Evaluation of Quality Assurance/Quality Control Data Collected by the U.S. Geological Survey for Water-Quality Activities at the Idaho National Engineering Laboratory, Idaho, 1994 through 1995

by LINDA M. WILLIAMS

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CONVERSION FACTORS AND ABBREVIATED UNITS

To convert from	To	Multiply by
liter (L)	gallon (gal)	0.2207
gram (gr)	ounce (oz)	.0353
kilometer (km)	mile (mi)	.6214
picocurie (pCi)	decompositions per minute (dpm)	2.22
degree Celsius (°C)	degree Fahrenheit (°F)	([1])

[1]Temp °C = (temp °C-32)/1.8.

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

Evaluation of the Quality Assurance/Quality Control Data Collected by the U.S. Geological Survey for Water-Quality Activities at the Idaho National Engineering Laboratory, Idaho, 1994 through 1995

by Linda M. Williams

Abstract

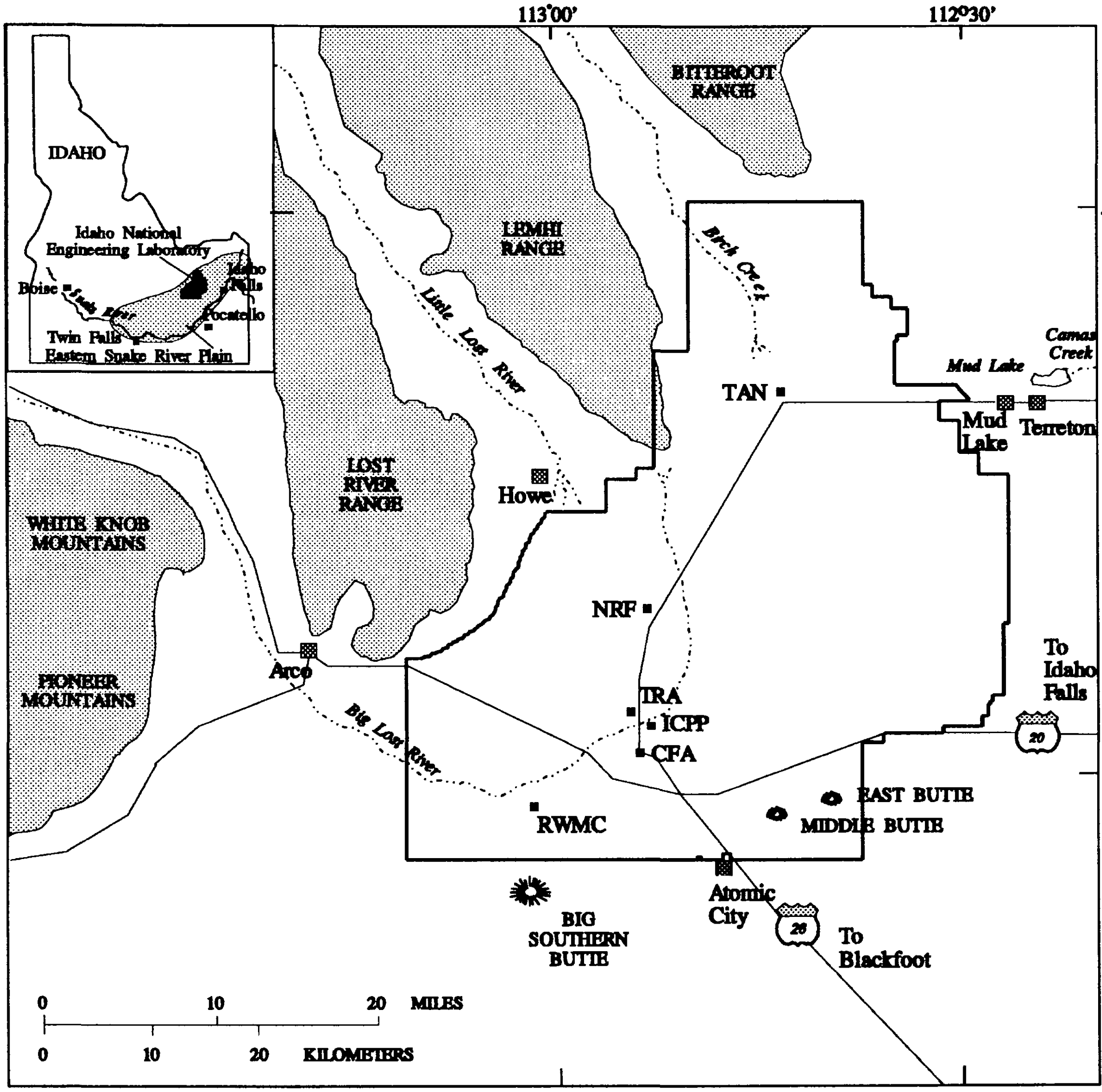
More than 4,000 water samples were collected by the U.S. Geological Survey (USGS) from 179 monitoring sites for the water-quality monitoring program at the Idaho National Engineering Laboratory from 1994 through 1995. Approximately 500 of the water samples were replicate or blank samples collected for the quality assurance/ quality control program. Analyses were performed to determine the concentrations of major ions, nutrients, trace elements, gross radioactivity and radionuclides, total organic carbon, and volatile organic compounds in the samples.

To evaluate the precision of field and laboratory methods, analytical results of the replicate pairs of samples were compared statistically for equivalence on the basis of the precision associated with each result. In all, the statistical comparison of the data indicated that 95 percent of the replicate pairs were equivalent. Within the major ion analyses, 97 percent were equivalent; nutrients, 88 percent; trace elements, 95 percent; gross radioactivity and radionuclides, 93 percent; and organic constituents, 98 percent. Ninety percent or more of the analytical results for each constituent were equivalent, except for nitrite, orthophosphate, phosphorus, aluminum, iron, strontium-90, and total organic carbon.

Blank-sample analytical results indicated that the inorganic blank water and volatile organic compound blank water from the USGS National Water Quality Laboratory and the deionized water from the USGS Idaho Falls Field Office were suitable source solutions for blanks. Equipment- and trip-blank analytical results were evaluated to determine if a bias had been introduced and the possible sources of bias. The results indicated that none of the blanks had measurable concentrations of the constituents of interest, except one equipment blank that had measurable concentrations of total organic carbon, gross radioactivity, and tritium.

INTRODUCTION

The Idaho National Engineering Laboratory (INEL) includes approximately 890 mi^2 of the eastern Snake River Plain in southeastern Idaho (fig. 1). The INEL was established in 1949 as the National Reactor Testing Station for nuclear-reactor research. The U.S. Department of Energy (DOE) continues the reactor research along with numerous other projects, including defense programs and environmental and waste remediation and research. These activities have produced aqueous radioactive and chemical wastes that have been discharged into ponds and wells. Prior to 1984, most of the aqueous radioactive and chemical wastes generated at the INEL were injected directly into the Snake River Plain aquifer through deep wells. Since 1984, most of the aqueous wastes have been discharged to unlined infiltration ponds. Many of the waste constituents have entered the aquifer after percolation through the unsaturated zone. The U.S. Geological Survey (USGS) conducts an extensive, ongoing water-quality monitoring program at 179 ground- and surface-water sites at the INEL in cooperation with the DOE. This program monitors effects of the waste disposal on the Snake River Plain aquifer. The information is provided to and used by many Federal and State government agencies, and the general public.



EXPLANATION

—— **Boundary of the Idaho National Engineering Laboratory**

▪ **Selected facilities at the Idaho National Engineering Laboratory**

CFA	**Central Facilities Area**
ICPP	**Idaho Chemical Processing Plant**
NRF	**Naval Reactors Facility**
RWMC	**Radioactive Waste Management Complex**
TAN	**Test Area North**
TRA	**Test Reactor Area**

Figure 1. Location of the Idaho National Engineering Laboratory and facilities where ground-water samples were collected for the quality assurance/quality control program, Idaho National Engineering Laboratory, 1994 through 1995

Table 1. Laboratories and respective analyses performed for the water-quality monitoring program at the Idaho National Engineering Laboratory

[Abbreviation: WWR, whole water, recoverable]

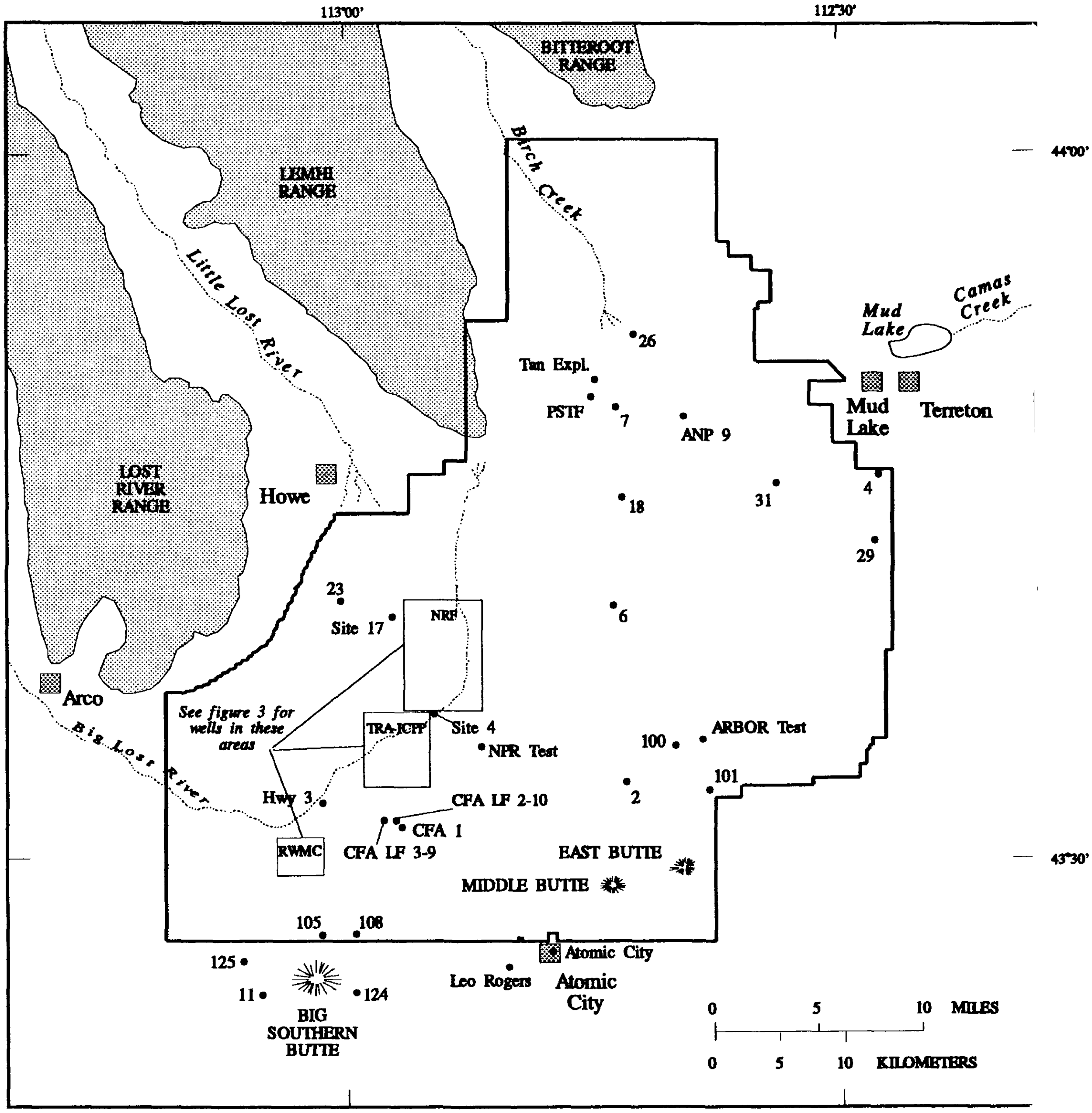
Laboratory	Quantitative analysis performed
National Water Quality Laboratory	Inorganic constituents: major ions, dissolved (sodium, sulfate, chloride, fluoride, and bromide) and WWR sodium; nutrients, dissolved (nitrite, nitrite plus nitrate, ammonia, and orthophosphate) and WWR (ammonia plus organic nitrogen and phosphorus); trace elements, dissolved and WWR (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc), dissolved (cobalt, molybdenum, selenium, thallium, and uranium), and WWR iron
	Gross radioactivity and radionuclides: gross alpha, gross beta, and tritium
	Organic constituents: total organic carbon and volatile organic compounds
Radiological and Environmental Sciences Laboratory	Gross radioactivity and radionuclides: gross alpha, gross beta, gamma radiation, strontium-90, tritium, and transuranics (americium-241, plutonium-238, and plutonium-239/240)

Purpose and Scope

The purpose of this report is to present an evaluation of the quality assurance/quality control (QA/QC) data from the water-quality monitoring program conducted by the USGS at the INEL. Approximately 4,000 water samples were collected for analysis from 1994 through 1995; more than 500 of those were replicate or blank samples (QA samples). Analytical results of the replicate pairs of samples are reported and compared for statistical equivalence. The replicate-pair analytical data and the results of the comparisons are compiled and tabulated along with the source-solution, trip- and equipment-blank analytical data. Evaluation of the results of the QA samples helps to assess precision and bias both in the field and in the laboratory. This evaluation not only validates the methods and procedures used at the INEL Project Office, but it also allows for planning future QA/QC efforts.

Included in this report is a brief description of the methods and procedures used by field personnel for collection of replicate pairs of samples and preparation of blanks. Locations of sampling sites and site identifiers are shown on figures 1 through 3. The laboratories involved in the project were the USGS National Water Quality Laboratory (NWQL) in Arvada, Colo., and the DOE Radiological and Environmental Sciences Laboratory (RESL) at the INEL. The laboratories and their respective analyses are listed in table 1. The inorganic constituent analyses included dissolved major ions; dissolved and whole water, recoverable (WWR)[1] nutrients; and dissolved and WWR trace elements. The gross radioactivity and radionuclide analyses included gross alpha radioactivity, gross beta radioactivity, gamma radiation, strontium-90, tritium, and transuranics. Analyses of organic constituents included total organic carbon and volatile organic compounds.

[1]Whole water, recoverable (WWR) pertains to the constituents in solution after an unfiltered representative water-suspended-sediment sample is digested (usually using a dilute acid solution). Complete dissolution of the particulate matter often is not achieved by the digestion treatment, and thus the determination represents something less than the "total" amount (that is, less than 95 percent) of the constituent present in the dissolved and suspended phases of the sample. For inorganic determinations, digestions are performed in the original sample container to ensure digestion of material absorbed on the container walls. To achieve comparability of analytical data, equivalent digestion procedures would be required of all laboratories performing such analyses because different digestion procedures are likely to produce different analytical results (Timme, 1995, p. 95).



EXPLANATION

—— **Boundary of Idaho National Engineering Laboratory**

11 • **Well completed in the Snake River Plain aquifer--Entry, 11, is the local well identifier**

In text and on tables, numerical site identifiers are designated as USGS *n*

Figure 2. Locations of wells where ground-water samples were collected for the quality assurance/quality control program, Idaho National Engineering Laboratory, 1994 through 1995

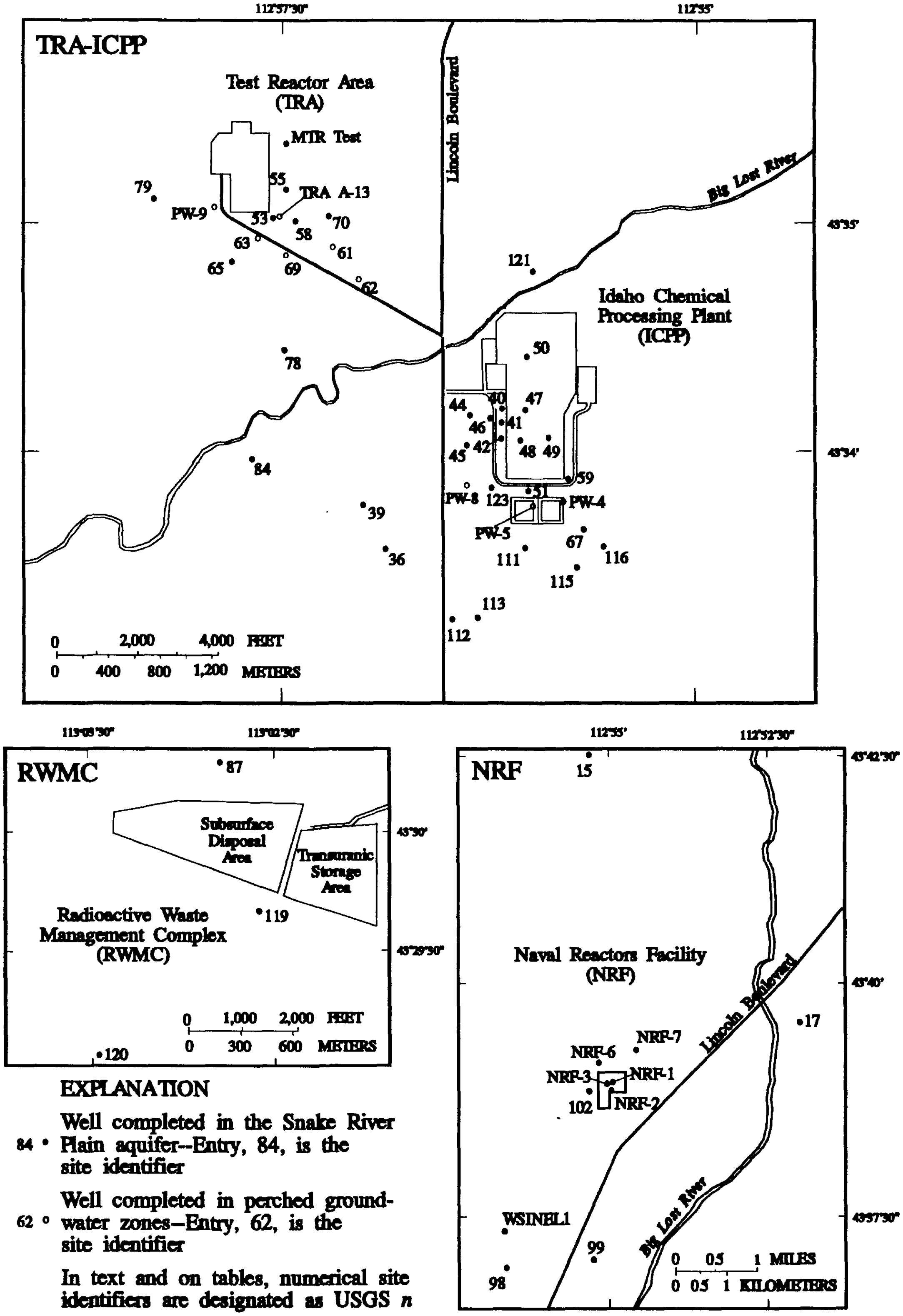


Figure 3. Locations of wells at the Test Reactor Area, Idaho Chemical Processing Plant (TRA-ICPP), Radioactive Waste Management Complex (RWMC), and Naval Reactors Facility (NRF) where ground-water samples were collected for the quality assurance/quality control program, Idaho National Engineering Laboratory, 1994 through 1995

Acknowledgments

The author thanks the employees of the USGS at the INEL Project Office and at the NWQL and the employees of DOE at the RESL who collected and analyzed the water samples described in this report. The author is especially grateful for the technical reviews by Amy Ludtke and Linda Davis of the USGS.

QUALITY ASSURANCE/QUALITY CONTROL PRACTICES

The USGS is committed to collecting water samples that are as representative of the sampling site as possible and to reporting reliable and reproducible data. Guidelines that are specific to the USGS activities at the INEL have been set forth in the Quality Assurance Plan and Field Methods for Quality of Water Activities (L.J. Mann, U.S. Geological Survey, written commun., 1992). This comprehensive plan defines the required procedures and tasks that are performed to ensure the reliability of water-quality data. It is available for inspection at the INEL Project Office. This plan is updated continually. A brief description of the procedures and tasks is included in this report.

Field personnel also participate in the National Field Quality Assurance Tests administered annually by the USGS (Erdmann and Thomas, 1985, p. 110–115). These tests are used to evaluate performance in making field measurements for pH, specific conductivity, and alkalinity.

Part of the QA/QC program, from 1994 through 1995, consisted of collecting and sending replicate pairs of samples and blank samples to the laboratories for analysis of specific constituents. Analytical results for the replicate pairs of samples were compared for statistical equivalence; the analytical results and the statistical comparisons are presented in tables 10 through 48 in the Supplemental Information section at the end of this report. The blank-sample results were evaluated and the data are presented in tables 49 through 52 in the same section.

Sample Containers and Preservatives

Sample containers and preservatives were supplied by the NWQL in accordance with the laboratory requirements specified by the NWQL Services Catalogs (Timme, 1994; 1995). The laboratory's Quality Assurance/Quality Control Manual (Pritt and Raese, 1992) describes the practices used to ensure that the containers are free of contamination. The NWQL receives the required containers from suppliers, tests for contamination, and cleans the containers according to written procedures. Sample preservatives, which are prepared by contract suppliers for the NWQL, also are tested according to written procedures prior to shipping to field personnel. Sample containers, preservatives, and treatments for specific constituents are listed in tables 2 through 4.

