, 1991
Mercury	µg/L	2	Final	CFR, 1991
Methoxychlor	µg/L	40	Final	CFR, 1991
Nitrate as nitrogen	µg/L	10,000	Final	CFR, 1991
Nitrate-nitrite as nitrogen	µg/L	10,000	Final	CFR, 1991
Nitrite as nitrogen	µg/L	1,000	Final	CFR, 1991
Nonvolatile beta[c]	pCi/L	5E+01	Final	EPA, 1977
PCBs[d]	µg/L	0.5	Final	CFR, 1991
Pentachlorophenol	µg/L	1	Final	CFR, 1991
Selenium	µg/L	50	Final	CFR, 1991
Strontium-89/90[e]	pCi/L	8E+00	Final	CFR, 1991
Strontium-90	pCi/L	8E+00	Final	CFR, 1991
Styrene	µg/L	100	Final	CFR, 1991
Tetrachloroethylene	µg/L	5	Final	CFR, 1991
Toluene	µg/L	1,000	Final	CFR, 1991
Total radium (Radium-226 and -228)	pCi/L	5E+00	Final	CFR, 1991
Total trihalomethanes	µg/L	100	Final	CFR, 1991
Toxaphene	µg/L	3	Final	CFR, 1991
2,4,5-TP (Silvex)	µg/L	50	Final	CFR, 1991
1,1,1-Trichloroethane	µg/L	200	Final	CFR, 1991

Analyte	Unit	Level	Status	Reference
Trichloroethylene	μg/L	5	Final	CFR, 1991
Tritium	pCi/mL	2E+01	Final	CFR, 1991
Xylenes	μg/L	10,000	Final	CFR, 1991

Note: The drinking water standard for lead was changed to the South Carolina Primary Drinking Water Standard of 50 μg/L fourth quarter 1992.

[a] This value is the drinking water standard for total trihalomethanes (the sum of bromoform, bromodichloromethane, chloroform, and dibromochloromethane).

[b] The standard given is for gross alpha including radium-226 but excluding radon and uranium.

[c] This is the screening level above which providers of public drinking water should perform analyses for specific man-made radionuclides. The standard for the total dose equivalent from all such radionuclides is 4 mrem per year.

[d] Analyses were conducted in 1992 for the following: PCB 1016, PCB 1221, PCB 1232, PCB 1242, PCB 1248, PCB 1254, and PCB 1260.

[e] For double radionuclide analyses where each separate radionuclide has its own standard, the more stringent standard is used.

References

CFR (Code of Federal Regulations), 1991. *National Primary Drinking Water Regulations*, **40 CFR, Part 141**, pp. 578–715. Washington, DC.

EPA (U.S. Environmental Protection Agency), 1977. **National Interim Primary Drinking Water Regulations**, EPA-570/9-76-003. Washington, DC.

SCDHEC (South Carolina Department of Health and Environmental Control), 1981. **State Primary Drinking Water Regulations**, R.61-58.5. Columbia, SC.

Appendix B – Flagging Criteria

Flagging Criteria

Beginning in 1991, the Savannah River Site Environmental Protection Department/ Environmental Monitoring Section modified its guidelines for flagging constituents in the Groundwater Monitoring Program. These flagging criteria are as follows:

- Flag 2 criteria for constituents equal the Safe Drinking Water Act (SDWA) final Primary Drinking Water Standard (PDWS), the SDWA proposed PDWS, or the SDWA Secondary Drinking Water Standard (SDWS). If a constituent does not have a drinking water standard, the Flag 2 criterion equals 10 times the method detection limit (MDL) calculated as the 90th percentile detection limit obtained recently by one of the primary analytical laboratories.

- Flag 1 criteria for constituents equal one-half of the final PDWS, one-half the proposed PDWS, or one-half the SDWS. If a constituent does not have an drinking water standard, the Flag 1 criterion equals 5 times the MDL calculated as the 90th percentile detection limit obtained recently by one of the primary analytical laboratories.

- Flag 0 criteria are assigned to constituent levels below Flag 1 criteria, constituent levels below the sample detection limits, or constituents having no flagging criteria.

The following parameters are not assigned flagging criteria: alkalinity, calcium, carbonate, color, corrosivity, magnesium, odor, potassium, Eh, silica, sodium, total dissolved solids, total phosphorus, total phosphates (as P), and turbidity. In addition, common laboratory contaminants and cleaners including phthalates, methylene chloride, ketones, and toluene are not assigned flagging criteria.

Analyte	Unit	Flag 1	Flag 2	Source
Acenaphthene	µg/L	50	100	EPA Method 8270
Acenaphthylene	µg/L	50	100	EPA Method 8270
Acetone	µg/L	50	100	EPA Method 8240
Acetonitrile (Methyl cyanide)	µg/L	500	1,000	EPA Method 8240
Acetophenone	µg/L	50	100	EPA Method 8270
2-Acetylaminofluorene	µg/L	50	100	EPA Method 8270
Acrolein	µg/L	100	200	EPA Method 8240
Acrylonitrile	µg/L	100	200	EPA Method 8240
Aldrin	µg/L	2.5	5	EPA Method 8080
Alkalinity (as $CaCO_3$)		No flag	No flag	Set by EPD/EMS
Allyl chloride	µg/L	250	500	EPA Method 8240
Aluminum	µg/L	25	50	Secondary DWS (CFR, 1991b)
Americium-241	pCi/L	3.17E+00	6.34E+00	Proposed DWS (EPA, 1991)
Americium-243	pCi/L	3.19E+00	6.37E+00	Proposed DWS (EPA, 1991)
4-Aminobiphenyl	µg/L	50	100	EPA Method 8270
Ammonia	µg/L	500	1,000	APHA Method 417B
Ammonia nitrogen	µg/L	50	100	EPA Method 350.1
Aniline	µg/L	50	100	EPA Method 8270
Anthracene	µg/L	50	100	EPA Method 8270
Antimony	µg/L	2.5	5	Proposed DWS (EPA, 1990)
Antimony-125	pCi/L	1.5E+02	3E+02	Final DWS (EPA, 1977)
Aramite	µg/L	50	100	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source
Arsenic	µg/L	25	50	Final DWS (CFR, 1991a)
Barium	µg/L	1,000	2,000	Final DWS (CFR, 1991a)
Barium-140	pCi/L	4.5E+01	9E+01	Final DWS (EPA, 1977)
Benzene	µg/L	2.5	5	Final DWS (CFR, 1991a)
alpha-Benzene hexachloride	µg/L	2.5	5	EPA Method 8080
beta-Benzene hexachloride	µg/L	2.5	5	EPA Method 8080
delta-Benzene hexachloride	µg/L	2.5	5	EPA Method 8080
Benzidine	µg/L	250	500	EPA Method 8270
Benzo[*a*]anthracene	µg/L	0.05	0.1	Proposed DWS (EPA, 1990)
Benzo[*b*]fluoranthene	µg/L	0.1	0.2	Proposed DWS (EPA, 1990)
Benzo[*k*]fluoranthene	µg/L	0.1	0.2	Proposed DWS (EPA, 1990)
Benzo[*g,h,i*]perylene	µg/L	50	100	EPA Method 8270
Benzo[*a*]pyrene	µg/L	0.1	0.2	Proposed DWS (EPA, 1990)
Benzoic acid	µg/L	250	500	EPA Method 8270
1,4-Benzoquinone	µg/L	50	100	EPA Method 8270
Benzyl alcohol	µg/L	100	200	EPA Method 8270
Beryllium	µg/L	0.5	1	Proposed DWS (EPA, 1990)
Beryllium-7	pCi/L	3E+03	6E+03	Final DWS (EPA, 1977)
Bis(2-chloroethoxy) methane	µg/L	50	100	EPA Method 8270
Bis(2-chloroethyl) ether	µg/L	50	100	EPA Method 8270
Bis(2-chloroisopropyl) ether	µg/L	50	100	EPA Method 8270
Bis(chloromethyl) ether	µg/L	50	100	EPA Method 8270
Bis(chloromethyl-ethyl) ether	µg/L	50	100	EPA Method 8270
Bis(2-ethylhexyl) phthalate		No flag	No flag	Set by EPD/EMS
Bromide	µg/L	5,000	10,000	EPA Method 300.0
Bromodichloromethane	µg/L	50	100	Final DWS (CFR, 1991a)
Bromoform	µg/L	50	100	Final DWS (CFR, 1991a)
Bromomethane (Methyl bromide)	µg/L	5	10	EPA Method 8240
4-Bromophenyl phenyl ether	µg/L	50	100	EPA Method 8270
2-sec-Butyl-4,6-dinitrophenol	µg/L	3.5	7	Proposed DWS (EPA, 1990)
Butylbenzyl phthalate		No flag	No flag	Set by EPD/EMS
Cadmium	µg/L	2.5	5	Final DWS (CFR, 1991a)
Calcium		No flag	No flag	Set by EPD/EMS
Carbon disulfide	µg/L	5	10	EPA Method 8240
Carbon tetrachloride	µg/L	2.5	5	Final DWS (CFR, 1991a)
Carbon-14	pCi/L	1E+03	2E+03	Final DWS (EPA, 1977)
Carbonate	µg/L	500	1,000	EPA Method 310.1
Cerium-141	pCi/L	1.5E+02	3E+02	Final DWS (EPA, 1977)
Cerium-144	pCi/L	1.31E+02	2.61E+02	Proposed DWS (EPA, 1991)
Cesium-134	pCi/L	4.07E+01	8.13E+01	Proposed DWS (EPA, 1991)
Cesium-137	pCi/L	1E+02	2E+02	Final DWS (EPA, 1977)
Chlordane	µg/L	1	2	Final DWS (CFR, 1991a)
Chloride	µg/L	125,000	250,000	Secondary DWS (CFR, 1991b)
4-Chloroaniline	µg/L	50	100	EPA Method 8270
Chlorobenzene	µg/L	5	10	EPA Method 8240
Chlorobenzilate	µg/L	50	100	EPA Method 8270
Chloroethane	µg/L	5	10	EPA Method 8240
Chloroethene (Vinyl chloride)	µg/L	1	2	Final DWS (CFR, 1991a)
Chloroethyl vinyl ether	µg/L	5	10	EPA Method 8240
2-Chloroethyl vinyl ether	µg/L	5	10	EPA Method 8240
Chloroform	µg/L	50	100	Final DWS (CFR, 1991a)
para-Chloro-meta-cresol	µg/L	50	100	EPA Method 8270
Chloromethane (Methyl chloride)	µg/L	5	10	EPA Method 8240
2-Chloronaphthalene	µg/L	50	100	EPA Method 8240
2-Chlorophenol	µg/L	50	100	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source
4-Chlorophenyl phenyl ether	µg/L	50	100	EPA Method 8270
Chloroprene	µg/L	1,000	2,000	EPA Method 8240
Chromium	µg/L	50	100	Final DWS (CFR, 1991a)
Chromium-51	pCi/L	3E+03	6E+03	Final DWS (EPA, 1977)
Chrysene	µg/L	0.1	0.2	Proposed DWS (EPA, 1990)
Cobalt	µg/L	20	40	EPA Method 6010
Cobalt-57	pCi/L	5E+02	1E+03	Final DWS (EPA, 1977)
Cobalt-58	pCi/L	4.5E+03	9E+03	Final DWS (EPA, 1977)
Cobalt-60	pCi/L	5E+01	1E+02	Final DWS (EPA, 1977)
Color		No flag	No flag	Set by EPD/EMS
Copper	µg/L	650	1,300	Final DWS (CFR, 1991a)
Corrosivity		No flag	No flag	Set by EPD/EMS
m-Cresol (3-Methylphenol)	µg/L	50	100	EPA Method 8270
o-Cresol (2-Methylphenol)	µg/L	50	100	EPA Method 8270
p-Cresol (4-Methylphenol)	µg/L	50	100	EPA Method 8270
Curium-242	pCi/L	6.65E+01	1.33E+02	Proposed DWS (EPA, 1991)
Curium-243	pCi/L	4.15E+00	8.3E+00	Proposed DWS (EPA, 1991)
Curium-244	pCi/L	4.92E+00	9.84E+00	Proposed DWS (EPA, 1991)
Curium-246	pCi/L	3.14E+00	6.27E+00	Proposed DWS (EPA, 1991)
Cyanide	µg/L	100	200	Proposed DWS (EPA, 1990)
p,p'-DDD	µg/L	2.5	5	EPA Method 8080
p,p'-DDE	µg/L	2.5	5	EPA Method 8080
p,p'-DDT	µg/L	2.5	5	EPA Method 8080
Di-n-butyl phthalate		No flag	No flag	Set by EPD/EMS
Di-n-octyl phthalate		No flag	No flag	Set by EPD/EMS
Diallate	µg/L	50	100	EPA Method 8270
Dibenz[*a,h*]anthracene	µg/L	0.15	0.3	Proposed DWS (EPA, 1990)
Dibenzofuran	µg/L	50	100	EPA Method 8270
Dibromochloromethane	µg/L	50	100	Final DWS (CFR, 1991a)
Dibromochloropropane	µg/L	0.1	0.2	Final DWS (CFR, 1991a)
1,2-Dibromo-3-chloropropane	µg/L	250	500	EPA Method 8240
1,2-Dibromoethane	µg/L	100	200	EPA Method 8240
Dibromomethane (Methylene bromide)	µg/L	5	10	EPA Method 8240
1,2-Dichlorobenzene	µg/L	300	600	Final DWS (CFR, 1991a)
1,3-Dichlorobenzene	µg/L	50	100	EPA Method 8270
1,4-Dichlorobenzene	µg/L	37.5	75	Final DWS (CFR, 1991a)
3,3'-Dichlorobenzidine	µg/L	50	100	EPA Method 8270
trans-1,4-Dichloro-2-butene	µg/L	150	300	EPA Method 8240
Dichlorodifluoromethane	µg/L	5	10	EPA Method 8240
1,1-Dichloroethane	µg/L	5	10	EPA Method 8240
1,2-Dichloroethane	µg/L	2.5	5	Final DWS (CFR, 1991a)
cis-1,2-Dichloroethene	µg/L	35	70	Final DWS (CFR, 1991a)
1,1-Dichloroethylene	µg/L	3.5	7	Final DWS (CFR, 1991a)
1,2-Dichloroethylene	µg/L	25	50	EPA Method 8240
trans-1,2-Dichloroethylene	µg/L	50	100	Final DWS (CFR, 1991a)
Dichloromethane (Methylene chloride)		No flag	No flag	Set by EPD/EMS
2,4-Dichlorophenol	µg/L	50	100	EPA Method 8270
2,6-Dichlorophenol	µg/L	50	100	EPA Method 8270
2,4-Dichlorophenoxyacetic acid	µg/L	35	70	Final DWS (CFR, 1991a)
1,2-Dichloropropane	µg/L	2.5	5	Final DWS (CFR, 1991a)
cis-1,3-Dichloropropene	µg/L	5	10	EPA Method 8240
trans-1,3-Dichloropropene	µg/L	5	10	EPA Method 8240
Dieldrin	µg/L	2.5	5	EPA Method 8080

