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

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Abstract

During third quarter 1993, samples collected from the four HAC monitoring wells at the H-Area Acid/Caustic Basin received comprehensive analyses and turbidity measurements. Monitoring results that exceeded the final Primary Drinking Water Standards (PDWS) or the Savannah River Site (SRS) flagging criteria or turbidity standard during the quarter are the focus of this report.

Tritium exceeded the final PDWS and aluminum exceeded its Flag 2 criterion in all four HAC wells during third quarter 1993. Iron was elevated in wells HAC 1, 2, and 3. Chromium was reported above the final PDWS in well HAC 2. Lead exceeded its Flag 2 criterion in HAC 1, specific conductance in HAC 3, and manganese in HAC 3. No well samples exceeded the SRS turbidity standard.

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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 1993, samples from the monitoring wells received comprehensive analyses. 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 1993, tritium exceeded the final PDWS in all four HAC wells, with activities between 3.7E+01 and 4.6E+01 pCi/mL. Chromium was detected above its PDWS in well HAC 2 at 118 μg/L. Aluminum exceeded its Flag 2 criterion in all four wells. Iron exceeded its Flag 2 criterion in wells HAC 1, 2, and 3. Lead exceeded its Flag 2 criterion in well HAC 1, specific conductance was elevated in well HAC 2, and manganese was above standard in well HAC 3. No well samples exceeded the SRS turbidity standard.

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). 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. 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 (District of South Carolina, Aiken Division), the basin became subject effective June 1, 1988, to requirements of Subtitle C of the Resource Conservation and Recovery Act (RCRA), the South Carolina Hazardous Waste Management Regulations (SCHWMR), and associated regulations. 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 were installed at the H-Area Acid/Caustic Basin.

The monitoring wells at the H-Area Acid/Caustic Basin are sampled quarterly as part of the SRS Groundwater Monitoring Program and to comply with SCHWMR. The revised Groundwater Quality Assessment Plan (WSRC, 1991), submitted to the South Carolina Department of Health and Environmental Control on April 30, 1991, indicates 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.

Discussion

Groundwater Monitoring Data

The groundwater sampling procedure was modified beginning fourth quarter 1992 in response to regulatory guidance and advances in sampling equipment design (EPD/EMS, 1992). The modified procedure 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.

A further modification in the procedure is that samples collected for metals analyses are not filtered. Thus, the analyses are for total metals rather than dissolved metals.

During third quarter 1993, samples from the four monitoring wells at the H-Area Acid/ Caustic Basin received comprehensive analyses. 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 (Appendix B), or the SRS turbidity standard.

The SRS flagging criteria are based on final and proposed PDWS, Secondary Drinking Water Standards, and method detection limits. Constituent levels that equal or exceed the final PDWS, screening levels, or Flag 2 criteria are described 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.

Appendix C presents illustrations of the monitored waste management unit at SRS (Figure 1), the individual monitoring wells (Figure 2), and the flow directions of the groundwater beneath the basin (Figure 3). All figures are aligned to true north. Figure 1 has both SRS grid coordinates and latitude/longitude. Figures 2 and 3 have latitude/longitude coordinates as well as Universal Transverse Mercator (UTM) coordinates. Monitoring results are presented in Appendix D, and a discussion of data quality and useability is in Appendix E.

Analytical Results Exceeding Standards

Results for analytes that exceeded the final PDWS (see Appendix A) during third quarter 1993 are summarized in Table 1 (Appendix D). All four HAC wells contained tritium activities that exceeded the final PDWS, with activities ranging from 3.7E+01 to 4.6E+01 pCi/mL. Well HAC 2 also contained levels of chromium above the final PDWS at 118 μg/L.

Constituents that exceeded other Flag 1 and 2 criteria (see Appendix B) during third quarter 1993 are summarized in Table 2 (Appendix D). Aluminum, which was added to the list of comprehensive analyses beginning first quarter 1993, was elevated in all four wells, with a maximum concentration of 259 μg/L in well HAC 2. Iron exceeded the Flag 2 criterion in wells HAC 1, 2, and 3, with a maximum concentration of 3,080 μg/L in HAC 2. Lead exceeded the Flag 2 criterion in well HAC 1 at 28 μg/L, specific conductance was elevated in HAC 2 at 519 μS/cm, and manganese was elevated in HAC 3 at 85 μg/L.

Table 3 (Appendix D) presents all of the results for individual wells and indicates those analyses that exceeded holding times and the final PDWS. Modifiers (qualifiers) which may appear in the *Mod* column of Table 3 are defined on pp. D-3 and D-4.

Table 3 also lists the number of well volumes of water purged from each well during third quarter 1993 at the H-Area Acid/Caustic Basin. Wells HAC 1, 2, and 3 went dry before meeting the criteria for purging and stabilization.

Some of the values for earlier quarters presented in Table 1 of this report may differ from the values for the same quarters presented in previous reports because some reanalyses may have been performed by the laboratories after the quarterly reports had gone to press.

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 correspond to 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 1993, 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 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 UTM coordinates) determined from this quarter's water-level elevations for wells HAC 1, 2, 3, and 4 and HTF 13, 14, 15, 16, 17, 18, 19, 20, and 21 is consistent with the historical flow pattern.

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% (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 = 8 ft and dl = 640 ft (see Figure 3 in Appendix C), the flow rate estimate for groundwater in the water table beneath the H-Area Acid/Caustic Basin is as follows:

$$\frac{10}{0.20} \times \frac{8}{640} = 0.63 \text{ ft/day}$$

$$0.63 \text{ ft/day} \times 365 \text{ days} \approx 230 \text{ ft/yr}$$

This result is consistent with those of recent quarters except the apparently anomalous flow rate of 580 ft/yr calculated for fourth quarter 1992.