Decontamination Procedures

Equipment used to collect water samples from monitoring wells may become contaminated during the collection of samples. Decontamination procedures are used to decontaminate the equipment prior to use. Most wells are equipped with dedicated submersible pumps and only the discharge lines are moved from well to well; therefore, these lines are rinsed thoroughly with deionized water, inside and outside, between sampling sites. Subsequent flushing with at least three borehole volumes of sample water further decontaminates the discharge lines. Because the concentrations of most contaminants are greatest in wells nearest disposal sites, the most distant wells are sampled first, minimizing the possibility of cross-contamination.

Wells not equipped with dedicated pumps are sampled either with a bailer or a portable submersible pump. The bailer and portable pumps are washed with warm water and detergent and rinsed with deionized water prior to use. At the sampling site, the pumps also are flushed with at least three borehole volumes of sample water.

Table 2. Sample containers and preservation methods for analyses of inorganic constituents in water samples from the Idaho National Engineering Laboratory

[Analyzing laboratory was the National Water Quality Laboratory. Abbreviation: WWR, whole water, recoverable; mL, milliliter. Except where noted, acidified samples were preserved with nitric acid to 0.4 percent, volume per volume]

Inorganic constituents	Container size and type	Preservation method
	Major ions	
Sodium, dissolved[1]	250-mL polyethylene	Filtered, acidified
Sodium, WWR[1]	250-mL polyethylene	Acidified
Sulfate, dissolved Chloride, dissolved Fluoride, dissolved Bromide, dissolved	250-mL polyethylene	Filtered
	Nutrients	
Nutrients, dissolved (ammonia, nitrite, nitrate plus nitrite, and orthophosphate)	125-mL brown polyethylene	Filtered, preserved with 0.5 mL of mercuric chloride and chilled or chilled only[2]
Nitrite, dissolved[3]	125-mL brown polyethylene	Filtered and chilled
Nitrate plus nitrite, dissolved	125-mL brown polyethylene	Filtered, preserved with 1 mL of sulfuric acid and chilled
Ammonia plus organic nitrogen, WWR Phosphorus, WWR	125-mL brown polyethylene	Preserved with 1 mL of sulfuric acid and chilled
	Trace elements	
Trace elements, dissolved	250-mL polyethylene	Filtered, acidified
Trace elements, WWR	250-mL polyethylene	Acidified
Chromium, dissolved[1]	250-mL polyethylene	Filtered, acidified
Chromium, hexavalent, dissolved[4]	250-mL polyethylene	Filtered, acidified
Chromium, WWR[1]	250-mL polyethylene	Acidified
Mercury, dissolved	250-mL glass	Filtered, preserved with 10 mL of potassium dichromate
Mercury, WWR	250-mL glass	Preserved with 10 mL of potassium dichromate

[1]The dissolved sodium sample also may be used for the dissolved chromium analysis, and the WWR sodium sample for the WWR chromium analysis.

[2]Prior to October, 1994, samples were filtered and preserved with 0.5 mL of mercuric chloride and chilled. Presently, mercuric chloride is not used and samples are filtered and chilled only.

[3]When nutrient samples must be acidified with sulfuric acid, an unacidified nitrite sample is prepared separately.

[4]The dissolved chromium and dissolved hexavalent chromium samples may be collected in one bottle.

Table 3. Sample containers and preservation methods for analyses of gross radioactivity and radionuclides in water samples from the Idaho National Engineering Laboratory

[Abbreviations: RESL, Radiological and Environmental Sciences Laboratory; NWQL, National Water Quality Laboratory; mL, milliliter; L, liter. Except where noted, acidified samples were preserved with nitric acid to 0.4 percent, volume per volume]

Gross radioactivity or radionuclide	Laboratory	Container size and type	Preservation method
Gross alpha	RESL	500-mL polyethylene	Acidified
Gross alpha, dissolved	NWQL	1-L polyethylene	Filtered, acidified
Gross alpha, dissolved and suspended	NWQL	1-L polyethylene	Untreated
Gross beta	RESL	500-mL polyethylene	Acidified
Gross beta, dissolved	NWQL	1-L polyethylene	Filtered, acidified
Gross beta, dissolved and suspended	NWQL	1-L polyethylene	Untreated
Gamma radiation	RESL	500-mL polyethylene	Acidified
Strontium-90	RESL	500-mL polyethylene	Acidified
Tritium	RESL	125-mL or 500-mL polyethylene	Untreated
	NWQL	250-mL or 1-L polyethylene	Untreated
Americium-241 Plutonium-238 Plutonium-239/240	RESL	500-mL polyethylene	Acidified

Table 4. Sample containers and preservation methods for analyses of organic constituents in water samples from the Idaho National Engineering Laboratory

[Analyzing laboratory was the National Water Quality Laboratory. Abbreviations: mL, milliliter]

Organic constituent	Container size and type	Preservation method
Total organic carbon	125-mL amber glass	Chilled
Volatile organic compounds	40-mL amber glass septum vials	Chilled

All measuring and sampling equipment that comes into contact with the sample water is thoroughly rinsed with deionized water prior to use. The thermometers, probes, and electrodes of the pH meters and the specific conductivity meters are rinsed with deionized water and rinsed again with sample water so that when measurements are made, the deionized water will not dilute the sample. Disposable latex gloves are worn, and changed when needed, to ensure that the samples are not contaminated by the field personnel themselves or cross-contaminated by preservatives or previous samples. Unless otherwise specified for a particular analysis or type of container, all the containers are rinsed with sample water, either filtered or unfiltered, as appropriate. To minimize the possibility of contamination, totally enclosed disposable capsule filters are used for filtration. Flexible tubing that connects the capsule filter to the sampling port at the well or to the peristaltic pump is thoroughly washed with water and detergent and rinsed with deionized water before use.

Sample Collection

The guidelines for water sample collection are being updated continually in accordance with new safety and environmental regulations and to accommodate the requirements of improved analytical procedures. Guidelines for field treatment of sample containers are specified in the NWQL Services Catalog (Timme, 1994; 1995). When field rinsing is required, the sample containers are rinsed three times with sample or deionized water before filling. The samples are untreated; or filtered, preserved, and chilled as established by the NWQL (Timme, 1994; 1995) or in the manner recommended by RESL (Olson and Percival, 1980, p. SP-1-1) depending on the analyses requested. Although some sample collection procedures changed from 1994 through 1995, each sample of a replicate pair was always collected in the same manner.

Most samples are collected from wells with dedicated submersible pumps. Wells without dedicated pumps are sampled with bailers or portable pumps. Grab samples are collected at the seven surface-water sites.

The INEL Project Office maintains mobile field laboratories in which the supplies and equipment necessary for sampling are available for immediate sample processing. Field measurements are taken in this relatively clean and protected environment, and samples are preserved and prepared for shipping without delay.

At the INEL, steps are taken to make certain that the water samples are representative of the ground water at the sampling site. To achieve this, a volume of water equivalent to a minimum of three borehole volumes is pumped from each well. In addition, the temperature, pH, and specific conductivity are monitored during pumping, using methods described by Wood (1981) and Hardy and others (1989). When the wells have been purged and measurements of these properties indicate probable hydraulic and chemical stability, field personnel collect the samples. Some wells do not contain or produce enough water to be purged three borehole volumes, so samples are collected from the bailer as soon as the temperature, pH, and specific conductivity measurements stabilize.

When filtration is required, disposable capsule filters are connected directly to the portable discharge line by flexible tubing. At the few sites where a bailer is used or where grab samples are collected, the filters are connected to a peristaltic pump. The intake tubing of the peristaltic pump is rinsed with sample water and inserted into the container. Regardless of the filtering technique, 1 liter of sample water is run through the capsule filter and tubing before the sample bottle is rinsed and filled. If the water at the sampling site contains large amounts of suspended material, it may be necessary to rinse the filter with 1 liter of deionized water, rather than with sample water, before the container is rinsed and filled. The containers are then capped and transported into the field laboratory for preservation. After the sample is preserved, the containers are recapped and labeled, and the caps are sealed with laboratory film.

To minimize analyte loss by biological processes or volatilization, samples for nutrient and organic constituent analyses are chilled to approximately 4°C. The samples are kept on ice until they are received at the laboratory, where they are refrigerated.

All water samples are stored in the mobile field laboratory until they can be transferred to a secured storage area. After a sufficient number of samples is collected, and before any holding-time limitations have been exceeded, the samples are delivered to the appropriate laboratories for analyses. Holding-time limitations for the nutrients and organic constituents are 7 and 14 days, respectively. Samples for the NWQL are shipped by overnight-delivery mail in a sealed ice chest and usually are sent to the laboratory within 5 days of collection. The samples to be analyzed by the RESL are hand-carried to the analytical chemistry area.

Conditions during sample collection at the well or surface-water site are recorded with permanent ink in a bound field logbook at the sampling site. The containers are labeled at each location to avoid sample mix-up. A chain-of-custody form is used to track samples from the time of collection until delivery to the laboratory. These procedures were instituted in September 1987, and all records are available for inspection at the INEL Project Office.

Analytical Methods and Reporting of Data

Methods of detection or instrumentation used by the laboratories for each type of analysis and their corresponding detection limits or MRL's are listed in tables 5 through 7.

Detection limits are used by the RESL. Because they are a function of sample matrix, sample size, and type of measurement, the limits are intended as guides to order-of-magnitude sensitivities and can easily change by a factor of two or even more for the conditions specified (Bodnar and Percival, 1982, p. DL-1-1). With each radiochemical result, the RESL reports a propagated random uncertainty that is calculated using many variables, including the yields, appropriate half-lives, counting efficiencies, and count times. This uncertainty is one standard deviation as defined on the RESL Sample Record Sheet (ID F–5484.1A, written commun., Rev. 12–1988).

The NWQL uses minimum reporting levels (MRL's), which are defined as the smallest measured concentration of a constituent that may be reliably reported using a given analytical method and also are used when documentation for the method detection limit is not available (Timme, 1995). For radiochemical results only, the NWQL reports a result and a value twice the standard deviation. Therefore, when comparing the results of analyses of gross radioactivity and radionuclides by the NWQL and the RESL, it is important to remember that two standard deviations are reported by the NWQL and one standard deviation is reported by the RESL.

Table 5. Analytical methods used to determine inorganic constituents in water samples from the Idaho National Engineering Laboratory, and minimum reporting levels

[Analyzing laboratory is the National Water Quality Laboratory. Abbreviations: MRL, minimum reporting level; mg/L, milligram per liter; µg/L, microgram per liter]

Inorganic constituent	Analytical method	MRL
Sodium	Atomic absorption spectrometry	0.1 mg/L
Sulfate	Ion-exchange chromatography	0.1 mg/L
Chloride	Ion-exchange chromatography	0.1 mg/L
Fluoride	Ion selective electrode	0.1 mg/L
Bromide	Ion-exchange chromatography	0.01 mg/L
Nutrients	Automated-segmented flow, colorimetry	0.01–0.2 mg/L[1]
Trace elements	Atomic absorption spectrometry Inductively coupled plasma-Atomic emission spectrometry	1–10 µg/L[1] 1–10 µg/L[1]
Chromium	Atomic absorption spectrometry Inductively coupled plasma-Atomic emission spectrometry	1 µg/L 1 µg/L
Mercury	Cold vapor atomic absorption	0.1 µg/L

[1]Multiple MRL's are dependent upon the constituent.

Table 6. Analytical methods used to determine gross radioactivity and radionuclides in water samples from the Idaho National Engineering Laboratory, and detection limits or minimum reporting levels

[Abbreviations: MRL, minimum reporting level; RESL, Radiological and Environmental Sciences Laboratory; NWQL, National Water Quality Laboratory; pCi/L, picocurie per liter; µg/L, microgram per liter]

Gross radioactivity or radionuclide	Laboratory	Analytical method	Detection limit or MRL[1]
Gross alpha	RESL	Scintillation	3 pCi/L
	NWQL	Low background alpha-beta counter	3 pCi/L
			3 µg/L
Gross beta	RESL	Low background beta counter	5 pCi/L
	NWQL	Low background alpha-beta counter	3–4 pCi/L[2]
Gamma radiation	RESL	Gamma spectroscopy	60 pCi/L
Strontium-90	RESL	Low background beta counter	5 pCi/L
Tritium	RESL	Liquid scintillation	200 pCi/L
	NWQL	Enrichment, gas counting	0.1 pCi/L
Americium-241	RESL	Alpha spectrometry	6×10^{-2} pCi/L
Plutonium-238	RESL	Alpha spectrometry	4×10^{-2} pCi/L
Plutonium-239/240	RESL	Alpha spectrometry	4×10^{-2} pCi/L

[1] The RESL uses detection limits and the NWQL uses MRL's.

[2] For gross beta radioactivity analyses by the NWQL, the MRL was lowered from 4 pCi/L in 1994 to 3 pCi/L in 1995.

Table 7. Analytical methods used to determine organic constituents in water samples from the Idaho National Engineering Laboratory, and minimum reporting levels

[Analyzing laboratory is the National Water Quality Laboratory. Abbreviations: MRL, minimum reporting level; mg/L, milligram per liter; µg/L, microgram per liter]

Organic constituent	Analytical method	MRL
Total organic carbon	Wet oxidation	0.1 mg/L
Volatile organic compounds	Gas chromatography/mass spectrometry	0.2–20 µg/L[1]

[1] Multiple MRL's are dependent upon the constituent.

QUALITY ASSURANCE/QUALITY CONTROL DATA, REPLICATE PAIRS OF SAMPLES

Two methods were used for collecting replicate pairs of samples for the for the water-quality monitoring program at the INEL. For the first method, replicate pairs of samples were collected sequentially; that is, the routine water-quality sample was collected for a specific analysis, then the QA sample for that same analysis, until all the required containers were filled for all the scheduled analyses. There was no correlation between the identifier of the routine water-quality sample and QA sample; the field personnel selected a QA number sequentially during a sampling session and recorded that number in the field logbooks along with the required information about that particular site. Each QA sample was labeled and preserved at the sampling site along with the routine sample to avoid sample mix-up. This type of QA sample is useful in determining the laboratory's analytical reproducibility related to equipment, materials, or analysts.

Beginning in 1993, a second method was also used: replicate samples (the QA samples) were collected at the same site for the same constituents within 24 hours of the collection of the routine water-quality samples. This type of QA sample assesses variability related to the collection process, such as ambient conditions at the site, field personnel, field-measurement instruments, and sampling equipment.

Statistical Comparisons of Replicate Pairs of Samples

If the standard deviations are known, it is possible to determine, within a specified confidence level, whether the results of a replicate pair of samples are statistically equivalent. When the standard deviations are unknown, approximations of the standard deviations are used for the statistical comparison. The comparison can be done using an adaptation of the equation to determine the standard deviate, Z, or the number of standard deviations the variable deviates from the mean (Volk, 1969, p. 55), where Z is the ratio of the absolute value of the difference of the two results and the square root of the sum of the squares of the standard deviations (the pooled standard deviation). In that way, a comparison can be made of two analytical results on the basis of the precision, or an approximation of the precision, associated with each of the results:

$$Z = \frac{|x - y|}{\sqrt{(s_x)^2 + (s_y)^2}} \qquad (1)$$

where

x is the result of the routine water-quality sample,

y is the result of the QA sample,

s_x is the standard deviation of x, and

s_y is the standard deviation of y.

When the population is distributed normally and the standard deviation is known, the analytical results of replicate pairs can be considered statistically equivalent at the 95-percent confidence level if the Z-value is less than or equal to 1.96. When the population is not distributed normally or an approximation of the standard deviation is used, a Z-value less than or equal to 1.96 must be considered a guide when testing for equivalence. At the 95-percent confidence level, the probability of error is 0.05. In other words, when a Z-value is less than or equal to 1.96, the results are within approximately two standard deviations of each other. Equation 1 is essentially the equation used to compare replicate data in the USGS protocol for collecting and processing surface-water samples (Horowitz and others, 1995, p. 36).

Instead of setting a value that is approximately equal to two standard deviations as a test of equivalence, the level of significance, or p-value, which indicates the weight of the evidence to reject the null hypothesis, $x \pm s_x = y \pm s_y$, may be determined. The null hypothesis is tested using the Z-value as the test statistic. The Z-value is calculated by using equation 1, then the p-value is determined by referring to table 53 in the Supplemental Information section. Assuming the distribution is normal, the p-value is the area under the curve for the Z-value. The greater the Z-value, the smaller the p-value and the more likely that the results of the replicate pair are not equivalent, and the null hypothesis will be rejected. When Z = 1.96, the p-value = 0.0250 for a one-tailed test and 0.0500 for a two-tailed test (table 53). This shows that these p-values are equivalent to the 95-percent confidence level and $\alpha = 0.05$, where α is the probability that the null hypothesis will be rejected when true.

Inorganic Constituents

Equation 1 cannot be applied directly to results when no standard deviations or uncertainties are reported. The analyses for inorganic constituents, which were done at the NWQL, were not reported with standard deviations; therefore, approximations of standard deviations were used.

The USGS administers an extensive interlaboratory comparison program in which approximately 150 laboratories are evaluated based on the results of their analyses of standard reference water samples (SRWS) (Long and Farrar, 1993). The data from the interlaboratory comparison program, or the SRWS program, are used by the USGS Branch of Technical Development and Quality Systems (BTD&QS), formerly the Branch of Quality Assurance, to derive linear regression equations that allow the calculation of an approximation of the standard deviation, called a most probable deviation (MPD), at any concentration for most analyses.

The BTD&QS conducts the Blind Sample Program (BSP) in which SRWS, disguised as environmental samples, are submitted to the NWQL for analysis. The BSP data are evaluated using control charts prepared with the MPD's calculated with the regression equations formulated from the SWRS program. A report by Maloney and others (1993) describes the BSP, evaluates the analytical results, and presents the linear regression equations and control and precision charts. The BSP data and control and precision charts are stored in the QADATA program that is available through the USGS computer network (Lucey, 1990, p. 1).

At the INEL project office, the linear regression equations are used to determine if the analytical results of the replicate pairs are statistically equivalent by calculating an MPD for each result and substituting the MPD for the standard deviation in equation 1. Because these are approximate standard deviations, the Z-value of 1.96 must be considered a guide when testing for equivalence. The results of the replicate pairs of the inorganic constituent analyses and the Z-values for each replicate pair are presented in tables 10 through 38.

For many samples, the analytical results were less than the MRL. If the results of both samples of the replicate pair were less than the MRL, the results were considered equivalent and the Z-value was reported as a zero. If, however, only one of the results was less than the MRL, one of two approaches was taken.

First, if one result was less than the MRL and the other exceeded the MRL, the numerical value and the MPD of the numerical value of the MRL were substituted in equation 1 for the result that was less than the MRL. For example, the analytical results of the barium analyses for the replicate pair collected at NRF-3 on June 8, 1995 were 200 µg/L and <100 µg/L (table 22). Using the minimum MPD of 75 µg/L (Maloney and others, 1993, p. 5) that has been set for this analysis, the results and MPD were 200±75 µg/L and <100±75 µg/L, respectively. The Z-value, calculated with equation 1, equaled 0.94. It was less than 1.96; therefore, it was within the 95-percent confidence interval. The results of the replicate pair were equivalent and no comment appears in the column labeled "Remark." If the Z-value had been greater than 1.96, an "N" would have appeared in the column labeled "Remark," signifying that the results were not equivalent.

Second, if one result was less than the MRL and the other was at the MRL, the MPD of the result was calculated at the MRL using the linear regression equation for that analysis. But, it is impractical to use equation 1 because the Z-value will always equal zero. Therefore, to compare the two results using the precision associated with them, the MPD was multiplied by 1.96. If the range of the MPD had included zero, the results would have been equivalent because any result less than the MRL was included in the 95-percent confidence interval. If the range had not included zero, as often is the case when the MPD is relatively small, equivalency could not be determined. For example, the analytical results for cadmium analyses of the replicate pair collected at NRF-6 on March 10, 1995 were <1 µg/L and 1 µg/L (table 24). Using the minimum MPD of 0.75 µg/L

(Maloney and others, 1993, p. 5) that has been set for this analysis, the results and MPD were <1±0.75 μg/L and 1±0.75 μg/L, respectively. Therefore, the result of 1 μg/L would have an MPD of 1.96 x 0.75 μg/L at the 95-percent confidence level: 1±1.47 μg/L. The range included zero and no comment appears in the column labeled "Remark." If the range had not included zero, a "U" would have appeared in the column labeled "Remark," signifying that equivalence was uncertain.

Gross Radioactivity and Radionuclides

The use of equation 1 is straightforward in determining if the results of radiochemical analyses of a replicate pair of samples were equivalent. Because the NWQL reported radiochemical results and two standard deviations, it was necessary to divide the value by two to compute the one standard deviation required by equation 1. The results and reported standard deviations for the analyses of gross radioactivity and radionuclides in replicate pairs and the Z-values are listed in tables 39 through 46. Calculations using equation 1 were performed on each replicate pair. If the analytical results of the pair were not statistically equivalent, an "N" appears in the column labeled "Remark."

Organic Constituents

Organic constituents were not included in the BSP. Therefore, the standard deviations for total organic carbon analyses were calculated from the relative standard deviations (RSD) reported by Wershaw and others (1987, p. 15–16). The standard deviations of the volatile organic compounds were calculated from the RSD's provided by Rose and Schroeder (1995, p. 18–23). The sites where replicate samples were collected for analyses of volatile organic compounds are listed in table 54; the volatile organic compounds, in table 55. The results of the replicate pairs analyzed for total organic carbon and the three volatile organic compounds that were reported at or above the MRL's are included, along with the Z-values, in tables 47 through 48. If analytical results of the pair were not statistically equivalent, an "N" appears in the column labeled "Remark." If the results of both samples of the replicate pair were less than the MRL, the results were considered equivalent and the Z-value is reported as a zero.

