

SHALLOW GROUND-WATER QUALITY IN THE PLATTE RIVER VALLEY ALLUVIUM, NEBRASKA, OCTOBER-NOVEMBER 1997

SIGNIFICANT FINDINGS

Nitrate was detected in samples from 25 of 27 wells; concentrations in 6 of the samples exceeded the U.S. Environmental Protection Agency maximum contaminant level of 10 milligrams per liter for drinking water.

Arsenic was detected in samples from 23 of 27 wells, but all concentrations were below the U.S. Environmental Protection Agency maximum contaminant level of 50 micrograms per liter.

Radon was detected in samples from all 27 wells.

No volatile organic compounds were detected with concentrations greater than the method detection limit.

INTRODUCTION

Contamination of surface and ground water from nonpoint sources is a national issue. Examples of nonpoint-source contaminants from agricultural activities are pesticides (fungicides, herbicides, and insecticides), sediments, and nutrients (nitrate and phosphorus). The Platte River Valley in Nebraska (fig. 1) is a flat lowland area underlain primarily by unconsolidated alluvial deposits of Quaternary age that have a maximum thickness of less than 100 ft (feet) and consist mostly of gravel, sand, silt, and clay (Gutentag and others, 1984, p. 9). These deposits are the single most important source of water for public supply for Nebraska's largest cities including Omaha, Lincoln, Grand Island, and Kearney. These deposits pro-

