National Water-Quality Assessment Program—Nitrate and Pesticides in Ground Water: Blaine, Cassia, Lincoln, and Minidoka Counties, South-Central Idaho

U.S. Department of the Interior—U.S. Geological Survey

Introduction

In June and July 1993, ground water samples from 60 wells in Blaine, Cassia, Lincoln, and Minidoka Counties, Idaho, were collected and analyzed for dissolved nitrite plus nitrate as nitrogen (nitrate) and pesticides. This Fact Sheet describes the results of those analyses. The data were collected as part of the National Water-Quality Assessment Program that the U.S. Geological Survey began in 1991.

Location

Blaine, Cassia, Lincoln, and Minidoka Counties are located in the southwestern part of the upper Snake River Basin, which covers 35,800 square miles and extends from western Wyoming to south-central Idaho (fig. 1). Ground-water samples for this study were collected from wells near Burley, Heyburn, Rupert, and Minidoka.

Geohydrology

Water samples were collected from two aquifers, the regional Snake River Plain basalt aquifer and a local alluvial aquifer. The Snake River Plain aquifer is composed of a series of Quaternary basalt flows that are vesicular and broken and are able to transmit large volumes of water (Whitehead, 1992). The Snake River Plain aquifer is recharged primarily by infiltration of water from surrounding tributary valleys and local infiltration of precipitation and irrigation water. Depth to water in the Snake River Plain aquifer in 1993 averaged 190 feet below land surface in the wells sampled.

The local alluvial aquifer overlies the Snake River Plain aquifer. The local alluvial aquifer is underlain by a clay layer about 40 to 60 feet below land surface. This clay layer retards downward movement of recharge water and allows that water to collect in the alluvium above it, thus creating a local aquifer. The local aquifer is recharged primarily by infiltration of irrigation water. According to local residents, this aquifer did not exist prior to construction of the irrigation network from Lake Walcott in 1907. Depth to water in the local alluvial aquifer in 1993 averaged about 15 feet below land surface in the wells sampled.

Approach

A systematic method was used to select wells for sampling. Sections of the township-range-section coordinate system were randomly selected using a computer program developed by Scott (1990). All existing wells in each selected section were evaluated for suitable construction criteria, and the wells that best met these criteria were selected for sampling. Well selection criteria included existence of a driller's record, a good surface seal, a short plumbing line, a sampling port prior to the pressure tank, permission to sample from the wellowner, access for water-level measurement, and the shallowest saturated thickness (less than 50 feet). Most wells selected were domestic wells.

Samples were collected using dedicated sampling vehicles, Teflon[1] hoses, stainless-steel connectors, and enclosed sampling and preservation chambers to reduce the chance of contamination during collection. Nitrate samples were filtered through a 0.45-micrometer filter prior to analysis. Pesticide samples were filtered through a 0.7-micrometer baked glass fiber filter and extracted onto solid-phase extraction cartridges prior to analysis. All samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory.

Quality-assurance and quality-control practices for nitrate samples included equipment blanks and replicate samples at 10 percent of the sample sites. Quality-assurance and quality-control practices for pesticide samples included equipment blanks, field spikes, and field spike replicates at 10 percent of the sample sites, and surrogate compounds added to every sample prior to extraction. Equipment blanks assure that the sampling equipment is not contaminating samples. Replicate samples help define the precision (or variability) of the sampling and laboratory analyses. Field spikes and field spike replicates help define the precision and accuracy of the laboratory analyses, potential matrix effects, and shipping losses. Surrogate compounds indicate the efficiency of the extraction technique, potential matrix effects, and shipping losses.

