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H-AREA ACID/CAUSTIC BASIN GROUNDWATER MONITORING REPORT (U)

THIRD QUARTER 1994

Publication Date: December 1994

Authorized Derivative Classifier
and Reviewing Official:

UNCLASSIFIED
Does Not Contain Unclassified
Controlled Nuclear Information

Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

Prepared for the U.S. Department of Energy under Control Contract No. DE-AC09-89SR18035

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Abstract

During third quarter 1994, samples collected from the four HAC monitoring wells at the H-Area Acid/Caustic Basin were analyzed for selected heavy metals, herbicides/pesticides, indicator parameters, major ions, radionuclide indicators, and other constituents. Monitoring results that exceeded the final Primary Drinking Water Standards (PDWS) or the Savannah River Site (SRS) flagging criteria or turbidity standard during third quarter are the focus of this report.

Tritium exceeded the final PDWS in all four HAC wells during third quarter 1994. Carbon tetrachloride exceeded the final PDWS in well HAC 4. Aluminum exceeded its Flag 2 criterion in all four HAC wells. Iron was elevated in wells HAC 1, 2, and 3. Manganese exceeded its Flag 2 criterion in well HAC 3, and total organic halogens was elevated in well HAC 2. No well samples exceeded the SRS turbidity standard.

Groundwater flow direction in the water table beneath the H-Area Acid/Caustic Basin was to the northwest during third quarter 1994. This data is consistent with previous quarters, when the flow direction has been to the northwest or the north-northwest.

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Executive Summary

The four monitoring wells at the H-Area Acid/Caustic Basin are sampled quarterly as part of the Savannah River Site (SRS) Groundwater Monitoring Program and to comply with a consent decree signed May 26, 1988, by the U.S. District Court (District of South Carolina, Aiken Division).

During third quarter 1994, groundwater from the HAC wells was analyzed for selected heavy metals, herbicides/pesticides, indicator parameters, major ions, radionuclide indicators, and other constituents. Monitoring results that exceeded the final Primary Drinking Water Standards (PDWS), the SRS flagging criteria, or the SRS turbidity standard are the focus of this report.

During third quarter 1994, tritium exceeded the final PDWS in all four HAC wells, with activities from 3.3E+01 to 6.5E+01 pCi/mL. Carbon tetrachloride exceeded the final PDWS in well HAC 4, with a concentration of 8.5 μg/L. Aluminum exceeded its Flag 2 criterion in all four HAC wells, ranging from 64 to 303 μg/L. Iron exceeded its Flag 2 criterion in wells HAC 1, 2, and 3. Manganese was elevated in well HAC 3. Total organic halogens exceeded its Flag 2 criterion in well HAC 2. No well samples exceeded the SRS turbidity standard.

Groundwater flow direction in the water table beneath the H-Area Acid/Caustic Basin was to the northwest during third quarter 1994. During the last two years, the groundwater flow direction has been consistently to the northwest or the north-northwest. An apparent change in flow direction during second quarter 1994 was attributed to the lack of water elevations for wells HTF 16 and 17 and the anomalous water elevation reported for well HAC 2 during second quarter. During third quarter, flow direction was again consistent with historical trends.

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Introduction

The H-Area Acid/Caustic Basin is southwest of the H-Area Canyon Building and north of the H-Area Tank Farm at the Savannah River Site (SRS) (Figure 1, Appendix C). The following description outlines important events at the H-Area Acid/Caustic Basin.

- The basin, constructed in the early 1950s, is an unlined earthen pit that received dilute sulfuric acid and sodium hydroxide solutions and other wastes from several areas within SRS. The basin provided an area for the mixing and neutralization of the dilute solutions before their discharge into nearby streams (Heffner and Exploration Resources, 1991).

- Disposal of acid/caustic solutions to the H-Area Acid/Caustic Basin was discontinued in 1982; however, the basin received steam condensate from a hose box and drainage from a chemical pad until 1985 (Heffner and Exploration Resources, 1991).

- Under the terms of a consent decree signed May 26, 1988, by the U.S. District Court (Civil Action 1:85-2583-6, District of South Carolina, Aiken Division), the basin became subject to requirements of Subtitle C of the Resource Conservation and Recovery Act (RCRA), the South Carolina Hazardous Waste Management Regulations (SCHWMR), and associated regulations on June 1, 1988.

- In the summer of 1988, a network of monitoring wells was proposed for the basin to ensure compliance with SCHWMR; in August 1988, four monitoring wells, HAC 1, 2, 3, and 4, were installed at the H-Area Acid/Caustic Basin (EPD/EMS, 1994) (Figure 2, Appendix C).

- The revised Groundwater Quality Assessment Plan (WSRC, 1991), submitted to the South Carolina Department of Health and Environmental Control (SCDHEC) on April 30, 1991, indicated that the monitoring well network at the H-Area Acid/Caustic Basin is sufficient to detect any degradation of the groundwater due to past operations at the basin.

- During July through September 1993, with SCDHEC's permission to proceed at risk, SRS stabilized the H- and P-Area Acid/Caustic Basins as proposed in the Interim Status Closure Plan for the F-, H-, K-, and P-Area Acid/Caustic Basins (Revision 3, February 5, 1992). The basins were dewatered and filled with compacted clay-rich soil, and a vegetative cover of winter- and drought-hardy grass was established.

Each quarter, the Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) samples the monitoring wells at the H-Area Acid/Caustic Basin as part of the SRS Groundwater Monitoring Program. The Environmental Restoration Department provides a quarterly report describing the monitoring results to SCDHEC in compliance with SCHWMR.

Discussion

Groundwater Monitoring Data

The groundwater sampling procedure (EPD/EMS, 1992) 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 the groundwater quality.

During third quarter 1994, samples from the four monitoring wells at the H-Area Acid/Caustic Basin were analyzed for selected heavy metals, herbicides/pesticides, indicator parameters, major ions, radionuclide indicators, and other constituents. This report describes monitoring results that exceeded the Safe Drinking Water Act final Primary Drinking Water Standards (PDWS) or screening levels set by the U.S. Environmental Protection Agency (EPA) (Appendix A); the South Carolina final PDWS for lead (Appendix A); other SRS Flag 2 criteria based on final and proposed PDWS, Secondary Drinking Water Standards, and method detection limits (Appendix B); or the SRS turbidity standard. Constituent levels that equal or exceed the final PDWS, screening levels, or Flag 2 criteria are described as *exceeding* standards, *above* standards, or as *elevated*.

The final PDWS for individual analytes provided in Appendix A may not always match the SRS flagging criteria provided in Appendix B. The final PDWS are used as guidelines in this compliance report to meet regulatory requirements; the flagging criteria are used by the Environmental Protection Department/Environmental Monitoring Section to identify relative levels of constituents in the groundwater and as guides for scheduling groundwater sampling.

Analytical Results Exceeding Standards

Results for analytes that exceeded the final PDWS (see Appendix A) during third quarter 1994 are summarized in Table 1 (Appendix D). All four HAC wells contained tritium activities that exceeded the final PDWS, with activities ranging from 3.3E+01 to 6.5E+01 pCi/mL. Carbon tetrachloride exceeded the final PDWS in well HAC 4, with a concentration of 8.5 μg/L.

Constituents that exceeded other Flag 2 criteria (see Appendix B) during third quarter 1994 are summarized in Table 2 (Appendix D). Aluminum, which was added to the analytes included in comprehensive analyses beginning first quarter 1993, exceeded its Flag 2 criterion in all four HAC wells, with a maximum concentration of 303 μg/L in well HAC 3. Iron exceeded its Flag 2 criterion in wells HAC 1, 2, and 3, with a maximum concentration of 1,280 μg/L in HAC 2. Manganese exceeded its Flag 2 criterion in well HAC 3, with a concentration of 61 μg/L. Total organic halogens also exceeded its Flag 2 criterion in well HAC 2, with a concentration of 110 μg/L.

Table 3 (Appendix D) presents all of the results for individual wells and indicates the analytical laboratories that conducted the analyses, the dilution factors used in the analyses, and the analyses that received modifiers (which help identify laboratory accuracy and precision) or that exceeded the EPA-approved holding times during third quarter 1994. Constituent results in Table 3 that appear to equal the final PDWS but are not marked in the *ST* column (exceeded final PDWS or screening level) are below the final PDWS in the database. Database results, the results that are compared to the final PDWS, are entered with more significant digits than the results given in this report. Apparent discrepancies are the result of the rounding of reported results.

Table 3 also lists the number of well volumes purged from each well during third quarter 1994 at the H-Area Acid/Caustic Basin. Wells HAC 2 and 3 went dry during purging; thus, they may not have produced representative groundwater samples.

Appendix D provides definitions of the abbreviations and the modifiers used in the results tables as well as descriptions of holding times, data rounding, and data qualification practices.

Appendix E provides a general assessment of the quality and usability of the data provided by EPD/EMS.

Turbidity Results Exceeding Standards

The value of 5 nephelometric turbidity units (NTU), established by EPA (1986) as a general standard for acceptability of groundwater samples, is considered unrealistic for monitoring wells at SRS. Gass (1989) has documented turbidity measurements ranging up to 5,000 NTU from properly designed wells screened in poorly productive formations, such as those screened in the water table. During the 1989 RCRA Compliance Evaluation Inspection, officials from EPA Region IV indicated that the SRS turbidity standard of 50 NTU is conservative. These officials also agreed that water-table wells in this area often screen nonaquifer formations, rendering development of these wells more difficult due to the low yield and high proportion of mobile fines typical of these formations (Bergren and Bennett, 1989).

During third quarter 1994, none of the samples exceeded the SRS turbidity standard of 50 NTU (Table 3, Appendix D).

Water Elevations, Flow Directions, and Flow Rates

Water-table elevations and the groundwater flow direction beneath the H-Area Acid/Caustic Basin are shown in Figure 3 (Appendix C). The horizontal gradient at the H-Area Acid/Caustic Basin is very low. Water elevations from nine nearby wells of the HTF series were included in determining water-elevation contours to supply more complete information on groundwater movement beneath the H-Area Acid/Caustic Basin and facilitate the determination of local flow direction. The northwest groundwater flow direction (using universal transverse Mercator coordinates) was determined from this quarter's water-level elevations for wells HAC 1, 2, 3, and 4 and adjacent wells HTF 13, 14, 15, 16, 17, 18, 19, 20, and 21. The flow direction for the last two years has been consistently northwest or north-northwest.

The groundwater flow rate in the water table (Aquifer Zone IIB_2) beneath the H-Area Acid/Caustic Basin is estimated using the following equation:

$$\text{Flow (ft/day)} = \frac{\text{Hydraulic Conductivity (ft/day)}}{\text{Porosity (unitless)}} \times \frac{dh \text{ (ft)}}{dl \text{ (ft)}}$$

A hydraulic conductivity constant of 10 ft/day (Geraghty & Miller, 1990) is used as a conservative estimate (i.e., the actual hydraulic conductivity should be somewhat less than 10 ft/day). The effective porosity value is estimated at 20 percent (Killian et al., 1987); *dh* is the difference in head, and *dl* is the length of the flow path to the nearest 10 ft. Flow rate estimates vary depending on the hydraulic gradient between wells, the size of the area under consideration, and the number of data points. For this reason, the estimation of flow rate should be considered accurate to an order of magnitude only.

Flow rate per day is calculated to two significant figures using the above equation. This value is then multiplied by 365 and rounded to two significant figures for the flow rate per year.

Using the above equation, with *dh* = 4 ft and *dl* = 370 ft, the flow rate estimate for groundwater in the water table beneath the H-Area Acid/Caustic Basin (see Figure 3, Appendix C) is as follows:

$$\frac{10}{0.20} \times \frac{4}{370} = 0.54 \text{ ft/day}$$

$$0.54 \text{ ft/day} \times 365 \text{ days} \approx 200 \text{ ft/year}$$

Results for Upgradient vs. Downgradient Wells

Well HAC 4 is the upgradient well, and wells HAC 1, 2, and 3 are the downgradient wells at the H-Area Acid/Caustic Basin.

During third quarter 1994, aluminum, carbon tetrachloride, and tritium were elevated in the upgradient well.

Tritium also exceeded the final PDWS in all three downgradient wells, with activity in well HAC 1 approximately twice that detected in the other HAC wells. Aluminum exceeded its Flag 2 criterion in all three downgradient wells. Iron, not detected above standards in the upgradient well, exceeded the Flag 2 criterion in all downgradient wells. Manganese was elevated in downgradient well HAC 3, and total organic halogens was elevated in downgradient well HAC 2.

Conclusions

Tritium activities exceeded the final PDWS during third quarter 1994 in all four HAC wells, with activities from 3.3E+01 to 6.5E+01 pCi/mL. Because historical records indicate that no radionuclides were disposed of at this waste management unit (Heffner and Exploration Resources, 1991), elevated levels of tritium in the HAC wells are not considered a result of seepage from the acid/caustic basin. Other facilities within H Area, including the high-level-waste tank farm adjacent to the H-Area Acid/Caustic Basin, are possible sources of the tritium.