Analyte	Unit	Flag 1	Flag 2	Source
Diethyl phthalate		No flag	No flag	Set by EPD/EMS
Dimethoate	µg/L	50	100	EPA Method 8270
p-Dimethylaminoazobenzene	µg/L	50	100	EPA Method 8270
p-(Dimethylamino)ethylbenzene	µg/L	50	100	EPA Method 8270
7,12-Dimethylbenz[a]anthracene	µg/L	50	100	EPA Method 8270
3,3'-Dimethylbenzidine	µg/L	50	100	EPA Method 8270
a,a-Dimethylphenethylamine	µg/L	50	100	EPA Method 8270
2,4-Dimethyl phenol	µg/L	50	100	EPA Method 8270
Dimethyl phthalate		No flag	No flag	Set by EPD/EMS
1,3-Dinitrobenzene	µg/L	50	100	EPA Method 8270
4,6-Dinitro-ortho-cresol	µg/L	250	500	EPA Method 8270
2,4-Dinitrophenol	µg/L	250	500	EPA Method 8270
2,4-Dinitrotoluene	µg/L	50	100	EPA Method 8270
2,6-Dinitrotoluene	µg/L	50	100	EPA Method 8270
1,4-Dioxane	µg/L	50	100	EPA Method 8270
Diphenylamine	µg/L	50	100	EPA Method 8270
1,2-Diphenylhydrazine	µg/L	50	100	EPA Method 8270
Dissolved organic carbon	µg/L	5,000	10,000	EPA Method 9060
Disulfoton	µg/L	50	100	EPA Method 8270
Eh		No flag	No flag	Set by EPD/EMS
alpha-Endosulfan	µg/L	50	100	EPA Method 8270
beta-Endosulfan	µg/L	50	100	EPA Method 8270
Endosulfan I	µg/L	2.5	5	EPA Method 8080
Endosulfan II	µg/L	2.5	5	EPA Method 8080
Endosulfan sulfate	µg/L	2.5	5	EPA Method 8080
Endrin	µg/L	0.1	0.2	Final DWS (CFR, 1991a)
Endrin aldehyde	µg/L	2.5	5	EPA Method 8080
Endrin ketone		No flag	No flag	Set by EPD/EMS
Ethyl methacrylate	µg/L	50	100	EPA Method 8270
Ethyl methanesulfonate	µg/L	50	100	EPA Method 8270
Ethylbenzene	µg/L	350	700	Final DWS (CFR, 1991a)
Europium-154	pCi/L	1E+02	2E+02	Final DWS (EPA, 1977)
Europium-155	pCi/L	3E+02	6E+02	Final DWS (EPA, 1977)
Famphur	µg/L	50	100	EPA Method 8270
Fluoranthene	µg/L	50	100	EPA Method 8270
Fluorene	µg/L	50	100	EPA Method 8270
Fluoride	µg/L	2,000	4,000	Final DWS (CFR, 1991a)
Gross alpha	pCi/L	7.5E+00	1.5E+01	Final DWS (CFR, 1991a)
Heptachlor	µg/L	0.2	0.4	Final DWS (CFR, 1991a)
Heptachlor epoxide	µg/L	0.1	0.2	Final DWS (CFR, 1991a)
Heptachlorodibenzo-p-dioxin isomers	µg/L	0.00325	0.0065	EPA Method 8280
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	µg/L	0.00325	0.0065	EPA Method 8280
Heptachlorodibenzo-p-furan isomers	µg/L	0.00225	0.0045	EPA Method 8280
1,2,3,4,6,7,8-Heptachlorodibenzo-p-furan	µg/L	0.00225	0.0045	EPA Method 8280
Hexachlorobenzene	µg/L	0.5	1	Proposed DWS (EPA, 1990)
Hexachlorobutadiene	µg/L	50	100	EPA Method 8270
Hexachlorocyclopentadiene	µg/L	25	50	Proposed DWS (EPA, 1990)
Hexachlorodibenzo-p-dioxin isomers	µg/L	0.00225	0.0045	EPA Method 8280
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	µg/L	0.00225	0.0045	EPA Method 8280
Hexachlorodibenzo-p-furan isomers	µg/L	0.002	0.004	EPA Method 8280

Analyte	Unit	Flag 1	Flag 2	Source
1,2,3,4,7,8-Hexachlorodibenzo-p-furan	µg/L	0.002	0.004	EPA Method 8280
Hexachloroethane	µg/L	50	100	EPA Method 8270
Hexachlorophene	µg/L	250	500	EPA Method 8270
Hexachloropropene	µg/L	50	100	EPA Method 8270
2-Hexanone	µg/L	100	200	EPA Method 8240
Indeno[1,2,3-*c,d*]pyrene	µg/L	50	100	EPA Method 8270
Iodine	µg/L	500	1,000	EPA Method 415
Iodine-129	pCi/L	5E-01	1E+00	Final DWS (EPA, 1977)
Iodine-131	pCi/L	1.5E+00	3E+00	Final DWS (EPA, 1977)
Iodomethane (Methyl iodide)	µg/L	75	150	EPA Method 8240
Iron	µg/L	150	300	Secondary DWS (CFR, 1991b)
Iron-55	pCi/L	1E+03	2E+03	Final DWS (EPA, 1977)
Iron-59	pCi/L	1E+02	2E+02	Final DWS (EPA, 1977)
Isobutyl alcohol	µg/L	500	1,000	EPA Method 8240
Isodrin	µg/L	50	100	EPA Method 8270
Isophorone	µg/L	50	100	EPA Method 8270
Isosafrole	µg/L	50	100	EPA Method 8270
Kepone	µg/L	50	100	EPA Method 8270
Lanthanum-140	pCi/L	3E+01	6E+01	Final DWS (EPA, 1977)
Lead	µg/L	7.5	15	Final DWS (CFR, 1991a)
Lindane	µg/L	0.1	0.2	Final DWS (CFR, 1991a)
Lithium	µg/L	25	50	EPA Method 6010
Magnesium		No flag	No flag	Set by EPD/EMS
Manganese	µg/L	25	50	Secondary DWS (CFR, 1991b)
Manganese-54	pCi/L	1.5E+02	3E+02	Final DWS (EPA, 1977)
Mercury	µg/L	1	2	Final DWS (CFR, 1991a)
Methacrylonitrile	µg/L	250	500	EPA Method 8240
Methapyrilene	µg/L	50	100	EPA Method 8270
Methoxychlor	µg/L	20	40	Final DWS (CFR, 1991a)
3-Methylcholanthrene	µg/L	50	100	EPA Method 8270
2-Methyl-4,6-dinitrophenol	µg/L	250	500	EPA Method 8270
Methyl ethyl ketone		No flag	No flag	Set by EPD/EMS
Methyl isobutyl ketone		No flag	No flag	Set by EPD/EMS
Methyl methacrylate	µg/L	50	100	EPA Method 8270
Methyl methanesulfonate	µg/L	50	100	EPA Method 8270
2-Methylnaphthalene	µg/L	50	100	EPA Method 8270
Molybdenum	µg/L	250	500	EPA Method 6010
Naphthalene	µg/L	50	100	EPA Method 8270
1,4-Naphthoquinone	µg/L	50	100	EPA Method 8270
1-Naphthylamine	µg/L	50	100	EPA Method 8270
2-Naphthylamine	µg/L	50	100	EPA Method 8270
Neptunium-237	pCi/L	3.53E+00	7.06E+00	Proposed DWS (EPA, 1991)
Nickel	µg/L	50	100	Proposed DWS (EPA, 1990)
Nickel-59	pCi/L	1.5E+02	3E+02	Final DWS (EPA, 1977)
Nickel-63	pCi/L	2.5E+01	5E+01	Final DWS (EPA, 1977)
Niobium-95	pCi/L	1.5E+02	3E+02	Final DWS (EPA, 1977)
Nitrate as nitrogen	µg/L	5,000	10,000	Final DWS (CFR, 1991a)
Nitrate-nitrite as nitrogen	µg/L	5,000	10,000	Final DWS (CFR, 1991a)
Nitrite as nitrogen	µg/L	500	1,000	Final DWS (CFR, 1991a)
2-Nitroaniline	µg/L	50	100	EPA Method 8270
3-Nitroaniline	µg/L	50	100	EPA Method 8270
4-Nitroaniline	µg/L	50	100	EPA Method 8270
Nitrobenzene	µg/L	50	100	EPA Method 8270
Nitrogen by Kjeldahl method	µg/L	500	1,000	EPA Method 351.2

Analyte	Unit	Flag 1	Flag 2	Source
2-Nitrophenol	µg/L	50	100	EPA Method 8270
4-Nitrophenol	µg/L	50	100	EPA Method 8270
4-Nitroquinoline-1-oxide	µg/L	50	100	EPA Method 8270
N-Nitrosodi-n-butylamine	µg/L	50	100	EPA Method 8270
N-Nitrosodiethylamine	µg/L	50	100	EPA Method 8270
N-Nitrosodimethylamine	µg/L	50	100	EPA Method 8270
N-Nitrosodiphenylamine	µg/L	50	100	EPA Method 8270
N-Nitrosodi-propylamine	µg/L	50	100	EPA Method 8270
N-Nitrosomethylethylamine	µg/L	50	100	EPA Method 8270
N-Nitrosomorpholine	µg/L	50	100	EPA Method 8270
N-Nitrosopiperidine	µg/L	50	100	EPA Method 8270
N-Nitrosopyrrolidine	µg/L	50	100	EPA Method 8270
5-Nitro-o-toluidine	µg/L	50	100	EPA Method 8270
Nonvolatile beta	pCi/L	2.5E+01	5E+01	Proposed DWS (EPA, 1986)
Octachlorodibenzo-p-dioxin isomers	µg/L	0.005	0.01	EPA Method 8280
Octachlorodibenzo-p-furan isomers	µg/L	0.005	0.01	EPA Method 8280
Odor		No flag	No flag	Set by EPD/EMS
Oil & Grease	µg/L	5,000	10,000	EPA Method 413.1
Parathion	µg/L	2.5	5	EPA Method 8080
Parathion methyl	µg/L	2.5	5	EPA Method 8080
PCB 1016	µg/L	0.25	0.5	Final DWS (CFR, 1991a)
PCB 1221	µg/L	0.25	0.5	Final DWS (CFR, 1991a)
PCB 1232	µg/L	0.25	0.5	Final DWS (CFR, 1991a)
PCB 1242	µg/L	0.25	0.5	Final DWS (CFR, 1991a)
PCB 1248	µg/L	0.25	0.5	Final DWS (CFR, 1991a)
PCB 1254	µg/L	0.25	0.5	Final DWS (CFR, 1991a)
PCB 1260	µg/L	0.25	0.5	Final DWS (CFR, 1991a)
PCB 1262	µg/L	0.25	0.5	Final DWS (CFR, 1991a)
Pentachlorobenzene	µg/L	50	100	EPA Method 8270
Pentachlorodibenzo-p-dioxin isomers	µg/L	0.00275	0.0055	EPA Method 8280
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	µg/L	0.00275	0.0055	EPA Method 8280
Pentachlorodibenzo-p-furan isomers	µg/L	0.00275	0.0055	EPA Method 8280
1,2,3,7,8-Pentachlorodibenzo-p-furan	µg/L	0.00275	0.0055	EPA Method 8280
Pentachloroethane	µg/L	50	100	EPA Method 8270
Pentachloronitrobenzene	µg/L	50	100	EPA Method 8270
Pentachlorophenol	µg/L	0.5	1	Final DWS (CFR, 1991a)
pH	pH	8	10	Set by EPD/EMS
pH	pH	4	3	Set by EPD/EMS
Phenacetin	µg/L	50	100	EPA Method 8270
Phenanthrene	µg/L	50	100	EPA Method 8270
Phenol	µg/L	50	100	EPA Method 8270
Phenols	µg/L	25	50	EPA Method 420.1
p-Phenylenediamine	µg/L	50	100	EPA Method 8270
Phorate	µg/L	2.5	5	EPA Method 8080
2-Picoline	µg/L	50	100	EPA Method 8270
Plutonium-238	pCi/L	3.51E+00	7.02E+00	Proposed DWS (EPA, 1991)
Plutonium-239	pCi/L	3.11E+01	6.21E+01	Proposed DWS (EPA, 1991)
Plutonium-239/240[a]	pCi/L	3.11E+01	6.21E+01	Proposed DWS (EPA, 1991)
Plutonium-240	pCi/L	3.11E+01	6.22E+01	Proposed DWS (EPA, 1991)
Plutonium-241	pCi/L	3.13E+01	6.26E+01	Proposed DWS (EPA, 1991)
Plutonium-242	pCi/L	3.27E+01	6.54E+01	Proposed DWS (EPA, 1991)
Potassium		No flag	No flag	Set by EPD/EMS

