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Water Resources Update
Illinois District Newsletter

U.S. Department of Interior
U.S. Geological Survey
District Web Site: http://il.water.usgs.gov/

May 2002

Compiled by D.M. Ayers

A Nationwide Reconnaissance of Pharmaceuticals, Hormones, and Other Contaminants in U.S. Streams

Chemicals used on a daily basis in industry, agriculture, and in our homes usually enter our wastewaters. These chemicals include pharmaceuticals, hormones, and other organic contaminants but very little is known about the fate of these chemicals once they end their designated use. The USGS recently completed its first nationwide reconnaissance of these chemicals in streams. The reconnaissance was completed as part of the USGS Toxic Substances Hydrology Program in order to develop and test new methods for measuring the levels of these chemicals, and to provide information on the occurrence of these chemicals in our streams. The reconnaissance was not designed to determine the levels of these chemicals in drinking-water sources, although it is possible that these chemicals are transported in streams and possibly present in some drinking-water sources. Although many programs are in place for protection of public and ecosystem health by local by State, and Federal Regulatory agencies, the potential for these chemicals to be detected in our environment is difficult to assess.

During 1999–2000, 139 streams in 30 States (7 sites were sampled in north-central and northeastern Illinois) were sampled and analyzed for the chemicals described above. Most sample sites were located downstream of highly urbanized areas (including wastewater-treatment plants) and livestock activity. Generally, although many chemicals were detected, concentration levels were low (rarely exceeding drinking-water standards, health advisories, or ecosystem criteria). However, only 14 of the 95 chemicals detected have established standards or criteria and little is know about the potential effects of these compounds. Also, little is known about the possible health effects of chemical mixtures. We detected chemicals used in industry, agriculture, and residences, including human and veterinary drugs (including antibiotics), hormones, detergents, and fire retardants in Illinois and throughout the Nation. This reconnaissance was not designed to determine the possible sources for these chemicals. However, results indicate that these chemicals are coming from industrial, agricultural, and residential sources.

The USGS has shared this information with agencies, industry, and the general public. Communication is vitally important to the success of this and future research and feedback is sought to help guide future USGS research on this most important issue. This information will be used by resource managers and regulators to make decisions on management practices and to set priorities for future research in setting water-quality standards. This stream reconnaissance is the first of various nationwide efforts by the USGS to determine the extent and presence of pharmaceuticals, hormones, and other organic contaminants in our Nation's water resources. Future research includes better understanding of how these chemicals move and their effects on the environment. The USGS is committed to meeting the health, safety, and knowledge needs of the changing environment around us. More information concerning this important issue can be found on the Web at http://toxics.usgs.gov/.

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GEOPROBE
BY
WILLIAM S. MORROW, HYDROLOGIST

The Illinois District recently increased its sampling capabilities by purchasing a Geoprobe™ system. This mobile unit, mounted on a truck chassis, is capable of obtaining soil, soil-gas, and ground-water samples using "direct push" technology. Push-rods are advanced into the ground by using the static weight of the truck combined with percussion energy. The Geoprobe™ is capable of obtaining samples at depths of 100+ feet, with hole-diameters generally from 0.5 to 1.5 inches. Two-inch hole diameters are possible in some cases. Continuous soil cores, temporary wells, piezometers, soil-gas implants, ground-water levels, ground-water samples, and slug test are some of the items that can be completed with the Geoprobe™.

Advantages of using the Geoprobe™ over conventional drilling and sampling technologies include ease of mobilization, faster sample collection, and ease of equipment decontamination. Ground-surface disturbance is minimal because the direct push technology does not produce drill cuttings. Ground-water samples obtained with the Geoprobe™ are used for screening purposes and their use for regulatory analyses currently is being reviewed by the U.S. Environmental Protection Agency.

The Geoprobe™ system is completely self-contained in a 4-wheel drive "dually" truck, making difficult off-road sampling possible. The truck comes complete with sampling tools and water-storage capability. The Illinois District's Geoprobe™ has been used to date in collection of soil and/or ground-water samples in investigations in Dover, Delaware; Canton, Illinois; and the eastern St. Louis area in Illinois. Samples have been obtained at depths up to 50 feet, although deeper sampling depths will be attempted in the near future.

The Illinois District's Geoprobe™ system, supporting equipment, and operators are available for use in investigations that involve programs of the U.S. Geological Survey. Additional information concerning the Illinois District's Geoprobe™ system is available from Pat Mills or Bill Morrow.

Collecting ground-water samples with the Geoprobe™ in Dover, Delaware.

