Radiochemical and Chemical Constituents in Water from Selected Wells and Springs from the Southern Boundary of the Idaho National Engineering Laboratory to the Hagerman Area, Idaho, 1996

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U.S. GEOLOGICAL SURVEY
Open-File Report 97-360

Prepared in cooperation with the
U.S. DEPARTMENT OF ENERGY
and
IDAHO DEPARTMENT OF WATER RESOURCES

Idaho Falls, Idaho
June 1997

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

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CONVERSION FACTORS AND ABBREVIATED UNITS

Multiply	By	To Obtain
acre-foot per year (acre-ft/yr)	1,233	cubic meter per year
foot (ft)	0.3048	meter
gallon (gal)	3.785	liter
mile (mi)	1.609	kilometer
millirem per year (mrem/yr)	0.010	millisievert per year
picocurie per liter (pCi/L)	0.037	becquerel per liter
square mile (mi^2)	2.590	square kilometer

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

Abbreviated units used in report: mL (milliliter); L (liter); µg/L (microgram per liter); mg/L (milligram per liter); µm (micrometer); 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 cooperation with the U.S. Department of Energy, sampled 19 sites as part of the fourth round 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 selected radiochemical and chemical constituents. The samples were collected from nine irrigation wells, three domestic wells, two dairy wells, two springs, one commercial well, one stock well, and one observation well. Two quality-assurance samples also were collected and analyzed. Additional sampling at six sites was done to complete the third round of sampling.

None of the radiochemical or chemical constituents exceeded the established maximum contaminant levels for drinking water. Many of the radionuclide- and inorganic-constituent concentrations were greater than their respective reporting levels.

INTRODUCTION

Recently, the public has expressed concern about waste-disposal practices at the Idaho National Engineering Laboratory (INEL) and the effect these practices might have had on the water quality of the Snake River Plain aquifer. The U.S. Department of Energy (DOE) requested that the U.S. Geological Survey (USGS) conduct two studies to respond to the public's concern and to gain a greater understanding of the radiochemical and 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 (IDWR) and the DOE. The first round of sampling for the second study involved analyzing water samples collected from 55 sites during August and September 1989 (Wegner and Campbell, 1991). The second round of sampling involved analyzing water samples collected from 19 of the initial 55 sites in 1990 (Bartholomay and others, 1992), another 18 of the initial 55 sites in 1991 (Bartholomay and others, 1993), and the remaining 18 sites in 1992 (Bartholomay and others, 1994a). The third round of sampling involved analyzing water samples collected from 19 of the initial 55 sites in 1993 (Bartholomay and others, 1994b), another 18 of the initial 55 sites during 1994 (Bartholomay and others, 1995), and another 17 of the initial 55 sites during 1995 (Bartholomay and others, 1996). This report summarizes the results of analyses of water samples collected in 1996 as the beginning of the fourth round of sampling, which involved analyzing 19 of the initial 55 sites. This report also presents data from one more water sample collected in 1996 as part of the third round and data from five round-three sites that were resampled for selected

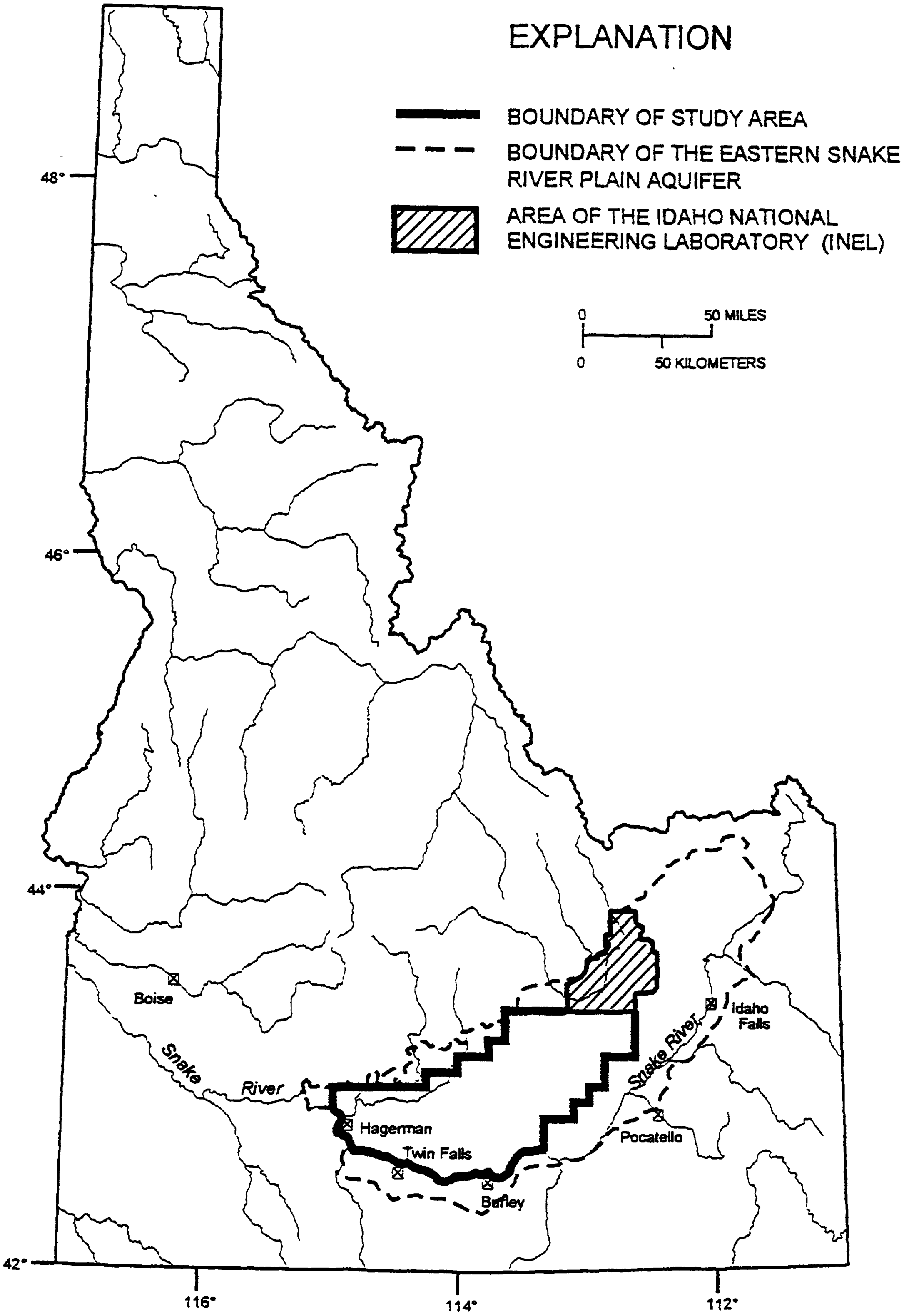

Figure 1. Location of study area, between the Idaho National Engineering Laboratory and Hagerman, Idaho.

stable isotopes because results were not obtained previously.

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). In the past, wastewater containing chemical and radiochemical wastes generated at the INEL was discharged mostly to ponds and wells. Since 1983, most aqueous wastes have been discharged to infiltration ponds. Many of the constituents in the wastewater enter the aquifer indirectly by 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 intermittently at concentrations of 3,400±200 pCi/L or less in water from three wells along the southern boundary of the INEL between 1983 and 1985. Since April 1985, tritium concentrations in water from wells near the southern boundary of the INEL have been less than the reporting level (Bartholomay and others, 1997, p. 27).

Water samples collected from the 19 sites (fig. 2) in the fourth round of sampling were analyzed for selected radionuclides, trace elements, common ions, nutrients, purgeable organic compounds, carbamate insecticides, organophophorus insecticides, gross polychlorinated biphenyls (PCBs), gross polychlorinated naphthalenes (PCNs), chlorophenoxy-acid herbicides, and other herbicides by the USGS National Water Quality Laboratory (NWQL) at Arvada, Colo. Samples also were collected at the same sites for selected radionuclide analyses by the Idaho State University (ISU) Environmental Monitoring Laboratory at Pocatello, Idaho. One replicate water sample and one blank sample also were collected and analyzed as a measure of quality assurance.