Analyte	Unit	Flag 1	Flag 2	Source
Potassium-40	pCi/L	1.5E+02	3E+02	Proposed DWS (EPA, 1986)
Pronamid	µg/L	50	100	EPA Method 8270
Propionitrile	µg/L	1,000	2,000	EPA Method 8240
Pyrene	µg/L	50	100	EPA Method 8270
Pyridine	µg/L	50	100	EPA Method 8270
Radium-226	pCi/L	7.85E+00	1.57E+01	Proposed DWS (EPA, 1991)
Radium-228	pCi/L	3.93E+00	7.85E+00	Proposed DWS (EPA, 1991)
Radon-222	pCi/L	1.5E+02	3E+02	Proposed DWS (EPA, 1991)
Ruthenium-103	pCi/L	1E+02	2E+02	Final DWS (EPA, 1977)
Ruthenium-106	pCi/L	1.5E+01	3E+01	Final DWS (EPA, 1977)
Safrole	µg/L	50	100	EPA Method 8270
Selenium	µg/L	25	50	Final DWS (CFR, 1991a)
Silica		No flag	No flag	Set by EPD/EMS
Silver	µg/L	25	50	Final DWS (CFR, 1991a)
Sodium		No flag	No flag	Set by EPD/EMS
Sodium-22	pCi/L	2.33E+02	4.66E+02	Proposed DWS (EPA, 1991)
Specific conductance	µS/cm	250	500	Set by EPD/EMS
Strontium-89	pCi/L	1E+01	2E+01	Final DWS (EPA, 1977)
Strontium-89/90[a]	pCi/L	4E+00	8E+00	Final DWS (CFR, 1991a)
Strontium-90	pCi/L	4E+00	8E+00	Final DWS (CFR, 1991a)
Styrene	µg/L	50	100	Final DWS (CFR, 1991a)
Sulfate	µg/L	200,000	400,000	Proposed DWS (EPA, 1990)
Sulfide	µg/L	5,000	10,000	EPA Method 9030
Sulfotepp	µg/L	50	100	EPA Method 8270
Surfactants		No flag	No flag	Set by EPD/EMS
2,3,7,8-TCDD	µg/L	0.00225	0.0045	EPA Method 8280
2,3,7,8-TCDF	µg/L	0.002	0.004	EPA Method 8280
Technetium-99	pCi/L	4.5E+02	9E+02	Final DWS (EPA, 1977)
1,2,4,5-Tetrachlorobenzene	µg/L	50	100	EPA Method 8270
Tetrachlorodibenzo-p-dioxin isomers	µg/L	0.00225	0.0045	EPA Method 8280
Tetrachlorodibenzo-p-furan isomers	µg/L	0.002	0.004	EPA Method 8280
1,1,1,2-Tetrachloroethane	µg/L	5	10	EPA Method 8240
1,1,2,2-Tetrachloroethane	µg/L	5	10	EPA Method 8240
Tetrachloroethylene	µg/L	2.5	5	Final DWS (CFR, 1991a)
2,3,4,6-Tetrachlorophenol	µg/L	50	100	EPA Method 8270
Tetraethyl dithiopyrophosphate	µg/L	50	100	EPA Method 8270
Thallium	µg/L	0.5	1	Proposed DWS (EPA, 1990)
Thionazin	µg/L	50	100	EPA Method 8270
Thorium-228	pCi/L	6.25E+01	1.25E+02	Proposed DWS (EPA, 1991)
Thorium-230	pCi/L	3.96E+01	7.92E+01	Proposed DWS (EPA, 1991)
Thorium-232	pCi/L	4.4E+01	8.8E+01	Proposed DWS (EPA, 1991)
Thorium-234	pCi/L	2E+02	4.01E+02	Proposed DWS (EPA, 1991)
Tin	µg/L	10	20	EPA Method 282.2
Tin-113	pCi/L	1.5E+02	3E+02	Final DWS (EPA, 1977)
Toluene	µg/L	500	1,000	Final DWS (CFR, 1991a)
o-Toluidine	µg/L	50	100	EPA Method 8270
Total carbon	µg/L	5,000	10,000	EPA Method 9060
Total dissolved solids		No flag	No flag	Set by EPD/EMS
Total hydrocarbons	µg/L	5,000	10,000	EPA Method 418.1
Total inorganic carbon	µg/L	5,000	10,000	EPA Method 9060
Total organic carbon	µg/L	5,000	10,000	EPA Method 9060
Total organic halogens	µg/L	25	50	EPA Method 9020
Total organic nitrogen	µg/L	500	1,000	EPA Method 420

Analyte	Unit	Flag 1	Flag 2	Source
Total petroleum hydrocarbons	µg/L	5,000	10,000	EPA Method 418.1
Total phosphates (as P)		No flag	No flag	Set by EPD/EMS
Total phosphorus		No flag	No flag	Set by EPD/EMS
Total radium	pCi/L	2.5E+00	5E+00	Final DWS (CFR, 1991a)
Total silica	µg/L	500	1,000	EPA Method 6010
Total trihalomethanes	µg/L	50	100	Final DWS (CFR, 1991a)
Toxaphene	µg/L	1.5	3	Final DWS (CFR, 1991a)
2,4,5-TP (Silvex)	µg/L	25	50	Final DWS (CFR, 1991a)
Tributyl phosphate	µg/L	50	100	EPA Method 8270
1,2,4-Trichlorobenzene	µg/L	4.5	9	Proposed DWS (EPA, 1990)
1,1,1-Trichloroethane	µg/L	100	200	Final DWS (CFR, 1991a)
1,1,2-Trichloroethane	µg/L	2.5	5	Proposed DWS (EPA, 1990)
Trichloroethylene	µg/L	2.5	5	Final DWS (CFR, 1991a)
Trichlorofluoromethane	µg/L	5	10	EPA Method 8240
2,4,5-Trichlorophenol	µg/L	50	100	EPA Method 8270
2,4,6-Trichlorophenol	µg/L	50	100	EPA Method 8270
2,4,5-Trichlorophenoxyacetic acid	µg/L	2.5	5	EPA Method 8150
1,2,3-Trichloropropane	µg/L	5	10	EPA Method 8240
O,O,O-Triethyl phosphorothioate	µg/L	50	100	EPA Method 8270
1,3,5-Trinitrobenzene	µg/L	50	100	EPA Method 8270
Tritium	pCi/mL	1E+01	2E+01	Final DWS (CFR, 1991a)
Turbidity		No flag	No flag	Set by EPD/EMS
Uranium	µg/L	10	20	Proposed DWS (EPA, 1991)
Uranium alpha activity	pCi/L	1.5E+01	3E+01	Proposed DWS (EPA, 1991)
Uranium-233/234[a]	pCi/L	6.9E-00	1.38E+01	Proposed DWS (EPA, 1991)
Uranium-234	pCi/L	6.95E+00	1.39E+01	Proposed DWS (EPA, 1991)
Uranium-235	pCi/L	7.25E+00	1.45E+01	Proposed DWS (EPA, 1991)
Uranium-238	pCi/L	7.3E+00	1.46E+01	Proposed DWS (EPA, 1991)
Vanadium	µg/L	50	100	EPA Method 6010
Vinyl acetate	µg/L	5	10	EPA Method 8240
Xylenes	µg/L	5,000	10,000	Final DWS (CFR, 1991a)
Zinc	µg/L	2,500	5,000	Secondary DWS (CFR, 1991b)
Zinc-65	pCi/L	1.5E+02	3E+02	Final DWS (EPA, 1977)
Zirconium-95	pCi/L	1E+02	2E+02	Final DWS (EPA, 1977)
Zirconium/Niobium-95[a]	pCi/L	1E+02	2E+02	Final DWS (EPA, 1977)

[a] For double radionuclide analyses where each separate radionuclide has its own standard, the more stringent standard is used.

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Appendix C – Figures

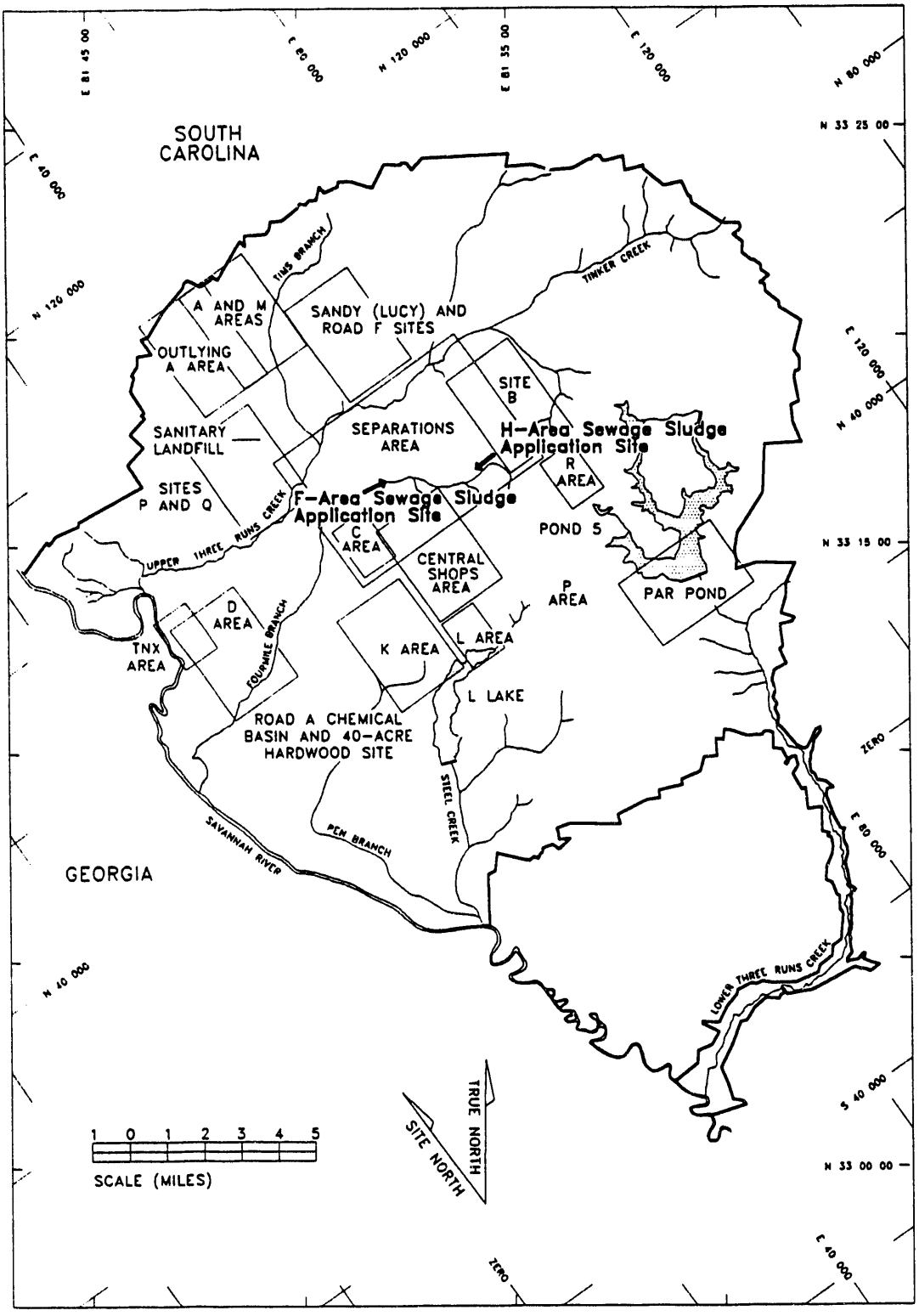

Figure 1. Location of the F- and H-Area Sewage Sludge Application Sites at the Savannah River Site

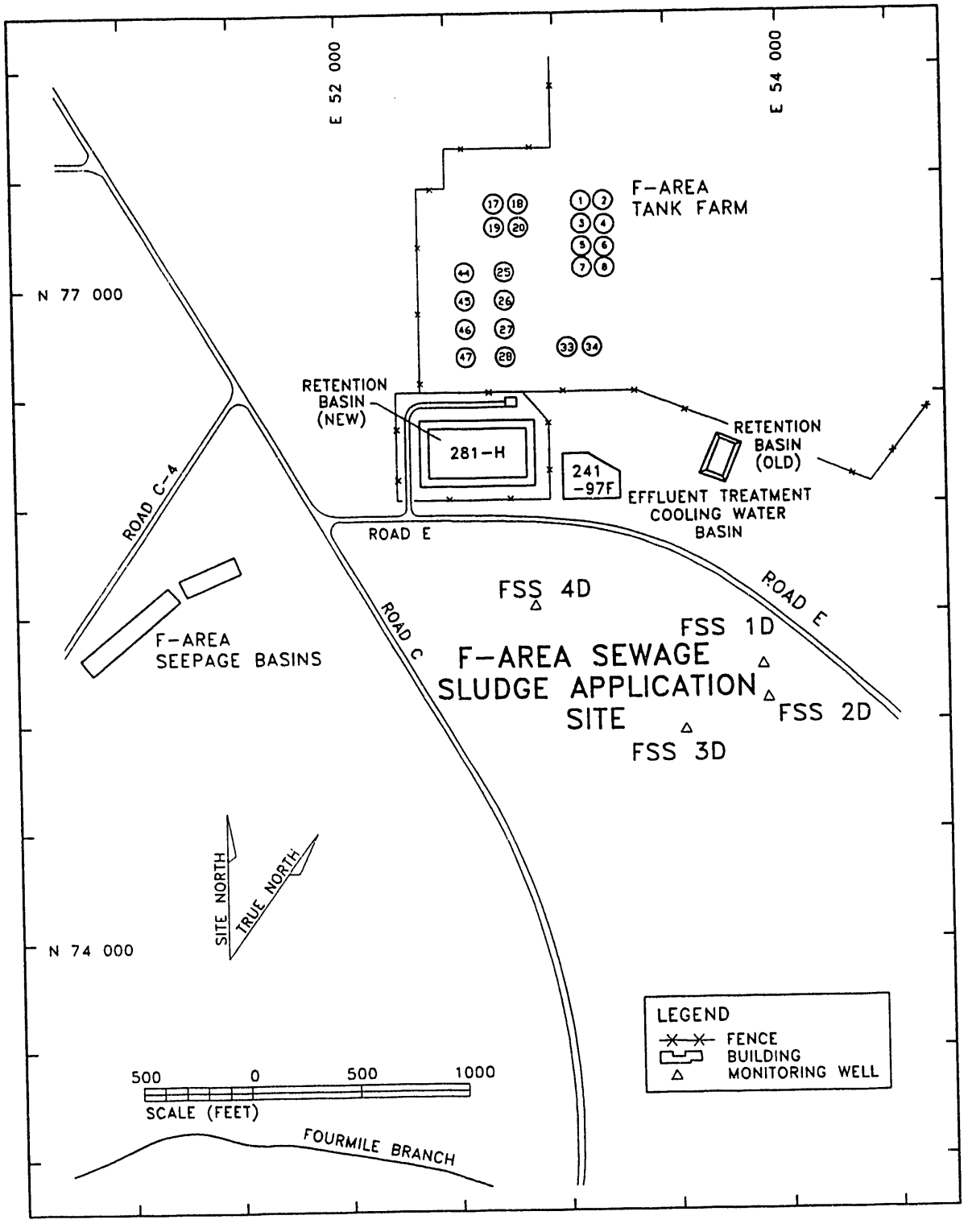

Figure 2. Location of Groundwater Monitoring Wells at the F-Area Sewage Sludge Application Site

