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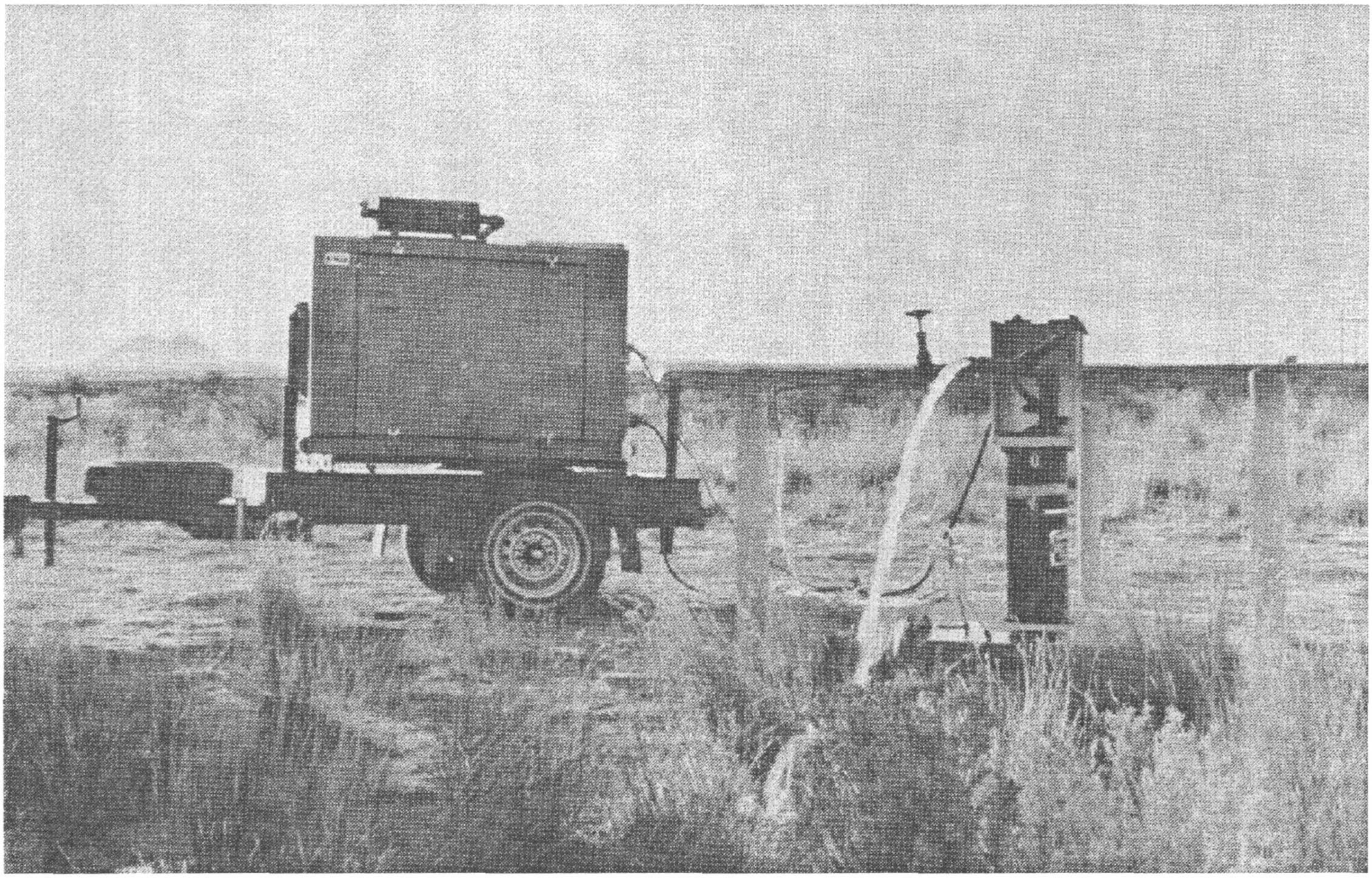
CHEMICAL AND RADIOCHEMICAL CONSTITUENTS IN WATER FROM WELLS IN THE VICINITY OF THE NAVAL REACTORS FACILITY, IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY, IDAHO, 1999

U.S. GEOLOGICAL SURVEY
OPEN-FILE Report 01-27



Prepared in cooperation with the U.S. DEPARTMENT OF ENERGY

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Idaho Falls, Idaho
January 2001

U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, Secretary

U.S. GEOLOGICAL SURVEY
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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED UNITS

Multiply	By	To obtain
foot (ft)	0.3048	meter
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
acre-foot (acre-ft)	1,233	cubic meter
foot per mile (ft/mi)	.1894	meter per kilometer
picocurie per liter (pCi/L)	.037	becquerel per liter

For temperature, degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by using the equation: °F = (1.8)(°C) + 32.

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated units used in report: mg/L (milligram per liter); µg/L (microgram per liter); pCi/L (picocuries per liter).

CHEMICAL AND RADIOCHEMICAL CONSTITUENTS IN WATER FROM WELLS IN THE VICINITY OF THE NAVAL REACTORS FACILITY, IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY, IDAHO, 1999

by **Roy C. Bartholomay, LeRoy L. Knobel, Betty J. Tucker, and Brian V. Twining**

Abstract

The U.S. Geological Survey, in response to a request from the U.S. Department of Energy's Pittsburgh Naval Reactors Office, Idaho Branch Office, sampled water from 13 wells during 1999 as part of a long-term project to monitor water quality of the Snake River Plain aquifer in the vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho. Water samples were analyzed for naturally occurring constituents and anthropogenic contaminants. A total of 52 samples were collected from the 13 monitoring wells. The routine samples contained detectable concentrations of total cations and dissolved anions, and nitrite plus nitrate as nitrogen. Most of the samples also contained detectable concentrations of gross alpha- and gross beta-particle radioactivity and tritium. Eight quality-assurance samples also were collected and analyzed; four were field-blank samples, and four were replicate samples. Most of the field blank samples contained less-than-detectable concentrations of target constituents.

INTRODUCTION

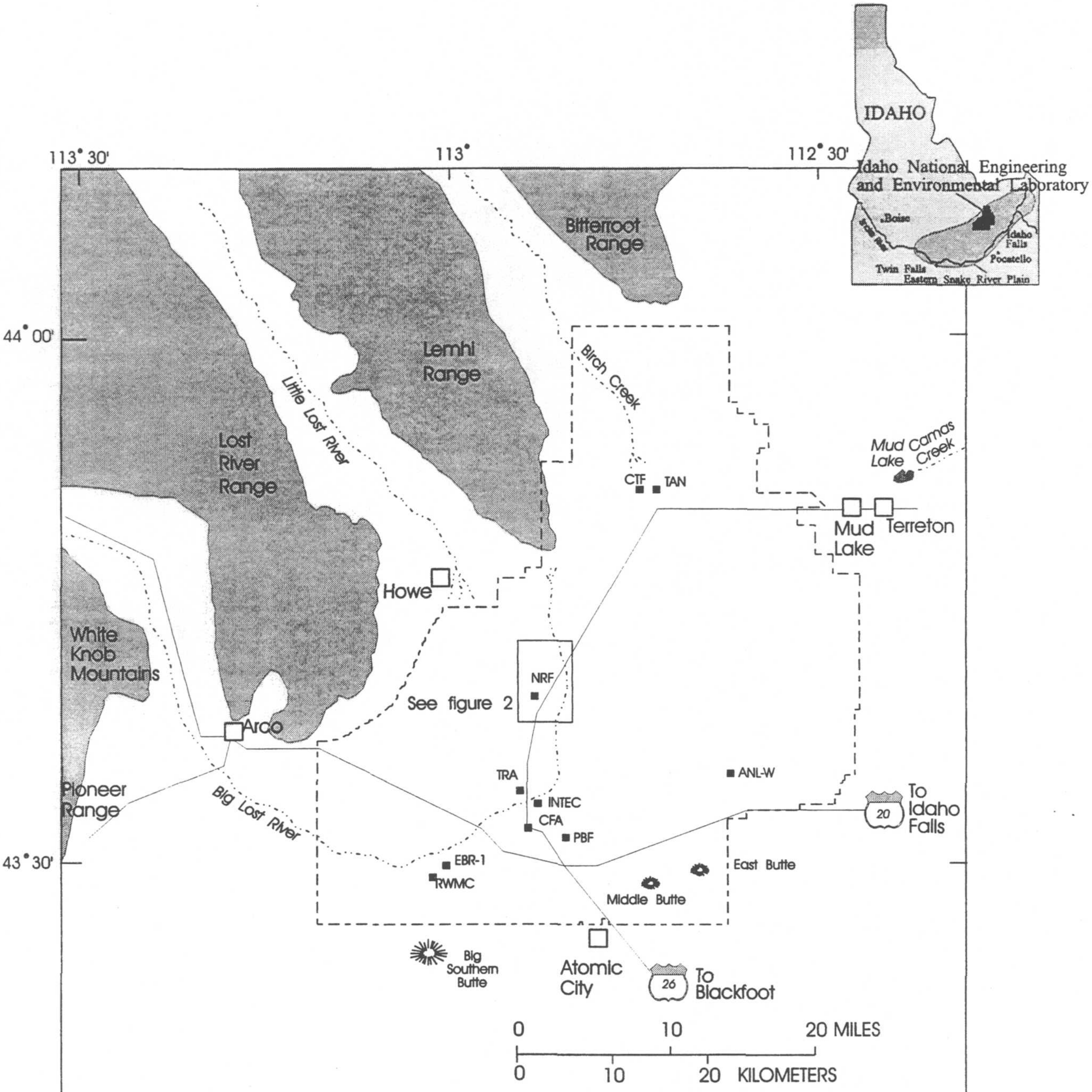
The Idaho National Engineering and Environmental Laboratory (INEEL), encompassing about 890 mi^2 of the eastern Snake River Plain in southeastern Idaho (fig. 1), is operated by the U.S. Department of Energy (DOE). INEEL facilities are used in the development of peacetime atomic-energy applications, nuclear safety research, defense programs, and advanced energy concepts. At the Naval Reactors Facility (NRF) (fig. 1), one facility at the INEEL, small amounts of some constituents have been released to the environment as described in two NRF Remedial Investigation/Feasibility Studies (Bettis Atomic Power Laboratory, 1994, 1997).

This study was conducted by the U.S. Geological Survey (USGS) in cooperation with the DOE's Pittsburgh Naval Reactors Office, Idaho Branch Office (IBO). IBO is responsible for the NRF at the INEEL. IBO requires information about the mobility of radionuclide- and chemical-waste constituents in the Snake River Plain aquifer. Waste-constituent mobility is determined principally by (1) the rate and direction of ground-water flow; (2) the locations, quantities, and methods of waste disposal; (3) waste-constituent chemistry; and (4) the geochemical processes taking place in the aquifer (Orr and Cecil, 1991, p. 2).