Results for Upgradient vs. Downgradient Wells

Well HAC 4 is the upgradient well, and HAC 1, 2, and 3 are the downgradient wells at the H-Area Acid/Caustic Basin. During third quarter 1993, tritium and aluminum were detected at elevated levels in the upgradient well. Tritium also exceeded the PDWS in all three downgradient wells, at very similar activities to those in HAC 4. Aluminum also exceeded its Flag 2 criterion in all three downgradient wells. Chromium exceeded the PDWS only in downgradient well HAC 2. Iron, not detected above standards in the upgradient well, exceeded the Flag 2 criterion in all three downgradient wells, as did lead in HAC 1, specific conductance in HAC 2, and manganese in HAC 3.

Conclusions

Tritium activities exceeded the final PDWS during third quarter 1993 in all four HAC wells, with activities ranging between 3.7E+01 and 4.6E+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. Releases of tritium from 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.

Chromium was reported above the PDWS in well HAC 2. Aluminum also exceeded standards in all four wells. Iron exceeded the Flag 2 criterion in downgradient wells HAC 1, 2, and 3. Lead exceeded its Flag 2 criterion in well HAC 1, specific conductance in HAC 2, and manganese in HAC 3. 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.

Water-table elevations at the H-Area Acid/Caustic Basin indicate that groundwater flow is toward the northwest at a rate of approximately 230 ft/yr; this flow direction is consistent with the historical flow pattern. 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

Third Quarter 1992:

- Prior to third quarter 1992, the results of certain analyses for *nitrate-nitrite as nitrogen* were reported incorrectly by the General Engineering laboratory as *nitrate as nitrogen* results. The analyses in the results tables beginning with this report are reported correctly (*nitrate-nitrite* results have been separated from true *nitrate* results).

Fourth Quarter 1992:

- No errata have been reported.

First Quarter 1993:

- No errata have been reported.

Second Quarter 1993:

- No errata have been reported.

Appendix A – Final Primary Drinking Water Standards

Final Primary Drinking Water Standards

Analyte	Unit	Level	Status	Source
Antimony	µg/L	6	Final	EPA, 1992b
Arsenic	µg/L	50	Final	EPA, 1992a
Asbestos	fibers/L	7,000,000	Final	EPA, 1992a
Barium	µg/L	2,000	Final	EPA, 1992a
Benzene	µg/L	5	Final	EPA, 1992a
Benzo[a]pyrene	µg/L	0.2	Final	EPA, 1992b
Beryllium	µg/L	4	Final	EPA, 1992b
Bis(2-ethylhexyl) phthalate	µg/L	6	Final	EPA, 1992b
Bromodichloromethane	µg/L	100[a]	Final	EPA, 1992a
Bromoform	µg/L	100[a]	Final	EPA, 1992a
2-sec-Butyl-4,6-dinitrophenol	µg/L	7	Final	EPA, 1992b
Cadmium	µg/L	5	Final	EPA, 1992a
Carbon tetrachloride	µg/L	5	Final	EPA. 1992a
Chlordane	µg/L	2	Final	EPA, 1992a
Chlorobenzene	µg/L	100	Final	EPA, 1992a
Chloroethene (Vinyl chloride)	µg/L	2	Final	EPA, 1992a
Chloroform	µg/L	100[a]	Final	EPA, 1992a
Chromium	µg/L	100	Final	EPA, 1992a
Copper	µg/L	1,300	Final	EPA, 1992a
Cyanide	µg/L	200	Final	EPA, 1992b
Dibromochloromethane	µg/L	100[a]	Final	EPA, 1992a
Dibromochloropropane	µg/L	0.2	Final	EPA, 1992a
1,2-Dibromoethane (Ethylene dibromide)	µg/L	0.05	Final	EPA, 1992a
1,2-Dichlorobenzene	µg/L	600	Final	EPA, 1992a
1,4-Dichlorobenzene	µg/L	75	Final	EPA, 1992a
1,2-Dichloroethane	µg/L	5	Final	EPA, 1992a
1,1-Dichloroethene	µg/L	7	Final	EPA, 1992a
1,2-Dichloroethene	µg/L	50	Final	EPA, 1992b
cis-1,2-Dichloroethene	µg/L	70	Final	EPA, 1992a
trans-1,2-Dichloroethene	µg/L	100	Final	EPA, 1992a
Dichloromethane (Methylene chloride)	µg/L	5	Final	EPA, 1992b
2,4-Dichlorophenoxyacetic acid	µg/L	70	Final	EPA, 1992a
1,2-Dichloropropane	µg/L	5	Final	EPA, 1992a
Endrin	µg/L	2	Final	EPA, 1992b
Ethylbenzene	µg/L	700	Final	EPA, 1992a
Fluoride	µg/L	4,000	Final	EPA, 1992a
Gross alpha[b]	pCi/L	1.5E+01	Final	EPA, 1992a
Heptachlor	µg/L	0.4	Final	EPA, 1992a
Heptachlor epoxide	µg/L	0.2	Final	EPA, 1992a
Hexachlorobenzene	µg/L	1	Final	EPA, 1992b
Hexachlorocyclopentadiene	µg/L	50	Final	EPA, 1992b
Lead	µg/L	50	Final	SCDHEC, 1981
Lindane	µg/L	0.2	Final	EPA, 1992a
Mercury	µg/L	2	Final	EPA, 1992a
Methoxychlor	µg/L	40	Final	EPA, 1992a
Nickel	µg/L	100	Final	EPA, 1992b
Nitrate as nitrogen	µg/L	10,000	Final	EPA, 1992a
Nitrate-nitrite as nitrogen	µg/L	10,000	Final	EPA, 1992a
Nitrite as nitrogen	µg/L	1,000	Final	EPA, 1992a
Nonvolatile beta[c]	pCi/L	5E+01	Final	EPA, 1977
PCBs[d]	µg/L	0.5	Final	EPA, 1992a
Pentachlorophenol	µg/L	1	Final	EPA, 1992a
Radium, total (Radium-226 and -228)	pCi/L	5E+00	Final	EPA, 1992a

