CHEMICAL CONSTITUENTS IN THE DISSOLVED AND SUSPENDED FRACTIONS OF GROUND WATER FROM SELECTED SITES, IDAHO NATIONAL ENGINEERING LABORATORY AND VICINITY, IDAHO, 1989

By

LeRoy L. Knobel, Roy C. Bartholomay, L. DeWayne Cecil,
Betty J. Tucker, and Steven J. Wegner

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED UNITS

Multiply	By	To obtain
foot (ft)	0.3048	meter
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
gallon (gal)	3.785	liter
acre-foot (acre-ft)	1,233	cubic meter
foot per mile (ft/mi)	0.1646	meter per kilometer
curie (Ci)	3.7×10^{10}	becquerel
picocurie per liter (pCi/L)	0.037	becquerel per liter

For temperature, degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) by using the formula: $°F = (°C \times 1.8) + 32$

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

Abbreviated units used in report: µg/L (microgram per liter); mg/L (milligram per liter); pCi/kg (picocurie per kilogram) and µS/cm (microsiemens per centimeter at 25 degrees Celsius).

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ABSTRACT

Ground-water-quality data--collected during 1989 from 23 locations in the eastern Snake River Plain--are presented as part of the U.S. Geological Survey's continuing hydrogeologic investigation at the Idaho National Engineering Laboratory. The ranges of concentrations for dissolved cations, anions, and silica were calcium--17 to 74 mg/L (milligrams per liter), magnesium--10 to 23 mg/L, sodium--7.4 to 97 mg/L, potassium--1.8 to 7.0 mg/L, silica--19 to 41 mg/L, chloride--9.8 to 150 mg/L, sulfate--7.0 to 64 mg/L, bicarbonate--100 to 279 mg/L, and fluoride--0.1 to 1.0 mg/L.

Purgeable organic compounds and extractable acid and base/neutral organic compounds were detected in water from 16 and 10 sites, respectively. Concentrations of dissolved organic carbon ranged from 0.3 to 2.0 mg/L.

Concentrations of gross alpha-particle radioactivity as thorium-230 ranged from less than the reporting level to 27.4±1.6 pCi/L (picocuries per liter) and concentrations of gross beta-particle radioactivity as cesium-137 ranged from 3.55±0.39 to 3,950±207 pCi/L. Concentrations of selected transuranics were less than the reporting level. Concentrations of radon-222 ranged from less than the reporting level to 344±18 pCi/L. Tritium concentrations in 26 samples analyzed by the U.S. Department of Energy's Radiological and Environmental Sciences Laboratory ranged from less than the reporting level to 28,600±700 pCi/L.

A sample of suspended sediment was analyzed for nine radionuclides.

Concentrations ranged from less than the reporting level for uranium-235 and uranium-238 to 3,480,000±60,000 picocuries per kilogram for cesium-137.

INTRODUCTION

The INEL (Idaho National Engineering Laboratory), encompassing about 890 mi^2 of the eastern Snake River Plain in southeastern Idaho (fig. 1), is operated by the U.S. Department of Energy. INEL facilities are used in the development of peacetime atomic-energy applications, nuclear safety research, defense programs, and advanced energy concepts. Liquid radionuclide and chemical wastes generated at these facilities have been discharged to onsite infiltration ponds and disposal wells since 1952. Liquid-waste disposal has resulted in detectable concentrations of several waste constituents in water in the Snake River Plain aquifer underlying the INEL.

The U.S. Department of Energy requires information about the mobility of dilute radionuclide- and chemical-waste constituents in the Snake River Plain aquifer. Waste-constituent mobility is, in part, determined by (1) the rate and direction of ground-water flow; (2) the locations, quantities, and methods of waste disposal; (3) waste-constituent chemistry; and (4) the geochemical processes taking place in the aquifer (Orr and Cecil, 1991, p. 2). This study was conducted by the U.S. Geological Survey in cooperation with the U.S. Department of Energy's Idaho Operations Office.

Purpose and Scope

In 1949, the U.S. Atomic Energy Commission, later to become the U.S. Department of Energy, requested that the U.S. Geological Survey describe the water resources of the area now known as the INEL. The purpose of the resulting study was to characterize these resources prior to the development of nuclear reactor testing facilities. The Geological Survey since has maintained a monitoring network at the INEL to determine hydrologic trends and to delineate the movement of facility-related radionuclide and chemical wastes in the Snake River Plain aquifer.

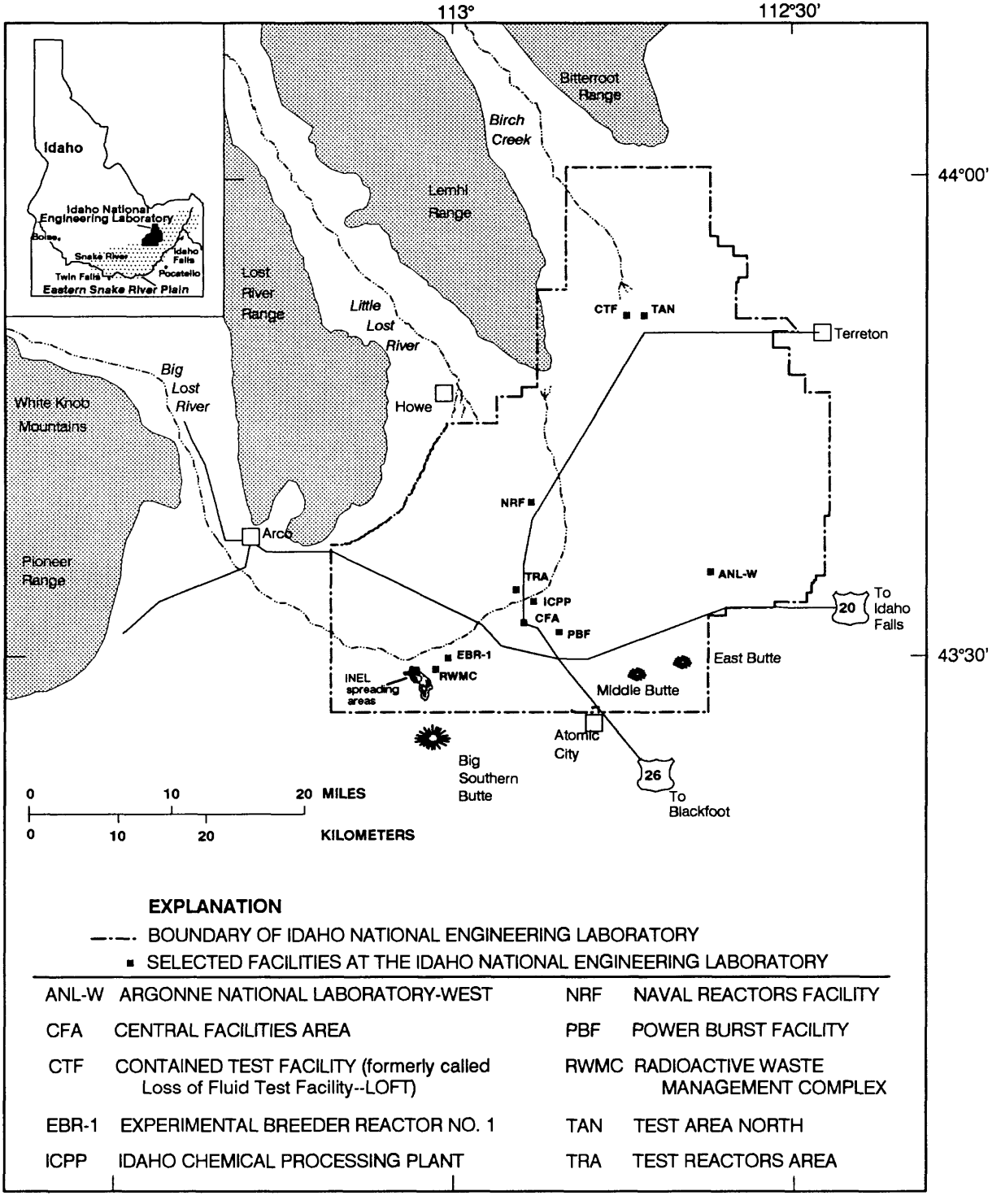

Figure 1.--Location of the Idaho National Engineering Laboratory.

This report presents a compilation of water-quality data collected during 1989 from the Snake River Plain aquifer and an associated spring that discharges from the rhyolitic rocks composing Big Southern Butte. The data were collected as part of the continuing hydrogeologic investigation at the INEL. The report documents the concentrations of selected chemical constituents in the dissolved and suspended fractions of ground water from the INEL and vicinity.

Hydrologic Conditions

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

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

The Big Lost River drains more than 1,400 mi^2 of mountainous area that includes parts of the Lost River Range and Pioneer Range west of the INEL (fig. 1). Flow in the Big Lost River infiltrates to the Snake River Plain aquifer along its channel and at sinks and playas. Since 1958, excess runoff has been diverted to spreading areas in the southwestern part of the INEL where much of the water rapidly infiltrates to the aquifer. Other surface drainages that provide recharge to the Snake River Plain aquifer at the INEL include Birch Creek and the Little Lost River (fig. 1) (Orr and Cecil, 1991, p. 23).

Ground Water.--Water in the Snake River Plain aquifer moves principally through fractures and interflow zones in the basalt. A significant proportion of ground water moves through the upper 800 ft of saturated rocks (Mann, 1986, p. 21). Hydraulic conductivity of basalt in the upper 800 ft of the aquifer generally is 1 to 100 ft/day. Hydraulic conductivity of underlying rocks is several orders of magnitude smaller. The effective base of the Snake River Plain aquifer at the INEL probably ranges from about 850 to 1,220 ft below land surface (Orr and Cecil, 1991, p. 25).

Depth to water in wells completed in the Snake River Plain aquifer ranges from about 200 ft at the northern part of the INEL to more than 900 ft in the southeastern part. In July 1988, the altitude of the water table was about 4,590 ft above sea level near TAN (Test Area North) and about 4,420 ft above sea level near the RWMC (Radioactive Waste Management Complex). Water flowed southward and southwestward beneath the INEL at an average hydraulic gradient of about 4 ft/mi. Locally, however, the hydraulic gradient ranged from about 1 to 15 ft/mi. From July 1985 to July 1988, water-level changes in INEL wells ranged from a 26.8-ft decline near the RWMC to a 4.3-ft rise north of TAN. Water levels generally declined in the southern two-thirds of the INEL during that time and rose in the northern one-third (Orr and Cecil, 1991, p. 25).

Ground water moves southwestward from the INEL and eventually discharges to springs along the Snake River downstream from Twin Falls, 100 mi southwest of the INEL. Approximately 4.3 million acre-ft of ground water discharged to these springs in 1988 (Mann, 1989, p. 2).

Guidelines for Interpreting Results of Radiochemical Analyses

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

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

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

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

True radionuclide concentrations between $1.6s$ and $3s$ have larger errors of the second kind. That is, there is a larger-than-5-percent probability

of false negative results for samples with true concentrations between 1.6s and 3s. Although the radionuclide might have been detected, such detection may not be considered reliable; at 1.6s, the probability of a false negative is about 50 percent.

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

Acknowledgments

The U.S. Department of Energy's RESL (Radiological and Environmental Sciences Laboratory) and the Idaho State University's Environmental Monitoring Laboratory provided radionuclide analyses of water samples. Technical staff at the RESL are under the supervision of T.F. Gesell, Director, and D.B. Martin, Chief, Analytical Chemistry Branch. Technical staff at Idaho State University's Laboratory are under the supervision of Bernard W. Graham. The authors are grateful to Timothy B. Spruill of the U.S. Geological Survey and James K. Olsen of the Idaho Department of Health and Welfare for technically reviewing the manuscript.

METHODS AND QUALITY ASSURANCE

The methodology used in sampling for selected chemicals generally followed the guidelines established by the U.S. Geological Survey (Goerlitz and Brown, 1972; Stevens and others, 1975; Skougstad and others, 1979; Wood, 1981; Claassen, 1982; W.L. Bradford, U.S. Geological Survey, written

commun., 1985; Wershaw and others, 1987; Hardy and others, 1989). The methods used in the field and quality assurance practices are outlined in following sections.

Sample Containers and Preservatives

Sample containers and preservatives differ depending on the constituent(s) for which analyses are requested. Samples analyzed by the NWQL (U.S. Geological Survey's National Water Quality Laboratory) are containerized and preserved in accordance with laboratory requirements specified by Pritt and Jones (1989). Containers and preservatives were supplied by the NWQL and had undergone a rigorous quality control procedure (Pritt, 1989, p. 75) to eliminate sample contamination. Samples analyzed by ISU (Idaho State University) and the RESL were containerized in accordance with laboratory requirements specified by the director of the Environmental Monitoring Program at ISU and by the chief and research chemists of the Analytical Chemistry Branch of the RESL, respectively. Containers and preservatives used for this study are listed on table 1.