Purpose and Scope

In 1989, IBO requested that the USGS initiate a water-quality data-collection program in the vicinity of the NRF at the INEEL (fig. 1). The purpose of the data-collection program is to provide IBO with water-chemistry data to evaluate the effect of NRF activities on the water quality of the Snake River Plain aquifer.

Through 1995, the data-collection program consisted of three rounds of sample collection. Round one was a one-time sampling of each well for a comprehensive suite of chemical constituents that approximates those contained in the U.S. Environmental Protection Agency's (EPA) Ground-Water Monitoring List—Appendix IX (U.S. Environmental Protection Agency, 1989, p. 636–642). Round two consisted of bimonthly collection of samples five times from each well that were analyzed for the chemical constituents listed in Appendix III-EPA Interim Primary Drinking Water Standards, the constituents listed as parameters establishing ground-water quality, and selected measurements used as indicators of ground-water contamination (U.S. Environmental Protection Agency, 1989, p. 660–661, 730). Additional constituents analyzed during round two included copper, nickel, zinc, and



EXPLANATION

- - - - BOUNDARY OF IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

■ FACILITIES AT THE IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

ANL-W	ARGONNE NATIONAL LABORATORY-WEST	NRF	NAVAL REACTORS FACILITY
CFA	CENTRAL FACILITIES AREA	PBF	POWER BURST FACILITY
CTF	CONTAINED TEST FACILITY (formerly called Loss of Fluid Test Facility-LOFT)	RWMC	RADIOACTIVE WASTE MANAGEMENT COMPLEX
EBR-1	EXPERIMENTAL BREEDER REACTOR NO. 1	TAN	TEST AREA NORTH
INTEC	IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER	TRA	TEST REACTOR AREA

Figure 1. Location of the Idaho National Engineering and Environmental Laboratory, Naval Reactors Facility, and other selected facilities.

extractable acid and base/neutral compounds. Round-three samples were collected quarterly through 1995. Constituents analyzed in 1994 included chloride, chromium, iron, lead, mercury, nickel, nitrate, silver, sodium, and sulfate. Other round-three measurements were gross alpha- and gross beta-particle radioactivity, pH, specific conductance, and total organic carbon (TOC). The round-three sampling program was expanded in 1995 to include analyses for aluminum, antimony, arsenic, barium, beryllium, cadmium, copper, manganese, selenium, thallium, tritium, and zinc. As a result of expanded laboratory procedures, rounds one through three of the sample-collection program included analyses for constituents in addition to those listed above. Results of analyses of rounds one through three samples are presented by Knobel, Bartholomay, and others (1992), Bartholomay and others (1993), Tucker and others (1995), and Bartholomay, Knobel, and Tucker (1997).

An analysis by Westinghouse Electric Corporation of the water-chemistry data collected for the NRF monitoring program during 1989–95 indicated that several changes to the program would improve the overall usefulness of the data. As a result, several older wells were eliminated from the program and replaced by monitoring wells specifically constructed to meet NRF needs and strategically placed to better intercept potential chemical plumes in ground water. To differentiate between the data generated from the NRF sampling program in rounds one through three (1989–95) and subsequent data (1996), the samples collected in 1996 were designated round-four samples (Knobel and others, 1999). Wells sampled in rounds one through three that were eliminated from the program were four water-supply production wells with line shaft turbine pumps (NRF-1, -2, -3, and -4; fig. 2) and three monitoring wells (USGS 15, USGS 17, and Water Supply INEL-1; fig. 2) with dedicated submersible pumps. The six newly constructed monitoring wells that were added to the sampling program in 1996 were NRF-8, -9, -10, -11, -12, and -13 (fig. 2). All of these wells and the older monitoring wells that remain in the monitoring network (NRF-6, NRF-7, USGS 12, 97, 98, 99, and 102; fig. 2) have dedicated submersible pumps.

At the end of 1996, NRF increased validation requirements for ground-water data on the basis of documents that supported the Record of Decision for the industrial waste ditch and NRF landfills. Because the USGS National Water Quality Laboratory (NWQL) could not supply this documentation cost effectively, NRF personnel sampled the wells during the first quarter of 1997. After further consideration of the program, it was determined that the sampling could be done under the USGS Department of Defense Environmental Conservation Program. Under this program, sample analyses are contracted to Quanterra Environmental Laboratory Services. Starting in June of 1997, water samples collected by the USGS were analyzed by the Quanterra laboratory. Results from the 1997–98 sampling were presented by Bartholomay and others (2000). This report presents results from the 1999 sampling. These samples are designated round-five samples. Location of wells sampled are shown in figure 2.

The constituent list for round-five samples was modified slightly from that from round-four samples because of availability of analyses at the laboratory. The constituents included in the round-five sampling program and analytical results are presented in tables 3 through 8 at the back of this report. Field measurements and calculations for round-five samples included alkalinity as $CaCO_3$, pH, specific conductance, temperature, total dissolved solids (TDS), and turbidity. Total dissolved solids were estimated by multiplying specific conductance by 0.543 as determined by Olmstead (1962, fig. 5). Round-five samples were collected quarterly at each well.

Hydrologic Conditions

The Snake River Plain aquifer is one of the most productive aquifers in the United States (U.S. Geological Survey, 1985, p. 193). The aquifer underlies the eastern Snake River Plain, a large, arcuate, structural basin in southeastern Idaho (fig. 1), and consists of a thick sequence of basalts and sedimentary interbeds.

Surface Water

The Big Lost River drains more than 1,400 mi^2 of mountainous area that includes parts of the Lost River Range and the Pioneer Range west of the INEEL (fig. 1). Flow in the Big Lost River infil-

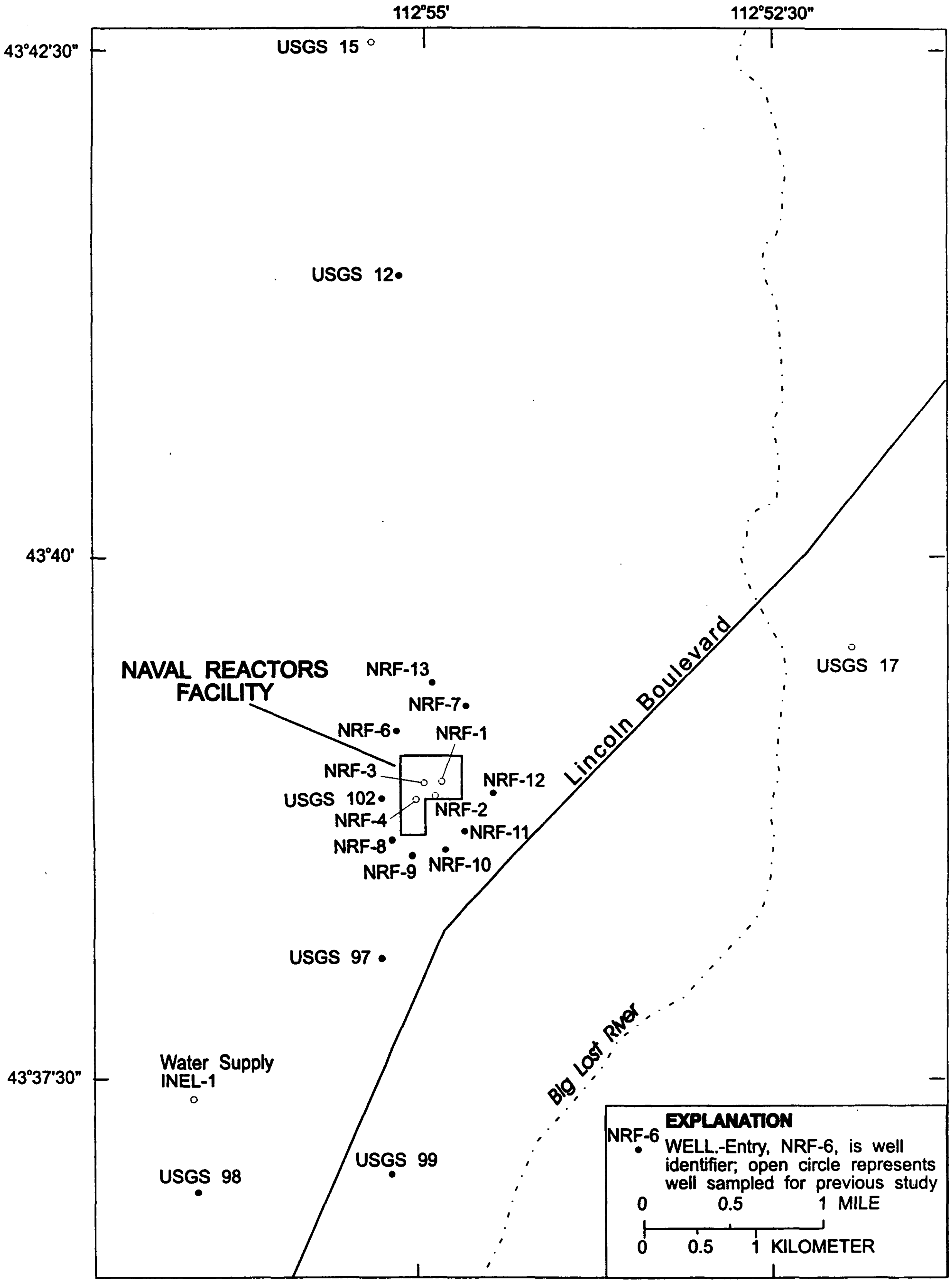


Figure 2. Location of wells, Naval Reactors Facility and vicinity, Idaho National Engineering and Environmental Laboratory.

trates to the Snake River Plain aquifer along its channel and in sinks and playas near its terminus. Since 1965, excess runoff has been diverted to spreading areas in the southwestern part of the INEEL where much of the water rapidly infiltrates to the aquifer. Other surface drainages that recharge the Snake River Plain aquifer at the INEEL include the Little Lost River, Birch Creek, and Camas Creek (fig. 1) (Bartholomay, Tucker, and others, 1997, p. 18).

Ground Water

Recharge to the Snake River Plain aquifer is principally from infiltration of applied irrigation water, infiltration of streamflow, and ground-water inflow from adjoining mountain drainage basins. Some recharge may be from direct infiltration of precipitation, although the small amount of annual precipitation on the plain (8 in. at the INEEL), evapotranspiration, and the great depth to water (in places exceeding 900 ft) probably minimize this source of recharge (Orr and Cecil, 1991, p. 22–23).

Water in the Snake River Plain aquifer moves principally through fractures and interflow zones in the basalt. Most ground water moves through the upper 800 ft of saturated rocks. Hydraulic conductivities of basalt in the upper 800 ft of the aquifer, estimated from INEEL-wide transmissivity data, are from about 0.01 to 32,000 ft/day (Anderson and others, 1999, p. 1). Estimated hydraulic conductivities in a 10,365-ft deep test hole near NRF are smaller; at depths exceeding 1,500 ft, hydraulic conductivities are from 0.002 to 0.03 ft/day (Mann, 1986, p. 21). The effective base of the Snake River Plain aquifer in the western part of the INEEL is from about 815 to 1,710 ft below land surface (Anderson and others, 1996, table 3, p. 23).