A water sample collected from one site (MV-35, fig. 2) to complete the third round of sampling was analyzed by the NWQL for selected radionuclides, stable isotopes, trace elements, common ions, nutrients, dissolved organic carbon, anionic surfactants as methylene blue active substances, purgeable organic compounds, carbamate insecticides, organophosphorus insecticides, organochlorine insecticides, PCBs, PCNs, chlorophenoxy-acid herbicides, and other herbicides. A sample also was collected at MV-35 for analyses of selected radionuclides by the ISU Environmental Monitoring Laboratory. Results of selected analyses are given in table 1. Selected stable-isotope data from five sites (MV-01, MV-02, MV-12, MV-29, and MV-53; fig. 2) resampled because of complications with sample collection, delivery, and analyses during the third round also are presented in table 1. A more detailed description of stable-isotope data is presented in a report by Bartholomay and others (1996, p. 12-13). The data in table 1 complete the third round of analyses and will not be included in discussions of constituents analyzed as part of the fourth round of sampling.

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 of several thousand feet in places. Alluvial fan deposits are composed primarily of sand and gravel, whereas in 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 8,205 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 of recharge and discharge locally affect the movement of ground water (Garabedian, 1986).

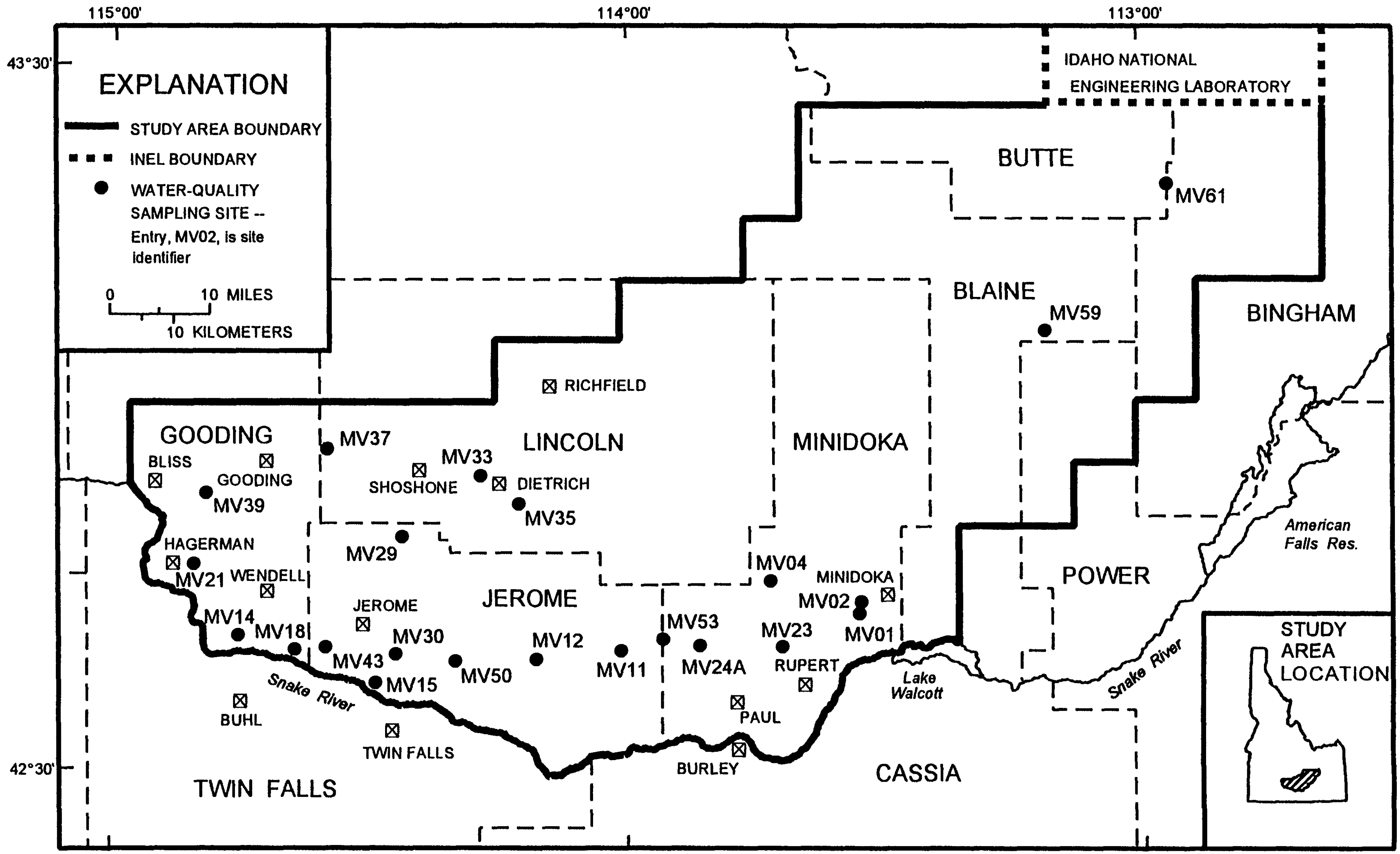

Figure 2. -- Location of selected water-quality sampling sites on the eastern Snake River Plain.

Table 1. Results of field measurements and concentrations of selected radiochemical and chemical constituents in water from round-three samples from selected wells, eastern Snake River Plain

[See figure 2 for location of sites. Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory (NWQL) and Idaho State University (ISU) Environmental Monitoring Laboratory. Analyses done by NWQL unless otherwise indicated. Analytical results in indicated units. Constituents dissolved unless otherwise indicated. Analytical uncertainties for radiochemical constituents are reported as 2s. Concentrations that exceed the reporting level of 3 times 1s are shown in boldface type. Units: pH, negative base-10 logarithm of hydrogen-ion activity in moles per liter; specific conductance, microsiemens per centimeter (µS/cm) at 25°C (degrees Celsius); water temperature, °C; alkalinity, milligrams per liter (mg/L) as calcium carbonate using digital titration with 0.16 normal sulfuric acid; dissolved oxygen, mg/L using azide modification of Winkler method (American Public Health Association of Water Pollution Control Federation, 1985). Abbreviations: µg/L, microgram per liter; pCi/L, picocurie per liter; NM, not measured; SD, sample destroyed; NR, not requested. Symbol: <, concentration was less than the respective minimum reporting level; ±, plus or minus; permil, parts per thousand relative to a standard. A more detailed description of stable-isotope data is presented in Bartholomay and others, 1996, p. 12-13]

	Well identifier					
Field measurement or constituent	**MV-01**	**MV-02**	**MV-12**	**MV-29**	**MV-35**	**MV-53**
pH	7.8	7.8	7.9	8.1	8.2	7.8
Specific conductance (µS/cm)	614	600	666	351	289	816
Water temperature (°C)	13.5	13.5	14.5	14.5	14.5	15.5
Alkalinity (mg/L)	NM	166	170	121	113	NM
Dissolved oxygen (mg/L)	NM	NM	NM	NM	7.6	NM
Strontium-90 (pCi/L)	NR	NR	NR	NR	SD	NR
Total tritium (pCi/L)	NR	NR	NR	NR	**4.00±0.576**	NR
Total tritium (ISU) (pCi/L)	NR	NR	NR	NR	0±100	NR
Gross alpha as thorium-230 (pCi/L)	NR	NR	NR	NR	1.97±1.52	NR
Total gross alpha as thorium-230 (ISU) (pCi/L)	NR	NR	NR	NR	1.1±2.3	NR
Gross beta as cesium-137 (pCi/L)	NR	NR	NR	NR	**3.43±0.948**	NR
Total gross beta as cesium-137 (ISU) (pCi/L)	NR	NR	NR	NR	2.6±2.1	NR
Hydrogen-2/hydrogen-1 (±2 permil)	NR	NR	-133	NR	-137	NR
Oxygen-18/oxygen-16 (±0.2 permil)	NR	NR	-17.38	NR	-17.92	NR
Carbon-13/carbon-12 (±0.3 permil)	-9.9	NR	NR	-9.5	-9.6	NR
Sulfur-34/sulfur-32 (±0.2 permil)	NR	NR	NR	NR	10.6	NR
Nitrogen-15/nitrogen-14 (±0.2 permil)	NR	4.5	NR	NR	2.8	4.6
Aluminum (µg/L)	NR	NR	NR	NR	7.7	NR
Arsenic (µg/L)	NR	NR	NR	NR	3	NR
Barium (µg/L)	NR	NR	NR	NR	13	NR
Beryllium (µg/L)	NR	NR	NR	NR	<.5	NR
Cadmium (µg/L)	NR	NR	NR	NR	2	NR
Chromium (µg/L)	NR	NR	NR	NR	<5	NR
Hexavalent chromium (µg/L)	NR	NR	NR	NR	1	NR
Total chromium (µg/L)	NR	NR	NR	NR	3.6	NR
Cobalt (µg/L)	NR	NR	NR	NR	<3	NR
Copper (µg/L)	NR	NR	NR	NR	<10	NR