Summary of Statistical Comparisons of Replicate Pairs of Samples

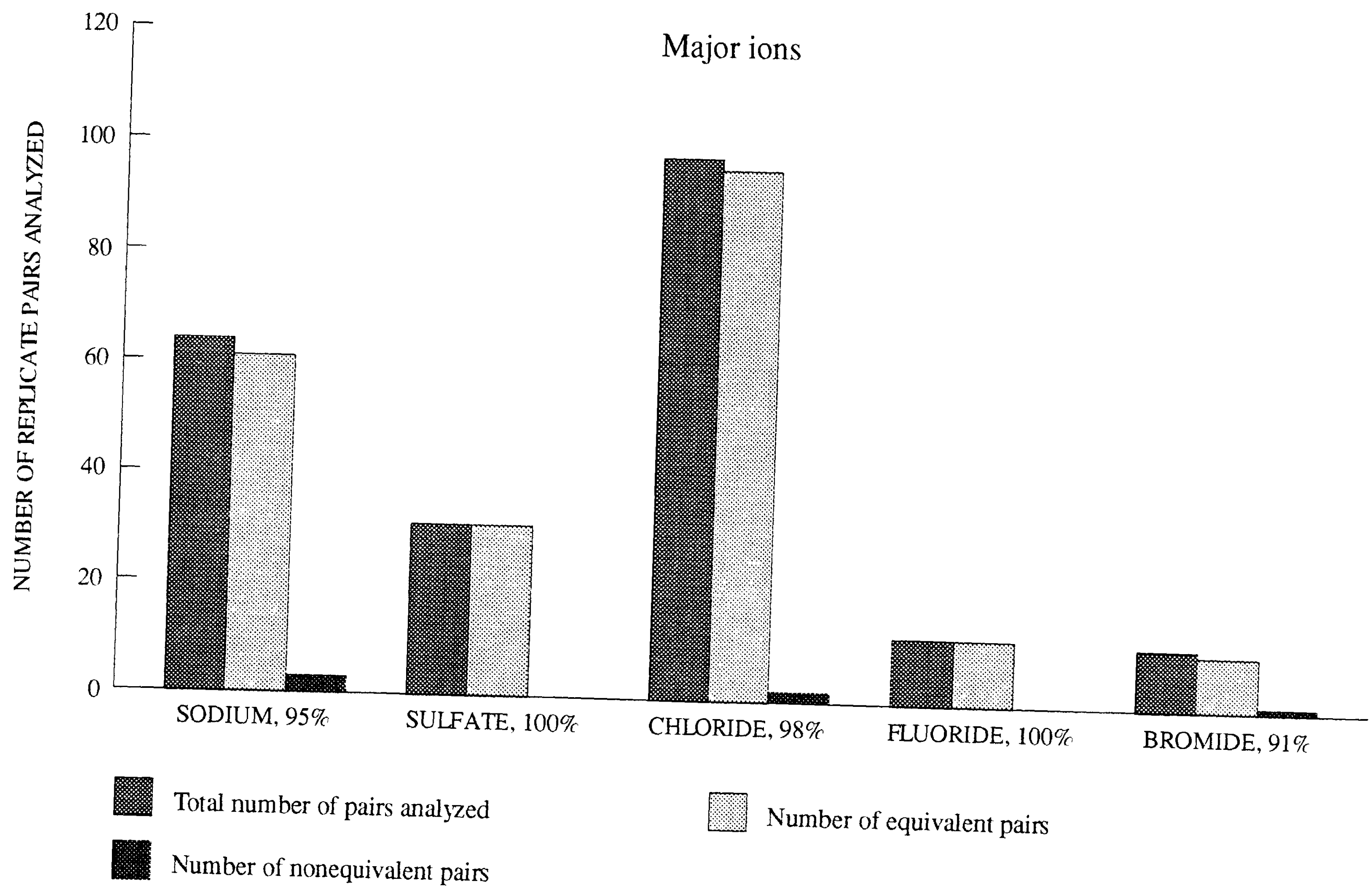
In all, the statistical comparisons of the data indicated that 95 percent of the replicate pairs were equivalent. Within the major ion analyses, 97 percent were equivalent; nutrients, 88 percent; trace elements, 95 percent; gross radioactivity and radionuclides, 93 percent; and organic constituents, 98 percent. Ninety percent or more of the analytical results for each constituent were equivalent, except for nitrite, orthophosphate, phosphorus, aluminum, iron, strontium-90, and total organic carbon. Lack of equivalence between results of replicate pairs indicates a problem. Because many factors, such as field methods, ambient conditions, laboratory procedures, and nonanalytical errors can affect precision, the source of the inconsistency cannot always be determined.

The following sections summarize the statistical comparisons for each constituent. Graphical summaries are provided in figures 4 through 8.

Inorganic Constituents

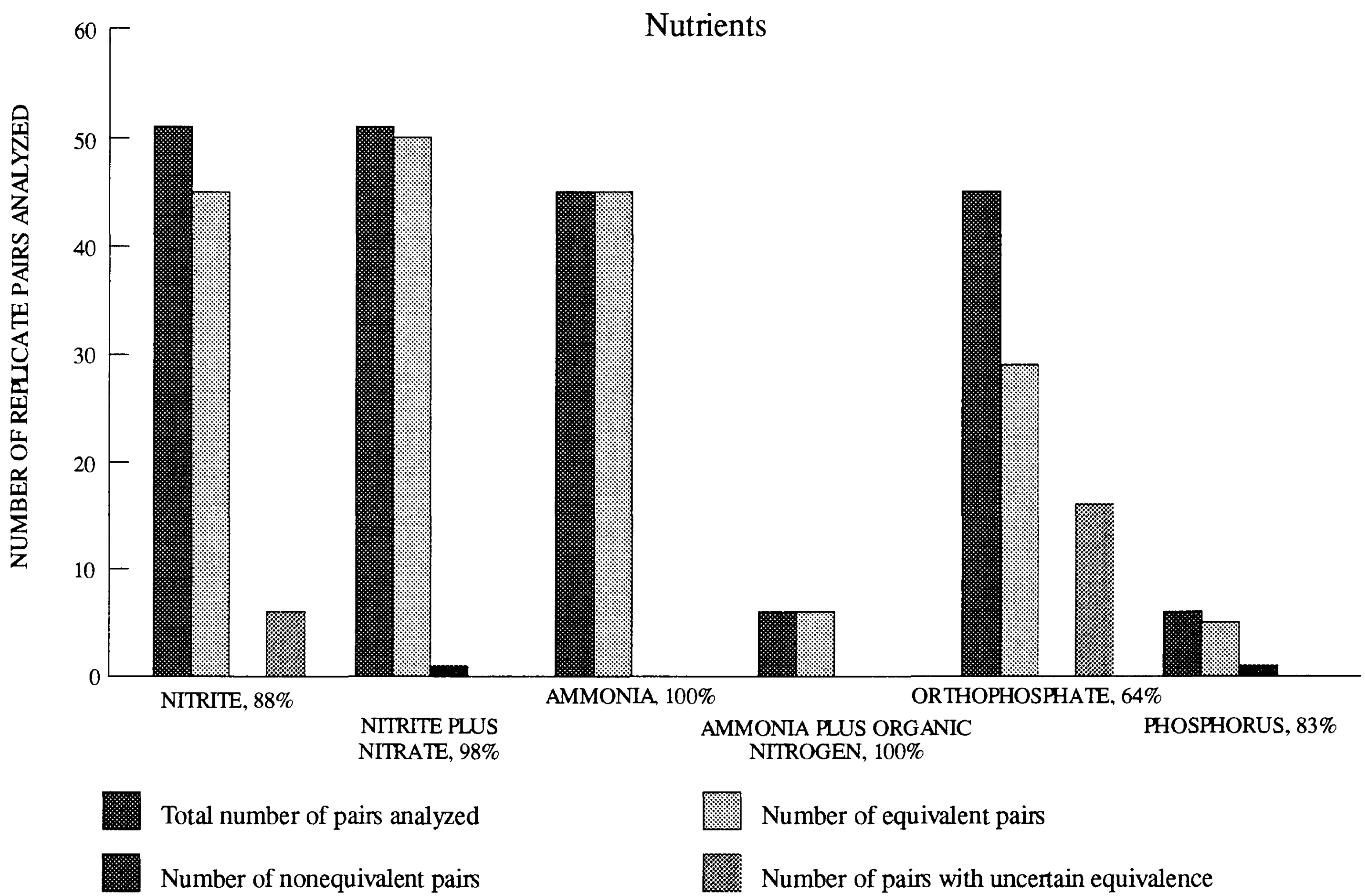
Major ions.—Several replicate pairs of samples were analyzed by the NWQL for dissolved major ions. The major ions and the number of replicate pairs follow: sodium, 64; sulfate, 31; chloride, 99; fluoride, 12; and bromide, 11. For all but the bromide analyses, the Z-values were calculated with the analytical results and the MPD's determined with the regression equations formulated by the BTD&QS from the SRWS program data. Because the bromide analysis is not included in the BSP, an RSD of 15 percent (Pritt and Jones, 1989, p. 5–6) was used in equation 1.

Major ions analyzed and percentages of the analytical results of the replicate pairs that were equivalent follow: sodium, 95 percent; sulfate, 100 percent; chloride, 98 percent; fluoride, 100 percent; and bromide, 91 percent. The Z-values



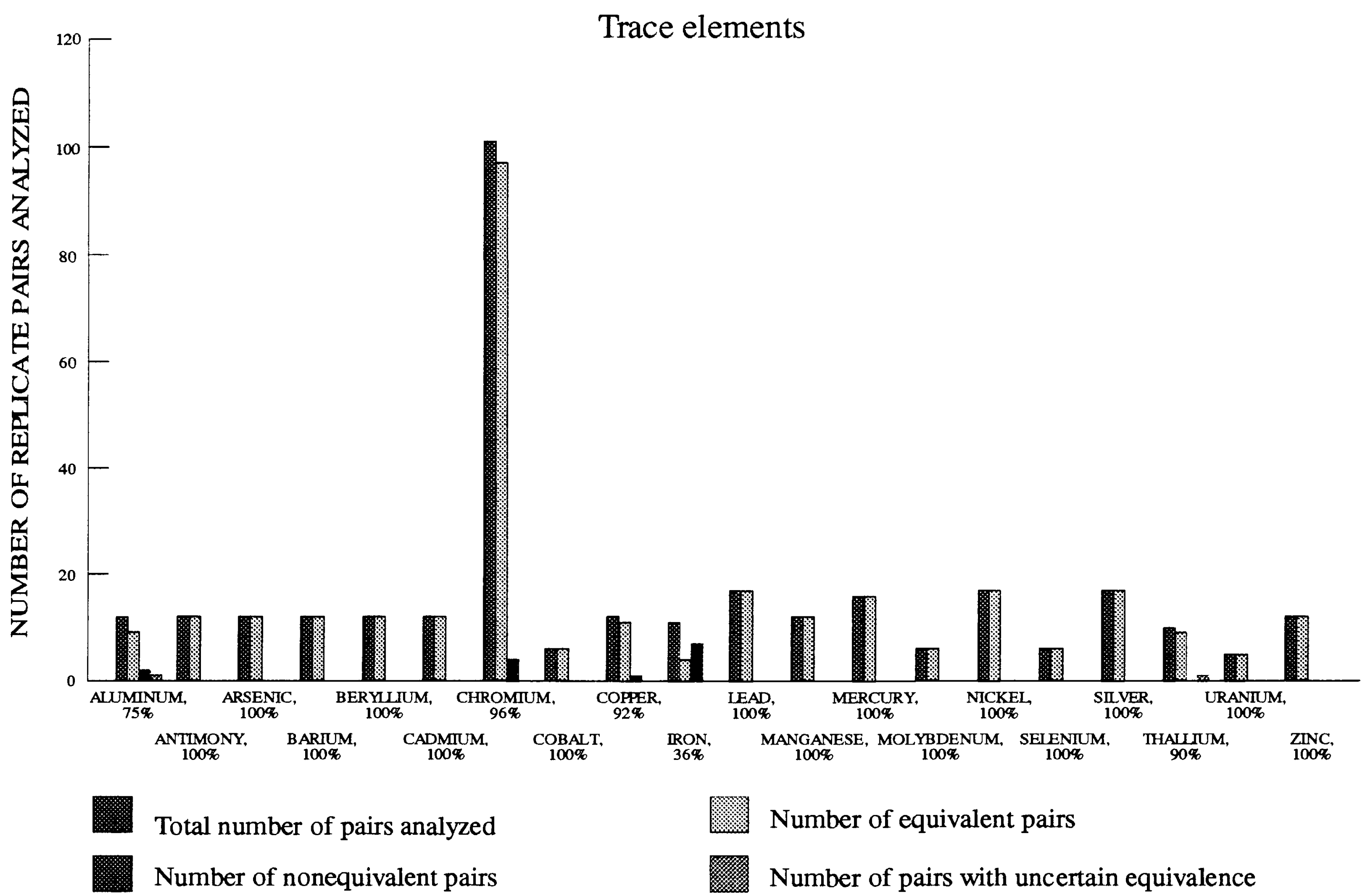
Explanation: Analytes are followed by the percentages of the replicate pairs that are equivalent.

Figure 4. Results of statistical comparisons of replicate pairs of samples analyzed for major ions



Explanation: Analytes are followed by the percentages of the replicate pairs that are equivalent.

Figure 5. Results of statistical comparisons of replicate pairs of samples analyzed for nutrients



Explanation: Analytes are followed by the percentages of the replicate pairs that are equivalent.

Figure 6. Results of statistical comparisons of replicate pairs of samples analyzed for trace elements

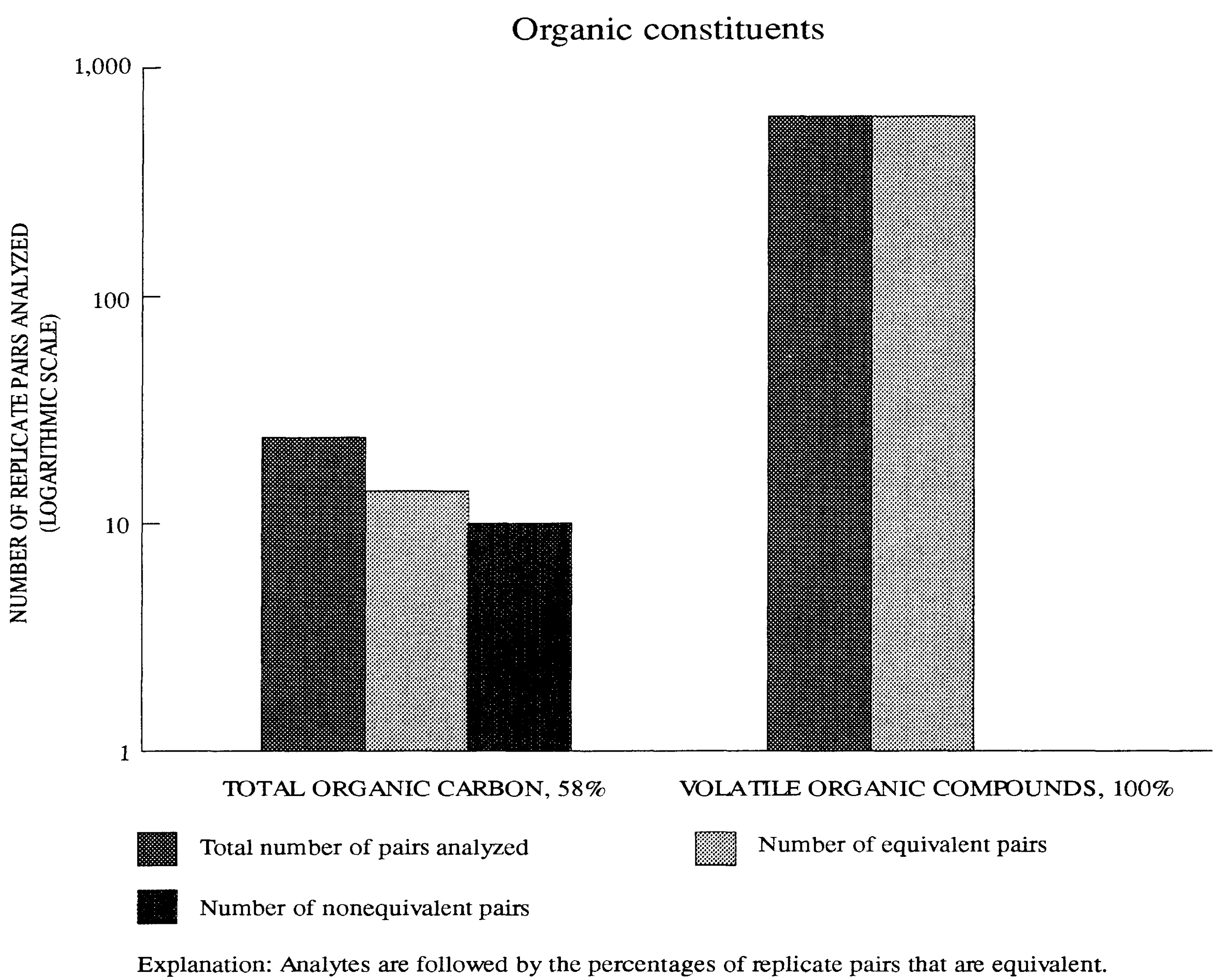
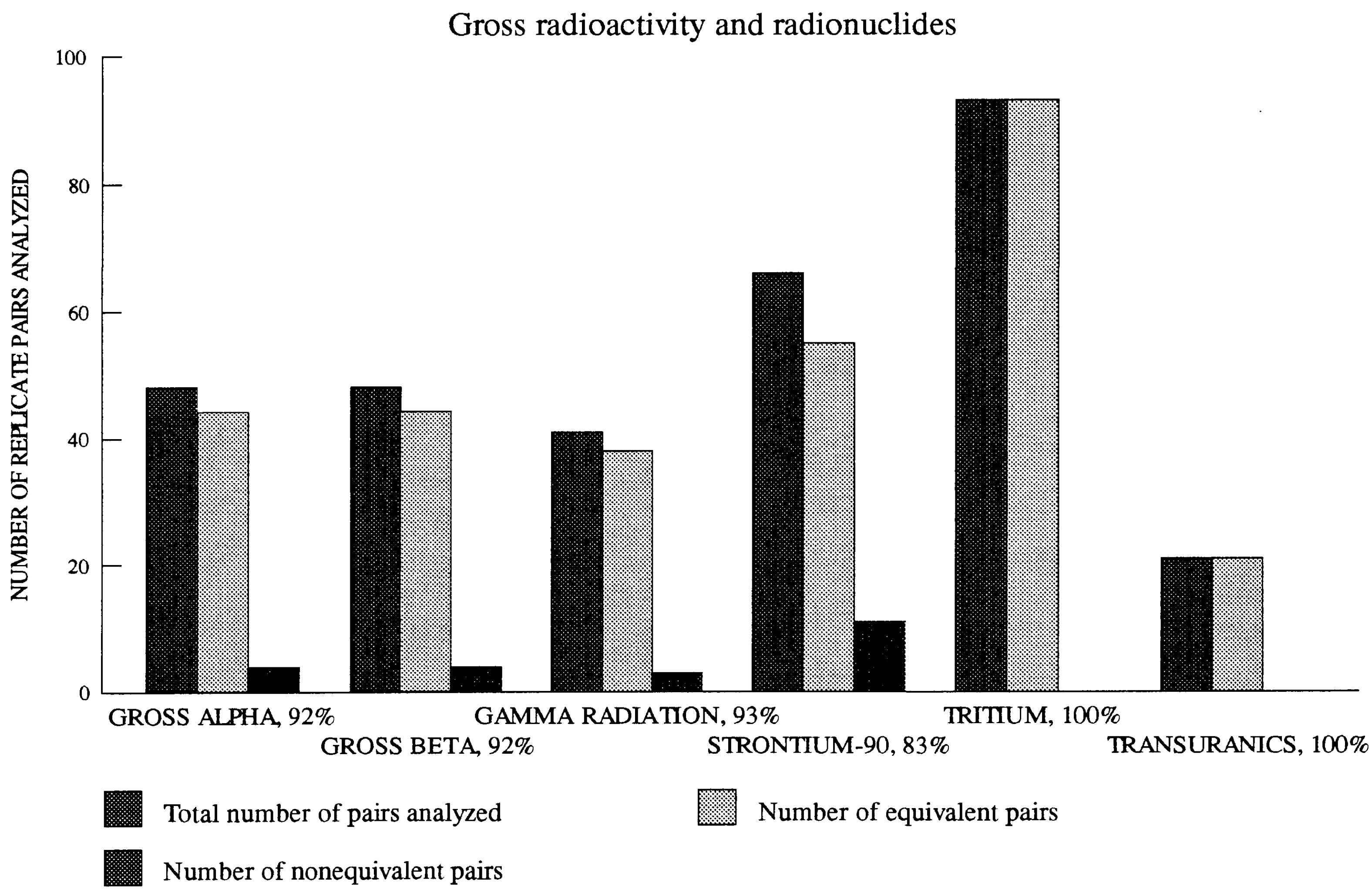


Figure 7. Results of statistical comparisons of replicate pairs of samples analyzed for gross radioactivity and radionuclides



Explanation: Analytes are followed by the percentages of the replicate pairs that are equivalent.