Analyte	Unit	Level	Status	Source
Selenium	µg/L	50	Final	EPA, 1992a
Strontium-89/90[e]	pCi/L	8E+00	Final	EPA, 1992a
Strontium-90	pCi/L	8E+00	Final	EPA, 1992a
Styrene	µg/L	100	Final	EPA, 1992a
2,3,7,8-TCDD	µg/L	0.00003	Final	EPA, 1992b
Tetrachloroethylene	µg/L	5	Final	EPA, 1992a
Thallium	µg/L	2	Final	EPA, 1992b
Toluene	µg/L	1,000	Final	EPA, 1992a
Total trihalomethanes	µg/L	100	Final	EPA, 1992a
Toxaphene	µg/L	3	Final	EPA, 1992a
2,4,5-TP (Silvex)	µg/L	50	Final	EPA, 1992a
1,2,4-Trichlorobenzene	µg/L	70	Final	EPA, 1992b
1,1,1-Trichloroethane	µg/L	200	Final	EPA, 1992a
1,1,2-Trichloroethane	µg/L	5	Final	EPA, 1992b
Trichloroethylene	µg/L	5	Final	EPA, 1992a
Tritium	pCi/mL	2E+01	Final	EPA, 1992a
Xylenes	µg/L	10,000	Final	EPA, 1992a

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[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

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Appendix B – Flagging Criteria

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

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)
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, 1992c)
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, 1992b)
Antimony-125	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Aramite	µg/L	50	100	EPA Method 8270
Arsenic	µg/L	25	50	Final PDWS (EPA, 1992a)

Analyte	Unit	Flag 1	Flag 2	Source[a]
Asbestos	Fibers/L	3,500,000	7,000,000	Final PDWS (EPA, 1992a)
Azobenzene	µg/L	50	100	EPA Method 625
Barium	µg/L	1,000	2,000	Final PDWS (EPA, 1992a)
Barium-140	pCi/L	4.5E+01	9E+01	Final PDWS (EPA, 1977)
Benzene	µg/L	2.5	5	Final PDWS (EPA, 1992a)
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, 1992b)
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, 1992b)
Beryllium-7	pCi/L	3E+03	6E+03	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, 1992b)
Bromide	µg/L	5,000	10,000	EPA Method 300.0
Bromodichloromethane	µg/L	50	100	Final PDWS (EPA, 1992a)
Bromoform	µg/L	50	100	Final PDWS (EPA, 1992a)
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	Final PDWS (EPA, 1992b)
Butylbenzyl phthalate		No flag	No flag	Set by EPD/EMS
Cadmium	µg/L	2.5	5	Final PDWS (EPA, 1992a)
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 PDWS (EPA, 1992a)
Carbon-14	pCi/L	1E+03	2E+03	Final PDWS (EPA, 1977)
Carbonate		No flag	No flag	Set by EPD/EMS
Cerium-141	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Cerium-144	pCi/L	1.31E+02	2.61E+02	Proposed PDWS (EPA, 1991)
Cesium-134[b]	pCi/L	4.07E+01	8.13E+01	Proposed PDWS (EPA, 1991)
Cesium-137	pCi/L	1E+02	2E+02	Final PDWS (EPA, 1977)
Chlordane	µg/L	1	2	Final PDWS (EPA, 1992a)
Chloride	µg/L	125,000	250,000	SDWS (EPA, 1992c)
4-Chloroaniline	µg/L	50	100	EPA Method 8270
Chlorobenzene	µg/L	50	100	Final PDWS (EPA, 1992a)
Chlorobenzilate	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, 1992a)
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, 1992a)
4-Chloro-m-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[a]
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, 1992a)
Chromium-51	pCi/L	3E+03	6E+03	Final PDWS (EPA, 1977)
Chrysene	µg/L	0.1	0.2	Proposed PDWS (EPA, 1990)
Cobalt	µg/L	20	40	EPA Method 6010
Cobalt-57	pCi/L	5E+02	1E+03	Final PDWS (EPA, 1977)
Cobalt-58	pCi/L	4.5E+03	9E+03	Final PDWS (EPA, 1977)
Cobalt-60	pCi/L	5E+01	1E+02	Final PDWS (EPA, 1977)
Color		No flag	No flag	Set by EPD/EMS
Copper	µg/L	650	1,300	Final PDWS (EPA, 1992a)
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[c]	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[c]	pCi/L	3.12E+00	6.23E+00	Proposed PDWS (EPA, 1991)
Curium-246	pCi/L	3.14E+00	6.27E+00	Proposed PDWS (EPA, 1991)
Cyanide	µg/L	100	200	Final PDWS (EPA, 1992b)
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
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 PDWS (EPA, 1990)
Dibenzofuran	µg/L	50	100	EPA Method 8270
Dibromochloromethane	µg/L	50	100	Final PDWS (EPA, 1992a)
1,2-Dibromo-3-chloropropane	µg/L	0.1	0.2	Final PDWS (EPA, 1992a)
1,2-Dibromoethane (Ethylene dibromide)	µg/L	0.025	0.05	Final PDWS (EPA, 1992a)
Dibromomethane (Methylene bromide)	µg/L	5	10	EPA Method 8240
1,2-Dichlorobenzene	µg/L	300	600	Final PDWS (EPA, 1992a)
1,3-Dichlorobenzene	µg/L	50	100	EPA Method 8270
1,4-Dichlorobenzene	µg/L	37.5	75	Final PDWS (EPA, 1992a)
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, 1992a)
1,1-Dichloroethene	µg/L	3.5	7	Final PDWS (EPA, 1992a)
1,2-Dichloroethene	µg/L	25	50	Final PDWS (EPA, 1992b)
cis-1,2-Dichloroethene	µg/L	35	70	Final PDWS (EPA, 1992a)
trans-1,2-Dichloroethene	µg/L	50	100	Final PDWS (EPA, 1992a)
Dichloromethane (Methylene chloride)	µg/L	2.5	5	Final PDWS (EPA, 1992b)
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, 1992a)
1,2-Dichloropropane	µg/L	2.5	5	Final PDWS (EPA, 1992a)
cis-1,3-Dichloropropene	µg/L	5	10	EPA Method 8240