Table 1. Results of field measurements and concentrations of selected radiochemical and chemical constituents in water from round-three samples from selected wells, eastern Snake River Plain—Continued

Field measurement or constituent	Well identifier					
	MV-01	MV-02	MV-12	MV-29	MV-35	MV-53
Iron (µg/L)	NR	NR	NR	NR	<3	NR
Lead (µg/L)	NR	NR	NR	NR	<1	NR
Lithium (µg/L)	NR	NR	NR	NR	11	NR
Manganese (µg/L)	NR	NR	NR	NR	<1	NR
Mercury (µg/L)	NR	NR	NR	NR	<.1	NR
Molybdenum (µg/L)	NR	NR	NR	NR	<10	NR
Nickel (µg/L)	NR	NR	NR	NR	<10	NR
Selenium (µg/L)	NR	NR	NR	NR	<1	NR
Silver (µg/L)	NR	NR	NR	NR	<1	NR
Strontium (µg/L)	NR	NR	NR	NR	150	NR
Vanadium (µg/L)	NR	NR	NR	NR	<6	NR
Zinc (µg/L)	NR	NR	NR	NR	<3	NR
Bromide (mg/L)	NR	NR	NR	NR	.02	NR
Calcium (mg/L)	NR	NR	NR	NR	24	NR
Chloride (mg/L)	NR	NR	NR	NR	8	NR
Fluoride (mg/L)	NR	NR	NR	NR	.5	NR
Magnesium (mg/L)	NR	NR	NR	NR	12	NR
Potassium (mg/L)	NR	NR	NR	NR	3	NR
Silica (mg/L)	NR	NR	NR	NR	30	NR
Sodium (mg/L)	NR	NR	NR	NR	13	NR
Sulfate (mg/L)	NR	NR	NR	NR	19	NR
Ammonia (as nitrogen) (mg/L)	NR	NR	NR	NR	.03	NR
Nitrite (as nitrogen) (mg/L)	NR	NR	NR	NR	<.01	NR
Nitrite plus nitrate (as nitrogen) (mg/L)	NR	NR	NR	NR	.5	NR
Orthophosphate (as phosphorous) (mg/L)	NR	NR	NR	NR	.01	NR
Organic carbon (mg/L)	NR	NR	NR	NR	.2	NR
Anionic surfactants (mg/L)	NR	NR	NR	NR	<.02	NR

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 from about 3.1 million to about 4.3 million acre-ft/yr, largely as a result of increased recharge from infiltration of irrigation water (Kjelstrom, 1992, fig. 27).

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. The authors are grateful for technical review of the manuscript by Helen Harrington of the IDWR and Linda C. Davis of the USGS.

METHODS AND QUALITY ASSURANCE

The methods used in sampling and analyzing for selected chemicals generally followed the guidelines established by the USGS (Goerlitz and Brown, 1972; Stevens and others, 1975; Wood, 1981; Claassen, 1982; W.L. Bradford, USGS, written commun., 1985; Wershaw and others, 1987; Fishman and Friedman, 1989; Faires, 1992; and Fishman, 1993). The methods used in the field and quality-assurance practices are described in the following sections.

Site Selection

Fourth-round water samples were collected at 19 sites (fig. 2), including 9 irrigation wells, 3 domestic wells, 2 dairy wells, 2 springs, 1 commercial well, 1 stock well, and 1 observation well. One replicate water sample and one blank sample also were collected. The irrigation wells were equipped with turbine pumps. The domestic, dairy, commercial, stock, and observation 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 Timme (1995). Water samples analyzed by ISU were collected in accordance with laboratory requirements specified by the Director of the Environmental Monitoring Program at ISU. Containers and preservatives were supplied by the respective laboratories. Containers and preservatives used for this study are listed on table 2.

Sample Collection

Three of the irrigation wells discharged into stilling ponds or canals and were sampled from the discharge pipe. The remaining irrigation wells were sampled from spigots in discharge lines near pumps; domestic, dairy, and commercial wells were sampled from spigots closest 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 pumped long enough to ensure that pressure tanks and pumping systems had been thoroughly flushed as evidenced by stable pH, specific conductance, and water-temperature measurements. The two springs were sampled as near the sources as possible by collecting a grab sample from an area of moving water.

Chemical and physical characteristics monitored at the water-sampling sites included pH, specific conductance, water temperature, alkalinity, and 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 characteristics indicated probable hydraulic and chemical stability. After collection, sample containers were sealed with laboratory film, labeled, and packed into ice chests for shipment to the NWQL. The samples

Table 2. Containers and preservatives used for water-sample collection

[Abbreviations: L, liter; mL, milliliter; µm, micrometer; gal, gallon; °C, degrees Celsius. Chemical formulas: HNO_3, nitric acid; $K_2Cr_2O_7$, potassium dichromate; $SrCl_2$, strontium chloride. Chilled samples were shipped by overnight-delivery mail. Analyzing laboratory: NWQL, U.S. Geological Survey National Water Quality Laboratory; ISU, Idaho State University Environmental Monitoring Laboratory]

Constituent or type of constituent	Container		Preservative		Other treatment	Analyzing laboratory
	Type	Size	Type	Size		
Strontium-90	Polyethylene, acid rinsed	1 L	HNO_3	4 mL	0.45-µm filter	NWQL
Tritium	Polyethylene	1 L	None	None	None	NWQL
	Polyethylene	1 L	None	None	None	ISU
Other radionuclides	Polyethylene, acid rinsed	1 L	HNO_3	4 mL	.45-µm filter	NWQL
	Polyethylene	1 gal	None	None	None	ISU
Stable isotopes for:						
Carbon	Glass, baked	1 L	Ammoniacal $SrCl_2$	50 mL	None	NWQL
Nitrogen	Glass, baked	1 L	None	None	Chill 4°C	NWQL
Sulfur	Polyethylene	1 L	None	None	None	NWQL
Hydrogen and oxygen	Glass	60 mL	None	None	None	NWQL
Trace elements	Polyethylene, acid rinsed	250 mL	HNO_3	1 mL	.45-µm filter	NWQL
	Polyethylene	125 mL	None	None	None	NWQL
Mercury	Glass, acid rinsed	250 mL	$HNO_3/K_2Cr_2O_7$	10 mL	.45-µm filter	NWQL
Common ions	Polyethylene, acid rinsed	500 mL	HNO_3	2 mL	.45-µm filter	NWQL
	Polyethylene, acid rinsed	500 mL	HNO_3	2 mL	None	NWQL
	Polyethylene	250 mL	None	None	.45-µm filter	NWQL
	Polyethylene	250 mL	None	None	None	NWQL
Nutrients	Polyethylene, brown	125 mL	None	None	.45-µm filter, chill 4°C	NWQL
Dissolved organic carbon	Glass, baked	125 mL	None	None	Silver filter, chill 4°C	NWQL
Anionic surfactants	Polyethylene	250 mL	None	None	Chill 4°C	NWQL
Purgeable organic compounds	Glass, baked	40 mL	None	None	Chill 4°C	NWQL
Pesticides	Glass, baked	1 L	None	None	Chill 4°C	NWQL

collected for ISU were stored in coolers until they were hand-delivered to the laboratory.

Field measurements of pH, specific conductance, water temperature, and alkalinity are shown on table 3. Ranges for these measurements, excluding values for the blank sample, were from 7.6 to 8.2 for pH, which is within the U.S. Environmental Protection Agency's (1994) recommended range of 6.5 to 8.5 for community water systems; from 306 to 988 µS/cm for specific conductance; from 11.5 to 16.5°C for water temperature; and from 121 to 251 mg/L for alkalinity as calcium carbonate.

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 USGS Project Office at the INEL.