Carbon tetrachloride exceeded the final PDWS in well HAC 4, with a concentration of 8.5 μg/L. Because well HAC 4 is upgradient of the H-Area Acid/Caustic Basin, the source of the carbon tetrachloride is not the basin. Heptachlor epoxide, which exceeded final PDWS in well HAC 4 during first quarter 1994, was not analyzed in the HAC wells during third quarter.

Aluminum exceeded the Flag 2 criterion in all four HAC wells. Iron exceeded the Flag 2 criterion in all downgradient wells, and manganese exceeded the Flag 2 criterion in downgradient well HAC 3. Total organic halogens exceeded the Flag 2 criterion in downgradient well HAC 2. Generally, elevated levels of constituents found in downgradient wells but not in upgradient wells at a waste management unit are considered products of the waste management unit.

No well samples exceeded the 50 NTU SRS turbidity standard.

Third quarter 1994 water-table elevations at the H-Area Acid/Caustic Basin indicate that groundwater flow was toward the northwest at a rate of approximately 200 ft/year. The flow direction has been consistently northwest or north-northwest for the last two years. Lack of water elevations from wells HTF 16 and 17 and an anomalous water elevation from well HAC 2 contributed to an apparent change in flow direction to the west during second quarter 1994. Third quarter groundwater flow direction and rate were again consistent with historical trends.

The revised Groundwater Quality Assessment Plan (WSRC, 1991) for the unit provides evidence that wells HAC 1, 2, and 3 are consistently downgradient of well HAC 4 and that the monitoring well network is sufficient to detect degradation of the groundwater due to past operations at the basin.

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Errata

In tables with four quarters of data, some values for earlier quarters may differ from values for those same quarters presented in earlier reports because some reanalyses may have been performed by the laboratories after the reports were printed.

Third Quarter 1993 through Fourth Quarter 1993:

- No errata have been reported.

First Quarter 1994:

- Page 4, Groundwater Monitoring Data: The copper standard is the final PDWS established by EPA.

Second Quarter 1994:

- No errata have been reported.

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Appendix A

Final Primary Drinking Water Standards

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Final Primary Drinking Water Standards

Analyte	Unit	Level	Status	Source
Alachlor	µg/L	2	Final	EPA, 1993
Aldicarb[a]	µg/L	3	Final	EPA, 1993
Aldicarb sulfone[a]	µg/L	2	Final	EPA, 1993
Aldicarb sulfoxide[a]	µg/L	4	Final	EPA, 1993
Antimony	µg/L	6	Final	EPA, 1993
Arsenic	µg/L	50	Final	EPA, 1993
Asbestos	Fibers/L	7,000,000	Final	EPA, 1993
Atrazine	µg/L	3	Final	EPA, 1993
Barium	µg/L	2,000	Final	EPA, 1993
Benzene	µg/L	5	Final	EPA, 1993
Benzo[a]pyrene	µg/L	0.2	Final	EPA, 1993
Beryllium	µg/L	4	Final	EPA, 1993
Bis(2-ethylhexyl) phthalate	µg/L	6	Final	EPA, 1993
Bromodichloromethane	µg/L	100	Final	EPA, 1993
Bromoform	µg/L	100	Final	EPA, 1993
2-sec-Butyl-4,6-dinitrophenol	µg/L	7	Final	EPA, 1993
Cadmium	µg/L	5	Final	EPA, 1993
Carbofuran	µg/L	40	Final	EPA, 1993
Carbon tetrachloride	µg/L	5	Final	EPA, 1993
Chlordane	µg/L	2	Final	EPA, 1993
Chlorobenzene	µg/L	100	Final	EPA, 1993
Chloroethene (Vinyl chloride)	µg/L	2	Final	EPA, 1993
Chloroform	µg/L	100	Final	EPA, 1993
Chromium	µg/L	100	Final	EPA, 1993
Copper	µg/L	1,300	Final	EPA, 1993
Cyanide	µg/L	200	Final	EPA, 1993
Dalapon[a]	µg/L	200	Final	EPA, 1993
Dibromochloromethane	µg/L	100	Final	EPA, 1993
1,2-Dibromo-3-chloropropane	µg/L	0.2	Final	EPA, 1993
1,2-Dibromoethane	µg/L	0.05	Final	EPA, 1993
1,2-Dichlorobenzene	µg/L	600	Final	EPA, 1993
1,4-Dichlorobenzene	µg/L	75	Final	EPA, 1993
1,2-Dichloroethane	µg/L	5	Final	EPA, 1993
1,1-Dichloroethylene	µg/L	7	Final	EPA, 1993
1,2-Dichloroethylene	µg/L	50	Final	EPA, 1993
cis-1,2-Dichloroethylene	µg/L	70	Final	EPA, 1993
trans-1,2-Dichloroethylene	µg/L	100	Final	EPA, 1993
Dichloromethane (Methylene chloride)	µg/L	5	Final	EPA, 1993
2,4-Dichlorophenoxyacetic acid	µg/L	70	Final	EPA, 1993
1,2-Dichloropropane	µg/L	5	Final	EPA, 1993
Di(2-ethylhexyl) adipate[a]	µg/L	400	Final	EPA, 1993
Diquat dibromide[a]	µg/L	20	Final	EPA, 1993
Endothall[a]	µg/L	100	Final	EPA, 1993
Endrin	µg/L	2	Final	EPA, 1993
Ethylbenzene	µg/L	700	Final	EPA, 1993
Fluoride	µg/L	4,000	Final	EPA, 1993
Glyphosate[a]	µg/L	700	Final	EPA, 1993
Gross alpha[b]	pCi/L	1.5E+01	Final	EPA, 1993
Heptachlor	µg/L	0.4	Final	EPA, 1993
Heptachlor epoxide	µg/L	0.2	Final	EPA, 1993
Hexachlorobenzene	µg/L	1	Final	EPA, 1993
Hexachlorocyclopentadiene	µg/L	50	Final	EPA, 1993
Lead	µg/L	50	Final	SCDHEC, 1981

Analyte	Unit	Level	Status	Source
Lindane	µg/L	0.2	Final	EPA, 1993
Mercury	µg/L	2	Final	EPA, 1993
Methoxychlor	µg/L	40	Final	EPA, 1993
Nickel	µg/L	100	Final	EPA, 1993
Nitrate as nitrogen	µg/L	10,000	Final	EPA, 1993
Nitrate-nitrite as nitrogen	µg/L	10,000	Final	EPA, 1993
Nitrite as nitrogen	µg/L	1,000	Final	EPA, 1993
Nonvolatile beta	pCi/L	5E+01	Interim Final	EPA, 1977
Oxamyl[a]	µg/L	200	Final	EPA, 1993
PCB 1016	µg/L	0.5	Final	EPA, 1993
PCB 1221	µg/L	0.5	Final	EPA, 1993
PCB 1232	µg/L	0.5	Final	EPA, 1993
PCB 1242	µg/L	0.5	Final	EPA, 1993
PCB 1248	µg/L	0.5	Final	EPA, 1993
PCB 1254	µg/L	0.5	Final	EPA, 1993
PCB 1260	µg/L	0.5	Final	EPA, 1993
PCB 1262	µg/L	0.5	Final	EPA, 1993
Pentachlorophenol	µg/L	1	Final	EPA, 1993
Picloram[a]	µg/L	500	Final	EPA, 1993
Selenium	µg/L	50	Final	EPA, 1993
Simazine[a]	µg/L	4	Final	EPA, 1993
Strontium-89/90[c]	pCi/L	8E+00	Final	EPA, 1993
Strontium-90	pCi/L	8E+00	Final	EPA, 1993
Styrene	µg/L	100	Final	EPA, 1993
2,3,7,8-TCDD	µg/L	0.00003	Final	EPA, 1993
Tetrachloroethylene	µg/L	5	Final	EPA, 1993
Thallium	µg/L	2	Final	EPA, 1993
Toluene	µg/L	1,000	Final	EPA, 1993
Toxaphene	µg/L	3	Final	EPA, 1993
2,4,5-TP (Silvex)	µg/L	50	Final	EPA, 1993
1,2,4-Trichlorobenzene	µg/L	70	Final	EPA, 1993
1,1,1-Trichloroethane	µg/L	200	Final	EPA, 1993
1,1,2-Trichloroethane	µg/L	5	Final	EPA, 1993
Trichloroethylene	µg/L	5	Final	EPA, 1993
Tritium	pCi/mL	2E+01	Final	EPA, 1993
Xylenes	µg/L	10,000	Final	EPA, 1993

Note: Final PDWS were assigned to alachlor, aldicarb, aldicarb sulfone, aldicarb sulfoxide, atrazine, carbofuran, dalapon, di(2-ethylhexyl) adipate, diquat dibromide, endothall, glyphosate, oxamyl, picloram, and simazine in the SRS Groundwater Monitoring Program for the first time beginning first quarter 1994.

[a] At present, EMS does not perform this analysis because the constituent is not in the current contract.
[b] The standard given is for gross alpha including radium-226 but excluding radon and uranium.
[c] For double radionuclide analyses where each separate radionuclide has its own standard, the more stringent standard is used.

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Appendix B

Flagging Criteria

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Flagging Criteria

The Savannah River Site Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) flagging criteria are as follows:

- Flag 2 criteria for constituents equal the Safe Drinking Water Act (SDWA) final Primary Drinking Water Standards (PDWS), the SDWA proposed PDWS, or the SDWA Secondary Drinking Water Standards (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 a 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 exceptions to the flagging rules:

- EPD/EMS sets flagging criteria for pH and specific conductance. No flags are set for alkalinity, calcium, carbonate, magnesium, potassium, silica, sodium, total dissolved solids, total phosphates (as P), and total phosphorus. Analyses for these parameters are conducted as part of the biennial comprehensive analyses or by special request.

- Aesthetic parameters such as color, corrosivity, Eh, odor, surfactants, and turbidity are not assigned flagging criteria but are analyzed by special request.

- Common laboratory contaminants and cleaners such as dichloromethane (methylene chloride), ketones, phthalates, and toluene are not assigned flagging criteria unless they have primary drinking water standards. These constituents are analyzed by special request.

Analyte	Unit	Flag 1	Flag 2	Source[a]
Acenaphthene	µg/L	50	100	EPA Method 8270
Acenaphthylene	µg/L	50	100	EPA Method 8270
Acetone	µg/L	500	1,000	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
Actinium-228	pCi/L	1.64E+03	3.27E+03	Proposed PDWS (EPA, 1991)
Alachlor	µg/L	1	2	Final PDWS (EPA, 1993a)
Aldicarb[b]	µg/L	1.5	3	Final PDWS (EPA, 1993a)
Aldicarb sulfone[b]	µg/L	1	2	Final PDWS (EPA, 1993a)
Aldicarb sulfoxide[b]	µg/L	2	4	Final PDWS (EPA, 1993a)
Aldrin	µg/L	0.25	0.5	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	SDWS (EPA, 1993b)
Aluminum, dissolved	µg/L	25	50	SDWS (EPA, 1993b)
Aluminum, total recoverable	µg/L	25	50	SDWS (EPA, 1993b)

