RADIONUCLIDES, INORGANIC CONSTITUENTS, ORGANIC COMPOUNDS, AND BACTERIA IN WATER FROM SELECTED WELLS AND SPRINGS FROM THE SOUTHERN BOUNDARY OF THE IDAHO NATIONAL ENGINEERING LABORATORY TO THE HAGERMAN AREA, IDAHO, 1990

By

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and
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CONVERSION FACTORS AND ABBREVIATED METRIC UNITS

Multiply	by	To obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
acre	4,047	square meter
square mile (mi^2)	2.590	square kilometer
acre-foot per year (acre-ft/yr)	1,233	cubic meter per year
millirem per year (mrem/yr)	0.010	millisievert per year
picocurie per liter (pCi/L)	0.037	becquerel per liter

Temperature can be converted from degrees Celsius (°C) to degrees Fahrenheit (°F) by the equation: °F = (°C × 1.8) + 32

Abbreviated metric units used in report: mL (milliliter); μg/L (microgram per liter); mg/L (milligram per liter); and μS/cm (microsiemens per centimeter at 25 degrees Celsius).

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ABSTRACT

The U.S. Geological Survey and the Idaho Department of Water Resources, in response to a request from the U.S. Department of Energy, sampled 19 sites as part of a long-term project to monitor water quality of the Snake River Plain aquifer from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area. Water samples were collected and analyzed for manmade pollutants and naturally occurring constituents. The samples were collected from seven irrigation wells, five domestic wells, two springs, one stock well, two dairy wells, one observation well, and one commercial well. Two quality assurance samples also were collected and analyzed. The water samples were analyzed for selected radionuclides, inorganic constituents, organic compounds, and bacteria.

None of the radionuclides, inorganic constituents, or organic compounds exceeded the established maximum contaminant levels for drinking water. Most of the radionuclide and inorganic constituent concentrations exceeded their respective reporting levels. All samples analyzed for surfactants and dissolved organic carbon had concentrations that exceeded their reporting level. Toluene concentrations exceeded the reporting level in one water sample. Two samples contained fecal coliform bacteria counts that exceeded established maximum contaminant levels for drinking water.

INTRODUCTION

Recently, the public has expressed much concern about waste disposal practices at the INEL (Idaho National Engineering Laboratory) and the impact these practices might have had on the water quality of the Snake River Plain aquifer. The U.S. Department of Energy requested that the U.S. Geological Survey conduct two studies to respond to the public's concern and to gain a greater understanding of the chemical quality of water in the aquifer. The first study described a one-time sampling effort in the eastern part of the A & B Irrigation District in Minidoka County (Mann and Knobel, 1990). The second study, an ongoing annual sampling effort in the area between the southern boundary of the INEL and Hagerman (fig. 1), is being conducted in cooperation with the Idaho Department of Water Resources. The initial round of sampling for the second study involved analyzing water samples collected from 55 sites during August and September 1989 (Wegner and Campbell, 1991). This report summarizes the analyses of water samples collected in July and August 1990 from 19 of the initial 55 sites.

The INEL includes about 890 mi^2 of the northeastern part of the eastern Snake River Plain and is about 110 mi northeast of the Hagerman area (fig. 1). Wastewater containing chemical and radiochemical wastes generated at the INEL was discharged mostly to ponds and wells in the past. Since 1983, most aqueous wastes have been discharged to infiltration ponds. Many of the constituents in the wastewater enter the aquifer indirectly following percolation through the unsaturated zone (Pittman and others, 1988).

Chemical and radioactive wastes have migrated from less than 1 to about 9 mi southwest of the disposal areas at the INEL (Pittman and others, 1988). Tritium was detected periodically at concentrations of 3,400±200 pCi/L (picocuries per liter) or less in water from three wells along the southern boundary of the INEL during 1983-85. Since April 1986, tritium concentrations in water from wells on the INEL near the southern boundary have been less than the RESL (Radiological and Environmental Sciences Laboratory) analytical method detection limit of 500 pCi/L (Mann and Cecil, 1990).

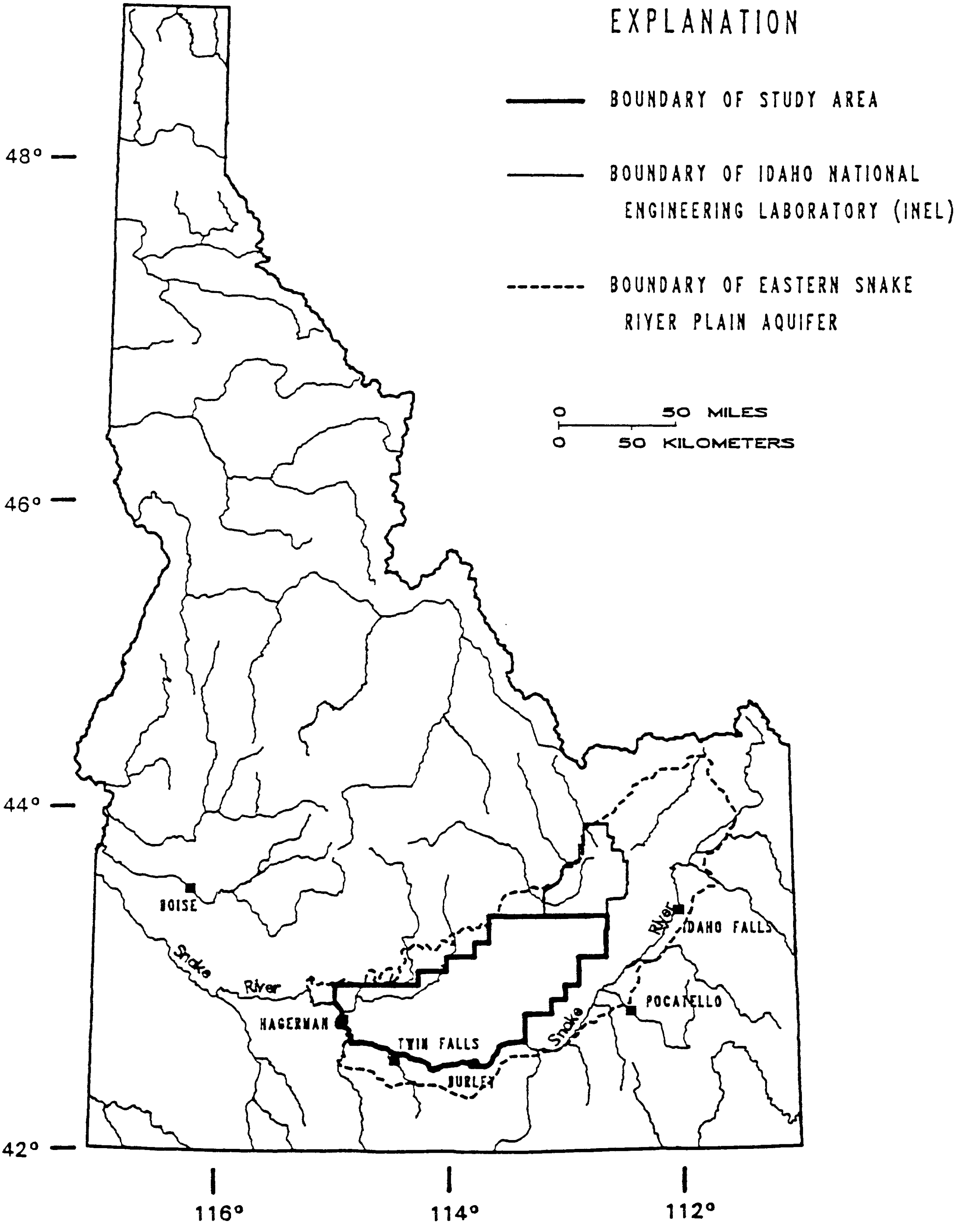

Figure 1.--Location of the study area between the Idaho National Engineering Laboratory and Hagerman, Idaho.

Water samples from 19 sites (fig. 2) were analyzed for selected radionuclides, trace elements, common ions, purgeable organic compounds, carbamate and organophosphorous insecticides, organochlorine insecticides, gross PCB's (polychlorinated biphenyls), gross PCN's (polychlorinated naphthalenes), triazine and chlorophenoxy acid herbicides, surfactants, DOC (dissolved organic carbon), cyanide, and fecal coliform bacteria. One replicate water sample and one blank water sample also were collected and analyzed as a measure of quality assurance. Analytical services for all analyses except fecal coliform bacteria were provided by the U.S. Geological Survey's NWQL (National Water Quality Laboratory) in Arvada, Colo. Fecal coliform bacteria samples were analyzed by the IDHW (Idaho Department of Health and Welfare) laboratory at Twin Falls, Idaho.