Sampling Locations and Sample Collection

Samples were collected from 23 locations (figs. 2-4): 13 ground-water monitoring wells (Arbor test, 11, 14, 24, 87-90, 98, 108, 117, and 119-120); 3 production wells (ANP-8, NRF-2, and RWMC Production); 5 disposal wells (IET 1 Disposal, TAN Disposal, TDD-1, TDD-2, and TDD-3); 1 perched-water well (92); and 1 spring (Webb Spring). The production wells were equipped with line-shaft turbine pumps. The ground-water monitoring wells (except 24) and the IET-1 and TAN disposal wells were equipped with dedicated submersible pumps. The remaining wells and Webb Spring did not have permanent pump installations.

Table 1.--Containers and preservatives used for water samples, Idaho National Engineering Laboratory and vicinity

[Abbreviations: L, liter; mL, milliliter; EDTA, ethylenediaminetetraacetic acid; $HgCl_2$, mercuric chloride; NaCl, sodium chloride; HNO_3, nitric acid; $K_2Cr_2O_7$, potassium dichromate; HCl, hydrochloric acid; °C, degrees Celsius. Samples were shipped by overnight-delivery mail. Analyzing laboratory: NWQL--U.S. Geological Survey's National Water Quality Laboratory; ISU--Idaho State University's Environmental Monitoring Laboratory; RESL--U.S. Department of Energy's Radiological and Environmental Sciences Laboratory]

Type of constituent	Container		Preservative		Other treatment	Analyzing laboratory
	Type	Size	Type	Size		
Anions and silica	Polyethylene	250 mL	None	None	Filter	NWQL
Cations, dissolved	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	Filter	NWQL
Cations, total	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	None	NWQL
Metals, dissolved	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	Filter	NWQL
Metals, total	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	None	NWQL
Mercury, dissolved	Glass, acid-rinsed	250 mL	$K_2Cr_2O_7$/ HNO_3	10 mL	Filter	NWQL
Mercury, total	Glass, acid-rinsed	250 mL	$K_2Cr_2O_7$/ HNO_3	10 mL	None	NWQL
Chromium, total	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	None	NWQL
Nutrients, dissolved	Polyethylene, brown	250 mL	$HgCl_2$/ NaCl	1 mL	Filter, chill 4°C	NWQL
Nutrients, total	Polyethylene, brown	250 mL	$HgCl_2$/ NaCl	1 mL	Chill 4°C	NWQL
Purgeable organic compounds	Glass, baked	40 mL	None	None	Chill 4°C	NWQL
Semivolatile organic compounds	Glass, baked	1 L	None	None	Chill 4°C	NWQL

Table 1.--Containers and preservatives used for water samples, Idaho National Engineering Laboratory and vicinity--Continued

Type of constituent	Container Type	Container Size	Preservative Type	Preservative Size	Other treatment	Analyzing laboratory
Dissolved organic carbon	Glass, baked	125 mL	None	None	Filter, silver, chill 4°C	NWQL
EDTA and citrate	Glass, baked	1 L	None	None	Chill 4°C	NWQL
Gross alpha and beta, dissolved	Polyethylene, acid-rinsed	1 L	HNO_3	4 mL	Filter	NWQL
Gross alpha and beta, dissolved and suspended	Polyethylene, acid-rinsed	1 L	None	None	None	NWQL
Tritium	Polyethylene	125 mL	None	None	None	NWQL
	Polyethylene	500 mL	None	None	None	RESL
	Polyethylene	250 mL	None	None	None	ISU
Radon-222	Glass vials	20 mL	Scintillation cocktail	10 mL	None	NWQL
Strontium-90	Polyethylene, acid-rinsed	1 L	HCl	20 mL	None	RESL
	Polyethylene, acid-rinsed	1 L	HCl	5 mL	Filter	NWQL
Radium-226	Polyethylene, acid-rinsed	1 L	HCl	5 mL	Filter	NWQL
Radium-228	Polyethylene, acid-rinsed	1 L	HCl	5 mL	Filter	NWQL
Gamma spectroscopy	Polyethylene, acid-rinsed	1 L	None	None	None	NWQL
	Polyethylene, acid-rinsed	1 L	HCl	20 mL	None	RESL
Uranium, total	Polyethylene, acid-rinsed	1 L	HCl	5 mL	Filter	NWQL
Transuranics	Polyethylene, acid-rinsed	1 L	HCl	20 mL	None	RESL

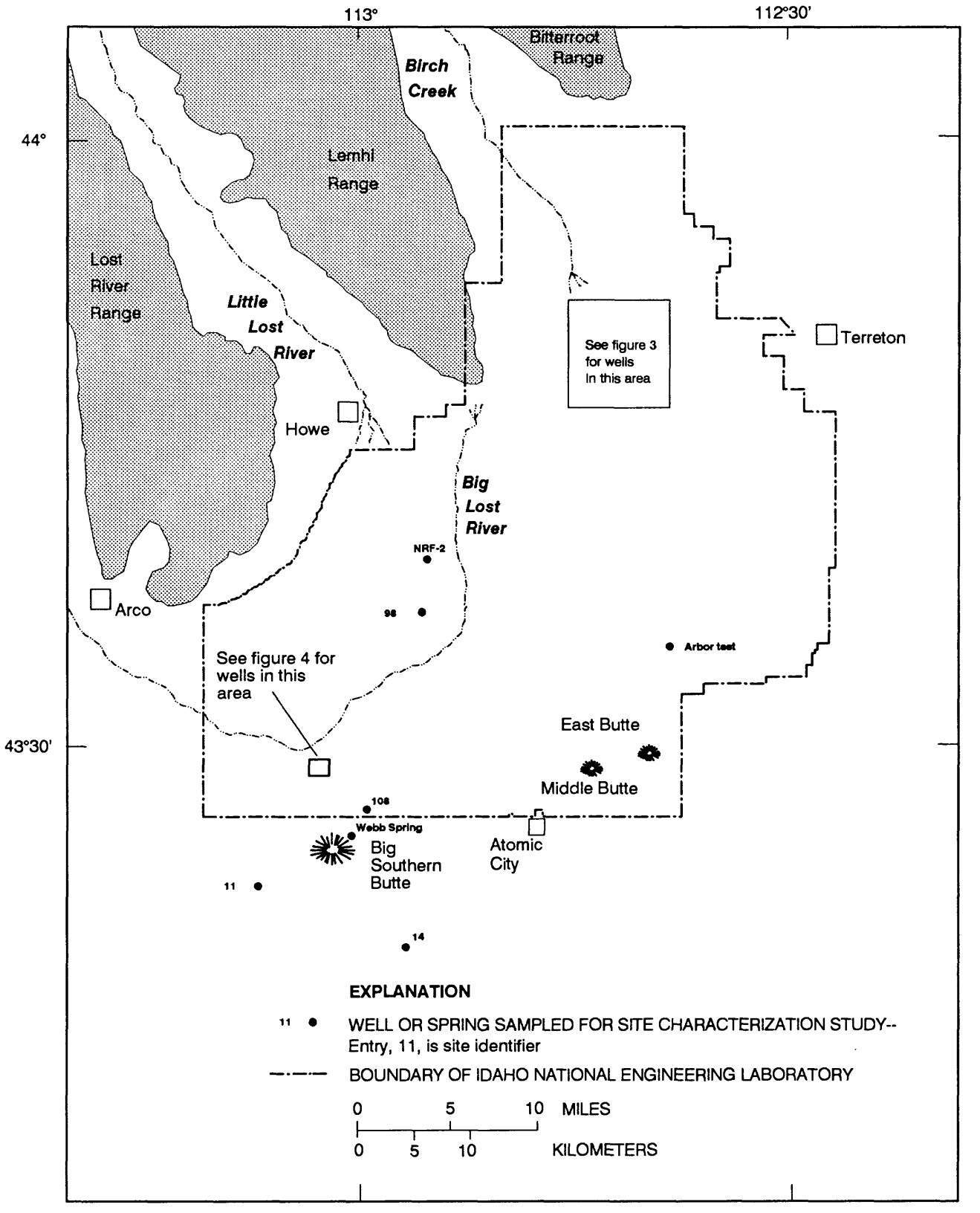

Figure 2.--Location of selected wells and Webb spring, Idaho National Engineering Laboratory and vicinity.

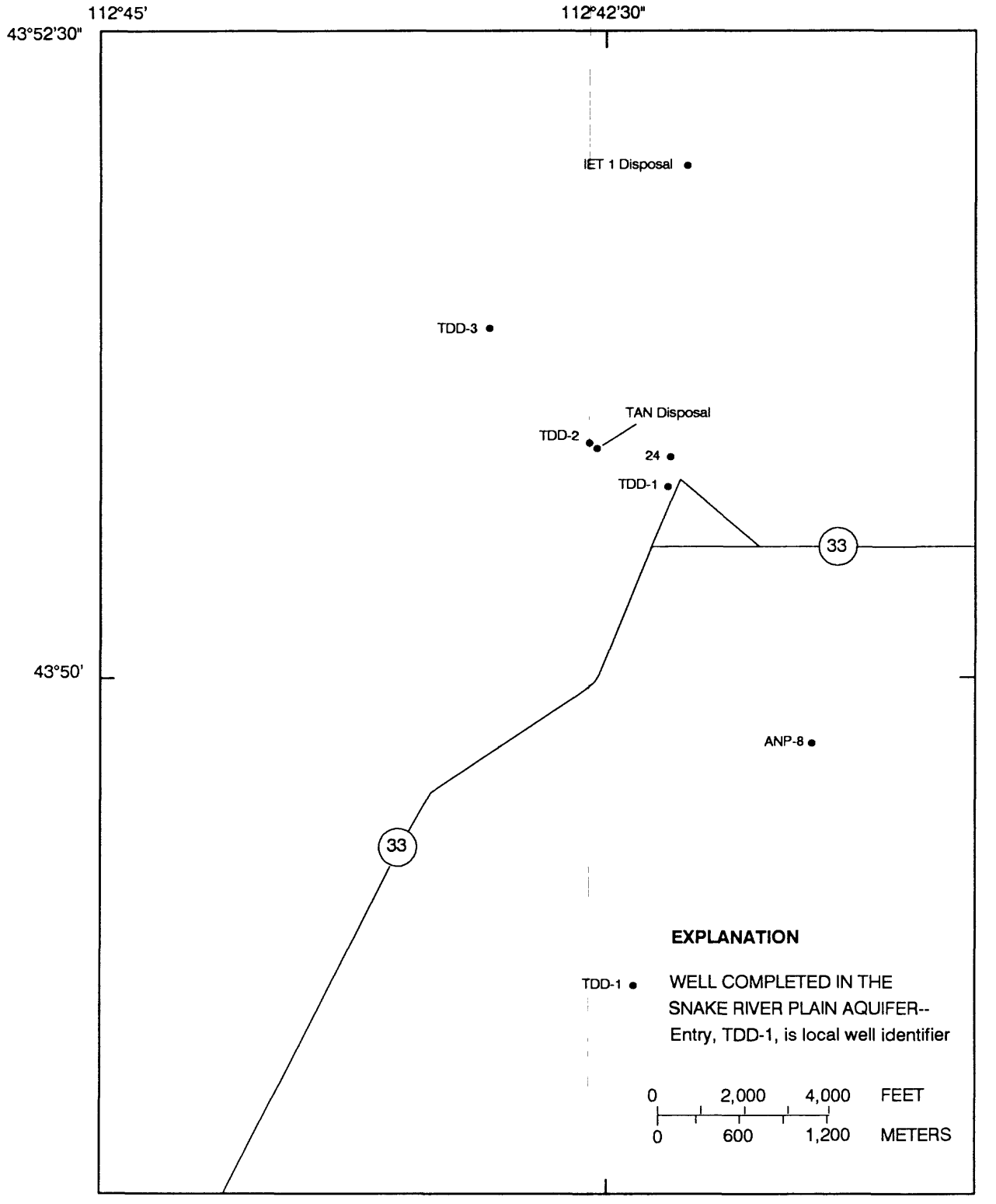

Figure 3.--Location of selected wells, Test Area North, Idaho National Engineering Laboratory.