Depth to water in wells completed in the Snake River Plain aquifer is from about 200 ft below land surface in the northern part of the INEEL to more than 900 ft in the southeastern part; in the vicinity of NRF, depth to water is about 375 ft below land surface. In March–May 1995, the altitude of the water table was about 4,575 ft above sea level near Test Area North (fig. 1) and about 4,425 ft above sea level near the Radioactive Waste Management Complex (fig. 1); near the NRF, the water table was about 4,475 ft above sea level. Water generally flows southward and southwestward beneath the INEEL at an average hydraulic gradient of about 4 ft/mi; however, significant local variation in flow direction is common. Beneath the NRF, water generally flows southward. From March–May 1991 to March–May 1995, water-level changes in INEEL wells ranged from an 8.5-ft decline north of the NRF to a 2.5-ft decline in wells in the southern part of the INEEL; near the NRF, the water-level decline was about 6 to 8 ft. Water levels generally declined at the INEEL during 1992–95 because of drought (Bartholomay, Tucker, and others, 1997, p. 20–25), but since 1995, have risen (fig. 3).

Ground water moves southwestward from the INEEL and eventually discharges as springs along the Snake River downstream from Twin Falls, about 100 mi southwest of the INEEL (fig. 1). Approximately 3.7 million acre-ft of ground water was discharged in 1995 (C.E. Berenbrock, USGS, written commun., 1996).

Guidelines for Interpreting Results of Radiochemical Analyses

Concentrations of radionuclides are reported with an estimated sample standard deviation, s, that is obtained by propagating sources of analytical uncertainty in measurements. The following guidelines for interpreting analytical results are based on an extension of a method proposed by Currie (1984).

In the analysis for a particular radionuclide, laboratory measurements are made on a target sample and a prepared blank. Instrument signals for the sample and the blank vary randomly. Therefore, it is essential to distinguish between two key aspects of the problem of detection: (1) the instrument signal for the sample must be larger than the signal observed for the blank before the decision can be made that the radionuclide was detected; and (2) an estimation must be made of the minimum radionuclide concentration that will yield a sufficiently large observed signal before the correct decision can be made for detection or nondetection of the radionuclide. The first aspect of the problem is a qualitative decision based on an observed signal and a definite criterion for detection. The second aspect of the problem is an estimation of the detection capabilities of a given measurement process.

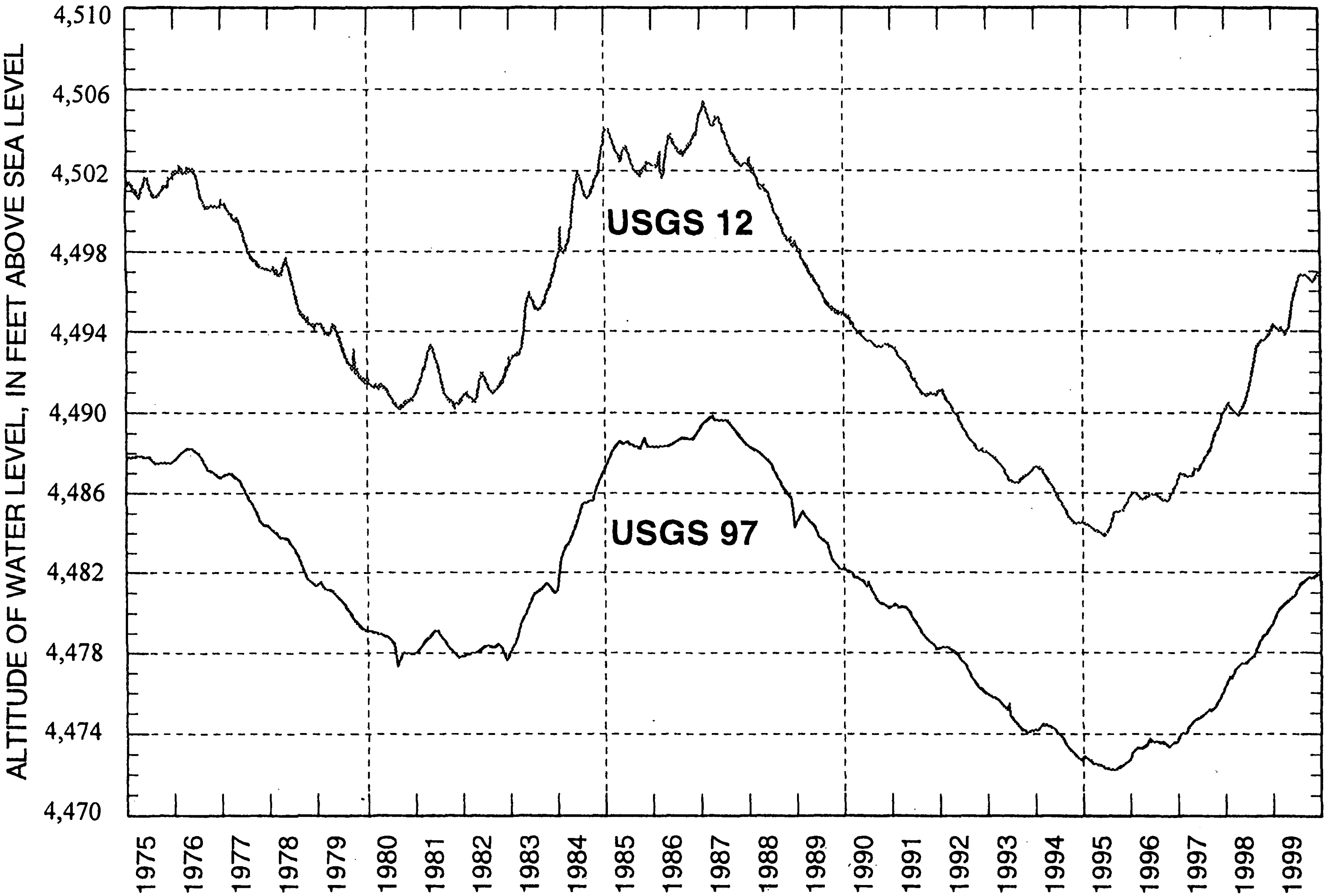


Figure 3. Water levels in two wells near the Naval Reactors Facility

In the laboratory, instrument signals must exceed a critical level of 1.6s before the qualitative decision can be made as to whether the radionuclide was detected. At 1.6s, there is a 95-percent probability that the correct conclusion—not detected—will be made. Given a large number of samples, as many as 5 percent of the samples with measured concentrations larger than or equal to 1.6s, which were concluded as being detected, might not contain the radionuclide. These measurements are referred to as false positives and are errors of the first kind in hypothesis testing.

Once the critical level of 1.6s has been defined, the minimum detectable concentration can be determined. Radionuclide concentrations that equal 3s represent a measurement at the minimum detectable concentration. For true concentrations of 3s or larger, there is a 95-percent or larger probability that the radionuclide was detected in a sample. In a large number of samples, the conclusion—not detected—will be made in 5 percent of the samples that contain true concentrations at the minimum detectable concentration of 3s. These measurements are referred to as false negatives and are errors of the second kind in hypothesis testing.

True radionuclide concentrations between 1.6s and 3s have larger errors of the second kind. That is, there is a larger-than-5-percent probability of false negative results for samples with true concentrations between 1.6s and 3s. Although the radionuclide might have been detected, such detection may not be considered reliable; at 1.6s, the probability of a false negative is about 50 percent.

The critical level and minimum detectable concentration are based on counting statistics alone and do not include systematic or random errors inherent in laboratory procedures. The values 1.6s and 3s vary slightly with background or blank counts, with the number of gross counts for individual analyses, and for different radionuclides. In this report, radionuclide concentrations less than 3s are considered to be below a "reporting level." The critical level, minimum detectable concentration, and reporting level aid the reader in the interpretation of analytical results and do not represent absolute concentrations of radioactivity which may or may not have been detected.

Many analytical results of environmental radioactivity measurements are at or near zero. If the true concentration for a given radionuclide is zero, a given set of analytical results for that radionuclide should be distributed about zero, with an equal number of negative and positive measurements. Negative analytical results occur if the radioactivity of a water sample is less than the background radioactivity or the radioactivity of the prepared blank sample in the laboratory (American Society for Testing and Materials, 1992, p. 126; Knobel, Orr, and Cecil, 1992, p. 51).

Guidelines for Interpreting Results of Inorganic and Organic Analyses

The term "reporting level" used for radiochemical analyses should not be confused with the term "reporting limit" used for inorganic and organic analyses. In this report, the term "reporting limit" is the lowest level at which measurements become quantitatively meaningful (Quanterra Environmental Services, 1998). Because of unpredictable matrix effects on detection limits, the laboratory reporting limits are set somewhat higher than the analytical method detection limits. Because of this, some estimated results are given.

Acknowledgments

The authors are grateful to Robert Hermandson of the USGS for checking data tables with original data and Kelly D. Willie of Bechtel-Bettis Corporation and Jeff Langman of the USGS for technically reviewing the manuscript.

METHODS AND QUALITY ASSURANCE

The methods used for collecting water samples generally followed the guidelines established by the USGS (Stevens and others, 1975; Wood, 1981; Claassen, 1982; W.L. Bradford, USGS, written commun., 1985; Hardy and others, 1989; Wilde and others, 1998). Descriptions of methods used for analysis are found in Quanterra Environmental Services (1998) and Thatcher and others (1977). The methods used in the field and the quality-assurance practices are described in the following sections.

Sample Containers and Preservatives

Sample containers and preservatives differed depending on the constituent(s) for which analyses were requested. Samples were placed in prepreserved containers in accordance with bottle-manufacturer requirements. Containers and preservatives were supplied by the Quanterra Environmental Services Laboratory. The containers and preservatives used for this study are listed in table 1 (all tables located at the end of report).

Sampling Locations and Sample Collection

Samples were collected from 13 monitoring wells (NRF-6, -7, -8, -9, -10, -11, -12, -13, USGS 12, 97, 98, 99, and 102) equipped with dedicated submersible pumps. NRF-6, -7, -13, and USGS 12 are upgradient of the NRF; USGS 102 is west of NRF; NRF-11 and -12 are east of NRF; and the remaining monitoring wells are downgradient of NRF (fig. 2).

Samples were collected from a portable sampling apparatus attached to the dedicated submersible pumps. The apparatus was decontaminated before sampling at each site by rinsing with deionized water. Samples were collected after three well-bore volumes of water were purged from each well and field measurements indicated probable hydraulic and chemical stability. After collection, sample containers were sealed with laboratory film, labeled, and stored under secured conditions. Water samples were placed in ice chests, chilled when appropriate, sealed, and shipped the same day to the laboratory.

Conditions at the sampling site during sample collection were recorded in a field logbook, and a chain-of-custody record was used to track samples from the time of collection until delivery to the laboratory. These records are available for inspection at the USGS INEEL Project Office. The results of field measurements and calculations for alkalinity, pH, specific conductance, water temperature, TDS, and turbidity are listed in table 2.