Geohydrologic Setting

The eastern Snake River Plain is a northeast-trending structural basin about 200 mi long and 50 to 70 mi wide. The basin, bounded by faults on the northwest and downwarping and faulting on the southeast, has been filled with basaltic lava flows interbedded with terrestrial sediments (Whitehead, 1986). Individual basalt flows average 20 to 25 ft in thickness with an aggregate thickness in places of several thousand feet. In areas of alluvial fan deposits, the sediments are composed primarily of sand and gravel, whereas in the areas where streams were dammed by basalt flows, the sediments are predominantly silt and clay (Garabedian, 1986). Rhyolitic lava flows and tuffs are exposed locally at the surface and may exist at depth under most of the eastern plain. A 10,365-ft-deep test hole at the INEL penetrated about 2,160 ft of basalt and sediment and 8,200 ft of tuffaceous and rhyolitic volcanic rocks (Mann, 1986).

Movement of water in the aquifer generally is from the northeast to the southwest. Water moves horizontally through basalt interflow zones and vertically through joints and interfingering edges of the interflow zones. Infiltration of surface water, heavy pumpage, geologic conditions, and seasonal fluxes in recharge and discharge locally affect the movement of ground water (Garabedian, 1986).

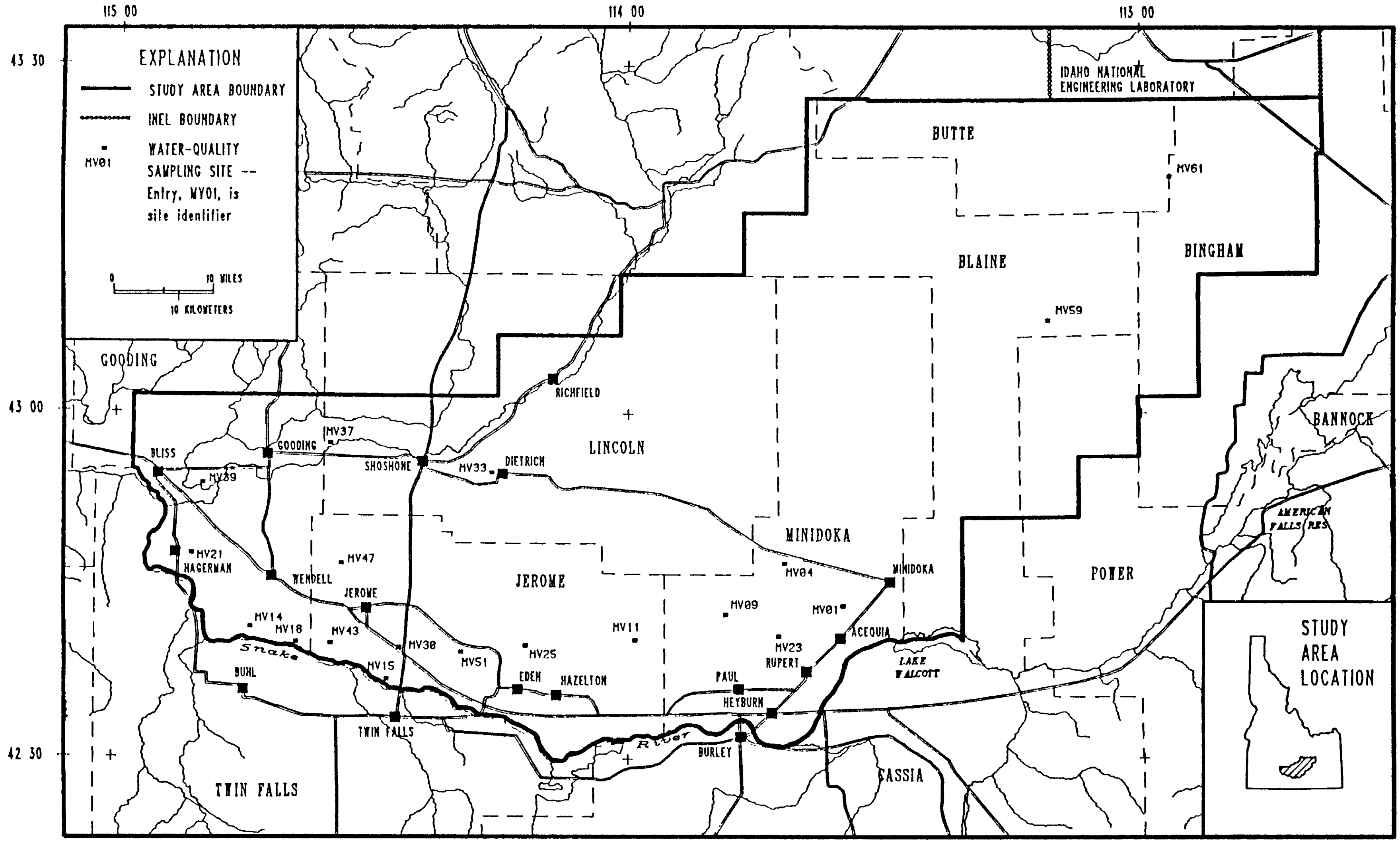

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Figure 2.--Location of selected water-quality sampling sites on the eastern Snake River Plain.

The Snake River Plain aquifer is recharged by seepage from the upper reaches of the Snake River, tributaries and canals, infiltration from irrigation and precipitation, and underflow from tributary valleys on the perimeter of the plain. Discharge from the aquifer primarily is by pumpage for irrigation and spring flow to the Snake River (Mann and Knobel, 1990). Between 1902 and 1980, spring flow to the Snake River increased about 1.2 million acre-feet per year, largely as a result of increased recharge from infiltration of irrigation water (Mann, 1989, p. 5).

Acknowledgments

The authors gratefully acknowledge the well owners for granting permission to collect the water samples and extend special thanks to Mike Smith of the Minidoka Grazing Association for his help in locating and pumping one of the wells for sample collection. Thanks are extended to the Idaho Image Analysis Facility, located at the Idaho Department of Water Resources, for assistance in preparing maps in this report. The authors are grateful for technical review of the manuscript by Bernard W. Graham, College of Pharmacy, Idaho State University, and Michael J. Liszewski of the U.S. Geological Survey.

METHODS AND QUALITY ASSURANCE

The methodology used in sampling for selected chemicals generally followed the guidelines established by the U.S. Geological Survey (Claassen, 1982; Goerlitz and Brown, 1972; Skougstad and others, 1979; Stevens and others, 1975; Wershaw and others, 1987; Wood, 1981; and W.L. Bradford, U.S. Geological Survey, written commun., 1985). The methods used in the field and quality assurance practices are outlined in following sections.

Site Selection

Water samples were collected at 19 locations (fig. 2), including 7 irrigation wells, 5 domestic wells, 2 springs, 1 stock well, 2 dairy wells, 1 observation well, and 1 commercial well. One replicate water sample and one blank water sample also were collected. The irrigation wells were equipped with turbine pumps. The domestic, stock, dairy, observation, and commercial wells were equipped with submersible pumps. Criteria for site selection were geographic location, ease of sample collection, and long-term access.

Sample Containers and Preservatives

Sample containers and preservatives differ depending on the constituent(s) for which analyses are requested. Samples analyzed by the NWQL were collected 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. Water samples analyzed by IDHW were collected in accordance with laboratory requirements specified by the director of the Bureau of Laboratories at IDHW. Containers and preservatives used for this study are listed on table 1.

Sample Collection

Four of the irrigation wells discharge into stilling ponds and were sampled near the discharge pipe. The rest of the irrigation wells were sampled from spigots in discharge lines near pumps. The domestic, dairy, and commercial wells were sampled from the closest available spigots to pumps. The stock well was sampled at the water-tank inlet pipe. The observation well was sampled at the well head. All the wells either were pumping on arrival of the sampling team or were started on arrival and, when possible, pumped long enough to ensure that pressure tanks and pumping systems had been thoroughly flushed as evidenced by stable pH, specific conductance, and temperature measurements. The two springs were sampled as near the source as possible by collecting a grab sample from an area of moving water.