Analyte	Unit	Flag 1	Flag 2	Source[a]
trans-1,3-Dichloropropene	µg/L	5	10	EPA Method 8240
Dieldrin	µg/L	2.5	5	EPA Method 8080
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
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	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
Endrin	µg/L	1	2	Final PDWS (EPA, 1992b)
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, 1992a)
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	Final PDWS (EPA, 1977)
Europium-154	pCi/L	1E+02	2E+02	Final PDWS (EPA, 1977)
Europium-155	pCi/L	3E+02	6E+02	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, 1992a)
Gross alpha	pCi/L	7.5E+00	1.5E+01	Final PDWS (EPA, 1992a)
Heptachlor	µg/L	0.2	0.4	Final PDWS (EPA, 1992a)
Heptachlor epoxide	µg/L	0.1	0.2	Final PDWS (EPA, 1992a)
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, 1992b)
Hexachlorobutadiene	µg/L	50	100	EPA Method 8270
Hexachlorocyclopentadiene	µg/L	25	50	Final PDWS (EPA, 1992b)
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

Analyte	Unit	Flag 1	Flag 2	Source[a]
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	Final PDWS (EPA, 1977)
Iodine-131	pCi/L	1.5E+00	3E+00	Final PDWS (EPA, 1977)
Iodomethane (Methyl iodide)	µg/L	75	150	EPA Method 8240
Iron	µg/L	150	300	SDWS (EPA, 1992c)
Iron-55	pCi/L	1E+03	2E+03	Final PDWS (EPA, 1977)
Iron-59	pCi/L	1E+02	2E+02	Final PDWS (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 PDWS (EPA, 1977)
Lead	µg/L	7.5	15	Final PDWS (EPA, 1992a)
Lindane	µg/L	0.1	0.2	Final PDWS (EPA, 1992a)
Lithium	µg/L	25	50	EPA Method 6010
Magnesium		No flag	No flag	Set by EPD/EMS
Manganese	µg/L	25	50	SDWS (EPA, 1992c)
Manganese-54	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Mercury	µg/L	1	2	Final PDWS (EPA, 1992a)
Methacrylonitrile	µg/L	250	500	EPA Method 8240
Methapyrilene	µg/L	50	100	EPA Method 8270
Methoxychlor	µg/L	20	40	Final PDWS (EPA, 1992a)
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 PDWS (EPA, 1991)
Nickel	µg/L	50	100	Final PDWS (EPA, 1992b)
Nickel-59	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Nickel-63	pCi/L	2.5E+01	5E+01	Final PDWS (EPA, 1977)
Niobium-95	pCi/L	1.5E+02	3.E+02	Final PDWS (EPA, 1977)
Nitrate as nitrogen	µg/L	5,000	10,000	Final PDWS (EPA, 1992a)
Nitrate-nitrite as nitrogen	µg/L	5,000	10,000	Final PDWS (EPA, 1992a)
Nitrite as nitrogen	µg/L	500	1,000	Final PDWS (EPA, 1992a)
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
2-Nitrophenol	µg/L	50	100	EPA Method 8270
4-Nitrophenol	µg/L	50	100	EPA Method 8270

Analyte	Unit	Flag 1	Flag 2	Source[a]
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	Proposed PDWS (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	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, 1992a)
PCB 1221	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1232	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1242	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1248	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1254	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1260	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
PCB 1262	µg/L	0.25	0.5	Final PDWS (EPA, 1992a)
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, 1992a)
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
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[c]	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	pCi/L	3.13E+01	6.26E+01	Proposed PDWS (EPA, 1991)
Plutonium-242	pCi/L	3.27E+01	6.54E+01	Proposed PDWS (EPA, 1991)
Potassium		No flag	No flag	Set by EPD/EMS
Potassium-40	pCi/L	1.5E+02	3E+02	Proposed PDWS (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

Analyte	Unit	Flag 1	Flag 2	Source[a]
Radium (alpha-emitting)[d]	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	pCi/L	1E+02	2E+02	Final PDWS (EPA, 1977)
Ruthenium-106	pCi/L	1.5E+01	3E+01	Final PDWS (EPA, 1977)
Safrole	µg/L	50	100	EPA Method 8270
Selenium	µg/L	25	50	Final PDWS (EPA, 1992a)
Silica		No flag	No flag	Set by EPD/EMS
Total silica	µg/L	500	1,000	EPA Method 6010
Silver	µg/L	50	100	SDWS (EPA, 1992c)
Sodium		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	Final PDWS (EPA, 1977)
Strontium-89/90[c]	pCi/L	4E+00	8E+00	Final PDWS (EPA, 1992a)
Strontium-90	pCi/L	4E+00	8E+00	Final PDWS (EPA, 1992a)
Styrene	µg/L	50	100	Final PDWS (EPA, 1992a)
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, 1992b)
2,3,7,8-TCDF	µg/L	0.002	0.004	EPA Method 8280
Technetium-99	pCi/L	4.5E+02	9E+02	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, 1992a)
2,3,4,6-Tetrachlorophenol	µg/L	50	100	EPA Method 8270
Tetraethyl dithiopyrophosphate	µg/L	50	100	EPA Method 8270
Thallium	µg/L	1	2	Final PDWS (EPA, 1992b)
Thionazin	µg/L	50	100	EPA Method 827C
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-113	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Toluene	µg/L	500	1,000	Final PDWS (EPA, 1992a)
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	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