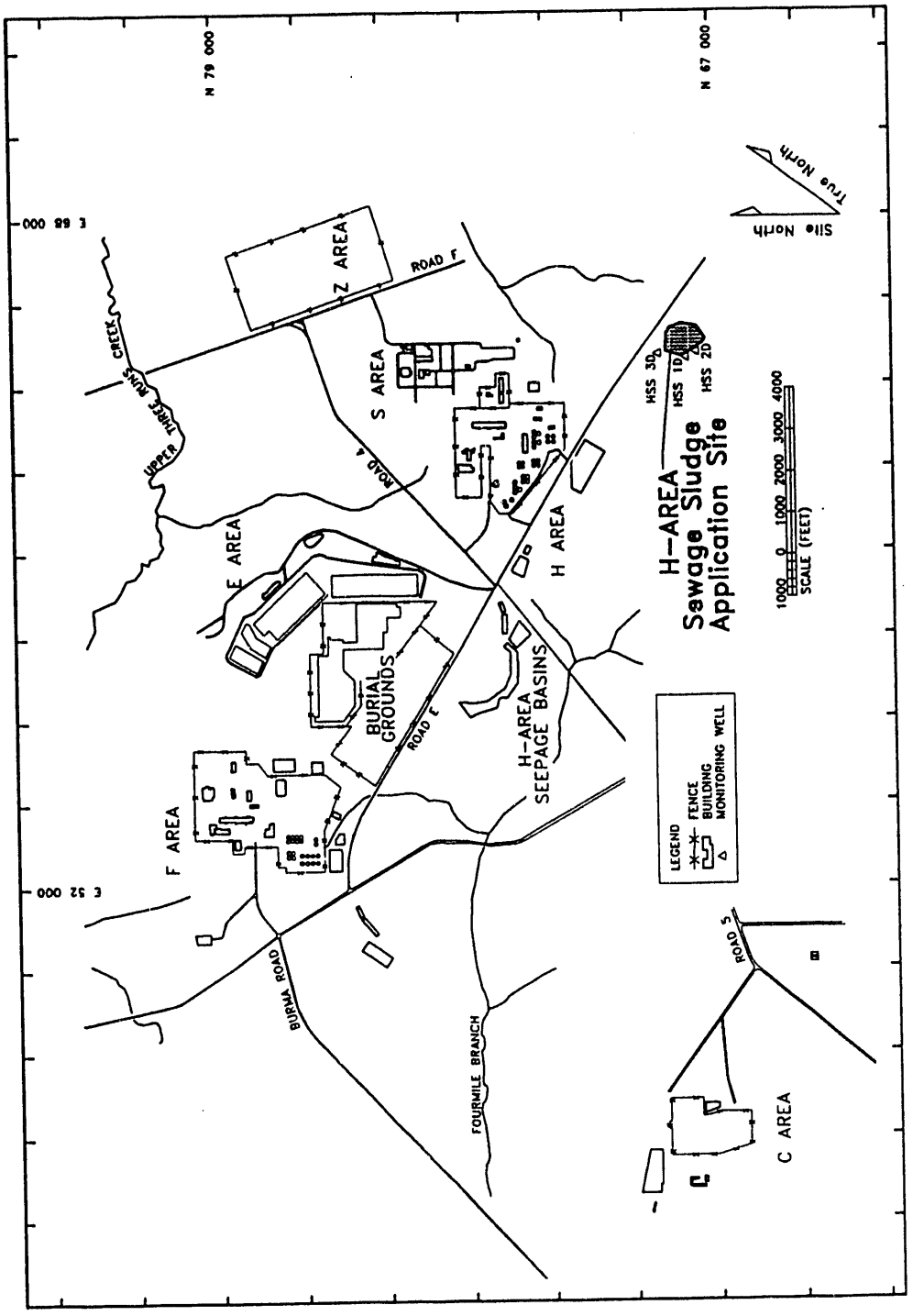

Figure 3. Location of Groundwater Monitoring Wells at the H-Area Sewage Sludge Application Site

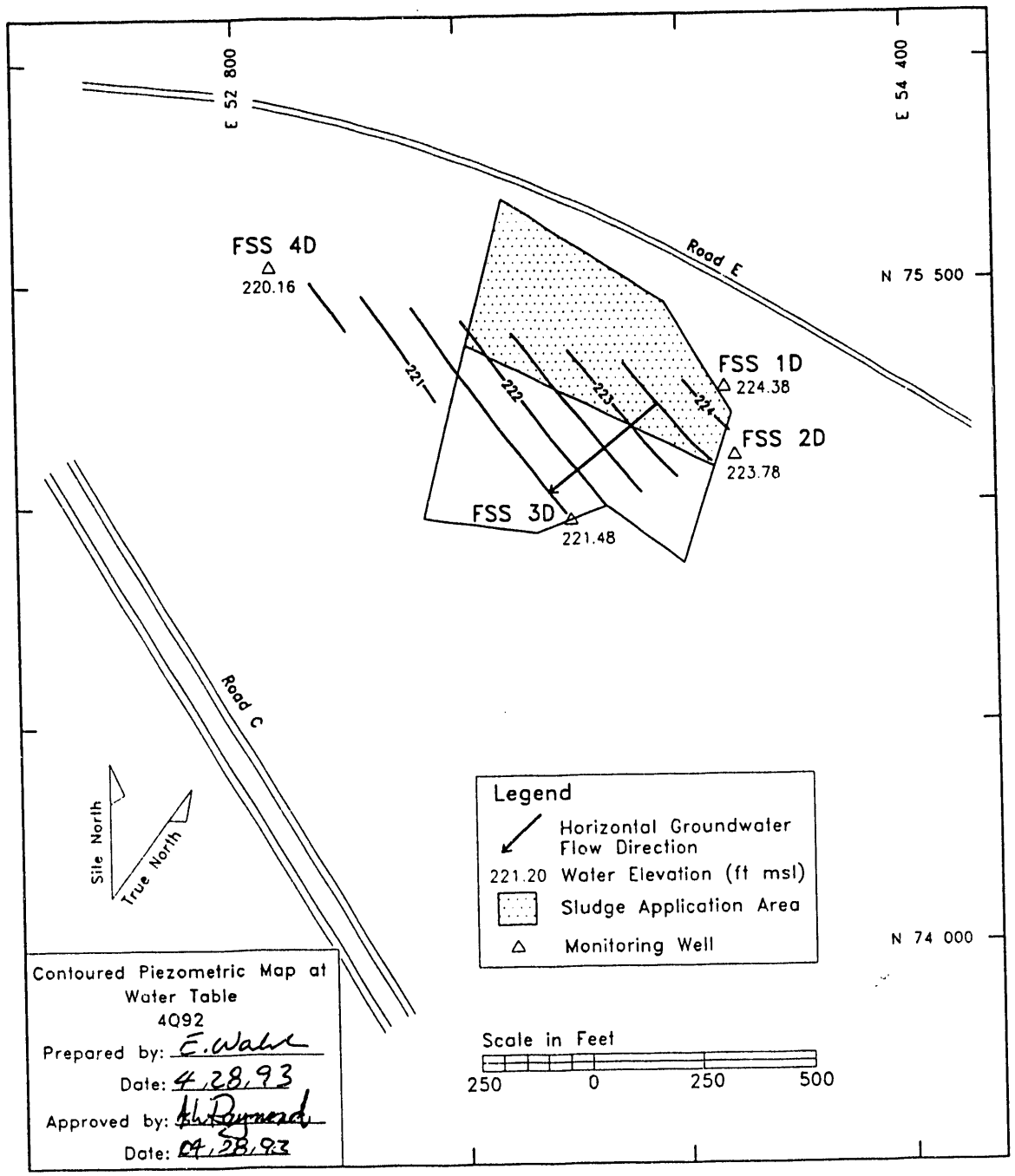

Figure 4. Piezometric Map of the Water Table at the F-Area Sewage Sludge Application Site

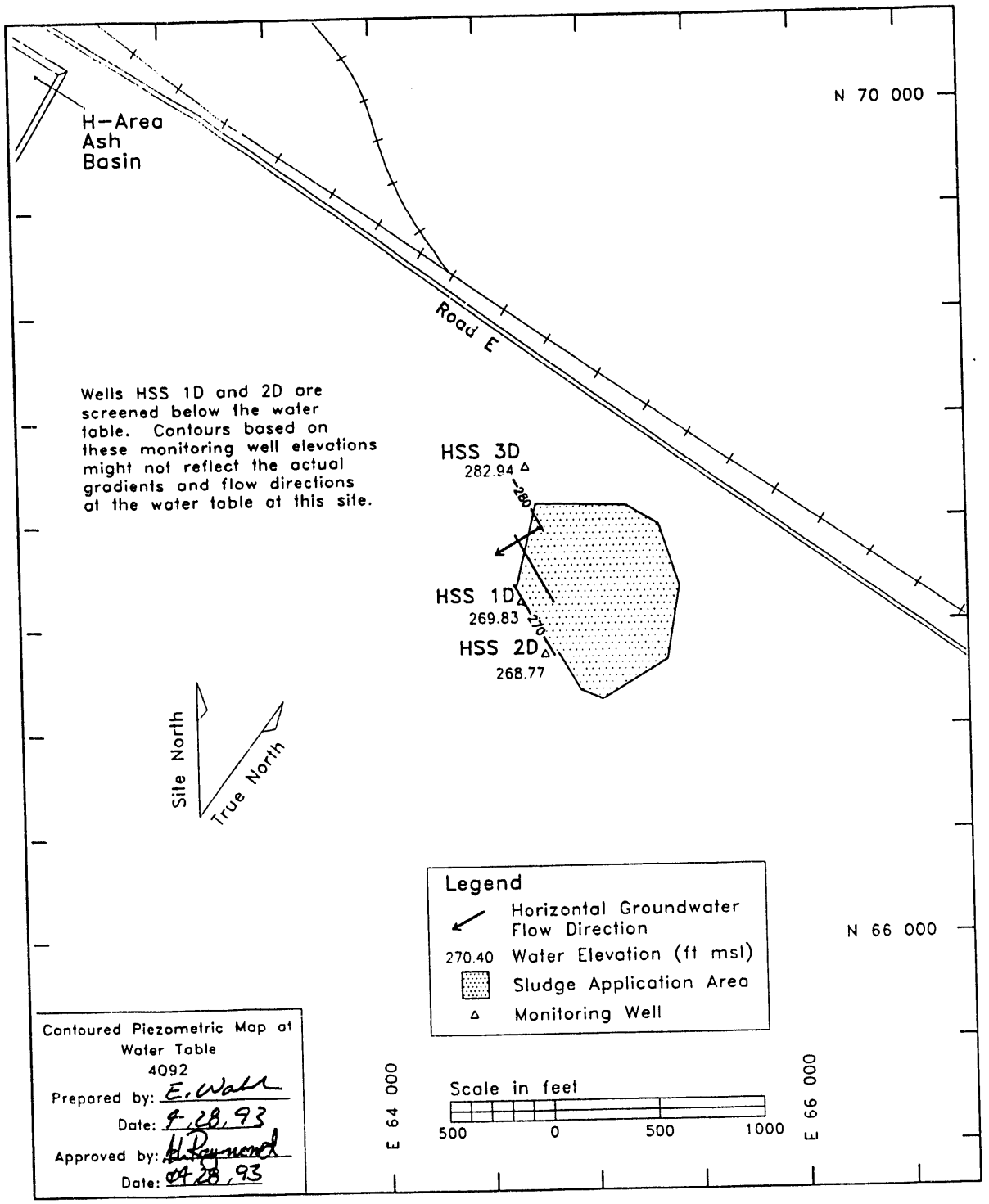

Figure 5. Piezometric Map of the Water Table at the H-Area Sewage Sludge Application Site