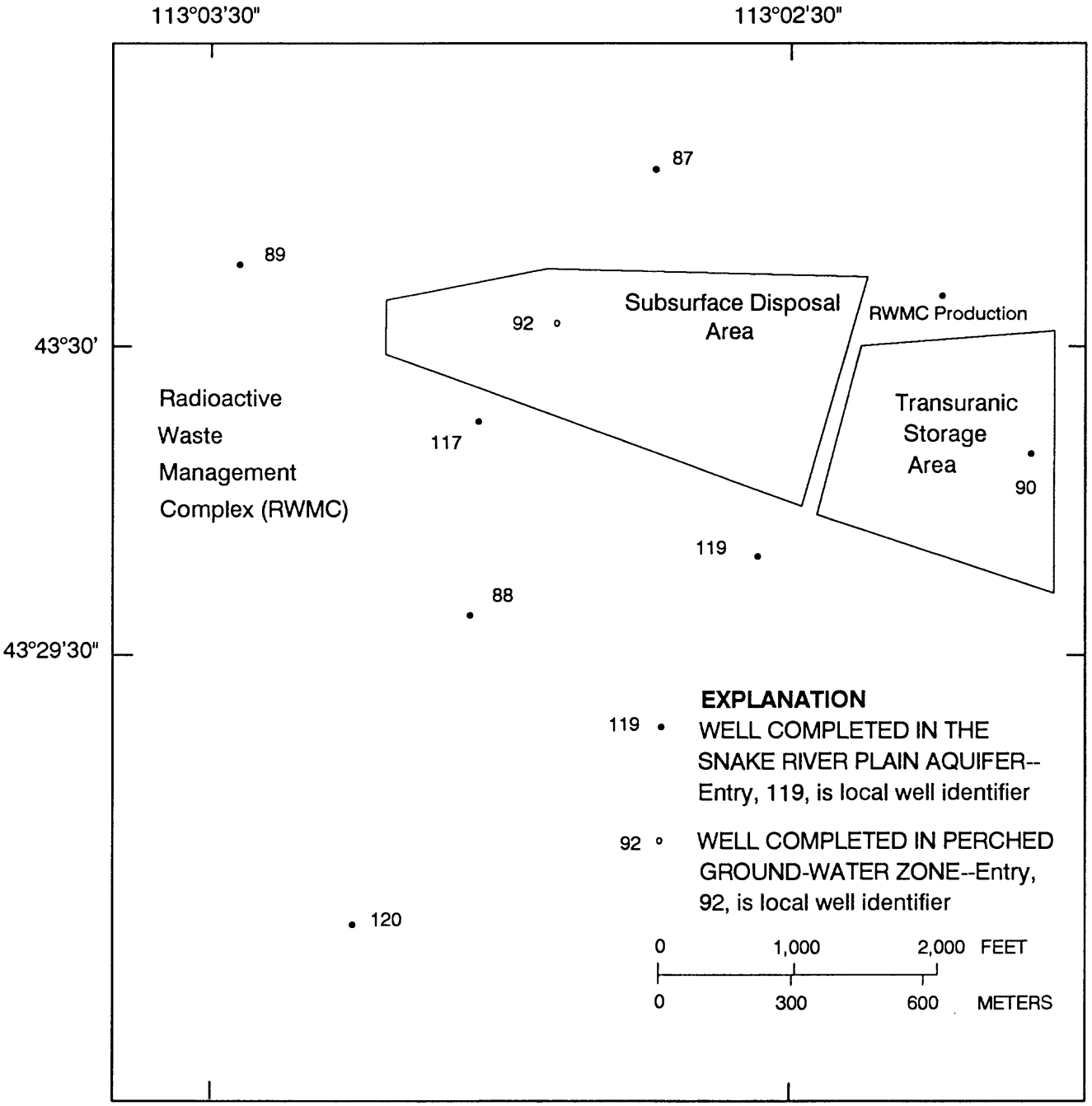

Figure 4.--Location of selected wells, Radioactive Waste Management Complex, Idaho National Engineering Laboratory.

Samples were collected from a portable sampling apparatus at the wells with dedicated submersible pumps; from sampling ports on the discharge lines of the turbine pumps; from the discharge line of a portable submersible pump at 24, TDD-1, TDD-2, and TDD-3; with a bailer at the perched-water well; and from the spring orifice at Webb Spring. All portable equipment was decontaminated after each sample. After collection, sample containers were sealed with laboratory film, labeled, and stored under secured conditions. Water samples to be analyzed by the NWQL were placed in ice chests and sealed. The sealed ice chests were shipped daily by overnight-delivery mail to the NWQL. Water samples to be analyzed by RESL and the ISU Environmental Monitoring Laboratory were hand-delivered to the laboratory.

Conditions at the sampling site during sample collection were recorded in a field logbook and a chain-of-custody record was used to track samples from the time of collection until delivery to the analyzing laboratory. These records are available for inspection at the U.S. Geological Survey Project Office at the INEL. The results of field measurements for pH, specific conductance, and water temperature are listed in table 2, and the results of field measurements for alkalinity and dissolved oxygen and laboratory calculations of hardness and dissolved solids are listed in table 3. The constituents for which water samples were analyzed are listed by site in table 4.

Quality Assurance

Detailed descriptions of internal quality control and of the overall quality assurance practices used by the U.S. Geological Survey's NWQL are provided in reports by Friedman and Erdmann (1982) and Jones (1987). The water samples were collected in accordance with a draft quality assurance plan for quality of water activities conducted by personnel assigned to the INEL Project Office; the draft plan was finalized in June 1989 and is available for inspection at the U.S. Geological Survey's Project Office at the INEL. A comparative study to determine agreement between analytical results for individual water-sample pairs by laboratories involved in the

Table 2.--Results of field measurements for pH, specific conductance, and temperature of water from selected sites, Idaho National Engineering Laboratory and vicinity

[Site identifier: see figures 2-4 for location of sites. Units: pH, negative base-10 logarithm of hydrogen ion activity in moles per liter; specific conductance, microsiemens per centimeter at 25°C (degrees Celsius); temperature, °C. Remarks: B, entry--for example--MV-48 is well identifier from Wegner and Campbell (1991). Additional results for pesticides are available in that report; QA indicates quality assurance]

Site identifier	Date sampled (m/d/y)	Time	pH	Specific conductance	Temperature	Remarks
		[Selected wells and springs]				
Arbor test	2/15/89	1115	8.2	310	13.5	
NRF-2	5/23/89	1010	7.7	680	12.5	
Webb Spring	9/5/89	1445	7.3	252	8.0	Spring
11	9/13/89	1400	8.0	355	12.5	MV-48 B
14	9/14/89	1330	8.2	380	15.5	MV-61 B
	9/14/89	1330	8.2	380	15.5	QA replicate, MV-60 B
	7/17/90	1330	8.1	385	15.5	QA resample
98	11/29/89	1230	7.9	430	12.0	
108	9/5/89	1230	8.1	355	13.5	
		[Test Area North wells]				
ANP-8	12/13/89	1135	8.2	376	10.0	
IET 1 Disposal	3/1/89	1215	7.8	440	14.0	
TAN Disposal	3/7/89	1310	8.0	945	15.0	
	3/7/89	1310	8.0	945	15.0	QA replicate
TDD-1	3/2/89	1320	8.0	525	11.0	
TDD-2	3/6/89	1315	7.9	820	12.5	
TDD-3	12/13/89	1305	7.8	400	9.5	
	12/13/89	1305	7.8	400	9.5	QA replicate
24	2/28/89	1430	8.0	645	11.0	
		[Radioactive Waste Management Complex wells]				
RWMC Production	3/23/89	1340	8.1	358	13.0	
87	4/5/89	1340	8.1	360	14.0	
88	4/4/89	1250	8.2	600	14.0	
89	4/4/89	1500	8.3	378	14.0	
90	4/5/89	1125	8.1	383	13.5	
92	4/3/89	1045	8.7	980	13.5	
	11/10/88	1355	7.7	912	10.0	Historical sample
	6/26/89	1630	8.7	880	17.5	Supplemental sample
117	4/3/89	1535	8.3	270	14.0	
119	4/3/89	1420	8.3	298	15.0	
	4/3/89	1420	8.3	298	15.0	QA replicate
	9/11/90	1145	8.3	270	15.5	Supplemental sample
120	4/4/89	1100	8.1	468	11.5	

Table 3.--Results of field measurements for alkalinity and dissolved oxygen and laboratory computations of total hardness and dissolved solids from selected sites, Idaho National Engineering Laboratory and vicinity

[Site identifier: see figures 2-4 for location of sites. Units: milligrams per liter. Chemical symbols: $CaCO_3$ indicates calcium carbonate. Alkalinity: digital titration with 0.16 normal sulfuric acid. Dissolved oxygen: digital titration using the azide modification of the Winkler method. Remarks: QA indicates quality assurance; sample collected on date (m/d/y) indicated. Symbols: < indicates less than; -- indicates data not available; IS indicates insufficient sample for measurement; NR indicates computation not requested]

Site identifier	Alkalinity (as $CaCO_3$)	Dissolved oxygen	Hardness, total (as $CaCO_3$)	Dissolved solids, sum (as $CaCO_3$)	Remarks
		[Selected wells and springs]			
Arbor test	147	8.3	130	205	
NRF-2	213	9.0	270	343	
Webb Spring	95	8.0	92	165	Spring
11	136	8.2	170	211	
14	129	5.1	150	226	
	129	5.1	150	226	QA replicate
98	174	10.1	200	244	
108	141	8.7	160	213	
		[Test Area North wells]			
ANP-8	127	10.5	170	227	
IET 1 Disposal	165	0.7	180	281	
TAN Disposal	229	<0.2	230	522	
TDD-1	122	2.4	220	286	
TDD-2	194	4.2	260	441	
TDD-3	127	9.2	190	237	
24	176	6.3	260	352	
		[Radioactive Waste Management Complex wells]			
RWMC Production	148	8.2	170	226	
87	111	10.2	160	216	
88	93	8.5	180	340	
89	82	11.6	130	--	
90	120	9.6	170	223	
92	355	IS	NR	NR	4/3/89
117	99	7.0	110	178	
119	94	8.4	--	--	4/3/89
	95	5.8	120	186	9/11/90
120	167	10.2	170	284	

Table 4.--Constituents for which water samples were analyzed, by site, Idaho National Engineering Laboratory and vicinity

[Site identifier: see figures 2-4 for location of sites. Laboratory designations: NWQL (U.S. Geological Survey's National Water Quality Laboratory); RESL (U.S. Department of Energy's Radiological and Environmental Sciences Laboratory); ISU (Idaho State University's Environmental Monitoring Laboratory). Constituent or laboratory schedule: SH121 (major cations, anions, silica, and selected trace elements); DOC (dissolved organic carbon); EDTA (ethylenediaminetetraacetic acid); POC's (purgeable organic compounds); semivolatile compounds (acidic and base/neutral organic compounds); SH458 (gross alpha and gross beta radioactivity in the dissolved fraction of water samples). SH609 (gross alpha and gross beta radioactivity in the dissolved and suspended fractions of water samples); other NWQL radchem (isotopes identified by isotope analysis or gamma spectroscopy); transuranics, RESL (plutonium-238, plutonium-239, -240 (undivided), and americium-241). Remarks: QA indicates quality assurance; QA resample, additional data from another study are available in the files of the U.S. Geological Survey. Symbols: X in column indicates a sample was analyzed for that constituent or laboratory schedule. Additionally, a water sample was collected at 98 for analysis of total concentrations of inorganic constituents and a suspended sediment sample was collected at the TAN Disposal well for radionuclide analysis]

	Constituent or laboratory schedule																		
Site identifier	SH 121	Trace metals	Nutrients	DOC	Detergents	EDTA and citrate	POCs	Semivolatile compounds	Radon-222	Tritium NWQL	Tritium RESL	Tritium ISU	SH 458	SH 609	Other NWQL radchem	Gamma spectroscopy RESL	Transuranics RESL	Strontium-90 RESL	Remarks
								[Selected wells and springs]											
Arbor test	X	X	X	X			X		X		X		X			X	X	X	
NRF-2	X	X	X	X		X	X	X	X		X		X			X	X	X	
Webb Spring	X	X	X	X		X	X	X	X	X	X		X			X	X	X	Spring
11	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	
14	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	
	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	QA replicate
													X	X	X				QA resample
98	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	
108	X	X	X	X		X	X	X	X	X	X		X			X	X	X	

Table 4.--Constituents for which water samples were analyzed, by site, Idaho National Engineering Laboratory and vicinity--Continued

Site identifier	Constituent or laboratory schedule: SH 121	Trace metals	Nutrients	DOC	Detergents	EDTA and citrate	POCs	Semivolatile compounds	Radon-222	Tritium NWQL	Tritium RESL	Tritium ISU	SH 458	SH 609	Other NWQL radchem	Gamma spectroscopy RESL	Transuranics RESL	Strontium-90 RESL	Remarks
								[Test Area North wells]											
ANP-8	X	X	X	X			X	X	X	X	X		X			X	X	X	
IET 1 Disposal	X	X	X	X			X	X	X		X		X			X	X	X	
TAN Disposal	X	X	X	X			X	X	X	X	X		X			X	X	X	
										X									QA replicate
TDD-1	X	X	X	X			X		X		X		X			X	X	X	
TDD-2	X	X	X	X			X	X	X		X		X			X	X	X	
TDD-3	X	X	X	X			X	X	X	X	X		X			X	X	X	
							X												QA replicate
24	X	X	X	X			X	X	X		X		X			X	X	X	
								[Radioactive Waste Management Complex wells]											
RWMC Production	X	X	X	X		X	X	X	X		X		X			X	X	X	
87	X	X	X	X		X	X	X	X		X		X			X	X	X	
88	X	X	X	X		X	X	X	X		X		X			X	X	X	
89	X	X	X	X		X	X	X	X		X		X			X	X	X	
90	X	X	X	X		X	X	X	X		X		X			X	X	X	
92											X					X	X	X	
											X					X	X	X	Historical sample
						X		X											Supplemental sample
117	X	X	X	X		X	X	X	X		X		X			X	X	X	
119	X	X	X	X		X	X	X	X		X		X			X	X	X	
											X					X	X	X	QA replicate
	X		X																Supplemental sample
120	X	X	X	X		X	X	X	X		X		X			X	X	X	

INEL Project Office's quality assurance program is summarized by Wegner (1989). Additional quality assurance instituted for this sampling program included a full-suite replicate from 14 and a resampling of selected NWQL radiochemical constituents from 14, a NWQL tritium replicate from the TAN Disposal well, a purgeable organic replicate from TDD-3, and a replicate of the RESL radiochemical sample from 119. In addition, results from a historical RESL radiochemical sample from 92 are included for comparison. Analytical results for the quality assurance samples will be discussed along with similar data in subsequent sections of this report.