Table 3. Results of field measurements of water for pH, specific conductance, temperature, and alkalinity from selected wells and springs, eastern Snake River Plain

[See figure 2 for location of sites. Site type: I, irrigation; QA, quality assurance (MV-08 is a replicate of MV-30; MV-22 is a blank of inorganic- and organic-free water); D, dairy; Sp, spring; H, domestic; C, commercial; S, stock; O, observation. Date sampled: month/day/year. 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; alkalinity, milligrams per liter (mg/L) as calcium carbonate using digital titration with 0.16 normal sulfuric acid. Abbreviation: NM, not measured]

Site identifier	Site type	Date sampled	pH	Specific conductance	Temperature	Alkalinity
MV-01	I	8/07/96	7.8	614	13.5	NM
MV-04	I	8/07/96	7.9	650	11.5	169
MV-08	QA	8/06/96	7.8	699	14.5	202
MV-11	I	8/07/96	7.8	844	14.0	230
MV-12	D	8/06/96	7.9	666	14.5	170
MV-14	I	8/08/96	7.8	600	14.0	NM
MV-15	Sp	8/08/96	8.0	620	16.0	182
MV-18	Sp	8/08/96	8.2	698	14.5	NM
MV-21	D	8/05/96	7.9	367	15.5	142
MV-22	QA	8/21/96	7.4	2	20.5	NM
MV-23	I	8/07/96	7.7	678	15.0	205
MV-24A	H	8/07/96	7.7	988	14.5	251
MV-29	I	8/06/96	8.1	351	14.5	121
MV-30	C	8/06/96	7.8	699	14.5	202
MV-33	H	8/05/96	8.0	306	15.5	125
MV-37	H	8/05/96	7.7	396	16.0	161
MV-39	I	8/05/96	7.6	702	14.0	248
MV-43	I	8/08/96	7.7	746	15.0	NM
MV-50	I	8/06/96	7.9	720	14.0	192
MV-59	S	8/20/96	8.2	310	16.5	121
MV-61	O	8/20/96	8.1	384	15.0	135

Quality Assurance

Detailed descriptions of internal quality control and overall quality-assurance practices used by the NWQL are provided in reports by Friedman and Erdmann (1982), Jones (1987), and Pritt and Raese (1995). Water samples analyzed by the NWQL were collected in accordance with a quality-assurance plan for quality-of-water activities conducted by personnel at the INEL Project Office. The plan was finalized in June 1989, revised in March 1992 and in 1996 (Mann, 1996), and is available for inspection at the USGS Project Office at the INEL. Water samples analyzed by ISU were collected in accordance with procedures described by B. Graham (ISU, written commun., 1991). About 10 percent of the water samples were quality-assurance samples. Sample MV-08 is a replicate of sample MV-30. Sample MV-22 is a blank of inorganic- and organic-free water. Because the blank water is not representative of wells and springs sampled for this report, it will not be included in the discussions of the constituents measured but will be included in some of the tables.

RADIOCHEMICAL CONSTITUENTS

Water samples were analyzed for strontium-90, tritium, gross alpha- and gross beta-particle radioactivity, and gamma-emitting radionuclides reported as cesium-137. The samples were analyzed using methods described by Thatcher and others (1977). Maximum contaminant levels for the types of radioactivity and for selected radionuclides are listed on table 4.

An analytical uncertainty, s, is calculated for each radionuclide concentration or radioactivity measurement. 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 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.

In the laboratory, instrument signals must exceed a critical level of 1.6s to make the qualitative decision whether the radionuclide or radioactivity was detected. 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

Table 4. 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 (1995, p. 913) for community water systems and are included for comparison purposes only. Maximum contaminant levels given 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. 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 and gamma radioactivity excludes radioactivity from natural sources and is included for comparison purposes only. Abbreviation: pCi/L, picocurie per liter]

Type of radioactivity or radionuclide	Maximum contaminant level
Strontium-90	8 pCi/L
Tritium	20,000 pCi/L
Gross alpha-particle radioactivity	15 pCi/L
Gross beta-particle and gamma radioactivity	4 mrem/yr

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 that 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.

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

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 water samples analyzed contained concentrations of dissolved strontium-90 less than the reporting level (table 5).

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. Samples were submitted to the ISU laboratory and the NWQL. The ISU laboratory used two techniques: a standard liquid scintillation technique and an enrichment and liquid scintillation technique. The NWQL used an enrichment and gas counting technique. The analytical method detection limit for the laboratories differed. The analytical method detection limits for the ISU laboratory were 150 and less than 25 pCi/L using ten 20-minute counting periods, and that for the NWQL was 1 pCi/L using a 1,000-minute counting period.

Table 5. Concentrations of strontium-90 and tritium in water from selected wells and springs, eastern Snake River Plain

[See figure 2 for location of sites. Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory (NWQL) and Idaho State University (ISU) Environmental Monitoring Laboratory using the following methods: strontium-90 by chemical separation and precipitation; tritium by enrichment and gas counting at the NWQL and by liquid scintillation at ISU. Analytical results and uncertainties—for example 0.216±0.515—in picocuries per liter. Analytical uncertainties are reported as 2**s**. Concentrations that exceed the reporting level of 3 times 1**s** are shown in bold-face type. Symbol: *, quality-assurance sample (MV-08 is a replicate of MV-30; MV-22 is a blank of inorganic- and organic-free water). Abbreviations: SD, sample destroyed, NR, analysis not requested. ISU tritium values were determined using two different detection methods. Two values for ISU tritium and ISU tritium (enriched) represent laboratory split samples]

Site identifier	Strontium-90, NWQL	Tritium, NWQL	Tritium, ISU	Tritium,ISU (Enriched)
MV-01	0.216±0.515	**43.8±2.6**	100±100	**52±8**
MV-04	.344±0.48	**4.8±1.0**	0±90	8±8
MV-08*	.788±0.611	**52.5±3.2**	0±100	**60±7**
MV-11	.466±0.45	**6.82±3.8**	100±100	**57±8**
MV-12	.247±0.251	**30.4±1.9**	0±90	**30±8**
MV-14	-.0651±0.74	**24.3±1.6**	100±90 -100±90	**27±8** **23±8**
MV-15	.266±0.27	**51.2±3.2**	100±100	**55±8**
MV-18	.221±0.33	**47.7±3.2**	0±90	**51±7**
MV-21	.391±0.371	**12.8±1.3**	-100±90	**16±7**
MV-22*	.300±0.281	**17.9±1.3**	NR	NR
MV-23	.331±0.42	**51.8±3.2**	0±100	**52±8**
MV-24A	.170±0.35	**71.0±3.8**	100±100 100±100	**71±9** **70±9**
MV-29	SD	**2.6±1.0**	0±90 0±100	3±7 **12±8**
MV-30	.486±0.49	**59.5±3.8**	-100±90	**60±9**
MV-33	SD	**6.7±1.0**	-100±90 0±90	**12±7** 8±8
MV-37	.008±0.348	**40.3±2.6**	0±100	**53±8**
MV-39	.345±0.393	**55.7±3.8**	0±100	**57±9**
MV-43	.322±0.44	**56.3±3.2**	0±90	**61±7**
MV-50	.538±0.577	**52.8±3.2**	100±90	**57±8**
MV-59	.043±0.252	.6±1.0	0±90 0±90	2±7 9±8
MV-61	.074±0.253	**18.2±1.3**	-100±90	**23±7**

The concentrations of tritium in the water samples are shown on table 5. Concentrations of tritium in 19 of the water samples analyzed by the NWQL were greater than the reporting level and ranged from 2.6±1.0 to 71.0±3.8 pCi/L (table 5). Concentrations of tritium in 18 of the water samples analyzed by the ISU laboratory using the enrichment technique were equal to or greater than the reporting level and ranged from 12±8 to 71±9 pCi/L. Two of the 18 ISU samples (MV-29, MV-33) had split sample values less than the reporting level. For the purpose of comparison, background concentrations of tritium in ground water in Idaho generally range from 0 to 40 pCi/L (Knobel and others, 1992). The maximum contaminant level for tritium in public drinking-water supplies is 20,000 pCi/L (table 4).

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 as dissolved thorium-230 in picocuries per liter by the NWQL, and as total thorium-230 in picocuries per liter by the ISU laboratory.

Concentrations of dissolved gross alpha-particle radioactivity reported as thorium-230 in five of the water samples analyzed by the NWQL were greater than the reporting level (table 6) and ranged from 3.25±1.87 to 5.79±3.79 pCi/L. Total concentrations of gross alpha-particle radioactivity reported as thorium-230 in all the water samples analyzed by ISU were less than the reporting level.

Gross Beta-Particle Radioactivity

Gross beta-particle radioactivity is a measure of the total radioactivity given off as beta particles during the radioactive decay process; however, laboratories normally report the radioactivity as if it were all given off by one radionuclide. In this report, concentrations are reported as dissolved cesium-137 in picocuries per liter by the NWQL, and as total cesium-137 in picocuries per liter by the ISU laboratory. 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 with these concentrations.