Table 1.--Containers and preservatives used for water-sample collection

[Abbreviations: L, liter; mL, milliliter; µm, micrometer; $HgCl_2$, mercuric chloride; NaCl, sodium chloride; HNO_3, nitric acid; $K_2Cr_2O_7$, potassium dichromate; NaOH, sodium hydroxide; °C, degrees Celsius. Samples were shipped by overnight-delivery mail. Analyzing laboratory: NWQL--U.S. Geological Survey's National Water Quality Laboratory; IDHWL--Idaho Department of Health and Welfare Laboratory]

Type of constituent	Container		Preservative		Other treatment	Laboratory providing analyses
	Type	Size	Type	Size		
Pesticides	Glass, baked	1 L	None	None	Chill 4°C	NWQL
Nutrients	Polyethylene, brown	250 mL	$HgCl_2$/ NaCl	1 mL	0.45 µm filter, chill 4°C	NWQL
Purgeable organic compounds	Glass, baked	40 mL	None	None	Chill 4°C	NWQL
Metals	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	0.45 µm filter	NWQL
Mercury	Glass, acid-rinsed	250 mL	$K_2Cr_2O_7$/ HNO_3	10 mL	0.45 µm filter	NWQL
Tritium	Glass, flint	1 L	None	None	None	NWQL
Radium	Polyethylene, acid-rinsed	1 L	HNO_3	4 mL	0.45 µm filter	NWQL
Radon-222	Glass vials	20 mL	Scintillation cocktail	10 mL	None	NWQL
Strontium-90	Polyethylene, acid-rinsed	1 L	HNO_3	4 mL	0.45 µm filter	NWQL
Uranium	Polyethylene, acid-rinsed	1 L	HNO_3	4 mL	0.45 µm filter	NWQL
Other radionuclides	Polyethylene, acid-rinsed	1 L	None	None	None	NWQL
Bacteria	Autoclave, polyethylene	250 mL	None	None	Chill 4°C	IDHWL

Table 1.--Containers and preservatives used for water-sample collection--Continued

Type of constituent	Container		Preservative		Other treatment	Laboratory providing analyses
	Type	Size	Type	Size		
Dissolved organic carbon	Glass, baked	125 mL	None	None	Silver filter, chill 4°C	NWQL
Surfactants	Polyethylene	250 mL	None	None	Chill 4°C	NWQL
Cyanide	Polyethylene	250 mL	NaOH	5 mL	Chill 4°C	NWQL
Common ions	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	0.45 μm filter	NWQL
	Polyethylene, acid-rinsed	500 mL	HNO_3	2 mL	None	NWQL
	Polyethylene	250 mL	None	None	0.45 μm filter	NWQL
	Polyethylene	250 mL	None	None	None	NWQL

Chemical and physical characteristics monitored at the water-sampling sites included pH, specific conductance, temperature, alkalinity, and concentrations of dissolved oxygen. These characteristics were monitored during pumping using methods described by Wood (1981), and Hardy and others (1989). A water sample was collected when measurements of these properties indicated probable hydraulic and chemical stability. After collection, sample containers were sealed with laboratory film, labeled, and packed into ice chests for shipment by overnight-delivery mail to the NWQL. The bacteria samples collected for the IDHW laboratory were stored in coolers until they were hand-delivered to the IDHW laboratory in Twin Falls, Idaho.

Measurements of pH, specific conductance, water temperature, alkalinity, and concentrations of dissolved oxygen are shown on table 2. Measured pH of water from sampling sites ranged from 7.5 to 8.1, within the U.S. Environmental Protection Agency's (1989) recommended range of 6.5 to 8.5 for community water systems. Specific conductance measurements ranged from 299 to 1,020 μS/cm. The IDHW has established a maximum contaminant level of 750 μS/cm for community water systems (Idaho Department of Health and Welfare, 1989). Two of the samples exceeded this level. Measurements of temperature ranged from 12.0° to 16.5°C. The IDHW (1989) has established a secondary maximum contaminant level of 26.6°C for temperature. All of the temperature measurements were below this level. Alkalinity as $CaCO_3$ ranged from 106 to 270 mg/L. Concentrations of dissolved oxygen ranged from 6.2 to 9.5 mg/L.

Conditions at the sampling site during sample collection were recorded in a field logbook; a chain-of-custody record was used to track the 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.

Quality Assurance

Detailed descriptions of internal quality control and 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). Ten percent of

Table 2.--Results of field measurements of water for pH, specific conductance, temperature, alkalinity, and concentrations of dissolved oxygen from selected wells and springs, eastern Snake River Plain

[Site identifer: see figure 2 for location of sites. Site use: I--irrigation; QA--quality assurance (see Quality Assurance section in text for explanation); H--domestic; Sp--spring; D--dairy; C--commercial; S--stock; O--observation. Date sampled: month/day/year. 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. Alkalinity: mg/L as $CaCO_3$. Dissolved oxygen: mg/L using Azide modification of Winkler method. -- indicates no analyses available]

Site identifier	Site use	Date sampled	pH	Specific conductance	Temperature	Alkalinity	Dissolved oxygen
MV-1	I	08/13/90	7.8	650	14.0	156	6.3
MV-4	I	08/13/90	7.8	640	12.0	139	8.8
MV-8	QA	08/13/90	7.8	640	12.0	139	8.8
MV-9	I	08/14/90	7.7	1,020	13.5	231	7.8
MV-11	I	08/14/90	7.7	900	14.0	229	7.8
MV-14	H	08/16/90	7.8	560	14.5	168	--
MV-15	Sp	08/16/90	7.6	650	15.5	184	--
MV-18	Sp	08/16/90	8.0	690	14.5	221	--
MV-21	D	08/15/90	7.9	365	16.0	137	7.6
MV-22	QA	11/02/90	5.8	28	23.0	2	5.4
MV-23	I	08/13/90	7.6	640	15.5	164	6.2
MV-25	H	08/16/90	7.6	735	14.0	252	8.1
MV-30	C	08/17/90	7.7	690	15.5	251	9.1
MV-33	H	08/15/90	8.0	299	15.5	118	7.4
MV-37	H	08/17/90	7.6	490	15.0	194	8.1
MV-39	I	08/15/90	7.5	715	15.0	255	8.2
MV-43	I	08/15/90	7.7	745	15.5	270	7.5
MV-47	D	08/17/90	7.9	480	15.5	135	8.3
MV-51	H	08/14/90	7.6	720	15.0	230	9.5
MV-59	S	08/24/90	8.1	300	16.5	121	6.4
MV-61	O	07/17/90	8.1	385	15.5	106	7.6

the water samples were quality assurance samples. Sample MV-8 is a replicate of sample MV-4. Sample MV-22 is a blank water sample collected from distilled water from the RESL (Radiological and Environmental Sciences Laboratory) at the INEL. The blank water sample contained 16,649.6±569.9 pCi/L of tritium, which is attributed to tritium in the water supply at the RESL. Because the blank water sample is not representative of wells and springs sampled for this report, it will not be included in the discussions of the various constituents measured but will be included in the tables.

RADIONUCLIDES

Water samples were analyzed for radon-222, strontium-90, tritium, gross alpha- and gross beta-particle radioactivity, total uranium, radium-226, and radium-228. In addition, gamma-emitting radionuclides were identified. The samples were analyzed using methods described by Thatcher and others (1977) and U.S. Environmental Protection Agency (1989). Maximum contaminant levels for the types of radioactivity and for selected radionuclides are listed on table 3.

An analytical uncertainty, s, is calculated for each radionuclide concentration. This report presents the analytical uncertainty as 2s. Guidelines for interpreting analytical results are based on an extension of the method described by Currie (1984). In radiochemical analyses, laboratory measurements are made on a target sample and a prepared blank. Instrument signals for the sample and 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 greater than the signal for the blank to make the decision that there was a detection; and (2) an estimation must be made of the minimum concentration that will yield a sufficiently large signal to make the correct decision for detection or nondetection most of the time. The first aspect of the problem is a qualitative decision based on signals and a definite criterion for detection. The second aspect of the problem is an estimation of the detection capabilities of a complete measurement process that includes hypothesis testing.

Table 3.--Maximum contaminant levels for types of radioactivity and selected radionuclides in drinking water

[The maximum contaminant levels were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1989, p. 550) for community water systems and are for comparison purposes only. The proposed maximum contaminant level--in parentheses--are from U.S. Environmental Protection Agency (1991). The maximum contaminant level given for gross alpha-particle radioactivity includes radium-226 but excludes radon and uranium. The maximum contaminant level given for gross beta-particle radioactivity excludes radioactivity from natural sources and should be used only for comparison. Maximum contaminant level values listed for strontium-90 and tritium are average annual concentrations assumed to produce a total body or organ dose of 4 mrem/yr (millirem per year) of beta-particle radiation. Abbreviations: pCi/L--picocurie per liter, μg/L--microgram per liter.