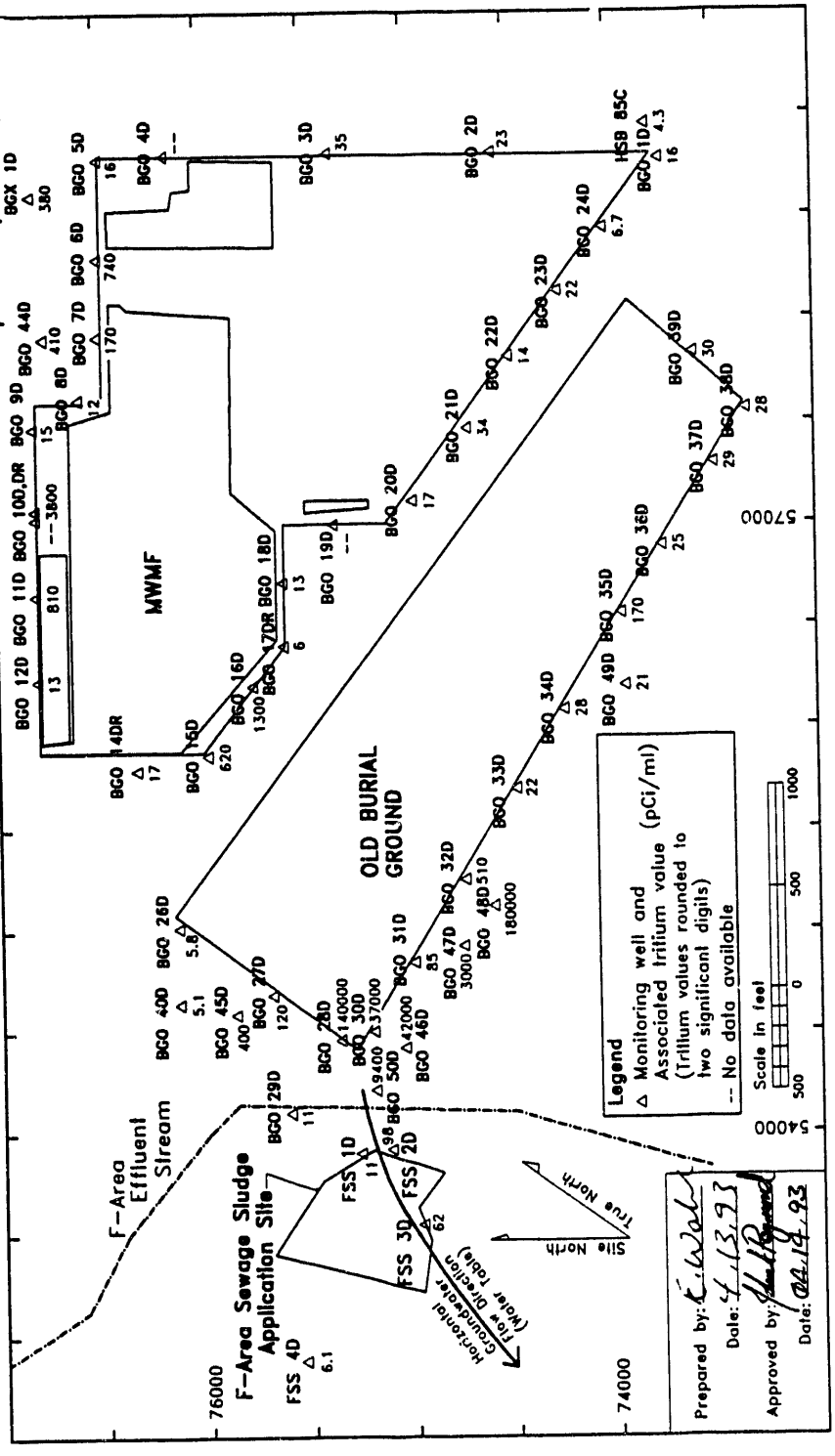

Figure 6. Tritium Activities at the F-Area Sewage Sludge Application Site and the Old Burial Ground

Appendix D – Groundwater Monitoring Results Tables

Key to Reading the Tables

The following abbreviations may appear in the tabular data:

B = sample collected from well using an open bucket bailer
BA = Barringer Laboratories, Inc.
CN = Clemson Technical Center, Inc.
CS = carbon steel
D = primary drinking water standard (PDWS)
E = exponential notation (e.g., 1.1E−09 = 1.1 × 10^{-9} = 0.0000000011)
EM = Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) Laboratory
GE = General Engineering Laboratories
GP = Environmental Physics, Inc.
H = holding time
1,2,3,4,6,7,8-HPCDD = 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin
1,2,3,4,6,7,8-HPCDF = 1,2,3,4,6,7,8-heptachlorodibenzo-p-furan
1,2,3,4,7,8-HXCDD = 1,2,3,4,7,8-hexachlorodibenzo-p-dioxin
1,2,3,4,7,8-HXCDF = 1,2,3,4,7,8-hexachlorodibenzo-p-furan
Lindane = gamma-benzene hexachloride
mg/L = milligrams per liter
Mod = modifier
msl = mean sea level
MSL = million structures per liter
NTU = turbidity unit
P = sample collected from well using a bladder pump
PCB = polychlorinated biphenyl
1,2,3,7,8-PCDD = 1,2,3,7,8-pentachlorodibenzo-p-dioxin
1,2,3,7,8-PCDF = 1,2,3,7,8-pentachlorodibenzo-p-furan
pCi/L = picocuries per liter
pCi/mL = picocuries per milliliter
PDWS = primary drinking water standard
pH = pH unit
PVC = polyvinyl chloride
S = sample collected from well using a single-speed centrifugal downhole pump
Sp. conductance = specific conductance
SP = Spencer Testing Services, Inc.
TCDD = tetrachlorodibenzo-p-dioxin
TCDF = tetrachlorodibenzo-p-furan
TM = TMA/Eberline
TOC = top of casing
V = sample collected from well using a variable-speed pump
WA = Roy F. Weston, Inc.
μg/L = micrograms per liter
μS/cm = microsiemens per centimeter

Holding Times

Standard analytical methods include a limit, called holding time, on the maximum elapsed time between sample collection and extraction or analysis by the laboratory. In the data tables, a large dot (•) in the H (holding time) column indicates that holding time was exceeded. Analyses performed beyond holding time may not yield valid results.

The South Carolina Department of Health and Environmental Control allows only 15 minutes to elapse between sampling and analysis for pH. Thus, only field pH measurements can meet the holding time criterion; laboratory pH analyses will always exceed it.

Laboratory-initiated procedures for reducing the number of other analyses performed out of holding time include subcontracting analyses when difficulties with equipment, personnel, or work load would prevent timely analyses. Beginning fourth quarter 1991, SRS reduced the compensation to laboratories for analyses performed out of holding time.

Data Qualification

The contract laboratories continually assess their own accuracy and precision according to U.S. Environmental Protection Agency (EPA) guidelines. They submit sample- or batch-specific quality assurance/quality control information either at the same time as analytical results or in a quarterly summary. Properly defined and used result modifiers (also referred to as qualifiers) can be a key component in assessing data useability. Result modifiers designed by EPD/EMS and provided to the primary laboratories are defined below. These modifiers appear in the data tables under the column "Mod."

Result modifier	Definition
(Blank)	Data are not qualified. Number should be interpreted exactly as reported.
A[a]	Value reported is the mean of two or more determinations.
J[a]	Value is estimated because quantitation in the sample or in associated quality control samples did not meet specifications.
L[a]	Value is off-scale high. The actual value is not known but is known to be greater than the value shown.
M[a]	Presence of the analyte is verified but not quantified.
R[a]	Result was rejected because performance requirements in the sample analysis or associated quality control analyses were not met.
T[a]	Analyte was not detected; if present, it was below the criteria for detection.
V[a]	Analyte was detected in the associated method blank.
1	Result may be an underestimation of the true value due to analytical bias.
2	Result may be an overestimation of the true value due to analytical bias.

Result modifier	Definition
3	The associated result may be of poor precision (high variability) due to analytical bias.
6	The associated result is from a reanalysis performed out of holding time due to problems with an earlier analysis.

[a] These codes are based on the STORET codes from EPA.

Table 1. Constituents Exceeding the Final Primary Drinking Water Standards at the F-Area Sewage Sludge Application Site

Well	Constituent	Unit	1Q92	2Q92	3Q92	4Q92	Mod
FSS 1D	Lead	µg/L	-[a]	-	-	100	
FSS 2D	Mercury	µg/L	-	-	5.8[b]	-	
	Tritium	pCi/mL	5.7E+01	8.2E+01	1.1E+02	9.8E+01	
FSS 3D	Lead	µg/L	-	-	-	154	
	Tritium	pCi/mL	4.0E+01	5.3E+01	4.9E+01	6.2E+01	

Note: The drinking water standard for lead was changed to the South Carolina Primary Drinking Water Standard of 50 µg/L fourth quarter 1992.

[a] - = result less than final PDWS.
[b] This value is not supported by the result (less than detection limit) of a reanalysis performed at the request of EPD/EMS or by historical results from this well.

Table 2. Constituents Exceeding the Final Primary Drinking Water Standards at the H-Area Sewage Sludge Application Site

Well	Constituent	Unit	1Q92	2Q92	3Q92	4Q92	Mod
N[a]	None	N	N	N	N	N	N

[a] N = not applicable.

Table 3. Constituents Exceeding Half the Final Primary Drinking Water Standards or Other Flag 1 or Flag 2 Criteria at the F-Area Sewage Sludge Application Site

Well	Constituent	Unit	4Q92	Flag	Mod
FSS 1D	Iron	µg/L	5,830	2	V
	Manganese	µg/L	100	2	
	Tritium	pCi/mL	1.1E+01	1	
FSS 2D	Iron	µg/L	10,300	2	V
	Lead	µg/L	41	2	
	Manganese	µg/L	104	2	
FSS 3D	Iron	µg/L	1,300	2	V
	Manganese	µg/L	83	2	
FSS 4D	Iron	µg/L	1,160	2	V

Note: Constituents exceeding half the final PDWS appear *italicized*. These results do not include field data results.

Table 4. Constituents Exceeding Half the Final Primary Drinking Water Standards or Other Flag 1 or Flag 2 Criteria at the H-Area Sewage Sludge Application Site

Well	Constituent	Unit	4Q92	Flag	Mod
N[a]	None	N	N	N	N

[a] N = not applicable.

Table 5. Groundwater Monitoring Results for Individual Wells at the F-Area Sewage Sludge Application Site

WELL FSS 1D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N75257.6 E53897.6	33.280161 °N 81.671063 °W	229.9-209.9 ft msl	266 ft msl	4" PVC	S	Water table

SAMPLE DATE	03/11/92	06/16/92	07/10/92	11/18/92

FIELD DATA

Analyte	1Q92	2Q92	3Q92	4Q92	Unit
Water elevation	224.3	223.9	224.1	224.4	ft msl
pH	5.3	5.6	5.9	6.2	pH
Sp. conductance	63	91	90	88	µS/cm
Water temperature	17.6	21.6	20.1	22.0	°C
Alkalinity as $CaCO_3$	17	31	32	30	mg/L
Volume purged	0.7	0.7	0.8	0.8	Well vol.

ANALYTICAL DATA

H	D	Analyte	1Q92	2Q92	3Q92	4Q92	Mod	Unit	Lab	Flag
		Arsenic	< 2.0	< 2.0	< 2.0	< 2.0		µg/L	WA	0
		Barium	7.6	11	12	25	J3	µg/L	WA	0
		Benzene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Bromodichloromethane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Bromoform	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Bromomethane (Methyl bromide)	< 10	< 10	< 10	< 10		µg/L	WA	0
		Cadmium	< 0.35	1.2	1.1	1.4	V	µg/L	WA	0
		Calcium	18,000	19,600	18,700	15,200		µg/L	WA	0
		Carbon tetrachloride	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Chloride	3,220	2,460	2,640	2,400		µg/L	WA	0
		Chlorobenzene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Chloroethane	< 10	< 10	< 10	< 10		µg/L	WA	0
		Chloroethene (Vinyl chloride)	< 10	< 10	< 10	< 10		µg/L	WA	0
		2-Chloroethyl vinyl ether	< 10	< 10	< 10	< 10		µg/L	WA	0
		Chloroform	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Chloromethane (Methyl chloride)	< 10	< 10	< 10	< 10		µg/L	WA	0
		Chromium	< 1.1	< 1.1	2.2	18		µg/L	WA	0
		Copper	62	64	66	528	V	µg/L	WA	0
		Dibromochloromethane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		1,1-Dichloroethane	< 5.0	< 5.0	< 5.0 *p1926X µg/L				WA	0
			< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0 ♦ ichloroethane
		1 •-Dichloroethylene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		trans-1,2-Dichloroethylene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Dichloromethane (Methylene chloride)	3.8	1.2	9.3	< 5.0		µg/L	WA	0
		2,4-Dichlorophenoxyacetic acid	< 1.1	< 1.1	< 1.0	< 1.1		µg/L	WA	0
		1,2-Dichloropropane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		cis-1,3-Dichloropropene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		trans-1,3-Dichloropropene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Endrin	< 0.11	< 0.11	< 0.11	< 0.11		µg/L	WA	0
		Ethylbenzene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Fluoride	< 100	< 100	< 100	< 100		µg/L	WA	0
		Gross alpha	8.6E + 00	< 3.0E + 00	< 2.0E + 00	< 2.0E + 00		pCi/L	CN	0
		Iron	7.8	33	29	5,830	V	µg/L	WA	2
	■	Lead	10	2.6	2.6	100		µg/L	WA	2
		Lindane	< 0.053	< 0.057	< 0.056	< 0.056		µg/L	WA	0
		Magnesium	514	433	491	462	V	µg/L	WA	0
		Manganese	24	12	10	100		µg/L	WA	2
		Mercury	< 0.20	< 0.20	< 0.20	< 0.20		µg/L	WA	0
		Methoxychlor	< 0.53	< 0.57	< 0.56	< 0.56		µg/L	WA	0
		Nickel	22	< 3.1	5.2	21		µg/L	WA	0
		Nitrate as nitrogen	367	291	532	365		µg/L	WA	0
		Nitrite as nitrogen	13	< 10	< 10	17		µg/L	WA	0
		Nonvolatile beta	7.0E + 00	< 5.0E + 00	< 2.0E + 00	< 2.0E + 00		pCi/L	CN	0

Note: Flagging levels, modifiers, and laboratories are for 4th quarter 1992 data only. See Appendix B for flagging criteria.

● = exceeded holding time for 4th quarter 1992.

■ = exceeded final primary drinking water standard for 4th quarter 1992.