Quality Assurance

Internal quality control and the overall quality-assurance practices used by the Quanterra Laboratory are described in a report by Quanterra Environmental Services (1998). The water samples were collected by personnel assigned to the INEEL Project Office in accordance with a quality-assurance plan for quality-of-water activities. The plan was finalized in June 1989, revised in March 1992 and again in 1996 (Mann, 1996), and is available from the USGS INEEL Project Office. Comparative studies to determine agreement between analytical results for water-sample pairs by laboratories involved in the INEEL Project Office's quality-assurance program are summarized by Wegner (1989), Williams (1996), and Williams (1997). Additional quality assurance used for this sampling program included four field-blank samples prepared with inorganic-free and organic-free water and four replicate samples. Bottles for the field-blank samples were filled in the field camper with the respective inorganic and organic-free water. Inorganic-free water was used for the radiochemical blanks. Respective bottles then were opened at the well while sample collection occurred. After collection of the primary sample, a replicate sample was immediately collected. Many organizations use the term "sequential replicate" rather than "replicate" sample.

ANALYTICAL RESULTS

During the period beginning in February 1999 and ending in November 1999, four sets of quarterly water samples were collected for round five of the NRF sampling program (table 2). All wells were sampled four times. Quality-assurance samples included four field-blank samples; NRF-6 (QAS-73), NRF-10 (QAS-68), NRF-11 (QAS-72), NRF-13 (QAS-70), and four replicate samples: NRF-9 (QAS-74), NRF-12 (QAS-67), USGS 97 (QAS-69), and USGS 98 (QAS-71).

Dissolved Anions and Total Cations

Water samples were analyzed for concentrations of dissolved chloride and sulfate and concentrations of total calcium, magnesium, potassium, and sodium (table 3).

Concentrations of calcium in samples from the 13 wells ranged from 27.1 to 117 mg/L. Concentrations of chloride ranged from 5.1 to 228 mg/L. Concentrations of magnesium ranged from 9.5 to

30.4 mg/L. Estimated concentrations of potassium ranged from 1.6 to 4.7 mg/L. Concentrations of sodium ranged from 8.2 to 95.6 mg/L. Concentrations of sulfate ranged from 13.2 to 138 mg/L.

Concentrations in the four field-blank samples were not detected except in QAS-73, which contained an estimated concentrations of 0.015 mg/L for calcium and 0.60 mg/L for sodium; and QAS-72 and -70, which contained estimated concentrations of 0.07 and 0.064 mg/L, respectively, for calcium and 0.02 and 0.014 mg/L, respectively, for magnesium.

Total Trace Elements

Water samples collected in 1999 were analyzed for concentrations of total aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, and zinc (table 4).

Aluminum.—Aluminum was detected in most samples from most wells; detectable concentrations ranged from an estimated 15 µg/L in USGS 12 to 3,800 µg/L in a sample from NRF-13.

Antimony.—Antimony was not detected in any but one sample; one sample from USGS 97 contained an estimated concentration of 3.2 µg/L.

Arsenic.—Arsenic was not detected in any but one sample; one sample from NRF-6 contained an estimated concentration of 4.2 µg/L.

Barium.—Concentrations of barium ranged from 55.2 µg/L in USGS 98 to 180 µg/L in NRF-12.

Beryllium.—Beryllium was not detected in most samples.

Cadmium.—Cadmium was not detected in any samples.

Chromium.—Concentrations of chromium ranged from an estimated 4.6 µg/L in USGS 99 to 92 µg/L in NRF-13.

Copper.—Copper was not detected in most samples.

Iron.—Iron was detected in most samples; detectable concentrations ranged from an estimated 9.0 µg/L in USGS 97 to 3,500 µg/L in a sample from NRF-13.

Lead.—Lead was not detected in many samples; detectable concentrations were as large as 9.2 µg/L in a sample from USGS 97.

Manganese.—Manganese was not detected in many samples; detectable concentrations were as large as 67 µg/L in a sample from NRF-13.

Mercury.—Mercury was not detected in most samples.

Nickel.—Nickel was not detected in most samples; detectable concentrations were as large as 41.8 µg/L in a sample from NRF-13.

Selenium.—Selenium was detected in only two samples.

Silver.—Silver was not detected in any samples.

Thallium.—Thallium was detected in only two samples.

Zinc.—Zinc was not detected in many samples; detectable concentrations were as large as 180 µg/L in a sample from USGS 98.

Field-blank samples contained either no detectable concentrations of trace elements or had estimated concentrations smaller than the respective reporting limits.

Dissolved and Total Nutrients

Water samples were analyzed for concentrations of dissolved nitrite as nitrogen and for total concentrations of kjeldahl nitrogen, nitrite plus nitrate as nitrogen and phosphorus as phosphorus (table 5).

Kjeldahl nitrogen.—Kjeldahl nitrogen was not detected in most samples; detectable concentrations were as large as 0.89 mg/L in a sample from USGS 102.

Nitrite as nitrogen.—Nitrite as nitrogen was not detected in most samples; detectable concentrations were as large as 0.33 mg/L in a sample from NRF-7.

Nitrite plus nitrate as nitrogen.—Concentrations ranged from 0.47 mg/L in NRF-6 and -7 to 2.4 mg/L in USGS 97 and USGS 102.

Phosphorus as phosphorus.—Phosphorus as phosphorus was detected in most samples; detectable concentrations were as large as 0.13 mg/L in a sample from NRF-13.

Field-blank samples contained either no detectable concentrations of nutrients or had estimated concentrations smaller than the reporting limits.

Total Organic Carbon and Total Organic Halogens

Water samples were analyzed for concentrations of TOC and total organic halogens (TOX) (table 5). TOC and TOX were not detected in most samples. TOC and TOX were not detected in any blank samples.

Gross Alpha- and Gross Beta-Particle Radioactivity

Water samples were analyzed for concentrations of dissolved gross alpha- and gross beta-particle radioactivity by the Quanterra Laboratory in Richland, Wash. through a contract with the NWQL using a residue procedure. Concentrations of radioactive constituents larger than or equal to 3 times the 1s uncertainty are considered to be above the reporting level in this report. All analytical measurements are listed in table 6. For a more detailed discussion of reporting levels for radioactive constituents and measurements, see the section of this report titled "Guidelines for Interpreting Results of Radiochemical Analyses."

Gross alpha-particle radioactivity.—Gross alpha-particle radioactivity is a measure of the total radioactivity given off as alpha particles during the radioactive decay process. For convenience, laboratories report the radioactivity as if it all were given off by one radionuclide. In this report, concentrations are reported as thorium-230 in picocuries per liter. Concentrations of dissolved gross alpha-particle radioactivity are listed in table 6.

Concentrations of gross alpha-particle radioactivity as thorium-230 ranged from -0.34±0.12 pCi/L in NRF-12 to 8.0±2.4 pCi/L in NRF-6. Concentrations in all the field blank samples were less than the reporting level.

Gross beta-particle radioactivity.—Gross beta-particle radioactivity is a measure of the total radioactivity given off as beta particles during the radioactive decay process. For convenience, laboratories report the radioactivity as if it all were given off by one radionuclide, cesium-137, in picocuries per liter. Concentrations of dissolved gross beta-particle radioactivity are listed in table 6.

Concentrations of gross beta-particle radioactivity as cesium-137 ranged from 0.34±0.75 pCi/L in NRF-6 to 7.6±1.0 pCi/L in NRF-6. Concentrations in all the field blank samples were less than the reporting level.

Strontium-90

Water samples were analyzed for strontium-90 by chemical separation and beta counting (table 6). The concentrations of strontium-90 in all but one regular sample and in all field-blank samples were less than the reporting level. A sample from NRF-12 contained 0.49±0.16 pCi/L.

Tritium

Water samples were analyzed for tritium by the University of Georgia Center for Isotopic Studies Laboratory through a contract with the NWQL by enrichment and liquid scintillation (table 6). Concentrations of tritium ranged from <3.57 pCi/L in NRF-7 to 200±28 pCi/L in NRF-11. The concentrations of tritium in field blank samples ranged from 14±1.5 pCi/L in QAS-73 (blank for NRF-6) to 51±4.8 pCi/L in QAS-70 (blank for NRF-13).

Selected Gamma-Emitting Radioisotopes

Gamma spectrometry involves using a series of detectors to simultaneously determine the concentrations of a variety of radionuclides by the detection of their characteristic gamma emissions. Radionuclides identified in selected samples include cobalt-60, cesium-137, potassium-40, radium-226, radium-228, thorium-228, uranium-235, uranium-238, and thallium-208. Concentrations of all the radionuclides identified using gamma spectrometry are given in table 6.

Concentrations reported as cesium-137 in all the regular field blank samples were less than the reporting level.

Regulatory Volatile and Base/Neutral Organic Compounds

Water samples collected in July 1999 were analyzed for 59 regulatory volatile organic compounds (table 7) and 17 base/neutral organic compounds (table 8). Concentrations of chloroform and tetrachloroethylene in one sample (NRF-6) were 0.2 and 0.3 µg/L, respectively. Concentrations of regulatory volatile organic compounds in all other samples were less than the reporting limits. Concentrations of Di(2-ethylhexyl) phthalate in two samples (NRF-9 and USGS 97) were 0.6 and 1.2 µg/L, respectively. Concentrations of base/neutral organic compounds in all other samples were less than the reporting limits.

SUMMARY

The USGS, in response to a request from the U.S. Department of Energy's Pittsburgh Naval Reactors Office, Idaho Branch Office, sampled 13 wells during 1999 as part of a long-term project to monitor water quality of the Snake River Plain aquifer in the vicinity of the NRF, INEEL, Idaho. Water samples were collected and analyzed for naturally occurring constituents and anthropogenic contaminants. A total of 52 samples were collected from 13 monitoring wells with dedicated submersible pumps. Eight quality-assurance samples also were collected and analyzed; four were field-blank samples and four were replicate samples.

The ranges of concentrations of dissolved anions and total cations follow: calcium, 27.1 to 117 mg/L; chloride, 5.1 to 228 mg/L; magnesium, 9.5 to 30.4 mg/L; potassium, 1.6 to 4.7 mg/L; sodium, 8.2 to 95.6 mg/L; and sulfate, 13.2 to 138 mg/L.

Samples were analyzed for 17 trace elements. Antimony, arsenic, beryllium, cadmium, copper, manganese, mercury, nickel, selenium, silver, thallium, and zinc were not detected in most samples. concentrations of manganese, nickel, and zinc were as large as 67, 41.8, and 180 µg/L, respectively. Aluminum, lead, and iron were detected in most samples. The largest concentration of iron was 3,500 µg/L. The ranges of concentrations for barium and chromium were 55.2 to 180 µg/L and 4.6 to 72 µg/L, respectively. Concentrations of the predominant nitrogen-bearing compound, nitrite plus nitrate as nitrogen, ranged from 0.47 to 2.4 µg/L.