Figure 8. Results of statistical comparisons of replicate pairs of samples analyzed for organic constituents

indicated that 6 replicate pairs analyzed for major ions were not equivalent and 211 pairs, or 97 percent of the results, were equivalent.

Nutrients.—Several replicate pairs of samples were analyzed by the NWQL for dissolved and WWR nutrients. The nutrients and the number of replicate pairs follow: dissolved nitrite, 51; dissolved nitrite plus nitrate, 51; dissolved ammonia, 45; WWR ammonia plus organic nitrogen, 6; dissolved orthophosphate, 45; and WWR phosphorus, 6.

For all but the nitrite analyses, the Z-values were calculated with the analytical results and the MPD's determined with the regression equations formulated by the BTD&QS from the SRWS program data. The precision statement for the method of nitrite analysis (Fishman, 1993, p.147) does not include concentrations at or even twice the reporting level; however, at 0.03 mg/L the standard deviation is listed as 0.001 mg/L. Although the orthophosphate analysis is included in the BSP, the concentrations are higher than the concentrations of the QA replicate sample pairs collected at the INEL. Equivalence could not be determined for either the replicate pairs analyzed for nitrite or orthophosphate which were below 0.03 mg/L; therefore, it is uncertain whether the results are equivalent and a "U" appears in the column labeled "Remark".

Nutrients analyzed and percentages of the analytical results of the replicate pairs that were equivalent, or that were uncertain follow: nitrite, 88 percent equivalent, 12 percent uncertain; nitrite plus nitrate, 98 percent equivalent; ammonia, 100 percent equivalent; ammonia plus organic nitrogen, 100 percent equivalent; orthophosphate, 64 percent equivalent, 36 percent uncertain; and phosphorus, 83 percent equivalent. The Z-values indicated that 2 replicate pairs analyzed for nutrients were not equivalent, 22 pair were uncertain, and 180 pairs, or 88 percent of the results, were equivalent.

Trace elements.—Several replicate pairs of samples were analyzed by the NWQL for trace elements; the analyses were for the dissolved and/or WWR constituents. The trace element and the number of replicate pairs follow: aluminum, 12; antimony, 12; arsenic, 12; barium, 12; beryllium, 12; cadmium, 12; chromium, 101; cobalt, 6; copper, 12; iron, 11; lead, 17; manganese, 12; mercury, 16; molybdenum, 6; nickel, 17; selenium, 6; silver, 17; thallium, 10; uranium, 5; and zinc, 12. All the Z-values were calculated with the analytical results and the MPD's determined with the regression equations formulated by the BTD&QS from the SRWS program data, except for thallium and uranium. These two analyses were not included in the BSP, but the results of each replicate pair were numerically the same, except for one thallium replicate pair where one result was below the MRL and the other at the MRL.

Statistical comparisons of the aluminum analyses indicated 2 replicate pairs were not equivalent, 1 pair was uncertain, and 9 pair, or 75 percent of the results, were equivalent. Only twelve replicate pairs were analyzed for aluminum; therefore, additional information from the BSP was used to support the conclusions. The information from the QADATA program that is available through the USGS computer network (Lucey, 1990) shows that the aluminum analyses of the BSP samples have displayed high variability with 20 percent of the dissolved aluminum analyses and 12 percent of the WWR aluminum analyses outside the two sigma control limits. The BTD&QS has reset the control limits to three sigma and the MPD's used in the statistical comparisons of the replicate pairs have been multiplied by 1.5 to adjust for the increased variability.

Statistical comparisons of the iron analyses indicated that 7 replicate pairs were not equivalent, and 4 pair, or 36 percent of the results, were equivalent. The BTD&QS has noted significant lack of precision for the same procedure at the NWQL and that the NWQL personnel are aware of the problem (Ludtke, A., 1995; and Ludtke, A. and Woodworth, M., 1995; U.S. Geological Survey, written commun.). The information from the QADATA program also shows that 12 percent of the WWR iron analyses were outside the two sigma control limits. Because the unfiltered samples collected at INEL were for WWR iron, they may not have been representative samples because of inhomogeneity of the water samples or contamination from the well structures. However, the samples analyzed for WWR iron in the BSP were split samples that were also analyzed for dissolved iron; the difference in the analyses was an added digestion procedure (Maloney and others, 1993, p. 3). This indicated that the lack of equivalence between replicate pairs analyzed for WWR iron partly resulted from laboratory conditions.

The argument that it may be difficult to compare replicate samples analyzed for a WWR constituent, rather than for the dissolved constituent, is valid. It is possible that sequential ground-water samples may be inhomogeneous because sediment may be present in each sample of a replicate pair in different quantities or different compositions. Therefore, sediment may contribute in varying amounts to the concentration of the WWR constituent, and the results of the replicate pair would not be equivalent statistically.

All of the results of the replicate pairs analyzed for trace elements were equivalent except the following, which are listed with the percentage that were equivalent: aluminum, 75 percent; chromium, 96 percent; copper, 92 percent; iron, 36 percent; and thallium, 90 percent. The Z-values indicated that 14 replicate pairs analyzed for trace elements were not equivalent, 2 pairs were uncertain, and 304 pairs, or 95 percent of the results, were equivalent.

Gross radioactivity and radionuclides

Gross alpha radioactivity.—There were 48 replicate pairs of samples analyzed by NWQL and the RESL for gross alpha radioactivity. The NWQL reported results as gross alpha, dissolved as thorium-230 and as natural uranium. The RESL reported results as gross alpha radioactivity. The Z-values indicated that 4 replicate pairs were not equivalent and 44 pairs, or 92 percent of the results, were equivalent.

Gross beta radioactivity.—There were 48 replicate pairs of samples analyzed by the NWQL and the RESL for gross beta radioactivity. The NWQL reported results as gross beta, dissolved as cesium-137 and as strontium-90/yttrium-90. The RESL reported results as gross beta radioactivity. The Z-values indicated that 4 replicate pairs were not equivalent and 44 pairs, or 92 percent of the results, were equivalent.

Gamma radiation.—There were 41 replicate pairs of samples analyzed by the RESL for gamma radiation. The Z-values indicated that 3 replicate pairs were not equivalent and 41 pairs, or 93 percent of the results, were equivalent.

Strontium-90.—There were 66 replicate pairs of samples analyzed by the RESL for strontium-90. The Z-values indicated that 11 replicate pairs were not equivalent and 55 pairs, or 83 percent of the results, were equivalent.

The reason for the lack of equivalence could not be clearly defined. A report that evaluates field sampling and preservation methods for strontium-90 in ground water at the INEL (Cecil and others, 1989) found no statistical difference between filtered or unfiltered, acidified or unacidified ground water samples. The samples, however, continue to be acidified as they have been in the past as recommended in the report. The samples are labeled at the sampling site to avoid sample mix-up.

Tritium.—There were 93 replicate pairs of samples analyzed for tritium; 5 pairs were analyzed by the NWQL and 86 pairs were analyzed by the RESL. The NWQL analyzed the routine water-quality sample and the RESL analyzed the QA sample in two additional replicate pairs. The Z-values indicated that 100 percent of the results were equivalent.

Transuranics: americium-241, plutonium-238, and plutonium-239/240.—There were seven replicate pairs of samples analyzed by the RESL for each of three transuranic isotopes. The Z-values indicated that 100 percent of the results of the replicate pairs were equivalent for each isotope.

Organic Constituents

Total organic carbon.—There were 24 replicate pairs of samples analyzed by the NWQL for total organic carbon. For most analyses, an MPD derived from linear regression equations formulated by the BTD&QS from the SRWS program data, or a reported standard deviation may be used to quantify the precision associated with the analytical results. Neither an MPD nor a standard deviation was available for analysis of total organic carbon.

The precision data for the dissolved organic carbon method (Wershaw and others, 1987, p. 15) was used to determine a linear regression equation for calculating standard deviations at low concentrations because there is no precision data for the total organic carbon method. The precision statement for the total organic carbon method only states that the percent RSD for total organic carbon will be greater than that for dissolved organic carbon (Wershaw and others, 1987, p. 16). When using the analytical results and the standard deviations at low concentrations calculated with the linear regression equation, the Z-values indicated that 10 replicate pairs were not equivalent and 14 pairs, or 58 percent of the results, were equivalent.

The reason for the lack of equivalence of the replicate pairs could not be clearly defined.

Volatile organic compounds.—There were 10 replicate pairs of samples analyzed by the NWQL for 63 volatile organic compounds. Two of the replicate pairs had concentrations of three of the volatile organic compounds that were at or greater than the MRL. Because neither an MPD nor a stan-dard deviation was available for these three volatile organic compounds, the standard deviations were calculated from the RSD's provided by Rose and Schroeder (1995). The compounds and the RSD's used to determine the standard deviations for the statistical comparisons follow: carbon tetrachloride, 8.4 percent; 1,1,1-trichloroethane, 12 percent; and trichloroethene, 13 percent.

All the replicate pairs analyzed for the compounds with concentrations at or above the MRL were equivalent when compared statistically using equation 1. All the results of the replicate pairs that were less than the MRL were considered equivalent. Therefore, 100 percent of the results of replicate pairs analyzed for volatile organic compounds were equivalent.

QUALITY ASSURANCE/QUALITY CONTROL DATA, BLANK SAMPLES

Blank samples were prepared using deionized water from the Idaho Falls Field Office and inorganic blank water (IBW) and volatile organic compound blank water (VBW) from the NWQL. Several different types of blank samples were prepared: three source-solution, one trip, and four equipment.

A source solution is water that is free of the constituents of interest and is used as a stock solution for other blanks. For example, deionized water may be used to prepare an equipment blank of the filtration apparatus, and the source-solution blank would be a sample of the deionized water before it was filtered. Analytical results of a source-solution blank are used to determine the variability of methods or analysts within a laboratory. They are also used to determine whether the laboratory has introduced a bias into the analytical process. Furthermore, this type of blank is used to determine if, in fact, the source solution is free of the constituents of interest.

A trip blank travels with the samples during collection, storage, and shipment to detect bias related to handling procedures or ambient conditions.

An equipment blank that has been run through all or part of the sampling apparatus can be used to detect a bias that has been introduced through use of that equipment. Also, equipment blanks can be used to identify contamination from the sample-collection or equipment-cleaning processes. Only deionized water from the Idaho Falls Field Office and IBW and VBW from NWQL, which have been shown to be free of the constituents of interest, are used for rinsing the sampling apparatus and preparing blanks.

Blanks should not have measurable concentrations of the constituents of interest. Measurable concentrations are those that exceed the MRL's plus twice the MPD or standard deviation; radiochemical concentrations should not exceed two standard deviations. When blanks have measurable concentrations of the constituents of interest, they are considered contaminated and corrective actions must be taken. For example, analytical results of source-solution blanks that had been prepared with the distilled and deionized water from the analytical laboratories at the RESL and the Idaho Chemical Processing Plant (ICPP) showed measurable concentrations of several constituents of interest (Williams, 1995). Consequently, water from the RESL and the ICPP is no longer used.

Equipment blanks that have measurable concentrations of the constituents of interest must be carefully evaluated to determine the source of contamination. After the possibilities that the contamination resulted from a laboratory error or an unsatisfactory source solution are ruled out, it could be concluded that the equipment was inadequately cleaned and additional training must be provided concerning the proper cleaning of sampling equipment. The analytical results of the affect-ed samples must be assessed to see whether there is a detectable bias present that could distort the data.

From 1994 through 1995, sequential QA designations were given to QA/QC samples beginning with QA-1 each sampling session; QAS designations were given to the Naval Reactors Facility QA/QC samples and were numbered sequentially from QAS-34 to QAS-45. Sources and descriptions of source-solution blanks, a trip blank, and equipment blanks that were analyzed by both the NWQL and the RESL for the water-quality monitoring program are presented in tables 8 through 9. Analytical results of the source-solution blanks, a trip blank, and equipment blanks are presented in tables 49 through 52.

Source-Solution Blank and Trip Blank Results

The deionized water from the Idaho Falls Field Office was used for rinsing the measuring and sampling equipment and for preconditioning filters when necessary. It was also used for preparing a trip blank and equipment blanks. Because the Idaho Falls Field Office is located some distance from the INEL Project Office, the deionized water is transported to the INEL in large polyethylene containers and stored until needed. To ensure that the deionized water is free of the constituents of interest, two source-solution blanks were prepared.

One source-solution blank, QA-2, was analyzed for chloride, dissolved chromium, and hexavalent chromium. This blank, and another source-solution blank, QA-3, were analyzed for gamma radiation, strontium-90, and tritium. No measurable concentrations of the constituents of interest were found.

At the beginning of the January 1995 sampling session, a trip blank, QA-318, and a source-solution blank, QA-317, were prepared with the deionized water from the Idaho Falls Field Office. The source-solution blank was sent to the NWQL for analyses, and the trip blank travelled throughout the sampling session in the field laboratory as the field personnel collected and prepared the routine water-quality samples. At the end of the sampling session, the trip blank was sent to the NWQL along with the last of the samples. The source-solution blank, QA-317, and trip blank, QA-318, were analyzed for sodium, chloride, dissolved chromium, hexavalent chromium, nutrients, and volatile organic compounds[1]. No measurable concentrations of those constituents were found.

Equipment-Blank Results

Three source solutions have been used for equipment blanks: deionized water from the Idaho Falls Field Office and IBW and VBW from the NWQL. The equipment-blank source solutions were passed through and collected from different sampling apparatus in the same manner as the routine water-quality samples. Then, the blanks were analyzed for the constituents of interest to determine if the sampling process had introduced a bias to the analytical results.

Three equipment blanks, QA-3, QA-5, and QA-8, were analyzed for chloride, dissolved chromium, hexavalent chromium, strontium-90, and tritium. Additionally, QA-5, was analyzed for sodium and gamma radiation; and QA-8, for sulfate. Those three equipment blanks had no measurable concentrations of the constituents of interest.

One equipment blank, QAS-39, was prepared with two source solutions; samples for analyses of major ions, nutrients, trace elements, tritium, gross alpha and gross beta radioactivity were prepared with IBW; for total organic carbon, VBW. Measurable concentrations of tritium, gross alpha and gross beta radioactivity, and total organic carbon were found. It is unlikely that the source solutions provided by the NWQL were contaminated with those constituents. The measurable concentrations of those constituents may have been due to bias or error in the sample analyses or may be due to inadequate cleaning of the equipment. The data

[1]Because all of the analytical results for volatile organic compounds were less than the minimum reporting level, they were not tabulated.

Table 8. Identification, source, and description of source-solution blanks and a trip blank for the water-quality monitoring program at the Idaho National Engineering Laboratory

[Site identifier: see Quality Assurance/Quality Control Data, Blank Samples section or explanation]

Site identifier	Date prepared	Source	Description
		Source-solution blanks	
QA-2	7/15/94	U.S. Geological Survey, Idaho Falls Field Office	Deionized water
QA-317	1/9/95		
QA-3	2/8/95		
		Trip blank	
QA-318	2/1/95	U.S. Geological Survey, Idaho Falls Field Office	Deionized water

Table 9. Identification, source, and description of equipment blanks for the water-quality monitoring program at the Idaho National Engineering Laboratory

[Site identifier: see section on Quality Assurance/Quality Control Data, Blank Samples for explanation. Abbreviation: IBW, inorganic blank water; VBW, volatile organic compound blank water]

Site identifier	Date prepared	Source	Description
QA-5	7/28/94	IBW from the National Water Quality Laboratory	Rinsate of sampling equipment and filtering apparatus
QAS-39[1]	11/10/94		
QA-8	7/17/95		
QA-3	7/15/94	Deionized water from the U.S. Geological Survey, Idaho Falls Field Office	Rinsate of sampling equipment and filtering apparatus
QAS-39[1]	11/10/94	VBW from the National Water Quality Laboratory	Rinsate of filtering apparatus

[1]The equipment blank was prepared with two source solutions.

from the last routine water-quality samples that were collected were carefully assessed to determine if there was a detectable bias. All the data were within range of the historical data and no bias could be determined.

SUMMARY AND CONCLUSIONS

More than 4,000 water samples were collected by the USGS from 179 monitoring sites for the water-quality monitoring program at the INEL from 1994 through 1995. Approximately 500 of the water samples were replicate or blank samples collected for the quality assurance/quality control program. Analyses were performed by the NWQL and the RESL to determine the concentrations of major ions, nutrients, trace elements, gross radioactivity and radionuclides, total organic carbon, and volatile organic compounds in those samples. The precision of field and laboratory methods can be assessed with the data from the analyses of the replicate pairs of samples. Although many factors may affect precision, the determination of the equivalence of replicate pairs of samples, along with the BTD&QS report concerning the NWQL (Maloney and others, 1993) and historical data, is useful in assessing sources of imprecision, bias, and, in some cases, inaccuracy.

To evaluate the precision of field and laboratory methods, analytical results of the replicate pairs of samples were compared statistically for equivalence on the basis of the precision associated with each result. Within the major ion analyses, 97 percent were equivalent; nutrients, 88 percent; trace elements, 95 percent; gross radioactivity and radionuclides, 93 percent; and organic constituents, 98 percent. In all, the statistical comparison of the data indicated that 95 percent of the replicate pairs were equivalent. The large percentage of analytical results of replicate pairs that were equivalent indicates that the samples were being collected in a manner that ensures the quality of the data.

Ninety percent or more of the analytical results of replicate pairs were equivalent for each constituent when tested statistically except for the following: (which are listed with the percentages that were equivalent) nitrite, 88 percent; orthophosphate, 64 percent; phosphorus, 83 percent; aluminum, 75 percent; iron, 36 percent; strontium-90, 83 percent; and total organic carbon, 58 percent.

The precision statement for the method of nitrite analysis (Fishman 1993, p.147) does not include concentrations at or twice the reporting level; however, at 0.03 mg/L the standard deviation is listed as 0.001 mg/L. Although, the orthophosphate analysis is included in the BSP, the concentrations are higher than the concentrations of the QA replicate sample pairs collected at the INEL. Therefore, equivalence of the replicate pairs analyzed for nitrite and orthophosphate that were below 0.03 mg/L was uncertain.

Lack of precision for analytical methods to determine the concentrations of aluminum and iron has been documented by the BTD&QS in the BSP. The information from the QADATA program that is available through the USGS computer network (Lucey, 1990) shows that 20 percent of the dissolved aluminum analyses and 12 percent of the WWR aluminum analyses were outside the two sigma control limits. The BTD&QS also has noted significant lack of precision for the WWR iron analyses at the NWQL (Ludtke, A., 1995; Ludtke A. and Woodworth, M., 1995, USGS, written communs.). The QADATA program shows that 14 percent of those analyses also were outside the two sigma control limits. Although the unfiltered samples collected at INEL were for WWR iron and they may not have been representative samples owing to inhomogeneity of the water samples or contamination from the well structures, information from the BTD&QS shows that the lack of equivalence between replicate pairs partly resulted from laboratory conditions.

The reason for the lack of equivalence between the replicate pairs analyzed for strontium-90 could not be clearly defined. A report that evaluates field sampling and preservation methods for strontium-90 in ground water at the INEL (Cecil and others, 1989) found no statistical difference between filtered or unfiltered, acidified or unacidified ground water samples. The samples, however, continue to be acidified as they have been in the past as recommended in the report. The samples are labeled at the sampling site to avoid sample mix-up.

Neither an MPD nor a standard deviation was available for analysis of total organic carbon. Therefore, precision data for the dissolved organic carbon method (Wershaw and others, 1987, p. 15) was used to determine a linear regression equation for the calculating standard deviations at low concentrations. When using the analytical results and the standard deviations at low concentrations calculated with the linear regression equation, the Z-values indicated that 11 replicate pairs were not equivalent and 13 pairs, or 54 percent of the results, were equivalent. The reason for the lack of equivalence of the replicate pairs could not be clearly defined.

Blanks are an important component of the QA/QC program. Source solutions were used for preparation of blanks were deionized water from the Idaho Falls Field Office and IBW and VBW from the NWQL. Analytical results of a source-solution blank are used to determine variability or bias at the laboratory. Furthermore, this type of blank is used to determine if, in fact, the blank solution is free of the constituents of interest. A trip blank travels with the samples during collection, storage, and shipment to detect bias related to handling procedures or ambient conditions. An equipment blank that has been passed through and collected from all or part of the sampling apparatus may be used to detect bias that may been introduced through use of that equipment. Blanks should not have measurable concentrations of the constituents of interest. Measurable concentrations are those that exceed the MRL's plus twice the MPD or standard deviation. The radiochemical concentrations of blanks should not exceed two standard deviations.

Three source-solution blanks, one trip blank, and four equipment blanks were prepared and analyzed. The blanks had no measurable concentrations of the constituents of interest, except for one equipment blank, QAS-39, which had measurable concentrations of total organic carbon, tritium, and gross alpha and gross beta radioactivity. It is unlikely that the source solutions provided by the NWQL were contaminated with those constituents, and the measurable concentrations of those constituents were probably due to bias or error in the sample analyses or inadequate cleaning of equipment. The data from the last routine water-quality samples that were collected were carefully assessed to determine if there was a detectable bias. All the data were within range of the historical data and no bias could be determined.