Analyte	Unit	Flag 1	Flag 2	Source[a]
Toxaphene	µg/L	1.5	3	Final PDWS (EPA, 1992a)
2,4,5-TP (Silvex)	µg/L	25	50	Final PDWS (EPA, 1992a)
Tributyl phosphate	µg/L	50	100	EPA Method 8270
1,2,4-Trichlorobenzene	µg/L	35	70	Final PDWS (EPA, 1992b)
1,1,1-Trichloroethane	µg/L	100	200	Final PDWS (EPA, 1992a)
1,1,2-Trichloroethane	µg/L	2.5	5	Final PDWS (EPA, 1992b)
Trichloroethylene	µg/L	2.5	5	Final PDWS (EPA, 1992a)
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, 1992a)
Turbidity		No flag	No flag	Set by EPD/EMS
Uranium	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[c]	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
Vinyl acetate	µg/L	5	10	EPA Method 8240
Xylenes	µg/L	5,000	10,000	Final PDWS (EPA, 1992a)
Zinc	µg/L	2,500	5,000	SDWS (EPA, 1992c)
Zinc-65	pCi/L	1.5E+02	3E+02	Final PDWS (EPA, 1977)
Zirconium-95	pCi/L	1E+02	2E+02	Final PDWS (EPA, 1977)
Zirconium/Niobium-95[c]	pCi/L	1E+02	2E+02	Final PDWS (EPA, 1977)

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[a] References for methods are found in Appendix E; references for dated sources are at the end of this appendix.
[b] EPD/EMS set this flagging criterion using the 1991 proposed PDWS because the final PDWS in 1977 may have been in error.
[c] When radionuclide analyses are combined, the lower PDWS of the two isotopes is used for flagging.
[d] The applied standard is for radium-226.

References

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EPA (U.S. Environmental Protection Agency), 1991. *National Primary Drinking Water Regulations; Radionuclides; Proposed Rule.* **Federal Register**, July 18, 1991, pp. 33052-33127. Washington, DC.

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EPA (U.S. Environmental Protection Agency), 1992c. *National Secondary Drinking Water Regulations,* **Code of Federal Regulations**, Section 40, Part 143, pp. 772-776. Washington, DC.