Type of radioactivity or radionuclide	Maximum contaminant level
Gross alpha-particle radioactivity	15 pCi/L
Gross beta-particle and gamma radioactivity	4 mrem/yr
Radium-226 plus radium-228	5 pCi/L
Radium-226	(20 pCi/L)
Radium-228	(20 pCi/L)
Radon-222	(300 pCi/L)
Strontium-90	8 pCi/L
Total uranium	(20 μg/L)
Tritium	20,000 pCi/L

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

Once the critical level of 1.6s has been defined, the minimum detectable concentration can be established. Concentrations that equal 3s represent a measurement at the minimum detectable concentration. For true concentrations of 3s or greater, there is a 95-percent-or-more probability of correctly concluding that the radioactive constituent was detected in a sample. Given a large number of samples, as many as 5 percent of the samples with measured concentrations greater than or equal to 3s, which were concluded as being not detected, could contain the radioactive constituent at the minimum detectable concentration. 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 greater-than-5-percent probability of false negative results for samples with true concentrations between 1.6s and 3s, and although the radionuclide or radioactivity might have been detected, such detection may not be considered reliable; at 1.6s, the probability of a false negative is about 50 percent.

These guidelines 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 and with the number of gross counts for individual analyses. The use of the critical level and minimum detectable concentration aids the reader in the interpretation of analytical results and does not represent absolute concentrations of radioactivity which may or may not have been detected. In this report, if the concentration of a selected radionuclide was equal to or greater than 3s, the concentration is considered to be above a "reporting level." The reporting level should not be confused with the analytical method detection limit, which is based on laboratory procedures. At small concentrations, the reporting level approaches the analytical method detection limit; however, at larger concentrations, they may be significantly different.

Radon-222

Radon-222 is a naturally occurring radioactive gas that results from the decay of radium-226. Concentrations of radon-222 in seven water samples exceeded the reporting level and ranged from 46±29 to 89±24 pCi/L (table 4). Concentrations in all the samples were below the proposed maximum contaminant level of 300 pCi/L (table 3).

Strontium-90

Strontium-90 is a fission product that was widely distributed in the environment during atmospheric weapons tests. Strontium-90 generally is present in ground water as a result of these tests and from nuclear industry waste-disposal practices. All the water samples contained dissolved strontium-90 concentration less than the reporting level (table 4). In 1989, MV-61 had a strontium-90 concentration (2.93±0.40 pCi/L) greater than the reporting level, whereas a quality assurance replicate sample (MV-60) had a concentration (0.06±0.18) less than the reporting level (Wegner and Campbell, 1991). In 1990, the concentration of strontium-90 at MV-61 was 0.177±0.408 pCi/L (table 4).

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. The concentrations of tritium in the water samples

Table 4.--Concentrations of radon-222, strontium-90, and tritium in water from selected wells and springs, eastern Snake River Plain

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using the following methods: radon-222 by liquid scintillation; tritium by enrichment and gas counting; strontium-90 by chemical separation and precipitation. Analytical results and uncertainties--for example, 70±25--in pCi/L (picocurie per liter). Analytical uncertainties are reported as 2s. Site identifier: see figure 2 for location of sites. Symbols: * indicates quality assurance sample (see Quality Assurance section in text for explanation)]

Site identifier	Radon-222	Strontium-90	Tritium
MV-1	70±25	-0.049±0.231	65.28±4.48
MV-4	24±35	.063±0.215	4.67±0.57
MV-8*	31±24	.037±0.229	4.96±0.57
MV-9	46±27	.273±0.270	85.44±5.76
MV-11	49±26	.141±0.312	106.56±7.04
MV-14	-20±63	.166±0.257	29.18±2.04
MV-15	-5±25	.272±0.277	72.64±4.48
MV-18	-39±43	.074±0.247	64.32±3.84
MV-21	-36±32	.223±0.264	17.5±0.96
MV-22*	53±41	.333±0.320	16,649.6±569.9
MV-23	46±29	.128±0.417	70.08±4.48
MV-25	-3±32	.277±0.414	72.0±5.12
MV-30	71±41	.127±0.256	78.4±5.12
MV-33	11±26	.078±0.256	6.04±0.57
MV-37	38±41	.140±0.243	74.24±5.12
MV-39	29±33	-.005±0.371	74.88±5.12
MV-43	19±29	.213±0.245	78.4±5.12
MV-47	-1±41	.194±0.256	12.89±0.89
MV-51	89±24	.165±0.247	71.68±4.48
MV-59	77±34	.009±0.204	-0.09±0.57
MV-61	14±28	.177±0.408	22.78±1.28

are shown on table 4. Nineteen of the twenty water samples analyzed contained concentrations of tritium larger than the reporting level; concentrations ranged from 4.67±0.57 to 106.56±7.04 pCi/L. For the purpose of comparison, background concentrations of tritium in ground water in Idaho generally range from 75 to 150 pCi/L (Orr and others, 1991). The maximum contaminant level for tritium in public drinking water supplies is 20,000 pCi/L (table 3).

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; however, laboratories normally report the radioactivity as if it were all given off by one radionuclide. In this report, concentrations are reported both as natural uranium in micrograms per liter and as thorium-230 in picocuries per liter. However, only the latter can be directly compared to the maximum contaminant level listed on table 3.

The gross alpha-particle radioactivity in the dissolved fraction of all the water samples exceeded the reporting level (table 5). The concentrations reported as thorium-230 ranged from 1.75±0.694 to 4.58±1.13 pCi/L. Gross alpha-particle radioactivity reported as thorium-230 in the suspended fraction of a water sample from one site (MV-14) exceeded the reporting level with a concentration of 1.10±0.563 pCi/L. Total concentrations of dissolved and suspended fractions of gross alpha-particle radioactivity in all the water samples were less than the maximum contaminant level of 15 pCi/L (table 3).

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. Laboratory instruments for these measurements are calibrated to a single radionuclide, cesium-137, or a chemically similar pair of radionuclides in

Table 5.--Concentrations of gross alpha-particle radioactivity in water from selected wells and springs, eastern Snake River Plain

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using a residue procedure. Analytical results and uncertainties--for example, 2.98±1.08--in indicated units. Abbreviations: µg/L--microgram per liter; pCi/L--picocurie per liter. Analytical uncertainties are reported as 2s. Site identifier: see figure 2 for location of sites. Symbols: * indicates quality assurance sample (see Quality Assurance section in text for explanation)]

Site identifier	Dissolved as uranium (µg/L)	Dissolved as thorium-230 (pCi/L)	Suspended as uranium (µg/L)	Suspended as thorium-230 (pCi/L)
MV-1	2.98±1.08	2.06±0.755	-0.026±0.449	-0.014±0.246
MV-4	5.62±1.51	4.07±1.09	-.276±0.318	-.148±0.180
MV-8*	4.04±1.22	2.79±0.845	-.166±0.278	-.087±0.150
MV-9	4.92±1.38	3.43±0.970	-.088±0.414	-.047±0.224
MV-11	5.59±1.47	3.91±1.04	-.155±0.395	-.083±0.212
MV-14	2.88±1.04	1.97±0.723	2.10±1.00	1.10±0.563
MV-15	3.71±1.18	2.58±0.824	.019±0.329	.010±0.178
MV-18	3.54±1.15	2.45±0.798	-.120±0.401	-.064±0.215
MV-21	2.46±0.976	1.75±0.694	-.187±0.314	-.101±0.173
MV-22*	.135±0.344	.092±0.235	-.096±0.373	-.050±0.198
MV-23	3.44±1.13	2.39±0.794	.081±0.361	.044±0.197
MV-25	6.33±1.59	4.54±1.14	.117±0.394	.061±0.207
MV-30	3.20±1.06	2.19±0.726	-.062±0.381	-.034±0.207
MV-33	3.19±1.12	2.29±0.806	.044±0.290	.024±0.160
MV-37	5.98±1.52	4.15±1.06	-.006±0.359	-.003±0.191
MV-39	6.16±1.55	4.30±1.09	-.274±0.316	-.149±0.180
MV-43	6.56±1.60	4.58±1.13	-.038±0.355	-.020±0.188
MV-47	2.89±1.04	2.02±0.729	-.304±0.296	-.167±0.173
MV-51	4.57±1.33	3.15±0.930	-.134±0.299	-.071±0.160
MV-59	2.54±0.954	1.76±0.667	.299±0.463	.161±0.256
MV-61	4.73±1.43	2.97±0.952	.130±0.499	.074±0.286

equilibrium, strontium-90 in equilibrium with yttrium-90. In this report, concentrations are reported in two ways: as strontium-90 in equilibrium with yttrium-90 in picocuries per liter, and as cesium-137 in picocuries per liter. Reporting of the concentrations of gross beta-particle radioactivity in either one of these ways is for reference purposes only and does not imply that the radioactivity is attributed to these specific isotopes. The average annual concentrations of strontium-90 and cesium-137 in public drinking water supplies that produce a 4-mrem/yr dose are 8 pCi/L and 120 pCi/L, respectively. Gross beta-particle radioactivity measurements should not be compared directly to these concentrations.