Evaluation of the QA/QC data, the information from the BSP, and historical data help to assess precision and bias of field methods used by the personnel at the INEL Project Office. The large percentage of replicate pairs of samples that are equivalent and of blank results that are free of the constituents of interest validates the methods and procedures and supports the reliability of the data. Furthermore, the QA/QC data are useful in determining the source of inconsistencies when lack of equivalence between replicate pairs or blanks with measurable concentrations of the constituents of interest are detected. For example, when results of a specific analysis for several replicate pairs are not equivalent, and the results for other analyses of those pairs are equivalent, the source of the inconsistencies may be the laboratory procedures. On the other hand, when results of all the analyses for a replicate pair are not equivalent, the source of the inconsistencies may be the field procedures. In general, replicate samples do not address accuracy; but, a large Z-value, when the results of two replicate samples are tested statistically for equivalence, suggests that at least one of the samples is inaccurate.

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SUPPLEMENTAL INFORMATION SECTION

Table 10. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for sodium—Continued

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; mg/L, milligram per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Sodium (mg/L)	Sodium, QA (mg/L)	Z-value	Remark
		Dissolved			
ANP-9	10/14/94	14	15	0.92	
ARBOR Test	9/29/94	16	16	.00	
CFA 1	4/7/94	29	30	.52	
	1/5/95	19	18	.76	
	4/13/95	29	*30	.52	
CFA LF 2-10	11/10/94	10	10	.00	
	10/25/95	13	13	.00	
Hwy 3	10/12/94	5.9	*5.7	.34	
MTR Test	4/26/95	26	26	.00	
NPR Test	4/14/94	8.1	8	.14	
PSTF	4/10/95	6.9	6.7	.31	
PW-5	10/20/94	160	160	.00	
Site 17	10/19/94	9.7	10	.36	
Tan Expl.	4/12/94	9.6	10	.49	
TRA A-13	10/4/95	22	23	.65	
USGS 2	7/13/95	16	16	.00	
USGS 4	4/19/95	48	48	.00	
USGS 6	7/19/94	13	14	.97	
USGS 7	4/6/95	23	23	.00	
USGS 11	10/26/95	9.1	9.2	.14	
USGS 17	10/28/94	7.0	*7.1	.15	
USGS 18	7/7/95	12	12	.00	
USGS 23	10/10/95	10	9.8	.24	
USGS 26	4/11/95	15	15	.00	
USGS 29	10/11/94	20	20	.00	
USGS 31	4/1/94	16	16	.00	
USGS 42	10/18/94	11	9.9	1.28	
USGS 44	10/16/95	8.8	9.1	.39	
USGS 45	10/11/95	11	12	1.09	
USGS 47	10/16/95	17	17	.00	
USGS 53	10/25/94	13	13	.00	
USGS 55	10/25/94	24	24	.00	
	10/4/95	22	22	.00	
USGS 59	10/23/95	65	64	.26	

Table 10. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for sodium—Continued

Site identifier	Date sampled	Sodium (mg/L)	Sodium, QA (mg/L)	Z-value	Remark
		Dissolved-cont.			
USGS 67	10/17/95	46	47	0.34	
USGS 69	7/11/94	11	10	1.16	
	7/6/95	11	*9.9	1.28	
USGS 70	10/24/94	14	14	.00	
USGS 78	7/13/95	7.1	7.7	.87	
USGS 84	10/18/95	8.4	*7.9	.69	
USGS 100	10/19/95	17	17	.00	
USGS 101	4/11/94	13	9.2	4.21	N
USGS 105	3/31/94	13	14	.97	
USGS 108	4/18/95	11	11	.00	
USGS 112	10/13/94	69	73	.93	
USGS 116	10/17/95	32	*33	.47	
USGS 119	10/25/95	11	11	.00	
USGS 120	10/23/95	26	25	.61	
USGS 121	10/24/94	7.3	7.3	.00	
USGS 123	10/31/94	46	46	.00	
	10/30/95	47	47	.00	
USGS 124	4/21/94	9.2	14	5.13	N
USGS 125	6/16/95	12	12	.00	
		Whole water, recoverable			
NRF-1	3/10/94	15	14	.92	
NRF-2	11/7/95	20	20	.00	
NRF-3	6/08/95	17	17	.00	
NRF-6	3/10/95	73	110	6.67	N
NRF-7	6/13/94	8.3	8.2	.14	
WSINEL1	6/9/94	14	15	.92	
USGS 15	11/7/94	7.6	7.4	.29	
USGS 17	11/7/95	6.3	6.7	.63	
USGS 98	6/12/95	11	9.9	.00	
USGS 99	9/7/94	13	13	.00	
USGS 102	9/13/95	15	14	.92	

Table 11. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for sulfate

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; mg/L, milligram per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Dissolved sulfate (mg/L)	Dissolved sulfate, QA (mg/L)	Z-value	Remark
CFA 1	4/13/95	34	*35	0.26	
CFA LF 2-10	10/25/95	28	28	.00	
NRF-1	3/10/94	39	39	.00	
NRF-2	11/7/95	46	46	.00	
NRF-3	6/8/95	39	40	.25	
NRF-6	3/10/95	270	270	.00	
NRF-7	6/13/94	14	14	.00	
PW-9	7/11/95	78	79	.16	
TRA A-13	10/4/95	270	270	.00	
WSINEL1	6/9/94	42	42	.00	
USGS 2	7/13/95	13	13	.00	
USGS 15	11/7/94	17	17	.00	
USGS 17	11/7/95	18	18	.00	
USGS 18	7/7/95	23	23	.00	
USGS 44	10/16/95	24	24	.00	
USGS 45	10/11/95	24	24	.00	
USGS 47	10/16/95	29	29	.00	
USGS 55	10/4/95	35	35	.00	
USGS 59	10/23/95	28	28	.00	
USGS 67	10/17/95	31	30	.28	
USGS 69	7/6/95	96	*99	.42	
USGS 78	7/13/95	18	18	.00	
USGS 84	10/18/95	26	*26	.00	
USGS 98	6/12/95	20	21	.33	
USGS 99	9/7/94	26	26	.00	
USGS 100	10/19/95	11	11	.00	
USGS 102	9/13/95	34	34	.00	
USGS 116	10/17/95	34	*34	.00	
USGS 120	10/25/95	36	36	.00	
USGS 121	10/24/94	23	23	.00	
USGS 123	10/30/95	29	29	.00	

Table 12. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for chloride—Continued

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; mg/L, milligram per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Dissolved chloride (mg/L)	Dissolved chloride, QA (mg/L)	Z-value	Remark
ANP-9	10/14/94	12	12	0.00	
ARBOR Test	9/29/94	15	14	.74	
Atomic City	4/6/94	18	18	.00	
CFA 1	4/7/94	100	100	.00	
	1/5/95	67	68	.24	
	4/13/95	110	*100	1.61	
CFA LF 2-10	11/10/94	32	33	.43	
	10/25/95	30	30	.00	
CFA LF 3-9	7/18/95	110	110	.00	
Hwy 3	10/12/94	6.2	*6.3	.11	
Leo Rogers	7/18/94	18	19	.64	
MTR Test	4/26/95	26	26	.00	
NPR Test	4/14/94	16	16	.00	
NRF-1	3/10/94	37	38	.39	
NRF-2	11/7/95	51	50	.30	
NRF-3	6/8/95	40	39	.37	
NRF-6	3/10/95	250	250	.00	
NRF-7	6/13/94	4.9	4.9	.00	
PSTF	4/10/95	6.9	6.2	.76	
PW-4	1/14/95	280	*270	.65	
PW-5	10/20/94	240	250	.73	
PW-6	1/24/94	220	220	.00	
PW-9	7/11/95	23	22	.56	
Site 4	4/13/95	12	12	.00	
Site 17	10/19/94	9.9	11	.98	
Tan Expl.	4/12/94	18	19	.64	
TRA A-13	10/4/95	33	33	.00	
WSINEL1	6/9/94	74	70	.95	
USGS 2	7/13/95	16	16	.00	
USGS 4	4/19/95	36	36	.00	
USGS 6	7/19/94	8.2	8.3	.10	
USGS 7	4/6/95	8.7	8.7	.00	
USGS 11	10/26/95	11	12	.84	
USGS 15	11/7/94	6.9	7.4	.53	

Table 12. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for chloride—Continued

Site identifier	Date sampled	Dissolved chloride (mg/L)	Dissolved chloride, QA (mg/L)	Z-value	Remark
USGS 17	10/28/94	5.8	*5.9	0.11	
	11/7/95	5.7	5.7	.00	
USGS 18	7/7/95	9.7	9.4	.28	
USGS 23	10/10/95	10	11	.88	
USGS 26	4/11/95	13	13	.00	
USGS 29	10/11/94	25	27	1.02	
USGS 31	4/01/94	22	20	1.18	
USGS 36	1/6/94	64	64	.00	
	7/14/94	65	66	.24	
USGS 39	4/25/94	12	12	.00	
	7/15/94	68	*64	.97	
	1/20/95	12	12	.00	
	7/03/95	12	12	.00	
USGS 40	1/13/94	27	29	.97	
USGS 41	5/3/94	25	25	.00	
USGS 42	10/18/94	22	23	.56	
USGS 44	10/16/95	17	18	.66	
USGS 45	4/13/95	20	21	.60	
	10/11/95	21	21	.00	
USGS 46	4/20/95	25	*28	1.51	
USGS 47	10/16/95	35	36	.40	
USGS 48	4/22/94	24	24	.00	
USGS 50	4/13/95	68	67	.24	
USGS 51	4/21/94	95	93	.36	
	4/19/95	100	100	.00	
USGS 53	10/25/94	17	17	.00	
USGS 55	10/25/94	28	28	.00	
	10/04/95	24	24	.00	
USGS 58	4/11/95	11	11	.00	
USGS 59	10/23/95	150	150	.00	
USGS 61	4/28/94	14	*14	.00	
USGS 62	4/25/94	18	18	.00	
USGS 63	4/7/95	20	21	.60	
USGS 65	1/12/94	18	18	.00	
USGS 67	4/12/95	140	150	1.20	
	10/17/95	150	150	.00	
USGS 69	7/11/94	16	15	.71	

Table 12. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for chloride—Continued

Site identifier	Date sampled	Dissolved chloride (mg/L)	Dissolved chloride, QA (mg/L)	Z-value	Remark
USGS 69-cont.	7/6/95	16	*16	0.00	
USGS 70	10/24/94	17	19	1.30	
	4/12/95	20	20	.00	
USGS 78	7/13/95	3.6	3.5	.13	
USGS 79	4/15/94	13	*12	.81	
USGS 84	10/18/95	6.7	*6.8	.11	
USGS 87	1/11/95	14	*14	.00	
USGS 98	6/12/95	15	15	.00	
USGS 99	9/7/94	21	21	.00	
USGS 100	10/19/95	16	16	.00	
USGS 101	4/11/94	9	14	4.20	N
USGS 102	9/13/95	34	35	.41	
USGS 105	3/31/94	14	14	.00	
USGS 108	4/18/95	14	14	.00	
USGS 111	4/18/94	140	150	1.20	
USGS 112	1/13/94	200	*190	.91	
	10/13/94	180	170	1.00	
USGS 113	7/13/94	230	*220	.79	
USGS 115	7/6/95	33	*34	.42	
USGS 116	2/1/95	110	110	.00	
	10/17/95	99	*99	.00	
USGS 119	10/25/95	11	11	.00	
USGS 120	10/23/95	20	20	.00	
USGS 121	10/24/94	15	15	.00	
USGS 123	10/31/94	110	120	1.48	
	10/30/95	120	120	.00	
USGS 124	4/21/94	14	8.3	4.85	N
USGS 125	6/16/95	14	14	.00	

Table 13. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for fluoride

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; mg/L, milligram per liter]

Site identifier	Date sampled	Dissolved fluoride (mg/L)	Dissolved fluoride, QA (mg/L)	Z-value	Remark
NRF-1	3/10/94	0.2	0.2	0.00	
NRF-2	11/7/95	.2	.2	.00	
NRF-3	6/8/95	.2	.1	.94	
NRF-6	3/10/95	.2	.2	.00	
NRF-7	6/13/94	.2	.2	.00	
WSINEL1	6/9/94	.1	.2	.94	
USGS 15	11/7/94	.1	.1	.00	
USGS 17	11/7/95	.3	.3	.00	
USGS 98	6/12/95	.2	.2	.00	
USGS 99	9/7/94	.2	.2	.00	
USGS 102	9/13/95	.2	.1	.94	
USGS 121	10/24/94	.2	.2	.00	

Table 14. Comparison of results of replicate pairs of samples from the Idaho National Engineering Labora*ory analyzed for bromide

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; mg/L, milligram per liter]

Site identifier	Date sampled	Dissolved bromide (mg/L)	Dissolved bromide, QA (mg/L)	Z-value	Remark
NRF-1	3/10/94	0.05	0.08	2.12	N
NRF-2	11/7/95	.08	.09	.55	
NRF-3	6/8/95	.09	.08	.55	
NRF-6	3/10/95	.10	.10	.00	
NRF-7	6/13/94	.03	.03	.00	
WSINEL1	6/9/94	.23	.22	.21	
USGS 15	11/7/94	.02	.02	.00	
USGS 17	11/7/95	.02	.02	.00	
USGS 98	6/12/95	.04	.05	1.04	
USGS 99	9/7/94	.06	.07	.72	
USGS 102	9/13/95	.09	.09	.00	

Table 15. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for nitrite, as nitrogen—Continued

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; U, statistical equivalence of the analytical results of replicate pairs is uncertain. Abbreviations: QA, quality-assurance replicate sample; mg/L, milligram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Dissolved nitrite, as nitrogen (mg/L)	Dissolved nitrite, as nitrogen, QA (mg/L)	Z-value	Remarks
ANP-9	10/14/94	<0.01	<0.01	0	
ARBOR Test	9/29/94	<.01	<.01	0	
CFA LF 2-10	11/10/94	<.01	<.01	0	
	10/25/95	.02	<.01		U
CFA LF 3-9	7/18/95	<.01	<.01	0	
Hwy 3	10/12/94	<.01	*<.01	0	
NPR Test	4/14/94	<.01	<.01	0	
NRF-1	3/10/94	.01	<.01		U
NRF-2	11/7/95	<.01	<.01	0	
NRF-3	6/08/95	<.01	<.01	0	
NRF-6	3/10/95	<.01	<.01	0	
NRF-7	6/13/94	<.01	<.01	0	
PSTF	4/10/95	<.01	<.01	0	
Site 17	10/19/94	<.01	<.01	0	
Tan Expl.	4/12/94	<.01	.02		U
WSINEL1	6/09/94	<.01	<.01	0	
USGS 2	7/13/95	<.01	<.01	0	
USGS 4	4/19/95	<.01	<.01	0	
USGS 6	7/19/94	<.01	<.01	0	
USGS 7	4/6/95	<.01	<.01	0	
USGS 11	10/25/95	<.01	<.01	0	
USGS 15	11/7/94	<.01	<.01	0	
USGS 17	10/28/94	<.01	*<.01	0	
	11/7/95	<.01	<.01	0	
USGS 18	7/7/95	<.01	<.01	0	
USGS 23	10/10/95	<.01	<.01	0	
USGS 26	4/11/95	<.01	<.01	0	
USGS 29	10/11/94	<.01	.01		U
USGS 31	4/1/94	<.01	.01		U
USGS 42	10/18/94	<.01	<.01	0	
USGS 44	10/16/95	<.01	<.01	0	
USGS 45	10/11/95	<.01	<.01	0	
USGS 47	10/16/95	<.01	<.01	0	

Table 15. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for nitrite, as nitrogen—Continued

Site identifier	Date sampled	Dissolved nitrite, as nitrogen (mg/L)	Dissolved nitrite, as nitrogen, QA (mg/L)	Z-value	Remarks
USGS 59	10/23/95	0.02	0.02	0.00	
USGS 67	10/17/95	.01	<.01		U
USGS 84	10/18/95	<.01	*<.01	0	
USGS 98	6/12/95	<.01	<.01	0	
USGS 99	9/7/94	<.01	<.01	0	
USGS 101	4/11/94	.01	.01	.00	
USGS 102	9/13/95	<.01	<.01	0	
USGS 105	3/31/94	.01	.01	.00	
USGS 108	4/18/95	<.01	<.01	0	
USGS 112	10/13/94	<.01	<.01	0	
USGS 116	10/17/95	<.01	*<.01	0	
USGS 119	10/25/95	<.01	<.01	0	
USGS 120	10/23/95	<.01	<.01	0	
USGS 121	10/24/94	<.01	<.01	0	
USGS 123	10/31/94	<.01	<.01	0	
	10/30/95	<.01	<.01	0	
USGS 124	4/21/94	<.01	<.01	0	
USGS 125	6/16/95	<.01	<.01	0	

Table 16. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for nitrite plus nitrate, as nitrogen—Continued

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; mg/L, milligram per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Dissolved nitrite plus nitrate, as nitrogen (mg/L)	Dissolved nitrite plus nitrate, as nitrogen, QA (mg/L)	Z-value	Remark
ANP-9	10/14/94	0.71	0.71	0.00	
ARBOR Test	9/29/94	1.1	1.3	1.36	
CFA LF 2-10	11/10/94	1.7	1.7	.00	
	10/25/95	1.9	1.8	.51	
CFA LF 3-9	7/18/95	3.8	3.8	.00	
Hwy 3	10/12/94	.34	*.57	2.45	N
NPR Test	4/14/94	1.4	1.2	1.29	
NRF-1	3/10/94	1.9	1.9	.00	
NRF-2	11/7/95	2.0	2.3	1.39	
NRF-3	6/08/95	1.8	1.8	.00	
NRF-6	3/10/95	1.9	1.9	.00	
NRF-7	6/13/94	.43	.45	.22	
PSTF	4/10/95	.59	.58	.10	
Site 17	10/19/94	1.1	1.1	.00	
Tan Expl.	4/12/94	.76	.80	.34	
WSINEL1	6/09/94	4.1	3.8	.87	
USGS 2	7/13/95	1.2	1.2	.00	
USGS 4	4/19/95	4.4	4.4	.00	
USGS 6	7/19/94	.54	.52	.20	
USGS 7	4/6/95	.38	.37	.11	
USGS 11	10/26/95	.55	.55	.00	
USGS 15	11/7/94	.35	.34	.12	
USGS 17	10/28/94	.30	*.33	.36	
	11/7/95	.34	.33	.24	
USGS 18	7/7/95	.59	.59	.00	
USGS 23	10/10/95	.57	.57	.00	
USGS 26	4/11/95	.78	.76	.17	
USGS 29	10/11/94	1.9	1.9	.00	
USGS 31	4/1/94	.9	.85	.40	
USGS 42	10/18/94	2.2	2.1	.46	
USGS 44	10/16/95	1.2	1.2	.00	
USGS 45	10/11/95	1.3	1.3	.00	
USGS 47	10/16/95	4.9	5.1	.47	
USGS 59	10/23/95	3.0	3.0	.00	

Table 16. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for nitrite plus nitrate, as nitrogen—Continued

Site identifier	Date sampled	Dissolved nitrite plus nitrate, as nitrogen (mg/L)	Dissolved nitrite plus nitrate, as nitrogen, QA (mg/L)	Z-value	Remark
USGS 67	10/17/95	3.3	3.3	0.00	
USGS 84	10/18/95	.82	*.83	.08	
USGS 98	6/12/95	1.0	1.0	.00	
USGS 99	9/7/94	1.4	1.4	.00	
USGS 101	4/11/94	.89	.89	.00	
USGS 102	9/13/95	2.0	1.9	.50	
USGS 105	3/31/94	.63	.68	.46	
USGS 108	4/18/95	.67	.66	.09	
USGS 112	10/13/94	2.9	2.9	.00	
USGS 116	10/17/95	2.8	*2.7	.39	
USGS 119	10/25/95	1.2	1.2	.00	
USGS 120	10/23/95	.84	.83	.08	
USGS 121	10/24/94	.82	.82	.00	
USGS 123	10/31/94	4.1	4.2	.28	
	10/30/95	3.8	3.8	.00	
USGS 124	4/21/94	.83	.79	.34	
USGS 125	6/16/95	.57	.57	.00	

Table 17. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for ammonia and ammonia plus organic nitrogen, as nitrogen—Continued

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; mg/L, milligram per liter; WWR, whole water, recoverable. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Dissolved ammonia, as nitrogen (mg/L)	Dissolved ammonia, as nitrogen, QA (mg/L)	Z-value	Remarks
ANP-9	10/14/94	<0.01	<0.01	0	
ARBOR Test	9/29/94	.01	.02	.44	
CFA LF 2-10	11/10/94	<.01	.01	0	
	10/25/95	.02	<.015	.22	
CFA LF 3-9	7/18/95	.02	.03	.42	
Hwy 3	10/12/94	.01	*<.01	0	
NPR Test	4/14/94	.01	.01	.00	
NRF-1	3/10/94	.02	.03	.42	
NRF-7	6/13/94	<.01	<.01	0	
PSTF	4/10/95	<.015	<.015	0	
Site 17	10/19/94	.02	.02	.00	
Tan Expl.	4/12/94	.01	.01	.00	
WSINEL1	6/9/94	.01	.02	.44	
USGS 2	7/13/95	.03	.04	.40	
USGS 4	4/19/95	<.015	<.015	0	
USGS 6	7/19/94	<.01	<.01	0	
USGS 7	4/6/95	.02	<.015	.22	
USGS 11	10/26/95	<.015	<.015	0	
USGS 15	11/7/94	<.01	.01	0	
USGS 17	10/28/94	<.015	*<.015	0	
USGS 18	7/7/95	.03	.02	.42	
USGS 23	10/10/95	.02	.02	.00	
USGS 26	4/11/95	<.015	<.015	0	
USGS 29	10/11/94	<.01	.02	.22	
USGS 31	4/1/94	.01	<.01	0	
USGS 42	10/18/94	<.015	.02	.22	
USGS 44	10/16/95	<.015	<.015	0	
USGS 45	10/11/95	<.015	<.015	0	
USGS 47	10/16/95	<.015	<.015	0	
USGS 59	10/23/95	<.015	<.015	0	
USGS 67	10/17/95	<.015	<.015	0	
USGS 84	10/18/95	<.015	*<.015	0	
USGS 99	9/7/94	.02	.02	.00	