Appendix C – Figures

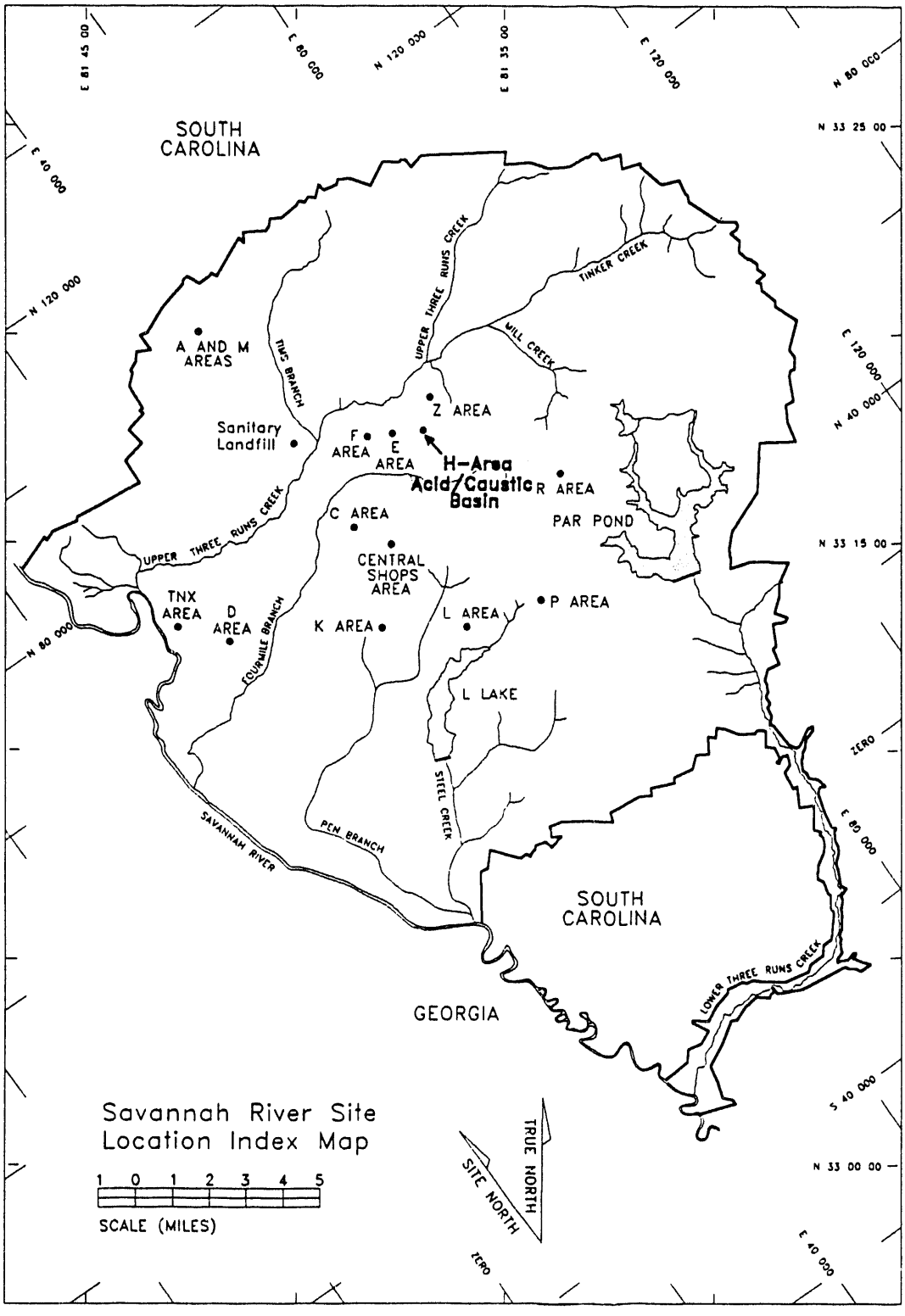

Figure 1. Location of the H-Area Acid/Caustic Basin at the Savannah River Site

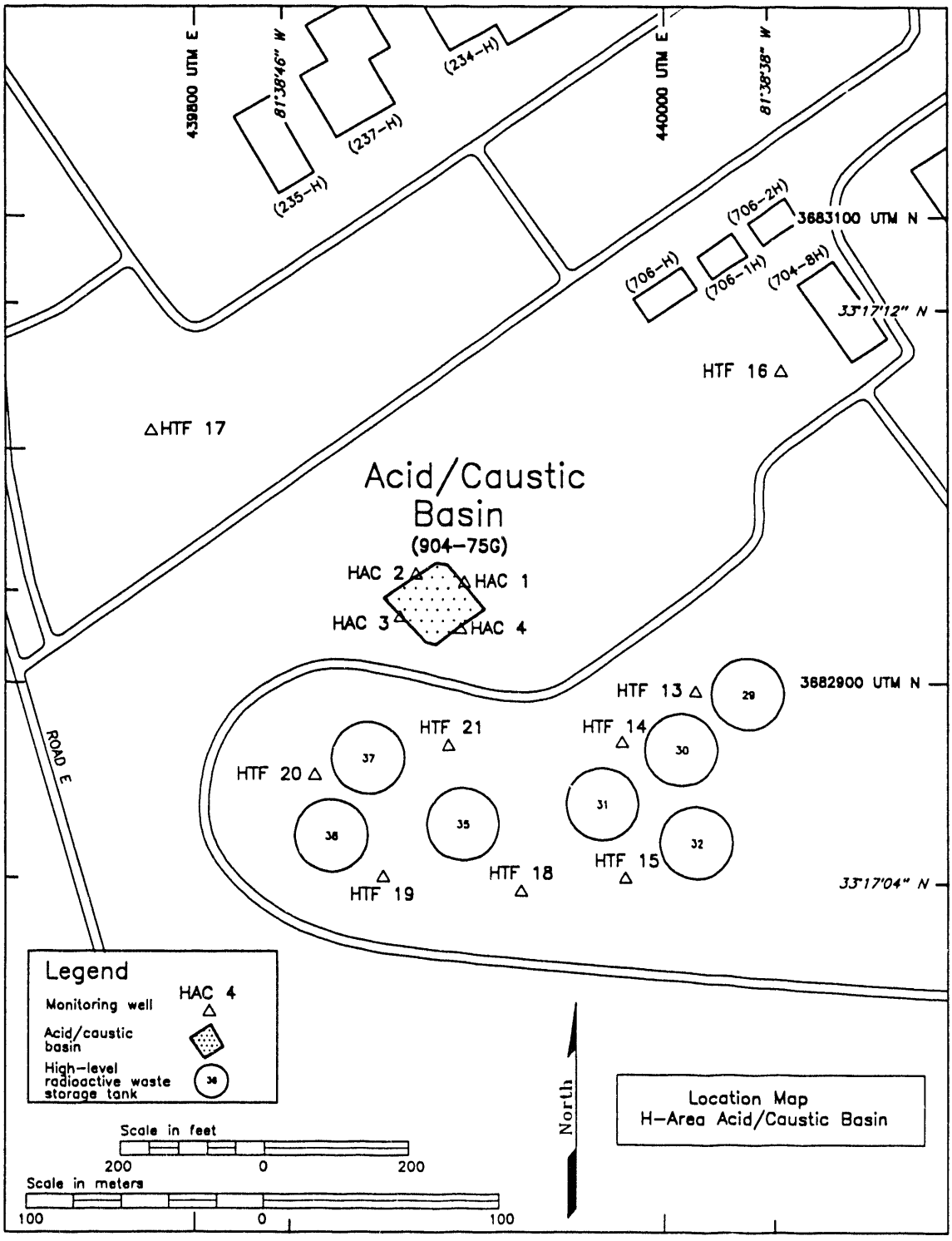

Figure 2. Location of Groundwater Monitoring Wells at the H-Area Acid/Caustic Basin

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

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 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 *D* (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 useability. Result modifiers designed by Environmental Protection Department/Environmental Monitoring Section 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	Definition
(Blank)	Data are not qualified. Number should be interpreted exactly as reported.
A	Value reported is the mean of two or more determinations.
J	Value is estimated because quantitation in the sample or in associated quality control samples did not meet specifications.
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.

Result modifier	Definition
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.
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	4Q92	1Q93	2Q93	3Q93	Mod
HAC 1	Tritium	pCi/mL	5.1E+01	5.3E+01	4.7E+01	4.6E+01	
HAC 2	Chromium	µg/L	-[a]	-	-	118	
	Tritium	pCi/mL	4.2E+01	-	4.7E+01	3.9E+01	
HAC 3	Tritium	pCi/mL	4.4E+01	-	4.2E+01	3.7E+01	
HAC 4	Tritium	pCi/mL	4.6E+01	-	4.3E+01	3.8E+01	

[a] - = not above PDWS.

Table 2. Maximum Results for Constituents Exceeding Half their Final Primary Drinking Water Standards, Other Flag 1 or Flag 2 Criteria, or the SRS Turbidity Standard

Well	Constituent	Unit	3Q93	Mod	Flag
HAC 1	Aluminum	µg/L	126		2
	Iron	µg/L	2,140	V	2
	Lead	µg/L	28		2
HAC 2	Aluminum	µg/L	259		2
	Iron	µg/L	3,080	V	2
	Lead	µg/L	7.5	J3	1
	Manganese	µg/L	37		1
	Mercury	µg/L	1.1		1
	Sulfate	µg/L	218,000		1
	Specific conductance	µS/cm	519	J	2
	Total organic halogens	µg/L	41		1
HAC 3	Aluminum	µg/L	224		2
	Iron	µg/L	338	V	2
	Lead	µg/L	7.5	J3	1
	Manganese	µg/L	85		2
	Total organic halogens	µg/L	35		1
HAC 4	Aluminum	µg/L	188		2
	Manganese	µg/L	36		1

Note: Constituents exceeding half their Appendix A standard appear *italicized*. These results do not include field data results.

