# Herbicides and Nitrates in the Iowa River Alluvial Aquifer Prior to Changing Land Use, Iowa County, Iowa, 1996

**U.S. Department of the Interior–U.S. Geological Survey**

The Iowa River alluvial aquifer in Iowa County, Iowa (fig. 1), underlies an area of intensive agricultural activity where pesticides and nitrogen-based fertilizers are extensively used. The effects of changing land use on shallow ground-water quality in part of the Iowa River alluvial aquifer are currently being investigated as part of the U.S. Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program. Approximately one-third of the cropland in the study area will be taken out of production over the next few years as part of wetland restoration. Over a three-week period in 1996, the USGS collected water samples from 23 observation wells completed in the Iowa River alluvial aquifer and analyzed the samples for selected agricultural chemicals.

Four herbicides (alachlor, atrazine, cyanazine, and metolachlor) and one nutrient (nitrate) were selected for study on the basis of frequent usage in Iowa and high detection rates in ground water (Detroy and Kuzniar, 1988). Alachlor was not detected at concentrations greater than the method detection limit (MDL). Atrazine was detected at concentrations greater than the MDL in samples from 48 percent of the 23 wells, cyanazine from 13 percent, metolachlor from 26 percent, and nitrate from 91 percent. None of the four herbicides were detected at concentrations greater than the respective U.S. Environmental Protection Agency's (USEPA) Maximum Contaminant Level (MCL) for drinking water. Thirteen percent of the samples had nitrate concentrations above the USEPA's MCL of 10 mg/L (milligrams per liter). Relations between constituent concentration and well depth were observed for specific constituents at individual well nests.

## Background

The goal of the USGS NAWQA Program is to assess the status and trends in the quality of the Nation's surface and ground water and to better understand the natural and human factors affecting water quality. The effects of changing land use on shallow ground-water quality in part of the Iowa River alluvial aquifer (fig. 1) are currently being investigated as part of the Eastern Iowa Basins NAWQA. One-third of the cropland in the study area is currently being changed from agricultural