Table 17. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for ammonia and ammonia plus organic nitrogen, as nitrogen—Continued

Site identifier	Date sampled	Dissolved ammonia, as nitrogen (mg/L)	Dissolved ammonia, as nitrogen, QA (mg/L)	Z-value	Remarks
USGS 101	4/11/94	<0.01	<0.01	0	
USGS 105	3/31/94	.02	.01	.44	
USGS 108	4/18/95	<.015	<.015	0	
USGS 112	10/13/94	<.01	.01	0	
USGS 116	10/17/95	<.015	*<.015	0	
USGS 119	10/25/95	<.015	<.015	0	
USGS 120	10/23/95	<.015	<.015	0	
USGS 121	10/24/94	<.015	<.015	0	
USGS 123	10/31/94	<.015	<.015	0	
	10/30/95	<.015	<.015	0	
USGS 124	4/21/94	.01	.01	.00	
USGS 125	6/16/95	.02	.02	.00	

Site identifier	Date sampled	WWR ammonia, plus organic nitrogen, as nitrogen (mg/L)	WWR ammonia, plus organic nitrogen, as nitrogen, QA (mg/L)	Z-value	Remarks
NRF-2	11/7/95	<.2	<.2	0	
NRF-3	6/8/95	<.2	<.2	0	
NRF-6	3/10/95	<.2	<.2	0	
USGS 17	11/7/95	<.2	<.2	0	
USGS 98	6/12/95	<.2	<.2	0	
USGS 102	9/13/95	<.2	<.2	0	

Table 18. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for orthophosphate, as phosphorus; and phosphorus—Continued

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent; U, statistical equivalence of the analytical results of replicate pairs is uncertain. Abbreviations: QA, quality-assurance replicate sample; mg/L, milligram per liter; WWR, whole water, recoverable. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Orthophosphate, as dissolved phosphorus (mg/L)	Orthophosphate, as dissolved phosphorus, QA (mg/L)	Z-value	Remark
ANP-9	10/14/94	<0.01	<0.01	0	
ARBOR Test	9/29/94	<.01	<.01	0	
CFA LF 2-10	11/10/94	.02	.02	.00	
	10/25/95	.03	.03	.00	
CFA LF 3-9	7/18/95	<.01	.02		U
Hwy 3	10/12/94	.01	*<.01		U
NPR Test	4/14/94	<.01	.01		U
NRF-1	3/10/94	.02	.02	.00	
NRF-7	6/13/94	.01	<.01		U
PSTF	4/10/95	.02	.02	.00	
Site 17	10/19/94	.01	.01	.00	
Tan Expl.	4/12/94	.02	.02	.00	
WSINEL1	6/9/94	.02	.01		U
USGS 2	7/13/95	.02	.03		U
USGS 4	4/19/95	.02	.02	.00	
USGS 6	7/19/94	.01	.02		U
USGS 7	4/6/95	<.01	<.01	0	
USGS 11	10/26/95	.01	.01	.00	
USGS 15	11/7/94	.01	.02		U
USGS 17	10/28/94	<.01	*<.01	0	
USGS 18	7/7/95	<.01	<.01	0	
USGS 23	10/10/95	<.01	<.01	0	
USGS 26	4/11/95	<.01	<.01	0	
USGS 29	10/11/94	<.01	.01		U
USGS 31	4/1/94	.01	<.01		U
USGS 42	10/18/94	.02	.02	.00	
USGS 44	10/16/95	.02	.02	.00	
USGS 45	10/11/95	.02	.02	.00	
USGS 47	10/16/95	.04	.03	1.75	
USGS 59	10/23/95	.02	.02	.00	
USGS 67	10/17/95	.03	.02		U
USGS 84	10/18/95	.02	*.03		U

Table 18. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for orthophosphate, as phosphorus; and phosphorus—Continued

Site identifier	Date sampled	Orthophosphate, as dissolved phosphorus (mg/L)	Orthophosphate, as dissolved phosphorus, QA (mg/L)	Z-value	Remark
USGS 99	9/7/94	<0.01	<0.01	0	
USGS 101	4/11/94	.01	<.01		U
USGS 105	3/31/94	<.01	.01		U
USGS 108	4/18/95	.01	.01	.00	
USGS 112	10/13/94	.02	.02	.00	
USGS 116	10/17/95	.02	*.01		U
USGS 119	10/25/95	.01	<.01		U
USGS 120	10/23/95	.01	.01	.00	
USGS 121	10/24/94	<.01	<.01	0	
USGS 123	10/31/94	.02	.02	.00	
	10/30/95	.02	.02	.00	
USGS 124	4/21/94	<.01	<.01	0	
USGS 125	6/16/95	<.01	<.01	0	
Site identifier	**Date sampled**	**WWR phosphorus, (mg/L)**	**WWR phosphorus, QA (mg/L)**	**Z-value**	**Remark**
NRF-2	11/7/95	<.01	.07	2.02	N
NRF-3	6/8/95	.02	.02	.00	
NRF-6	3/16/95	.09	.1	.30	
USGS 17	11/7/95	.03	.06	1.00	
USGS 98	6/12/95	.03	.03	.00	
USGS 102	9/13/95	.03	<.01	0	

Table 19. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for aluminum

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent; U, statistical equivalence of the analytical results of replicate pairs is uncertain. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Aluminum (µg/L)	Aluminum, QA (µg/L)	Z-value	Remark
		Dissolved			
ANP-9	10/14/94	4	9	0.77	
PSTF	4/10/95	3	4	.16	
Tan Expl.	4/12/94	4	3	.16	
USGS 7	4/6/95	3	4	.16	
USGS 26	4/11/95	4	4	.00	
USGS 84	10/18/95	5	*6	.16	
		Whole water, recoverable			
NRF-2	11/7/95	10	<10		U
NRF-3	6/8/95	<10	30	2.53	N
NRF-6	3/10/95	<10	<10	0	
USGS 17	11/7/95	20	10	1.36	
USGS 98	6/12/95	20	40	2.24	N
USGS 102	9/13/95	20	20	.00	

Table 20. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for antimony

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Antimony (µg/L)	Antimony, QA (µg/L)	Z-value	Remark
		Dissolved			
ANP-9	10/14/94	<1	1	0	
PSTF	4/10/95	<1	<1	0	
Tan Expl.	4/12/94	<1	<1	0	
USGS 7	4/6/95	<1	<1	0	
USGS 26	4/11/95	<1	<1	0	
USGS 84	10/18/95	<1	*<1	0	
		Whole water, recoverable			
NRF-2	11/07/95	<1	<1	0	
NRF-3	6/08/95	<1	<1	0	
NRF-6	3/10/95	<1	<1	0	
USGS 17	11/07/95	<1	<1	0	
USGS 98	6/12/95	<1	<1	0	
USGS 102	9/13/95	<1	<1	0	

Table 21. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for arsenic

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Arsenic (µg/L)	Arsenic, QA (µg/L)	Z-value	Remark
			Dissolved		
ANP-9	10/14/94	3	3	0.00	
PSTF	4/10/95	2	2	.00	
Tan Expl.	4/12/94	2	2	.00	
USGS 7	4/6/95	4	4	.00	
USGS 26	4/11/95	2	2	.00	
USGS 84	10/18/95	1	*1	.00	
			Whole water, recoverable		
NRF-2	11/7/95	2	2	.00	
NRF-3	6/8/95	2	1	.87	
NRF-6	3/10/95	3	4	.70	
USGS 17	11/7/95	2	2	.00	
USGS 98	6/12/95	2	2	.00	
USGS 102	9/13/95	2	2	.00	

Table 22. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for barium

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Barium (µg/L)	Barium, QA (µg/L)	Z-value	Remark
			Dissolved		
ANP-9	10/14/94	85	90	1.35	
PSTF	4/10/95	67	67	.00	
Tan Expl.	4/12/94	68	67	.35	
USGS 7	4/6/95	16	16	.00	
USGS 26	4/11/95	37	36	.24	
USGS 84	10/18/95	84	*83	.25	
			Whole water, recoverable		
NRF-2	11/7/95	200	100	.94	
NRF-3	6/8/95	200	<100	.94	
NRF-6	3/10/95	100	100	.00	
USGS 17	11/7/95	<100	<100	0	
USGS 98	6/12/95	<100	<100	0	
USGS 102	9/13/95	<100	<100	0	

Table 23. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for beryllium

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Beryllium (µg/L)	Beryllium, QA (µg/L)	Z-value	Remark
			Dissolved		
ANP-9	10/14/94	<1	<1	0	
PSTF	4/10/95	<1	<1	0	
Tan Expl.	4/12/94	<1	<1	0	
USGS 7	4/6/95	<1	<1	0	
USGS 26	4/11/95	<1	<1	0	
USGS84	10/18/95	<1	*<1	0	
			Whole water, recoverable		
NRF-2	11/7/95	<10	<10	0	
NRF-3	6/8/95	<10	<10	0	
NRF-6	3/10/95	<10	<10	0	
USGS 17	11/7/95	<10	<10	0	
USGS 98	6/12/95	<10	<10	0	
USGS 102	9/13/95	<10	<10	0	

Table 24. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for cadmium

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Cadmium (µg/L)	Cadmium, QA (µg/L)	Z-value	Remark
			Dissolved		
ANP-9	10/14/94	<1	<1	0	
PSTF	4/10/95	<1	<1	0	
Tan Expl.	4/12/94	<1	<1	0	
USGS 7	4/6/95	<1	<1	0	
USGS 26	4/11/95	<1	<1	0	
USGS 84	10/18/95	<1	*<1	0	
			Whole water, recoverable		
NRF-2	11/7/95	<1	<1	0	
NRF-3	6/8/95	<1	<1	0	
NRF-6	3/10/95	<1	1	0	
USGS 17	11/7/95	<1	<1	0	
USGS 98	6/12/95	<1	<1	0	
USGS 102	9/13/95	<1	<1	0	

Table 25. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for chromium—Continued

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter; WWR, whole water, recoverable. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Dissolved chromium (µg/L)	Dissolved chromium, QA (µg/L)	Z-value	Remark	Hexavalent chromium (µg/L)	Hexavalent chromium, QA (µg/L)	Z-value	Remark
ANP-9	10/14/94	5	5	0.00		<1	1	0.32	
ARBOR Test	9/29/94	1.5	1.5	.00		<1	<1	.00	
CFA 1	1/5/95	12	12	.00		7	15	2.07	N
CFA LF 2-10	11/10/94	11	12	.26		10	10	.00	
	10/25/95	14	15	.24		9	9	.00	
Hwy 3	10/12/94	1.9	*1.3	.18		1	*<1	.32	
MTR Test	4/26/95	7	5	.57		<1	<1	.00	
NPR Test	4/14/94	6.9	7.7	.22		5	4	.29	
PSTF	4/10/95	4	4	.00		4	3	.30	
PW-9	7/11/95	180	180	.00		190	180	.66	
Site 4	4/13/95	7	10	.81		3	<1	.93	
Site 17	10/19/94	4.3	4.3	.00		2	2	.00	
Tan Expl.	4/12/94	13	9	1.04		8	6	.56	
TRA A-13	10/4/95	<5	<5	0		<1	<1	0	
USGS 4	4/19/95	10	9	.27		5	4	.29	
USGS 7	4/6/95	3	3	.00		3	2	.30	
USGS 11	10/26/95	<5	<5	0		2	2	.00	
USGS 17	10/28/94	1.8	*1.9	.03		<1	*1	.32	
USGS 23	10/10/95	<5	<5	0		1	1	0	
USGS 26	4/11/95	4	4	.00		2	2	.00	
USGS 29	10/11/94	4.3	3.5	.24		3	1	.61	
USGS 31	4/1/94	4.2	3.8	.12		4	2	.50	

Table 25. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for chromium—Continued

Site identifier	Date sampled	Dissolved chromium (µg/L)	Dissolved chromium, QA (µg/L)	Z-value	Remark	Hexavalent chromium (µg/L)	Hexavalent chromium, QA (µg/L)	Z-value	Remark
USGS 53	10/25/94	82	75	.85		65	75	1.30	
USGS 55	10/25/94	74	56	2.44	N	40	28	2.24	N
USGS 55-cont.	10/4/95	53	53	0.00		54	44	1.54	
USGS 58	4/11/95	13	9	1.04		16	3	3.44	N
USGS 61	4/28/94	17	*14	.72		7	*6	.28	
USGS 62	4/25/94	35	35	.00		11	19	1.94	
USGS 63	4/7/95	33	32	.19		15	9	1.53	
USGS 65	1/12/94	210	190	1.24		150	150	.00	
USGS 69	7/11/94	1.2	1.5	.09		1	<1	.32	
	7/6/95	<5	*<5	.00		2	*3	.30	
USGS 70	10/24/94	28	28	.00		23	17	1.35	
	4/12/95	34	36	.37		12	12	.00	
USGS 78	7/13/95	<5	<5	.00		1	1	.00	
USGS 79	4/15/94	6.5	*6.7	.06		3	*5	.59	
USGS 84	10/18/95	11	11	.00		10	14	1.02	
USGS 100	10/19/95	<5	<5	.00		2	2	.00	
USGS 101	4/11/94	1.5	6.5	1.47		<1	5	1.51	
USGS 105	3/31/94	7.3	7.2	.03		9	3	1.70	
USGS 108	4/18/95	6	9	.83		6	5	.29	
USGS 120	10/23/95	11	11	.00		7	7	.00	
USGS 121	10/24/94	5.4	5.5	.03		7	6	.28	
USGS 124	4/21/94	6.6	1.3	1.56		4	<1	1.22	
USGS 125	6/16/95	5.1	5	.03		4	4	.00	

Table 25. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for chromium—Continued

Site identifier	Date sampled	WWR chromium (µg/L)	WWR chromium, QA (µg/L)	Z-value	Remark
NRF-1	3/10/94	6.9	7.6	0.86	
NRF-2	11/7/95	11	11	.00	
NRF-3	6/8/95	7.7	8.2	0.90	
NRF-6	3/10/95	37	31	1.18	
NRF-7	6/13/94	27	18	1.47	
WSINEL1	6/9/94	8.9	8.8	.97	
USGS 15	11/7/94	12	9.6	1.20	
USGS 17	11/7/95	1.9	1.9	.00	
USGS 98	6/12/95	6.3	5.9	.98	
USGS 99	9/7/94	5.4	5.3	.92	
USGS 102	9/13/95	6	6	.00	

Table 26. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for cobalt

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Dissolved cobalt (µg/L)	Dissolved cobalt, QA (µg/L)	Z-value	Remark
ANP-9	10/14/94	<1	<1	0	
PSTF	4/10/95	<1	<1	0	
Tan Expl.	4/12/94	<1	<1	0	
USGS 7	4/6/95	<1	<1	0	
USGS 26	4/11/95	<1	<1	0	
USGS 84	10/18/95	<1	*<1	0	

Table 27. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for copper

[Analyses by the National Water Quality Laboratory. .Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Copper (µg/L)	Copper, QA (µg/L)	Z-value	Remark
			Dissolved		
ANP-9	10/14/94	<1	<1	0	
PSTF	4/10/95	<1	<1	0	
Tan Expl.	4/12/94	<1	<1	0	
USGS 7	4/6/95	<1	<1	0	
USGS 26	4/11/95	<1	<1	0	
USGS 84	10/18/95	1	*2	.33	
			Whole water, recoverable		
NRF-2	11/7/95	1	19	4.72	N
NRF-3	6/8/95	3	4	.31	
NRF-6	3/10/95	1	3	.64	
USGS 17	11/7/95	<1	<1	0	
USGS 98	6/12/95	4	6	.60	
USGS 102	9/13/95	2	<1	.33	

Table 28. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for iron

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see Statistical Comparisons of Replicate Pairs of Samples section for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: WWR, whole water, recoverable; QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value]

Site identifier	Date sampled	WWR iron (µg/L)	WWR iron, QA (µg/L)	Z-value	Remark
NRF-1	3/10/94	30	<10	1.38	
NRF-2	11/7/95	30	<10	1.38	
NRF-3	6/8/95	320	460	4.32	N
NRF-6	3/10/95	800	410	8.94	N
NRF-7	6/13/94	4800	1200	20.01	N
WSINEL1	6/9/94	4000	2600	7.98	N
USGS 15	11/7/94	480	540	1.58	
USGS 17	11/7/95	40	30	.66	
USGS 98	6/12/95	1300	670	10.05	N
USGS 99	9/7/94	580	360	6.03	N
USGS 102	9/13/95	450	600	3.86	N

Table 29. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for lead

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Lead (µg/L)	Lead, QA (µg/L)	Z-value	Remark
			Dissolved		
ANP-9	10/14/94	<1	<1	0	
PSTF	4/10/95	<1	<1	0	
Tan Expl.	4/12/94	<1	<1	0	
USGS 7	4/6/95	<1	<1	0	
USGS 26	4/11/95	<1	<1	0	
USGS 84	10/18/95	16	*14	.39	
			Whole water, recoverable		
NRF-1	3/10/94	<1	<1	0	
NRF-2	11/07/95	<1	<1	0	
NRF-3	6/08/95	2	1	.31	
NRF-6	3/10/95	<1	1	0	
NRF-7	6/13/94	<1	<1	0	
WSINEL1	6/09/94	4	4	.00	
USGS 15	11/07/94	<1	<1	0	
USGS 17	11/07/95	<1	<1	0	
USGS 98	6/12/95	9	9	.00	
USGS 99	9/07/94	5	2	.86	
USGS 102	9/13/95	<1	<1	0	

Table 30. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for manganese

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample rather than sequentially]

Site identifier	Date sampled	Manganese (µg/L)	Manganese, QA (µg/L)	Z-value	Remark
		Dissolved			
ANP-9	10/14/94	2	2	0.00	
Tan Expl.	4/12/94	<1	<1	0	
PSTF	4/10/95	<1	<1	0	
USGS 7	4/6/95	2	2	.00	
USGS 26	4/11/95	<1	<1	0	
USGS 84	10/18/95	<1	*<1	0	
		Whole water, recoverable			
NRF-2	11/7/95	<10	<10	0	
NRF-3	6/8/95	<10	<10	0	
NRF-6	3/10/95	10	10	.00	
USGS 17	11/7/95	<10	<10	0	
USGS 98	6/12/95	<10	<10	0	
USGS 102	9/13/95	<10	<10	0	

Table 31. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for mercury

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Mercury (µg/L)	Mercury, QA (µg/L)	Z-value	Remark
			Dissolved		
PSTF	4/10/95	<0.1	0.1	0	
Tan Expl.	4/12/94	<.1	<.1	0	
USGS 7	4/6/95	<.1	<.1	0	
USGS 26	4/11/95	<.1	<.1	0	
USGS 84	10/18/95	<.1	*<.1	0	
			Whole water, recoverable		
NRF-1	3/10/94	<.1	<.1	0	
NRF-2	11/7/95	<.1	.1	0	
NRF-3	6/8/95	<.1	<.1	0	
NRF-6	3/10/95	<.2	<.2	0	
NRF-7	6/13/94	<.1	<.1	0	
WSINEL1	6/9/94	<.1	<.1	0	
USGS 15	11/7/94	<.1	<.1	0	
USGS 17	11/7/95	<.1	<.1	0	
USGS 98	6/12/95	<.1	<.1	0	
USGS 99	9/7/94	<.1	<.1	0	
USGS 102	9/13/95	<.1	<.1	0	

Table 32. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for molybdenum

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Dissolved molybdenum (µg/L)	Dissolved molybdenum, QA (µg/L)	Z-value	Remark
ANP-9	10/14/94	4	3	0.27	
PSTF	4/10/95	2	2	.00	
Tan Expl.	4/12/94	6	6	.00	
USGS 7	4/6/95	4	4	.00	
USGS 26	4/11/95	3	3	.00	
USGS 84	10/18/95	2	*2	.00	

Table 33. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for nickel

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Nickel (µg/L)	Nickel, QA (µg/L)	Z-value	Remark
			Dissolved		
ANP-9	10/14/94	<1	<1	0	
PSTF	4/10/95	1	1	.00	
Tan Expl.	4/12/94	<1	<1	0	
USGS 7	4/6/95	1	1	.00	
USGS 26	4/11/95	1	1	.00	
USGS 84	10/18/95	<1	*1	0	
			Whole water, recoverable		
NRF-1	3/10/94	<1	<1	0	
NRF-2	11/7/95	<1	2	.28	
NRF-3	6/8/95	<1	<1	0	
NRF-6	3/10/95	12	12	.00	
NRF-7	6/13/94	17	9	1.71	
WSINEL1	6/9/94	<1	<1	0	
USGS 15	11/7/94	2	2	.00	
USGS 17	11/7/95	<1	<1	0	
USGS 98	6/12/95	<1	1	0	
USGS 99	9/7/94	5	6	.26	
USGS 102	9/13/95	<1	<1	0	