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: 08/12/93
Depth to water: 28.91 ft (8.81 m) below TOC
Water elevation: 269.49 ft (82.14 m) msl
Sp. conductance: 283 µS/cm
Turbidity: 10.0 NTU
Water evacuated before sampling: 5 gal
The well went dry during purging.

Time: 11:14
pH: 5.3
Alkalinity: 5 mg/L
Water temperature: 23.7 °C

Volumes purged: 0.7 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
●		pH	5.5	J	pH	0	WA
●		pH	5.5	J	pH	0	WA
●		Specific conductance	236	J	µS/cm	0	WA
●		Turbidity	2.4	JV	NTU	0	WA
●		Turbidity	2.4	JV	NTU	0	WA
		Aluminum	126		µg/L	2	WA
		Arsenic	<2.0		µg/L	0	WA
		Barium	<4.0		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	109	V	µg/L	0	WA
		Chloride	2,130		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1		µg/L	0	WA
		Endrin	<0.11		µg/L	0	WA
		Endrin	<0.11		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Iron	2,140	V	µg/L	2	WA
		Lead	28		µg/L	2	WA
		Lindane	<0.056		µg/L	0	WA
		Lindane	<0.056		µg/L	0	WA
		Magnesium	111	V	µg/L	0	WA
		Manganese	24		µg/L	0	WA
		Mercury	<0.20		µg/L	0	WA
		Methoxychlor	<0.53		µg/L	0	WA
		Methoxychlor	<0.56		µg/L	0	WA
		Methoxychlor	<0.56		µg/L	0	WA
		Nitrate as nitrogen	1,300		µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	<500		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	6,340		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	48,800	V	µg/L	0	WA
		Sulfate	74,500		µg/L	0	WA
		Total dissolved solids	123,000		µg/L	0	WA
		Total organic carbon	<1,000		µg/L	0	WA
		Total organic halogens	7.5		µg/L	0	WA
		Total phosphates (as P)	<50		µg/L	0	WA

● = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL HAC 1 collected on 08/12/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Toxaphene	<1.0		µg/L	0	WA
		Toxaphene	<1.1		µg/L	0	WA
		Toxaphene	<1.1		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.56		µg/L	0	WA
		Gross alpha	<8.0E-01		pCi/L	0	TM
		Gross alpha	<8.0E-01		pCi/L	0	TM
		Nonvolatile beta	3.4E+00 ± 2.1E+00		pCi/L	0	TM
		Nonvolatile beta	3.5E+00 ± 2.1E+00		pCi/L	0	TM
		Radium-226	<2.2E-01		pCi/L	0	TM
		Radium-226	<2.7E-01		pCi/L	0	TM
		Radium-228	<4.0E-01		pCi/L	0	TM
		Radium-228	1.9E+00 ± 1.1E+00		pCi/L	0	TM
	■	Tritium	4.2E+01 ± 5.7E+00		pCi/mL	2	TM
	■	Tritium	4.6E+01 ± 5.7E+00		pCi/mL	2	TM

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: 08/12/93
Depth to water: 29.15 ft (8.89 m) below TOC
Water elevation: 268.95 ft (81.98 m) msl
Sp. conductance: 355 µS/cm
Turbidity: 7.0 NTU
Water evacuated before sampling: 5 gal
The well went dry during purging.

Time: 11:30
pH: 5.3
Alkalinity: 4 mg/L
Water temperature: 22.8 °C

Volumes purged: 0.8 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
●		pH	5.1	J	pH	0	WA
●		Specific conductance	519	J	µS/cm	2	WA
●		Turbidity	2.4	JV	NTU	0	WA
		Aluminum	259		µg/L	2	WA
		Arsenic	<2.0		µg/L	0	WA
		Barium	9.8		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	312	V	µg/L	0	WA
		Chloride	6,060		µg/L	0	WA
	■	Chromium	118		µg/L	2	WA
		2,4-Dichlorophenoxyacetic acid	<1.1		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<2.2		µg/L	0	WA
		Endrin	<0.10		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Iron	3,080	V	µg/L	2	WA
		Lead	7.5	J3	µg/L	1	WA
		Lindane	<0.050		µg/L	0	WA
		Magnesium	425	V	µg/L	0	WA
		Manganese	37		µg/L	1	WA

● = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL HAC 2 collected on 08/12/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Mercury	1.1		µg/L	1	WA
		Methoxychlor	<0.50		µg/L	0	WA
		Nitrate as nitrogen	263		µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	<500		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	7,190		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	108,000	V	µg/L	0	WA
		Sulfate	218,000		µg/L	1	WA
		Total dissolved solids	301,000		µg/L	0	WA
		Total organic carbon	1,040		µg/L	0	WA
		Total organic halogens	41		µg/L	1	WA
		Total phosphates (as P)	<50		µg/L	0	WA
		Toxaphene	<1.0		µg/L	0	WA
		2,4,5-TP (Silvex)	<1.1		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.56		µg/L	0	WA
		Gross alpha	1.9E+00 ± 2.6E+00		pCi/L	0	TM
		Nonvolatile beta	6.0E+00 ± 4.1E+00		pCi/L	0	TM
		Radium-226	2.2E-01 ± 1.6E-01		pCi/L	0	TM
		Radium-228	<4.0E-01		pCi/L	0	TM
	■	Tritium	3.9E+01 ± 1.4E+00		pCi/mL	2	TM

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: 08/12/93
Depth to water: 28.85 ft (8.79 m) below TOC
Water elevation: 269.15 ft (82.04 m) msl
Sp. conductance: 216 µS/cm
Turbidity: 18.7 NTU
Water evacuated before sampling: 8 gal
The well went dry during purging.