Analyte	Unit	Flag 1	Flag 2	Source
Americium-241	pCi/L	3.17E+00	6.34E+00	Proposed PDWS (EPA, 1991)
Americium-243	pCi/L	3.19E+00	6.37E+00	Proposed PDWS (EPA, 1991)
4-Aminobiphenyl	µg/L	50	100	EPA Method 8270
Ammonia	µg/L	500	1,000	APHA Method 417B
Ammonia nitrogen	µg/L	500	1,000	EPA Method 350.1
Aniline	µg/L	50	100	EPA Method 8270
Anthracene	µg/L	50	100	EPA Method 8270
Antimony	µg/L	3	6	Final PDWS (EPA, 1993a)
Antimony, dissolved	µg/L	3	6	Final PDWS (EPA, 1993a)
Antimony, total recoverable	µg/L	3	6	Final PDWS (EPA, 1993a)
Antimony-125	pCi/L	1.5E+02	3E+02	Interim Final PDWS (EPA, 1977)
Aramite	µg/L	50	100	EPA Method 8270
Arsenic	µg/L	25	50	Final PDWS (EPA, 1993a)
Arsenic, dissolved	µg/L	25	50	Final PDWS (EPA, 1993a)
Arsenic, total recoverable	µg/L	25	50	Final PDWS (EPA, 1993a)
Asbestos	Fibers/L	3,500,000	7,000,000	Final PDWS (EPA, 1993a)
Atrazine	µg/L	1.5	3	Final PDWS (EPA, 1993a)
Azobenzene	µg/L	50	100	EPA Method 625
Barium	µg/L	1,000	2,000	Final PDWS (EPA, 1993a)
Barium, dissolved	µg/L	1,000	2,000	Final PDWS (EPA, 1993a)
Barium, total recoverable	µg/L	1,000	2,000	Final PDWS (EPA, 1993a)
Barium-140[c]	pCi/L	4.5E+01	9E+01	Interim Final PDWS (EPA, 1977)
Benzene	µg/L	2.5	5	Final PDWS (EPA, 1993a)
alpha-Benzene hexachloride	µg/L	0.25	0.5	EPA Method 8080
beta-Benzene hexachloride	µg/L	0.25	0.5	EPA Method 8080
delta-Benzene hexachloride	µg/L	0.25	0.5	EPA Method 8080
Benzidine	µg/L	250	500	EPA Method 8270
Benzo[*a*]anthracene	µg/L	0.05	0.1	Proposed PDWS (EPA, 1990)
Benzo[*b*]fluoranthene	µg/L	0.1	0.2	Proposed PDWS (EPA, 1990)
Benzo[*k*]fluoranthene	µg/L	0.1	0.2	Proposed PDWS (EPA, 1990)
Benzoic acid	µg/L	250	500	EPA Method 8270
Benzo[*g,h,i*]perylene	µg/L	50	100	EPA Method 8270
Benzo[*a*]pyrene	µg/L	0.1	0.2	Final PDWS (EPA, 1993a)
1,4-Benzoquinone	µg/L	50	100	EPA Method 8270
Benzyl alcohol	µg/L	50	100	EPA Method 8270
Beryllium	µg/L	2	4	Final PDWS (EPA, 1993a)
Beryllium, dissolved	µg/L	2	4	Final PDWS (EPA, 1993a)
Beryllium, total recoverable	µg/L	2	4	Final PDWS (EPA, 1993a)
Beryllium-7	pCi/L	3E+03	6E+03	Interim Final PDWS (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(2-ethylhexyl) phthalate	µg/L	3	6	Final PDWS (EPA, 1993a)
Bismuth-214	pCi/L	9.4E+03	1.89E+04	Proposed PDWS (EPA, 1991)
Boron	µg/L	150	300	EPA Method 6010
Boron, dissolved	µg/L	150	300	EPA Method 6010
Boron, total recoverable	µg/L	150	300	EPA Method 6010
Bromide	µg/L	5,000	10,000	EPA Method 300.0
Bromodichloromethane	µg/L	50	100	Final PDWS (EPA, 1993a)
Bromoform	µg/L	50	100	Final PDWS (EPA, 1993a)
Bromomethane (Methyl bromide)	µg/L	5	10	EPA Method 8240
4-Bromophenyl phenyl ether	µg/L	50	100	EPA Method 8270
Butylbenzyl phthalate		No flag	No flag	Set by EPD/EMS
2-sec-Butyl-4,6-dinitrophenol	µg/L	3.5	7	Final PDWS (EPA, 1993a)

Analyte	Unit	Flag 1	Flag 2	Source
Cadmium	µg/L	2.5	5	Final PDWS (EPA, 1993a)
Cadmium, dissolved	µg/L	2.5	5	Final PDWS (EPA, 1993a)
Cadmium, total recoverable	µg/L	2.5	5	Final PDWS (EPA, 1993a)
Calcium		No flag	No flag	Set by EPD/EMS
Calcium, dissolved		No flag	No flag	Set by EPD/EMS
Calcium, total recoverable		No flag	No flag	Set by EPD/EMS
Carbofuran	µg/L	20	40	Final PDWS (EPA, 1993a)
Carbon-14	pCi/L	1E+03	2E+03	Interim Final PDWS (EPA, 1977)
Carbonate		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 PDWS (EPA, 1993a)
Cerium-141[c]	pCi/L	1.5E+02	3E+02	Interim Final PDWS (EPA, 1977)
Cerium-144	pCi/L	1.31E+02	2.61E+02	Proposed PDWS (EPA, 1991)
Cesium-134[d]	pCi/L	4.07E+01	8.13E+01	Proposed PDWS (EPA, 1991)
Cesium-137	pCi/L	1E+02	2E+02	Interim Final PDWS (EPA, 1977)
Chlordane	µg/L	1	2	Final PDWS (EPA, 1993a)
Chloride	µg/L	125,000	250,000	SDWS (EPA, 1993b)
4-Chloroaniline	µg/L	50	100	EPA Method 8270
Chlorobenzene	µg/L	50	100	Final PDWS (EPA, 1993a)
Chlorobenzilate	µg/L	50	100	EPA Method 8270
4-Chloro-m-cresol	µg/L	50	100	EPA Method 8270
Chloroethane	µg/L	5	10	EPA Method 8240
Chloroethene (Vinyl chloride)	µg/L	1	2	Final PDWS (EPA, 1993a)
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 PDWS (EPA, 1993a)
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
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 PDWS (EPA, 1993a)
Chromium, dissolved	µg/L	50	100	Final PDWS (EPA, 1993a)
Chromium, total recoverable	µg/L	50	100	Final PDWS (EPA, 1993a)
Chromium-51[c]	pCi/L	3E+03	6E+03	Interim Final PDWS (EPA, 1977)
Chrysene	µg/L	0.1	0.2	Proposed PDWS (EPA, 1990)
Cobalt	µg/L	20	40	EPA Method 6010
Cobalt, dissolved	µg/L	20	40	EPA Method 6010
Cobalt, total recoverable	µg/L	20	40	EPA Method 6010
Cobalt-57	pCi/L	5E+02	1E+03	Interim Final PDWS (EPA, 1977)
Cobalt-58[d]	pCi/L	4.5E+03	9E+03	Interim Final PDWS (EPA, 1977)
Cobalt-60	pCi/L	5E+01	1E+02	Interim Final PDWS (EPA, 1977)
Color		No flag	No flag	Set by EPD/EMS
Copper	µg/L	500	1,000	Final PDWS (SCDHEC, 1981)
Copper, dissolved	µg/L	500	1,000	Final PDWS (SCDHEC, 1981)
Copper, total recoverable	µg/L	500	1,000	Final PDWS (SCDHEC, 1981)
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 PDWS (EPA, 1991)
Curium-243	pCi/L	4.15E+00	8.3E+00	Proposed PDWS (EPA, 1991)
Curium-243/244[e]	pCi/L	4.15E+00	8.3E+00	Proposed PDWS (EPA, 1991)
Curium-244	pCi/L	4.92E+00	9.84E+00	Proposed PDWS (EPA, 1991)
Curium-245/246[e]	pCi/L	3.12E+00	6.23E+00	Proposed PDWS (EPA, 1991)

Analyte	Unit	Flag 1	Flag 2	Source
Curium-246	pCi/L	3.14E+00	6.27E+00	Proposed PDWS (EPA, 1991)
Cyanide	µg/L	100	200	Final PDWS (EPA, 1993a)
Dalapon[b]	µg/L	100	200	Final PDWS (EPA, 1993a)
p,p'-DDD	µg/L	0.5	1	EPA Method 8080
p,p'-DDE	µg/L	0.5	1	EPA Method 8080
p,p'-DDT	µg/L	0.5	1	EPA Method 8080
Diallate	µg/L	50	100	EPA Method 8270
Dibenz[*a,h*]anthracene	µg/L	0.15	0.3	Proposed PDWS (EPA, 1990)
Dibenzofuran	µg/L	50	100	EPA Method 8270
Dibromochloromethane	µg/L	50	100	Final PDWS (EPA, 1993a)
1,2-Dibromo-3-chloropropane	µg/L	0.1	0.2	Final PDWS (EPA, 1993a)
1,2-Dibromoethane	µg/L	0.025	0.05	Final PDWS (EPA, 1993a)
Dibromomethane (Methylene bromide)	µg/L	5	10	EPA Method 8240
Di-n-butyl phthalate		No flag	No flag	Set by EPD/EMS
1,2-Dichlorobenzene	µg/L	300	600	Final PDWS (EPA, 1993a)
1,3-Dichlorobenzene	µg/L	50	100	EPA Method 8270
1,4-Dichlorobenzene	µg/L	37.5	75	Final PDWS (EPA, 1993a)
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 PDWS (EPA, 1993a)
1,1-Dichloroethylene	µg/L	3.5	7	Final PDWS (EPA, 1993a)
1,2-Dichloroethylene	µg/L	25	50	Final PDWS (EPA, 1993a)
cis-1,2-Dichloroethylene	µg/L	35	70	Final PDWS (EPA, 1993a)
trans-1,2-Dichloroethylene	µg/L	50	100	Final PDWS (EPA, 1993a)
Dichloromethane (Methylene chloride)	µg/L	2.5	5	Final PDWS (EPA, 1993a)
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 PDWS (EPA, 1993a)
1,2-Dichloropropane	µg/L	2.5	5	Final PDWS (EPA, 1993a)
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
Di(2-ethylhexyl) adipate	µg/L	200	400	Final PDWS (EPA, 1993a)
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
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
Di-n-octyl phthalate		No flag	No flag	Set by EPD/EMS
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
Diquat dibromide[b]	µg/L	10	20	Final PDWS (EPA, 1993a)