EMPLOYEE SPOTLIGHT

DAVID T. SOONG, PHD, RESEARCH HYDROLOGIST

David T. Soong is a research hydrologist with the U.S. Geological Survey (USGS), Water Resources Discipline in the Illinois District. He joined the USGS in July 2000. David primarily has worked on two projects since joining the USGS: updating the flood-frequency estimates for rural streams of Illinois and revising the floodplain map for Blackberry Creek in Kane County, Illinois. The project on updating the flood estimates is developed based on two factors: more years of streamflow data from 1986 to 1999 has become available at many streamflow-gaging stations for improving the at-site estimates since the last report was published and new basin characteristics now can be obtained for developing the regional regression equations. These new basin characteristics are derived through the advances in geographic information system (GIS) and Statewide database on digital elevation, soil and land-use coverages. The frequency analysis is challenging because the Illinois District also is evaluating the application of partial duration series (PDS). Conventional flood-frequency analysis uses the annual maximum series (AMS) with the emphasis on larger peaks for flood protections. Analyzing PDS gives the District an opportunity to examine its application and deficiency in the peak estimates for lower return intervals; an area of particular interests to investigations on channel morphology and/or fishery management. Therefore, if successful, the results can complement the usage of traditional flood estimates. The project on floodplain mapping deals with a watershed that is subject to rapid urbanization. The re-delineated base floodplain map will reflect the effects of urbanization and, thus, provide tools/information for watershed management. The project requires the development and application of hydrologic, hydraulic, and hydrodynamic models, and familiarity with the watershed. Both projects involve large efforts in data gathering and processing besides modeling work done with various members of the District staff. In turn, these projects give David the opportunity to work and become acquainted with the Illinois District staff and other USGS personnel throughout the country.

Before joining the USGS, David worked more than 16 years at the Illinois State Water Survey in the Surface Water Section. During that period, he conducted many projects primarily focused on large rivers issues including flooding, sedimentation, physical changes induced by inland navigation, bank erosion, water quality after major floods, hydrodynamics, and surface-water/ground-water interactions. Study results have been presented in more than 25 technical reports, 9 peered reviewed papers, and many conference papers. This work has given him a unique perspective in the problems associated with the large river systems in the U.S. Midwest and China. Through the support of the National Science Foundation, he joined Chinese scientists to investigate the effectiveness of levees and sedimentation-induced problems along the Lower Yellow River in China. In 1996, he investigated and documented bank erosion conditions for the entire length of the Upper Mississippi and Illinois Rivers with scientists from the University of Iowa, four Corps of Engineer Districts, and various State agencies. In 1997, David visited the Loess Plateau and Three Gorge Dam sites in China through a scholarly grant from the United Nations. These experiences gave him the opportunities to observe the causes, magnitudes, and consequences of floods and sedimentation as well as how Chinese and the U.S. scientists approach these problems.

David received an MS and PhD in Civil Engineering from the University of Illinois in 1980 and 1986, respectively. Besides work activities, he also participates in committee work such as co-organizing the U.S.-Chinese Joint Workshop on Sediment Transport and Disasters in 1999, and served on the organizing committee for various international conferences. David is a board member of the Chinese American Water Resources Association with the goal in promoting technology exchange with scientists in Asia. David and his wife, Joanne Chou, have a daughter, Lillian, who is in junior high school. David enjoys fishing with his family, vegetable gardening, and playing basketball.

Agricultural Chemicals in Illinois Ground Water — Recent Studies by the U.S. Geological Survey

By
Patrick Mills, Hydrologist

Illinois is a leading producer of corn and soybeans. Approximately two-thirds of the land area of the State is cropland. In about 80 percent of the State's townships, more than 50 percent of the land is used for corn and soybean production (McKenna and others, 1990). Associated with this production is the extensive application of nutrient supplements (particularly nitrogen fertilizer) and herbicides for weed management. In the late 1980's, annual applications included about 2 billion pounds of nitrogen fertilizer and 50 million pounds of herbicides. However, in response to recent research on application requirements, changes in usage regulations, and training, application rates of both nitrogen fertilizer and herbicides have varied over the past decade. For example, acetochlor has increased from zero usage in 1990 to one of most heavily used herbicides by 2000. With the introduction of "Roundup Ready" corn and soybeans, glyphosate usage in Illinois and Iowa dramatically increased from less than 1 million pounds in 1991 to about 9 million pounds in 1998. Conversely, alachlor and cyanazine usage have decreased dramatically from some of the most heavily used herbicides in 1990 to limited use by 2000.