TOC and TOX were not detected in most samples.

Concentrations of dissolved gross alpha- and gross beta-particle radioactivity and tritium exceeded the reporting level in most samples. Concentrations of strontium-90 and gross gamma as cesium-137 were less than the reporting level in most samples.

Concentrations of two regulatory volatile organic compounds were detected in one sample. Concentrations of the base/neutral organic compound Di(2-ethylhexyl) phthalate were detected in two samples. All of the field blank samples contained concentrations of the constituents that were less than the reporting limits.

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Table 1. Containers and preservatives used for water samples, Naval Reactors Facility and vicinity

[Analyses were performed by Quanterra Laboratory. Abbreviations: L, liter; mL, milliliter. Symbols: HNO_3, nitric acid; H_2SO_4, sulfuric acid; HCL, hydrochloric acid; °C, degrees Celsius. Samples were shipped by overnight-delivery mail]

	Container		Preservative		
Type of constituent	Type	Size	Type	Volume	Other treatment
Anions	Polyethylene	1 L	None	None	Filter
Cations, total recoverable	Polyethylene	500 mL	HNO_3	10 mL	None
Trace elements, total recoverable	Polyethylene	500 mL	HNO_3	10 mL	None
Nitrite	Polyethylene	1 L	None	None	Filter
Nutrients, total recoverable	Glass, baked	500 L	H_2SO_4	2 mL	Chill 4°C
Specific conductance	Polyethylene	1L	None	None	Filter
Total organic carbon	Glass, baked	500 L	H_2SO_4	2 mL	Chill 4°C
Total organic halogens	Glass, baked	250 mL	H_2SO_4	1 mL	Chill 4°C
Purgeable organic compounds	Glass, baked	40 mL	HCL	4 drops	Chill
Semi-volatile organic compounds	Glass, baked	1L	None	None	Chill
Gamma	Polyethylene, acid-rinsed	1L	HNO_3	20 mL	Filter
Gross alpha- and beta-particle radioactivity	Polyethylene, acid-rinsed	1L	HNO_3	20 mL	Filter
Strontium-90	Polyethylene, acid-rinsed	1L	HNO_3	20 mL	Filter
Tritium	Polyethylene or glass, baked	500 mL	None	None	None

Table 2. Results of measurements of water for alkalinity, pH, specific conductance, temperature, and turbidity, and calculated total dissolved solids, Naval Reactors Facility and vicinity

[Sample identifier: see figure 2 for location of wells. QAS indicates water-quality-assurance sample; 73, sample number; B, field blank; R, replicate. Date sampled: (m/d/y), month/day/year. Units: Alkalinity, as calcium carbonate ($CaCO_3$) in milligrams per liter (mg/L); pH, negative base-10 logarithm of hydrogen ion activity in moles per liter; specific conductance, microsiemens per centimeter at 25 deg C (degrees Celsius); temperature, deg C; total dissolved solids, mg/L calculated from specific conductance; turbidity; NTU, nephlometric turbidity units. Abbreviation: NA, not analyzed. Symbol: *, estimated result]

Sample identifier	Date sampled m/d/y	Time	Alkalinity as $CaCO_3$	pH	Specific conductance (field)	Specific conductance (lab)	Temperature	Total dissolved solids	Turbidity
NRF-6	2/4/99	1325	179	8.0	1,290	1,220	11.5	700	3.66
	5/3/99	1155	178	8.0	1,301	1,170	11.5	706	5.07
	7/26/99	1155	181	7.9	1,212	1,180	11.5	658	1.91
	11/1/99	1235	184	7.8	1,114	1,080	11.5	605	1.72
QAS-73B	11/1/99	1315	NA	8.4	11	1.4*	17.5	6	.24
NRF-7	2/4/99	1130	112	8.2	261	258	14.5	142	6.56
	5/3/99	1110	104	8.4	255	254	15.5	138	4.48
	7/26/99	1100	112	8.0	262	265	14.5	142	10.1
	11/1/99	1140	110	8.1	261	264	14.5	142	43.7
NRF-8	2/11/99	1005	210	8.0	604	590	11.0	328	.34
	5/3/99	1320	213	8.1	600	572	11.5	326	.42
	7/27/99	1055	215	7.9	597	593	11.5	324	.62
	11/2/99	1005	218	8.0	595	571	11.5	323	7.95
NRF-9	2/11/99	1050	210	8.0	639	623	11.0	347	.45
	5/4/99	1030	210	7.8	634	594	11.5	344	.56
	7/27/99	1200	207	7.9	631	624	11.5	343	.51
	11/2/99	1050	209	8.0	623	598	11.5	338	.40
QAS-74R	11/2/99	1115	209	8.0	623	598	11.5	338	.40
NRF-10	2/11/99	1150	195	8.1	601	589	11.0	326	1.48
QAS-68B	2/11/99	1210	NA	5.4	3	2.3	8.0	2	NA
NRF-10	5/4/99	1115	194	7.9	595	558	11.5	323	2.67
	7/28/99	0955	198	7.9	600	583	11.5	326	2.75
	11/2/99	1145	196	8.0	590	562	11.5	320	1.88

Table 2. Results of measurements of water for alkalinity, pH, specific conductance, temperature, and turbidity, and calculated total dissolved solids, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Time	Alkalinity as $CaCO_3$	pH	Specific conductance (field)	Specific conductance (lab)	Temperature	Total dissolved solids	Turbidity
NRF-11	2/11/99	1250	205	8.0	638	623	11.5	346	3.87
	5/4/99	1200	207	7.9	630	589	11.5	342	37.6
	7/28/99	1100	205	7.9	630	614	12.0	342	2.33
QAS-72B	7/28/99	1120	NA	7.0	8	2	22.5	4	1.22
NRF-11	11/3/99	1040	207	8.0	625	595	11.5	339	1.94
NRF-12	2/4/99	1225	199	8.0	698	680	11.5	379	2.06
QAS-67R	2/4/99	1300	199	8.0	698	678	11.5	379	2.06
NRF-12	5/5/99	1015	203	7.8	686	639	11.5	372	7.17
	7/28/99	1215	200	7.9	676	657	11.5	367	6.14
	11/3/99	1130	203	7.9	663	630	11.5	360	3.95
NRF-13	2/11/99	1335	97	8.1	623	607	15.5	338	56.4
	5/5/99	1320	85	8.0	578	547	18.5	314	105
QAS-70B	5/5/99	1400	NA	7.0	3	3.7	13.5	2	.36
NRF-13	7/28/99	1305	103	7.9	624	606	16.0	339	61.4
	11/3/99	1225	105	8.0	618	585	17.5	336	83.8
USGS 12	2/11/99	0905	196	8.0	491	480	11.0	267	.42
	5/5/99	0920	198	7.8	479	456	11.5	260	.28
	7/28/99	0845	197	7.8	472	464	11.5	256	.59
	11/3/99	0940	200	7.9	470	453	11.5	255	1.20
USGS 97	2/9/99	1135	220	7.9	615	603	11.5	334	.36
	5/4/99	0940	218	7.8	614	576	11.5	333	.47
QAS-69R	5/4/99	0955	218	7.8	614	575	11.5	333	.47
USGS 97	7/27/99	1005	219	7.9	609	602	11.5	331	.28
USGS 98	2/9/99	0935	176	7.8	443	436	12.0	241	.36
	5/4/99	0805	176	7.5	439	421	12.0	238	.65
	7/27/99	0750	179	7.8	438	437	12.0	238	.55
QAS-71R	7/27/99	0830	179	7.8	438	436	12.0	238	.55

Table 2. Results of measurements of water for alkalinity, pH, specific conductance, temperature, and turbidity, and calculated total dissolved solids, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Time	Alkalinity as $CaCO_3$	pH	Specific conductance (field)	Specific conductance (lab)	Temperature	Total dissolved solids	Turbidity
USGS 98	11/2/99	0745	180	8.0	438	430	12.0	238	.69
USGS 99	2/9/99	1040	211	8.0	530	521	11.0	288	1.30
	5/4/99	0850	210	7.8	528	502	11.5	287	1.13
	7/27/99	0910	212	7.9	526	523	11.5	286	.72
	11/2/99	0835	214	8.0	530	511	11.5	288	1.09
USGS 102	2/9/99	1235	210	7.9	604	594	11.0	328	1.38
	5/3/99	1240	214	8.1	602	573	11.5	327	.81
	7/26/99	1300	214	7.9	596	591	11.5	324	.22
	11/1/99	1325	210	7.8	593	586	11.5	322	.51

Table 3. Concentrations of dissolved anions and total cations in water, Naval Reactors Facility and vicinity
[Analyses were performed by Quanterra Laboratory. Analytical results in milligrams per liter. Sample identifier: see figure 2 for location of wells. QAS indicates water-quality-assurance sample; 73, sample number; B, field blank; R, replicate. Date sampled: (m/d/y), month/day/year. Abbreviations: Q, reporting limit was elevated because of large analyte values; ND, not detected. Symbol: *, estimated concentration]

Sample identifier	Date sampled m/d/y	Calcium (total)	Chloride (dissolved)	Magnesium (total)	Potassium (total)	Sodium (total)	Sulfate (dissolved)
NRF-6	2/4/99	114	199Q	29.3	4.5*	93.6	138Q
	5/3/99	117	228Q	30.4	4.7*	95.6	131Q
	7/26/99	111	191Q	28.8	4.3*	83.9	128Q
	11/1/99	96.3	176Q	26.5	3.7*	77.2	113Q
QAS-73B	11/1/99	.015*	ND	ND	ND	.60*	ND
NRF-7	2/4/99	27.1	5.1	9.5	3.0*	8.7	13.2
	5/3/99	27.7	5.3	9.7	3.2*	9.5	13.3
	7/26/99	30.0	5.3	9.8	2.9*	8.2	14.0
	11/1/99	28.3	5.8	9.8	3.0*	8.9	14.2
NRF-8	2/11/99	70.5	36.5	22.3	2.4*	14.5	34.7
	5/3/99	71.5	39.8	23.1	2.5*	14.6	34.6
	7/27/99	71.6	36.4	23.1	2.2*	15.6	35.5
	11/2/99	66.7	41.7	22.9	2.3*	15.2	36.2
NRF-9	2/11/99	74.9	45.6	23.0	2.2*	17.2	42.8
	5/4/99	75.3	49.5	23.3	2.4*	18.0	42.7
	7/27/99	74.7	45.1	23.4	2.2*	17.6	43.1
	11/2/99	68.7	49.3	22.7	2.4*	16.9	42.4
QAS-74R	11/2/99	71.0	49.9	23.2	2.4*	16.7	42.6
NRF-10	2/11/99	68.7	42.2	21.7	2.6*	14.4	39.9
QAS-68B	2/11/99	ND	ND	ND	ND	ND	ND
NRF-10	5/4/99	70.5	45.7	22.7	2.8*	14.5	39.5
	7/28/99	71.1	41.7	23.0	2.4*	16.2	39.9
	11/2/99	66.9	50.0	22.6	2.4*	15.2	40.8
NRF-11	2/11/99	73.6	46.6	22.9	2.4*	16.8	41.9
	5/4/99	74.1	44.5Q	23.4	2.5*	17.3	41.4
	7/28/99	69.1	47.2	21.9	2.5*	18.5	42.3