Calculation of Estimated Experimental Standard Errors

The analytical results for radionuclides are presented with calculated analytical uncertainties. There is about a 67-percent probability that the true radionuclide concentration is in a range of the reported concentration plus or minus the uncertainty. The uncertainties are expressed as one sample standard deviation. The associated uncertainties presented with mean concentrations are experimental standard errors and are an estimate of the uncertainty of the mean concentration (Iman and Conover, 1983, p. 158).

CATIONS, ANIONS, AND SILICA

Water samples were analyzed for dissolved concentrations of calcium, magnesium, sodium, potassium, silica, chloride, sulfate, bicarbonate, and fluoride (tables 5-6). The ranges of concentrations, the median concentration, and the mean concentration for each constituent follow: calcium--17 to 74, 41, and 43 mg/L; magnesium--10 to 23, 15, and 16 mg/L; sodium--7.4 to 97, 13.5, and 21 mg/L; potassium--1.8 to 7.0, 2.85, and 3.3 mg/L; silica--19 to 41, 27.5, and 28 mg/L; chloride--9.8 to 150, 14, and 35 mg/L; sulfate--7.0 to 64, 30.5, and 30 mg/L; bicarbonate--100 to 279, 157, and 168 mg/L; and fluoride--0.1 to 1.0, 0.2, and 0.3 mg/L.

Table 5.--Concentrations of dissolved major cations and silica in water, Idaho National Engineering Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in milligrams per liter. Site identifier: see figures 2-4 for location of sites. Remarks: QA indicates quality assurance; sample collected on date (m/d/y) indicated; **A** indicates that additional data from another study are available in table 9. Chemical symbols: Ca^{+2}, calcium; Mg^{+2}, magnesium; Na^{+}, sodium; K^{+}, potassium; and SiO_2, silica. Symbols: NA indicates analysis not performed by laboratory]

Site identifier	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	SiO_2	Remarks
		[Selected wells and springs]				
Arbor test	35	11	16	3.2	35	
NRF-2	70	22	18	1.8	22	
Webb Spring	17	12	11	6.4	41	Spring
11	42	15	8.4	2.4	24	
14	36	15	17	2.7	32	
	36	15	17	2.6	32	QA replicate
98	49	18	9.6	2.3	26	**A**
108	38	15	11	2.5	29	
		[Test Area North wells]				
ANP-8	45	14	8.8	3.2	27	
IET 1 Disposal	50	14	22	2.9	21	
TAN Disposal	57	22	97	4.3	23	
TDD-1	53	20	15	3.5	19	
TDD-2	71	19	57	4.4	19	
TDD-3	51	15	7.4	3.1	23	
24	74	19	26	2.4	21	
		[Radioactive Waste Management Complex wells]				
RWMC Production	45	15	9.0	2.8	28	
87	40	14	12	3.0	28	
88	33	23	47	7.0	30	
89	26	16	20	3.9	30	
90	44	15	9.4	2.7	27	
117	25	12	11	2.8	34	
119	30	NA	10	2.6	32	4/3/89
	30	10	11	2.6	31	9/11/90
120	37	19	35	4.1	26	

Table 6.--Concentrations of dissolved major anions and alkalinity in water, Idaho National Engineering Laboratory and vicinity

[Laboratory analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Alkalinity data were calculated from field measurements listed in table 3; the alkalinity (as calcium carbonate) was divided by 0.8202 (Hem, 1985, p. 57). Analytical results in milligrams per liter. Site identifier: see figures 2-4 for location of sites. Remarks: QA indicates quality assurance; sample collected on date (m/d/y) indicated; Chemical symbols: Cl^-, chloride; SO_4^{-2}, sulfate; HCO_3^-, bicarbonate; and F^-, fluoride. Symbols: NA indicates analysis not performed by laboratory]

Site identifier	Cl^-	SO_4^{-2}	Alkalinity (as HCO_3^-)	F^-	Remarks
		[Selected wells and springs]			
Arbor test	13	13	179	0.8	
NRF-2	46	39	260	.3	
Webb Spring	9.8	7.0	116	.5	Spring
11	12	23	166	.2	
14	19	23	157	1.0	
	19	23	157	1.0	QA replicate
98	13	22	212	.2	
108	13	23	172	.2	
		[Test Area North wells]			
ANP-8	10	30	155	0.2	
IET 1 Disposal	38	33	201	.2	
TAN Disposal	150	32	279	.1	
TDD-1	64	39	149	.2	
TDD-2	120	40	237	.2	
TDD-3	12	33	155	.2	
24	69	36	215	.2	
		[Radioactive Waste Management Complex wells]			
RWMC Production	13	27	180	0.2	
87	13	26	135	.2	
88	82	64	113	.3	
89	38	36	100	.3	
90	13	27	146	.2	
117	14	20	121	.2	
119	NA	31	115	.2	4/3/89
	12	35	116	.5	9/11/90
120	23	43	204	.2	

The concentrations in the replicate sample from 14 were the same as in the primary sample, except for potassium, which was 2.6 mg/L compared to 2.7 mg/L. The NWQL failed to analyze the April 1989 sample from 119 for magnesium and chloride, and a supplemental sample was collected in September 1990. The other constituents were determined in both samples and the analytical results are similar.

SELECTED INORGANIC CONSTITUENTS

Water samples were collected and analyzed for dissolved concentrations of aluminum, arsenic, barium, bromide, cadmium, chromium, hexavalent chromium, iron, lead, manganese, mercury, selenium, silver, and strontium (table 7). The replicate sample from 14 contained the same concentrations as the primary sample for most constituents; however, aluminum, bromide, and hexavalent chromium differed slightly (table 7). The supplemental sample from 119 that was collected in September 1990 has several constituents in common with the sample collected in April 1989. Concentrations of bromide, hexavalent chromium, iron, manganese, and strontium were slightly different in the two samples.

Aluminum.--Concentrations in 17 samples were less than the reporting level of 10 µg/L. Concentrations in the remaining seven samples ranged from 10 to 30 µg/L and were distributed about median and mean concentrations of 20 and 19 µg/L, respectively.

Arsenic.--Concentrations in three samples were less than the reporting level of 1 µg/L. Concentrations in the remaining 20 samples ranged from 1 to 3 µg/L and were distributed about median and mean concentrations of 2 and 2 µg/L, respectively.

Barium.--Concentrations in 24 samples ranged from 16 to 240 µg/L and were distributed about median and mean concentrations of 36 and 63 µg/L, respectively.

Table 7.--Concentrations of selected dissolved minor inorganic constituents in water, Idaho National Engineering Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in micrograms per liter. Site identifier: see figures 2-4 for location of sites. Remarks: QA indicates quality assurance; sample collected on date (m/d/y) indicated; **A** indicates that additional data from another study are available in table 9. Symbols: NR indicates analysis not requested; NA indicates analysis not performed by laboratory; < indicates concentration is less than the indicated reporting level]

Site identifier	Aluminum	Arsenic	Barium	Bromide	Cadmium	Remarks
		[Selected wells and springs]				
Arbor test	<10	2	28	34	<1	
NRF-2	30	1	140	60	<1	
Webb Spring	<10	<1	16	10	<1	Spring
11	10	1	50	<10	<1	
14	20	3	20	41	<1	
	<10	3	20	30	<1	QA replicate
98	<10	1	41	41	<1	**A**
108	<10	1	35	30	<1	
		[Test Area North wells]				
ANP-8	20	2	86	41	1.0	
IET 1 Disposal	<10	2	110	49	<1	
TAN Disposal	<10	<1	130	310	<1	
TDD-1	<10	<1	68	140	<1	
TDD-2	10	2	240	310	<1	
TDD-3	20	2	84	30	<1	
24	<10	2	190	300	<1	
		[Radioactive Waste Management Complex wells]				
RWMC Production	20	2	37	<10	<1	
87	<10	2	29	<10	<1	
88	<10	2	22	220	<1	
89	<10	2	17	120	<1	
90	<10	1	35	<10	<1	
117	<10	3	17	<10	<1	
119	<10	3	28	60	<1	4/3/89
	<10	NR	28	80	NR	9/11/90
120	<10	3	51	<10	<1	

Table 7.--Concentrations of selected dissolved minor inorganic constituents in water, Idaho National Engineering Laboratory and vicinity--Continued

Site identifier	Chromium	Chromium, hexavalent	Iron	Lead	Manganese	Remarks
			[Selected wells and springs]			
Arbor test	2	<1	6	<5	<1	
NRF-2	9	2	6	1	<1	
Webb Spring	<1	1	2,800	1	40	Spring
11	4	3	8	<1	<1	
14	5	5	15	2	<1	
	5	4	15	2	<1	QA replicate
98	6	4	4	<1	<1	A
108	9	8	8	1	<1	
			[Test Area North wells]			
ANP-8	5	3	5	1	<1	
IET 1 Disposal	<1	3	120	<5	170	
TAN Disposal	<1	1	410	<5	84	
TDD-1	2	3	30	<5	3	
TDD-2	<1	1	8	<5	17	
TDD-3	3	<1	5	2	1	
24	4	3	15	<5	2	
			[Radioactive Waste Management Complex wells]			
RWMC Production	20	9	7	<5	130	
87	10	2	6	<5	3	
88	30	30	7	<5	6	
89	50	38	4	6	1	
90	20	9	4	9	2	
117	20	13	14	5	<1	
119	30	20	6	<1	4	4/3/89
	NR	26	16	<1	1	9/11/90
120	8	<1	8	<5	<1	

Table 7.--Concentrations of selected dissolved minor inorganic constituents in water, Idaho National Engineering Laboratory and vicinity--Continued

Site identifier	Mercury	Selenium	Silver	Strontium	Remarks
		[Selected wells and springs]			
Arbor test	<0.1	<1	<1	120	
NRF-2	NA	2	<1	300	
Webb Spring	NA	<1	<1	59	Spring
11	<.1	1	2	230	
14	NA	1	<1	170	
	NA	1	<1	170	QA replicate
98	NA	1	2	220	A
108	<.1	1	<1	200	
		[Test Area North wells]			
ANP-8	<0.1	2	4	210	
IET 1 Disposal	NA	1	1	260	
TAN Disposal	NA	<1	<1	350	
TDD-1	NA	2	4	270	
TDD-2	NA	<1	2	470	
TDD-3	<.1	2	<1	230	
24	NA	<1	2	450	
		[Radioactive Waste Management Complex wells]			
RWMC Production	NA	2	<1	240	
87	NA	1	2	230	
88	NA	3	1	190	
89	NA	4	1	130	
90	NA	1	2	240	
117	NA	1	<1	160	
119	<.1	2	<1	130	4/3/89
	NR	NR	NR	140	9/11/90
120	NA	2	<1	220	

Bromide.--Concentrations in six samples were less than the reporting level of 10 µg/L. Concentrations in the remaining 18 samples ranged from 10 to 310 µg/L and were distributed about median and mean concentrations of 54.5 and 106 µg/L, respectively.

Cadmium.--Concentrations in 22 samples were less than the reporting level of 1 µg/L. The sample from ANP-8 contained a concentration of 1.0 µg/L.

Chromium.--Concentrations in four samples were less than the reporting level of 1 µg/L. Concentrations in the remaining 19 samples ranged from 2 to 50 µg/L and were distributed about median and mean concentrations of 8 and 13 µg/L, respectively.

Hexavalent chromium.--Concentrations in three samples were less than the reporting level of 1 µg/L. Concentrations in the remaining 21 samples ranged from 1 to 38 µg/L and were distributed about median and mean concentrations of 4 and 9 µg/L, respectively.

Iron.--Concentrations in 24 samples ranged from 4 to 2,800 µg/L and were distributed about median and mean concentrations of 8 and 150 µg/L, respectively.

Lead.--Concentrations of 4 and 10 samples were less than the respective reporting levels of 1 and 5 µg/L. Concentrations in the remaining 10 samples ranged from 1 to 9 µg/L and were distributed about median and mean concentrations of 2 and 3 µg/L, respectively.

Manganese.--Concentrations in 10 samples were less than the reporting level of 1 µg/L. Concentrations in the remaining 14 samples ranged from 1 to 170 µg/L and were distributed about median and mean concentrations of 3.5 and 33 µg/L, respectively.