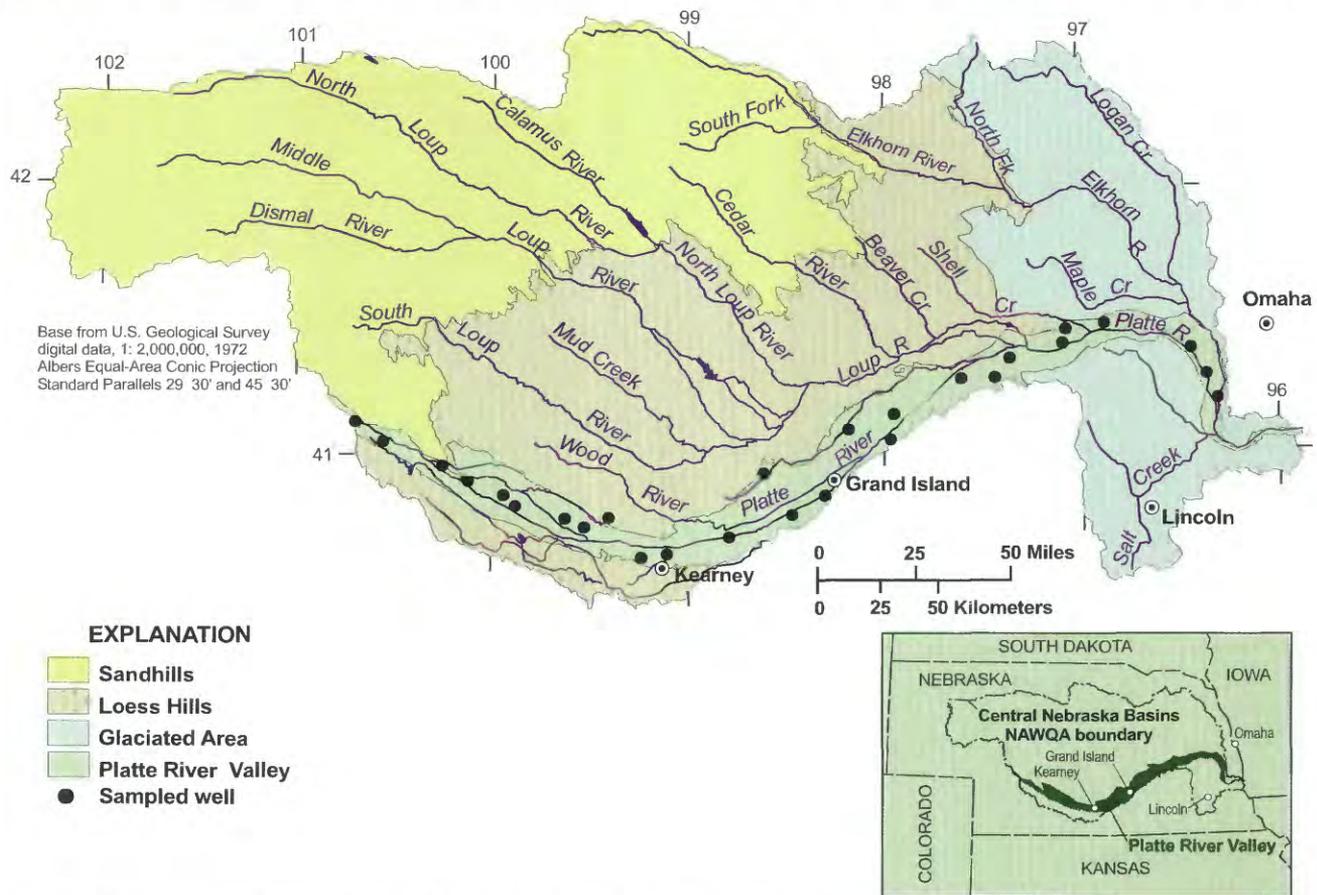


Figure 1. Location and sampled wells of the Platte River Valley alluvium in the Central Nebraska Basins study unit.

vide about 117 Mgal/d (million gallons per day), nearly 50 percent of the total daily ground-water production for Nebraska (Nebraska Natural Resources Commission, 1994). The Platte River Valley also includes permeable soils, shallow ground-water levels, and extensive areas of irrigated land used to grow corn. These conditions increase the vulnerability of the ground water to agricultural contaminants.

The U.S. Geological Survey's (USGS) National Water Quality Assessment (NAWQA) Program is designed to describe the status and trends in the quality of the Nation's surface- and ground-water resources and to provide a sound understanding of the natural and human factors affecting the quality of these resources. Important components of the program are assessments of more than 50 major river basins and aquifers, called study units. The Central Nebraska Basins study unit (CNBR) was among the set of 20 study-unit investigations begun in 1991. The

Central Nebraska Basins comprise sandhills, loess hills, and glaciated areas adjacent to the valley of the Platte River, the main river draining the study unit (fig. 1). This study provides data regarding water quality in Platte River Valley alluvium that was not included in the previous study (Frenzel and others, 1998).

In 1997, 27 wells completed in the Platte River Valley alluvium were randomly selected and sampled as part of a CNBR Study (Sub)-Unit Survey (SUS). Quality of shallow ground-water (water in alluvial deposits) of the Platte River Valley is described in this report. A total of 27 wells (fig. 1) were sampled. Well depths ranged from 12 to 124 ft and the water table ranged from about 2.9 to 31 ft below land surface. Physical properties of specific conductance, pH, and dissolved oxygen were measured on-site at the time of sample collection. Water was collected from the wells using nationally consistent sampling methods developed as part of the NAWQA program, and was

analyzed by the U.S. Geological Survey's National Water Quality Laboratory in Arvada, Colorado for the presence of major ions, nutrients, trace elements, radionuclides, volatile organic compounds (VOCs), and pesticides. The following is a description of the quality of the water in the Platte River Valley alluvium based on the results of this SUS.

GROUND-WATER QUALITY

The physical properties of the shallow ground water in the Platte River alluvial aquifer revealed some variation. The specific conductance values ranged from 293 to 2,870 $\mu\text{S}/\text{cm}$ (microsiemens per centimeter at 25 degrees Celsius) with a median of 721 $\mu\text{S}/\text{cm}$. The pH values ranged from 6.2 to 7.8 with a median of 7.2. The U.S. Environmental Protection Agency (USEPA) Secondary Maximum Contaminant Level (SMCL) for pH is a range of 6.5 to 8.5 (U.S. Environmental Protection Agency, 1996). An SCML is a standard set for aesthetic purposes and is