Gross beta-particle radioactivity was measured in both the dissolved and suspended fractions of the water samples. Dissolved concentrations of gross beta-particle radioactivity reported as cesium-137 and reported as strontium-90 in equilibrium with yttrium-90 in all water samples exceeded the reporting levels (table 6); concentrations ranged from 3.27±1.06 to 13.4±2.85 pCi/L, and 2.45±0.921 to 9.97±2.12 pCi/L, respectively. Suspended concentrations in all water samples were less than the reporting level.

Total Uranium

Uranium is a widely distributed element that has three naturally occurring radioactive isotopes: uranium-238, uranium-235, and uranium-234. These isotopes undergo a complex series of radioactive decay that results in their ultimate conversion to stable isotopes of lead (Haglund, 1972). Total uranium is a measurement of the combined concentrations of these three isotopes. Dissolved total uranium concentrations in all water samples except from MV-30 exceeded the reporting levels (table 7). The dissolved total uranium concentrations that exceeded the reporting level ranged from 1.26±0.189 to 6.10±0.915 μg/L. The proposed maximum contaminant level for total uranium is 20 μg/L (table 3).

Table 6.--Concentrations of gross beta-particle radioactivity in water from selected wells and springs, eastern Snake River Plain

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using a residue procedure. Analytical results and uncertainties--for example, 7.30±1.65--in picocuries per liter. Analytical uncertainties are reported as 2s. Site identifier: see figure 2 for location of sites. Abbreviations: Sr-90/Y-90--Strontium-90 in equilibrium with yttrium-90. Symbols: * indicates quality assurance sample (see Quality Assurance section in text for explanation)]

Site identifier	Dissolved as cesium-137	Dissolved as Sr-90/Y-90	Suspended as cesium-137	Suspended as Sr-90/Y-90
MV-1	7.30±1.65	5.46±1.24	0.269±0.484	0.261±0.468
MV-4	7.38±1.67	5.48±1.24	.009±0.512	.008±0.498
MV-8*	5.94±1.40	4.51±1.07	-.207±0.549	-.195±0.519
MV-9	8.96±2.31	6.86±1.77	.257±0.591	.205±0.471
MV-11	13.4±2.85	9.97±2.12	.418±0.514	.399±0.492
MV-14	3.56±1.12	2.77±0.867	.253±0.561	.204±0.452
MV-15	10.6±2.22	8.00±1.68	-.116±0.561	-.109±0.530
MV-18	7.51±1.86	5.72±1.42	.482±0.526	.469±0.512
MV-21	4.60±1.29	3.37±0.813	.448±0.599	.354±0.473
MV-22*	-.158±0.311	-.157±0.308	-.398±0.518	-.376±0.489
MV-23	8.41±1.89	6.27±1.41	.002±0.589	.002±0.499
MV-25	9.13±2.08	6.85±1.56	-.069±0.580	-.058±0.491
MV-30	6.25±1.62	4.74±1.23	-.304±0.569	-.242±0.453
MV-33	3.27±1.06	2.45±0.921	-.078±0.501	-.076±0.487
MV-37	4.75±1.45	3.49±1.38	.312±0.586	-.246±0.463
MV-39	7.81±1.88	5.92±1.42	.086±0.569	.068±0.453
MV-43	9.17±2.13	6.86±1.60	.125±0.586	.101±0.472
MV-47	4.07±1.06	3.13±0.812	.338±0.594	.286±0.503
MV-51	7.22±1.83	5.42±1.38	.233±0.570	.184±0.450
MV-59	4.37±1.24	3.26±0.796	-.561±0.538	-.446±0.428
MV-61	4.70±1.35	3.40±0.850	-.033±0.576	-.026±0.463

Table 7.--Concentrations of total uranium and selected radium isotopes in water from selected wells and springs, eastern Snake River Plain

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using the following methods: total uranium by extraction and laser-induced phosphorimetry; radium-226 by radon emanation; and radium-228 by separation and beta counting. Analytical results and uncertainties--for example, 2.13±0.319--in indicated units. Analytical uncertainties are reported as 2s. Site identifier: see figure 2 for location of sites. Abbreviations: µg/L--microgram per liter, pCi/L--picocurie per liter; Symbols: * indicates quality assurance sample (see Quality Assurance section in text for explantion)]

Site identifier	Total uranium (µg/L)	Radium-226 (pCi/L)	Radium-228 (pCi/L)
MV-1	2.13±0.319	0.072±0.016	0.018±0.464
MV-4	3.35±0.503	.058±0.018	.182±0.498
MV-8*	3.40±0.510	.079±0.016	.071±0.460
MV-9	4.48±0.673	.054±0.014	.327±0.444
MV-11	3.52±0.528	.145±0.026	-.081±0.496
MV-14	2.37±0.356	.154±0.026	.192±0.308
MV-15	3.52±0.528	.129±0.024	.308±0.316
MV-18	3.19±0.478	.097±0.018	.383±0.404
MV-21	1.78±0.267	.073±0.020	.280±0.332
MV-22*	.003±0.010	.086±0.016	.121±0.398
MV-23	2.03±0.304	.022±0.008	.311±0.530
MV-25	4.26±0.638	.074±0.020	.111±0.278
MV-30	.342±0.351	.098±0.020	.126±0.356
MV-33	1.26±0.189	.090±0.016	.158±0.504
MV-37	4.66±0.699	.108±0.022	.035±0.389
MV-39	6.10±0.915	.106±0.020	.176±0.328
MV-43	4.66±0.698	.134±0.022	.250±0.318
MV-47	1.70±0.254	.103±0.020	.127±0.280
MV-51	3.08±0.462	.135±0.024	.164±0.464
MV-59	1.61±0.241	.054±0.014	.239±0.286
MV-61	2.06±0.308	.082±0.016	.218±0.424

Radium

Radium-224 and radium-228 are naturally occurring radioactive decay products of thorium-232; radium-226 is a naturally occurring decay product of uranium-238. Radium-224 was not detected in any of the water samples. Concentrations of radium-226 exceeded the reporting level in all the water samples analyzed; concentrations ranged from 0.022±0.008 to 0.154±0.026 pCi/L (table 7). Concentrations of radium-228 in all the water samples were less than the reporting level. The sum of radium-226 and radium-228 concentrations in all the water samples was less than the maximum contaminant level of 5 pCi/L (table 3).

Cesium-137, Lead-212, Lead-214, and Bismuth-214

Gamma spectrometry involves using a series of detectors to simultaneously determine the concentrations of a variety of radionuclides by the identification of their characteristic gamma emissions. Four radionuclides were identified in the suspended fraction of water samples by gamma spectrometry.

Cesium-137 is a fission product of uranium-235, uranium-233, or plutonium-239. None of the samples had concentrations of cesium-137 that exceeded the reporting level (table 8).

Lead-212 is a decay product of radium-224 in the thorium-232 decay series. Lead-212 was identified in three water samples, but only one sample (MV-59), which had a concentration of 0.211±0.124 pCi/L, exceeded the reporting level (table 8).

Lead-214 is an intermediate isotope in the uranium-238 decay series. Lead-214 was identified in one water sample, MV-4, at a concentration less than the reporting level (table 8), but was not identified in the quality assurance replicate, MV-8.

Table 8.--Concentrations of cesium-137, lead-212, lead-214, and bismuth-214 in water from selected wells and springs, eastern Snake River Plain

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory using gamma spectrometry. All analytical results and uncertainties--for example, 0.0782±0.104--are for suspended concentrations in pCi/L (picocurie per liter). Analytical uncertainties are reported as 2s. Site identifier: see figure 2 for location of sites. Symbols: * indicates quality assurance sample (see Quality Assurance section in text for explanation); ·· indicates that the radionuclide was not detected in that sample; -- indicates no analysis available]

Site identifier	Cesium-137	Lead-212	Lead-214	Bismuth-214
MV-1	0.0782±0.104	··	··	··
MV-4	··	··	0.318±0.244	··
MV-8*	.0129±0.103	··	··	··
MV-9	.0465±0.103	··	··	··
MV-11	.0464±0.095	··	··	··
MV-14	-.013±0.092	··	··	··
MV-15	-.018±0.093	··	··	··
MV-18	-.077±0.101	··	··	··
MV-21	.131±0.131	··	··	··
MV-22*	-.0309±0.111	··	··	··
MV-23	-.012±0.095	··	··	··
MV-25	-.0034±0.089	··	··	··
MV-30	-.041±0.092	··	··	··
MV-33	-.0088±0.092	··	··	··
MV-37	.001±0.104	··	··	··
MV-39	··	0.180±0.121	··	··
MV-43	··	.166±0.114	··	··
MV-47	-.0036±0.096	··	··	··
MV-51	.0314±0.096	··	··	··
MV-59	··	.211±0.124	··	0.552±0.234
MV-61	--	--	--	--

Bismuth-214 is a naturally occurring member of the uranium-238 decay series. Bismuth-214 was identified in the sample from MV-59 at a concentration of 0.552±0.234 pCi/L, which exceeded the reporting level.