Mercury.--Six samples were analyzed for mercury, and concentrations in all six samples were less than the reporting level of 0.1 µg/L.

Selenium.--Concentrations in five samples were less than the reporting level of 1 µg/L. Concentrations in the remaining 18 samples ranged from 1 to 4 µg/L and were distributed about median and mean concentrations of 1.5 and 2 µg/L, respectively.

Silver.--Concentrations in 12 samples were less than the reporting level of 1 µg/L. Concentrations in the remaining 11 samples ranged from 1 to 4 µg/L and were distributed about median and mean concentrations of 2 and 2 µg/L, respectively.

Strontium.--Concentrations in 24 samples ranged from 59 to 470 µg/L and were distributed about median and mean concentrations of 220 and 220 µg/L, respectively.

NUTRIENTS

Concentrations of nitrite as nitrogen, nitrite plus nitrate as nitrogen, and orthophosphate as phosphorus were analyzed in 24 water samples. In addition, 10 water samples were analyzed for concentrations of ammonia as nitrogen (table 8). The concentrations in the replicate from 14 were the same as in the primary sample except for nitrite plus nitrate as nitrogen. The concentrations were 0.97 and 0.98 mg/L (table 8). The supplemental sample from 119 collected in September 1990 had the same concentrations as the sample collected in April 1989.

Ammonia as nitrogen.--Concentrations in 7 of 10 samples were less than the reporting level of 0.01 mg/L; the remaining 3 concentrations were 0.01 mg/L.

Nitrite as nitrogen.--Concentrations in 20 of 24 samples were less than the reporting level of 0.01 mg/L. Concentrations in the remaining four samples ranged from 0.01 to 0.02 mg/L.

Table 8.--Concentrations of nutrients dissolved in water, Idaho National Engineering Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in milligrams per liter. Site identifier: see figures 2-4 for location of sites. Remarks: QA indicates quality assurance; sample collected on date (m/d/y) indicated; **A** indicates that additional data from another study are available in table 9. Symbols: NR indicates analysis not requested; < indicates concentration is less than the indicated reporting level. Water samples from 11, 14, the QA replicate of 14, and 98 were analyzed for detergents. The respective concentrations are <0.01, <0.01, 0.02, and 0.01 milligrams per liter]

Site identifier	Ammonia (as nitrogen)	Nitrite (as nitrogen)	Nitrite plus nitrate (as nitrogen)	Ortho-phosphate (as phosphorus)	Remarks
		[Selected wells and springs]			
Arbor test	NR	<0.01	1.0	<0.01	
NRF-2	<0.01	<.01	1.7	.02	
Webb Spring	.01	<.01	.38	.02	Spring
11	<.01	<.01	.69	.01	
14	.01	<.01	.98	<.01	
	.01	<.01	.97	<.01	QA replicate
98	<.01	<.01	1.1	.02	**A**
108	<.01	<.01	.66	.01	
		[Test Area North wells]			
ANP-8	<0.01	0.01	0.86	<0.01	
IET 1 Disposal	NR	.02	.56	.19	
TAN Disposal	NR	.01	<.10	.24	
TDD-1	NR	<.01	1.2	<.01	
TDD-2	NR	.01	2.3	.06	
TDD-3	<.01	<.01	.94	<.01	
24	NR	<.01	1.7	.03	
	[Radioactive Waste Management Complex wells]				
RWMC Production	NR	<0.01	0.67	0.03	
87	NR	<.01	.68	<.01	
88	NR	<.01	1.8	<.01	
89	NR	<.01	1.8	<.01	
90	NR	<.01	.69	<.01	
117	NR	<.01	.67	<.01	
119	NR	<.01	1.3	<.01	4/3/89
	<.01	<.01	1.3	<.01	9/11/90
120	NR	<.01	.87	.01	

Nitrite plus nitrate as nitrogen.--The concentration in the sample from the TAN Disposal well was less than the reporting level of 0.10 mg/L. Concentrations in the remaining 23 samples ranged from 0.38 to 2.3 mg/L and were distributed about median and mean concentrations of 0.97 and 1.1 mg/L, respectively.

Orthophosphate as phosphorus.--Concentrations in 13 samples were less than the reporting level of 0.01 mg/L. Concentrations in the remaining 11 samples ranged from 0.01 to 0.24 mg/L and were distributed about median and mean concentrations of 0.02 and 0.06 mg/L, respectively.

MISCELLANEOUS INORGANIC CHEMICAL DATA

Total concentrations of selected inorganic constituents in water from 98 were determined as part of another study. The results are listed in table 9 and can be compared to dissolved concentrations listed in tables 5 and 7-8.

PURGEABLE ORGANIC COMPOUNDS

Concentrations of 36 purgeable organic compounds (table 10) were determined by the NWQL using a method that conforms to U.S. Environmental Protection Agency method 524 (Pritt and Jones, 1989). The resampling at 14, the replicate samplings at 119 and the TAN Disposal well, the supplemental sampling at 119, and all samplings at 92 did not include purgeable organic samples (table 4). The concentrations of purgeable organic compounds from the remaining sites (table 4) are listed in table 11. Compounds with concentrations less than the reporting level of 0.2 µg/L are excluded. An additional compound (1,2,4-trimethylbenzene) was detected in two samples and concentrations are included in table 11. The quality assurance replicate from 14 contained identical concentrations--except for toluene--as the primary sample. The respective concentrations were 0.9 and less than 0.2 µg/L.

Table 9.--Concentrations of total major cations, minor inorganic constituents, and nutrients in water from well 98, Idaho National Engineering Laboratory

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Water sample was collected on November 29, 1989, as part of another study. Abbreviations: mg/L indicates milligrams per liter; µg/L indicates micrograms per liter. Symbols: < indicates less than]

Constituent	Concentration, total
Calcium, mg/L	42
Magnesium, mg/L	17
Sodium, mg/L	7.9
Potassium, mg/L	2.2
Aluminum, µg/L	<10
Arsenic, µg/L	2
Barium, µg/L	<100
Beryllium, µg/L	<10
Cadmium, µg/L	1
Chromium, µg/L	7
Cobalt, µg/L	50
Copper, µg/L	7
Iron, µg/L	20
Lead, µg/L	2
Manganese, µg/L	<10
Mercury, µg/L	<.1
Nickel, µg/L	1
Selenium, µg/L	1
Silver, µg/L	<1
Zinc, µg/L	100
Ammonia (as nitrogen), mg/L	<.01
Nitrite (as nitrogen), mg/L	<.01
Nitrite plus nitrate (as nitrogen), mg/L	1.1
Phosphorus, mg/L	.02

Table 10.--Purgeable organic compounds for which water samples were analyzed

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using an analytical method that conforms to U.S. Environmental Protection Agency method 524. Reporting level for all compounds is 0.2 micrograms per liter (Pritt and Jones, 1989)]

Compound	Compound
Benzene	Cis-1,3-Dichloropropene
Bromoform	Trans-1,3-Dichloropropene
Carbon tetrachloride	1,3-Dichloropropene
Chlorobenzene	Ethylbenzene
Chloroethane	Methyl bromide
2-Chloroethyl vinyl ether	Styrene
Chloroform	Methylene chloride
Chloromethane	1,1,2,2-Tetrachloroethane
Dibromochloromethane	Tetrachloroethylene
Dichlorobromomethane	Toluene
1,2-Dichlorobenzene	Trichlorofluoromethane
1,3-Dichlorobenzene	1,1,1-Trichloroethane
1,4-Dichlorobenzene	1,1,2-Trichloroethane
Dichlorodifluoromethane	Trichloroethylene
1,2-Dibromoethane	Vinyl chloride
1,1-Dichloroethane	Xylenes, mixed
1,2-Dichloroethane	
1,1-Dichloroethylene	
1,2-trans-Dichloroethylene	
1,2-Dichloropropane	

Table 11.--Concentrations of selected purgeable organic compounds in water, Idaho National Engineering Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in µg/L (microgram per liter); no entry indicates the concentration was less than the reporting level of 0.2 µg/L except for the resampling at 14, the replicate samples from 119 and the TAN Disposal well, the supplemental sample from 119, and all samples from 92 for which purgeable organic samples were not collected (see table 4). Site identifier: see figures 2-4 for location of sites. CAS number: Chemical Abstract Services number. Remarks: QA indicates quality assurance. Symbols: # indicates CAS number not tabulated in Pritt and Jones (1989)]

Site identifier	Compound	Concentration	CAS number	Remarks
	[Selected wells and springs]			
NRF-2	Toluene	0.3	108-88-3	
	Xylenes, mixed	.5	#	
11	Toluene	1.7	108-88-3	
14	Toluene	.9	108-88-3	QA replicate
	[Test Area North wells]			
ANP-8	Tetrachloroethylene	3.7	127-18-4	
	Trichloroethylene	6.4	79-01-6	
IET 1 Disposal	Tetrachloroethylene	.7	127-18-4	
	Trichloroethylene	.3	79-01-6	
TAN Disposal	1,2-trans-Dichloroethylene	13,000	540-59-0	
	Trichloroethylene	24,000	79-01-6	
TDD-1	1,1-Dichloroethane	.3	75-34-3	
	1,2-trans-Dichloroethylene	.9	540-59-0	
	Tetrachloroethylene	9.2	127-18-4	
	1,1,1-Trichloroethane	.3	71-55-6	
	Trichloroethylene	44	79-01-6	
TDD-2	Chloroform	.4	67-66-3	
	1,2-trans-Dichloroethylene	1.2	540-59-0	
	Tetrachloroethylene	11	127-18-4	
	1,1,1-Trichloroethane	.3	71-55-6	
	Trichloroethylene	180	79-01-6	
TDD-3	1,2,4-Trimethylbenzene	.2	#	
	Trichloroethylene	.4	79-01-6	
	Toluene	.4	108-88-3	Teflon bailer, QA replicate
	1,2,4-Trimethylbenzene	.2	#	Teflon bailer, QA replicate
	Xylene, total	.3	#	Teflon bailer, QA replicate

Table 11.--Concentrations of selected purgeable organic compounds in water, Idaho National Engineering Laboratory and vicinity--Continued

Site identifier	Compound	Concentration	CAS number	Remarks
	[Test Area North wells--continued]			
24	Chloroform	1.0	67-66-3	
	1,1-Dichloroethane	1.5	75-34-3	
	1,2-Dichloroethane	.5	107-06-2	
	1,1-Dichloroethylene	9.0	75-35-4	
	1,2-trans-Dichloroethylene	11	540-59-0	
	Tetrachloroethylene	64	127-18-4	
	1,1,1-Trichloroethane	12	71-55-6	
	1,1,2-Trichloroethane	.3	79-00-5	
	Trichloroethylene	1,400	79-01-6	
	[Radioactive Waste Management Complex wells]			
RWMC Production	Carbon tetrachloride	1.4	56-23-5	
	1,1,1-Trichloroethane	.3	71-55-6	
	Trichloroethylene	.5	79-01-6	
87	Carbon tetrachloride	.6	56-23-5	
	Trichloroethylene	.2	79-01-6	
88	Carbon tetrachloride	2.2	56-23-5	
	Chloroform	.4	67-66-3	
	1,1,1-Trichloroethane	.4	71-55-6	
	Trichloroethylene	1.0	79-01-6	
89	1,1-Dichloroethane	.2	75-34-3	
90	Carbon tetrachloride	.8	56-23-5	
	1,1,1-Trichloroethane	.2	71-55-6	
	Trichloroethylene	.3	79-01-6	
120	Carbon tetrachloride	.8	56-23-5	
	1,1,1-Trichloroethane	.2	71-55-6	
	Trichloroethylene	.2	79-01-6	

EXTRACTABLE ACID AND BASE/NEUTRAL ORGANIC COMPOUNDS

Extractable acid and base/neutral organic compound samples for 11, 14, the resampling at 14, the replicates from 14, 119, TDD-3, and the TAN Disposal well, the supplemental sampling at 119, the primary and historical sampling at 92, and Arbor test were not collected (table 4). The sample from TDD-1 was lost by the laboratory. The samples from the remaining sites (table 4) were analyzed by the NWQL for 54 compounds (table 12). Concentrations of compounds that are larger than the reporting level (table 12) are listed in table 13. Compounds in table 13 that are not listed in table 12 are TIOC's (tentatively identified organic compounds[1]). No quality assurance replicate samples for extractable acid and base/neutral organic compounds were collected.

MISCELLANEOUS ORGANIC CHEMICAL DATA

Concentrations of DOC (dissolved organic carbon) were determined for 23 samples, and concentrations of EDTA (ethylenediaminetetraacetic acid) and citrate were each determined for 16 samples (table 4). Concentrations of EDTA and citrate were less than the reporting levels in both the primary and replicate samples from 14 (table 14). The DOC concentration from 14 was 0.4 mg/L and the replicate concentration was 0.5 mg/L.

EDTA and citrate were not present in any sample at concentrations larger than the reporting levels of 20 and 5 µg/L, respectively. Concentrations of DOC ranged from 0.3 to 2.0 mg/L and were distributed about median and mean concentrations of 0.4 and 0.5 mg/L, respectively.