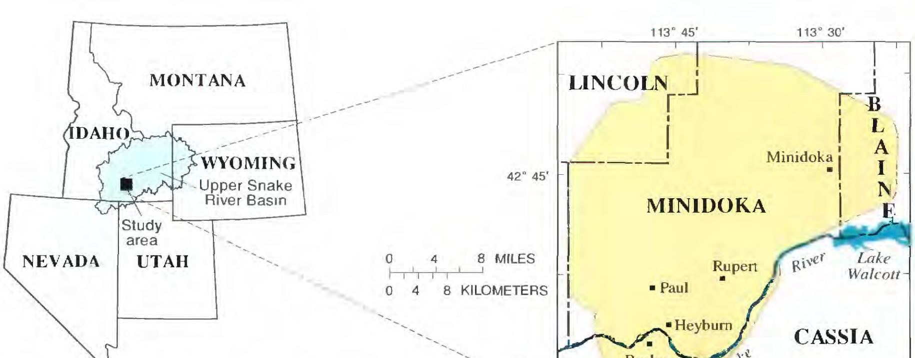

Figure 1. Location of study area.

Nitrate Results

Thirty-one wells in the Snake River Plain aquifer and 29 wells in the local alluvial aquifer were sampled during June and July 1993 (fig. 2). The median nitrate concentration in water from wells in the Snake River Plain aquifer was 3.9 milligrams per liter (parts per million); the median concentration from wells in the local alluvial

[1] Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

aquifer was 7.1 milligrams per liter (table 1). Median nitrate concentrations from both aquifers were higher than the median concentration (1.5 milligrams per liter) in wells in the upper Snake River Basin as a whole (Rupert, 1994, table 9). The higher nitrate concentrations from both aquifers presumably are associated with a predominance of irrigated agricultural land in the study area. Nitrate concentrations are statistically higher in irrigated agricultural areas than in dryland agricultural or rangeland areas (Rupert, 1994, p. 29).

Nitrate concentrations in 1 of 31 wells (3 percent) sampled in the Snake River Plain aquifer exceeded the U.S. Environmental Protection Agency maximum contaminant level of 10 milligrams per liter (USEPA, 1995), whereas concentrations in 7 of 29 wells (24 percent) sampled in the local alluvial aquifer exceeded this criteria. The higher nitrate concentrations in the local alluvial aquifer are probably due to shallow depth to ground water, irrigation methods, soil type, and aquifer materials.

Rupert (1994, p. 29) reported that nitrate concentrations in the Snake River Plain aquifer may be increasing with time. No long-term data are available to determine whether nitrate concentrations in the local alluvial aquifer are increasing or decreasing with time. Concentrations in the Snake River Plain aquifer are increasing in a southwesterly (downgradient) direction (fig. 2), which is consistent with earlier findings (Rupert, 1994, p. 21).

Pesticide Results

"Pesticide" is a generic term for a compound used as an herbicide, insecticide, rodenticide, or nematocide. At least one pesticide compound was detected in 25 of 31 wells (81 percent) sampled in the Snake River Plain aquifer; at least one pesticide compound was detected in 25 of 29 wells (86 percent) sampled in the local alluvial aquifer (fig. 3). More pesticide compounds were detected in the local alluvial aquifer than in the Snake River Plain aquifer

Table 1. Summary statistics for dissolved nitrite plus nitrate as nitrogen in ground-water samples from Blaine, Cassia, Lincoln, and Minidoka Counties, Idaho, 1993

[Concentrations are in milligrams per liter; <, less than]

Aquifer sampled	Number of wells sampled	Minimum concentration measured	Percentile 10	Percentile 25	Percentile 50	Percentile 75	Percentile 90	Maximum concentration measured
Snake River Plain basalt aquifer	31	0.6	1.1	1.8	3.9	5.8	8.5	11
Local alluvial aquifer	29	<.05	.3	2.2	7.1	13.4	25	58