Table 3. Concentrations of dissolved anions and total cations in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Calcium (total)	Chloride (dissolved)	Magnesium (total)	Potassium (total)	Sodium (total)	Sulfate (dissolved)
QAS-72B	7/28/99	.07*	ND	.02*	ND	ND	ND
NRF-11	11/3/99	73.2	47.1Q	23.5	2.8*	19.5	42.2
NRF-12	2/4/99	77.1	56.0Q	23.6	2.9*	23.5	48.9Q
QAS-67R	2/4/99	78.2	55.6Q	24.0	2.7*	23.7	49.0Q
NRF-12	5/5/99	79.2	59.1Q	24.4	3.1*	25.2	47.8Q
	7/28/99	76.3	53.4Q	23.8	2.5*	23.7	48.4Q
	11/3/99	76.0	55.9Q	24.1	2.6*	23.3	49.7
NRF-13	2/11/99	71.1	69.0Q	20.4	3.9*	9.6	82.1
	5/5/99	74.0	69.6Q	20.5	4.1*	11.2	75.6Q
QAS-70B	5/5/99	.064*	ND	.014*	ND	ND	ND
NRF-13	7/28/99	78.1	69.0Q	24.1	3.9*	11.9	81.0Q
	11/3/99	73.9	81.2Q	21.9	4.0*	12.3	86.9Q
USGS 12	2/11/99	56.0	17.4	17.7	1.9*	13.3	24.3
	5/5/99	58.7	17.3	18.6	2.2*	13.4	23.2
	7/28/99	57.5	14.9	18.4	1.7*	13.3	23.9
	11/3/99	57.3	15.8	18.6	1.8*	13.1	24.0
USGS 97	2/9/99	71.3	14.4	23.3	1.9*	16.9	21.4
	5/4/99	73.7	40.0	24.0	2.1*	15.8	34.4
QAS-69R	5/4/99	72.8	40.2	23.7	2.2*	15.3	34.6
USGS 97	7/27/99	71.6	36.8	23.6	2.1*	16.6	35.4
	11/2/99	66.6	41.6	23.0	1.9*	15.7	35.6
USGS 98	2/9/99	50.9	14.4	19.3	2.0*	10.1	21.6
	5/4/99	51.3	15.4	19.4	2.3*	10.2	21.3
	7/27/99	51.1	14.5	19.5	2.0*	10.7	22.1
QAS-71R	7/27/99	50.4	14.4	19.2	1.6*	8.8	22.0
USGS 98	11/2/99	46.7	16.7	18.8	2.1*	9.1	22.6
USGS 99	2/9/99	62.5	20.5	21.8	1.6*	15.4	25.2
	5/4/99	62.9	22.4	21.9	1.9*	14.9	24.9

Table 3. Concentrations of dissolved anions and total cations in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Calcium (total)	Chloride (dissolved)	Magnesium (total)	Potassium (total)	Sodium (total)	Sulfate (dissolved)
USGS 99	7/27/99	61.3	20.8	21.5	1.7*	14.4	25.9
	11/2/99	57.1	24.0	21.2	1.6*	13.4	26.5
USGS 102	2/9/99	71.9	36.0	23.0	2.2*	16.3	34.4
	5/3/99	71.7	39.5	23.4	2.4*	15.7	34.3
	7/26/99	73.1	36.2	23.6	2.0*	14.0	35.1
	11/1/99	65.7	41.2	22.4	2.4*	15.5	35.7

Table 4. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity

[Analyses were performed by Quanterra Laboratory. Analytical results in micrograms per liter. Sample identifier: see figure 2 for location of wells. QAS indicates water-quality-assurance sample; 73, sample number; B, field blank; R, replicate. Date sampled: (m/d/y), month/day/year. Abbreviations: ND, not detected; W, Post digestion spike recovery fell between 40-85 percent due to matrix interference; D, result was obtained from the analysis of a dilution; Q, elevated reporting limit because of large analyte levels. Symbol: *, estimated concentration]

Constituent	NRF-6 2/4/99	NRF-6 5/3/99	NRF-6 7/26/99	NRF-6 11/1/99	QAS-73B 11/1/99	NRF-7 2/4/99	NRF-7 5/3/99	NRF-7 7/26/99	NRF-7 11/1/99
Aluminum	60.6*	31*	39*	54*	50*	120	120	200	560
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	4.3*	ND	ND	ND	ND	ND	ND	ND
Barium	68.8	71	64	58	ND	59.6	62	61	69
Beryllium	ND	ND	ND	ND	ND	1.1*	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	24.2W	30WDQ	31	27DQ	ND	10.1	8.5	11W	13
Copper	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	486	570	1,100	150	ND	101	270	310	700
Lead	ND	ND	1.5*	2.1*	2.6*	ND	ND	ND	3.5
Manganese	4.6*	5.2*	9.3*	1.4*	ND	3.3*	5.4*	10	24
Mercury	ND	ND	.16*	ND	ND	ND	ND	.14*	ND
Nickel	11.5*	15*	10*	15*	ND	ND	9.5*	9.3*	11*
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	8.6*	ND	ND	ND	ND	ND	ND
Zinc	ND	ND	2.7*	ND	ND	ND	37	9.0*	11*

Table 4. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	NRF-8 2/11/99	NRF-8 5/3/99	NRF-8 7/27/99	NRF-8 11/2/99	NRF-9 2/11/99	NRF-9 5/4/99	NRF-9 7/27/99	NRF-9 11/2/99	QAS-74R 11/2/99
Aluminum	ND	27*	37*	500	ND	29*	26*	110	110
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	125	140	140	140	133	140	140	150	150
Beryllium	ND	ND	ND	1.7*	ND	ND	ND	1.6*	1.6*
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	6.0W	6.2W	7.8	9.5	8.2W	8.5W	12	9	9.2
Copper	ND	ND	3.3*	ND	ND	ND	ND	ND	ND
Iron	ND	310	31*	570	ND	33*	52*	18*	32*
Lead	ND	ND	1.2*	3.8	ND	ND	ND	1.7*	3.6
Manganese	ND	2.1*	ND	9.8*	ND	ND	ND	ND	ND
Mercury	.18*	ND	ND	ND	.16*	ND	ND	ND	ND
Nickel	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ND	3.1*	5.3*	3.2*	ND	ND	ND	ND	7.9*

Table 4. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	NRF-10 2/11/99	QAS-68B 2/11/99	NRF-10 5/4/99	NRF-10 7/28/99	NRF-10 11/2/99	NRF-11 2/11/99	NRF-11 5/4/99	NRF-11 7/28/99	QAS-72B 7/28/99	NRF-11 11/3/99
Aluminum	ND	ND	110	64*	180	ND	220	93*	25*	44*
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	124	ND	140	140	140	138	150	140	ND	150
Beryllium	ND	ND	ND	ND	1.8*	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	9.6W	1.1*	11W	13W	12	13.5W	14W	17W	2*	15
Copper	ND	ND	ND	1.1*	ND	ND	ND	28	ND	ND
Iron	ND	ND	180	120	97*	ND	200	220	23*	69*
Lead	ND	ND	ND	ND	4.4*	ND	1.6*	1.6*	ND	2*
Manganese	3.0*	ND	4.3*	3.8*	3.7*	ND	3.0*	2.4*	ND	1*
Mercury	.14*	.21*	ND	ND	ND	.15*	ND	ND	ND	ND
Nickel	12.1*	ND	34*	24*	23*	ND	ND	ND	ND	ND
Selenium	ND	ND	ND	4.1*	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.2*
Zinc	ND	ND	ND	ND	9.6*	ND	ND	ND	ND	ND

Table 4. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	NRF-12 2/4/99	QAS-67R 2/4/99	NRF-12 5/5/99	NRF-12 7/28/99	NRF-12 11/3/99	NRF-13 2/11/99	NRF-13 5/5/99	QAS-70B 5/5/99	NRF-13 7/28/99	NRF-13 11/3/99
Aluminum	70.1*	72.7*	33*	27*	ND	1,680	2,200	22*	3,800	2,400
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	175	176	180	170	170	87.5	110	ND	110	110
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	14.1W	13W	21DQ	20W	18W	78WDQ	74WDQ	ND	49DQ	92DQ
Copper	ND	ND	ND	ND	3.4*	4*	4.5*	ND	4.6*	7*
Iron	ND	329	140	250	83*	2,030	2,600	ND	3,500	2,600
Lead	ND	ND	ND	1.6*	2.6*	ND	1.8*	ND	1*	2*
Manganese	ND	4.6*	1.4*	1.3*	ND	37	67	ND	58	44
Mercury	ND	ND	ND	ND	ND	.16*	ND	ND	ND	ND
Nickel	17.3*	18.6*	24*	18*	15*	41.8	20	ND	13*	27*
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ND	ND	20	ND	ND	ND	9.1*	5*	9.1*	13*

Table 4. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	USGS 12 2/11/99	USGS 12 5/5/99	USGS 12 7/28/99	USGS 12 11/3/99	USGS 97 2/9/99	USGS 97 5/4/99	QAS-69R 5/4/99	USGS 97 7/27/99	USGS 97 11/2/99
Aluminum	ND	25*	15*	58*	ND	27*	28*	24*	110
Antimony	ND	ND	ND	ND	3.2*	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	123	130	130	130	131	150	150	140	150
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	1.6*
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	5.1W	5.7	6.5	6.4	5.4W	5.3	5.1W	7.2	7.0
Copper	ND	ND	ND	ND	ND	ND	ND	1.0*	ND
Iron	ND	86*	85*	77*	ND	14*	22*	66*	9.0*
Lead	ND	ND	1.5*	2.7*	ND	9.2	ND	1.6*	2.8*
Manganese	ND	ND	ND	1.7*	ND	ND	ND	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND	ND	4.2*	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	ND	2.9*	ND	10*	111	100	96	100	98

Table 4. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	USGS 98 2/9/99	USGS 98 5/4/99	USGS 98 7/27/99	QAS-71R 7/27/99	USGS-98 11/2/99	USGS 99 2/9/99	USGS 99 5/4/99	USGS-99 7/27/99	USGS 99 11/2/99
Aluminum	ND	26*	21*	17*	89*	ND	24*	18*	110
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	55.2	57	57	56	57	101	110	110	110
Beryllium	ND	ND	ND	ND	1.5*	ND	ND	ND	1.4*
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	4.9*	4.8*W	6.5	6.2	6.3	5.0W	4.6*	6.2	5.8
Copper	ND	ND	1.0*	1.4*	ND	4.0*	ND	1.1*	ND
Iron	ND	160	54*	100	19*	ND	93*	77*	58*
Lead	3.5	6.5	4.3	4.4	6.3	ND	1.7*	2.2*	3.6
Manganese	ND	1.4*	ND	ND	ND	ND	ND	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	120	180	140	140	130	102	120	94	99