[1] Data for TIOC's in this report are based on comparison of sample spectra with library spectra followed by visual examination by gas chromatograph/mass spectrometer analysts. TIOC data have not been confirmed by direct comparison with reference standards. Therefore, TIOC identification is tentative, and reported concentrations are semiquantitative.

Table 12.--Extractable acid and base/neutral organic compounds for which water samples were analyzed

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using gas chromatography to separate the compounds and mass spectrometry and flame ionization for identification and quantification. Initial extraction was with methylene chloride. Reporting levels are in micrograms per liter (Pritt and Jones, 1989)]

Compound	Reporting level	Compound	Reporting level
Acenaphthene	5.0	2,4-Dinitrophenol	20.0
Acenaphthylene	5.0	2,4-Dinitrotoluene	5.0
Anthracene	5.0	2,6-Dinitrotoluene	5.0
Benzo (a) anthracene	10.0	Di-n-octylphthalate	10.0
Benzo (b) fluoranthene	10.0	bis (2-Ethylhexyl) phthalate	5.0
Benzo (k) fluoranthene	10.0	Fluoranthene	5.0
Benzo (g,h,i) perylene	10.0	Fluorene	5.0
Benzo (a) pyrene	10.0	Hexachlorobenzene	5.0
4-Bromophenyl phenyl ether	5.0	Hexachlorobutadiene	5.0
Butyl benzyl phthalate	5.0	Hexachlorocyclopentadiene	5.0
bis (2-Chloroethoxy) methane	5.0	Hexachloroethane	5.0
bis (2-Chloroethyl) ether	5.0	Indeno (1,2,3-cd) pyrene	10.0
bis (2-Chloroisopropyl) ether	5.0	Isophorone	5.0
4-Chloro-3-methylphenol	30.0	2-Methyl-4,6-dinitrophenol	30.0
2-Chloronaphthalene	5.0	Naphthalene	5.0
2-Chlorophenol	5.0	Nitrobenzene	5.0
4-Chlorophenyl phenyl ether	5.0	2-Nitrophenol	5.0
Chrysene	10.0	4-Nitrophenol	30.0
Dibenzo (a,h) anthracene	10.0	n-Nitrosodimethylamine	5.0
1,2-Dichlorobenzene	5.0	n-Nitrosodi-n-propylamine	5.0
1,3-Dichlorobenzene	5.0	n-Nitrosodiphenylamine	5.0
1,4-Dichlorobenzene	5.0	Pentachlorophenol	30.0
2,4-Dichlorophenol	5.0	Phenanthrene	5.0
Diethyl phthalate	5.0	Phenol	5.0
Dimethyl phthalate	5.0	Pyrene	5.0
2,4-Dimethylphenol	5.0	1,2,4-Trichlorobenzene	5.0
Di-n-butyl phthalate	5.0	2,4,6-Trichlorophenol	20.0

Table 13.--Concentrations of selected extractable acid and base/neutral organic compounds in water, Idaho National Engineering Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in micrograms per liter; no entry indicates the concentration was less than the reporting level except for 11, 14, the resampling at 14, the replicates from 14, 119, TDD-3, and the TAN Disposal well, the supplemental sample from 119, the primary and historical sample from 92, and Arbor test, which were not sampled. The sample from TDD-1 was lost by the laboratory (see table 4). Compounds not listed in table 12 are TIOC's (tentatively identified organic compounds): the reported concentration generally is accurate to one order of magnitude. Data for TIOC's in this report are based on a comparison of sample spectra with library spectra followed by visual examination by gas chromatograph/mass spectrometer analysts. TIOC data have not been confirmed by direct comparison with reference standards. Therefore, TIOC identification is tentative, and reported concentrations are semiquantitative. Site identifier: see figures 2-4 for location of sites. Retention time: time required for a compound to pass through the column of a gas chromatograph. Remarks: sample collected on date (m/d/y) indicated. Symbols: # indicates that retention time was not reported by the laboratory]

Site identifier	Compound	Concentration	Retention time (minutes)	Remarks
	[Selected wells and springs]			
Webb Spring 98	Di-n-butyl phthalate	7.0	#	CAS No. 84-74-2
	Unknown compound	.3	30.64	
	Unknown compound	.3	32.57	
	Unknown compound	.3	32.85	
	Unknown compound	.2	36.49	
	Fatty acid ester	.1	37.55	
	1,3-Benzenediamine, 2,4-dinitro-6-(trif)	4.0	37.66	CAS No. 38949198
	[Test Area North wells]			
TDD-3	bis (2-Ethylhexyl) phthalate	8.2	#	CAS No. 117-81-7
	Butylbenzylphthalate	1.6	#	CAS No. 85-68-7
	Di-n-butyl phthalate	1.2	#	CAS No. 84-74-2
	Trimethyl benzene	.3	12.00	
	1-Hexene, 4-methyl-	.6	13.08	CAS No. 3769231
	Benzenamine, N-phenyl-	1.0	28.01	CAS No. 122394
	Aromatic hydrocarbon	.3	32.93	
	Acridine, 9,10-dihydro-9,9-dimethyl	.6	33.71	CAS No. 6267023
	Sulfer, Mol. (S8)	.1	35.93	CAS No. 10544500
	1,3-Benzenediamine, 2,4-dinitro-6 (trif)	.1	37.75	CAS No. 38949198

Table 13.--Concentrations of selected extractable acid and base/neutral organic compounds in water, Idaho National Engineering Laboratory and vicinity--Continued

Site identifier	Compound	Concentration	Retention time (minutes)	Remarks
	[Test Area North wells--Continued]			
TDD-3 (continued)	Hexanedioic acid, dioctyl ester	.7	40.69	CAS No. 123795
IET 1 Disposal	Butylbenzylphthalate	6.0	#	CAS No. 85-68-7
ANP 8	bis (2-Ethylhexyl) phthalate	17	#	CAS No. 117-81-7
	1H-Azepine, hexahydro-	.1	13.08	CAS No. 111499
	Unknown compound	.3	30.65	
	Alkane	.2	34.58	
	Alkane	.1	35.82	
	Dibrominated hydrocarbon	.1	35.87	
	1,3-Benzenediamine, 2,4-dinitro-6-(trif)	1.0	37.72	CAS No. 38949198
	Alkane	.4	38.28	
	Fatty acid methyl ester	.3	39.50	
	Alkene	.9	45.34	
	[Radioactive Waste Management Complex wells]			
RWMC Production	Phenol, 4-4'-(1-methyl-ethylidene) bis-	9.0	35.83	CAS No. 80057
88	Unknown compound	.5	15.10	
89	Alkane	.4	25.71	
	Alkane	.8	27.64	
119	Unknown compound	.5	23.86	4/3/89
	[Radioactive Waste Management Complex perched well]			
92	Hexachloroethane	0.2	#	CAS No. 67-72-1
	Pentachlorophenol	1.0	#	CAS No. 87-86-5
	Benzene, methyl-	10	3.32	CAS No. 108883
	Ethene, tetrachloro-	10	4.29	CAS No. 127184
	Unknown compound	200	4.82	
	Ethane, 1,1,2,2-tetrachloro-	10	7.64	CAS No. 79345
	Ethane, pentrachloro-	.2	9.74	CAS No. 76017
	Unknown compound	10	11.72	
	Unknown compound	10	12.23	

Table 13.--Concentrations of selected extractable acid and base/neutral organic compounds in water, Idaho National Engineering Laboratory and vicinity--Continued

Site identifier	Compound	Concentration	Retention time (minutes)	Remarks
[Radioactive Waste Management Complex perched well--Continued]				
92 (continued)	2H-Indol-2-one, 1,3-dihydro-	.2	12.43	CAS No. 59483
	Unknown compound	2.0	14.35	
	Benzothiazole	1.0	16.71	CAS No. 95169
	Tertio butyl hydroxy anisole	.6	22.34	CAS No. 121006
	Alkane	.1	22.85	
	Unknown compound	5.0	24.91	
	Benzothiazole, 2-(methylthio)-	.2	25.07	CAS No. 615225
	Benzoic acid, 4-hydroxy-	.4	25.33	CAS No. 99967
	Unknown compound	1.0	25.71	
	Phosphoric acid, tributyl ester	.8	25.86	CAS No. 126738
	Benzenesulfonamide, N-ethyl-4-methyl-	1.0	26.05	CAS No. 80397
	Alkane	.3	26.75	
	Alkane	.2	26.88	
	Ethanol, 2-chloro-, phosphate	1.0	27.99	CAS No. 115968
	Alkane	.2	28.55	
	Alkane	.2	30.28	
	Alkane	.2	31.92	
	Alkane	.5	33.51	
	Phenol, 4-4'-(1-methyl-ethylidene) bis-	.4	34.81	CAS No. 80057
	Alkane	.2	35.05	
	Alkene/Cycloalkane	.1	35.92	
	Alkane/Alkene (total)	4.0	36.14	

Table 14.--Concentrations of dissolved organic carbon, ethylenediaminetetraacetic acid, and citrate in water, Idaho National Engineering Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Chemical symbols: DOC indicates dissolved organic carbon; EDTA indicates ethylenediaminetetraacetic acid; C indicates carbon. Abbreviations: mg/L indicates milligrams per liter; µg/L indicates micrograms per liter. Site identifier: see figures 2-4 for location of sites. Remarks: QA indicates quality assurance; sample collected on date (m/d/y) indicated. Symbols: < indicates less than; LS indicates sample lost by laboratory; NR indicates analysis not requested]

Site identifier	DOC (mg/L as C)	EDTA (µg/L)	Citrate (µg/L)	Remarks
		[Selected wells and springs]		
Arbor test	0.9	NR	NR	
NRF-2	.5	<20	<5	
Webb Spring	1.3	<20	<5	
11	.4	<20	<5	
14	.4	<20	<5	
	.5	<20	<5	QA replicate
98	.3	<20	<5	
108	.4	<20	<5	
		[Test Area North wells]		
ANP-8	0.3	LS	LS	
IET 1 Disposal	.5	LS	LS	
TAN Disposal	2.0	LS	LS	
TDD-1	.6	LS	LS	
TDD-2	.6	LS	LS	
TDD-3	.3	LS	LS	
24	.5	LS	LS	
		[Radioactive Waste Management Complex wells]		
RWMC Production	0.3	<20	<5	
87	.3	<20	<5	
88	.7	<20	<5	
89	.3	<20	<5	
90	.3	<20	<5	
92	NR	<20	<5	6/26/89
117	.3	<20	<5	
119	.3	<20	<5	4/3/89
120	.6	<20	<5	

GROSS ALPHA- AND GROSS BETA-PARTICLE RADIOACTIVITY

Concentrations of gross alpha- and gross beta-particle radioactivity were determined for 25 samples using two sample collection and preservation techniques. Raw samples from 11, 14, the quality assurance replicate from 14, the resample from 14, and 98-A were processed in the laboratory prior to analysis. Other samples were field filtered and acidified. Concentrations in the dissolved fraction of the water samples are listed in table 15 and those in the suspended fraction are listed in table 16.

Concentrations of dissolved and suspended gross alpha-particle radioactivity in the quality assurance replicate and the primary sample from 14 were not in agreement (tables 15 and 16). Another sample was collected in July 1990, and although some overlap occurred, the results generally did not agree. The reason for the disagreement between sample results is unknown. Concentrations of dissolved and suspended gross beta-particle radioactivity in the primary, the replicate, and the July 1990 samples were in general agreement (tables 15 and 16). Because of the ambiguity in the results of the gross alpha concentrations an additional sample was collected on August 21, 1991, for radionuclide analysis. Concentrations of dissolved gross alpha-particle radioactivity reported as thorium-230 and as uranium were 2.88±0.445 pCi/L and 4.15±0.635 µg/L, respectively. Concentrations of suspended gross alpha-particle radioactivity reported as thorium-230 and uranium were 0.045±0.070 pCi/L and 0.084±0.128 µg/L, respectively. These concentrations are similar to concentrations in the replicate sample and the resample from 14 (tables 15 and 16).

The dissolved concentrations of gross alpha- and gross beta-particle radioactivity in the two samples from 98 should not be compared as quality assurance samples because they were collected and analyzed using different methods.