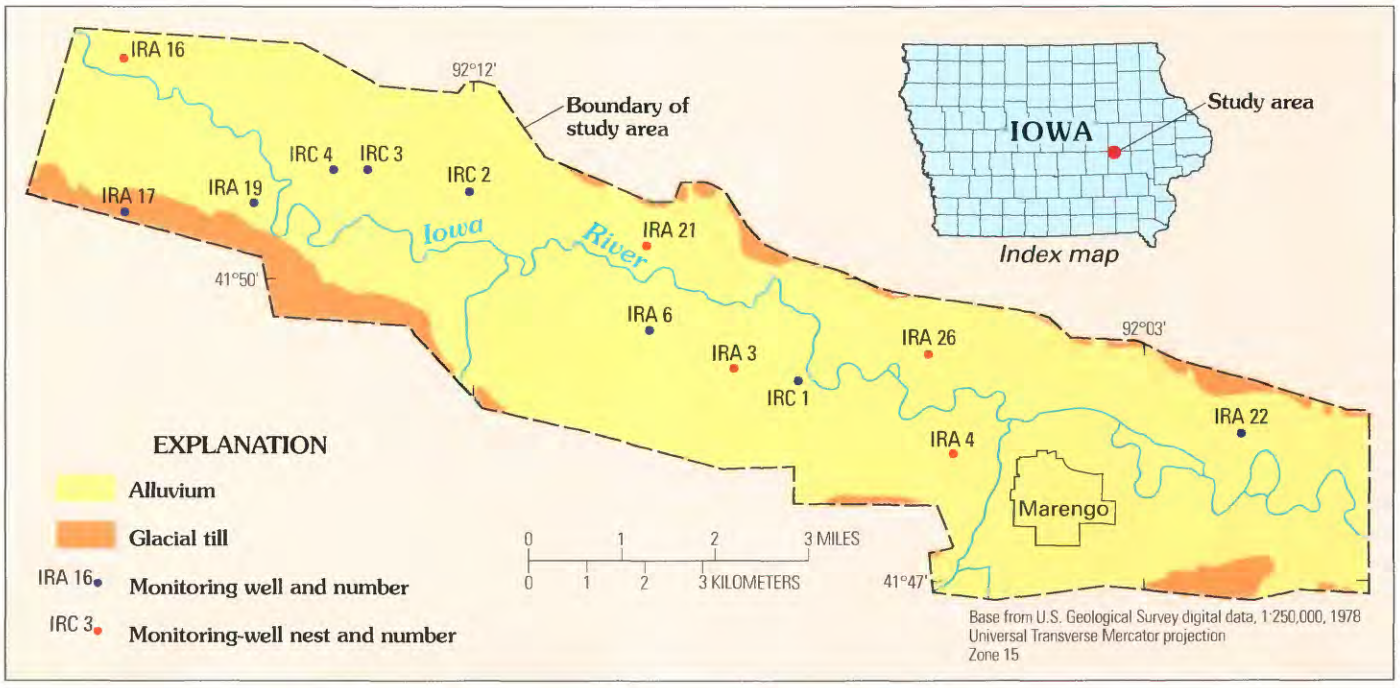


**Figure 1.** Monitoring-well locations within the study area.

production to wetlands through the Wetland Reserve Program implemented by the Natural Resources Conservation Service and the U.S. Fish and Wildlife Service buy-out program. As a result, the use of pesticides and nitrogen-based fertilizers will diminish in this area. Comparison of water-quality results over time will provide a unique opportunity to document the effects of changing land use on shallow ground-water quality. This report presents selected herbicide and nitrate concentration data from samples collected from 23 wells during July and August 1996.

## Description of the Study Area

The study area encompasses 83 square miles along a 16-mile reach of the southeast-flowing Iowa River in east-central Iowa (fig. 1). The river valley is underlain by alluvial clay, silt, sand, and gravel of variable thickness (10 to 55 feet); the alluvial deposits are underlain by glacial till (Detroy and Kuzniar, 1988). Recharge to the area is primarily from local precipitation, and ground-water flow is toward the Iowa River (Detroy and Kuzniar, 1988). Depth to water typically ranged from 3 to 6 feet below land surface. Alachlor, atrazine, cyanazine, metolachlor, and nitrate are commonly applied on Iowa cropland. Agricultural land-use practices are a source of herbicides and nitrate in ground water. Eighty-four percent of the land in the study area is agricultural (fig. 2), and about one-third of the cropland will be taken out of production over the next few years.

## Approach and Methods

This study includes 19 monitoring wells available from a previous USGS and Iowa Department of Natural Resources study (Detroy and Kuzniar, 1988) and 4 wells drilled by the USGS in 1996. Well locations were selected on the basis of proximity to areas of anticipated changes in land use, proximity to areas of continuing agricultural activity, and broad spatial coverage of the study area. Well depths range from 8 to 40 feet. Five locations consist of well nests of two to four wells that are screened at various depths within the alluvial aquifer.

Ground-water samples were collected from the 23 monitoring wells during the summer of 1996 (July and August), near the time of year typically exhibiting greatest agricultural-chemical concentrations in ground water (Detroy and Kuzniar, 1988; Kalkhoff and others, 1992). All samples were collected using NAWQA protocols (Lapham and others, 1995). The samples were analyzed for major ions, nutrients, pesticides, volatile organic compounds, and tritium. Nitrite concentrations in 87 percent of the samples were no more than a small fraction of the nitrate concentration; therefore, nitrate plus nitrite as nitrogen are referred to as nitrate in this report.

The MDL represents the lowest concentration at which a constituent is reliably detected for the specific laboratory method used. The MDLs for the five constituents studied (analyzed at the USGS National Water-Quality Laboratory in Arvada, Colorado) are listed in table 1. MCLs have been established for three of the five constituents discussed (table 1) (USEPA, 1995).