Analyte	Unit	Flag 1	Flag 2	Source
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
Endosulfan I	µg/L	0.5	1	EPA Method 8080
Endosulfan II	µg/L	0.5	1	EPA Method 8080
Endosulfan sulfate	µg/L	0.5	1	EPA Method 8080
Endothall[b]	µg/L	50	100	Final PDWS (EPA, 1993a)
Endrin	µg/L	1	2	Final PDWS (EPA, 1993a)
Endrin aldehyde	µg/L	0.5	1	EPA Method 8080
Endrin ketone		No flag	No flag	Set by EPD/EMS
Ethylbenzene	µg/L	350	700	Final PDWS (EPA, 1993a)
Ethyl methacrylate	µg/L	50	100	EPA Method 8270
Ethyl methanesulfonate	µg/L	50	100	EPA Method 8270
Europium-152	pCi/L	3E+01	6E+01	Interim Final PDWS (EPA, 1977)
Europium-154	pCi/L	1E+02	2E+02	Interim Final PDWS (EPA, 1977)
Europium-155	pCi/L	3E+02	6E+02	Interim Final PDWS (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 PDWS (EPA, 1993a)
Glyphosate[b]	µg/L	350	700	Final PDWS (EPA, 1993a)
Gross alpha	pCi/L	7.5E+00	1.5E+01	Final PDWS (EPA, 1993a)
Heptachlor	µg/L	0.2	0.4	Final PDWS (EPA, 1993a)
Heptachlor epoxide	µg/L	0.1	0.2	Final PDWS (EPA, 1993a)
Heptachlorodibenzo-p-dioxin isomers	µg/L	0.00325	0.0065	EPA Method 8280
1,2,3,4,6,7,8-HPCDD	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-HPCDF	µg/L	0.00225	0.0045	EPA Method 8280
Hexachlorobenzene	µg/L	0.5	1	Final PDWS (EPA, 1993a)
Hexachlorobutadiene	µg/L	50	100	EPA Method 8270
Hexachlorocyclopentadiene	µg/L	25	50	Final PDWS (EPA, 1993a)
Hexachlorodibenzo-p-dioxin isomers	µg/L	0.00225	0.0045	EPA Method 8280
1,2,3,4,7,8-HXCDD	µg/L	0.00225	0.0045	EPA Method 8280
Hexachlorodibenzo-p-furan isomers	µg/L	0.002	0.004	EPA Method 8280
1,2,3,4,7,8-HXCDF	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	50	100	EPA Method 8240
Indeno[1,2,3-*c,d*]pyrene	µg/L	50	100	EPA Method 8270
Iodine	µg/L	250	500	APHA Method 415A
Iodine-129	pCi/L	5E−01	1E+00	Interim Final PDWS (EPA, 1977)
Iodine-131[c]	pCi/L	1.5E+00	3E+00	Interim Final PDWS (EPA, 1977)
Iodomethane (Methyl iodide)	µg/L	75	150	EPA Method 8240
Iron	µg/L	150	300	SDWS (EPA, 1993b)
Iron, dissolved	µg/L	150	300	SDWS (EPA, 1993b)
Iron, total recoverable	µg/L	150	300	SDWS (EPA, 1993b)
Iron-55[c]	pCi/L	1E+03	2E+03	Interim Final PDWS (EPA, 1977)
Iron-59[c]	pCi/L	1E+02	2E+02	Interim Final PDWS (EPA, 1977)
Isobutyl alcohol	µg/L	500	1,000	EPA Method 8240
Isodrin	µg/L	50	100	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source
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[c]	pCi/L	3E+01	6E+01	Interim Final PDWS (EPA, 1977)
Lead	µg/L	25	50	Final PDWS (SCDHEC, 1981)
Lead, dissolved	µg/L	25	50	Final PDWS (SCDHEC, 1981)
Lead, total recoverable	µg/L	25	50	Final PDWS (SCDHEC, 1981)
Lead-212	pCi/L	6.2E+01	1.23E+02	Proposed PDWS (EPA, 1991)
Lindane	µg/L	0.1	0.2	Final PDWS (EPA, 1993a)
Lithium	µg/L	25	50	EPA Method 6010
Lithium, dissolved	µg/L	25	50	EPA Method 6010
Lithium, total recoverable	µg/L	25	50	EPA Method 6010
Magnesium		No flag	No flag	Set by EPD/EMS
Magnesium, dissolved		No flag	No flag	Set by EPD/EMS
Magnesium, total recoverable		No flag	No flag	Set by EPD/EMS
Manganese	µg/L	25	50	SDWS (EPA, 1993b)
Manganese, dissolved	µg/L	25	50	SDWS (EPA, 1993b)
Manganese, total recoverable	µg/L	25	50	SDWS (EPA, 1993b)
Manganese-54	pCi/L	1.5E+02	3E+02	Interim Final PDWS (EPA, 1977)
Mercury	µg/L	1	2	Final PDWS (EPA, 1993a)
Mercury, dissolved	µg/L	1	2	Final PDWS (EPA, 1993a)
Mercury, total recoverable	µg/L	1	2	Final PDWS (EPA, 1993a)
Methacrylonitrile	µg/L	250	500	EPA Method 8240
Methapyrilene	µg/L	50	100	EPA Method 8270
Methoxychlor	µg/L	20	40	Final PDWS (EPA, 1993a)
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
Molybdenum, dissolved	µg/L	250	500	EPA Method 6010
Molybdenum, total recoverable	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 PDWS (EPA, 1991)
Nickel	µg/L	50	100	Final PDWS (EPA, 1993a)
Nickel, dissolved	µg/L	50	100	Final PDWS (EPA, 1993a)
Nickel, total recoverable	µg/L	50	100	Final PDWS (EPA, 1993a)
Nickel-59[c]	pCi/L	1.5E+02	3E+02	Interim Final PDWS (EPA, 1977)
Nickel-63[c]	pCi/L	2.5E+01	5E+01	Interim Final PDWS (EPA, 1977)
Niobium-95[c]	pCi/L	1.5E+02	3.E+02	Interim Final PDWS (EPA, 1977)
Nitrate as nitrogen	µg/L	5,000	10,000	Final PDWS (EPA, 1993a)
Nitrate-nitrite as nitrogen	µg/L	5,000	10,000	Final PDWS (EPA, 1993a)
Nitrite as nitrogen	µg/L	500	1,000	Final PDWS (EPA, 1993a)
m-Nitroaniline	µg/L	50	100	EPA Method 8270
o-Nitroaniline	µg/L	50	100	EPA Method 8270
p-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
2-Nitrophenol	µg/L	50	100	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source
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-Nitrosodipropylamine	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	Interim Final PDWS (EPA, 1977)
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
Oxamyl[b]	µg/L	100	200	Final PDWS (EPA, 1993a)
Parathion	µg/L	0.25	0.5	EPA Method 8080
Parathion methyl	µg/L	0.25	0.5	EPA Method 8080
PCB 1016	µg/L	0.25	0.5	Final PDWS (EPA, 1993a)
PCB 1221	µg/L	0.25	0.5	Final PDWS (EPA, 1993a)
PCB 1232	µg/L	0.25	0.5	Final PDWS (EPA, 1993a)
PCB 1242	µg/L	0.25	0.5	Final PDWS (EPA, 1993a)
PCB 1248	µg/L	0.25	0.5	Final PDWS (EPA, 1993a)
PCB 1254	µg/L	0.25	0.5	Final PDWS (EPA, 1993a)
PCB 1260	µg/L	0.25	0.5	Final PDWS (EPA, 1993a)
PCB 1262	µg/L	0.25	0.5	Final PDWS (EPA, 1993a)
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-PCDD	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-PCDF	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 PDWS (EPA, 1993a)
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	0.5	1	EPA Method 8080
Picloram[b]	µg/L	250	500	Final PDWS (EPA, 1993a)
2-Picoline	µg/L	50	100	EPA Method 8270
Plutonium-238	pCi/L	3.51E+00	7.02E+00	Proposed PDWS (EPA, 1991)
Plutonium-239	pCi/L	3.11E+01	6.21E+01	Proposed PDWS (EPA, 1991)
Plutonium-239/240[e]	pCi/L	3.11E+01	6.21E+01	Proposed PDWS (EPA, 1991)
Plutonium-240	pCi/L	3.11E+01	6.22E+01	Proposed PDWS (EPA, 1991)
Plutonium-241[c]	pCi/L	3.13E+01	6.26E+01	Proposed PDWS (EPA, 1991)

Analyte	Unit	Flag 1	Flag 2	Source
Plutonium-242[c]	pCi/L	3.27E+01	6.54E+01	Proposed PDWS (EPA, 1991)
Potassium		No flag	No flag	Set by EPD/EMS
Potassium, dissolved		No flag	No flag	Set by EPD/EMS
Potassium, total recoverable		No flag	No flag	Set by EPD/EMS
Potassium-40	pCi/L	1.5E+02	3E+02	Proposed PDWS (EPA, 1986)
Promethium-144	pCi/L	5E+01	1E+02	EPA Method 901.1
Promethium-146	pCi/L	5E+01	1E+02	EPA Method 901.1
Promethium-147	pCi/L	2.62E+03	5.24E+03	Proposed PDWS (EPA, 1991)
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 (alpha-emitting)[f]	pCi/L	1E+01	2E+01	Proposed PDWS (EPA, 1991)
Radium-226	pCi/L	1E+01	2E+01	Proposed PDWS (EPA, 1991)
Radium-228	pCi/L	1E+01	2E+01	Proposed PDWS (EPA, 1991)
Radon-222	pCi/L	1.5E+02	3E+02	Proposed PDWS (EPA, 1991)
Ruthenium-103[c]	pCi/L	1E+02	2E+02	Interim Final PDWS (EPA, 1977)
Ruthenium-106	pCi/L	1.5E+01	3E+01	Interim Final PDWS (EPA, 1977)
Safrole	µg/L	50	100	EPA Method 8270
Selenium	µg/L	25	50	Final PDWS (EPA, 1993a)
Selenium, dissolved	µg/L	25	50	Final PDWS (EPA, 1993a)
Selenium, total recoverable	µg/L	25	50	Final PDWS (EPA, 1993a)
Silica		No flag	No flag	Set by EPD/EMS
Silica, dissolved		No flag	No flag	Set by EPD/EMS
Silica, total recoverable		No flag	No flag	Set by EPD/EMS
Silver	µg/L	50	100	SDWS (EPA, 1993b)
Silver, dissolved	µg/L	50	100	SDWS (EPA, 1993b)
Silver, total recoverable	µg/L	50	100	SDWS (EPA, 1993b)
Simazine[b]	µg/L	2	4	Final PDWS (EPA, 1993a)
Sodium		No flag	No flag	Set by EPD/EMS
Sodium, dissolved		No flag	No flag	Set by EPD/EMS
Sodium, total recoverable		No flag	No flag	Set by EPD/EMS
Sodium-22	pCi/L	2.33E+02	4.66E+02	Proposed PDWS (EPA, 1991)
Specific conductance	µS/cm	250	500	Set by EPD/EMS
Strontium-89	pCi/L	1E+01	2E+01	Interim Final PDWS (EPA, 1977)
Strontium-89/90[e]	pCi/L	4E+00	8E+00	Final PDWS (EPA, 1993a)
Strontium-90	pCi/L	4E+00	8E+00	Final PDWS (EPA, 1993a)
Styrene	µg/L	50	100	Final PDWS (EPA, 1993a)
Sulfate	µg/L	200,000	400,000	Proposed PDWS (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	0.000015	0.00003	Final PDWS (EPA, 1993a)
2,3,7,8-TCDF	µg/L	0.002	0.004	EPA Method 8280
Technetium-99	pCi/L	4.5E+02	9E+02	Interim Final PDWS (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 PDWS (EPA, 1993a)
2,3,4,6-Tetrachlorophenol	µg/L	50	100	EPA Method 8270
Thallium	µg/L	1	2	Final PDWS (EPA, 1993a)

Analyte	Unit	Flag 1	Flag 2	Source
Thallium, dissolved	µg/L	1	2	Final PDWS (EPA, 1993a)
Thallium, total recoverable	µg/L	1	2	Final PDWS (EPA, 1993a)
Thionazin	µg/L	50	100	EPA Method 8270
Thorium-228	pCi/L	6.25E+01	1.25E+02	Proposed PDWS (EPA, 1991)
Thorium-230	pCi/L	3.96E+01	7.92E+01	Proposed PDWS (EPA, 1991)
Thorium-232	pCi/L	4.4E+01	8.8E+01	Proposed PDWS (EPA, 1991)
Thorium-234	pCi/L	2E+02	4.01E+02	Proposed PDWS (EPA, 1991)
Tin	µg/L	10	20	EPA Method 282.2
Tin, dissolved	µg/L	10	20	EPA Method 282.2
Tin, total recoverable	µg/L	10	20	EPA Method 282.2
Tin-113[c]	pCi/L	1.5E+02	3E+02	Interim Final PDWS (EPA, 1977)
Toluene	µg/L	500	1,000	Final PDWS (EPA, 1993a)
o-Toluidine	µg/L	50	100	EPA Method 8270
Total carbon	µg/L	5,000	10,000	EPA Method 9060
Total coliform		0	0	Final PDWS (EPA, 1993a)
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	APHA Method 420
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
Toxaphene	µg/L	1.5	3	Final PDWS (EPA, 1993a)
2,4,5-TP (Silvex)	µg/L	25	50	Final PDWS (EPA, 1993a)
Tributyl phosphate	µg/L	50	100	EPA Method 8270
1,2,4-Trichlorobenzene	µg/L	35	70	Final PDWS (EPA, 1993a)
1,1,1-Trichloroethane	µg/L	100	200	Final PDWS (EPA, 1993a)
1,1,2-Trichloroethane	µg/L	2.5	5	Final PDWS (EPA, 1993a)
Trichloroethylene	µg/L	2.5	5	Final PDWS (EPA, 1993a)
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 PDWS (EPA, 1993a)
Turbidity[g]		No flag	No flag	Set by EPD/EMS
Uranium	µg/L	10	20	Proposed PDWS (EPA, 1991)
Uranium, dissolved	µg/L	10	20	Proposed PDWS (EPA, 1991)
Uranium, total recoverable	µg/L	10	20	Proposed PDWS (EPA, 1991)
Uranium alpha activity	pCi/L	1.5E+01	3E+01	Proposed PDWS (EPA, 1991)
Uranium-233/234[e]	pCi/L	6.9E+00	1.38E+01	Proposed PDWS (EPA, 1991)
Uranium-234	pCi/L	6.95E+00	1.39E+01	Proposed PDWS (EPA, 1991)
Uranium-235	pCi/L	7.25E+00	1.45E+01	Proposed PDWS (EPA, 1991)
Uranium-238	pCi/L	7.3E+00	1.46E+01	Proposed PDWS (EPA, 1991)
Vanadium	µg/L	40	80	EPA Method 6010
Vanadium, dissolved	µg/L	40	80	EPA Method 6010
Vanadium, total recoverable	µg/L	40	80	EPA Method 6010
Vinyl acetate	µg/L	5	10	EPA Method 8240

Analyte	Unit	Flag 1	Flag 2	Source
Xylenes	µg/L	5,000	10,000	Final PDWS (EPA, 1993a)
Yttrium-88	pCi/L	5E+01	1E+02	EPA Method 901.1
Zinc	µg/L	2,500	5,000	SDWS (EPA, 1993b)
Zinc, dissolved	µg/L	2,500	5,000	SDWS (EPA, 1993b)
Zinc, total recoverable	µg/L	2,500	5,000	SDWS (EPA, 1993b)
Zinc-65	pCi/L	1.5E+02	3E+02	Interim Final PDWS (EPA, 1977)
Zirconium-95[c]	pCi/L	1E+02	2E+02	Interim Final PDWS (EPA, 1977)
Zirconium/Niobium-95[c]	pCi/L	1E+02	2E+02	Interim Final PDWS (EPA, 1977)

[a] References for methods are in Appendix E; references for dated sources are at the end of this appendix.
[b] EMS is currently unable to perform this analysis.
[c] EMS discontinued monitoring this radionuclide because it is inappropriate for the SRS Groundwater Monitoring Program.
[d] EPD/EMS set this flagging criterion using the 1991 proposed PDWS because the final PDWS in 1977 may have been in error.
[e] For double radionuclide analyses where each separate radionuclide has its own standard, the more stringent standard is used.
[f] The applied standard is for radium-226.
[g] The primary maximum contaminant level range for turbidity is 1–5 NTU, which is inappropriate for the SRS Groundwater Monitoring Program.