INORGANIC CONSTITUENTS

Water samples were analyzed for selected inorganic constituents. These constituents included trace elements, common ions, nutrients, and cyanide. In this report, reporting levels established for these constituents (Pritt and Jones, 1989) are not to be confused with reporting levels and analytical method detection limits for selected radionuclides.

Trace Elements

Water samples were collected and analyzed for selected dissolved trace elements including aluminum, arsenic, barium, cadmium, chromium, iron, lead, manganese, mercury, selenium, silver, and strontium. Water samples were also analyzed for total and hexavalent chromium. The maximum contaminant level and reporting level for selected trace elements are shown on table 9. The concentrations of dissolved trace elements are shown on table 10.

Aluminum concentrations in seven samples were equal to or greater than the reporting level and ranged from 10 to 30 μg/L; the proposed secondary maximum contaminant level is 50 μg/L. Concentrations of arsenic in all samples exceeded the reporting level and ranged from 2 to 4 μg/L; the maximum contaminant level is 50 μg/L. Barium concentrations in all samples were greater than the reporting level and ranged from 10 to 140 μg/L; the maximum contaminant level is 1,000 μg/L. Cadmium concentrations in samples from MV-1 and MV-11 were equal to the reporting level of 1 μg/L each; the maximum contaminant level is 10 μg/L. Chromium analyses included total, dissolved, and hexavalent chromium. Concentrations of total chromium in all the samples except MV-37 equaled or exceeded the reporting level and ranged from 1 to 6 μg/L; the maximum contaminant level is 50 μg/L. Concentrations of dissolved chromium in 14 samples were equal to or greater than the

Table 9.--Maximum contaminant levels and reporting levels of selected inorganic constituents in drinking water

[The maximum contaminant levels are for total measurements and were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1989, p. 547) for community water systems and are included only for comparison purposes. Proposed maximum contaminant levels--shown in parentheses--are from U.S. Environmental Protection Agency (1990a). Secondary maximum contaminant levels--shown in brackets--are from U.S. Environmental Protection Agency (1989, 1990a); -- indicates that maximum contaminant level has not been established for that chemical constituent. Units are in µg/L (microgram per liter) unless otherwise indicated. Reporting levels are from Pritt and Jones (1989). Abbreviations: mg/L--milligram per liter]

Constituent	Maximum contaminant level	Reporting level
Aluminum	[50]	10
Arsenic	50 (30)	1
Barium	1,000 (5,000)	2
Bromide (mg/L)	--	.01
Cadmium	10 (5)	1
Calcium (mg/L)	--	.02
Chloride (mg/L)	[250] --	.1
Chromium	50 (100)	1
Fluoride (mg/L)	4 [2]	.1
Iron	[300] --	3
Lead	50 (5)	1
Magnesium (mg/L)	--	.01
Manganese	[50] --	1
Mercury	2	.1
Potassium (mg/L)	--	.1
Selenium	10 (50)	1
Silica (mg/L)	--	.01
Silver	50 [90]	1
Sodium[1] (mg/L)	--	.2
Strontium	--	1
Sulfate (mg/L)	[250] --	1

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[1] Idaho Department of Health and Welfare (1989) recommends an optimum concentration of 20 mg/L.

Table 10.--Concentrations of some dissolved trace elements in water from selected wells and springs, eastern Snake River Plain

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in µg/L (microgram per liter); <1 indicates the concentration was less than the reporting level of 1 µg/L. Site identifier: see figure 2 for location of sites. Symbols: * indicates quality assurance sample (see Quality Assurance section in text for explanation)]

Site iden-					Chromium									
tifier	Aluminum	Arsenic	Barium	Cadmium	total	dissolved	hexavalent	Iron	Lead	Manganese	Mercury	Selenium	Silver	Strontium
MV-1	10	3	73	1	3	2	4	5	<1	<1	<0.1	<1	<1	320
MV-4	<10	3	46	<1	3	<1	2	4	<1	<1	<.1	<1	<1	300
MV-8*	<10	4	42	<1	3	4	5	7	<1	<1	<.1	<1	<1	280
MV-9	<10	4	140	<1	3	<1	<1	<3	1	<1	<.1	1	<1	440
MV-11	<10	3	110	1	2	<1	1	<3	<1	<1	<.1	1	<1	460
MV-14	20	2	44	<1	2	2	2	15	1	<1	<.1	<1	<1	280
MV-15	30	2	82	<1	3	2	1	11	<1	1	<.1	<1	<1	320
MV-18	10	3	59	<1	2	1	<1	<3	1	<1	<.1	<1	<1	340
MV-21	<10	2	20	<1	4	3	3	<3	1	<1	<.1	<1	<1	170
MV-22*	10	<1	<2	<1	1	<1	<1	4	2	<1	<.1	<1	<1	<1
MV-23	<10	3	100	<1	1	<1	<1	<3	<1	2	<.1	1	<1	340
MV-25	<10	4	58	<1	2	<1	2	<3	1	1	<.1	1	<1	290
MV-30	<10	2	73	<1	1	2	<1	9	1	1	<.1	1	<1	340
MV-33	<10	3	15	<1	4	4	5	80	1	2	<.1	<1	<1	150
MV-37	10	2	53	<1	<1	2	<1	<3	<1	4	<.1	<1	<1	230
MV-39	<10	3	61	<1	2	4	<1	16	1	<1	<.1	<1	<1	330
MV-43	<10	2	90	<1	2	1	1	<3	1	1	<.1	<1	<1	390
MV-47	<10	2	18	<1	3	3	<1	3	1	<1	<.1	<1	<1	180
MV-51	<10	3	63	<1	3	<1	3	5	1	<1	<.1	1	<1	340
MV-59	10	2	10	<1	4	2	4	16	8	4	<.1	<1	<1	120
MV-61	10	3	20	<1	6	5	<1	21	1	3	<.1	2	<1	170

reporting level and ranged from 1 to 5 μg/L. Hexavalent chromium concentrations in 12 samples were equal to or greater than the reporting level and ranged from 1 to 5 μg/L. Iron concentrations in 12 samples equaled or exceeded the reporting level and ranged from 3 to 80 μg/L; the secondary maximum contaminant level is 300 μg/L. Lead concentrations in 13 samples equaled or exceeded the reporting level and ranged from 1 to 8 μg/L; the maximum contaminant level is 50 μg/L. Concentrations of manganese in nine samples equaled or exceeded the reporting level and ranged from 1 to 4 μg/L; the secondary maximum contaminant level is 50 μg/L. All the samples had mercury concentrations less than the reporting level of 0.1 μg/L. Selenium concentrations in seven samples were equal to or greater than the reporting level and ranged from 1 to 2 μg/L; the maximum contaminant level is 10 μg/L. Concentrations of silver in all the samples were less than the reporting level of 1 μg/L. Strontium concentrations in all samples exceeded the reporting level and ranged from 120 to 460 μg/L; a maximum contaminant level has not been established.

Common Ions

Water samples were collected and analyzed for dissolved common ions including bromide, calcium, chloride, fluoride, magnesium, potassium, silica, sodium, and sulfate. The maximum contaminant levels or secondary maximum contaminant levels and the reporting levels for these ions are shown on table 9. The concentrations of common ions are shown on table 11.