Well FSS 1D continued

ANALYTICAL DATA

H	D	Analyte	1Q92	2Q92	3Q92	4Q92	Mod	Unit	Lab	Flag
•		pH	7.0	7.6	6.2	6.4	J	pH	WA	0
		Phenols	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Potassium	379	518	401	292	V	µg/L	WA	0
		Radium-226	1.5E+00	<1.0E+00	<1.0E+00	<1.0E+00		pCi/L	CN	0
		Radium-228	<6.7E+00		<1.0E+00			pCi/L		
		Selenium	<2.0	<2.0	<2.0	<2.0		µg/L	WA	0
		Silica	7,740	6,880	6,980	8,280		µg/L	WA	0
		Silver	<0.70	<0.70	3.3	1.2	V	µg/L	WA	0
		Sodium	2,900	3,090	3,370	2,380	V	µg/L	WA	0
•		Specific conductance	122	100	87	124	J	µS/cm	WA	0
		Sulfate		1,980	1,320	1,510		µg/L	WA	0
		1,1,2,2-Tetrachloroethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Tetrachloroethylene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Toluene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
•		Total dissolved solids	97,000	57,000	61,000	83,000	J	µg/L	WA	0
		Total organic carbon	<500	<500	718	1,090		µg/L	WA	0
		Total organic halogens	9.4	<20	<5.0	<5.0		µg/L	WA	0
		Total phosphates (as P)	189	122	58	374		µg/L	WA	0
		Toxaphene	<1.1	<1.1	<1.1	<1.1		µg/L	WA	0
		2,4,5-TP (Silvex)	<0.55	<0.56	<0.51	<0.56		µg/L	WA	0
		1,1,1-Trichloroethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		1,1,2-Trichloroethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Trichloroethylene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Trichlorofluoromethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Tritium	9.9E+00	9.4E+00	1.0E+01	1.1E+01		pCi/mL	CN	1

WELL FSS 2D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N75103.5 E53918.9	33.279855 °N 81.670708 °W	224.4-204.4 ft msl	261.6 ft msl	4" PVC	S	Water table

SAMPLE DATE	03/11/92	06/16/92	07/10/92	11/18/92

FIELD DATA

Analyte	1Q92	2Q92	3Q92	4Q92	Unit
Water elevation	223.8	223.3	223.6	223.8	ft msl
pH	6.2	6.0	5.9	5.7	pH
Sp. conductance	175	164	111	74	µS/cm
Water temperature	17.6	20.9	20.5	20.2	°C
Alkalinity as $CaCO_3$	54	48	13	9	mg/L
Volume purged	0.9	1.0	1.0	0.9	Well vol.

ANALYTICAL DATA

H	D	Analyte	1Q92	2Q92	3Q92	4Q92	Mod	Unit	Lab	Flag
		Arsenic	<2.0	<2.0	<2.0	<2.0		µg/L	WA	0
		Barium	77	49	33	79		µg/L	WA	0
		Benzene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Bromodichloromethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Bromoform	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Bromomethane (Methyl bromide)	<10	<10	<10	<10		µg/L	WA	0
		Cadmium	<0.35	1.2	0.65	<0.35	V	µg/L	WA	0
		Calcium	24,500	19,800	10,900	3,550		µg/L	WA	0
		Carbon tetrachloride	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Chloride	4,930	5,170	3,120	6,840		µg/L	WA	0
		Chlorobenzene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Chloroethane	<10	<10	<10	<10		µg/L	WA	0
		Chloroethene (Vinyl chloride)	<10	<10	<10	<10		µg/L	WA	0

Note: Flagging levels, modifiers, and laboratories are for 4th quarter 1992 data only. See Appendix B for flagging criteria.

• = exceeded holding time for 4th quarter 1992.

■ = exceeded final primary drinking water standard for 4th quarter 1992.

Well FSS 2D continued

ANALYTICAL DATA

H	D	Analyte	1Q92	2Q92	3Q92	4Q92	Mod	Unit	Lab	Flag
		2-Chloroethyl vinyl ether	< 10	< 10	< 10	< 10		µg/L	WA	0
		Chloroform	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Chloromethane (Methyl chloride)	< 10	< 10	< 10	< 10		µg/L	WA	0
		Chromium	1.2	< 1.1	4.3	11		µg/L	WA	0
		Copper	< 1.1	< 1.1	< 1.1	17	V	µg/L	WA	0
		Dibromochloromethane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		1,1-Dichloroethane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		1,2-Dichloroethane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		1,1-Dichloroethylene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		trans-1,2-Dichloroethylene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Dichloromethane (Methylene chloride)	< 5.0	< 5.0	2.1	< 5.0		µg/L	WA	0
		2,4-Dichlorophenoxyacetic acid	< 1.1	< 1.1	< 1.1	< 1.1		µg/L	WA	0
		1,2-Dichloropropane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		cis-1,3-Dichloropropene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		trans-1,3-Dichloropropene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Endrin	< 0.11	< 0.11	< 0.11	< 0.11		µg/L	WA	0
		Ethylbenzene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Fluoride	< 100	< 100	< 100	< 100		µg/L	WA	0
		Gross alpha	1.3E + 01	< 3.0E + 00	2.8E + 00	3.5E + 00		pCi/L	CN	0
		Iron	27	15	35	10,300	V	µg/L	WA	2
		Lead	< 2.0	< 2.0	2.8	41		µg/L	WA	2
		Lindane	< 0.057	< 0.055	< 0.055	< 0.055		µg/L	WA	0
		Magnesium	1,090	1,010	933	682	V	µg/L	WA	0
		Manganese	87	69	59	104		µg/L	WA	2
		Mercury	< 0.20	< 0.20	5.8	< 0.20		µg/L	WA	0
		Methoxychlor	< 0.57	< 0.55	< 0.55	< 0.55		µg/L	WA	0
		Nickel	3.6	< 3.1	< 3.1	9.9	J3	µg/L	WA	0
		Nitrate as nitrogen	639	712	704	4,840		µg/L	WA	0
		Nitrite as nitrogen	12	12	< 10	30		µg/L	WA	0
		Nonvolatile beta	9.3E + 00	< 5.0E + 00	2.5E + 00	4.0E + 00		pCi/L	CN	0
•		pH	7.0	6.9	6.1	5.9	J	pH	WA	0
		Phenols	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Potassium	1,160	1,270	871	635	V	µg/L	WA	0
		Radium-226	1.3E + 01	< 1.0E + 00	< 1.0E + 00	< 1.0E + 00		pCi/L	CN	0
		Radium-228	< 7.9E + 00		< 1.0E + 00			pCi/L		
		Selenium	< 2.0	< 2.0	< 2.0	< 2.0		µg/L	WA	0
		Silica	6,590	5,140	5,600	8,030		µg/L	WA	0
		Silver	< 0.70	3.4	< 0.70	< 0.70	V	µg/L	WA	0
		Sodium	7,230	6,390	7,410	5,190	V	µg/L	WA	0
•		Specific conductance	146	134	95	59	J	µS/cm	WA	0
		Sulfate		14,500	15,900	11,200		µg/L	WA	0
		1,1,2,2-Tetrachloroethane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Tetrachloroethylene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Toluene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
•		Total dissolved solids	57,000	80,000	52,000	45,000	J	µg/L	WA	0
		Total organic carbon	< 500	< 500	622	992		µg/L	WA	0
		Total organic halogens	44	13	< 5.0	< 5.0		µg/L	WA	0
		Total phosphates (as P)	235	125	161	541		µg/L	WA	0
		Toxaphene	< 1.1	< 1.1	< 1.1	< 1.1		µg/L	WA	0
		2,4,5-TP (Silvex)	< 0.56	< 0.56	< 0.56	< 0.55		µg/L	WA	0
		1,1,1-Trichloroethane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		1,1,2-Trichloroethane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Trichloroethylene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Trichlorofluoromethane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
	■	Tritium	5.7E + 01	8.2E + 01	1.1E + 02	9.8E + 01		pCi/mL	CN	2

Note: Flagging levels, modifiers, and laboratories are for 4th quarter 1992 data only. See Appendix B for flagging criteria.

• = exceeded holding time for 4th quarter 1992.

■ = exceeded final primary drinking water standard for 4th quarter 1992.

WELL FSS 3D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N74960.5 E53548.0	33.278933 °N 81.671406 °W	225.8-205.8 ft msl	258.2 ft msl	4" PVC	S	Water table

SAMPLE DATE	03/11/92	06/16/92	07/10/92	11/18/92

FIELD DATA

Analyte	1Q92	2Q92	3Q92	4Q92	Unit
Water elevation	221.6	221.1	220.4	221.5	ft msl
pH	4.4	4.7	5.0	5.1	pH
Sp. conductance	55	61	56	46	µS/cm
Water temperature	17.3	21.3	20.6	19.9	°C
Alkalinity as $CaCO_3$	1	1	1	1	mg/L
Volume purged	0.6	0.6	0.6	0.9	Well vol.

ANALYTICAL DATA

H	D	Analyte	1Q92	2Q92	3Q92	4Q92	Mod	Unit	Lab	Flag
		Arsenic	< 2.0	< 2.0	< 2.0	< 2.0		µg/L	WA	0
		Barium	16	20	17	26	J3	µg/L	WA	0
		Benzene	< 5.0	< 5 0	< 5.0	< 5.0		µg/L	WA	0
		Bromodichloromethane	< 5.0	< 5 0	< 5.0	< 5.0		µg/L	WA	0
		Bromoform	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Bromomethane (Methyl bromide)	< 10	< 10	< 10	< 10		µg/L	WA	0
		Cadmium	< 0.35	0 78	1 4	1.2	V	µg/L	WA	0
		Calcium	1,310	1,480	1,540	1,290		µg/L	WA	0
		Carbon tetrachloride	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Chloride	5,800	3,940	3,420	3,160		µg/L	WA	0
		Chlorobenzene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Chloroethane	< 10	< 10	< 10	< 10		µg/L	WA	0
		Chloroethene (Vinyl chloride)	< 10	< 10	< 10	< 10		µg/L	WA	0
		2-Chloroethyl vinyl ether	< 10	< 10	< 10	< 10		µg/L	WA	0
		Chloroform	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Chloromethane (Methyl chloride)	< 10	< 10	< 10	< 10		µg/L	WA	0
		Chromium	1.9	< 1.1	1.7	6.1		µg/L	WA	0
		Copper	6.7	20	24	109	V	µg/L	WA	0
		Dibromochloromethane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		1,1-Dichloroethane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		1,2-Dichloroethane	< 5.0	< 5.0	< 5 0	< 5.0		µg/L	WA	0
		1,1-Dichloroethylene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		trans-1,2-Dichloroethylene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Dichloromethane (Methylene chloride)	< 5 0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		2,4-Dichlorophenoxyacetic acid	< 1 1	< 1.1	< 1 1	< 1.1		µg/L	WA	0
		1,2-Dichloropropane	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		cis-1,3-Dichloropropene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		trans-1,3-Dichloropropene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Endrin	< 0.11	< 0.12	< 0.11	< 0.11		µg/L	WA	0
		Ethylbenzene	< 5.0	< 5.0	< 5.0	< 5.0		µg/L	WA	0
		Fluoride	< 100	< 100	< 100	< 100		µg/L	WA	0
		Gross alpha	4.3E + 00	< 3.0E + 00	4.0E + 00	2.4E + 00		pCi/L	CN	0
		Iron	50	64	1,840	1,300	V	µg/L	WA	2
	■	Lead	26	19	34	154		µg/L	WA	2
		Lindane	< 0.057	< 0.060	< 0.056	< 0.055		µg/L	WA	0
		Magnesium	977	1,130	1,220	1,080	V	µg/L	WA	0
		Manganese	77	76	62	83		µg/L	WA	2
		Mercury	< 0.20	< 0.20	< 0.20	< 0.20		µg/L	WA	0
		Methoxychlor	< 0.57	< 0.60	< 0.56	< 0.55		µg/L	WA	0
		Nickel	3.7	< 3.1	5.0	7.6	J3	µg/L	WA	0
		Nitrate as nitrogen	843	931	763	868		µg/L	WA	0
		Nitrite as nitrogen	12	< 10	< 10	19		µg/L	WA	0

Note: Flagging levels, modifiers, and laboratories are for 4th quarter 1992 data only. See Appendix B for flagging criteria.

● = exceeded holding time for 4th quarter 1992.

■ = exceeded final primary drinking water standard for 4th quarter 1992.

Well FSS 3D continued

ANALYTICAL DATA

H	D	Analyte	1Q92	2Q92	3Q92	4Q92	Mod	Unit	Lab	Flag
		Nonvolatile beta	4.2E+00	<5.0E+00	3.0E+01	2.5E+00		pCi/L	CN	0
•		pH	5.6	5.8	5.4	5.4	J	pH	WA	0
		Phenols	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Potassium	780	1,000	675	780	V	µg/L	WA	0
		Radium-226	2.0E+00	<1.0E+00	<1.0E+00	<1.0E+00		pCi/L	CN	0
		Radium-228	<7.3E+00		<1.0E+00			pCi/L		
		Selenium	<2.0	<2.0	<2.0	<2.0		µg/L	WA	0
		Silica	7,680	7,600	6,610	8,550		µg/L	WA	0
		Silver	<0.70	1.9	0.75	0.78	V	µg/L	WA	0
		Sodium	6,680	6,890	5,990	6,300	V	µg/L	WA	0
•		Specific conductance	53	52	54	53	J	µS/cm	WA	0
		Sulfate		10,500	10,800	11,200		µg/L	WA	0
		1,1,2,2-Tetrachloroethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Tetrachloroethylene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Toluene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
•		Total dissolved solids	33,000	39,000	4,000	43,000	J	µg/L	WA	0
		Total organic carbon	<500	<500	622	1,090		µg/L	WA	0
		Total organic halogens	46	21	38	<5.0		µg/L	WA	0
		Total phosphates (as P)	115	223	101	309		µg/L	WA	0
		Toxaphene	<1.1	<1.2	<1.1	<1.1		µg/L	WA	0
		2,4,5-TP (Silvex)	<0.55	<0.57	<0.56	<0.56		µg/L	WA	0
		1,1,1-Trichloroethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		1,1,2-Trichloroethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Trichloroethylene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Trichlorofluoromethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
	■	Tritium	4.0E+01	5.3E+01	4.9E+01	6.2E+01		pCi/mL	CN	2

WELL FSS 4D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N75537.8 E52876.1	33.279114 °N 81.674297 °W	222.6-202.6 ft msl	291.8 ft msl	4" PVC	S	Water table

SAMPLE DATE	03/11/92	06/16/92	07/10/92	11/18/92

FIELD DATA

Analyte	1Q92	2Q92	3Q92	4Q92	Unit
Water elevation	220.4	220.0	219.8	220.2	ft msl
pH	4.8	4.3	4.7	4.9	pH
Sp. conductance	47	50	47	49	µS/cm
Water temperature	18.4	20.7	21.1	21.8	°C
Alkalinity as $CaCO_3$	0	0	0	0	mg/L
Volume purged	1.0	1.0	1.2	1.0	Well vol.