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

Appendix C

Figures

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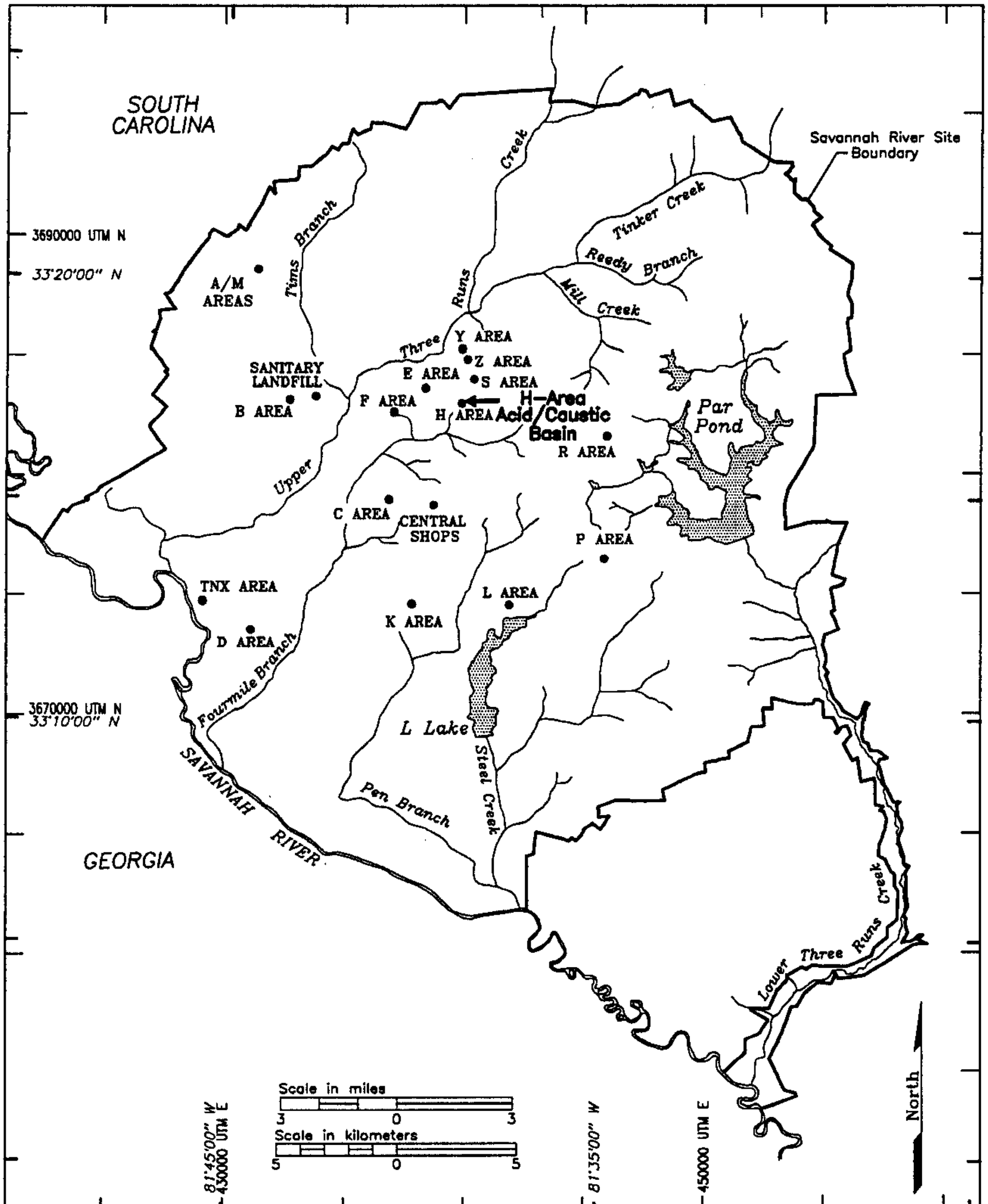

Figure 1. Location of the H-Area Acid/Caustic Basin at the Savannah River Site

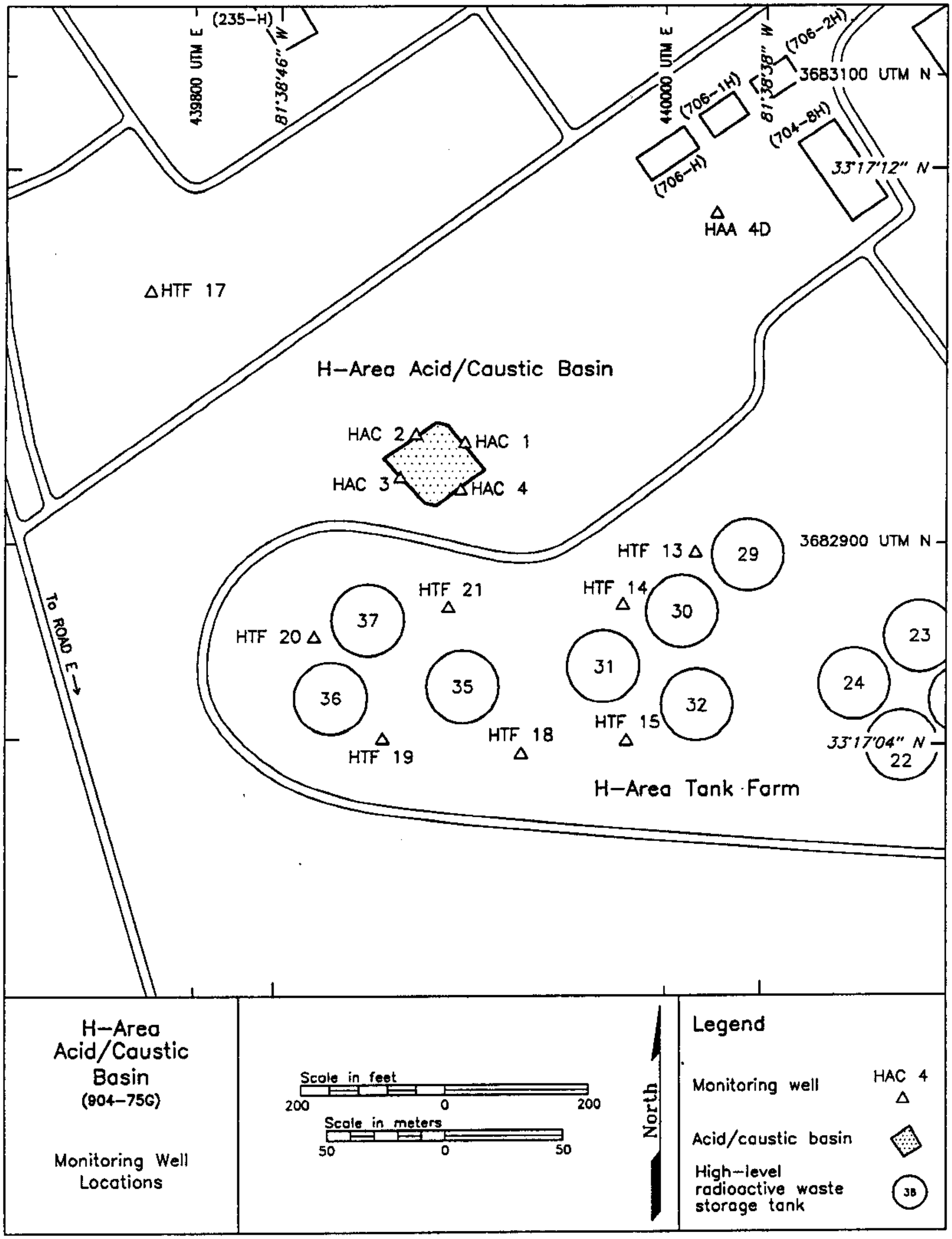

Figure 2. Location of Groundwater Monitoring Wells at the H-Area Acid/Caustic Basin

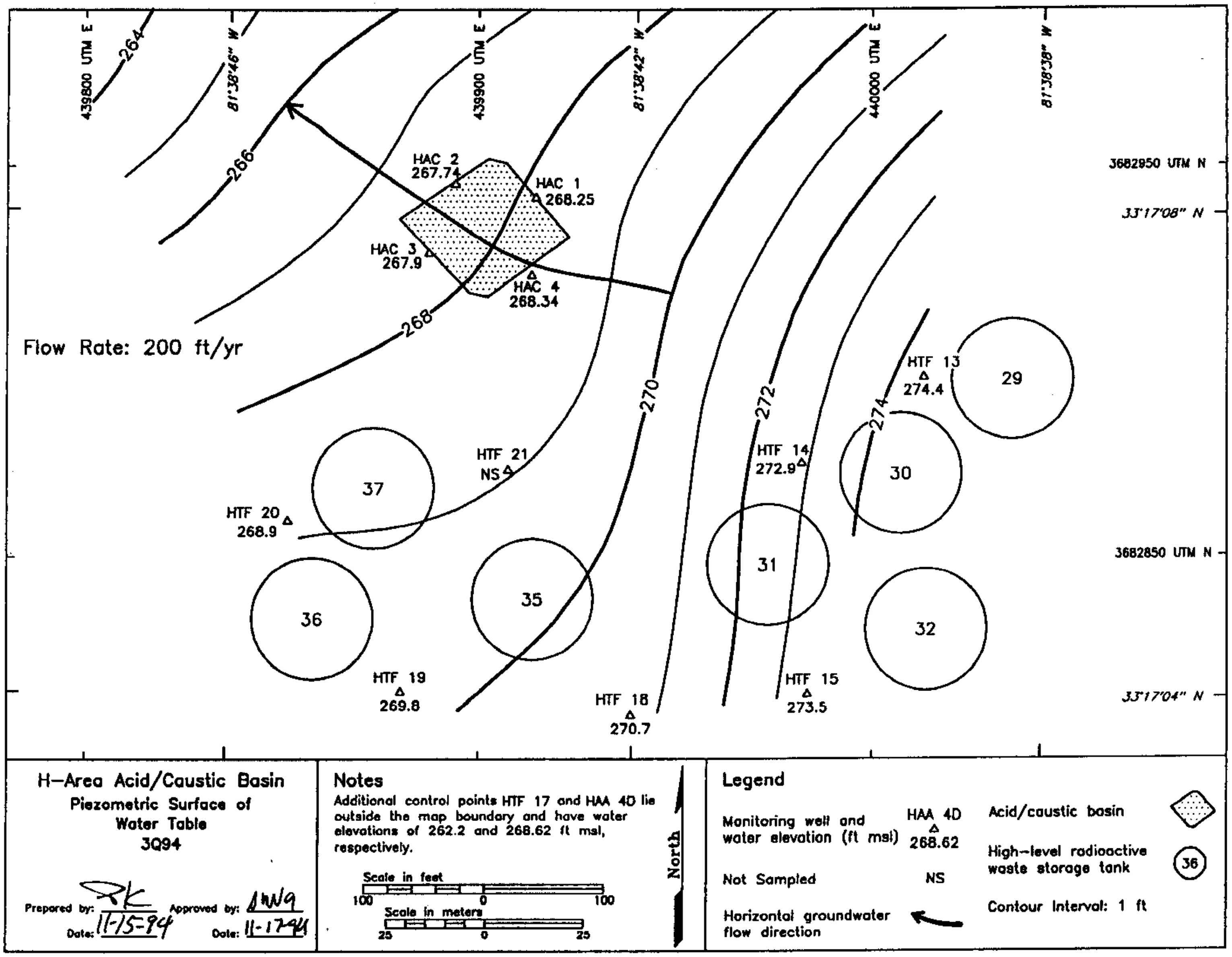

Figure 3. Piezometric Surface Map of the Water Table at the H-Area Acid/Caustic Basin

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Appendix D

Groundwater Monitoring Results Tables

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Key to Reading the Tables

The following abbreviations may appear in the data tables:

Constituents

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
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
Sp. conductance	specific conductance
TCDD	tetrachlorodibenzo-p-dioxin
TCDF	tetrachlorodibenzo-p-furan

Laboratories

CN	Clemson Technical Center, Inc.
EM	Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) Laboratory
GE and GP	General Engineering Laboratories
SC	Savannah River Technology Center
SP	Spencer Testing Services, Inc.
TM	TMA/Eberline
WA and WS	Roy F. Weston, Inc.

Sampling Codes

B	blank sample was collected
C	well was pumping continuously
D	well was dry
E	equipment blank was collected
I	well went dry during sampling; insufficient water to collect all samples
L	well went dry before sampling began; only depth to water can be determined
P	inaccessibility or mechanical failure prevented sample collection and field analysis of the water
S	no water in standpipe; for water level events only
X	well went dry during purging; samples collected after well recovered

Sampling Methods

B	sample collected using an open-bucket bailer
P	sample collected using a bladder pump
S	sample collected using a single-speed centrifugal downhole pump
V	sample collected using a variable-speed pump

Units

E	exponential notation (e.g., 1.1E−09 = 1.1×10^{-9} = 0.0000000011)
mg/L	milligrams per liter
msl	mean sea level
MSL	million structures per liter
NTU	turbidity unit
pCi/L	picocuries per liter
pCi/mL	picocuries per milliliter
pH	pH unit
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter

Other

CS	carbon steel
DF	dilution factor column in data tables
H	holding time column in data tables
Mod	modifier column in data tables
PDWS	primary drinking water standard
PVC	polyvinyl chloride
ST	exceeded standard column in data tables
TOC	top of casing

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 bullet (•) in the *H* (holding time) column indicates that holding time was exceeded. Analyses performed beyond holding times 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 always will exceed it.