Concentrations of dissolved gross beta-particle radioactivity reported as cesium-137 in all of the water samples analyzed by the NWQL were greater than the reporting level (table 6) and ranged from 3.75±1.21 to 8.83±3.45 pCi/L. Concentrations of total gross beta-particle radioactivity reported as cesium-137 in 16 of the water samples analyzed by ISU were equal to or greater than the reporting level (table 6) and ranged from 3.4± 2.2 to 11.2± 2.9 pCi/L.

Cesium-137

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. When no specific gamma-emitting radionuclides are identified, the concentration is reported by ISU as total cesium-137. Cesium-137 is a fission product of uranium-235, uranium-233, or plutonium-239. Concentrations of total cesium-137 in all water samples were less than the reporting level (table 7).

CHEMICAL CONSTITUENTS

Water samples were analyzed for selected chemical constituents. These constituents included trace elements, common ions, nutrients, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides. In this report, minimum reporting levels and method detection limits established for these constituents are not to be confused with reporting levels and analytical method detection limits for selected radionuclides. The minimum reporting level for inorganic and organic constituents is the smallest measured concentration of a constituent that may be reliably reported using a given analytical method (Timme, 1995, p. 92). The method

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

[See figure 2 for location of sites. Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory (NWQL) and the Idaho State University (ISU) Environmental Monitoring Laboratory using a residue procedure. Analytical results and uncertainties—for example 1.60±2.13—in picocuries per liter. Analytical uncertainties are reported as 2s. Concentrations that equal or exceed the reporting level of 3 times 1s are shown in bold-face type. Symbol: *, quality-assurance sample (MV-08 is a replicate of MV-30; MV-22 is a blank of inorganic- and organic-free water). Abbreviation: NR, analysis not requested. Two values for ISU gross alpha and gross beta analyses represent laboratory split samples]

Site identifier	Gross alpha, dissolved as thorium-230, NWQL	Gross alpha, total as thorium-230, ISU	Gross beta, dissolved as cesium-137, NWQL	Gross beta, total as cesium-137, ISU
MV-01	1.60±2.13	0.7±3.2	**6.86±1.76**	**5.4±2.5**
MV-04	3.07±2.24	-.5±3.0	**5.83±3.11**	**4.8±2.5**
MV-08*	2.37±2.13	4.2±3.9 1.0±3.3	**6.31±3.18**	**5.0±2.6** **7.3±2.6**
MV-11	**5.79±3.79**	4.2±4.1 4.4±4.1	**8.20±3.50**	**7.5±2.8** **8.0±2.8**
MV-12	2.56±1.98	-.5±3.0	**7.22±1.89**	**5.1±2.5**
MV-14	1.61±2.11	.4±3.0	**5.78±1.89**	**5.1±2.4**
MV-15	**4.84±2.86**	1.3±3.3	**8.12±2.07**	**5.2±2.5**
MV-18	3.22±2.68	3.2±3.7	**6.24±3.27**	**4.5±2.5**
MV-21	**3.25±1.87**	-.9±2.1 .1±2.3	**4.43±1.13**	3.1±2.2 .5±2.1
MV-22*	.0626±0.217	NR	.761±0.555	NR
MV-23	3.54±2.77	1.3±3.3	**8.83±3.45**	**7.4±2.6**
MV-24A	3.13±3.23	3.3±4.1	**8.38±3.62**	**11.2±2.9**
MV-29	1.06±1.64	-.4±2.0	**4.11±1.12**	2.6±2.1
MV-30	1.77±1.94	1.9±3.5	**6.59±3.19**	**5.2±2.5**
MV-33	1.19±1.30	.3±2.7 .3±2.1	**4.39±1.04**	1.5±2.2 2.7±2.1
MV-37	1.94±1.61	.5±2.5	**3.75±1.21**	**3.4±2.2**
MV-39	**3.96±2.48**	-.6±3.4	**5.26±3.08**	**3.9±2.6**
MV-43	4.49±3.01	2.0±3.6	**6.68±3.32**	**5.5±2.6**
MV-50	2.12±2.09	3.8±3.8	**4.95±3.10**	**7.2±2.6**
MV-59	2.19±2.00	1.4±2.3	**8.44±2.75**	**3.5±2.1**
MV-61	**3.68±2.43**	2.7±2.7	**6.13±2.37**	-.2±2.1

Table 7. Concentrations of cesium-137 in water from selected wells and springs, eastern Snake River Plain

[See figure 2 for location of sites. Analyses were performed by the Idaho State University Environmental Monitoring Laboratory using gamma spectrometry. Analytical results and uncertainties—for example 0.42±3.41—are for total concentrations in picocuries per liter. Analytical uncertainties are reported as 2s. Symbol: *, quality-assurance sample (MV-08 is a replicate of MV-30). Two values represent laboratory split samples]

Site identifier	Cesium-137
MV-01	0.42±3.41
MV-04	.78±3.77
MV-08*	1.07±2.64 -.61±2.51
MV-11	-.49±3.41 2.90±3.63
MV-12	.62±3.33
MV-14	-2.23±2.88
MV-15	-2.17±2.85
MV-18	-1.16±3.13
MV-21	-.27±3.18 -1.01±3.2
MV-23	-.82±3.27
MV-24A	-1.66±2.97
MV-29	.70±3.28
MV-30	1.34±3.32
MV-33	2.24±3.88 2.12±3.49
MV-37	1.66±3.04
MV-39	-3.36±2.61
MV-43	-.24±3.42
MV-50	-2.09±3.4
MV-59	.44±3.07
MV-61	.07±3.17

detection limit is defined as the minimum concentration of a substance that can be identified, measured, and reported with 99-percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte (Timme, 1995, p. 92).

Trace Elements

Water samples were analyzed for selected dissolved trace elements including arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, vanadium, and zinc. The maximum or secondary maximum contaminant levels and minimum reporting levels of selected trace elements are shown on table 8. The concentrations of dissolved trace elements are shown on table 9.

Arsenic.—Concentrations of arsenic in all samples were greater than the minimum reporting level and ranged from 2 to 3 µg/L. The maximum contaminant level is 50 µg/L.

Barium.—Concentrations of barium in all samples were greater than the minimum reporting level and ranged from 11 to 140 µg/L. The maximum contaminant level is 2,000 µg/L.

Table 8. Maximum or secondary maximum contaminant levels and minimum reporting levels of selected trace elements 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 (1994; 1995, p. 912, 974) for community water systems and are for comparison purposes only. Secondary maximum contaminant levels—in brackets—are from U.S. Environmental Protection Agency (1995, p. 1,055). Minimum reporting levels are from Timme (1995). Units are in micrograms per liter (µg/L). Symbols: ••, maximum contaminant level has not been established; *, lead has an action level of 15 µg/L]

Trace element	Maximum or secondary maximum contaminant level	Minimum reporting level
Arsenic	50	1
Barium	2,000	1
Beryllium	4	.5
Cadmium	5	1
Chromium	100	5
Cobalt	••	3
Copper	[1,000]	10
Iron	[300]	3
Lead	*	1
Lithium	••	4
Manganese	[50]	1
Mercury	2	.1
Molybdenum	••	10
Nickel	100	10
Selenium	50	1
Silver	[100]	1
Strontium	••	.5
Vanadium	••	6
Zinc	[5,000]	3

Beryllium.—Concentrations of beryllium in two samples (MV-59, MV-61) were 1 µg/L each; the other samples had concentrations less than the minimum reporting level. The maximum contaminant level is 4 µg/L.

Cadmium.—Concentrations of cadmium in three samples were equal to or greater than the minimum reporting level and ranged from 1 to 2 µg/L. The maximum contaminant level is 5 µg/L.

Chromium.—Concentrations of chromium in six samples were greater than the minimum reporting level and ranged from 6 to 9 µg/L. The maximum contaminant level is 100 µg/L.

Cobalt.—Concentrations of cobalt in three samples were equal to or greater than the minimum reporting level and ranged from 3 to 5 µg/L. The other samples had concentrations less than the minimum reporting level of 3 µg/L.

Copper.—Concentrations of copper in all samples were less than the minimum reporting level of 10 µg/L. The secondary maximum contaminant level is 1,000 µg/L.

Iron.—Concentrations of iron in four samples were greater than the minimum reporting level and ranged from 4 to 7 µg/L. The secondary maximum contaminant level is 300 µg/L.