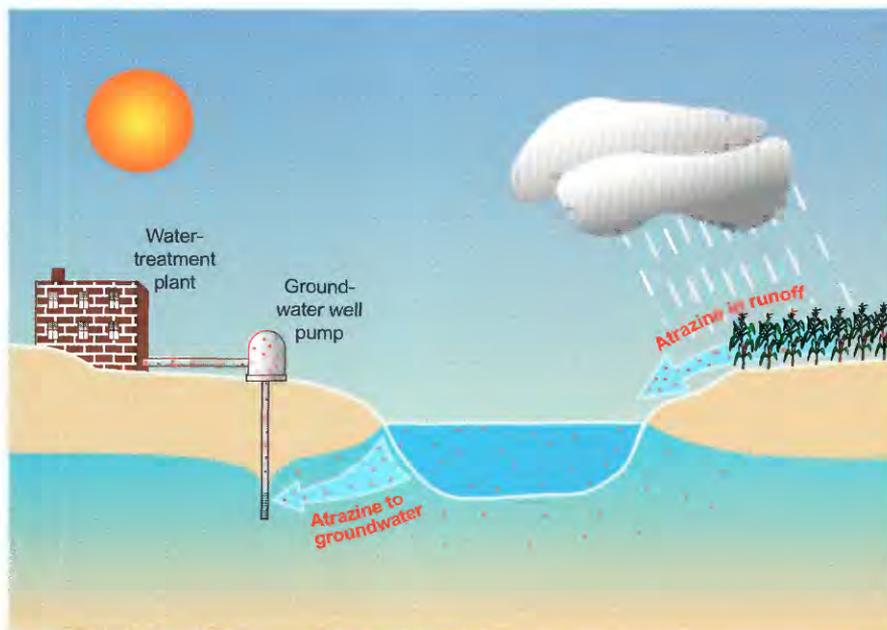


Figure 2. Atrazine movement from the Platte River through alluvial aquifers (Frenzel and others, 1998).

not health-based. Dissolved-oxygen concentrations ranged from 7.9 to 0.14 mg/L (milligrams per liter) with a median of 0.62 mg/L.

Results of analyses for the selected constituents are summarized in table 1. No VOC concentrations greater than the method detection limit were found in water samples analyzed for 55 VOCs.

MAJOR IONS

The major-ion concentrations, including calcium, magnesium, sodium, potassium, sulfate, chloride, fluoride, and silica, were typical of the Platte River Valley (Zelt and Jordan, 1993). Sulfate in drinking water currently has an SMCL of 250 mg/L, based on aesthetic effects (taste and odor). The concentrations of sulfate ranged from 18 to 941 mg/L with a median concentration of 68 mg/L. Five of the 27 sulfate concentrations exceeded the SMCL.

NUTRIENTS

The nutrients nitrogen and phosphorus commonly occur naturally in ground water, but elevated concentrations may be from the influence of human activity. Nitrite plus nitrate (table 1), herein referred to as nitrate, has a USEPA-established maximum contaminant level (MCL) for drinking water of 10 mg/L as nitrogen. In this study, 6 of the 27 ground-water samples collected exceeded this level. Concentrations ranged from 0.05 to 48 mg/L, with a median of 2.9 mg/L (table 1). Previous evaluations of nitrate concentrations in the Platte Valley indicated that the major source of the nitrate is from application of fertilizers on the land surface (Spalding, 1975; Exner and Spalding, 1976; Engberg and Spalding, 1978) and that the median concentrations in shallow ground water were larger than those in deep ground water

Table 1. Concentrations of selected chemical constituents and method detection limits in ground-water samples collected from 27 wells in the Platte River Valley, Nebraska, October - November 1997

[mg/L, milligrams per liter; µg/L, micrograms per liter; pCi/L, picocuries per liter; <, less than]

Chemical constituents	Number of detections	Method detection limit	Concentration		
			Minimum	Median	Maximum
Major ions (mg/L)					
Calcium	27	0.02	43	81	298
Magnesium	27	.004	5.5	20	65
Sodium	27	.10	5.8	35	396
Potassium	27	.10	3.8	9.0	57
Sulfate	27	.10	18	68	941
Chloride	27	.10	1.9	14	57
Fluoride	27	.10	.10	.39	1.1
Silica	27	.10	19	38	58
Dissolved nutrients (mg/L)					
Nitrogen, nitrite	10	.01	.02	.06	.17
Nitrogen, nitrite plus nitrate	25	.05	.05	2.9	48
Nitrogen, ammonia	7	.02	.04	.02	.24
Nitrogen, ammonia plus organic	15	.10	.13	.25	.67
Phosphorus	25	.01	.01	.11	.86
Phosphorus, orthophosphate	25	.01	.02	.15	.90
Trace elements (µg/L)					
Arsenic	23	1	1	6	24
Radionuclides					
Radon 222 (pCi/L))	27	70	132	293	733
Uranium (µg/L)	23	.30	2.45	18.1	174
Pesticides (µg/L)					
Atrazine	21	.004	.004	.180	.690
Metolachlor	10	.004	.004	.006	.300