The laboratory procedure used for the determination of specific conductance allows one day to elapse between sampling and analysis. Thus, laboratory specific conductance measurements may exceed the holding time criterion.

Data Rounding

Constituent results in analytical results tables that appear to equal the final PDWS but are not marked in the *ST* (exceeded the final PDWS or screening level) column are below the final PDWS in the database. Values stored in the database contain more significant digits than the reported results. Apparent discrepancies in the tables are due to the rounding of reported results.

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 usability. Result modifiers designed by the EPD/EMS and provided to the primary laboratories are defined below. These modifiers appear in the data tables under the column *Mod*. The lettered modifiers are based on EPA's STORET codes.

Result modifier

(Blank)	Data are not qualified. Numbers should be interpreted exactly as reported.
J	Value is estimated because quantitation in the sample or in associated quality control samples did not meet specifications.
I	The value in the result field is the instrument reading, not the sample quantification limit. Always used with the result qualifier *U*.
L	Value is off-scale high. The actual value is not known but is known to be greater than the value shown.
M	Presence of the analyte is verified but not quantified.
R	Result was rejected because performance requirements in the sample analysis or associated quality control analyses were not met.
T	Analyte was not detected; if present, it was below the criteria for detection.
U	Material analyzed for but not detected. Analytical result reported is less than the sample quantitation limit.
V	Analyte was detected in an associated method blank.
Y	Result was obtained from an unpreserved or improperly preserved sample. Data may not be accurate.
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.
3	The associated result may be of poor precision (high variability) due to analytical bias.
4	Result is associated with QA results indicating matrix interference.
6	The associated result is from a reanalysis performed out of holding time due to problems with an earlier analysis.

Table 1. Maximum Results for Constituents Exceeding Final Primary Drinking Water Standards

Well	Constituent	Unit	4Q93	1Q94	2Q94	3Q94	Mod
HAC 1	Tritium	pCi/mL	4.6E+01	6.2E+01	6.1E+01	6.5E+01	
HAC 2	Tritium	pCi/mL	3.8E+01	3.6E+01	3.5E+01	3.9E+01	
HAC 3	Tritium	pCi/mL	3.9E+01	3.6E+01	3.6E+01	3.7E+01	Y
HAC 4	Carbon tetrachloride	µg/L	NA[a]	7.4	5.1	8.5	
	Heptachlor epoxide	µg/L	NA	0.22	–[b]	NA	
	Tritium	pCi/mL	3.9E+01	3.6E+01	3.0E+01	3.3E+01	

Note: The modifier column applies to third quarter 1994 only.

[a] NA = not analyzed.
[b] – = not above final PDWS.

Table 2. Maximum Results for Constituents Exceeding Other Flag 2 Criteria or the SRS Turbidity Standard

Well	Constituent	Unit	3Q94	Mod
HAC 1	Aluminum	µg/L	64	Y
	Iron	µg/L	595	Y
HAC 2	Aluminum	µg/L	162	Y
	Iron	µg/L	1,280	Y
	Total organic halogens	µg/L	110	Y
HAC 3	Aluminum	µg/L	303	Y
	Iron	µg/L	678	Y
	Manganese	µg/L	61	Y
HAC 4	Aluminum	µg/L	123	Y

Notes: These results do not include field data. The groundwater samples are unfiltered. Thus, the results for metals are for total recoverable metals. Flags are established by EPD/EMS and are based on final PDWS, Secondary Drinking Water Standards, or method detection limits (Appendix B).

Table 3. Groundwater Monitoring Results for Individual Wells

WELL HAC 1

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N72171.0 E61415.2	33.285599 °N 81.645272 °W	278.8-258.8 ft msl	298.4 ft msl	4" PVC	S	Water Table

FIELD MEASUREMENTS

Sample date: 07/20/94
Depth to water: 30.15 ft (9.19 m) below TOC
Water elevation: 268.25 ft (81.76 m) msl
Sp. conductance: 125 μS/cm
Turbidity: 0.4 NTU
Water evacuated before sampling: 40 gal

Time: 13:02
pH: 5.2
Alkalinity: 0 mg/L
Water temperature: 23.6 °C

Volumes purged: 6.5 well volumes

LABORATORY ANALYSES

H	ST	Analyte	Result	DF	Mod	Unit	Flag	Lab
●		pH	4.9	1	JY3	pH	0	WA
		Specific conductance	121	1	Y	μS/cm	0	WA
●		Turbidity	0.50	1	JY3	NTU	0	WA
		Aluminum, total recoverable	64	1	Y	μg/L	2	WA
		Arsenic, total recoverable	<2.0	1	Y	μg/L	0	WA
		Barium, total recoverable	<4.0	1	Y	μg/L	0	WA
		Cadmium, total recoverable	<2.0	1	Y	μg/L	0	WA
		Calcium, total recoverable	82	1	VY	μg/L	0	WA
		Carbon tetrachloride	<1.0	1	Y	μg/L	0	WA
		Chloride	5,660	1	Y	μg/L	0	WA
		Chloroform	<1.0	1	Y	μg/L	0	WA
		Chromium, total recoverable	<4.0	1	Y	μg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1	1.1	Y	μg/L	0	WA
		Endrin	<0.10	1.04	Y	μg/L	0	WA
		Fluoride	<100	1	Y	μg/L	0	WA
		Iron, total recoverable	595	1	Y	μg/L	2	WA
		Lead, total recoverable	15	1	Y	μg/L	0	WA
		Lindane	<0.052	1.04	Y	μg/L	0	WA
		Magnesium, total recoverable	102	1	Y	μg/L	0	WA
		Manganese, total recoverable	9.0	1	Y	μg/L	0	WA
		Mercury, total recoverable	<0.20	1	Y	μg/L	0	WA
		Methoxychlor	<0.52	1.04	Y	μg/L	0	WA
		Nitrate as nitrogen	1,790	5	Y	μg/L	0	WA
		Phenols	<5.0	1	Y	μg/L	0	WA
		Potassium, total recoverable	<500	1	Y	μg/L	0	WA
		Selenium, total recoverable	<2.0	1	Y	μg/L	0	WA
		Silica, total recoverable	6,020	2.1	Y	μg/L	0	WA
		Silver, total recoverable	<2.0	1	Y	μg/L	0	WA
		Sodium, total recoverable	21,200	1	Y	μg/L	0	WA
		Sulfate	34,000	5	Y	μg/L	0	WA
		Tetrachloroethylene	<1.0	1	Y	μg/L	0	WA
		Total dissolved solids	58,000	1	VY	μg/L	0	WA
		Total organic carbon	1,780	1	Y	μg/L	0	WA
		Total organic halogens	7.0	1	Y	μg/L	0	WA
		Total organic halogens	6.7	1	Y	μg/L	0	WA
		Total phosphates (as P)	<50	1	Y	μg/L	0	WA
		Toxaphene	<1.0	1.04	Y	μg/L	0	WA
		2,4,5-TP (Silvex)	<0.55	1.1	Y	μg/L	0	WA

● = exceeded holding time. ■ = exceeded screening level or final PDWS.

WELL HAC 1 collected on 07/20/94, laboratory analyses (cont.)

H	ST	Analyte	Result	DF	Mod	Unit	Flag	Lab
		1,1,1-Trichloroethane	<1.0	1	Y	µg/L	0	WA
		Trichloroethylene	<1.0	1	Y	µg/L	0	WA
		Gross alpha	2.5E-01	1	UI	pCi/L	0	GP
		Nonvolatile beta	1.8E+00	1	J3	pCi/L	0	GP
	■	Tritium	6.5E+01	1		pCi/mL	2	GP

WELL HAC 2

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N72220.2 E61366.9	33.285629 °N 81.645495 °W	278.8-258.8 ft msl	298.1 ft msl	4" PVC	S	Water Table

FIELD MEASUREMENTS

Sample date: 07/20/94
Depth to water: 30.36 ft (9.25 m) below TOC
Water elevation: 267.74 ft (81.61 m) msl
Sp. conductance: 276 µS/cm
Turbidity: 13.7 NTU
Water evacuated before sampling: 4 gal
The well went dry during purging.

Time: 12:22
pH: 5.9
Alkalinity: 28 mg/L
Water temperature: 23.3 °C

Volumes purged: 0.7 well volumes

LABORATORY ANALYSES

H	ST	Analyte	Result	DF	Mod	Unit	Flag	Lab
●		pH	5.5	1	JY3	pH	0	WA
		Specific conductance	<1.0	1	Y	µS/cm	0	WA
●		Turbidity	11	1	JY3	NTU	0	WA
		Aluminum, total recoverable	162	1	Y	µg/L	2	WA
		Arsenic, total recoverable	<2.0	1	Y	µg/L	0	WA
		Barium, total recoverable	5.8	1	Y	µg/L	0	WA
		Cadmium, total recoverable	<2.0	1	Y	µg/L	0	WA
		Calcium, total recoverable	216	1	VY	µg/L	0	WA
		Carbon tetrachloride	<1.0	1	Y	µg/L	0	WA
		Chloride	6,250	1	Y	µg/L	0	WA
		Chloroform	<1.0	1	Y	µg/L	0	WA
		Chromium, total recoverable	<4.0	1	Y	µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1	1.09	Y	µg/L	0	WA
		Endrin	<0.10	1.04	Y	µg/L	0	WA
		Fluoride	<100	1	Y	µg/L	0	WA
		Iron, total recoverable	1,280	1	Y	µg/L	2	WA
		Lead, total recoverable	9.3	1	Y	µg/L	0	WA
		Lindane	<0.052	1.04	Y	µg/L	0	WA
		Magnesium, total recoverable	290	1	Y	µg/L	0	WA
		Manganese, total recoverable	20	1	Y	µg/L	0	WA
		Mercury, total recoverable	0.47	1	Y	µg/L	0	WA
		Methoxychlor	<0.52	1.04	Y	µg/L	0	WA
		Nitrate as nitrogen	194	1	Y	µg/L	0	WA
		Phenols	<5.0	1	Y	µg/L	0	WA
		Potassium, total recoverable	<500	1	Y	µg/L	0	WA
		Selenium, total recoverable	<2.0	1	Y	µg/L	0	WA
		Silica, total recoverable	6,070	2.1	Y	µg/L	0	WA
		Silver, total recoverable	<2.0	1	Y	µg/L	0	WA
		Sodium, total recoverable	87,700	1	Y	µg/L	0	WA
		Sulfate	164,000	50	Y	µg/L	0	WA

● = exceeded holding time. ■ = exceeded screening level or final PDWS.

WELL HAC 2 collected on 07/20/94, laboratory analyses (cont.)

H	ST	Analyte	Result	DF	Mod	Unit	Flag	Lab
		Tetrachloroethylene	<1.0	1	Y	µg/L	0	WA
		Total dissolved solids	247,000	1	VY	µg/L	0	WA
		Total organic carbon	<1,000	1	Y	µg/L	0	WA
		Total organic halogens	110	2	Y	µg/L	2	WA
		Total phosphates (as P)	<50	1	Y	µg/L	0	WA
		Toxaphene	<1.0	1.04	Y	µg/L	0	WA
		2,4,5-TP (Silvex)	<0.55	1.09	Y	µg/L	0	WA
		1,1,1-Trichloroethane	1.9	1	Y	µg/L	0	WA
		Trichloroethylene	<1.0	1	Y	µg/L	0	WA
		Gross alpha	1.2E+00	1	UI	pCi/L	0	GP
		Nonvolatile beta	3.4E-01	1	UI	pCi/L	0	GP
	■	Tritium	3.9E+01	1		pCi/mL	2	GP

WELL HAC 3

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N72183.4 E61313.6	33.285461 °N 81.645564 °W	275.0-255.0 ft msl	298 ft msl	4" PVC	S	Water Table

FIELD MEASUREMENTS

Sample date: 07/21/94
Depth to water: 30.10 ft (9.17 m) below TOC
Water elevation: 267.90 ft (81.66 m) msl
Sp. conductance: 292 µS/cm
Turbidity: 39.2 NTU
Water evacuated before sampling: 6 gal
The well went dry during purging.