Table 34. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for selenium

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: WWR, whole water, recoverable; QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	WWR selenium (µg/L)	WWR selenium, QA (µg/L)	Z-value	Remark
NRF-2	11/7/95	2	2	0.00	
NRF-3	6/8/95	2	2	.00	
NRF-6	3/10/95	2	3	.67	
USGS 17	11/7/95	1	1	.00	
USGS 98	6/12/95	1	1	.00	
USGS 102	9/13/95	2	2	.00	

Table 35. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for silver

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; μg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Silver (μg/L)	Silver, QA (μg/L)	Z-value	Remark
			Dissolved		
ANP-9	10/14/94	<1	<1	0	
PSTF	4/10/95	<1	<1	0	
Tan Expl.	4/12/94	<1	<1	0	
USGS 7	4/6/95	<1	<1	0	
USGS 26	4/11/95	<1	<1	0	
USGS 84	10/18/95	1	*1	.00	
			Whole water, recoverable		
NRF-1	3/10/94	<1	<1	0	
NRF-2	11/7/95	<1	<1	0	
NRF-3	6/8/95	<1	<1	0	
NRF-6	3/10/95	<1	<1	0	
NRF-7	6/13/94	<1	<1	0	
WSINEL1	6/09/94	<1	<1	0	
USGS 15	11/7/94	<1	<1	0	
USGS 17	11/7/95	<1	<1	0	
USGS 98	6/12/95	<1	<1	0	
USGS 99	9/7/94	<1	<1	0	
USGS 102	9/13/95	<1	<1	0	

Table 36. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laborator' analyzed for thallium

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; U, statistical equivalence of the analytical results of replicate pairs is uncertain. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbol: <, the result was less than the stated value]

Site identifier	Date sampled	Dissolved thallium (µg/L)	Dissolved thallium, QA (µg/L)	Z-value	Remark
ANP-9	10/14/94	<0.5	<0.5	0	
NRF-2	11/7/95	<.5	<.5	0	
NRF-3	6/8/95	<.5	<.5	0	
PSTF	4/10/95	<.5	.5		U
Tan Expl.	4/12/94	<.5	<.5	0	
USGS 7	4/6/95	<.5	<.5	0	
USGS 17	11/7/95	<.5	<.5	0	
USGS 26	4/11/95	<.5	<.5	0	
USGS 98	6/12/95	<.5	<.5	0	
USGS 102	9/13/95	<.5	<.5	0	

Table 37. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for uranium

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Dissolved uranium (µg/L)	Dissolved uranium, QA (µg/L)	Z-value	Remark
ANP-9	10/14/94	2	2	0.00	
PSTF	4/10/95	1	1	.00	
USGS 7	4/06/95	2	2	.00	
USGS 26	4/11/95	2	2	.00	
USGS 84	10/18/95	1	*1	.00	

Table 38. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for zinc

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; μg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Zinc (μg/L)	Zinc, QA (μg/L)	Z-value	Remark
		Dissolved			
ANP-9	10/14/94	12	11	0.14	
PSTF	4/10/95	2	6	.61	
Tan Expl.	4/12/94	<1	<1	.00	
USGS 7	4/6/95	1	<1	.16	
USGS 26	4/11/95	4	1	.47	
USGS 84	10/18/95	410	*383	.81	
		Whole water, recoverable			
NRF-2	11/7/95	<10	20	.94	
NRF-3	6/8/95	<10	20	.94	
NRF-6	3/10/95	<10	<10	.00	
USGS 17	11/7/95	<10	<10	.00	
USGS 98	6/12/95	200	210	.50	
USGS 102	9/13/95	<10	<10	.00	

Table 39. Comparison of the results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for gross alpha radioactivity by the National Water Quality Laboratory

[Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; pCi/L, picocurie per liter; μg/L, microgram per liter]

Site identifier	Date sampled	Dissolved gross alpha, as thorium-230 (pCi/L)	Dissolved gross alpha, as thorium-230, QA (pCi/L)	Z-value	Remark
NRF-1	3/10/94	3.48±1.75	2.91±1.68	0.47	
NRF-2	11/7/95	3.77±1.84	2.75±0.942	.99	
NRF-3	6/8/95	9.08±4.08	2.06±2.59	2.91	N
NRF-6	3/10/95	2.94±7.22	14.9±7.50	2.30	N
NRF-7	6/13/94	1.14±0.80	1.88±1.06	1.12	
WSINEL1	6/9/94	1.84±1.51	1.62±1.46	.21	
USGS 15	11/7/94	4.55±2.38	2.92±2.01	1.05	
USGS 17	11/7/95	1.66±0.956	2.10±0.873	.68	
USGS 98	6/12/95	2.18±2.03	1.73±1.93	.32	
USGS 99	9/7/94	2.59±1.15	3.01±1.55	.39	
USGS 102	9/13/95	2.19±1.36	1.58±1.22	.67	

Site identifier	Date sampled	Dissolved gross alpha, as natural uranium (μg/L)	Dissolved gross alpha, as natural uranium, QA (μg/L)	Z-value	Remark
NRF-1	3/10/94	4.95±2.49	4.54±2.61	.23	
NRF-2	11/7/95	5.44±2.66	5.37±3.00	.03	
NRF-3	6/8/95	13.10±6.04	3.40±4.29	2.62	N
NRF-6	3/10/95	4.96±12.20	24.10±12.40	2.20	N
NRF-7	6/13/94	1.78±1.25	2.43±1.38	.70	
WSINEL1	6/9/94	2.62±2.15	2.29±2.07	.22	
USGS 15	11/7/94	6.70±3.52	4.55±3.17	.91	
USGS 17	11/7/95	2.34±1.35	2.48±1.20	.16	
USGS 98	6/12/95	3.50±3.28	2.83±3.18	.29	
USGS 99	9/7/94	3.50±2.04	4.70±2.42	.34	
USGS 102	9/13/95	3.10±1.93	2.19±1.69	.71	

Table 40. Comparison of the results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for gross alpha radioactivity by the Radiological and Environmental Sciences Laboratory

[Samples were unfiltered and regarded as whole water, recoverable. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; pCi/L, picocurie per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Gross alpha (pCi/L)	Gross alpha, QA (pCi/L)	Z-value	Remark
ANP-9	10/14/94	1.0±0.9	2.8±1.2	1.20	
ARBOR Test	9/29/94	-.3±0.7	1.7±0.9	1.75	
CFA LF2-10	11/10/94	.7±0.8	2.8±1.2	1.46	
	10/25/95	2.4±1.1	1.4±0.9	.70	
Hwy 3	10/12/94	1.4±0.9	*1.4±1.0	.00	
Leo Rogers	7/18/94	1.4±0.9	2.8±1.2	.93	
NPR Test	4/14/94	2.8±1.2	.7±0.8	1.46	
PSTF	4/10/95	1.7±0.9	1.4±0.9	.24	
Site 17	10/19/94	2.4±1.1	2.1±1.0	.20	
Tan Expl.	4/12/94	1.7±0.9	1.0±0.9	.55	
USGS 4	4/19/95	.7±0.8	.7±0.8	.00	
USGS 7	4/6/95	1.4±0.9	1.4±0.9	.00	
USGS 11	10/26/95	1.7±0.9	1.4±0.9	.24	
USGS 17	10/27/94	.7±1.0	*1.0±0.9	.22	
USGS 23	10/10/95	1.4±0.9	1.7±0.9	.24	
USGS 26	4/11/95	1.0±0.9	2.1±1.0	.82	
USGS 29	10/11/94	.1±1.0	.7±0.8	.47	
USGS 31	4/1/94	1.4±0.9	1.0±0.9	.31	
USGS 84	10/18/95	2.1±1.0	*1.0±0.9	.82	
USGS 101	4/11/94	2.1±1.0	.3±0.8	1.41	
USGS 105	3/31/94	.7±0.8	.3±0.8	.35	
USGS 108	4/18/95	2.1±1.0	1.0±0.9	.82	
USGS 120	10/23/95	1.4±0.9	1.4±0.9	.00	
USGS 121	10/24/94	.7±0.8	1.7±0.9	.83	
USGS 124	4/21/94	1.4±0.9	.7±0.8	.58	
USGS 125	6/16/95	1.0±0.9	1.4±0.9	.31	

Table 41. Comparison of the results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for gross beta radioactivity by the National Water Quality Laboratory

[Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; pCi/L, picocurie per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Dissolved gross beta, as cesium-137 (pCi/L)	Dissolved gross beta, as cesium-137, QA (pCi/L)	Z-value	Remark
NRF-1	3/10/94	4.02±1.18	3.63±1.06	0.49	
NRF-2	11/7/95	4.21±1.32	4.71±1.56	.49	
NRF-3	6/8/95	11.80±4.07	2.46±4.59	3.05	N
NRF-6	3/16/95	6.21±9.54	12.30±7.55	1.00	
NRF-7	6/13/94	3.89±1.15	3.38±1.08	.65	
WSINEL1	6/09/94	3.65±1.16	3.66±1.21	.01	
USGS 15	11/7/94	1.89±1.84	7.91±3.01	3.41	N
USGS 17	11/7/95	3.26±1.06	3.50±1.07	.32	
USGS 98	6/12/95	5.09±3.28	2.75±3.07	1.04	
USGS 99	9/7/94	2.81±0.97	2.95±0.99	.20	
USGS 102	9/13/95	3.34±1.11	4.08±1.21	.90	
Site identifier	**Date sampled**	**Dissolved gross beta, as Sr-90/Y-90 (pCi/L)**	**Dissolved gross beta, as Sr-90/Y-90, QA (pCi/L)**	**Z-value**	**Remark**
NRF-1	3/10/94	2.99±0.88	2.73±0.80	.44	
NRF-2	11/7/95	3.17±0.995	3.43±1.48	.29	
NRF-3	6/8/95	5.17±1.38	1.65±3.07	2.09	N
NRF-6	3/16/95	2.94±4.48	5.97±3.44	1.07	
NRF-7	6/13/94	2.96±0.76	2.60±0.73	.68	
WSINEL1	6/9/94	2.76±0.88	2.74±0.90	.03	
USGS 15	11/7/94	1.50±1.46	3.98±1.29	2.55	N
USGS 17	11/7/95	2.50±0.693	2.67±0.711	.34	
USGS 98	6/12/95	3.47±2.16	1.85±2.05	1.09	
USGS 99	9/7/94	2.12±0.73	2.20±0.74	.15	
USGS 102	9/13/95	2.53±0.839	3.05±0.908	.84	

Table 42. Comparison of the results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for gross beta radioactivity by the Radiological and Environmental Sciences Laboratory

[Samples were unfiltered and regarded as whole water, recoverable.. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; pCi/L, picocurie per liter. Symbols: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Gross beta (pCi/L)	Gross beta, QA (pCi/L)	Z-value	Remark
ANP-9	10/14/94	6±2	5±2	0.35	
ARBOR Test	9/29/94	4±2	7±2	1.06	
CFA LF2-10	11/10/94	4±2	4±2	.00	
	10/25/95	5±2	4±2	.35	
Hwy 3	10/12/94	2±2	*5±2	1.06	
Leo Rogers	7/18/94	4±2	5±2	.35	
NPR Test	4/14/94	3±2	1.1±1.8	.71	
PSTF	4/10/95	4±2	2±2	.71	
Site 17	10/19/94	3±2	*3±2	.00	
Tan Expl.	4/12/94	3±2	6±2	1.06	
USGS 4	4/19/95	6±2	5±2	.35	
USGS 7	4/06/95	1.3±1.9	4±2	.98	
USGS 11	10/26/95	5±2	0±2	1.77	
USGS 17	10/27/94	2±2	5±2	1.06	
USGS 23	10/10/95	3±2	0±2	1.06	
USGS 26	4/11/95	2±2	2±2	.00	
USGS 29	10/11/94	4±2	5±2	.35	
USGS 31	4/1/94	6±2	4±2	.71	
USGS 84	10/18/95	5±2	*1.6±2.1	1.17	
USGS 101	4/11/94	3±2	5±2	.71	
USGS 105	3/31/94	4±2	4±2	.00	
USGS 108	4/18/95	3±2	4±2	.35	
USGS 120	10/23/95	6±2	3±2	1.06	
USGS 121	10/24/94	3.0±1.4	4±2	.41	
USGS 124	4/21/94	5±2	7±2	.71	
USGS 125	6/16/95	6±2	7±2	.35	

Table 43. Comparison of the results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for gamma radiation–Continued

[Analyses by the Radiological and Environmental Sciences Laboratory. Samples were unfiltered and regarded as whole water, recoverable. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; pCi/L, picocurie per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Gamma radiation (pCi/L)	Gamma radiation, QA (pCi/L)	Z-value	Remark
ANP-9	10/14/94	16±28	20±20	0.12	
ARBOR Test	9/29/94	60±20	-20±30	2.22	N
CFA LF 2-10	11/10/94	0±20	20±20	.71	
	10/25/95	20±30	0±20	.71	
Hwy 3	10/12/94	14±27	*30±20	.48	
Leo Rogers	7/18/94	12±13	10±30	.06	
NPR Test	4/14/94	-10±30	14±28	.58	
PSTF	4/10/95	-14±27	30±40	.91	
Site 17	10/19/94	30±20	40±20	.35	
Tan Expl.	4/12/94	50±30	-40±30	2.12	N
TRA A-13	10/4/95	14±21	-20±30	.93	
USGS 4	4/19/95	-20±40	-40±20	.45	
USGS 7	4/6/95	0±30	-10±40	.20	
USGS 11	10/26/95	10±40	16±36	.11	
USGS 17	10/27/94	20±20	*20±30	.00	
USGS 23	10/10/95	20±30	-10±25	.77	
USGS 26	4/11/95	7±16	-10±30	.50	
USGS 29	10/11/94	16±29	-40±30	1.34	
USGS 31	4/1/94	0±30	-15±27	.37	
USGS 40	1/13/94	40±20	30±30	.28	
USGS 44	10/16/95	-20±20	16±23	1.18	
USGS 46	4/20/95	0±20	*-13±26	.40	
USGS 47	10/16/95	-30±40	0±20	.68	
USGS 50	4/13/95	10±30	-20±30	.71	
USGS 51	4/19/95	-50±40	0±20	1.12	
USGS 58	4/11/95	16±24	20±30	.10	
USGS 61	4/28/94	-14±29	*-15±31	.02	
USGS 62	4/25/94	30±20	20±30	.28	
USGS 63	4/7/95	-30±30	20±30	1.18	
USGS 65	1/12/94	-12±16	20±20	1.25	
USGS 70	4/12/95	-20±40	0±20	.45	
USGS 84	10/18/95	-80±40	*16±26	2.01	N
USGS 87	1/11/95	12±30	*11±27	.02	
USGS 101	4/11/94	30±20	15±29	.43	

Table 43. Comparison of the results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for gamma radiation–Continued

Site identifier	Date sampled	Gamma radiation (pCi/L)	Gamma radiation, QA (pCi/L)	Z-value	Remark
USGS 105	3/31/94	30±30	-16±29	1.10	
USGS 108	4/18/95	30±40	-50±40	1.41	
USGS 119	10/25/95	0±40	20±40	.45	
USGS 120	10/23/95	0±20	30±20	1.06	
USGS 121	10/24/94	10±20	10±20	.00	
USGS 124	4/21/94	10±30	-20±30	.71	
USGS 125	6/16/95	20±20	50±40	.67	

Table 44. Comparison of the results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for strontium-90—Continued

[Analyses by the Radiological and Environmental Sciences Laboratory (RESL) and the National Water Quality Laboratory (NWQL). Samples for the RESL were unfiltered and regarded as whole water, recoverable. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; pCi/L, picocurie per liter. Symbols: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially; ##, analysis of a filtered sample was performed by the NWQL and compared with the routine water-quality sample]

Site identifier	Date sampled	Strontium-90 (pCi/L)	Strontium-90, QA (pCi/L)	Z-value	Remark
ANP-9	10/14/94	-1.4±1.7	0±2	0.53	
CFA 1	4/7/94	1.1±1.6	.5±1.5	.27	
	4/13/95	.2±0.7	*.6±0.7	.40	
CFA LF 2-10	11/10/94	-1.3±1.8	1±2	.85	
CFA LF 3-9	7/18/95	2.6±0.7	3.5±0.8	.85	
PSTF	4/10/95	.5±0.8	.7±0.7	.19	
PW-4	1/14/94	3±2	*2±2	.35	
PW-5	10/20/94	6±2	7±2	.35	
PW-6	1/24/94	-1.1±1.9	-4.0±1.6	1.17	
PW-9	7/11/95	2.7±0.8	.13±0.76	2.33	N
Tan Expl.	4/2/94	1±2	-3±2	1.41	
TRA A-13	10/4/95	42±2	39±2	1.06	
USGS 2	7/13/95	-.1±0.7	.0±0.7	.10	
USGS 6	7/19/94	0±2	6±2	2.12	N
USGS 7	4/6/95	-.3±0.7	.4±0.7	.71	
USGS 18	7/7/95	0±0.8	.3±0.7	.27	
USGS 26	4/11/95	-2.1±0.9	-.8±0.8	1.08	
USGS 36	1/6/94	14±2	13±2	.35	
	7/14/94	11±2	19±3	2.22	N
USGS 39	4/25/94	-2±2	2±1.7	1.52	
	1/20/95	-1.0±0.4	-.5±0.7	.62	
	7/3/95	1.4±0.8	1.6±0.7	.19	
USGS 40	1/13/94	19±3	30±3	2.59	N
USGS 41	5/3/94	17±3	23±3	1.41	
USGS 42	10/18/94	10±2	9±3	.28	
USGS 44	10/16/95	6.6±0.9	7.2±0.9	.47	
USGS 45	4/13/95	4.1±0.8	4.3±0.8	.18	
	10/11/95	1.6±0.9	12±2	4.74	N
USGS 46	4/20/95	14.6±1.1	*14.1±1.1	.32	
USGS 47	10/16/95	76±3	47±2	8.04	N
USGS 48	4/22/94	17± 2	18±2	.35	
USGS 50	4/13/95	164±5	178±6	1.79	
USGS 51	4/21/94	-1.9±1.6	.6±1.6	1.10	

Table 44. Comparison of the results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for strontium-90—Continued

Site identifier	Date sampled	Strontium-90 (pCi/L)	Strontium-90, QA (pCi/L)	Z-value	Remark
USGS 51-cont.	9/19/95	0.6±0.7	-0.5± 0.6	1.19	
USGS 53	10/25/94	120±6	117±6	.35	
USGS 55	10/25/94	10±2	8±2	0.71	
	10/4/95	6.4±0.9	8.8±1.0	1.78	
USGS 58	4/11/95	-1.2±0.7	-1.6±0.8	.38	
USGS 59	10/23/95	16.2±1.1	24±2	3.42	N
USGS 61	4/28/94	1.6± 2.2	*0±2	.54	
USGS 62	4/25/94	4±2	2±2	.71	
USGS 63	4/7/95	7.9±.9	8.4±1.0	.37	
USGS 65	1/12/94	-3±2	-2±2	.35	
USGS 67	4/12/95	13.8±1.1	16.0±1.1	1.41	
	10/17/95	13.7±1.1	1±2	5.56	N
USGS 69	7/11/94	1±2	6±2	1.77	
	7/6/95	.3±0.8	*.2±0.7	.09	
USGS 70	10/27/94	61±4	65±4	.71	
	4/12/95	55±2	57±3	.55	
USGS 78	7/13/95	.9±0.8	2.5±0.8	1.41	
USGS 84	10/18/95	-.13±0.76	*-.12±0.76	.01	
USGS 87	1/11/95	.3±0.9	2.7±0.8	1.99	N
			##-.089±0.25	.42	
USGS 111	4/18/94	-1.0±1.6	.3±1.6	.57	
USGS 112	1/13/94	25±3	*23±3	.47	
	10/13/94	28±3	26±6	.30	
USGS 113	7/13/94	17±3	*19±3	.47	
USGS 115	7/6/95	-1.2±.8	*.1±1.6	.73	
USGS 116	2/1/95	.7±0.9	-.1±0.8	.66	
	10/17/95	.5±0.7	*-.1±1.4	.38	
USGS 119	10/25/95	-.9±0.7	-.4±0.7	.51	
USGS 120	10/23/95	-.7±0.8	2.5±0.8	2.83	N
USGS 121	10/24/94	.6±1.6	2±2	.55	
USGS 123	10/31/94	37±3	36±3	.24	
	10/30/95	34.2±1.6	74±4	9.24	N
USGS 124	4/21/94	1±2	.6±1.6	.16	

Table 45. Comparison of the results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for tritium—Continued

[Analyses by the Radiological and Environmental Sciences Laboratory (RESL) and the National Water Quality Laboratory (NWQL). Samples for the RESL were unfiltered and regarded as whole water, recoverable (WWR). Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; pCi/L, picocurie per liter. Symbols: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially; ##, analysis was performed by the NWQL for WWR tritium]