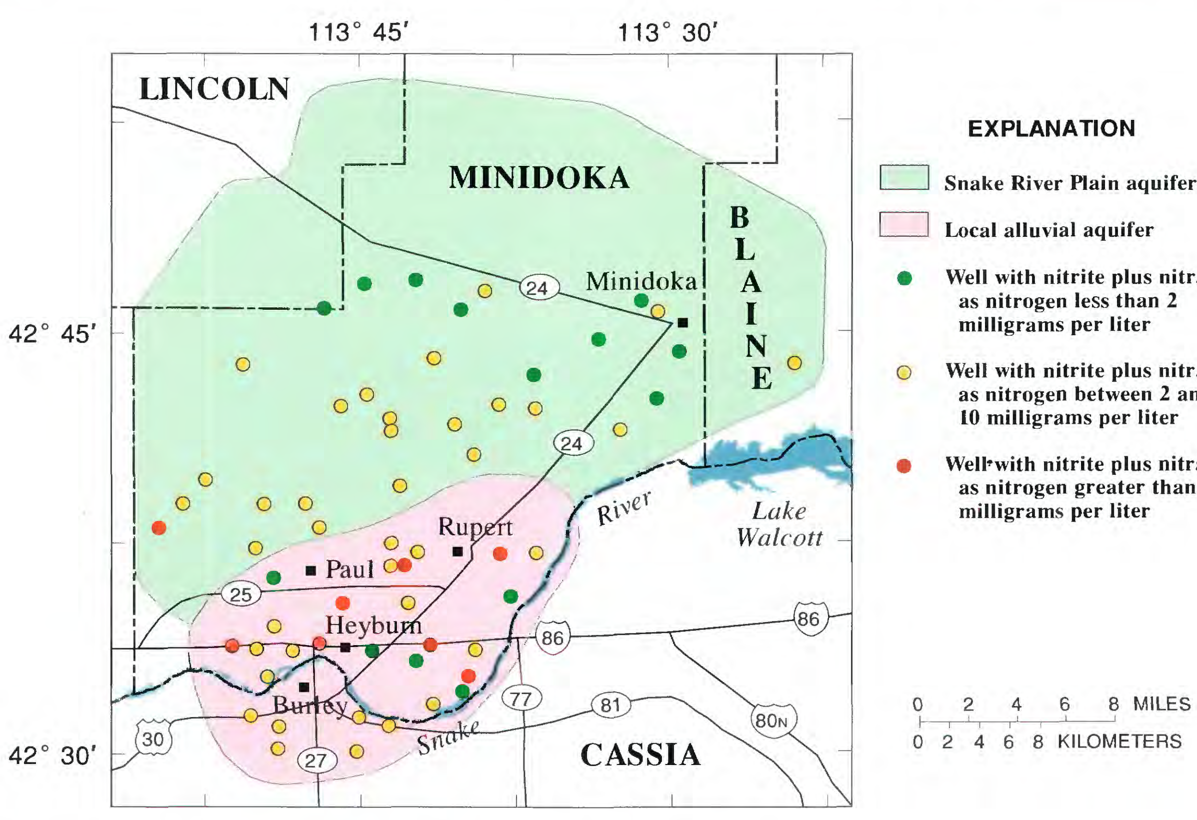

Figure 2. Wells sampled for nitrite plus nitrate as nitrogen, 1993.