ANALYTICAL DATA

H	D	Analyte	1Q92	2Q92	3Q92	4Q92	Mod	Unit	Lab	Flag
		Arsenic	<2.0	<2.0	<2.0	<2.0		µg/L	WA	0
		Barium	8.1	8.7	6.8	17	J3	µg/L	WA	0
		Benzene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Bromodichloromethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Bromoform	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Bromomethane (Methyl bromide)	<10	<10	<10	<10		µg/L	WA	0
		Cadmium	<0.35	1.1	0.65	1.2	V	µg/L	WA	0
		Calcium	1,310	1,770	1,110	1,220		µg/L	WA	0
		Carbon tetrachloride	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Chloride	5,150	4,410	4,240	3,830		µg/L	WA	0
		Chlorobenzene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Chloroethane	<10	<10	<10	<10		µg/L	WA	0

Note: Flagging levels, modifiers, and laboratories are for 4th quarter 1992 data only. See Appendix B for flagging criteria.

• = exceeded holding time for 4th quarter 1992.

■ = exceeded final primary drinking water standard for 4th quarter 1992.

Well FSS 4D continued

ANALYTICAL DATA

H	D	Analyte	1Q92	2Q92	3Q92	4Q92	Mod	Unit	Lab	Flag
		Chloroethene (Vinyl chloride)	<10	<10	<10	<10		µg/L	WA	0
		2-Chloroethyl vinyl ether	<10	<10	<10	<10		µg/L	WA	0
		Chloroform	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Chloromethane (Methyl chloride)	<10	<10	<10	<10		µg/L	WA	0
		Chromium	2.3	<1.1	5.9	2.4	J3	µg/L	WA	0
		Copper	14	27	18	7.7	V	µg/L	WA	0
		Dibromochloromethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		1,1-Dichloroethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		1,2-Dichloroethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		1,1-Dichloroethylene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		trans-1,2-Dichloroethylene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Dichloromethane (Methylene chloride)	3.0	3.5	8.1	<5.0		µg/L	WA	0
		2,4-Dichlorophenoxyacetic acid	<1.1	<1.1	<1.0	<1.1		µg/L	WA	0
		1,2-Dichloropropane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		cis-1,3-Dichloropropene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		trans-1,3-Dichloropropene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Endrin	<0.11	<0.11	<0.11	<0.11		µg/L	WA	0
		Ethylbenzene	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Fluoride	<100	<100	<100	<100		µg/L	WA	0
		Gross alpha	2.6E+00	<3.0E+00	<2.0E+00	<2.0E+00		pCi/L	CN	0
		Iron	472	826	114	1,160	V	µg/L	WA	2
		Lead	<2.0	<2.0	<2.0	<2.0		µg/L	WA	0
		Lindane	<0.053	<0.056	<0.056	<0.056		µg/L	WA	0
		Magnesium	758	1,760	686	844	V	µg/L	WA	0
		Manganese	15	13	11	24		µg/L	WA	0
		Mercury	<0.20	<0.20	<0.20	<0.20		µg/L	WA	0
		Methoxychlor	<0.53	<0.56	<0.56	<0.56		µg/L	WA	0
		Nickel	<3.1	<3.1	<3.1	4.7	J3	µg/L	WA	0
		Nitrate as nitrogen	2,330	421	2,340	236		µg/L	WA	0
		Nitrite as nitrogen	11	45	<10	33	J3	µg/L	WA	0
		Nonvolatile beta	3.7E+00	<5.0E+00	<2.0E+00	<2.0E+00		pCi/L	CN	0
•		pH	5.2	5.4	5.1	5.2	J	pH	WA	0
		Phenols	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Potassium	370	546	306	692	V	µg/L	WA	0
		Radium-226	8.7E-01	<1.0E+00	<1.0E+00	<1.0E+00		pCi/L	CN	0
		Radium-228	<9.5E+00		<1.0E+00			pCi/L		
		Selenium	<2.0	<2.0	<2.0	<2.0		µg/L	WA	0
		Silica	9,480	9,260	7,660	11,200		µg/L	WA	0
		Silver	<0.70	<0.70	<0.70	0.75	V	µg/L	WA	0
		Sodium	4,440	4,790	4,170	4,470	V	µg/L	WA	0
•		Specific conductance	37	41	40	48	J	µS/cm	WA	0
		Sulfate		501	1,420	779		µg/L	WA	0
		1,1,2,2-Tetrachloroethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Tetrachloroethylene	<5.0	<5.0	<5(1566X<5.0			µg/L	WA	0
			<5.0	<5.0	<5.0	<.0		µg/L	WA	041XToluene
•		Total dissolved solids	41,000	36,000	20,000	41,000	J	µg/L	WA	0
		Total organic carbon	<500	<500	815	788		µg/L	WA	0
		Total organic halogens	<5.0	<10	29	<5.0		µg/L	WA	0
		Total phosphates (as P)	54	47	64	106		µg/L	WA	0
		Toxaphene	<1.0	<1.1	<1.1	<1.1		µg/L	WA	0
		2,4,5-TP (Silvex)	<0.56	<0.56	<0.51	<0.56		µg/L	WA	0
		1,1,1-Trichloroethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		1,1,2-Trichloroethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Trichloroethylene	1.1	<5.0	1.1	<5.0		µg/L	WA	0
		Trichlorofluoromethane	<5.0	<5.0	<5.0	<5.0		µg/L	WA	0
		Tritium	5.5E+00	6.6E+00	5.1E+00	6.1E+00		pCi/mL	CN	0

Note: Flagging levels, modifiers, and laboratories are for 4th quarter 1992 data only. See Appendix B for flagging criteria.

• = exceeded holding time for 4th quarter 1992.

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Table 6. Groundwater Monitoring Results for Individual Wells at the H-Area Sewage Sludge Application Site

WELL HSS 1D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N67610.3 E64675.6	33.280828 °N 81.627829 °W	256.5-236.5 ft msl	310.1 ft msl	4" PVC	S	Water table

SAMPLE DATE	03/02/92	06/02/92	07/10/92	11/18/92

FIELD DATA

Analyte	1Q92	2Q92	3Q92	4Q92	Unit
Water elevation	269.6	269.0	269.6	269.8	ft msl
pH	5.7	5.3	5.5	5.5	pH
Sp. conductance	44	28	31	27	µS/cm
Water temperature	19.3	19.9	20.3	16.9	°C
Alkalinity as $CaCO_3$	8	2	4	2	mg/L
Volume purged	1.0	0.9	1.0	1.1	Well vol.

ANALYTICAL DATA

H	D	Analyte	1Q92	2Q92	3Q92	4Q92	Mod	Unit	Lab	Flag
		Cadmium	< 0.35					µg/L		
		Calcium	1,860					µg/L		
		Chloride	2,400	2,640	1,930	1,720		µg/L	WA	0
		Copper	89					µg/L		
		Iron	9.1					µg/L		
		Lead	6.4		5.6			µg/L		
		Magnesium	550					µg/L		
		Manganese	4.8					µg/L		
		Nickel	3.1					µg/L		
		Nitrate as nitrogen	1,220	1,250	1,310	1,150		µg/L	WA	0
•		Nitrite as nitrogen	< 10	17	< 10	16	J	µg/L	WA	0
•		pH	5.5	6.0	5.8	6.0	J	pH	WA	0
		Potassium	1,440					µg/L		
		Radium-226	1.3E + 00		< 1.0E + 00			pCi/L		
		Radium-228	< 6.8E + 00		< 1.0E + 00			pCi/L		
		Silicon	5,120					µg/L		
		Sodium	1,680	1,700	1,780	1,920	V	µg/L	WA	0
•		Specific conductance	28	25	26	24	J	µS/cm	WA	0
•		Total dissolved solids	26,000	33,000	37,000	48,000	J	µg/L	WA	0
		Total phosphates (as P)	< 20					µg/L		

Note: Flagging levels, modifiers, and laboratories are for 4th quarter 1992 data only. See Appendix B for flagging criteria.

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WELL HSS 2D

SRS Coord	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N67355.9 E64785.9	33.280445 °N 81.627045 °W	254.5-234.5 ft msl	304.4 ft msl	4" PVC	S	Water table

SAMPLE DATE	02/26/92	06/02/92	07/09/92	11/18/92

FIELD DATA

Analyte	1Q92	2Q92	3Q92	4Q92	Unit
Water elevation	268.9	268.0	268.7	268.8	ft msl
pH	5.0	4.9	5.0	5.2	pH
Sp. conductance	29	26	29	26	µS/cm
Water temperature	18.6	19.1	20.2	18.6	°C
Alkalinity as $CaCO_3$	1	1	1	1	mg/L
Volume purged	4.0	4.0	4.0	4.3	Well vol.

ANALYTICAL DATA

H	D	Analyte	1Q92	2Q92	3Q92	4Q92	Mod	Unit	Lab	Flag
		Cadmium	<0.35					µg/L		
		Calcium	1,290					µg/L		
		Chloride	2,130	2,780	2,770	2,150		µg/L	GE	0
		Copper	1.6					µg/L		
		Iron	3.5					µg/L		
		Lead	<2.0		<2.0			µg/L		
		Magnesium	440					µg/L		
		Manganese	5.4					µg/L		
		Nickel	<3.1					µg/L		
		Nitrate as nitrogen	1,190	1,190	1,120	1,140		µg/L	WA	0
		Nitrate-nitrite as nitrogen				1,140		µg/L	GE	0
•		Nitrite as nitrogen	16	10	<10	31	J	µg/L	WA	0
•		pH	6.7	5.6	5.5	5.8	J	pH	GE	0
		Potassium	1,340					µg/L		
		Radium-226	3.0E-01		<1.0E+00			pCi/L		
		Radium-228	7.0E-01		2.2E+00			pCi/L		
		Silica	23,600					µg/L		
		Silicon	9,380					µg/L		
		Sodium	2,030	1,940	2,020	2,070	V	µg/L	WA	0
		Specific conductance	26	26	28	25		µS/cm	GE	0
		Total alpha-emitting radium	1.5E+00					pCi/L		
•		Total dissolved solids	46,000	42,000	43,000	50,000	J	µg/L	WA	0
		Total phosphates (as P)	26					µg/L		

Note: Flagging levels, modifiers, and laboratories are for 4th quarter 1992 data only. See Appendix B for flagging criteria.

• = exceeded holding time for 4th quarter 1992.

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WELL HSS 3D

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N68257.5 E64709.5	33.282315 °N 81.628996 °W	282.6-262.6 ft msl	309.8 ft msl	4" PVC	S	Water table

SAMPLE DATE	03/02/92	06/02/92	07/10/92	11/18/92

FIELD DATA

Analyte	1Q92	2Q92	3Q92	4Q92	Unit
Water elevation	281.4	281.5	282.1	282.9	ft msl
pH	3.6	4.3	4.4	4.5	pH
Sp. conductance	29	28	29	27	µS/cm
Water temperature	20.1	21.3	21.4	18.2	°C
Alkalinity as $CaCO_3$	0	0	0	0	mg/L
Volume purged	4.0	1.9	1.5	1.6	Well vol.

ANALYTICAL DATA

H	D	Analyte	1Q92	2Q92	3Q92	4Q92	Mod	Unit	Lab	Flag
		Cadmium	<0.35					µg/L		
		Calcium	356					µg/L		
		Chloride	3,610	3,890	3,290	2,930		µg/L	WA	0
		Copper	34					µg/L		
		Iron	37					µg/L		
		Lead	39		21			µg/L		
		Magnesium	282					µg/L		
		Manganese	6.8					µg/L		
		Nickel	<3.1					µg/L		
		Nitrate as nitrogen	1,130	1,120	1,090	956		µg/L	WA	0
•		Nitrite as nitrogen	<10	17	<10	23	J	µg/L	WA	0
•		pH	5.0	5.1	4.9	4.9	J	pH	WA	0
		Potassium	407					µg/L		
		Radium-226	3.0E+00		<1.0E+00			pCi/L		
		Radium-228	<6.0E+00		<1.0E+00			pCi/L		
		Silicon	2,430					µg/L		
		Sodium	2,360	2,710	2,810	2,280	V	µg/L	WA	0
•		Specific conductance	24	24	24	24	J	µS/cm	WA	0
•		Total dissolved solids	9.0E+06	21,000	19,000	23,000	J	µg/L	WA	0
		Total phosphates (as P)	58					µg/L		

Note: Flagging levels, modifiers, and laboratories are for 4th quarter 1992 data only. See Appendix B for flagging criteria.
• = exceeded holding time for 4th quarter 1992.
■ = exceeded final primary drinking water standard for 4th quarter 1992.

Appendix E – Data Quality/Useability Assessment

Data Quality/Useability Assessment

Quality assurance/quality control (QA/QC) procedures relating to accuracy and precision of analyses performed on groundwater samples are followed in the field and laboratory and are reviewed prior to publication of results. The Environmental Protection Department/ Environmental Monitoring Section's (EPD/EMS) review of the volume of analytical data acquired each quarter and presented in various reports is an ongoing process; its review of the QA/QC data cannot be completed in time to meet the deadlines for the reports required by the Resource Conservation and Recovery Act and associated regulations. Other site and regulatory personnel can obtain further information on the data quality and useability in a variety of ways, including those described below.

Data Qualification

The contract laboratories continually assess their own accuracy and precision according to U.S. Environmental Protection Agency (EPA) guidelines. They submit sample- or batch-specific QA/QC information either at the same time as analytical results or in a quarterly summary. Properly defined and used result modifiers (also referred to as qualifiers) can be a key component in assessing data useability. Result modifiers designed by EPD/EMS and provided to the primary laboratories are presented in Appendix D.

Assessment of Accuracy of the Data

Accuracy, or the nearness of the reported result to the true concentration of a constituent in a sample, can be assessed in several ways.