Gross alpha-particle radioactivity.--Gross alpha-particle radioactivity is a measure of the total radioactivity given off as alpha particles during the radioactive decay process. For convenience, laboratories report the radioactivity as if it were all given off by one radionuclide. In this

Table 15.--Concentrations of gross alpha- and gross beta-particle radioactivity in the dissolved fraction of water, Idaho National Engineering Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using a residue procedure. Analytical results and uncertainties--for example, 2.84±0.52--in indicated units. Analytical uncertainties are reported as 1s. Concentrations that exceed the reporting level of 3 times the 1s value are shown in bold-face type. Site identifier: see figures 2-4 for location of sites. Remarks: QA indicates quality assurance. **A** indicates that additional data were collected for another study. Abbreviations: µg/L--microgram per liter; pCi/L--picocurie per liter. Raw samples from 11, 14, the QA replicate from 14, the resample from 14, and 98-**A** were processed in the laboratory prior to analysis. These samples also have additional radiochemical data available in tables 16 and 19. Other samples were field filtered and acidified]

Site identifier	Alpha		Beta		Remarks
	as uranium (µg/L)	as thorium-230 (pCi/L)	as strontium-90 in equilibrium with yttrium-90 (pCi/L)	as cesium-137 (pCi/L)	
			[Selected wells and springs]		
Arbor test	4.13±0.74	2.84±0.52	2.89±0.42	3.93±0.66	
NRF-2	4.51±0.54	4.91±0.60	3.76±1.08	4.76±1.36	
Webb Spring	.758±0.194	.838±0.214	5.80±0.42	7.07±0.50	Spring
11	1.93±0.26	2.12±0.28	3.76±0.32	4.20±0.36	
14	10.2±0.75	11.2±0.80	3.96±0.36	4.65±0.42	
	2.69±0.28	2.94±0.32	3.37±0.31	3.86±0.36	QA replicate
	4.73±0.72	2.97±0.48	3.40±0.42	4.70±0.68	Resample
98	.669±0.338	.736±0.371	3.11±0.34	3.55±0.39	**A**
	3.75±0.52	4.06±0.56	4.80±0.39	5.44±0.44	
108	24.9±1.5	27.4±1.6	3.25±0.29	3.86±0.34	
			[Test Area North wells]		
ANP-8	4.18±0.48	4.51±0.52	4.51±0.34	5.19±0.40	
IET 1 Disposal	3.84±0.72	2.62±0.50	4.59±0.54	6.02±0.72	
TAN Disposal	5.02±0.74	3.44±0.52	2,780±146	3,950±207	
TDD-1	2.86±0.67	1.97±0.46	5.18±0.60	6.97±0.82	
TDD-2	10.1±1.06	6.86±0.71	343±18	475±25	
TDD-3	4.08±0.50	4.44±0.54	7.80±0.50	9.03±0.58	
24	4.07±0.72	2.76±0.48	4.96±0.60	6.65±0.82	
			[Radioactive Waste Management Complex wells]		
RWMC Production	3.01±0.56	2.07±0.39	5.49±0.59	7.25±0.78	
87	2.27±0.50	1.56±0.35	3.82±0.50	5.04±0.66	
88	2.30±0.48	1.56±0.33	8.35±0.80	11.2±1.07	
89	2.02±0.49	1.42±0.34	4.08±0.51	5.37±0.67	
90	1.88±0.46	1.29±0.32	3.57±0.47	4.63±0.60	
117	1.98±0.47	1.36±0.33	5.34±0.58	6.91±0.75	
119	2.40±0.49	1.63±0.33	3.41±0.45	4.36±0.58	4/3/89
120	4.74±0.76	2.91±0.50	5.95±0.64	7.99±0.86	

Table 16.--Concentrations of gross alpha- and gross beta-particle radioactivity in the suspended fraction of water, Idaho National Engineering Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using a residue procedure. Analytical results and uncertainties--for example, 0.353±0.134--in indicated units. Analytical uncertainties are reported as 1s. Concentrations that exceed the reporting level of 3 times the 1s value are shown in bold-face type. Site identifier: see figures 2-4 for location of sites. Remarks: QA indicates quality assurance. **A** indicates that additional data were collected for another study. Abbreviations: µg/L--microgram per liter; pCi/L--picocurie per liter. Raw field samples were processed in the laboratory prior to analysis]

Site identifier	Alpha		Beta		Remarks
	as uranium (µg/L)	as thorium-230 (pCi/L)	as strontium-90 in equilibrium with yttrium-90 (pCi/L)	as cesium-137 (pCi/L)	
11	0.087±0.034	0.085±0.034	0.311±0.124	0.313±0.125	
14	**.148±0.040**	**.145±0.039**	.357±0.136	.353±0.134	
	-.032±0.040	-.031±0.040	.180±0.130	.183±0.132	QA replicate
	.130±0.250	.074±0.143	-.026±0.232	-.033±0.288	Resample
98	-.110±0.098	-.108±0.096	-.929±0.218	-.918±0.216	**A**

report, concentrations are reported two ways: as thorium-230 in picocuries per liter, and as natural uranium in micrograms per liter. In addition to dissolved concentrations (table 15), gross alpha-particle radioactivity was measured in the suspended fractions of five water samples (table 16). All the water samples except one contained concentrations of gross alpha-particle radioactivity in the dissolved fraction larger than the reporting level (table 15). The concentrations reported as thorium-230 ranged from less than the reporting level to 27.4±1.6 pCi/L. The concentrations of 25 samples were distributed about median and mean concentrations of 2.76±0.48 and 4.02±1.07 pCi/L, respectively. Concentrations of gross alpha-particle radioactivity in the suspended fractions of five water samples--reported as thorium-230--ranged from less than the reporting level to 0.145±0.039 pCi/L. Only the concentration in the primary sample from 14 was larger than the reporting level (table 16). The concentrations in the dissolved fractions reported as uranium ranged from less than the reporting level to 24.9±1.5 µg/L. The concentrations of 25 samples were distributed about median and mean concentrations of 3.75±0.52 and 4.52±0.97 µg/L, respectively. Concentrations of gross alpha-particle radioactivity in the suspended fractions of five water samples--reported as uranium--ranged from less than the reporting level to 0.148±0.040 µg/L. Only the concentration in the primary sample from 14 was larger than the reporting level (table 16).

Gross beta-particle radioactivity.--Gross beta-particle radioactivity is a measure of the total radioactivity given off as beta particles during the radioactive decay process. For convenience, laboratories report the radioactivity as if it were all given off by one radionuclide or a chemically similar pair of radionuclides in equilibrium. In this report, concentrations are reported two ways: as strontium-90 in equilibrium with yttrium-90 in picocuries per liter, and as cesium-137 in picocuries per liter. In addition to dissolved concentrations (table 15), gross beta-particle radioactivity was measured in the suspended fractions of five water samples (table 16). All the water samples contained concentrations of gross beta-particle radioactivity in the dissolved fraction larger than the reporting level (table 15). The concentrations reported as strontium-90 in equilibrium with yttrium-90 ranged from 2.89±0.42 to 2,780±146 pCi/L. Concentrations of 25 samples were distributed about median and mean

concentrations of 4.51±0.34 and 129±110 pCi/L, respectively. If the two largest concentrations are omitted, the mean concentration is 4.57±0.30 pCi/L. Concentrations of gross beta-particle radioactivity in the suspended fractions of the water samples--reported as strontium-90 in equilibrium with yttrium-90--were all less than the reporting level. The concentrations in the dissolved fractions reported as cesium-137 ranged from 3.55±0.39 to 3,950±207 pCi/L. Concentrations of 25 samples were distributed about median and mean concentrations of 5.37±0.67 and 182±160 pCi/L, respectively. If the two largest concentrations are omitted, the mean concentration is 5.77±0.39 pCi/L. Concentrations of gross beta-particle radioactivity in the suspended fractions of the water samples--reported as cesium-137--were all less than the reporting level.

TRANSURANIC ELEMENTS AND CESIUM-137

Transuranic elements.--Some transuranic elements may be produced in nature because of the availability of neutrons that can be captured by uranium isotopes (Orr and others, 1991, p. 16) and some are produced as by-products of the nuclear industry (Wampler, 1972, p. 6-7). Concentrations of plutonium-238, plutonium-239, -240 (undivided), and americium-241 were determined in 26 samples by the RESL (table 17). All concentrations--including the replicate samples from 14 and 119, and the historical sample from 92--were less than the reporting level (table 17).

Cesium-137.--Cesium-137 is not naturally occurring but is present in ground water as a fission product from nuclear facilities and weapons tests (Orr and others, 1991, p. 28). The concentrations of cesium-137 in the primary and replicate samples from 14 and 119 were in agreement. The concentration in the historical sample from 92--November 1988--was in agreement with the April 1989 sample. The concentrations of cesium-137 in 25 samples--including the replicates and historical sample--were less than the reporting level. The concentration of cesium-137 in the sample from the TAN Disposal well was 3,170±150 pCi/L (table 17).

Table 17.--Concentrations of selected transuranic elements and cesium-137 in water, Idaho National Engineering Laboratory and vicinity

[Analyses were performed by the U.S. Department of Energy's Radiological and Environmental Sciences Laboratory. Analytical results and uncertainties--for example, 0.04±0.02--in picocuries per liter. Analytical uncertainties are reported as 1s. Concentrations that exceed the reporting level of 3 times the 1s value are shown in bold-face type. Site identifier: see figures 2-4 for location of sites. Remarks: Sample collected on date (m/d/y) indicated. QA indicates quality assurance. Solid-phase data for the TAN Disposal well are given in table 20]

Site identifier	Plutonium-238	Plutonium-239,-240 (undivided)	Americium-241	Cesium-137	Remarks
		[Selected wells and springs]			
Arbor test	-0.02±0.04	-0.03±0.02	-0.01±0.03	10±30	
NRF-2	-.04±0.02	-.012±0.016	.02±0.03	0±30	
Webb Spring	-.008±0.017	-.008±0.014	.02±0.03	50±30	
11	.006±0.013	-.001±0.013	-.03±0.04	-80±40	
14	0±0.02	.005±0.015	-.04±0.05	-12±39	
	.01±0.02	-.005±0.015	.16±0.08	-11±29	QA replicate
98	.01±0.02	-.005±0.016	.21±0.08	-30±40	
108	.002±0.017	-.005±0.013	.03±0.03	-20±20	
		[Test Area North wells]			
ANP-8	0.01±0.02	0.015±0.020	0.09±0.06	20±30	
IET 1 Disposal	-.02±0.02	0±0.02	.01±0.03	-30±30	
TAN Disposal	.01±0.03	.02±0.02	.03±0.04	**3,170±150**	See table 20
TDD-1	-.03±0.02	-.01±0.02	.03±0.03	60±50	
TDD-2	-.03±0.02	.004±0.016	-.02±0.03	14±32	
TDD-3	-.001±0.014	.003±0.014	-.02±0.04	-10±20	
24	-.04±0.02	0±0.02	0±0.03	-10±30	
		[Radioactive Waste Management Complex wells]			
RWMC					
Production	-0.04±0.02	0.02±0.02	-0.012±0.024	-40±50	
87	.07±0.03	-.03±0.02	.01±0.02	11±28	
88	-.04±0.02	-.01±0.02	.012±0.025	20±30	
89	.01±0.02	.016±0.018	0±0.02	-30±40	
90	-.02±0.02	.015±0.017	.016±0.030	40±30	
92	-.017±0.060	0±0.04	.02±0.05	20±30	4/3/89
	-.013±0.018	.004±0.016	-.06±0.03	-10±30	11/10/88
117	-.01±0.02	.014±0.016	.015±0.031	-40±30	
119	.10±0.04	-.08±0.03	.03±0.03	-14±39	4/3/89
	-.011±0.023	.004±0.016	-.01±0.02	0±30	QA replicate
120	-.03±0.02	-.001±0.015	-.016±0.025	30±40	

RADON-222

Radon-222 is a radioactive noble gas that is a naturally occurring decay product of radium-226. The primary sample and the quality assurance replicate from 14 both had concentrations less than the reporting level (table 18). Of 23 samples, 17 had concentrations larger than the reporting level. The concentrations ranged from less than the reporting level to 344±18 pCi/L and were distributed about median and mean concentrations of 145±12 and 146±23 pCi/L, respectively.

STRONTIUM-90

Strontium-90 does not occur naturally with the exception of natural reactors such as Oklo, where nuclear fission reactions have occurred in a uranium-enriched deposit (Durrance, 1986, p. 90). This radionuclide is anthropogenically present in ground water as a fission product of nuclear-weapons tests and as a result of disposal practices in the nuclear industry (Orr and others, 1991, p. 19). Twenty-six water samples were analyzed by the RESL (table 18) and 4 samples were analyzed by the NWQL (table 19) for strontium-90 concentrations. Concentrations in the primary and replicate samples from 14 that were analyzed by the RESL were less than the reporting level (table 18). Concentrations in the quality assurance replicate and the July 1990 sample from 14 that were analyzed by the NWQL also were less than the reporting level; however, the primary sample contained 2.93±0.2 pCi/L of strontium-90. The reason for this discrepancy in analytical results is unknown; however, 14 was resampled on August 21, 1991, and the strontium-90 concentration--0.076±0.066 pCi/L--was less than the reporting level. Concentrations in the primary and replicate samples from 119 were less than the reporting level (table 18).