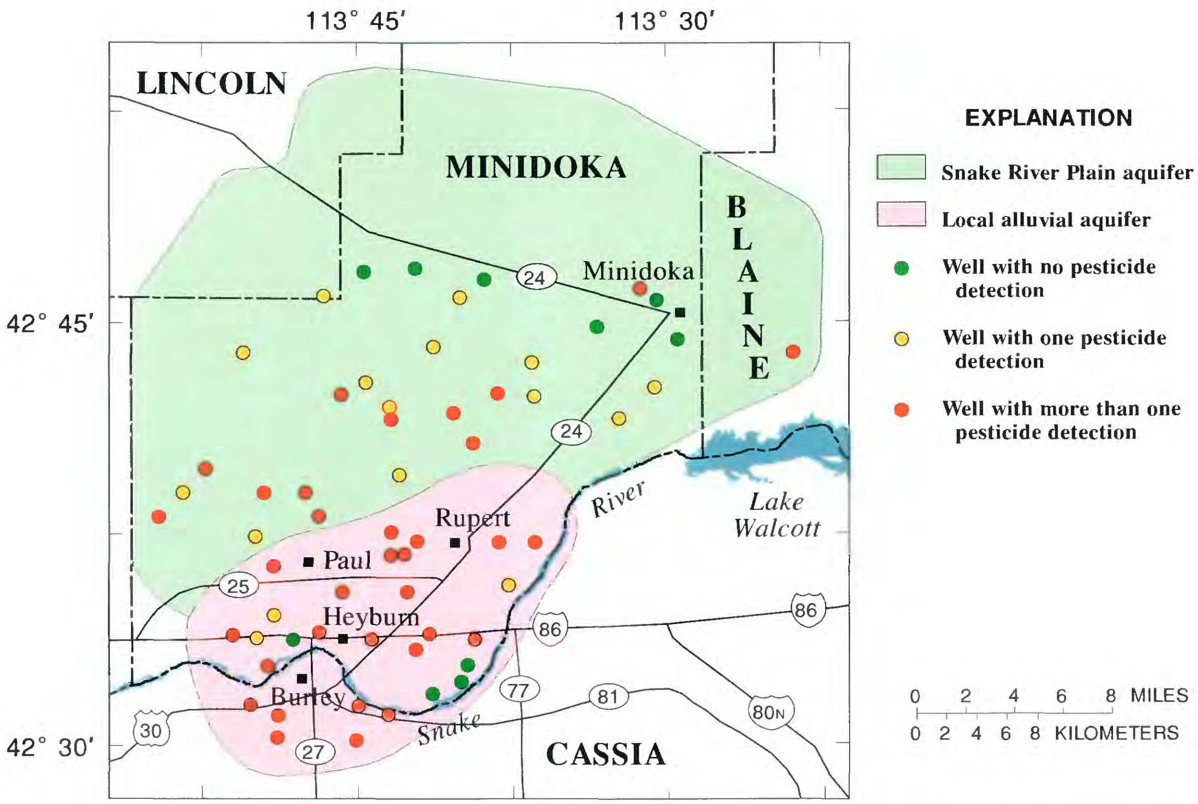

Figure 3. Wells sampled for pesticides, 1993.

Table 2. Pesticides detected in ground-water samples from Blaine, Cassia, Lincoln, and Minidoka Counties, Idaho, 1993

[Concentrations are in micrograms per liter; [1], 31 wells were sampled; [2], 29 wells were sampled; [m], maximum contaminant level; [h], lifetime 70-kilogram adult health advisory; [u], below method detection limit; ----, not established; --, not detected; maximum contaminant levels and health advisories from U.S. Environmental Protection Agency (1995); information on general use from Sine (1992)]

Pesticide name	General use	Maximum contaminant level or health advisory	Method detection limit	Number of detections from the Snake River Plain aquifer[1]	Number of detections from the local alluvial aquifer[2]	Concentrations detected		
						Minimum	Median	Maximum
Alachlor	Herbicide	2[m]	0.002	--	1	0.010	--	0.010
Atrazine	Herbicide	3[m]	.001	25	25	.003	0.02	.5
Carbaryl (Sevin)	Insecticide	70[h]	.003	--	1	.002[u]	--	.002[u]
p,p'-DDE	Insecticide	----	.006	--	1	.002[u]	--	.002[u]
Desethyl-Atrazine	Herbicide	----	.002	2	10	.02	.045	.2
1,2-Dichloropropane	Nematocide	5[m]	.2	--	1	6.6	--	6.6
1,3-Dichloropropane	Nematocide	5[m]	.2	--	1	.2	--	.2
Eptam (EPTC)	Herbicide	----	.002	--	1	.003	--	.003
Metolachlor	Herbicide	70[h]	.002	5	3	.002	.003	.008
Metribuzin	Herbicide	100[h]	.004	4	5	.005	.01	.08
Prometon	Herbicide	100[h]	.018	--	6	.004[u]	.015[u]	.03
Propachlor	Herbicide	90[h]	.007	1	1	.002[u]	--	.002[u]
Propanil	Herbicide	----	.004	1	3	.003[u]	.007	.008
Simazine	Herbicide	4[m]	.005	5	14	.01	.02	.1
Terbacil	Herbicide	90[h]	.007	--	2	.005[u]	.005[u]	.005[u]