Table 4. Concentrations of selected total trace elements in water, Naval Reactors Facility and vicinity—Continued

Constituent	**USGS 102 2/9/99**	**USGS 102 5/3/99**	**USGS 102 7/26/99**	**USGS 102 11/1/99**
Aluminum	49.8*	49*	24*	75*
Antimony	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND
Barium	122	130	130	130
Beryllium	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND
Chromium	5.6W	7.7W	5.0	7.2
Copper	ND	ND	ND	ND
Iron	ND	220	88*	57*
Lead	ND	ND	2.2*	1.8*
Manganese	ND	1.5*	ND	ND
Mercury	ND	ND	.16*	ND
Nickel	ND	ND	ND	ND
Selenium	ND	ND	ND	ND
Silver	ND	ND	ND	ND
Thallium	ND	ND	ND	ND
Zinc	ND	39	9.1*	ND

Table 5. Concentrations of dissolved and total nutrients, total organic carbon, and total organic halogens in water, Naval Reactors Facility and vicinity

[Analyses were performed by Quanterra Laboratory. Analytical results in milligrams per liter. Sample identifier: see figure 2 for location of wells. QAS indicates water-quality-assurance sample; 73, sample number; B, field blank; R, replicate. Date sampled: (m/d/y), month/day/year. Abbreviations: ND, analysis not detected; Q, reporting limit is elevated because of large analyte values. Symbol: *, indicates estimated result]

Sample identifier	Date sampled m/d/y	Kjeldahl nitrogen (total)	Nitrite as nitrogen (dissolved)	Nitrite plus nitrate as nitrogen (total)	Phosphorus as phosphorus (total)	Total organic carbon	Total organic halogens
NRF-6	2/4/99	0.088*	ND	1.7	0.093	ND	0.014*
	5/3/99	ND	.007*	.47	ND	.53*	.012*
	7/26/99	.18*	ND	1.8	.045*	1.0	ND
	11/1/99	ND	ND	1.8	.035*	ND	ND
QAS-73B	11/1/99	ND	ND	ND	.018*	ND	ND
NRF-7	2/4/99	.11*	ND	.53	.039*	ND	ND
	5/3/99	ND	.33	.66	ND	ND	ND
	7/26/99	.12*	ND	.47	.031*	ND	ND
	11/1/99	ND	ND	.47	.04*	ND	ND
NRF-8	2/11/99	.1*	.002*	2.2Q	.047*	ND	ND
	5/4/99	.34*	.011	2.2	ND	.37*	ND
	7/27/99	.11*	ND	2.3	.035*	.51*	ND
	11/2/99	ND	ND	2.0	.057	ND	ND
NRF-9	2/11/99	ND	.002*	2.0Q	.057	ND	.010*
	5/4/99	ND	ND	2.3	ND	.85*	.004*
	7/27/99	.12*	ND	2.3	.031*	.49*	ND
	11/2/99	ND	ND	2.2	.041*	ND	.004*
QAS-74R	11/2/99	ND	ND	2.1	.029*	.26*	ND
NRF-10	2/11/99	.091*	.002*	1.8Q	.058	ND	ND
QAS-68B	2/11/99	.36*	.003*	ND	.035*	ND	ND
NRF-10	5/4/99	ND	ND	1.9	.084	.86*	.004*
	7/28/99	ND	ND	2.1	.017*	.95*	ND
	11/2/99	ND	ND	1.8	.043*	ND	ND

Table 5. Concentrations of dissolved and total nutrients, total organic carbon, and total organic halogens in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Kjeldahl nitrogen (total)	Nitrite as nitrogen (dissolved)	Nitrite plus nitrate as nitrogen (total)	Phosphorus as phosphorus (total)	Total organic carbon	Total organic halogens
NRF-11	2/11/99	.079*	.013	2.2Q	.05	ND	.012*
	5/4/99	ND	ND	2.1	ND	.98*	ND
	7/28/99	.41*	ND	2.3	.053	.48*	ND
QAS-72B	7/28/99	.22*	ND	ND	.045*	ND	ND
NRF-11	11/3/99	ND	ND	2.1	ND	ND	ND
NRF-12	2/4/99	ND	ND	2.1	.035*	ND	.008*
QAS-67R	2/4/99	.095*	ND	2.3	.044*	.59*	ND
NRF-12	5/5/99	ND	ND	2.1	ND	.54*	.005*
	7/28/99	ND	ND	2.1	.05*	.38*	ND
	11/3/99	.099*	ND	2.0	.034*	ND	ND
NRF-13	2/11/99	.2*	.007*	.91	.084	ND	.013*
	5/5/99	.24*	ND	.80	.12	.31*	.008*
QAS-70B	5/5/99	ND	ND	ND	ND	ND	ND
NRF-13	7/28/99	ND	ND	.87	.13	.43*	ND
	11/3/99	ND	ND	.84	.085	ND	.006*
USGS 12	2/11/99	ND	.003*	1.1	.048*	ND	ND
	5/5/99	.33*	ND	1.0	ND	ND	ND
	7/28/99	.20*	.008*	.95	.053	.64*	ND
	11/3/99	.12*	ND	.82	.041*	ND	ND
USGS 97	2/9/99	.18*	ND	2.4	.049*	ND	ND
	5/4/99	ND	ND	2.2	ND	.76*	ND
QAS-69R	5/4/99	ND	ND	2.3	ND	.82*	.003*
USGS 97	7/27/99	ND	ND	2.3	.033*	.31*	ND
	11/2/99	ND	ND	2.2	.032*	ND	ND

Table 5. Concentrations of dissolved and total nutrients, total organic carbon, and total organic halogens in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled m/d/y	Kjeldahl nitrogen (total)	Nitrite as nitrogen (dissolved)	Nitrite plus nitrate as nitrogen (total)	Phosphorus as phosphorus (total)	Total organic carbon	Total organic halogens
USGS 98	2/9/99	ND	ND	.96	.038*	ND	ND
	5/4/99	ND	ND	1.2	ND	.54*	.004*
	7/27/99	.072*	ND	1.2	.036*	.65*	ND
QAS-71R	7/27/99	.088*	ND	1.2	.028*	.57*	ND
USGS 98	11/2/99	ND	ND	1.1	.027*	ND	.012*
USGS 99	2/9/99	ND	ND	1.5	.055	ND	ND
	5/4/99	ND	ND	1.7	ND	.86*	ND
	7/27/99	.42*	ND	1.7	.026*	.89*	ND
	11/2/99	ND	ND	1.6	.044*	ND	ND
USGS 102	2/9/99	ND	ND	2.4	.053	ND	.0091*
	5/3/99	.076*	.012	1.9	ND	.36*	.003*
	7/26/99	.15*	ND	2.1	.03*	.48*	ND
	11/1/99	.89	ND	2.1	.027*	.57*	ND

Table 6. Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, tritium, and selected isotopes from gamma spectroscopy in water, Naval Reactors Facility and vicinity

[Analyses were performed by the Quanterra Laboratory using a residue procedure for gross alpha- and beta-particle radioactivity, chemical separation and beta counting for strontium-90, and gamma spectroscopy for gamma emmissions. Tritium analyses were performed by the University of Georgia using electrolytic enrichment and liquid scintillation. Analytical results and uncertainties—for example, 3.8±0.9—in picocuries per liter. Analytical uncertainties are reported as 1s. Concentrations that meet or exceed the reporting level of 3 times the 1s value are shown in boldface type. Sample identifier: see figure 2 for location of wells. QAS indicates water-quality-assurance sample; 73, sample number; B, field blank; R, replicate. Date sampled: (m/d/y), month/day/year. Isotopes: isotope reported in parenthesis after value. Symbols: #, value is questionable, and sample lost while rerunning; <, less than; Co, cobalt; Cs, cesium; K, potassium; Ra, radium; Th, thorium; U, uranium; Tl, thallium; ±, plus or minus]

Sample identifier	Date sampled (m/d/y)	Gross alpha-particle radioactivity, as Th-230	Gross beta-particle radioactivity, as Cs-137	Strontium-90	Tritium	Isotopes
NRF-6	2/4/99	**3.8±0.9**	**5.1±0.8**	0.01±0.12	**102±10**	0.65±0.38(Co-60); -0.14±0.36(Cs-137); -17.2±14(K-40); -3.8±1.5(Ra-226); **26±2.3**(Ra-228); 1.1±2.7(Th-228); 0.86±1.6(U-235); -1.5±1.3(U-238)
	5/3/99	2.4±1.0	**7.6±1.0**	.12±0.26	**103±13**	-.25±0.56(Cs-137)
	7/26/99	2.7±1.4	.34±0.75	-.03±0.08	**84±5.9**	-.18±0.33(Cs-137)
	11/1/99	**8.0±2.4**	**4.9±0.95**	.26±0.14	**62±4.5**	.27±0.36(Cs-137)
QAS-73B	11/1/99	.09±0.1	-.07±0.14	.08±0.12	**14±1.5**	.06±0.35(Cs-137)
NRF-7	2/4/99	**1.8±0.28**	**4.1±0.34**	.11±0.11	**16±1.4**	.67±0.38(Co-60);-.41±0.36(Cs-137); -24.1±11(K-40); -1.0±1.4(Ra-226);**.12±2.2**(Ra-228); -1.5±1.8(Th-228); -4.1±2.2(U-235); -1.3±1.0(U-238)
	5/3/99	**1.7±0.5**	**4.2±0.44**	.02±0.09	**38±3.6**	.10±0.32(Cs-137)
	7/26/99	**1.7±0.5**	**1.7±0.32**	-.001±0.08	**8.7±1.1**	.25±0.34(Cs-137)
	11/1/99	1.1±0.44	**4.6±0.55**	.26±0.14	<3.57	-.006±0.35(Cs-137)
NRF-8	2/11/99	**2.6±0.55**	**2.6±0.48**	.22±0.12	**63±6.1**	.85±0.36(Cs-137)
	5/3/99	1.4±0.65	**4.0±0.50**	.06±0.1	**94±10**	.03±0.34(Cs-137)
	7/27/99	**3.0±1.0**	**3.1±0.55**	.2±0.12	**65±4.6**	.08±0.38(Cs-137)
	11/2/99	**3.8±1.2**	**3.5±0.7**	.009±0.11	**47±3.4**	.14±0.36(Cs-137)