Of the 26 samples analyzed by the RESL, only the TAN Disposal well and TDD-2 had concentrations larger than the reporting level (table 18). The concentrations ranged from less than the reporting level to 680±20 pCi/L and

Table 18.--Concentrations of radon-222, strontium-90, and tritium in water, Idaho National Engineering Laboratory and vicinity

[NWQL indicates the U.S. Geological Survey's National Water Quality Laboratory. RESL indicates the U.S. Department of Energy's Radiological and Environmental Sciences Laboratory. Analyses for radon-222 and tritium were performed by the NWQL and analyses for strontium-90 and tritium were performed by the RESL. Analytical results and uncertainties--for example, 90±14--in picocuries per liter. Analytical uncertainties are reported as 1s. Concentrations that exceed the reporting level of 3 times the 1s value are shown in bold-face type. Site identifier: see figures 2-4 for location of sites. Remarks: QA indicates quality assurance. Symbols: NR indicates that an analysis was not requested for that radionuclide. **A** indicates that additional data from another study are available in table 19. Water samples from 11, 14, and the QA replicate from 14 were analyzed for tritium by the Idaho State University Environmental Monitoring Laboratory in Pocatello, Idaho. The respective concentrations were -40±110, -100±110, and -30±110 picocuries per liter]

Site identifier	Radon-222	Strontium-90	Tritium, NWQL	Tritium, RESL	Remarks
		[Selected wells and springs]			
Arbor test	**90±14**	1.0±1.4	NR	50±160	
NRF-2	0±12	-1.5±1.5	NR	-40±160	
Webb Spring	**344±18**	.6±1.3	**48±13**	20±160	
11	7±14	-2±2	38±13	20±160	**A**
14	5±12	-1.6±1.8	3.2±13	-30±150	**A**
	-8±12	-3±2	19.2±13	60±160	**A**, QA replicate
98	**187±12**	-1.0±1.4	12.8±13	210±160	Strontium-90 blank 0±500
108	35±16	-.3±1.3	**230±13**	220±160	
		[Test Area North wells]			
ANP-8	**260±26**	0.6±1.5	38±13	120±150	
IET 1 Disposal	**211±11**	2.3±1.6	NR	40±160	
TAN Disposal	**250±14**	**680±20**	**27,600±220**	**28,600±700**	
	NR	NR	**29,600±450**	NR	QA replicate
TDD-1	32±14	2.0±1.6	NR	**900±200**	
TDD-2	**285±16**	**184±7**	NR	**3,100±200**	
TDD-3	**147±24**	-.7±1.4	-3.2±13	90±150	
24	**277±14**	1.2±1.5	NR	**10,100±400**	

Table 18.--Concentrations of radon-222, strontium-90, and tritium in water, Idaho National Engineering Laboratory and vicinity--Continued

Site identifier	Radon-222	Strontium-90	Tritium, NWQL	Tritium, RESL	Remarks
		[Radioactive Waste Management Complex wells]			
RWMC Production	145±12	-0.6±1.4	NR	1,700±200	
87	100±12	.9±1.5	NR	1,200±200	
88	209±12	2.5±1.6	NR	90±160	
89	84±12	-2.4±1.3	NR	-20±150	
90	141±12	.6±1.5	NR	1,600±200	
92	NR	-1.3±1.5	NR	200±160	
	NR	-1.1±1.6	NR	140±170	11/10/88
117	312±12	.8±1.5	NR	0±150	
119	165±12	0±1.5	NR	-70±150	
	NR	.3±1.4	NR	-20±150	QA replicate 4/3/89
120	88±12	-.6±1.4	NR	90±160	

Table 19.--Concentrations of selected radionuclides in water, Idaho National Engineering Laboratory and vicinity

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using the following methods: radium-226 by radon emanation or by gamma spectroscopy; radium-228 by separation, precipitation, and beta counting, or by gamma spectroscopy; strontium-90 by chemical separation, precipitation, and beta counting; total uranium by extraction and laser-induced phosphorimetry; radium-224, potassium-40, lead-212, thorium-234, and cobalt-60 by gamma spectroscopy. Analytical results and uncertainties--for example, 2.43±0.24--in picocuries per liter unless otherwise indicated. Analytical uncertainties are reported as 1s. Concentrations that exceed the reporting level of 3 times the 1s value are shown in bold-face type. Site identifier: see figures 2-4 for location of sites. Symbols: NP indicates that radionuclide was not present in the sample at detectable concentrations; DS indicates sample for gamma spectroscopy was destroyed in a laboratory accident]

Radio-nuclide	Site identifier				Remarks
	11	14	QA[1]	QA[2]	
Cobalt-60	NP	0.31±0.04	NP	DS	
Lead-212	0.74±0.08	NP	NP	DS	
Potassium-40	5.22±0.62	5.68±0.64	2.84±0.71	DS	
Radium-226[3]	.058±0.008	.085±0.008	.096±0.010	.082±0.008	Isotopic analysis
Radium-228[3]	.245±0.229	.618±0.312	-.116±0.392	.218±0.212	Isotopic analysis
Radium-224	.86±0.08	.91±0.09	.284±0.056	DS	
Radium-226	NP	.39±0.07	NP	DS	Gamma spectroscopy
Radium-228	NP	NP	.393±0.116	DS	Gamma spectroscopy
Strontium-90	.08±0.08	2.93±0.20	.06±0.09	.177±0.204	
Thorium-234	NP	NP	3.38±0.48	DS	
Total uranium	2.54±0.13	5.75±0.30	2.97±0.30	2.06±0.154	Micrograms per liter

[1]Quality assurance replicate from 14.
[2]Quality assurance resample from 14 on July 17, 1990.
[3]Well 98 (see fig. 2) was sampled for radium-226 and radium-228 for another study. The respective concentrations are 0.087±0.009 and 0.36±0.40 picocuries per liter.

were distributed about median and mean concentrations of 0.15±1.0 and 33±27 pCi/L, respectively. If the concentrations from the TAN Disposal well and TDD-2 are eliminated, the mean concentration is -0.1±0.3 pCi/L.

TRITIUM

Tritium, a radioactive isotope of hydrogen, is formed in nature by interactions of cosmic rays with gases in the upper atmosphere. Tritium also is produced in thermonuclear detonations and is a waste product of the nuclear-power industry (Orr and others, 1991, p. 17). Twenty-six and ten water samples were collected and analyzed for tritium concentrations by the RESL and the NWQL, respectively. The primary and replicate samples from 14 and 119 that were analyzed by RESL had concentrations that were less than the reporting level (table 18). The primary and replicate samples from 14 that were analyzed by the NWQL also had concentrations that were less than the reporting level. The NWQL tritium concentration in the replicate sample (29,600±450 pCi/L) from the TAN Disposal well did not agree with the concentration in the primary sample (27,600±220 pCi/L). The single sample from the TAN Disposal well that was analyzed by the RESL had a tritium concentration of 28,600±700 pCi/L. The concentration in the RESL sample overlaps the concentration in the larger NWQL sample but not the smaller. The reason for the slight disagreement in tritium concentrations is unknown. A remediation of the TAN Disposal well has begun and the concentrations cannot be verified by resampling.

The concentrations of 26 samples analyzed by RESL ranged from less than the reporting level to 28,600±700 pCi/L and were distributed about median and mean concentrations of 90±113 and 1,900±1,100 pCi/L, respectively. If the concentration from the TAN Disposal well is eliminated, the mean concentration is 790±420 pCi/L. The concentrations in 10 samples analyzed by the NWQL ranged from less than the reporting level to 29,600±450 pCi/L and were distributed about median and mean concentrations of 38±9.2 and 5,800±3,800 pCi/L, respectively. If the TAN Disposal well samples are eliminated, the mean concentration is 48±27 pCi/L.

MISCELLANEOUS RADIONUCLIDE DATA

Aqueous concentrations of several radionuclides were determined by the NWQL as part of another study. The samples were from 11, 14, the quality assurance replicate from 14, and the quality assurance resample from 14 (table 19). In addition, a suspended sediment sample from the TAN Disposal well was analyzed for selected radionuclides (table 20).

Aqueous radionuclides.--Concentrations of cobalt-60, lead-212, potassium-40, radium-226 and radium-228 by two methods, radium-224, strontium-90, thorium-234, and total uranium are listed in table 19. The sample for gamma spectroscopy from the July 1990 resampling of 14 was destroyed in a laboratory accident and concentrations for several constituents are not available. Concentrations for several radionuclides in the primary and replicate samples from 14 are not in agreement. As an example, the concentration of potassium-40 in the replicate sample (2.84±0.71 pCi/L) is half that in the primary sample (5.68±0.64 pCi/L). Total uranium in the replicate sample (2.97±0.30 pCi/L) is about half that in the primary sample (5.75±0.30 pCi/L). Several radionuclides, most notably thorium-234, have reportable concentrations in one of the samples and are not present in the other. The well was resampled on August 21, 1991, in an attempt to clarify the ambiguity. Concentrations of cesium-137, potassium-40, radium-226 by isotopic analysis, radium-228 by isotopic analysis, and total uranium were -0.036±0.048 pCi/L, 1.28±1.06 pCi/L, 0.039±0.005 pCi/L, 0.220±0.163 pCi/L, and 2.11±0.158 µg/L, respectively. Cobalt-60, lead-212, and thorium-234 were not identifed in the sample collected August 21, 1991.

Suspended radionuclides.--A sample of suspended sediment was collected from the TAN Disposal well on March 7, 1989, and was analyzed by the RESL for nine radionuclides (table 20). The concentrations range from less than the reporting level for uranium-235 and uranium-238 to 3,480,000±60,000 pCi/kg for cesium-137.

Table 20.--Concentrations of selected radionuclides in suspended sediment from the TAN Disposal well, Idaho National Engineering Laboratory

[Analyses were performed by the U.S. Department of Energy's Radiological and Environmental Sciences Laboratory. Analytical results and uncertainties--for example, 390±40--in picocuries per kilogram. Analytical uncertainties are reported as 1s. Concentrations that exceed the reporting level of 3 times the 1s value are shown in bold-face type. See figure 3 for location]

Radionuclide	Concentration
Americium-241	**390±40**
Cobalt-60	**1,360,000±20,000**
Cesium-137	**3,480,000±60,000**
Europium-154	**11,000±3,000**
Plutonium-238	**2,480±120**
Plutonium-239, -240 (undivided)	**7,200±300**
Uranium-233, 234 (undivided)	**15,000±2,000**
Uranium-235	1,700±900
Uranium-238	2,300±900

SUMMARY

This report presents ground-water-quality data collected during 1989 from 23 locations in the eastern Snake River Plain. The data were collected as part of the U.S. Geological Survey's continuing hydrogeologic investigations at the INEL. The ranges of concentrations for dissolved cations, anions, and silica follow: calcium, 17 to 74 mg/L; magnesium, 10 to 23 mg/L; sodium, 7.4 to 97 mg/L; potassium, 1.8 to 7.0 mg/L; silica, 19 to 41 mg/L; chloride, 9.8 to 150 mg/L; sulfate, 7.0 to 64 mg/L; bicarbonate, 100 to 279 mg/L; and fluoride, 0.1 to 1.0 mg/L.

Samples were analyzed for as many as 14 trace elements. Concentrations of aluminum, arsenic, cadmium, lead, and mercury were either less than or near the laboratory reporting levels. Selenium and silver concentrations both ranged from less than the reporting level to 4 µg/L. Hexavalent chromium ranged from less than the reporting level to 38 µg/L, and dissolved chromium ranged from less than the reporting level to 50 µg/L. The respective ranges of concentrations for barium, bromide, iron, manganese, and stable strontium were 16 to 240 µg/L, less than the reporting level to 310 µg/L, 4 to 2,800 µg/L, less than the reporting level to 170 µg/L, and 59 to 470 µg/L. The predominant nitrogen-bearing compound in these samples was nitrite plus nitrate, which ranged in concentration from less than the reporting level to 2.3 mg/L expressed as nitrogen.

At least one purgeable organic compound was present in water from 16 of 22 sampling sites and one or more extractable acid and base/neutral organic compounds were present in water from 10 of 19 sampling sites. EDTA and citrate were not present in any sample at concentrations larger than the laboratory reporting levels of 20 and 5 µg/L, respectively. Concentrations of DOC ranged from 0.3 to 2.0 mg/L.

Concentrations of dissolved gross alpha-particle radioactivity reported as thorium-230 ranged from less than the reporting level to 27.4±1.6 pCi/L and concentrations of dissolved gross beta-particle radioactivity reported as cesium-137 ranged from 3.55±0.39 to 3,950±207 pCi/L. Concentrations of plutonium-238, plutonium-239, -240 (undivided), and americium-241 were less

than the reporting level. Cesium-137 was less than the reporting level in all samples except the sample from the TAN Disposal well, which had a concentration of 3,170±150 pCi/L. Concentrations of radon-222 ranged from less than the reporting level to 344±18 pCi/L. Strontium-90 concentrations ranged from less than the reporting level to 680±20 pCi/L; however, only the TAN Disposal well and TDD-2 had concentrations larger than the reporting level. Tritium concentrations in 26 samples analyzed by the RESL ranged from less than the reporting level to 28,600±700 pCi/L, and concentrations in 10 samples analyzed by the NWQL ranged from less than the reporting level to 29,600±450 pCi/L.

A sample of suspended sediment from the TAN Disposal well was analyzed for nine radionuclides. Concentrations ranged from less than the reporting level for uranium-235 and uranium-238 to 3,480,000±60,000 pCi/kg for cesium-137.

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