Time: 12:39
pH: 4.9
Alkalinity: 0 mg/L
Water temperature: 22.4 °C

Volumes purged: 0.9 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
●		pH	4.7	J	pH	0	WA
●		Specific conductance	197	J	µS/cm	0	WA
●		Turbidity	2.2	JV	NTU	0	WA
		Aluminum	224		µg/L	2	WA
		Arsenic	<2.0		µg/L	0	WA
		Barium	14		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	550	V	µg/L	0	WA
		Chloride	6,180		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1		µg/L	0	WA

● = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL HAC 3 collected on 08/12/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Endrin	<0.11		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Iron	388	V	µg/L	2	WA
		Lead	7.5	J3	µg/L	1	WA
		Lindane	<0.053		µg/L	0	WA
		Magnesium	425	V	µg/L	0	WA
		Manganese	85		µg/L	2	WA
		Mercury	0.27		µg/L	0	WA
		Methoxychlor	<0.53		µg/L	0	WA
		Nitrate as nitrogen	1,820		µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	<500		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	6,730		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	37,600	V	µg/L	0	WA
		Sulfate	58,100		µg/L	0	WA
		Total dissolved solids	99,000		µg/L	0	WA
		Total organic carbon	1,140		µg/L	0	WA
		Total organic halogens	35		µg/L	1	WA
		Total phosphates (as P)	<50		µg/L	0	WA
		Toxaphene	<1.0		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.53		µg/L	0	WA
		Gross alpha	1.6E+00 ± 1.2E+00		pCi/L	0	TM
		Nonvolatile beta	3.3E+00 ± 2.1E+00		pCi/L	0	TM
		Radium-226	5.3E-01 ± 2.4E-01		pCi/L	0	TM
		Radium-228	1.4E+00 ± 1.2E+00		pCi/L	0	TM
	■	Tritium	3.7E+01 ± 1.4E+00		pCi/mL	2	TM

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: 08/12/93
Depth to water: 27.24 ft (8.30 m) below TOC
Water elevation: 269.66 ft (82.19 m) msl
Sp. conductance: 54 µS/cm
Turbidity: 0.4 NTU
Water evacuated before sampling: 41 gal

Time: 12:15
pH: 4.6
Alkalinity: 0 mg/L
Water temperature: 22.3 °C

Volumes purged: 4.0 well volumes

LABORATORY ANALYSES

H	D	Analyte	Result	Mod	Unit	Flag	Lab
●		pH	4.5	J	pH	0	WA
●		Specific conductance	45	J	µS/cm	0	WA
●		Specific conductance	45	J	µS/cm	0	WA
●		Turbidity	<0.20	J	NTU	0	WA
		Aluminum	188		µg/L	2	WA
		Arsenic	<2.0		µg/L	0	WA

● = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

WELL HAC 4 collected on 08/12/93, laboratory analyses (cont.)

H	D	Analyte	Result	Mod	Unit	Flag	Lab
		Barium	11		µg/L	0	WA
		Cadmium	<2.0		µg/L	0	WA
		Calcium	60	V	µg/L	0	WA
		Chloride	4,260		µg/L	0	WA
		Chromium	<4.0		µg/L	0	WA
		2,4-Dichlorophenoxyacetic acid	<1.1		µg/L	0	WA
		Endrin	<0.10		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Fluoride	<100		µg/L	0	WA
		Iron	45	V	µg/L	0	WA
		Lead	5.0	J3	µg/L	0	WA
		Lindane	<0.052		µg/L	0	WA
		Magnesium	316	V	µg/L	0	WA
		Manganese	36		µg/L	1	WA
		Mercury	<0.20		µg/L	0	WA
		Methoxychlor	<0.52		µg/L	0	WA
		Nitrate as nitrogen	1,070		µg/L	0	WA
		Phenols	<5.0		µg/L	0	WA
		Potassium	<500		µg/L	0	WA
		Selenium	<2.0		µg/L	0	WA
		Silica	5,820		µg/L	0	WA
		Silver	<2.0		µg/L	0	WA
		Sodium	6,500	V	µg/L	0	WA
		Sulfate	2,120		µg/L	0	WA
		Sulfate	2,170		µg/L	0	WA
		Total dissolved solids	1,000	J3	µg/L	0	WA
		Total dissolved solids	2,000	J3	µg/L	0	WA
		Total organic carbon	<1,000		µg/L	0	WA
		Total organic halogens	11		µg/L	0	WA
		Total phosphates (as P)	51		µg/L	0	WA
		Toxaphene	<1.0		µg/L	0	WA
		2,4,5-TP (Silvex)	<0.53		µg/L	0	WA
		Gross alpha	1.8E+00 ± 1.2E+00		pCi/L	0	TM
		Nonvolatile beta	5.7E+00 ± 2.1E+00		pCi/L	0	TM
		Radium-226	4.3E-01 ± 2.2E-01		pCi/L	0	TM
		Radium-228	1.1E+00 ± 1.1E+00		pCi/L	0	TM
	■	Tritium	3.8E+01 ± 1.4E+00		pCi/mL	2	TM

● = exceeded holding time. ■ = exceeded screening level or final primary drinking water standard.

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 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 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. 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 com-

pound, 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
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

Method	Used to Analyze	Source
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]
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

Element	True value (µg/L)	Mean reported value (µg/L)	Mean percent RSD[a]
Vanadium	70	69	2.9
Zinc	16	19	45

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

[a] Relative 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]	$1.00C$	$0.20\bar{X}$	$0.35\bar{X}$
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	$0.18\bar{X}$	$0.32\bar{X}$
Dichloromethane (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	$0.87C + 0.48$	$0.13\bar{X} - 0.03$	$0.23\bar{X} + 0.30$
Trichlorofluoromethane	$0.89C - 0.07$	$0.15\bar{X} + 0.67$	$0.26\bar{X} + 0.91$
Vinyl chloride	$0.97C - 0.36$	$0.13\bar{X} + 0.65$	$0.27\bar{X} + 0.40$

[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 in a single laboratory.

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