Table 6. Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, tritium, and selected isotopes from gamma spectroscopy in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled (m/d/y)	Gross alpha-particle radioactivity, as Th-230	Gross beta-particle radioactivity, as Cs-137	Strontium-90	Tritium	Isotopes
NRF-9	2/11/99	**4.3±0.8**	**5.3±0.65**	.04±0.11	102±10	-.11±0.36(Cs-137)
	5/4/99	2.6±0.95	**3.5±0.5**	.04±0.1	**125±15**	-.24±0.32(Cs-137)
	7/27/99	**5.2±1.4**	**3.2±0.55**	.12±0.12	**97±6.7**	.59±0.36(Cs-137)
	11/2/99	**3.3±0.8**	**5.0±0.75**	-.009±0.12	**80±5.5**	-.36±0.36(Cs-137); **9.0±1.6**(Th-228); **3.1±0.55**(Tl-208)
QAS-74R	11/2/99	**3.6±1.2**	**4.2±0.7**	.23±0.13	**77±5.4**	-.44±0.34(Cs-137)
NRF-10	2/11/99	**2.7±0.55**	**3.7±0.6**	.26±0.12	**140±15**	-.42±0.35(Cs-137)
QAS-68B	2/11/99	0±0.03	.15±0.16	.001±0.1	**19±1.7**	.04±0.33(Cs-137)
NRF-10	5/4/99	**3.8±1.1**	**3.8±0.45**	.02±0.1	**166±23**	.32±0.32(Cs-137)
	7/28/99	**2.9±0.9**	**3.9±0.55**	.15±0.10	**116±8.1**	.90±0.34(Cs-137)
	11/2/99	2.1±0.95	**4.0±0.7**	.01±0.12	**108±7.4**	-.07±0.36(Cs-137)
NRF-11	2/11/99	**4.2±0.75**	**3.6±0.6**	.08±0.12	**120±13**	-.32±0.37(Cs-137)
	5/4/99	2.5±0.9	**4.7±0.55**	.09±0.11	**200±28**	.31±0.35(Cs-137)
	7/28/99	**3.1±0.95**	**4.3±0.6**	.13±0.10	**124±8.6**	.30±0.36(Cs-137)
QAS-72B	7/28/99	-.05±0.02	-.21±0.14	.11±0.08	**23±1.9**	-.08±0.32(Cs-137)
NRF-11	11/3/99	**4.4±1.0**	**4.8±0.75**	.18±0.14	**92±6.3**	.34±0.33(Cs-137)
NRF-12	2/4/99	**4.4±0.75**	**4.2±0.45**	**.49±0.16**	**76±7.2**	-.2±0.37(Co-60); -.16±0.36(Cs-137); 5.9±11(K-40); **4.9±1.3**(Ra-226); **5.0±1.4**(Ra-228); **5.9±1.8**(Th-228); 1.9±1.6(U-235); 1.8±0.7(U-238)
QAS-67R	2/4/99	**3.0±0.5**	**3.7±0.44**	.26±0.14	**89±8.8**	**1.8±0.44**(Co-60); .58±0.38(Cs-137); -30±12(K-40); -6.2±1.6(Ra-226); **7.3±1.6**(Ra-228); 2.5±1.2(Th-228); 1.3±1.9(U-235); -.65±1.2(U-238)

Table 6. Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, tritium, and selected isotopes from gamma spectroscopy in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled (m/d/y)	Gross alpha-particle radioactivity, as Th-230	Gross beta-particle radioactivity, as Cs-137	Strontium-90	Tritium	Isotopes
NRF-12	5/5/99	1.4±0.8	**5.0±0.6**	.08±0.10	**67±6.9**	-.007±0.34(Cs-137)
	7/28/99	1.6±0.8	**3.4±0.6**	.11±0.1	**69±4.9**	.14±0.36(Cs-137)
	11/3/99	-.34±0.12	**3.8±0.65**	.21±0.13	**56±4.0**	.90±0.36(Cs-137)
NRF-13	2/11/99	**3.9±0.8**	**4.7±0.5**	.01±0.10	**59±5.4**	.04±0.42(Cs-137)
	5/5/99	1.3±0.75	**5.2±0.6**	-.02±0.1	**59±6.5**	.21±0.32(Cs-137)
QAS-70B	5/5/99	-.05±0.02	-.11±0.16	.02±0.1	**51±4.8**	-.28±0.34(Cs-137)
NRF-13	7/28/99	**3.7±1.2**	**4.7±0.65**	.03±0.10	**49±3.5**	-.08±0.34(Cs-137)
	11/3/99	3.0±1.2	**6.1±0.8**	-.13±0.10	**38±2.8**	.44±0.4(Cs-137)
USGS 12	2/11/99	**3.4±0.6**	**3.0±0.48**	.16±0.12	**82±8.2**	.29±0.35(Cs-137)
	5/5/99	**3.8±1.0**	**2.2±0.38**	.05±0.13	**220±26#**	.10±0.34(Cs-137)
	7/28/99	1.7±0.65	**3.3±0.46**	.17±0.12	**75±5.3**	.01±0.35(Cs-137)
	11/3/99	2.1±0.8	**3.4±0.5**	-.009±0.1	**62±4.3**	.44±0.34(Cs-137)
USGS 97	2/9/99	**2.8±0.6**	**3.5±0.6**	.22±0.12	**64±6.2**	.04±0.36(Cs-137)
	5/4/99	**4.0±1.1**	**4.1±0.5**	.03±0.1	**80±9.4**	.24±0.32(Cs-137)
QAS-69R	5/4/99	2.3±0.85	**2.6±0.42**	-.06±0.95	**74±8.4**	.37±0.36(Cs-137)
USGS 97	7/27/99	**3.1±0.95**	**4.0±0.55**	.03±0.1	**56±4.1**	-.36±0.36(Cs-137)
	11/2/99	1.7±0.85	**2.5±0.55**	-.04±0.1	**44±3.2**	.44±0.40(Cs-137)
USGS 98	2/9/99	**2.3±0.48**	**2.5±0.45**	.17±0.11	**27±2.4**	.07±0.38(Cs-137); **4.3±1.0**(U-238)
	5/4/99	**2.2±0.7**	**3.4±0.41**	.06±0.11	**29±2.9**	-.44±0.40(Cs-137)
	7/27/99	**2.1±0.7**	**1.8±0.39**	.09±0.85	**27±2.1**	-.10±0.36(Cs-137)

Table 6. Concentrations of gross alpha-particle radioactivity, gross beta-particle radioactivity, strontium-90, tritium, and selected isotopes from gamma spectroscopy in water, Naval Reactors Facility and vicinity—Continued

Sample identifier	Date sampled (m/d/y)	Gross alpha-particle radioactivity, as Th-230	Gross beta-particle radioactivity, as Cs-137	Strontium-90	Tritium	Isotopes
QAS-71R	7/27/99	1.3±0.55	**2.8±0.46**	.28±0.15	**34±2.7**	.16±0.36(Cs-137)
USGS 98	11/2/99	1.2±0.6	**2.9±0.48**	.03±0.18	**11±1.1**	-.17±0.36(Cs-137)
USGS 99	2/9/99	**2.6±0.55**	**2.4±0.41**	-.04±0.1	**38±3.5**	-.61±0.33(Cs-137)
	5/4/99	**3.0±0.9**	**2.7±0.42**	.17±0.11	**40±4.2**	.75±0.34(Cs-137)
	7/27/99	**3.2±0.9**	**2.8±0.5**	-.08±0.1	**37±2.7**	-.53±0.35(Cs-137)
	11/2/99	**4.0±1.2**	**3.0±0.6**	-.05±0.1	**23±1.7**	.41±0.35(Cs-137)
USGS 102	2/9/99	**1.8±0.5**	**3.8±0.6**	.15±0.12	**66±6.4**	.37±0.36(Cs-137)
	5/3/99	2.3±0.8	**4.0±0.49**	.24±0.12	**95±11**	-.52±0.38(Cs-137)
	7/26/99	**3.7±1.0**	**2.2±0.5**	.08±0.14	**60±4.3**	.34±0.36(Cs-137)
	11/1/99	**3.4±1.1**	**2.4±0.49**	-.007±0.12	**47±3.3**	.04±0.38(Cs-137)

Table 7. Regulatory volatile organic compounds for which water samples were analyzed

[Analyses were performed by the Quanterra Laboratory using U.S. Environmental Protection Agency method 524.2. Reporting limits are in micrograms per liter]

Compound	Reporting limit	Compound	Reporting limit
Benzene	0.5	1,2-Dichloropropane	0.1
Bromobenzene	.2	1,3-Dichloropropane	.1
Bromochloromethane	.2	2,2-Dichloropropane	.5
Bromodichloromethane	.1	1,1-Dichloropropylene	.1
Bromoform	.1	cis-1,3-Dichloropropylene	.1
Bromomethane	.5	trans-1,3-Dichloropropylene	.1
n-Butylbenzene	.2	Ethylbenzene	.1
sec-Butylbenzene	.2	Hexachlorobutadiene	.2
tert-Butylbenzene	.2	Isopropylbenzene	.1
Carbon tetrachloride	.1	4-Isopropyltoluene	.1
Chlorobenzene	.2	Methyl-t-butyl ether (MTBE)	.5
Chloroethane	.5	Naphthalene	.2
Chloroform	.1	n-Propylbenzene	.1
Chloromethane	.5	Styrene	.2
2-Chlorotoluene	.2	1,1,1,2-Tetrachloroethane	.1
4-Chlorotoluene	.2	1,1,2,2-Tetrachloroethane	.1
Dibromochloromethane	.1	Tetrachloroethylene	.2
1,2-Dibromo-3-chloropropane (DBCP)	.2	Toluene	.5
1,2-Dibromoethane (EDB)	.1	1,2,3-Trichlorobenzene	.2
Dibromomethane	.1	1,2,4-Trichlorobenzene	.2
1,2-Dichlorobenzene	.1	1,1,1-Trichloroethane	.1
1,3-Dichlorobenzene	.1	1,1,2-Trichloroethane	.1
1,4-Dichlorobenzene	.1	Trichloroethylene	.1
Dichlorodifluoromethane	.5	Trichlorofluoromethane	.5
1,1-Dichloroethane	.1	1,2,3,-Trichloropropane	.2
1,2-Dichloroethane	.1	1,2,4-Trimethylbenzene	.1
1,1-Dichloroethylhene	.2	1,3,5-Trimethylbenzene	.1
cis-1,2-Dichloroethylene	.1	Vinyl chloride	.2
trans-1,2-Dichloroethylene	.1	Xylenes (total)	.2
Dichloromethane	.5		

Table 8. Base/neutral organic compounds for which water samples were analyzed
[Analyses were performed by the Quanterra Laboratory using U.S. Environmental Protection Agency method 525.2. Reporting limits are in micrograms per liter]

Compound	Reporting limit	Compound	Reporting limit
Alachlor	0.1	Endrin	0.01
Aldrin	.1	Heptachlor	.04
Atrazine	.1	Heptachlor epoxide	.02
Benzo [a]pyrene	.02	Methoxychlor	.1
gamma-BHC (Lindane)	.02	Metolachlor	.1
Butachlor	.1	Metribuzin	.1
Dieldrin	.1	Propachlor	.1
Di (2-ethylhexyl) adipate	.6	Simazine	.07
Di(2-ethylhexyl) phthalate	.6		