Table 9. Concentrations of dissolved trace elements in water from selected wells and springs, eastern Snake River Plain

[See figure 2 for location of sites. Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. Analytical results in micrograms per liter. Symbols: <, concentration was less than the respective minimum reporting level; *, quality-assurance sample (MV-08 is a replicate of MV-30; MV-22 is a blank of inorganic- and organic-free water)]

Site identifier	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Lithium
MV-01	3	65	<0.5	<1	<5	<3	<10	<3	<10	38
MV-04	3	43	<.5	<1	6	4	<10	<3	10	36
MV-08*	2	71	<.5	<1	6	<3	<10	<3	<10	36
MV-11	3	100	<.5	<1	<5	<3	<10	<3	20	47
MV-12	2	50	<.5	<1	<5	<3	<10	4	<10	38
MV-14	2	43	<.5	1	<5	<3	<10	<3	<10	33
MV-15	3	79	<.5	<1	<5	<3	<10	<3	20	29
MV-18	3	57	<.5	2	<5	<3	<10	<3	<10	37
MV-21	2	21	<.5	<1	<5	<3	<10	<3	<10	15
MV-22*	<1	<2	1	<1	<5	<3	<10	<3	<10	<4
MV-23	3	97	<.5	<1	<5	<3	<10	<3	<10	35
MV-24A	3	140	<.5	<1	6	<3	<10	<3	20	47
MV-29	2	19	<.5	<1	6	<3	<10	<3	<10	19
MV-30	3	71	<.5	<1	<5	3	<10	<3	<10	36
MV-33	2	14	<.5	<1	<5	<3	<10	<3	10	12
MV-37	2	39	<.5	<1	<5	<3	<10	6	<10	6
MV-39	3	58	<.5	<1	<5	<3	<10	<3	<10	9
MV-43	2	86	<.5	2	<5	<3	<10	<3	<10	35
MV-50	2	58	<.5	<1	6	5	<10	<3	<10	40
MV-59	2	11	1	<1	9	<3	<10	7	<10	12
MV-61	3	19	1	<1	<5	<3	<10	5	<10	25

Table 9. Concentrations of dissolved trace elements in water from selected wells and springs, eastern Snake River Plain—Continued

Site identifier	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Strontium	Vanadium	Zinc
MV-01	<1	<0.1	20	<10	<1	2	300	7	<3
MV-04	<1	<.1	<10	<10	<1	1	290	11	<3
MV-08*	<1	<.1	<10	<10	<1	<1	340	8	<3
MV-11	<1	<.1	<10	<10	<1	<1	430	<6	<3
MV-12	<1	<.1	<10	<10	<1	<1	330	<6	21
MV-14	<1	<.1	<10	<10	<1	2	280	7	17
MV-15	<1	<.1	<10	<10	<1	<1	310	<6	<3
MV-18	<1	<.1	<10	<10	<1	<1	340	7	5
MV-21	<1	<.1	<10	<10	<1	<1	180	<6	<3
MV-22*	<1	<.1	<10	<10	<1	<1	<.5	<6	14
MV-23	<1	<.1	10	<10	<1	<1	340	<6	16
MV-24A	<1	<.1	<10	<10	1	1	430	7	31
MV-29	<1	<.1	<10	<10	<1	<1	160	8	<3
MV-30	<1	<.1	<10	<10	<1	1	340	9	<3
MV-33	<1	.1	<10	<10	<1	<1	160	10	170
MV-37	<1	<.1	<10	<10	<1	<1	180	<6	120
MV-39	<1	<.1	10	<10	<1	<1	320	10	4
MV-43	<1	<.1	<10	<10	<1	<1	370	<6	20
MV-50	<1	<.1	<10	<10	<1	3	350	8	<3
MV-59	<1	<.1	10	<10	<1	<1	120	13	310
MV-61	<1	<.1	<10	<10	2	<1	160	7	85

Lead.—Concentrations of lead in five samples were equal to or greater than the minimum reporting level and ranged from 10 to 20 µg/L. Lead has an action level of 15 µg/L.

Lithium.—Concentrations of lithium in all samples were greater than the minimum reporting level and ranged from 6 to 47 µg/L.

Manganese.—Concentrations of manganese in all samples were less than the minimum reporting level of 1 µg/L. The secondary maximum contaminant level is 50 µg/L.

Mercury.—The concentration of mercury in one sample (MV-33) was equal to the minimum reporting level of 0.1 µg/L. The maximum contaminant level is 2 µg/L.

Molybdenum.—Concentrations of molybdenum in four samples were equal to or greater than the minimum reporting level and ranged from 10 to 20 µg/L.

Nickel.—Concentrations of nickel in all the samples were less than the minimum reporting level of 10 µg/L. The maximum contaminant level is 100 µg/L.

Selenium.—Concentrations of selenium in two samples (MV-24A, MV-61) were 1 and 2 µg/L, respectively; the other samples had concentrations less than the minimum reporting level of 1 µg/L. The maximum contaminant level is 50 µg/L.

Silver.—Concentrations of silver in six samples were equal to or greater than the minimum reporting level and ranged from 1 to 3 µg/L. The secondary maximum contaminant level is 100 µg/L.

Strontium.—Concentrations of strontium in all samples were greater than the minimum reporting level and ranged from 120 to 430 µg/L.

Vanadium.—Concentrations of vanadium in 13 samples were greater than the minimum reporting level and ranged from 7 to 13 µg/L.

Zinc.—Concentrations of zinc in 11 samples were greater than the minimum reporting level and ranged from 4 to 310 µg/L. The secondary maximum contaminant level is 5,000 µg/L.

Common Ions

Water samples were analyzed for dissolved common ions including calcium, magnesium, silica, and sodium. The minimum reporting levels of these ions are shown on table 10. Maximum contaminant levels have not been established for any of these common ions. The concentrations of dissolved common ions are shown on table 11.

Calcium.—Concentrations of calcium in all samples were greater than the minimum reporting level and ranged from 23 to 68 mg/L.

Magnesium.—Concentrations of magnesium in all samples were greater than the minimum reporting level and ranged from 12 to 31 mg/L.

Silica.—Concentrations of silica in all samples were greater than the minimum reporting level and ranged from 27 to 37 mg/L.

Sodium.—Concentrations of sodium in all samples were greater than the minimum reporting level and ranged from 13 to 69 mg/L. The Idaho Department of Health and Welfare (1989) recommends an optimum concentration of 20 mg/L of sodium for public drinking-water supplies.

Nutrients

Water samples were analyzed for dissolved ammonia (as nitrogen), nitrite (as nitrogen), nitrite plus nitrate (as nitrogen), and orthophosphate (as phosphorus). The maximum contaminant levels and the minimum reporting levels are shown on table 10. A maximum contaminant level has not been established or proposed for ammonia or orthophosphate. Concentrations of nutrients are shown on table 11.

Ammonia (as nitrogen).—Concentrations of ammonia (as nitrogen) in 14 of the samples were greater than the minimum reporting level and ranged from 0.02 to 0.07 mg/L.

Table 10. Maximum contaminant levels and minimum reporting levels of selected common ions and nutrients 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 (1995, p. 974) for community water systems and are for comparison purposes only. Minimum reporting levels are from Timme (1995). Units are in milligrams per liter (mg/L). Symbol: ••, maximum contaminant level has not been established]

Constituent	Maximnm contaminant level	Minimum reporting level
Calcium	••	0.02
Magnesium	••	.01
Silica	••	.01
Sodium[1]	••	.2
Ammonia (as nitrogen)	••	.015
Nitrite (as nitrogen)	1	.01
Nitrite plus nitrate (as nitrogen)	10	.05
Orthophosphate (as phosphorus)	••	.01

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

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

[See figure 2 for location of sites. Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. Analytical results in milligrams per liter. Symbols: <, concentration is less than the minimum reporting level; *, quality-assurance sample (MV-08 is a replicate of MV-30; MV-22 is a blank of inorganic- and organic-free water). Abbreviation: LS, indicates lost sample]