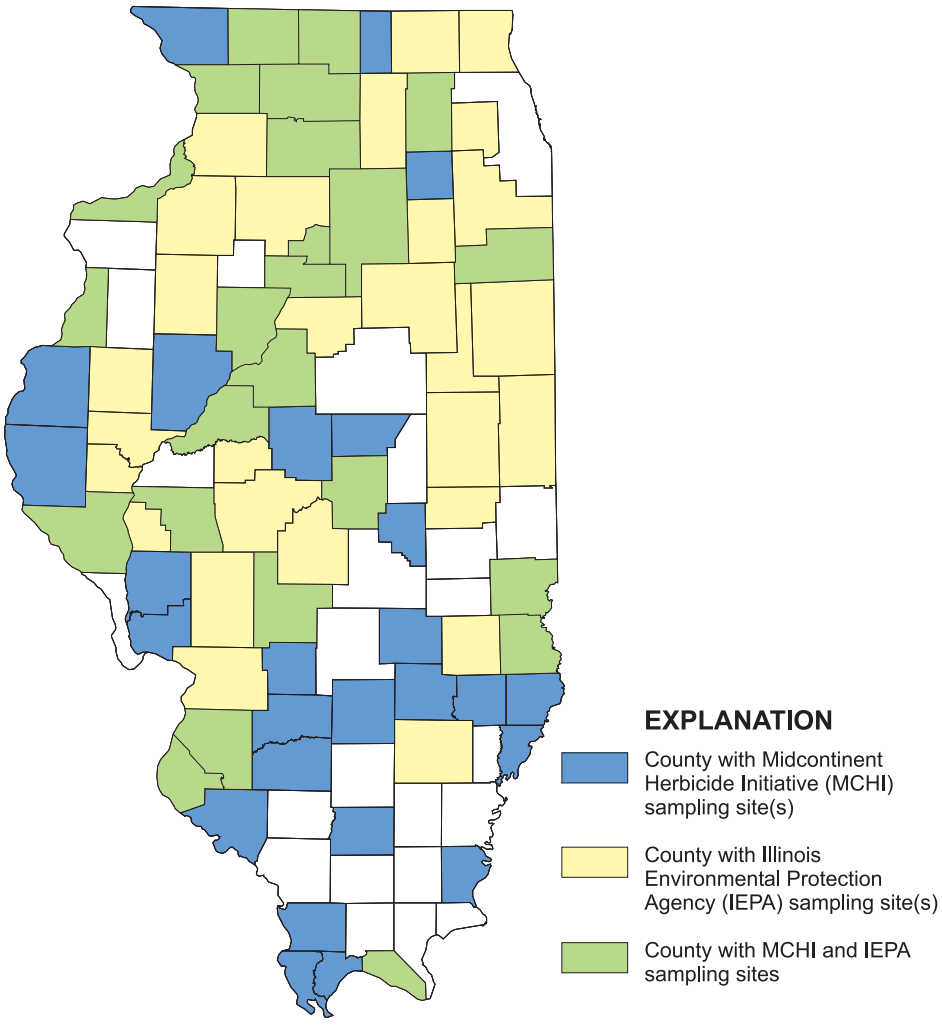

Figure 1. Counties where samples were collected from one or more wells for studies of agricultural chemicals in Illinois ground water.

The extensive application of these agricultural chemicals has resulted in the potential for nonpoint source contamination of the Nation's water resources. For example, the herbicide atrazine has been detected in samples from less than 1 to almost 50 percent of the wells included in initial national and Midwestern surveys. For these surveys, various sampling methodologies and analytical detection limits were used. Because shallow aquifers (within 50 feet of land surface) underlie at least 40 percent of the agricultural regions of the State, Illinois may be particularly vulnerable to ground-water contamination.

Since 1991, the U.S. Geological Survey (USGS) has conducted two Statewide studies in Illinois in order to better assess the potential for agricultural-chemical contamination of the State's ground-water resources. Each study is ongoing. Study results are expected to indicate the spatial and temporal occurrence of the chemicals and factors that may contribute to this occurrence. Those factors may include depth of the aquifers, well depth, aquifer material, and chemical-application rates. For the first study, referred to as the Midcontinent Herbicide Initiative (MCHI), 68 wells in Illinois were sampled during 1991–94 (fig. 1) as part of a regional study of the midcontinental United States (303 wells in 12 States) (Kolpin and others, 1993, 1994, 1996; Kolpin, 1998). A variety of well types (public and domestic supply, and monitoring) were selected randomly from areas where underlying aquifers are shallow

and at least 25 percent of the land is used for corn and soybean production. Fifty-five of these wells (fig. 1) were resampled during October 2000–February 2001. For the second study, conducted in cooperation with the Illinois Environmental Protection Agency (IEPA), 119 public-supply wells are being sampled during October 2001–September 2002. The wells were selected randomly to represent ambient water quality in the major aquifers of the State. Nearby agricultural land use, depth of the aquifers, nor well depth were considered during well selection. Samples collected during both studies were analyzed for nutrients, herbicides, and herbicide-transformation products (table 1).