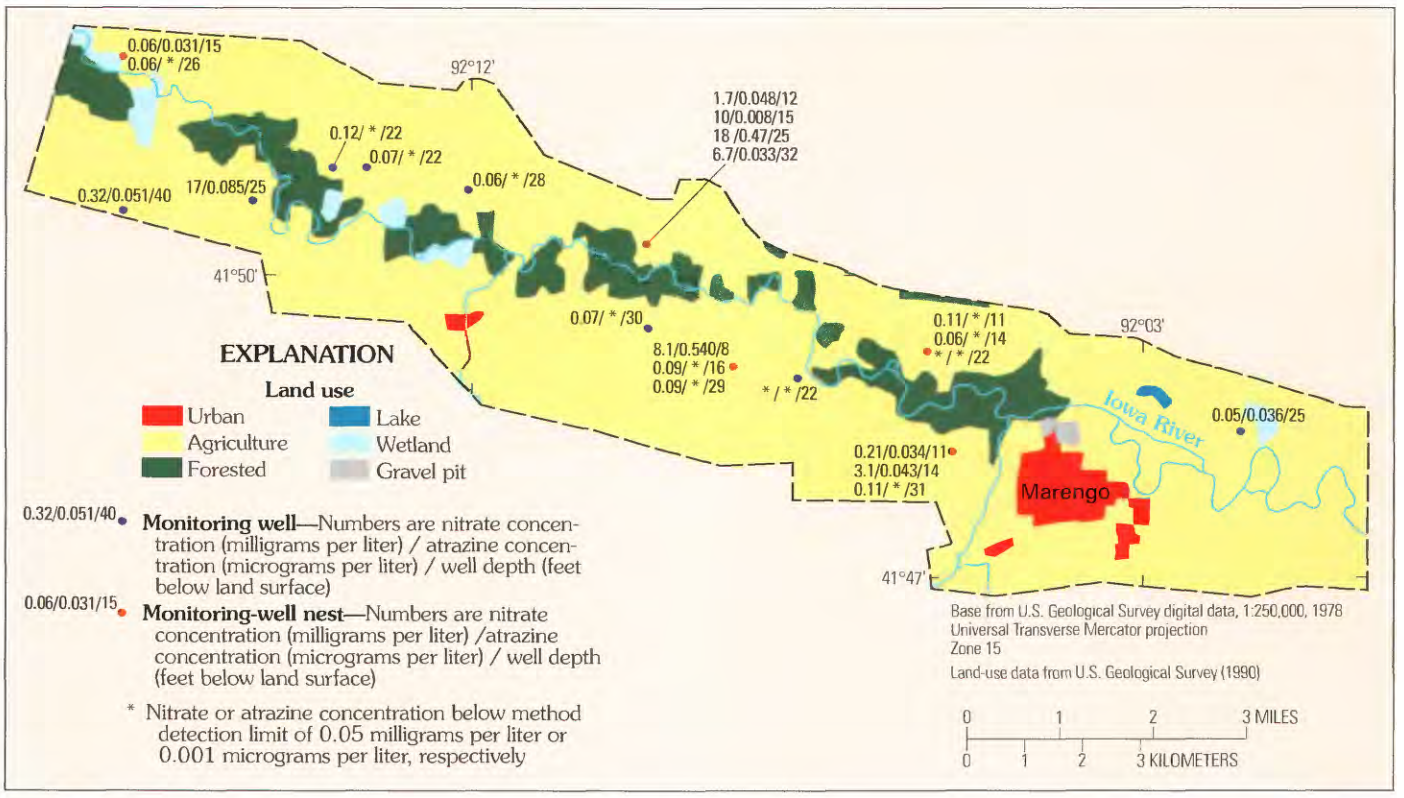


**Figure 2.** Land use and nitrate and atrazine concentrations with depth in ground water from the alluvial aquifer within the study area.

## Results

Alachlor, atrazine, cyanazine, metolachlor, and nitrate concentration data were evaluated for areal distribution and variation with depth within the aquifer.

### Areal Distribution in Concentrations

None of the four pesticides were detected at concentrations greater than the respective USEPA's MCL in samples collected from the 23 monitoring wells (table 1). Alachlor was not detected at concentrations greater than the MDL. Atrazine was detected at concentrations greater than the MDL in samples from 11 wells, with a maximum concentration of 0.54 µg/L (micrograms per liter). Cyanazine was detected at concentrations greater than the MDL in samples from three wells, with a maximum concentration of 0.021 µg/L. Metolachlor was detected at concentrations greater than the MDL in samples from six wells, with a maximum concentration of 0.17 µg/L.

Nitrate was detected at concentrations greater than the MDL in samples from 21 wells, with a maximum concentration of 18 mg/L. Nitrate concentrations in samples from three wells (IRA 19 and two wells in the IRA 21 well nest) were equal to or greater than the USEPA's MCL of 10 mg/L. Well locations are shown on figure 1. Nitrate and atrazine concentrations throughout the study area are shown with well depth in figure 2.

### Variations With Depth in Concentrations

At least one of the selected constituents was detected in ground-water samples from each of the well nests in the study area (fig. 3). Consistent relations between constituent concentrations and well depths for all the well nests were not observed; however, relations between concentration and depth were observed for specific constituents at individual well nests. Variations in constituent concentrations with well depth for atrazine, cyanazine, metolachlor, and

**Table 1.** Constituent concentrations in ground-water samples, July and August 1996

[MCL, maximum contaminant level in drinking water established by USEPA (1995); MDL, method detection limit; µg/L, micrograms per liter; mg/L, milligrams per liter; <, less than]

| Constituent (USGS parameter code) | MCL | MDL | Percentage of samples with concentrations above MDL | Minimum concentration | Maximum concentration |
|---|---|---|---|---|---|
| Alachlor (46342) | 2.0 µg/L | 0.002 µg/L | 0 | <0.002 µg/L | <0.002 µg/L |
| Atrazine (39632) | 3.0 µg/L | .001 µg/L | 48 | <.001 µg/L | .540 µg/L |
| Cyanazine (04041) | -- | .004 µg/L | 13 | <.004 µg/L | .021 µg/L |
| Metolachlor (39415) | -- | .002 µg/L | 26 | <.002 µg/L | .170 µg/L |
| Nitrate (00631) | 10 mg/L | .05 mg/L | 91 | <.05 mg/L | 18 mg/L |