Time: 13:37
pH: 5.1
Alkalinity: 0 mg/L
Water temperature: 23.7 °C

Volumes purged: 0.7 well volumes

LABORATORY ANALYSES

H	ST	Analyte	Result	DF	Mod	Unit	Flag	Lab
●		pH	4.9	1	JY3	pH	0	WA
		Specific conductance	169	1	Y	µS/cm	0	WA
		Specific conductance	168	1	Y	µS/cm	0	WA
●		Turbidity	3.8	1	JY3	NTU	0	WA
●		Turbidity	3.5	1	JY3	NTU	0	WA
		Aluminum, total recoverable	303	1	Y	µg/L	2	WA
		Arsenic, total recoverable	<2.0	1	Y	µg/L	0	WA
		Barium, total recoverable	9.8	1	Y	µg/L	0	WA
		Cadmium, total recoverable	<2.0	1	Y	µg/L	0	WA
		Calcium, total recoverable	282	1	VY	µg/L	0	WA
		Carbon tetrachloride	<1.0	1	Y	µg/L	0	WA
		Chloride	6,800	1	Y	µg/L	0	WA
		Chloroform	<1.0	1	Y	µg/L	0	WA
		Chromium, total recoverable	<4.0	1	Y	µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1	1.1	Y	µg/L	0	WA
		Endrin	<0.10	1.04	Y	µg/L	0	WA
		Fluoride	<100	1	Y	µg/L	0	WA
		Fluoride	<100	1	Y	µg/L	0	WA
		Iron, total recoverable	678	1	Y	µg/L	2	WA
		Lead, total recoverable	12	1	Y	µg/L	0	WA
		Lindane	<0.052	1.04	Y	µg/L	0	WA
		Magnesium, total recoverable	280	1	Y	µg/L	0	WA

● = exceeded holding time. ■ = exceeded screening level or final PDWS.

WELL HAC 3 collected on 07/21/94, laboratory analyses (cont.)

H	ST	Analyte	Result	DF	Mod	Unit	Flag	Lab
		Manganese, total recoverable	61	1	Y	μg/L	2	WA
		Mercury, total recoverable	0.50	1	Y	μg/L	0	WA
		Methoxychlor	<0.52	1.04	Y	μg/L	0	WA
		Nitrate as nitrogen	1,600	5	Y	μg/L	0	WA
		Phenols	<5.0	1	Y	μg/L	0	WA
		Potassium, total recoverable	<500	1	Y	μg/L	0	WA
		Selenium, total recoverable	<2.0	1	Y	μg/L	0	WA
		Silica, total recoverable	4,980	2.1	VY	μg/L	0	WA
		Silver, total recoverable	<2.0	1	Y	μg/L	0	WA
		Sodium, total recoverable	25,100	1	VY	μg/L	0	WA
		Sulfate	50,400	20	Y	μg/L	0	WA
		Tetrachloroethylene	<1.0	1	Y	μg/L	0	WA
		Total dissolved solids	47,000	1	Y	μg/L	0	WA
		Total organic carbon	<1,000	1	Y	μg/L	0	WA
		Total organic halogens	46	2	Y	μg/L	1	WA
		Total phosphates (as P)	<50	1	Y	μg/L	0	WA
		Toxaphene	<1.0	1.04	Y	μg/L	0	WA
		2,4,5-TP (Silvex)	<0.55	1.1	Y	μg/L	0	WA
		1,1,1-Trichloroethane	1.7	1	Y	μg/L	0	WA
		Trichloroethylene	<1.0	1	Y	μg/L	0	WA
		Gross alpha	8.8E-01	1	JY3	pCi/L	0	GP
		Nonvolatile beta	1.2E+00	1	JY3	pCi/L	0	GP
	■	Tritium	3.7E+01	1	Y	pCi/mL	2	GP

WELL HAC 4

SRS Coord.	Lat/Longitude	Screen Zone Elevation	Top of Casing	Casing	Pump	Formation
N72120.3 E61372.0	33.285416 °N 81.645287 °W	274.1-254.1 ft msl	296.9 ft msl	4" PVC	S	Water Table

FIELD MEASUREMENTS

Sample date: 07/21/94
Depth to water: 28.56 ft (8.71 m) below TOC
Water elevation: 268.34 ft (81.79 m) msl
Sp. conductance: 57 μS/cm
Turbidity: 0.4 NTU
Water evacuated before sampling: 40 gal

Time: 12:52
pH: 4.8
Alkalinity: 0 mg/L
Water temperature: 23.1 °C

Volumes purged: 4.3 well volumes

LABORATORY ANALYSES

H	ST	Analyte	Result	DF	Mod	Unit	Flag	Lab
●		pH	4.8	1	J1	pH	0	GE
●		pH	5.0	1	J1	pH	0	GE
●		pH	5.2	1	J1	pH	0	GE
●		pH	5.1	1	JY3	pH	0	WA
●		pH	5.0	1	JY3	pH	0	WA
		Specific conductance	45	1		μS/cm	0	GE
		Specific conductance	46	1		μS/cm	0	GE
		Specific conductance	43	1	Y	μS/cm	0	WA
		Specific conductance	43	1	Y	μS/cm	0	WA
		Turbidity	<0.10	1		NTU	0	GE
		Turbidity	<0.10	1		NTU	0	GE

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WELL HAC 4 collected on 07/21/94, laboratory analyses (cont.)

H	ST	Analyte	Result	DF	Mod	Unit	Flag	Lab
		Turbidity	0.12	1	J3	NTU	0	GE
●		Turbidity	0.21	1	JY3	NTU	0	WA
●		Turbidity	0.74	1	JY3	NTU	0	WA
		Aluminum, total recoverable	98	1		µg/L	2	GE
		Aluminum, total recoverable	97	1		µg/L	2	GE
		Aluminum, total recoverable	111	1	Y	µg/L	2	WA
		Aluminum, total recoverable	123	1	Y	µg/L	2	WA
		Aluminum, total recoverable	105	1	Y	µg/L	2	WA
		Arsenic, total recoverable	<2.0	1		µg/L	0	GE
		Arsenic, total recoverable	<2.0	1		µg/L	0	GE
		Arsenic, total recoverable	<2.0	1	Y	µg/L	0	WA
		Arsenic, total recoverable	<2.0	1	Y	µg/L	0	WA
		Arsenic, total recoverable	<2.0	1	Y	µg/L	0	WA
		Barium, total recoverable	6.5	1		µg/L	0	GE
		Barium, total recoverable	6.2	1		µg/L	0	GE
		Barium, total recoverable	5.8	1	Y	µg/L	0	WA
		Barium, total recoverable	6.2	1	Y	µg/L	0	WA
		Barium, total recoverable	5.8	1	Y	µg/L	0	WA
		Cadmium, total recoverable	<2.0	1		µg/L	0	GE
		Cadmium, total recoverable	<2.0	1		µg/L	0	GE
		Cadmium, total recoverable	<2.0	1	Y	µg/L	0	WA
		Cadmium, total recoverable	<2.0	1	Y	µg/L	0	WA
		Cadmium, total recoverable	<2.0	1	Y	µg/L	0	WA
		Calcium, total recoverable	68	1		µg/L	0	GE
		Calcium, total recoverable	39	1		µg/L	0	GE
		Calcium, total recoverable	<135	1	JVY	µg/L	0	WA
		Calcium, total recoverable	<135	1	JVY	µg/L	0	WA
		Calcium, total recoverable	78	1	VY	µg/L	0	WA
	■	Carbon tetrachloride	8.5	1		µg/L	2	GE
	■	Carbon tetrachloride	6.6	1		µg/L	2	GE
	■	Carbon tetrachloride	8.5	1		µg/L	2	GE
	■	Carbon tetrachloride	7.7	1	Y	µg/L	2	WA
	■	Carbon tetrachloride	7.7	1	Y	µg/L	2	WA
		Chloride	3,530	1		µg/L	0	GE
		Chloride	3,410	1		µg/L	0	GE
		Chloride	3,530	1	Y	µg/L	0	WA
		Chloride	3,420	1	Y	µg/L	0	WA
		Chloroform	<1.0	1		µg/L	0	GE
		Chloroform	<1.0	1		µg/L	0	GE
		Chloroform	<1.0	1		µg/L	0	GE
		Chloroform	<1.0	1	Y	µg/L	0	WA
		Chloroform	<1.0	1	Y	µg/L	0	WA
		Chromium, total recoverable	<4.0	1		µg/L	0	GE
		Chromium, total recoverable	<4.0	1		µg/L	0	GE
		Chromium, total recoverable	<4.0	1	Y	µg/L	0	WA
		Chromium, total recoverable	<4.0	1	Y	µg/L	0	WA
		Chromium, total recoverable	<4.0	1	Y	µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<0.0015	1		µg/L	0	GE
		2,4-Dichlorophenoxyacetic acid	<0.0015	1		µg/L	0	GE
		2,4-Dichlorophenoxyacetic acid	<1.1	1.11	Y	µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1	1.08	Y	µg/L	0	WA
		Endrin	<0.0060	1		µg/L	0	GE
		Endrin	<0.0060	1		µg/L	0	GE
		Endrin	<0.10	1.04	Y	µg/L	0	WA
		Endrin	<0.11	1.06	Y	µg/L	0	WA
		Fluoride	<20	1		µg/L	0	GE

● = exceeded holding time. ■ = exceeded screening level or final PDWS.

WELL HAC 4 collected on 07/21/94, laboratory analyses (cont.)

H	ST	Analyte	Result	DF	Mod	Unit	Flag	Lab
		Fluoride	<20	1		µg/L	0	GE
		Fluoride	<100	1	Y	µg/L	0	WA
		Fluoride	<100	1	Y	µg/L	0	WA
		Iron, total recoverable	21	1		µg/L	0	GE
		Iron, total recoverable	22	1		µg/L	0	GE
		Iron, total recoverable	96	1	Y	µg/L	0	WA
		Iron, total recoverable	101	1	Y	µg/L	0	WA
		Iron, total recoverable	69	1	Y	µg/L	0	WA
		Lead, total recoverable	5.3	1		µg/L	0	GE
		Lead, total recoverable	5.2	1		µg/L	0	GE
		Lead, total recoverable	4.9	1	Y	µg/L	0	WA
		Lead, total recoverable	5.0	1	Y	µg/L	0	WA
		Lead, total recoverable	5.6	1	Y	µg/L	0	WA
		Lindane	<0.0050	1		µg/L	0	GE
		Lindane	<0.0050	1		µg/L	0	GE
		Lindane	<0.052	1.04	Y	µg/L	0	WA
		Lindane	<0.053	1.06	Y	µg/L	0	WA
		Magnesium, total recoverable	214	1		µg/L	0	GE
		Magnesium, total recoverable	212	1		µg/L	0	GE
		Magnesium, total recoverable	201	1	Y	µg/L	0	WA
		Magnesium, total recoverable	211	1	Y	µg/L	0	WA
		Magnesium, total recoverable	206	1	Y	µg/L	0	WA
		Manganese, total recoverable	14	1		µg/L	0	GE
		Manganese, total recoverable	14	1		µg/L	0	GE
		Manganese, total recoverable	15	1	Y	µg/L	0	WA
		Manganese, total recoverable	16	1	Y	µg/L	0	WA
		Manganese, total recoverable	14	1	Y	µg/L	0	WA
		Mercury, total recoverable	<0.20	1		µg/L	0	GE
		Mercury, total recoverable	<0.20	1		µg/L	0	GE
		Mercury, total recoverable	<0.20	1		µg/L	0	GE
		Mercury, total recoverable	<0.20	1	Y	µg/L	0	WA
		Mercury, total recoverable	<0.20	1	Y	µg/L	0	WA
		Mercury, total recoverable	<0.20	1	Y	µg/L	0	WA
		Methoxychlor	<0.50	1		µg/L	0	GE
		Methoxychlor	<0.50	1		µg/L	0	GE
		Methoxychlor	<0.52	1.04	Y	µg/L	0	WA
		Methoxychlor	<0.53	1.06	Y	µg/L	0	WA
		Nitrate as nitrogen	1,710	5	Y	µg/L	0	WA
		Nitrate as nitrogen	1,720	5	Y	µg/L	0	WA
		Nitrate-nitrite as nitrogen	1,790	1		µg/L	0	GE
		Nitrate-nitrite as nitrogen	1,930	1		µg/L	0	GE
		Phenols	<5.0	1		µg/L	0	GE
		Phenols	<5.0	1		µg/L	0	GE
		Phenols	<5.0	1	Y	µg/L	0	WA
		Phenols	<5.0	1	Y	µg/L	0	WA
		Potassium, total recoverable	<500	1		µg/L	0	GE
		Potassium, total recoverable	<500	1		µg/L	0	GE
		Potassium, total recoverable	<500	1	Y	µg/L	0	WA
		Potassium, total recoverable	<500	1	Y	µg/L	0	WA
		Potassium, total recoverable	<500	1	Y	µg/L	0	WA
		Selenium, total recoverable	<2.0	1		µg/L	0	GE
		Selenium, total recoverable	<2.0	1		µg/L	0	GE
		Selenium, total recoverable	<2.0	1	Y	µg/L	0	WA
		Selenium, total recoverable	<2.0	1	Y	µg/L	0	WA
		Selenium, total recoverable	<2.0	1	Y	µg/L	0	WA
		Silica, total recoverable	5,520	1		µg/L	0	GE

● = exceeded holding time. ■ = exceeded screening level or final PDWS.

WELL HAC 4 collected on 07/21/94, laboratory analyses (cont.)