Site identifier	Date sampled	Tritium (pCi/L)	Tritium, QA (pCi/L)	Z-value	Remark
ANP-9	10/14/94	-200±200	-270±170	0.27	
ARBOR Test	9/29/94	-120±170	-250±170	.54	
Atomic City	4/6/94	-170±80	-240±80	.62	
CFA 1	4/7/94	14,300±600	14,000±600	.35	
	1/5/95	18,100±800	18,200±800	.09	
	4/13/95	13,700±600	*13,400±600	.35	
CFA LF 2-10	11/10/94	6,500±400	6,700±400	.35	
	10/25/95	6,100±400	6,000±400	.18	
CFA LF 3-9	7/18/95	24,100±1,000	23,700±900	.30	
Hwy 3	10/12/94	0±200	*-100±200	.35	
Leo Rogers	7/18/94	100±200	-60±170	.61	
MTR Test	4/26/95	1,600±200	1,900±200	1.06	
NPR Test	4/14/94	-250±170	-220±170	.12	
NRF-2	11/7/95	##64.0±25.6	##-1.2±25.6	.35	
NRF-3	6/8/95	##64.0±25.6	##92.8±25.6	1.59	
NRF-6	3/10/95	##124.8±25.6	80±32	1.09	
PSTF	4/10/95	-70±170	-80±170	.04	
PW-4	1/14/94	1,100±200	*1,100±200	.00	
PW-5	10/20/94	400±200	400±200	.00	
PW-6	1/24/94	21,500±900	22,200±900	.55	
PW-9	7/11/95	162,000±5,000	160,000±5,000	.28	
Site 4	4/13/95	0±200	-60±170	.23	
Site 17	10/19/94	-140±170	*0±200	.53	
Tan Expl.	4/12/94	-240±170	-290±170	.21	
TRA A-13	10/4/95	100 200	0 200	.35	
USGS 2	7/13/95	-70±170	-140±160	.30	
USGS 4	4/19/95	-50±170	0±200	.19	
USGS 6	7/19/94	100±200	-120±160	.86	
USGS 7	4/6/95	-130±170	-140±170	.04	
USGS 11	10/26/95	-11±70	20±70	.31	
USGS 17	10/28/94	##57.6±25.6	*-100±200	.78	
	11/7/95	##38.4±25.6	##54.4±25.6	.44	
USGS 18	7/7/95	-160±170	-70±170	.37	

Table 45. Comparison of the results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for tritium—Continued

Site identifier	Date sampled	Tritium (pCi/L)	Tritium, QA (pCi/L)	Z-value	Rema-k
USGS 23	10/10//95	-130±170	0±200	0.50	
USGS 26	4/11/95	-130±170	-140±170	.04	
USGS 29	10/11/94	-100±200	-100±200	.00	
USGS 31	4/1/94	-100±200	-200±200	.35	
USGS 36	1/6/94	9,700±500	10,300±500	.85	
	7/14/94	9,300±500	9,700±500	.57	
USGS 39	4/25/94	6,000±400	5,800±400	.35	
	1/20/95	6,200±400	6,100±400	.18	
	7/3/95	5,800±400	5,800±400	.00	
USGS 40	1/13/94	6,800±400	6,900±400	.18	
USGS 41	5/3/94	4,400±300	4,300±300	.24	
USGS 42	10/18/94	2,200±200	2,200±200	.00	
USGS 44	10/16/95	600±200	500±200	.35	
USGS 45	4/13/95	2,000±200	1,800±200	.71	
	10/11/95	2,300±200	2,300±200	.00	
USGS 46	4/20/95	3,200±300	*3,300±300	.24	
USGS 47	10/16/95	7,600±400	7,600±400	.00	
USGS 48	4/22/94	4,400±300	4,200±300	.47	
USGS 50	4/13/95	58,400±2,100	58,200±2,100	.07	
USGS 51	4/21/94	23,100±900	22,500±900	.47	
	4/19/95	20,100±800	20,900±800	.71	
USGS 53	10/25/94	122,000±4,000	122,000±4,000	.00	
USGS 55	10/25/94	900±200	1,000±200	.35	
	10/4/95	1,600±200	1,300±200	1.06	
USGS 58	4/11/95	4,600±300	4,100±300	1.18	
USGS 59	10/23/95	13,000±600	13,600±600	.71	
USGS 61	4/28/94	36,700±1,400	*37,500±1,400	.40	
USGS 62	4/25/94	1,500±200	1,200±200	1.06	
USGS 63	4/7/95	600±200	400±200	.71	
USGS 65	1/12/94	26,800±1,000	26,500±1,000	.21	
USGS 67	4/12/95	18,600±800	18,400±800	.18	
	10/16795	16,800±700	16,400±700	.40	
USGS 69	7/11/94	-100±160	100±200	.78	
	7/6/95	-20±170	*0±200	.08	
USGS 70	10/2794	29,100±1,100	28,000±1,100	.71	
	4/12/95	33,900±1,300	35,800±1,300	1.03	
USGS 78	7/13/95	-60±170	-100±170	.17	
USGS 79	4/15/94	-110±170	*-160±170	.21	

Table 45. Comparison of the results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for tritium—Continued

Site identifier	Date sampled	Tritium (pCi/L)	Tritium, QA (pCi/L)	Z-value	Remark
USGS 84	10/18/95	1,600±200	*1,900±200	1.06	
USGS 87	1/11/95	1,000±200	*1,100±200	.35	
USGS 98	6/12/95	##9.6±25.6	##22.4±25.6	.35	
USGS 100	10/19/95	-100±200	-100±200	.00	
USGS 101	4/11/94	-300±170	-330±160	.13	
USGS 102	9/13/95	##35.2±25.6	##57.6±25.6	.62	
USGS 105	3/31/94	100±80	30±80	.62	
USGS 108	4/18/95	-140±70	-110±80	.28	
USGS 111	4/18/94	12,600±600	12,700±600	.12	
USGS 112	1/13/94	16,000±700	*15,600±700	.40	
	10/13/94	14,800±700	14,700±700	.06	
USGS 113	7/13/94	122,000±6,000	*119,000±6,000	.35	
USGS 115	7/6/95	4,500±300	*4,500±300	.00	
USGS 116	2/1/95	8,600±500	9,000±500	.57	
	10/17/95	4,100±300	*4,300±300	.47	
USGS 119	10/25/95	-100±200	–160±170	.23	
USGS 120	10/23/95	100±180	100±200	.00	
USGS 121	10/23/94	0±200	-200±200	.71	
USGS 123	10/31/94	26,400±1,000	25,300±1,000	.78	
	10/30/95	20,500±800	20,700±800	.18	
USGS 124	4/21/94	-140±79	30±80	1.51	
USGS 125	6/16/95	30±70	40±70	.10	

Table 46. Comparison of the result of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for transuranics (americium-241, plutonium-238, and plutonium-239/240)

[Analyses by the Radiological and Environmental Sciences Laboratory. Samples were unfiltered and regarded as whole water, recoverable. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; pCi/L, picocurie per liter. Symbol: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Americium-241 (pCi/L)	Americium-241, QA (pCi/L)	Z-value	Remark
USGS 40	1/13/94	0.02±0.02	0.013±0.019	0.25	
USGS 47	10/16/95	.03±0.02	.00±0.02	1.06	
USGS 84	10/18/95	.00±0.02	*.01±0.02	.35	
USGS 87	1/11/95	.00±0.02	*.010±0.020	.35	
USGS 119	10/25/95	.010±0.018	.017±0.018	.27	
USGS 120	10/23/95	.010±0.018	.01±0.02	.00	
USGS 121	10/24/94	-.02±0.02	.00±0.02	.71	
Site identifier	**Date sampled**	**Plutonium-238 (pCi/L)**	**Plutonium-238, QA (pCi/L)**	**Z-value**	**Remark**
USGS 40	1/13/94	.022±0.016	.010±0.016	.53	
USGS 47	10/16/95	.003±0.015	.008±0.014	.24	
USGS 84	10/18/95	.01±0.02	*.001±0.014	.37	
USGS 87	1/11/95	-.008±0.015	*-.019±0.014	.54	
USGS 119	10/25/95	.017±0.017	-.016±0.014	1.50	
USGS 120	10/23/95	-.012±0.02	-.007±0.013	.23	
USGS 121	10/24/94	.02±0.02	.003±0.014	.70	
Site identifier	**Date sampled**	**Plutonium-239/240 (pCi/L)**	**Plutonium-239/240, QA (pCi/L)**	**Z-value**	**Remark**
USGS 40	1/13/94	.003±0.011	.010±0.013	.41	
USGS 47	10/16/95	.008±0.014	-.015±0.013	.34	
USGS 84	10/18/95	.01±0.02	*.002±0.014	.33	
USGS 87	1/11/95	-.009±0.015	*-.009±0.014	.00	
USGS 119	10/25/95	.001±0.014	-.015±0.014	.81	
USGS 120	10/23/95	.002±0.016	.004±0.014	.09	
USGS 121	10/24/94	-.007±0.012	-.019±0.015	.62	

Table 47. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for total organic carbon

[Analyses by the National Water Quality Laboratory. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent; N, analytical results of replicate pairs are not statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; mg/L, milligram per liter. Symbols: *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Total organic carbon (mg/L)	Total organic carbon, QA (mg/L)	Z-value	Remark
ANP-9	10/14/94	0.4	0.8	1.94	
ARBOR Test	9/29/94	.8	.4	1.94	
CFA LF 2-10	11/10/94	.2	.4	.96	
	10/25/95	5.6	.2	27.21	N
Hwy 3	10/12/94	.9	*.6	1.46	
NRF-1	3/10/94	.9	.4	2.24	N
NRF-2	11/7/95	1.5	.4	5.37	N
NRF-3	6/8/95	3.2	3.4	1.03	
NRF-6	3/10/95	.2	2.1	9.31	N
NRF-7	6/13/94	.1	.2	.48	
Site 17	10/19/94	.5	1.4	4.39	N
WSINEL1	6/9/94	.7	.5	0.97	
USGS 11	10/26/95	.2	.5	1.45	
USGS 15	11/7/94	.2	.2	.00	
USGS 17	10/28/94	.7	*.7	.00	
	11/7/95	1.0	.2	3.88	N
USGS 23	10/10/95	.1	.1	.00	
USGS 29	10/11/94	.6	.7	.48	
USGS 84	10/18/95	.2	*1.8	7.82	N
USGS 98	6/12/95	.3	.2	.48	
USGS 99	9/7/94	1.2	.6	2.92	N
USGS 102	9/13/95	4.6	6.1	8.07	N
USGS 120	10/23/95	2.0	.7	6.40	N
USGS 121	10/24/94	2.0	2.1	.50	

Table 48. Comparison of results of replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for volatile organic compounds

[Analyses by the National Water Quality Laboratory. Samples were analyzed for the whole water, recoverable, constituent. Site identifier: see figures 1–3 for location of sites. Z-value: see section on statistical comparisons for explanation. Remark: no entry, analytical results of replicate pairs are statistically equivalent. Abbreviations: QA, quality-assurance replicate sample; µg/L, microgram per liter. Symbols: <, the result was less than the stated value; *, the QA sample was collected within 24 hours of the routine water-quality sample, rather than sequentially]

Site identifier	Date sampled	Carbon tetrachloride (µg/L)	Carbon tetrachloride, QA (µg/L)	Z-value	Remark
USGS 87	1/11/95	1.9	*1.9	0.00	
USGS 120	10/23/95	.7	.7	.00	
Site identifier	**Date sampled**	**1,1,1-Trichloroethane (µg/L)**	**1,1,1-Trichloroethane, QA (µg/L)**	**Z-value**	**Remark**
USGS 87	1/11/95	.2	*.2	.00	
USGS 120	10/23/95	<.2	<.2	0	
Site identifier	**Date sampled**	**Trichloroethene (µg/L)**	**Trichloroethene, QA (µg/L)**	**Z-value**	**Remark**
USGS 87	1/11/95	.4	*.4	.00	
USGS 120	10/23/95	<.2	<.2	0	

Table 49. Results of source-solution blanks, a trip blank, and equipment blanks from the Idaho National Engineering Laboratory analyzed for sodium, sulfate, chloride, fluoride, and chromium

[Analyses by the National Water Quality Laboratory. Site identifier: see Quality Assurance/Quality Control Data, Blank Samples section for explanation. Abbreviations: mg/L, milligram per liter; µg/L, microgram per liter; DW, deionized water; IBW, inorganic blank water; VBW, volatile organic compound blank water; na, no analysis. Symbols: <, the result was less than the stated value; #, the sample was analyzed for the whole water, recoverable constituent, rather than dissolved constituent]

Site identifier	Date prepared	Dissolved sodium (mg/L)	Dissolved sulfate (mg/L)	Dissolved chloride (mg/L)	Dissolved fluoride (mg/L)	Dissolved chromium (µg/L)	Hexavalent chromium (µg/L)
			Source-solution blanks				
QA-2 (DW)	7/15/94	na	na	<0.1	na	<1	<1
QA-317 (DW)	1/9/95	<0.1	na	<.1	na	<1	3
			Trip blank				
QA-318 (DW)	2/1/95	<.1	na	<.1	na	<5	<1
			Equipment blanks				
QA-3 (DW)	7/15/94	na	na	<.1	na	<1	<1
QA-5 (IBW)	7/28/94	<.1	na	<.1	na	<1	<1
QAS-39 (IBW, VBW)	11/10/94	#<.1	<.1	<.1	<0.1	na	na
QA-8 (IBW)	7/17/95	na	<.1	<.1	na	<5	1

Table 50. Results of a source-solution blank, a trip blank, and an equipment blank from the Idaho National Engineering Laboratory analyzed for nitrite, nitrite plus nitrate, and ammonia, as nitrogen; orthophosphate, as phosphorus; and total organic carbon

[Analyses by the National Water Quality Laboratory. Site identifier: see Quality Assurance/Quality Control Data, Blank Samples section for explanation. Abbreviations: mg/L, milligram per liter; DW, deionized water; IBW, inorganic blank water; VBW, volatile organic compound blank water; na, no analysis. Symbols: <, the result was less than the stated value. Number in bold indicates the result exceeded two standard deviations]

Site identifier	Date prepared	Dissolved nitrite, as nitrogen (mg/L)	Dissolved nitrite plus nitrate, as nitrogen (mg/L)	Dissolved ammonia, as nitrogen (mg/L)	Orthophosphate, as dissolved phosphorus (mg/L)	Total organic carbon (mg/L)
			Source-solution blank			
QA-317 (DW)	1/9/95	<0.01	<0.05	<0.015	<0.01	na
			Trip blank			
QA-318 (DW)	2/1/95	<.01	<.05	.02	<.01	na
			Equipment blank			
QAS-39 (IBW, VBW)	11/10/94	<.01	<.05	<.01	<.01	**0.2**

Table 51. Results of source-solution blanks and equipment blanks from the Idaho National Engineering Laboratory analyzed for gamma radiation, strontium-90, and tritium

[Analyses by the Radiological and Environmental Sciences Laboratory (RESL) and the National Water Quality Laboratory (NWQL). Samples for the RESL were unfiltered and regarded as whole water, recoverable (WWR). Site identifier: see Quality Assurance/Quality Control Data, Blank Samples section for explanation. Abbreviations: pCi/L, picocurie per liter; DW, deionized water; IBW, inorganic blank water; VBW, volatile organic compound blank water; na, no analysis. Symbol ##, the analysis was performed by the NWQL for WWR tritium. Number in bold indicates the result exceeded two standard deviations]

Site identifier	Date prepared	Gamma radiation (pCi/L)	Strontium-90 (pCi/L)	Tritium (pCi/L)
		Source-solution blank		
QA-2 (DW)	7/15/94	40±30	−0.5±1.6	−60±170
QA-3 (DW)	2/8/95	-30±30	1.4±0.7	−60±160
		Equipment blank		
QA-3 (DW)	7/15/94	14±21	−.1±1.6	30±170
QA-5 (IBW)	7/28/94	-12±24	−1.8±1.6	−70±160
QAS-39 (IBW)	11/10/94	na	na	**##48±25.6**
QA-8 (IBW, VBW)	7/17/95	na	.9±0.7	−20±170

Table 52. Results of an equipment blank from the Idaho National Engineering Laboratory analyzed for bromide; trace elements: iron, lead, mercury, nickel, and silver; and gross radioactivity

[Analyses were performed by the National Water Quality Laboratory. Site identifier: see Quality Assurance/Quality Control Data, Blank Samples section for explanation. Source solution was inorganic blank water. Abbreviations: WWR, whole water, recoverable; mg/L, milligram per liter; µg/L, microgram per liter; pCi/L, picocurie per liter. Symbol: <, the result was less than the stated value. Numbers in bold indicate the result exceeded two standard deviations]

Site identifier	Date prepared	Dissolved bromide (mg/L)	WWR iron (µg/L)	WWR lead (µg/L)	WWR mercury (µg/L)	WWR nickel (µg/L)	WWR silver (µg/L)
QAS-39	11/10/94	<0.01	10	<1	<0.1	<1	<1

Site identifier	Date prepared	Dissolved gross alpha,, as uranium, (µg/L)	Dissolved gross alpha, as thorium-230, (pCi/L)	Dissolved gross beta, as cesium-137, (pCi/L)	Dissolved gross beta, as strontium-90 / yttrium-90 (pCi/L)
QAS-39	11/10/94	**1.05±0.574**	**1.16±0.633**	**1.93±1.01**	**3.10±1.80**

Table 53. Upper-tail areas for a normal curve

[The statistical table was compiled by J.W. Stegeman (Ott, 1993, p. A-3). The level of significance (or *p*-value) is the area and must be multiplied by two for two-tailed tests. Number in bold is the level of significance for a one-tailed test when *z* equals 1.96]

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.00	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641
0.10	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
0.20	.4207	.4168	.4129.	.4090	.4052	.4013	.3974	.3936	.3897	.3859
0.30	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
0.40	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
0.50	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
0.60	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
0.70	.2420	.2389	.2258	.2327	.2296	.2266	.2236	.2206	.2177	.2148
0.80	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
0.90	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
1.00	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
1.10	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
1.20	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
1.30	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
1.40	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
1.50	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
1.60	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
1.70	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
1.80	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
1.90	.0287	.0281	.0274	.0268	.0262	.0256	**.0250**	.0244	.0239	.0233
2.00	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
2.10	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
2.20	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
2.30	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
2.40	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
2.50	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
2.60	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
2.70	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
2.80	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
2.90	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
3.00	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010

z	Area
3.500	.00023263
4.000	.00003167
4.500	.00000340
5.000	.00000029

Table 54. Site identifiers and sampling dates for replicate pairs of samples from the Idaho National Engineering Laboratory analyzed for volatile organic compounds

[Site identifier: see figures 1-3 for location of sites]

Site identifier	Date sampled
ANP-9	10/14/94
Hwy 3	10/12/94
PSTF	4/10/95
Tan Expl.	4/12/94
USGS 7	4/06/95
USGS 26	4/11/95
USGS 87	1/11/95
USGS 119	10/25/95
USGS 120	10/23/95
USGS 121	10/24/94

Table 55. Volatile organic compounds with Chemical Abstracts Service (CAS) Registry numbers, and minimum reporting levels

[The minimum reporting levels are 0.2 micrograms per liter except where noted (Rose and Schroeder, 1995; Timme, 1994,1995)]

Compound	CAS Registry number	Compound	CAS Registry number
Benzene	71-43-2	1,3-Dichloropropane	142-28-9
Bromobenzene	108-86-1	2,2-Dichloropropane	590-20-7
Bromochloromethane	74-97-5	1,1-Dichloropropene	563-58-6
Bromodichloromethane	75-27-4	*cis*-1,3-Dichloropropene	10061-01-5
Bromoform	75-25-2	*trans*-1,3-Dichloropropene	10061-02-6
Bromomethane	74-83-9	Ethylbenzene	100-41-4
n-Butylbenzene	104-51-8	Hexachlorobutadiene	87-68-3
sec-Butylbenzene	135-98-8	Isopropylbenzene	98-82-8
tert-Butylbenzene	98-06-6	*p*-Isopropyltoluene	99-87-6
Carbon tetrachloride	56-23-5	Methylene chloride	75-09-2
Chlorobenzene	108-90-7	Methyl *tert*-butylether	1634-04-4
Chloroethane	75-00-3	Naphthalene	91-20-3
2-Chloroethyl vinyl ether[1]	110-75-8	*n*-Propylbenzene	103-65-1
Chloroform	67-66-3	Styrene	100-42-5
Chloromethane	74-87-3	1,1,1,2-Tetrachloroethane	630-20-6
2-Chlorotoluene	95-49-8	1,1,2,2-Tetrachloroethane	79-34-5
4-Chlorotoluene	106-43-4	Tetrachloroethene	127-18-4
Dibromochloromethane	124-48-1	Toluene	108-88-3
1,2-Dibromo-3-chloropropane[1]	96-12-8	1,2,3-Trichlorobenzene	87-61-6
1,2-Dibromoethane	106-93-4	1,2,4-Trichlorobenzene	120-82-1
Dibromomethane	74-95-3	1,1,1-Trichloroethane	71-55-6
1,2-Dichlorobenzene	95-50-1	1,1,2-Trichloroethane	79-00-5
1,3-Dichlorobenzene	541-73-1	Trichloroethene	79-01-6
1,4-Dichlorobenzene	106-46-7	Trichlorofluoromethane	75-69-4
Dichlorodifluoromethane	75-71-8	1,2,3-Trichloropropane	96-18-4
1,1-Dichloroethane	75-34-3	1,1,2-Trichloro 1,2,2-trifluoromethane	76-13-1
1,2-Dichloroethane	107-06-2	1,2,4-Trimethylbenzene	95-63-6
1,1-Dichloroethene	75-35-4	1,3,5-Trimethylbenzene	108-67-8
cis-1,2-Dichloroethene	156-59-4	Vinyl chloride	75-01-4
trans-1,2-Dichloroethene	156-60-5	Xylenes (*meta*-)	108-38-3
1,2-Dichloropropane	78-87-5	(*para*-)	106-42-3
		(*ortho*-)	95-47-6

[1]The reporting level is 1 microgram per liter.