Site identifier	Calcium	Mag-nesium	Silica	Sodium	Ammonia (as nitrogen)	Nitrite (as nitrogen)	Nitrite plus nitrate (as nitrogen)	Orthophosphate (as phosphorus)
MV-01	47	19	34	36	0.02	<0.01	1.4	0.02
MV-04	46	21	29	42	.02	<.01	2.1	.03
MV-08*	59	22	33	38	.02	<.01	2.5	.02
MV-11	68	27	34	50	LS	LS	LS	LS
MV-12	57	20	32	37	.02	<.01	1.7	.02
MV-14	52	21	31	28	.02	<.01	1.9	.02
MV-15	53	19	37	35	.03	<.01	1.9	.03
MV-18	59	24	33	34	.02	<.01	2.5	.02
MV-21	29	15	31	17	<.015	<.01	1.6	.02
MV-22*	.02	<.01	<.01	<.2	<.015	<.01	<.05	<.01
MV-23	67	20	27	28	.03	<.01	3.8	.06
MV-24A	68	31	33	69	.03	<.01	6.1	.04
MV-29	28	13	29	15	.02	<.01	.56	.02
MV-30	59	22	34	39	.02	<.01	2.7	.02
MV-33	25	13	31	13	<.015	<.01	.59	.02
MV-37	38	13	29	19	<.015	<.01	1.3	.06
MV-39	63	25	37	38	<.015	<.01	2.8	.05
MV-43	65	25	35	37	.02	<.01	4.2	.02
MV-50	59	22	30	40	.02	<.01	2.2	.02
MV-59	23	12	32	16	<.015	<.01	.74	<.01
MV-61	34	14	29	16	.07	<.01	1.2	<.01

Nitrite (as nitrogen).—Concentrations of nitrite (as nitrogen) in all the samples were less than the minimum reporting level of 0.01 mg/L. The maximum contaminant level is 1 mg/L.

Nitrite plus nitrate (as nitrogen).— Concentrations of nitrite plus nitrate (as nitrogen) in all samples were greater than the minimum reporting level and ranged from 0.56 to 6.1 mg/L. The maximum contaminant level is 10 mg/L.

Orthophosphate (as phosphorus).—Concentrations of orthophosphate (as phosphorus) in 17 of the samples were greater than the minimum reporting level and ranged from 0.02 to 0.06 mg/L.

Purgeable Organic Compounds

Water samples were analyzed for 60 purgeable organic compounds. The maximum contaminant levels and minimum reporting levels of these compounds are shown on table 12. Dichlorodifluoromethane was detected in one sample (MV-33) at a concentration of 0.6 µg/L. Tetrachloroethylene was detected in one sample (MV-59) at a concentration of 1.1 µg/L. Concentrations of purgeable organic compounds in all other samples were less than their respective minimum reporting levels.

Insecticides and Gross Polychlorinated Compounds

Water samples were analyzed for concentrations of 8 carbamate insecticides, 11 organophosphate insecticides, 15 organochlorine insecticides, gross PCBs, and gross PCNs (table 13). The minimum reporting levels ranged from 0.01 to 1.0 µg/L. Water samples also were analyzed for an additional group of 19 insecticides that included 11 of the carbamate, organophosphate, and organochlorine insecticides mentioned above; therefore, 11 insecticides are listed twice with two different minimum reporting levels. The maximum contaminant levels and minimum reporting levels for all the compounds are shown on table 13. None of the samples contained concentrations of insecticides or polychlorinated compounds greater than their respective minimum reporting levels; however, one sample (MV-21) had an estimated concentration of DDE, p,p'- of 0.002 µg/L.

Herbicides

Water samples were analyzed for concentrations of 4 chlorophenoxy-acid herbicides and 28 other herbicides. Maximum contaminant levels and minimum reporting levels for these compounds are shown on table 14. Because a new laboratory schedule with lower method detection limits and minimum reporting levels than past schedules was used, several samples had concentrations of some herbicides that exceeded the method detection limits or minimum reporting levels (table 15). Some of the samples listed in table 15 had concentrations that exceeded the method detection limit but were less than the minimum reporting level. Concentrations of atrazine in 14 samples ranged from 0.001 to 0.02 µg/L. Estimated concentrations of desethyl atrazine in 16 samples ranged from 0.002 to 0.015 µg/L. The analyses for desethyl atrazine demonstrate low recovery because of poor retention on the solid-phase extraction column (Zaugg and others, 1995). Estimated concentrations of EPTC in two samples (MV-29 and MV-50) were 0.034 and 0.005 µg/L, respectively. The estimated concentration of prometon in one sample (MV-23) was 0.005 µg/L. Estimated concentrations of simazine in three samples ranged from 0.006 to 0.018 µg/L. The estimated concentrations in table 15 need to be evaluated carefully because of variable performance (Zaugg and others, 1995). Samples from sites not listed in table 15 had concentrations less than the minimum reporting levels and method detection limits for all herbicides. Concentrations of herbicides not listed in table 15 were below the minimum reporting levels and method detection limits in all the samples.

SUMMARY

The USGS and the IDWR, in cooperation with the DOE, sampled 19 sites as part of the fourth round 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 selected radiochemical and chemical constituents. The samples were collected from nine irrigation wells, three domestic wells, two dairy wells, two springs,

Table 12. Maximum contaminant levels and minimum reporting levels of selected purgeable organic compounds in drinking water

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory using an analytical method equivalent to U.S. Environmental Protection Agency method 524.2. Maximum contaminant levels were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1994; 1995, p. 972) for community water systems and are included for comparison purposes only. Minimum reporting levels are from Timme (1995). Units are in micrograms per liter (µg/L). Symbols: ••, maximum contaminant level has not been established or proposed; *, total trihalomethanes—which include bromoform, chlorodibromomethane, chloroform, and dichlorobromomethane—in community water systems serving 10,000 or more persons cannot exceed 100 µg/L (U.S. Environmental Protection Agency, 1995, p. 912). Abbreviations: MCL, maximum contaminant level; MRL, minimum reporting level]

Compound	MCL	MRL	Compound	MCL	MRL
Benzene	5	0.2	1,3-Dichloropropane	••	0.2
Bromobenzene	••	.2	2,2-Dichloropropane	••	.2
Bromochloromethane	••	.2	cis-1,3-Dichloropropene	••	.2
Bromoform	*	.2	trans-1,3-Dichloropropene	••	.2
Bromomethane	••	.2	1,1-Dichloropropene	••	.2
n-Butylbenzene	••	.2	Ethylbenzene	700	.2
sec-Butylbenzene	••	.2	Hexachlorobutadiene	••	.2
tert-Butylbenzene	••	.2	Isopropylbenzene	••	.2
Carbon tetrachloride	5	.2	p-Isopropyltoluene	••	.2
Chlorobenzene	100	.2	Methylene chloride	5	.2
Chlorodibromomethane	*	.2	Methyl tert-butylether	••	1
Chloroethane	••	.2	Naphthalene	••	.2
Chloroform	*	.2	n-Propylbenzene	••	.2
Chloromethane	••	.2	Styrene	100	.2
2-Chlorotoluene	••	.2	1,1,1,2-Tetrachloroethane	••	.2
4-Chlorotoluene	••	.2	1,1,2,2-Tetrachloroethane	••	.2
1,2-Dibromo-3-chloropropane	.2	1	Tetrachloroethylene	5	.2
1,2-Dibromoethane	.05	.2	Toluene	1,000	.2
Dibromomethane	••	.2	1,2,3-Trichlorobenzene	••	.2
1,2-Dichlorobenzene	600	.2	1,2,4-Trichlorobenzene	70	.2
1,3-Dichlorobenzene	600	.2	1,1,1-Trichloroethane	200	.2
1,4-Dichlorobenzene	75	.2	1,1,2-Trichloroethane	5	.2
Dichlorobromomethane	*	.2	Trichloroethene	5	.2
Dichlorodifluoromethane	••	.2	Trichlorofluoromethane	••	.2
1,1-Dichloroethane	••	.2	1,2,3-Trichloropropane	••	.2
1,2-Dichloroethane	5	.2	1,1,2-Trichloro 1,2,2-trifluoroethane	••	.2
cis-1,2-Dichloroethene	70	.2	1,2,4-Trimethylbenzene	••	.2
1,1-Dichloroethene	7	.2	1,3,5-Trimethylbenzene	••	.2
trans-1,2-dichloroethene	100	.2	Vinyl chloride	2	.2
1,2-Dichloropropane	5	.2	Xylenes, total ortho, meta, and para	10,000	.2

Table 13. Maximum contaminant levels and minimum reporting levels of selected insecticides and gross polychlorinated compounds in drinking water