Table 3. Method detection limits of pesticides analyzed in ground-water samples from Blaine, Cassia, Lincoln, and Minidoka Counties, Idaho, 1993

[Concentrations are in micrograms per liter]

Pesticide name	Method detection limit	Pesticide name	Method detection limit	Pesticide name	Method detection limit
Alachlor	0.002	cis-1,3-Dichloropropene	0.2	Ethyl-Parathion	0.004
Desethyl-Atrazine	.002	trans-1,3-Dichloropropene	.2	Methyl-Parathion	.006
Atrazine	.001	Dieldrin	.001	Pebulate	.004
Methyl-Azimphos	.001	Diethylanaline	.003	Pendimethalin	.004
Benfluralin	.002	Disulfoton	.017	cis-Permethrin	.005
Butylate	.002	Eptam (EPTC)	.002	Phorate	.002
Carbaryl (Sevin)	.003	Ethalfluralin	.004	Prometon	.018
Carbofuran	.003	Ethoprop	.003	Pronamide	.003
Chlorpyrifos	.004	Ethylene dibromide	.2	Propachlor	.007
Cyanazine	.004	Fonofos	.003	Propanil	.004
Dacthal (DCPA)	.002	*alpha*-HCH	.002	Propargite	.013
p,p'-DDE	.006	*gamma*-HCH (Lindane)	.004	Simazine	.005
Diazinon	.002	Linuron	.002	Tebuthiuron	.010
1,2-Dibromo-3-chloropropane	.2	Malathion	.005	Terbacil	.007
1,2-Dichloropropane	.2	Metolachlor	.002	Terbufos	.013
1,3-Dichloropropane	.2	Metribuzin	.004	Thiobencarb	.002
2,2-Dichloropropane	.2	Molinate	.004	Triallate	.001
1,3-Dichloropropene	.2	Napropamide	.003	Trifluralin	.002

(table 2), and concentrations were usually higher. The larger occurrence of pesticides in the local alluvial aquifer is probably due to shallow depth to ground water, irrigation methods, soil type, and aquifer materials.

Of the 54 pesticides analyzed (table 3), 11 herbicides, 2 insecticides, and 2 nematocides were detected (table 2). Only 1,2-dichloropropane exceeded the maximum contaminant level of 5 micrograms per liter (USEPA, 1995). Although the concentrations of most pesticides were low, these compounds might be a concern in the future if they persist and accumulate in the ground water. Pesticides are not included in most water-quality investigations, so data are insufficient to determine how concentrations may change with time.

Facts About Nitrate and Pesticides

The greatest health hazard from nitrate in drinking water is methemoglobinemia, or blue baby syndrome. The U.S. Environmental Protection Agency (1995) has set a maximum contaminant level of 10 milligrams per liter for nitrate on the basis of health risks to children of pregnant or nursing mothers or infants younger than 6 months. Sources of excess nitrate in ground water include fertilizers, animal waste, and domestic septic system effluent. Potential health hazards from pesticides vary depending on the compound. Information regarding any of these compounds may be obtained by calling the U.S. Environmental Protection Agency hotline at 1-800-426-4791.

Nitrate and pesticides usually are not removed by conventional water-treatment methods such as water softeners; more extensive methods such as charcoal absorption or ion exchange usually are required.

More About the National Water-Quality Assessment Program

In 1991, the U.S. Geological Survey implemented the National Water-Quality Assessment Program. Long-term goals of this program are to describe the status and trends of the quality of a large representative part of the Nation's surface- and ground-water resources and to provide a sound, scientific understanding of the primary natural and human factors affecting the quality of these resources. In meeting these goals, the program will produce a wealth of water-quality information that will be useful to policy makers and managers at national, State, and local levels. The upper Snake River Basin was among the first 20 study units that began this water-quality assessment.

—Michael G. Rupert, M.A.J. Stone, and D.S. Ott

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