H	ST	Analyte	Result	DF	Mod	Unit	Flag	Lab
		Silica, total recoverable	5,490	1		µg/L	0	GE
		Silica, total recoverable	5,450	2.1	JY3	µg/L	0	WA
		Silica, total recoverable	5,640	2.1	JY3	µg/L	0	WA
		Silica, total recoverable	5,530	2.1	Y	µg/L	0	WA
		Silver, total recoverable	<2.0	1		µg/L	0	GE
		Silver, total recoverable	<2.0	1		µg/L	0	GE
		Silver, total recoverable	<2.0	1	Y	µg/L	0	WA
		Silver, total recoverable	<2.0	1	Y	µg/L	0	WA
		Silver, total recoverable	<2.0	1	Y	µg/L	0	WA
		Sodium, total recoverable	7,150	1		µg/L	0	GE
		Sodium, total recoverable	7,160	1		µg/L	0	GE
		Sodium, total recoverable	7,040	1	Y	µg/L	0	WA
		Sodium, total recoverable	7,140	1	Y	µg/L	0	WA
		Sodium, total recoverable	6,970	1	Y	µg/L	0	WA
		Sulfate	4,730	1		µg/L	0	GE
		Sulfate	4,650	1		µg/L	0	GE
		Sulfate	5,520	1	Y	µg/L	0	WA
		Sulfate	5,920	1	Y	µg/L	0	WA
		Tetrachloroethylene	<1.0	1		µg/L	0	GE
		Tetrachloroethylene	<1.0	1		µg/L	0	GE
		Tetrachloroethylene	<1.0	1		µg/L	0	GE
		Tetrachloroethylene	<1.0	1	Y	µg/L	0	WA
		Tetrachloroethylene	<1.0	1	Y	µg/L	0	WA
		Total dissolved solids	24,000	1		µg/L	0	GE
		Total dissolved solids	26,000	1		µg/L	0	GE
		Total dissolved solids	39,000	1	Y	µg/L	0	WA
		Total dissolved solids	7,000	1	Y	µg/L	0	WA
		Total organic carbon	<1,000	1		µg/L	0	GE
		Total organic carbon	<1,000	1		µg/L	0	GE
		Total organic carbon	<1,000	1	Y	µg/L	0	WA
		Total organic carbon	<1,000	1	Y	µg/L	0	WA
		Total organic halogens	13	1		µg/L	0	GE
		Total organic halogens	15	1		µg/L	0	GE
		Total organic halogens	12	1	Y	µg/L	0	WA
		Total organic halogens	11	1	Y	µg/L	0	WA
		Total phosphates (as P)	628	1		µg/L	0	GE
		Total phosphates (as P)	<50	1		µg/L	0	GE
		Total phosphates (as P)	156	1	Y	µg/L	0	WA
		Total phosphates (as P)	282	1	Y	µg/L	0	WA
		Toxaphene	<0.24	1		µg/L	0	GE
		Toxaphene	<0.24	1		µg/L	0	GE
		Toxaphene	<1.0	1.04	Y	µg/L	0	WA
		Toxaphene	<1.1	1.06	Y	µg/L	0	WA
		2,4,5-TP (Silvex)	<0.00044	1		µg/L	0	GE
		2,4,5-TP (Silvex)	<0.00045	1		µg/L	0	GE
		2,4,5-TP (Silvex)	<0.56	1.11	Y	µg/L	0	WA
		2,4,5-TP (Silvex)	<0.54	1.08	Y	µg/L	0	WA
		1,1,1-Trichloroethane	<1.0	1		µg/L	0	GE
		1,1,1-Trichloroethane	<1.0	1		µg/L	0	GE
		1,1,1-Trichloroethane	<1.0	1	Y	µg/L	0	WA
		1,1,1-Trichloroethane	<1.0	1	Y	µg/L	0	WA
		Trichloroethylene	2.2	1		µg/L	0	GE
		Trichloroethylene	2.1	1		µg/L	0	GE
		Trichloroethylene	2.3	1		µg/L	0	GE
		Trichloroethylene	2.0	1	Y	µg/L	0	WA
		Trichloroethylene	2.0	1	Y	µg/L	0	WA

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WELL HAC 4 collected on 07/21/94, laboratory analyses (cont.)

H	ST	Analyte	Result	DF	Mod	Unit	Flag	Lab
		Gross alpha	1.9E+00	1	J3	pCi/L	0	GP
		Gross alpha	1.4E+00	1	J3	pCi/L	0	GP
		Gross alpha	3.1E+00	1		pCi/L	0	TM
		Gross alpha	2.5E+00	1		pCi/L	0	TM
		Gross alpha	3.6E+00	1		pCi/L	0	TM
		Nonvolatile beta	1.6E+00	1	UI	pCi/L	0	GP
		Nonvolatile beta	9.0E-01	1	UI	pCi/L	0	GP
		Nonvolatile beta	1.2E+00	1	UI	pCi/L	0	TM
		Nonvolatile beta	3.0E+00	1		pCi/L	0	TM
		Nonvolatile beta	1.0E+00	1	UI	pCi/L	0	TM
	■	Tritium	3.3E+01	1		pCi/mL	2	GP
	■	Tritium	3.2E+01	1		pCi/mL	2	GP
	■	Tritium	3.0E+01	1		pCi/mL	2	TM
	■	Tritium	3.0E+01	1		pCi/mL	2	TM
	■	Tritium	3.1E+01	1		pCi/mL	2	TM

● = exceeded holding time. ■ = exceeded screening level or final PDWS.

Appendix E

Data Quality/Usability Assessment

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Data Quality/Usability 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 review by the Environmental Protection Department/Environmental Monitoring Section (EPD/EMS) 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 usability 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 quarterly summaries. Properly defined and used result modifiers (also referred to as qualifiers) can be a key component in assessing data usability. Result modifiers designed by EPD/EMS and used by 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 groundwater monitoring quarterly reports. 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 exceed 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 acid compounds and three base/neutral compounds are used. Two surrogates are used in organochlorine 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 reanalyze the samples or attach 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 the sample is spiked with known concentrations of compounds appropriate to the analyses being performed, typically five volatile organic compounds for volatile organics analyses, eleven semivolatile compounds for semivolatiles, six pesticide compounds for pesticides, all metals for metals analyses by SW-846 methods (EPA, 1986), 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 laboratory 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 assigned by the laboratories on the basis of the percentage of spike recovery 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 initiated by the laboratory and blind replicates provided by EPD/EMS. The results of duplicate and replicate analyses are presented in those results tables of the quarterly reports which report only one quarter of data, usually during first, second, and third quarters. Duplicate and replicate results are not presented in results tables that report more than one quarter of data, generally provided in fourth quarter reports. In this case, the results tables instead present only the highest result for each analyte for each quarter of the year.

The laboratories assess precision by calculating the relative percent difference (RPD) for each pair of laboratory-initiated duplicate results. One of the contract laboratories uses a data qualifier (J3) to modify metals analyses when the RPD for laboratory duplicates is greater than 20 percent.

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 mean relative difference (MRD) which is similar to EPA's RPD except that the MRD is the average of all the RPD values from one laboratory for each compound (intralaboratory MRD) or all the RPD values from all laboratories for each compound (interlaboratory MRD), 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 duplicate and replicate 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 usability. 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 a 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 fourth quarter 1993 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.

Methods Used by the Contract Laboratories

Method	Used to Analyze	Source
EPA120.1	Specific conductance	EPA EMSL, 1983
EPA150.1	pH	EPA EMSL, 1983
EPA160.1	Total dissolved solids	EPA EMSL, 1983
EPA160.2	Total dissolved solids, total suspended solids	EPA EMSL, 1983
EPA180.1	Turbidity	EPA EMSL, 1983
EPA200.7	Metals	EPA EMSL, 1983
EPA204.2	Antimony	EPA EMSL, 1983
EPA206.2	Arsenic	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	Chloride, nitrite, sulfate	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
EPA365.1	Phosphorus, all forms (reported as total phosphates)	EPA EMSL, 1983
EPA365.2	Phosphorus, all forms (reported as total phosphates)	EPA EMSL, 1983
EPA376.2	Sulfide	EPA EMSL, 1983
EPA413.1	Oil & grease	EPA EMSL, 1983
EPA415.1	Dissolved organic carbon, total inorganic carbon, total organic carbon	EPA EMSL, 1983
EPA418.1	Total petroleum hydrocarbons	EPA EMSL, 1983
EPA420.2	Phenols	EPA EMSL, 1983
EPA900.0	Gross alpha, nonvolatile beta	EPA EMSL, 1980
EPA900.1	Total alpha-emitting radium	EPA EMSL, 1980
EPA906.0	Tritium	EPA EMSL, 1980
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	Chlorinated volatile organics	EPA, 1986
EPA8080	Organochlorine pesticides and PCBs	EPA, 1986
EPA8150	Chlorinated herbicides	EPA, 1986
EPA8240	GCMS volatiles	EPA, 1986
EPA8270	GCMS semivolatiles	EPA, 1986
EPA8280	Dioxins and furans	EPA, 1986
EPA9012	Cyanide	EPA, 1986
EPA9020	Total organic halogens	EPA, 1986
EPA9020A	Total organic halogens	EPA, 1986
EPA9030	Sulfide	EPA, 1986

Method	Used to Analyze	Source
EPA9060	Dissolved organic carbon, total inorganic carbon, total organic carbon	EPA, 1986

An example of 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 spiked 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]
Aluminum	60	62	33
Arsenic	22	19	23
Beryllium	20	20	9.8
Cadmium	2.5	2.9	16
Chromium	10	10	18
Cobalt	20	20	4.1
Copper	11	11	40
Iron	20	19	15
Lead	24	30	32
Manganese	15	15	6.7
Nickel	30	28	11
Selenium	6	8.5	42
Vanadium	70	69	2.9
Zinc	16	19	45

[a] Relative standard deviation. In EPA (1986), the column heading is Mean Standard Deviation (%).

As another example, EPA Method 601/8010 (EPA, 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]	$1.00C$	$0.20\bar{X}$	$0.35\bar{X}$

Parameter	Accuracy as recovery, X' (μg/L)	Single analyst precision (μg/L)	Overall precision (μg/L)
Chloroform	0.93*C*−0.39	$0.13\bar{X}+0.15$	$0.19\bar{X}-0.02$
Chloromethane	0.77*C*+0.18	$0.28\bar{X}-0.31$	$0.52\bar{X}+1.31$
Dibromochloromethane	0.94*C*+2.72	$0.11\bar{X}+1.10$	$0.24\bar{X}+1.68$
1,2-Dichlorobenzene	0.93*C*+1.70	$0.20\bar{X}+0.97$	$0.13\bar{X}+6.13$
1,3-Dichlorobenzene	0.95*C*+0.43	$0.14\bar{X}+2.33$	$0.26\bar{X}+2.34$
1,4-Dichlorobenzene	0.93*C*−0.09	$0.15\bar{X}+0.29$	$0.20\bar{X}+0.41$
1,1-Dichloroethane	0.95*C*−1.08	$0.09\bar{X}+0.17$	$0.14\bar{X}+0.94$
1,2-Dichloroethane	1.04*C*−1.06	$0.11\bar{X}+0.70$	$0.15\bar{X}+0.94$
1,1-Dichloroethene	0.98*C*−0.87	$0.21\bar{X}-0.23$	$0.29\bar{X}-0.40$
trans-1,2-Dichloroethene	0.97*C*−0.16	$0.11\bar{X}+1.46$	$0.17\bar{X}+1.46$
Dichloromethane (Methylene chloride)	0.91*C*−0.93	$0.11\bar{X}+0.33$	$0.21\bar{X}+1.43$
1,2-Dichloropropane[f]	1.00*C*	$0.13\bar{X}$	$0.23\bar{X}$
cis-1,3-Dichloropropene[f]	1.00*C*	$0.18\bar{X}$	$0.32\bar{X}$
trans-1,3-Dichloropropene[f]	1.00C	$0.18\bar{X}$	$0.32\bar{X}$
1,1,2,2-Tetrachloroethane	0.95*C*+0.19	$0.14\bar{X}+2.41$	$0.23\bar{X}+2.79$
Tetrachloroethylene	0.94*C*+0.06	$0.14\bar{X}+0.38$	$0.18\bar{X}+2.21$
1,1,1-Trichloroethane	0.90*C*−0.16	$0.15\bar{X}+0.04$	$0.20\bar{X}+0.37$
1,1,2-Trichloroethane	0.86*C*+0.30	$0.13\bar{X}-0.14$	$0.19\bar{X}+0.67$
Trichloroethylene	0.87*C*+0.48	$0.13\bar{X}-0.03$	$0.23\bar{X}+0.30$
Trichlorofluoromethane	0.89*C*−0.07	$0.15\bar{X}+0.67$	$0.26\bar{X}+0.91$
Vinyl chloride	0.97*C*−0.36	$0.13\bar{X}+0.65$	$0.27\bar{X}+0.40$

[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] $\bar{X}$ = average recovery found for measurements of samples containing a concentration of *C*, in μg/L.
[f] Estimates based on performance of a single laboratory.

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