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. The maximum contaminant levels were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1995, p. 973-974) for community water systems and are included for comparison purposes only. Minimum reporting levels are from Timme (1995). Method detection limits are from Zaugg and others (1995). Units are in micrograms per liter. Symbols: ••, maximum contaminant level has not been established or proposed; *, samples analyzed using two different laboratory schedules with different minimum reporting levels. Abbreviations: MCL, maximum contaminant level; MRL, minimum reporting level; MDL, method detection limit]

Carbamate insecticides

Insecticide	MCL	MRL	Insecticide	MCL	MRL
Aldicarb	3	0.5	Methomyl	••	0.5
*Carbaryl (Sevin)	••	.5	1-Naphthol	••	.5
*Carbofuran	40	.5	Propham	••	.5
Methiocarb	••	.5	Propoxur	••	.5

Organophosphate insecticides

Insecticide	MCL	MRL	Insecticide	MCL	MRL
*Chlorpyrifos; Dursban	••	0.01	*Malathion	••	0.01
DEF	••	.01	Methylparathion	••	.01
*Diazinon	••	.01	Parathion	••	.01
*Di-Syston (Disulfoton)	••	.01	*Phorate	••	.01
Ethion	••	.01	Trithion	••	.01
*Fonofos	••	.01			

Organochlorine insecticides

Insecticide	MCL	MRL	Insecticide	MCL	MRL
Aldrin	••	0.01	Heptachlor	0.4	0.01
Chlordane, technical	2	.1	Heptachlor epoxide	.2	.01
DDD, p,p'-	••	.01	*Lindane	.2	.01
*DDE, p,p'-	••	.01	Methoxychlor, p,p'-	40	.01
DDT, p,p'-	••	.01	Mirex	••	.01
*Dieldrin	••	.01	Perthane	••	.1
Endosulfan I	••	.01	Toxaphene	3	1.0
Endrin	2	.01			

Gross polychlorinated compounds

Compound	MCL	MRL
Gross polychlorinated biphenyls (PCBs)	0.5	0.1
Gross polychlorinated naphthalenes (PCNs)	••	0.1

Table 13. Maximum contaminant levels and minimum reporting levels of selected insecticides and gross polychlorinated compounds in drinking water—Continued

19 insecticides with different MRLs

Insecticide	MCL	MRL	MDL	Insecticide	MCL	MRL	MDL
Azinphos methyl-	••	0.038	0.001	HCH, alpha-	••	0.007	0.002
*Carbaryl (Sevin)	••	.046	.003	*HCH, gamma- (Lindane)	0.2	.011	.004
*Carbofuran	40	.013	.003	*Malathion	••	.010	.005
*Chlorpyrifos	••	.005	.004	Parathion, ethyl-	••	.022	.004
*DDE, p,p'-	••	.010	.006	Parathion, methyl-	••	.035	.006
*Diazinon	••	.008	.002	Permethrine, cis-	••	.019	.005
*Dieldrin	••	.008	.001	*Phorate	••	.011	.002
*Disulfoton	••	.028	.017	Propargite I & II	••	.006	.013
Ethoprop	••	.012	.003	Terbufos	••	.012	.013
*Fonofos	••	.008	.003				

Table 14. Maximum contaminant levels and minimum reporting levels of chlorophenoxy-acid herbicides and other herbicides in drinking water

[Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. The maximum contaminant levels were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1995, p. 973, 974) for community water systems and are included for comparison purposes only. Minimum reporting levels are from Timme (1995). Method detection limits are from Zaugg and others (1995). Units are in micrograms per liter. Symbol: ••, maximum contaminant level has not been established or proposed. Abbreviations: MCL, maximum contaminant level; MRL, minimum reporting level; MDL, method detection limit]

Chlorophenoxy-acid herbicides

Herbicide	MCL	MRL	Herbicide	MCL	MRL
2,4-D	70	0.01	Silvex	50	0.01
2,4-DP	••	.01	2,4,5-T	••	.01

Other herbicides

Herbicide	MCL	MRL	MDL	Herbicide	MCL	MRL	MDL
Acetochlor	••	0.009	0.002	Molinate	••	0.007	0.004
Alachlor	2	.009	.002	Napropamide	••	.010	.003
Atrazine	3	.017	.001	Pebulate	••	.009	.004
Atrazine, desethyl-	••	.007	.002	Pendimethalin	••	.018	.004
Benfluralin	••	.013	.002	Prometon	••	.008	.018
Butylate	••	.008	.002	Pronamide	••	.009	.003
Cyanazine	••	.013	.004	Propachlor	••	.015	.007
DCPA (Dacthal)	••	.004	.002	Propanil	••	.016	.004
Diethylaniline	••	.006	.003	Simazine	4	.008	.005
EPTC (Eptam)	••	.005	.002	Tebuthiuron	••	.015	.010
Ethalfluralin	••	.013	.004	Terbacil	••	.030	.007
Linuron	••	.039	.002	Thiobencarb	••	.008	.002
Metolachlor	••	.009	.002	Triallate	••	.008	.001
Metribuzin	••	.012	.004	Trifluralin	••	.012	.002

Table 15. Concentrations of herbicides in water from selected wells and springs, eastern Snake River Plain
[See figure 2 for location of sites. Analyses were performed by the U.S. Geological Survey National Water Quality Laboratory. Units are in micrograms per liter. Symbols: <, concentration was less than the respective minimum reporting level; *, quality-assurance sample (MV-08 is a replicate of MV-30). Concentrations for desethyl atrazine, EPTC, prometon, and simazine were estimated and need to be evaluated carefully because of variable performance. Samples from wells not listed had concentrations below the minimum reporting levels and method detection limits for all herbicides. Concentrations of herbicides not listed were below the minimum reporting levels and method detection limits in all samples]

Site identifier	Atrazine	Desethyl atrazine	EPTC	Prometon	Simazine
MV-01	0.004	0.002	<0.002	<0.018	<0.005
MV-04	.0063	.004	<.002	<.018	<.005
MV-08*	.001	.003	<.002	<.018	<.005
MV-11	.011	.009	<.002	<.018	.006
MV-12	.002	.002	<.002	<.018	<.005
MV-14	.004	.004	<.002	<.018	<.005
MV-15	<.001	.002	<.002	<.018	<.005
MV-18	.004	.004	<.002	<.018	<.005
MV-21	.004	.003	<.002	<.018	<.005
MV-23	.014	.004	<.002	.005	.018
MV-24A	.02	.015	<.002	<.018	.009
MV-29	<.001	<.002	.034	<.018	<.005
MV-30	.001	.003	<.002	<.018	<.005
MV-37	.005	.003	<.002	<.018	<.005
MV-39	.0136	.0115	<.002	<.018	<.005
MV-43	<.001	.003	<.002	<.018	<.005
MV-50	.002	.003	.005	<.018	<.005

one commercial well, one stock well, and one observation well. Two quality-assurance samples also were collected and analyzed. Additional sampling at six sites was done to complete the third round of sampling.

Concentrations of strontium-90 in all samples were less than the reporting level. Concentrations of tritium in 19 of the samples analyzed by the NWQL and 18 of the samples analyzed by ISU using an enrichment technique were equal to or greater than the reporting level, but none exceeded the maximum contaminant level for drinking water. Concentrations of dissolved gross alpha-particle radioactivity in five of the samples analyzed by the NWQL were greater than the reporting level; none exceeded the maximum contaminant levels. Concentrations of dissolved gross beta-particle radioactivity in all samples analyzed by the NWQL were greater than the reporting level. Concentrations of total gross beta-particle radioactivity in 16 of the samples analyzed by ISU were equal to or greater than the reporting level. Concentrations of total cesium-137 were analyzed using gamma spectrometry and concentrations in all the samples were less than the reporting level.

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

Concentrations of ammonia (as nitrogen) in 14 of the water samples were greater than the minimum reporting level. Concentrations of nitrite (as nitrogen) in all the samples were less than the minimum reporting level. Concentrations of nitrite plus nitrate (as nitrogen) in all the water samples were greater than the minimum reporting level. Concentrations of orthophosphate (as phosphorus) in 17 of the water samples were greater than the minimum reporting level. No nutrient concentration exceeded an established maximum contaminant level.

The concentrations of dichlorodifluoromethane and tetrachloroethylene in one sample each exceeded their respective minimum reporting levels. No carbamate insecticides, organophosphate insecticides, organochlorine insecticides, gross PCBs, or gross PCNs were detected at concentrations exceeding their respective minimum reporting levels. Concentrations of some herbicides were greater than their method detection limits and minimum reporting levels, but none exceeded established maximum contaminant levels.

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