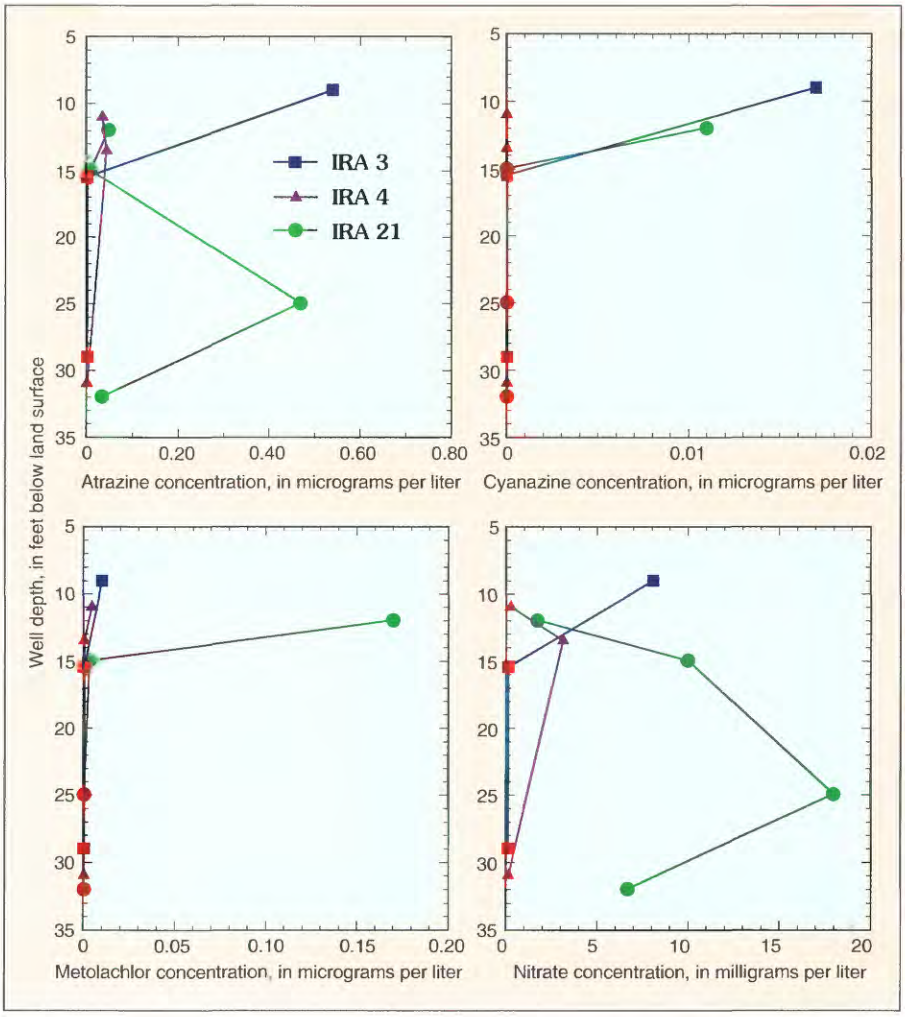


**Figure 3.** Constituent concentrations with depth for well nests IRA 3, IRA 4, and IRA 21. Concentrations below MDL are shown as red symbols. Location of well nests is shown in figure 1.

nitrate at three well nests are shown in figure 3.

### Atrazine

Samples from four of the five well nests had detectable concentrations of atrazine. Detectable concentrations in three well nests (IRA 3, IRA 4, and IRA 16) were not observed below 15 feet. Atrazine was detected to a depth of 32 feet in IRA 21.

### Cyanazine

Samples from two of the five well nests had detectable concentrations of cyanazine. In these two well nests (IRA 3 and IRA 21), cyanazine was not detected below 12 feet.

### Metolachlor

Samples from three of the five well nests had detectable concentrations of metolachlor. In these three well nests (IRA 3, IRA 4, and IRA 21), metolachlor was not detected below 12 feet.

### Nitrate

Detectable concentrations of nitrate were present at 14 of the 15 nest wells. Nitrate was detected to a depth of 32 feet at well nest IRA 21.

## Future Study Objectives

With restoration of the wetlands and the attendant reduction in the use of pesticides and fertilizers, changes in groundwater quality are possible. Future sampling and analyses will enable identification and evaluation of such changes.

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## References


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