Concentrations of bromide in all samples exceeded the reporting level and ranged from 0.02 to 0.21 mg/L. Calcium and chloride concentrations in all samples exceeded their respective reporting levels and ranged from 26 to 75 mg/L and from 9.1 to 100 mg/L, respectively. The secondary maximum contaminant level for chloride is 250 mg/L. Concentrations of fluoride in 18 samples exceeded the reporting level and ranged from 0.3 to 1.0 mg/L; the maximum contaminant level is 4 mg/L. Magnesium concentrations in all samples exceeded the reporting level and ranged from 14 to 32 mg/L. Concentrations of potassium in all samples exceeded the reporting level and ranged from 2.7 to 7.9 mg/L. Silica concentrations in all samples were

Table 11.--Concentrations of dissolved common ions in water from selected wells and springs, eastern Snake River Plain

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory. Analytical results in mg/L (milligram per liter); <1 indicates the concentration was less than the reporting level of 1 mg/L. Site identifier: see figure 2 for location of sites. Symbols: * indicates quality assurance sample (see Quality Assurance section in text for explanation)]

Site identifier	Bromide	Calcium	Chloride	Fluoride	Magnesium	Potassium	Silica	Sodium	Sulfate
MV-1	0.10	54	58	0.5	23	7.2	39	44	56
MV-4	.12	50	61	.5	25	4.8	33	54	67
MV-8*	.12	47	60	.4	23	4.4	33	49	66
MV-9	.21	72	100	.3	32	7.9	37	89	88
MV-11	.20	75	88	.3	30	7.3	37	63	82
MV-14	.11	53	44	<.1	21	4.5	34	29	61
MV-15	.13	60	51	.4	21	6.2	38	38	59
MV-18	.14	63	53	.3	26	5.3	37	37	72
MV-21	.03	31	12	.4	15	3.6	33	17	22
MV-22*	<.01	.07	.2	<.1	.04	<.1	.2	<.2	<1
MV-23	.09	68	46	.4	20	6.2	30	31	47
MV-25	.09	62	43	.3	25	6.4	35	50	60
MV-30	.14	65	54	.3	24	6.2	38	40	73
MV-33	.02	26	9.4	.6	14	3.3	33	14	20
MV-37	.04	56	20	<.1	18	4.1	31	23	39
MV-39	.07	66	31	.4	26	4.2	39	42	77
MV-43	.11	69	50	.4	27	5.6	37	42	61
MV-47	.03	33	15	.5	16	3.4	34	19	29
MV-51	.13	66	58	.4	26	6.1	35	40	62
MV-59	.02	27	9.1	.5	14	3.2	35	17	17
MV-61	.05	37	22	1.0	16	2.7	32	17	16

greater than the reporting level and ranged from 30 to 39 mg/L. Concentrations of sodium in all samples were greater than the reporting level and ranged from 14 to 89 mg/L. IDHW (1989) has recommended an optimum level of sodium for public drinking water supplies of 20 mg/L. Concentrations of sulfate in all samples exceeded the reporting level and ranged from 16 to 88 mg/L; the secondary maximum contaminant level for sulfate is 250 mg/L.

Nutrients and Cyanide

Water samples were analyzed for dissolved ammonia (as nitrogen), nitrite (as nitrogen), nitrite plus nitrate (as nitrogen), orthophosphate, and cyanide. The maximum contaminant level proposed by the U.S. Environmental Protection Agency (1989 and 1990b) and the reporting level for nitrite, nitrite plus nitrate, and cyanide are shown on table 12. A maximum contaminant level has not been established or proposed for ammonia or orthophosphate.

Concentrations of nutrients are shown on table 13. Ammonia concentrations in 15 samples equaled or exceeded the reporting level and ranged from 0.010 to 0.041 mg/L. Concentrations of nitrite in all samples were less than the reporting level of 0.010 mg/L. Concentrations of nitrite plus nitrate in all samples exceeded the reporting level and ranged from 0.5 to 5.5 mg/L; the maximum contaminant level is 10 mg/L (table 12). Orthophosphate concentrations as phosphorus in 10 samples equaled or exceeded the reporting level and ranged from 0.010 to 0.070 mg/L. Concentrations of cyanide were all less than the reporting level of 0.01 mg/L.

ORGANIC COMPOUNDS

Water samples were analyzed for selected organic compounds. These compounds included dissolved organic carbon, surfactants, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides. In this report, reporting levels established for these constituents (Pritt and

Table 12.--Maximum contaminant levels and reporting levels for selected nutrients, surfactants, cyanide, and dissolved organic carbon in drinking water

[The maximum contaminant level was established pursuant to the recommendations of the U.S. Environmental Protection Agency (1989 amd 1990a) for community water systems and are included only for comparison purposes. Proposed maximum contaminant levels--shown in parentheses--are from U.S. Environmental Protection Agency (1990a). Units are milligrams per liter. Reporting levels are from Pritt and Jones (1989). Symbols: -- indicates that a maximum contaminant level has not been established or proposed for that constituent]

Constituent	Maximum contaminant level	Reporting level
Ammonia (as nitrogen)	--	0.010
Nitrite (as nitrogen)	(1)	.010
Nitrite plus nitrate (as nitrogen)	10	.10
Orthophosphate (as phosphorus)	--	.010
Cyanide	(.2)	.01
Dissolved organic carbon	--	.1
Surfactants[1]	--	.01

[1] Secondary maximum contaminant level for surfactants is 0.5 mg/L (U.S. Environmental Protection Agency, 1989, p. 656).

Jones, 1989) are not be be confused with reporting levels and analytical method detection limits for selected radionuclides.

Dissolved Organic Carbon

Water samples were analyzed for DOC (dissolved organic carbon), and concentrations are shown on table 13. Concentrations of DOC in all samples were greater than the reporting level of 0.1 mg/L (table 12), and ranged from 0.3 to 2.2 mg/L; no maximum contaminant level has been established.

Surfactants

Water samples were analyzed for surfactants (table 13). Concentrations of surfactants in all samples equaled or exceeded the reporting level of 0.01 mg/L (table 12) and ranged from 0.01 to 0.07 mg/L; the secondary maximum contaminant level is 0.5 mg/L (U.S. Environmental Protection Agency, 1989).

Purgeable Organic Compounds

Samples from all sites were analyzed for 36 purgeable organic compounds. The maximum contaminant levels and reporting levels for these compounds are shown on table 14. Only one of the compounds, toluene, was detected in one water sample. The toluene concentration from MV-11 was 0.3 μg/L; the proposed maximum contaminant level is 2,000 μg/L.

Insecticides and Polychlorinated Compounds

Water samples were analyzed for concentrations of 10 carbamate insecticides, 11 organophosphorus insecticides, 15 organochlorine insecticides, gross polychlorinated biphenyls (PCB's) and gross polychlorinated naphthalenes (PCN's). The maximum contaminant levels and reporting levels

Table 13.--Concentrations of nutrients, cyanide, dissolved organic carbon, and surfactants in water from selected wells and springs, eastern Snake River Plain

[Analyses by U.S. Geological Survey's National Water Quality Laboratory. Analytical results in mg/L (milligram per liter); <0.010 indicates the concentration was less than the reporting level of 0.010 mg/L. Site identifier: see figure 2 for location of sites. Symbols: * indicates quality assurance sample (see Quality Assurance section in text for explantion)]

Site identifier	Ammonia (as nitrogen)	Nitrite (as nitrogen)	Nitrite plus nitrate (as nitrogen)	Orthophosphate (as phosphorus)	Cyanide	Dissolved organic carbon	Surfactants
MV-1	0.021	<0.010	1.2	0.010	<0.01	0.8	0.05
MV-4	<.010	<.010	1.8	.010	<.01	1.1	.04
MV-8*	<.010	<.010	1.9	<.010	<.01	1.2	.04
MV-9	.010	<.010	5.5	.021	<.01	2.2	.07
MV-11	<.010	<.010	4.9	<.010	<.01	1.6	.06
MV-14	.041	<.010	1.6	<.010	<.01	.9	.04
MV-15	.021	<.010	2.1	<.010	<.01	.9	.05
MV-18	.021	<.010	2.2	<.010	<.01	1.0	.05
MV-21	.030	<.010	1.0	.021	<.01	.3	.03
MV-22*	.010	<.010	<.1	.021	<.01	.5	.01
MV-23	<.010	<.010	3.7	.050	<.01	.8	.05
MV-25	.021	<.010	2.7	.070	<.01	1.4	.06
MV-30	.021	<.010	2.5	<.010	<.01	.9	.05
MV-33	<.010	<.010	.5	.010	<.01	.4	.03
MV-37	.030	<.010	2.0	.041	<.01	1.0	.04
MV-39	.021	<.010	2.4	.050	<.01	1.2	.05
MV-43	.010	<.010	4.1	<.010	<.01	1.1	.07
MV-47	.041	<.010	.7	<.010	<.01	.4	.03
MV-51	.010	<.010	3.5	.041	<.01	1.3	.04
MV-59	.010	<.010	.7	<.010	<.01	.3	.03
MV-61	.021	<.010	1.1	<.010	<.01	.4	.05

Table 14.--Maximum contaminant levels and reporting levels of selected purgeable organic compounds in drinking water

[Analyses were performed by the U.S. Geological Survey's National Water Quality Laboratory (NWQL) using an analytical method equivalent to U.S. Environmental Protection Agency method 524 (Pritt and Jones, 1989). The reporting level for all compounds is 0.2 micrograms per liter (Pritt and Jones, 1989). Maximum contaminant level: * indicates that total trihalomethanes--which include bromoform, chloroform, dibromochloromethane, and dichlorobromomethane--in community water systems serving 10,000 or more persons cannot exceed 100 micrograms per liter (U.S. Environmental Protection Agency, 1989, p. 548). Symbols: -- indicates that a maximum contaminant level has not been established or proposed for that compound. Proposed maximum contaminant levels--shown in parentheses--are from J. Rodin (U.S. Environmental Protection Agency, written commun., 1989) and U.S. Environmental Protection Agency (1990a). Units are $\mu g/L$ (microgram per liter)]