A laboratory's general accuracy can be judged by analysis of results obtained from known samples. The non-radionuclide contract laboratories analyze commercial reference samples every quarter at EPD/EMS' request. The results of these analyses are presented in the EPD/EMS quarterly report, *The Savannah River Site's Groundwater Monitoring Program.* The primary laboratories also seek or maintain state certification by participating periodically in performance studies; reference samples and analysis of results are provided by EPA. Results of these studies also are published in the EPD/EMS quarterly reports.

Analysis of blanks provides a tool for assessing the accuracy of both sampling and laboratory analysis. Results for all field blanks for the quarter can be found in the EPD/EMS quarterly reports. Any field or laboratory blanks that exceeded established minimums are identified in the same reports, in tables associating them with groundwater samples analyzed in the same batches.

Surrogates, organic compounds similar in chemical behavior to the compounds of interest but not normally found in environmental samples, are used to monitor the effect of the matrix on the accuracy of analyses for organic parameters. For example, for analyses of volatile organics by EPA Method 8240, three surrogate compounds are added to all samples

and blanks in each analytical batch. In analyses of semivolatile organics, three to four acid compounds and three to four base/neutral compounds are used. Other surrogates are used in pesticides analyses. Percent recoveries for surrogate analyses are calculated by laboratory personnel, reported to EPD/EMS, reviewed, and entered into the database, but they are not published. If recoveries are not within specified limits, the laboratory is expected to re-run the samples or attach result qualifiers to the data identifying the anomalous results.

Sample-specific accuracy for both organic and inorganic parameters can be assessed by examination of matrix spike/matrix spike duplicate results. A sample is analyzed unspiked to determine a baseline set of values. A second portion of sample is spiked with known concentrations of compounds appropriate to the analyses being performed, typically 5 volatile organic compounds for volatile organics analyses, 11 semivolatile compounds for semivolatiles, 6 pesticide compounds for pesticides, all metals for metals analyses, and a known quantity of cyanide for cyanide analysis. The percentage of the spike compound that is recovered (i.e., measured in excess of the value obtained for the unspiked sample) is a direct measure of analytical accuracy. EPA requires matrix spike/matrix spike duplicates to be run at least once per 20 samples of similar matrix.

Matrix spike/matrix spike duplicate results are reported to EPD/EMS but are not published. For organic compounds, according to EPA guidelines, no action is taken on the basis of matrix spike/matrix spike duplicate data alone (i.e., no result modifiers are assigned solely on the basis of matrix spike results); however, the results can indicate if a lab is having a systematic problem in the analysis of one or more analytes.

In the case of inorganic compounds, such as metals, the matrix spike sample analysis provides information about the effect of each sample matrix on the digestion and measurement methodology. Data qualifiers can be assigned on the basis of the percentage of spike recovery and are reported in the published results tables.

Assessment of Precision

Precision of the analyses, or agreement of a set of replicate results among themselves, is assessed through the use of duplicates (laboratory-initiated) and blind replicates (provided by EPD/EMS). The results of duplicate and replicate analyses are presented in the results tables of the first, second, and third quarter reports as multiple entries for an analyte under a single well heading. The results of replicate analyses are presented in the results tables in first, second, and third quarter reports as two separate sets of results for the same well. Duplicate and replicate results are not presented in fourth quarter reports; the results tables present instead only the highest result for each analyte for each quarter of the year.

The laboratories assess precision by calculating the relative percent difference, or RPD, for each pair of laboratory-initiated duplicate results. During 1992, at least one of the contract laboratories used a data qualifier (J3) to modify metals analyses when the RPD for laboratory duplicates was greater than 20%.

Additional statistical comparisons of laboratory duplicate and blind replicate results, both intra- and interlaboratory, are presented in the EPD/EMS quarterly reports. The calculation used for these reports is the MRD, or mean relative difference, which is similar to EPA's RPD except that the MRD provides a single value for all of the analyses of a particular compound, either inter- or intralaboratory, during one quarter. Because detection limits may vary among samples, the MRD requires calculation of a reference detection limit, which is the detection limit at the 90th percentile of the array of limits in the population of all replicate and duplicate analyses for a given analyte during a particular quarter. The MRD is not method-specific.

Method-Specific Accuracy and Precision

The contract laboratories' EPA-approved laboratory procedures include QA/QC requirements as an integral part of the methods. Thus, knowledge of the method used in obtaining data is an important component of determining data useability. EPA has conducted extensive research and development on the methods approved for the analysis of water and waste water; information on the accuracy and precision of the method is available from EPA publications, as is full information on required QA/QC procedures. A listing of the methods used by the primary laboratories during first quarter 1992 is given below along with the source for the method description. Many, if not all, of these sources include presentations of representative accuracy and precision results.

Method	Used to Analyze	Source
EPA120.1	Specific conductance	EPA EMSL 1983
EPA150.1	pH	EPA EMSL 1983
EPA160.1	Filterable residue (total dissolved solids)	EPA EMSL 1983
EPA160.2	Nonfilterable residue	EPA EMSL 1983
EPA180.1	Turbidity	EPA EMSL 1983
EPA200.7	Trace elements	EPA EMSL 1983
EPA206.2	Arsenic	EPA EMSL 1983
EPA208.2	Barium	EPA EMSL 1983
EPA239.2	Lead	EPA EMSL 1983
EPA245.1	Mercury	EPA EMSL 1983
EPA270.2	Selenium	EPA EMSL 1983
EPA279.2	Thallium	EPA EMSL 1983
EPA300.0	Inorganics, non-metallics	EPA EMSL 1991
EPA310.1	Alkalinity	EPA EMSL 1983
EPA325.2	Chloride	EPA EMSL 1983
EPA335.3	Cyanide	EPA EMSL 1983
EPA340.2	Fluoride	EPA EMSL 1983
EPA353.1	Nitrogen, nitrate-nitrite	EPA EMSL 1983
EPA353.2	Nitrogen, nitrate, nitrite, or combined	EPA EMSL 1983
EPA353.3	Nitrogen, nitrate-nitrite, or nitrite only	EPA EMSL 1983
EPA354.1	Nitrogen, nitrite	EPA EMSL 1983
EPA365.1	Phosphorus, all forms (reported as total phosphates)	EPA EMSL 1983
EPA365.2	Phosphorus, all forms (reported as total phosphates)	EPA EMSL 1983
EPA375.4	Sulfate, turbidimetric	EPA EMSL 1983
EPA376.2	Sulfide	EPA EMSL 1983
APHA403	Alkalinity	APHA 1985
EPA413.1	Oil & grease	EPA EMSL 1983
APHA415A	Iodine	APHA 1985

Method	Used to Analyze	Source
EPA415.1	Total organic carbon	EPA EMSL 1983
EPA418.1	Petroleum hydrocarbons	EPA EMSL 1983
EPA420.1	Phenolics	EPA EMSL 1983
EPA420.2	Phenolics	EPA EMSL 1983
APHA705	Total alpha-emitting radium	APHA 1985
ASTMD3869C	Iodide	ASTM 1992
APHA5320	Dissolved organic halogen	APHA 1989
EPA6010	Metals	EPA 1986
EPA7041	Antimony	EPA 1986
EPA7060	Arsenic	EPA 1986
EPA7421	Lead	EPA 1986
EPA7470	Mercury	EPA 1986
EPA7740	Selenium	EPA 1986
EPA7841	Thallium	EPA 1986
EPA8010	Halogenated volatile organics	EPA 1986
EPA8020	Aromatic volatile organics	EPA 1986
EPA8080	Organochlorine pesticides and PCBs	EPA 1986
EPA8140	Organophosphorus pesticides	EPA 1986
EPA8150	Chlorinated herbicides	EPA 1986
EPA8240	GCMS VOA	EPA 1986
EPA8270	GCMS semivolatiles	EPA 1986
EPA8280	Dioxins and furans	EPA 1986
EPA9012	Total cyanide	EPA 1986
EPA9020	Total organic halides	EPA 1986
EPA9030	Sulfides	EPA 1986

An example of the available method-specific QA/QC information is that for the analysis of metals by EPA Method 6010/200.7 (EPA, 1986/EPA EMSL, 1983). The primary laboratories, General Engineering Laboratories (GE) and Roy F. Weston, Inc. (Weston), use this inductively coupled plasma (ICP) atomic emission spectrometric method.

The following precision and accuracy data are based on the experience of seven laboratories that applied the ICP technique to acid-distilled water matrices that had been dosed with various metal concentrates. (Note: not all seven laboratories analyzed all 14 elements.) The references give results for samples having three concentration ranges; the results here are for samples having the lowest values, similar to actual groundwater results for SRS.

ICP Precision and Accuracy Data

Element	True value (µg/L)	Mean reported value (µg/L)	Mean percent RSD[a]
Beryllium	20	20	9.8
Manganese	15	15	6.7
Vanadium	70	69	2.9
Arsenic	22	19	23
Chromium	10	10	18
Copper	11	11	40
Iron	20	19	15
Aluminum	60	62	33

Element	True value (µg/L)	Mean reported value (µg/L)	Mean percent RSD[a]
Cadmium	2.5	2.9	16
Cobalt	20	20	4.1
Nickel	30	28	11
Lead	24	30	32
Zinc	16	19	45
Selenium	6	8.5	42

Note: In EPA (1986), the column heading is Mean Standard Deviation (%).

[a] Relative standard deviation.

As another example, EPA Method 601/8010 (CFR, 1991/EPA, 1986) is used by both GE and Weston for analyses of halogenated volatile organics. In the presentation of the method in both references, the following table gives method-specific accuracy and precision as functions of concentration. Contract laboratories are expected to achieve or at least approach these limits.

Accuracy and Precision as Functions of Concentration for EPA Method 601/8010

Parameter	Accuracy as recovery, X'[a] (µg/L)	Single analyst precision (µg/L)[b]	Overall precision (µg/L)[c]
Bromodichloromethane	$1.12C - 1.02$[d]	$0.11\bar{X} + 0.04$[e]	$0.20\bar{X} + 1.00$
Bromoform	$0.96C - 2.05$	$0.12\bar{X} + 0.58$	$0.21\bar{X} + 2.41$
Bromomethane	$0.76C - 1.27$	$0.28\bar{X} + 0.27$	$0.36\bar{X} + 0.94$
Carbon tetrachloride	$0.98C - 1.04$	$0.15\bar{X} + 0.38$	$0.20\bar{X} + 0.39$
Chlorobenzene	$1.00C - 1.23$	$0.15\bar{X} - 0.02$	$0.18\bar{X} + 1.21$
Chloroethane	$0.99C - 1.53$	$0.14\bar{X} - 0.13$	$0.17\bar{X} + 0.63$
2-Chloroethyl vinyl ether[f]	$1.00C$	$0.20\bar{X}$	$0.35\bar{X}$
Chloroform	$0.93C - 0.39$	$0.13\bar{X} + 0.15$	$0.19\bar{X} - 0.02$
Chloromethane	$0.77C + 0.18$	$0.28\bar{X} - 0.31$	$0.52\bar{X} + 1.31$
Dibromochloromethane	$0.94C + 2.72$	$0.11\bar{X} + 1.10$	$0.24\bar{X} + 1.68$
1,2-Dichlorobenzene	$0.93C + 1.70$	$0.20\bar{X} + 0.97$	$0.13\bar{X} + 6.13$
1,3-Dichlorobenzene	$0.95C + 0.43$	$0.14\bar{X} + 2.33$	$0.26\bar{X} + 2.34$
1,4-Dichlorobenzene	$0.93C - 0.09$	$0.15\bar{X} + 0.29$	$0.20\bar{X} + 0.41$
1,1-Dichloroethane	$0.95C - 1.08$	$0.09\bar{X} + 0.17$	$0.14\bar{X} + 0.94$
1,2-Dichloroethane	$1.04C - 1.06$	$0.11\bar{X} + 0.70$	$0.15\bar{X} + 0.94$
1,1-Dichloroethene	$0.98C - 0.87$	$0.21\bar{X} - 0.23$	$0.29\bar{X} - 0.40$
trans-1,2-Dichloroethene	$0.97C - 0.16$	$0.11\bar{X} + 1.46$	$0.17\bar{X} + 1.46$
1,2-Dichloropropane[f]	$1.00C$	$0.13\bar{X}$	$0.23\bar{X}$
cis-1,3-Dichloropropene[f]	$1.00C$	$0.18\bar{X}$	$0.32\bar{X}$
trans-1,3-Dichloropropene[f]	$1.00C$	$0.18\bar{X}$	$0.32\bar{X}$
Methylene chloride	$0.91C - 0.93$	$0.11\bar{X} + 0.33$	$0.21\bar{X} + 1.43$
1,1,2,2-Tetrachlorethane	$0.95C + 0.19$	$0.14\bar{X} + 2.41$	$0.23\bar{X} + 2.79$
Tetrachloroethylene	$0.94C + 0.06$	$0.14\bar{X} + 0.38$	$0.18\bar{X} + 2.21$
1,1,1-Trichloroethane	$0.90C - 0.16$	$0.15\bar{X} + 0.04$	$0.20\bar{X} + 0.37$
1,1,2-Trichloroethane	$0.86C + 0.30$	$0.13\bar{X} - 0.14$	$0.19\bar{X} + 0.67$
Trichloroethylene	$0.87C + 0.48$	$0.13\bar{X} - 0.03$	$0.23\bar{X} + 0.30$

Parameter	Accuracy as recovery, X'[a] (µg/L)	Single analyst precision (µg/L)[b]	Overall precision (µg/L)[c]
Trichlorofluoromethane	$0.89C - 0.07$	$0.15\overline{X} + 0.67$	$0.26\overline{X} + 0.91$
Vinyl chloride	$0.97C - 0.36$	$0.13\overline{X} + 0.65$	$0.27\overline{X} + 0.40$

[a] X' = expected recovery for one or more measurements of a sample containing a concentration of C, in µg/L.
[b] Expected single analyst standard deviation of measurements.
[c] Expected interlaboratory standard deviation of measurements.
[d] C = true value for the concentration, in µg/L.
[e] $\overline{X}$ = average recovery found for measurements of samples containing a concentration of C, in µg/L.
[f] Estimates based on performance in a single laboratory.

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