(Helgesen and others, 1994). Dissolved-phosphorus concentrations in samples collected for this study generally were low (table 1). Two of the 27 samples were below the detection limits. The range was from less than the detection limit (0.01 mg/L) to 0.86 mg/L, and the median concentration was 0.11 mg/L.

TRACE ELEMENTS

Analyses of ground-water samples for trace elements were examined to determine whether or not the

MCLs were exceeded for any of the following constituents: antimony, arsenic, barium, beryllium, cadmium, chromium, lead, and selenium. For this study, no trace elements exceeded the MCLs.

Recently, the National Research Council (1999) recommended lowering the current MCL for arsenic in drinking water of 50 µg/L (micrograms per liter) to a proposed 10 µg/L, citing risks for developing bladder and other cancers. The World Health Organization (1999) provisional guideline for arsenic in drinking water is 10 µg/L. The USEPA will propose a new, and likely lower,

arsenic MCL during 2000 (U.S. Environmental Protection Agency, 2000). Arsenic was detected in 23 of the 27 samples collected for this study. No concentrations exceeded the current MCL of 50 µg/L, although three samples exceeded 10 µg/L.

RADIONUCLIDES

Radon is a product of the radioactive decay of uranium that is soluble in water and organic liquids, but readily degasses from water into the atmosphere as a result of its low partial pressure in air. Radon from tap water is a smaller source but when released into the air from household water uses increases the risk of lung cancer over the course of one's lifetime (U.S. Environmental Protection Agency, 1999). There is currently no federally enforced drinking-water standard for radon. Radon was detected in all 27 ground-water samples. Radon concentrations ranged from 132 to 733 pCi/L (picocuries per liter) with a median radon concentration of 293 pCi/L.

Uranium is a naturally occurring radioactive element that is present in igneous rocks, sedimentary ore bodies, and phosphate rocks and their weathered products (Maynard, 1983). It has been suggested that higher uranium concentrations throughout the Platte River Valley occur as a result of the weathering of crystalline and sedimentary rocks (Spalding and Druliner, 1981). Uranium was detected in 23 of the 27 ground-water samples (table 1). Uranium concentrations ranged from 2.45 to 174 µg/L with a median of 18.1 µg/L.

PESTICIDES

Samples were analyzed for pesticides, including insecticides, herbicides, and fungicides. Only two of the

44 pesticides for which samples were analyzed—atrazine and metolachlor—were detected (table 1). Atrazine was detected in 21 of the 27 samples (table 1). The concentrations of atrazine ranged from 0.004 to 0.690 µg/L, with a median concentration of 0.180 µg/L. Metolachlor was detected in 10 of the 27 samples, with a median value of 0.006 µg/L. Concentrations of pesticides may be a concern in water supplies that rely on shallow wells where the alluvial aquifer is hydraulically connected to nearby streams (see following section).

SURFACE-WATER/GROUND-WATER INTERACTION

An important hydrologic process in the Platte River Valley is surface-water/ground-water interaction (Huntzinger and Ellis, 1993). Ground water in the alluvial deposits has a direct hydraulic connection with the Platte River (Steele and Verstraeten, 1999; Verstraeten and others, 1999); thus, ground-water gradients and water quality are affected by flows in the river (fig. 2), and by diversions and return flows of surface water used for irrigation and power generation. The results of studies using atrazine in the Platte River as a tracer (Duncan and others, 1991; Blum and others, 1993; Verstraeten and others, 1999) revealed how dissolved constituents moved from the Platte River through the alluvium in nearby observation and municipal wells. Travel times as short as 5 days have been determined. This information helps water-resources managers to protect the quality of the drinking water supplied to the cities that rely on alluvium in the Platte River as a source.

—By *James M. Parnell*

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