Compound	Maximum contaminant level	Compound	Maximum contaminant level
Benzene	5.0	Ethylbenzene	(70)
Bromoform	*	1,3-Dichloropropene	--
Carbon tetrachloride	5.0	Cis-1,3-Dichloropropene	--
Chlorobenzene	(100)	Styrene	(5/100)
Chloroethane	--	Methyl bromide	--
2-Chloroethyl vinyl ether	--	Trans-1,3-Dichloropropene	--
Chloroform	*	Chloromethane	--
Dibromochloromethane	*	Dichlorobromomethane	*
Methylene chloride	--	Toluene	(2,000)
1,1,2,2-Tetrachloroethane	--	Trichlorofluoromethane	--
1,2-Dichloroethane	5.0	Tetrachloroethylene	(5.0)
1,2-Dichlorobenzene	(600)	1,3-Dichlorobenzene	--
1,4-Dichlorobenzene	75	Trichloroethylene	5.0
1,1,1-Trichloroethane	200	1,2-trans-Dichloroethylene	(100)
1,1,2-Trichloroethane	(5)	Dichlorodifluoromethane	--
1,2-Dibromoethane	--	1,2-Dichloropropane	(5.0)
1,1-Dichloroethane	--	Xylenes, mixed	(10,000)
Vinyl chloride	2.0	1,1-Dichloroethylene	7.0

for these compounds are shown on table 15. None of the measured organic compounds exceeded their respective reporting levels.

Herbicides

Concentrations of 12 triazine herbicides and 4 chlorophenoxy acid herbicides were determined by the NWQL. Maximum contaminant levels and reporting levels for these compounds are shown on table 16. None of the measured herbicides exceeded their respective reporting levels.

FECAL COLIFORM BACTERIA

Water samples were analyzed for fecal coliform bacteria by the IDHW laboratory at Twin Falls, Idaho. Coliform-density tests indicated two samples, MV-11 and MV-15, had counts of one colony per 100 mL. The other samples had zero counts per 100 mL. The maximum contaminant level for public drinking water supplies for bacteria is based on the presence or absence of total coliforms (essentially zero colonies per 100 mL) (U.S. Environmental Protection Agency, 1990a). Because fecal coliform is one of the species included in the total coliform test, the presence of fecal coliform in a sample suggests that the sample exceeds the maximum contaminant level.

SUMMARY

The U.S. Geological Survey and the Idaho Department of Water Resources, in response to a request from the U.S. Department of Energy, sampled 19 sites as part of a long-term project to monitor water quality of the Snake River Plain aquifer from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area. Water samples were collected and analyzed for manmade pollutants and naturally occurring constituents. The samples were collected from seven irrigation wells, five domestic wells, two springs, one stock well, two dairy wells, one observation well, and one

Table 15.--Maximum contaminant levels and reporting levels of selected insecticides and gross polychlorinated compounds in drinking water

[The maximum contaminant levels were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1989, p. 548) for community water systems and are included only for comparison purposes. Proposed maximum contaminant levels--shown in parentheses--are from U.S. Environmental Protection Agency (1990a). Reporting levels are from Pritt and Jones (1989). Units are in µg/L (microgram per liter). Symbols: -- indicates that a maximum contaminant level has not been established or proposed for that compound]

Carbamate insecticides: reporting level is 0.5 µg/L

Insecticide	Maximum contaminant level	Insecticide	Maximum contaminant level
Aldicarb	(10)	Methomyl	--
Aldicarb sulfone	(40)	1-Naphthol	--
Aldicarb sulfoxide	(10)	Oxamyl	(200)
Carbofuran	(40)	Propham	--
3-Hydroxycarbofuran	--	Carbaryl (Sevin)	--

Organophosphorus insecticides: reporting level is 0.01 µg/L

Insecticide	Maximum contaminant level	Insecticide	Maximum contaminant level
Chlorpyrifos; Dursban	--	Methyl parathion	--
Diazinon	--	Methyl trithion	--
Disulfoton	--	Parathion	--
Ethion	--	Phorate	--
Fonofos	--	Trithion	--
Malathion	--		

Table 15.--Maximum contaminant levels and reporting levels of selected insecticides and gross polychlorinated compounds in drinking water--Continued

Organochlorine insecticides: reporting level is 0.01 μg/L except for chlordane and perthane (0.1 μg/L), and toxaphene (1.0 μg/L)

Insecticide	Maximum contaminant level	Insecticide	Maximum contaminant level
Aldrin	--	Heptachlor	(0.4)
Chlordane	(2.0)	Heptachlor epoxide	(.2)
DDD	--	Lindane	4.0
DDE	--		(.2)
DDT	--	Methoxychlor	100
Dieldrin	--		(400)
Endosulfan	--	Mirex	--
Endrin	.2	Perthane	--
		Toxaphene	5.0

Gross polychlorinated compounds: reporting level is 0.1 μg/L

Compound	Maximum contaminant level
Gross polychlorinated biphenyls (PCB's)	(0.5)
Gross polychlorinated naphthalenes (PCN's)	--

Table 16.--Maximum contaminant levels and reporting levels of triazines and chlorophenoxy acid herbicides in drinking water

[The maximum contaminant levels were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1989) for community water systems and are included only for comparison purposes. Proposed maximum contaminant levels--shown in parentheses--are from U.S. Environmental Protection Agency (1990a). Reporting levels are from Pritt and Jones (1989). Symbols: -- indicates that a maximum contaminant level has not been established or proposed for that compound. Units are µg/L (microgram per liter)]

Triazines and other nitrogen-containing herbicides: reporting level is 0.1 µg/L

Herbicide	Maximum contaminant level	Herbicide	Maximum contaminant level
Alachlor	(2.0)	Prometon	--
Ametryn	--	Prometryn	--
Atrazine	(3.0)	Propazine	--
Cyanazine	--	Simazine	(1.0)
Metolachlor	--	Simetryn	--
Metribuzin	--	Trifluralin	--

Chlorophenoxy acid herbicides: reporting level is 0.01 µg/L

Herbicide	Maximum contaminant level	Herbicide	Maximum contaminant level
2,4-D	100, (70)	Silvex	10, (50)
2,4-DP	--	2,4,5-T	--

commercial well. Two quality assurance samples also were collected and analyzed. The samples were analyzed for selected radionuclides, inorganic constituents, organic compounds, and bacteria.

Radon-222 was detected at concentrations exceeding the reporting level at seven sites, but none exceeded the proposed maximum contaminant level. Concentrations of strontium-90 in all samples were less than the reporting level. Nineteen water samples had concentrations of tritium greater than the reporting level, but none exceeded the maximum contaminant level for drinking water.

Concentrations of dissolved and/or suspended gross alpha-particle radioactivity in all samples exceeded the reporting level; none exceeded the U.S. Environmental Protection Agency maximum contaminant level. Concentrations of dissolved gross beta-particle radioactivity in all samples exceeded the reporting level. Total uranium concentrations exceeded the reporting level in 19 water samples, but none exceeded the proposed maximum contaminant level. Radium-226 concentrations exceeded the reporting level in all samples; radium-228 concentrations were less than the reporting level in all samples; none exceeded the established maximum contaminant levels for radium isotopes. Four radionuclides were identified using gamma spectroscopy. Cesium-137 was identified in 16 samples, lead-212 in 3 samples, lead-214 in 1 sample, and bismuth-214 in 1 sample. Concentrations of lead-212 in one sample and bismuth-214 in one sample exceeded the reporting level.

All the samples contained one or more dissolved trace elements and common ions in concentrations greater than the reporting levels. No samples exceeded an established maximum contaminant level.

Concentrations of ammonia (as nitrogen) in water samples from 15 sites exceeded the reporting level. Concentrations of nitrite plus nitrate (as nitrogen) in all the water samples exceeded the reporting level. Concentrations of orthophosphate (as phosphorus) in 10 of the water samples exceeded the reporting level. Concentrations of nitrite (as nitrogen) and cyanide in all samples were less than the reporting level. Nutrient concentrations did not exceed established maximum contaminant levels.

Concentrations of dissolved organic carbon exceeded the reporting level in all the samples. Surfactants in all water samples exceeded the reporting level but did not exceed secondary maximum contaminant levels. Toluene concentrations exceeded the reporting level in one water sample. No carbamate insecticides, organophosphorous insecticides, organochlorine insecticides, gross PCB's, gross PCN's, or herbicides were detected at concentrations exceeding their respective reporting levels.

Water samples from two sites had fecal coliform bacteria counts that exceeded the U.S. Environmental Protection Agency's maximum contaminant level for drinking water.

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