Table 1: Herbicides and transformation products analyzed for studies by the U.S. Geological Survey of agricultural chemical in Illinois ground water, 1991–2002.

[Type: parent, P; transformation product, TP; Analytical method: GC/MS, gas chromatography/mass spectrometry; IA, immunoassay; LC, liquid chromatography; Study included: 1, 1991 MCHI; 2, 1992–94 MCHI; 3, 2000–01 MCHI; 4, 2001–02 IEPA]

Constituent	Type	Analytical Method	Study Included
Acetochlor	P	GC/MS	2,3,4
Alachlor	P	GC/MS	1,2,3,4
Ametryn	P	GC/MS	2,3,4
Atrazine	P	GC/MS	1,2,3,4
Cyanazine	P	GC/MS	1,2,3,4
Dimenthenamid	P	GC/MS	3,4
Flufenacet	P	GS/MC	3,4
Metolachlor	P	GC/MS	1,2,3,4
Metribuzin	P	GC/MS	1,2,3,4
Pendimethalin	P	GC/MS	3,4
Prometon	P	GC/MS	1,2,3,4
Prometryn	P	GC/MS	2,3,4
Propachlor	P	GC/MS	3,4
Propazine	P	GC/MS	2,3,4
Simazine	P	GC/MS	1,2,3,4
Terbutryn	P	GC/MS	2,3,4
Glyphosate	P	IA	3
Glyphosate	P	LC	4
Deethylatrazine	TP	GC/MS	1,2,3,4
Deisopropylatrazine	TP	GC/MS	1,2,3,4
Cyanazine-amide	TP	GC/MS	2,3,4
Acetochlor ESA[1]	TP	LC	3,4
Acetochlor OXA[2]	TP	LC	3,4
Alachlor ESA	TP	LC	2,3,4
Alachlor OXA	TP	LC	3,4
Dimethenamid ESA	TP	LC	3,4
Dimenthenamid OXA	TP	LC	3,4
Flufenacet ESA	TP	LC	3,4
Flufenacet OXA	TP	LC	e,r
Metolachlor ESA	TP	LC	3,4
Metolachlor OXA	TP	LC	3,4

1. ESA, ethanesulfonic acid
2. OXA, oxanilic acid

Results available from the MCHI surveys during 1991–94 indicated that for samples from Illinois wells considered vulnerable to agricultural-chemical contamination, nitrate is detected above 3 micrograms per liter (the level assumed to result from human activities) at about 37 percent of the wells and above 10 micrograms per liter at about 7 percent of the wells. Herbicides are detected with a frequency of about 25 percent. Atrazine and its transformation product deethylatrazine were detected most often (about 18 percent of the wells) (fig. 2). Other herbicides were detected at frequencies of less than about 5 percent. No concentrations exceeded maximum contaminant levels established by the U.S. Environmental Protection Agency for drinking-water protection (fig. 3). Concentrations typically were higher in samples collected in late summer than in early spring before herbicide application and planting. The results from Illinois are essentially the same as those from the regional MCHI study. Analytical results from the 2000–2001 MCHI survey will be available to the public in the USGS, Illinois District Annual Data Report for water year 2001 (October 2000–September 2001), to be distributed by July 2002. Interpretive results of the available data will be presented in a future publication. Results from the IEPA survey will be available during 2003.

References:

Kolpin, D.W., 1998, Herbicides in ground water of the Midwest: a

regional study of shallow aquifers, 1991–94: U.S. Geological Survey Fact Sheet FS-076-98, 4 p.

Kolpin, D.W., Burkhart, M.R., and Thurman, E.M., 1993, Hydrogologic, water-quality, and-land-use data for the reconnaissance of herbicides and nitrate in near-surface aquifers of the midcontinental United States, 1991: U.S. Geological Survey Water-Supply Paper 2413, 34 p.

Kolpin, D.W., Burkhart, M.R., and Thurman, E.M., 1994, Herbicides and nitrate in near-surface aquifers in the midwestern United States, 1991: U.S. Geological Survey Water-Supply Paper 2413, 34 p.

Kolpin, D.W., Zichelle, K.E., and Thurman, E.M., 1996, Water-quality data for nitrates, pesticides, and volatile organic compounds in near-surface aquifers of the midcontinental United States, 1992–1994: U.S. Geological Survey Open-File Report 96-435, 47 p.

McKenna, D.P., and others, 1990, An evaluation of the impact of pesticides on groundwater in Illinois: Illinois State Geological Survey/Illinois State Water Survey Groundwater Cooperative Report 12, 107 p.

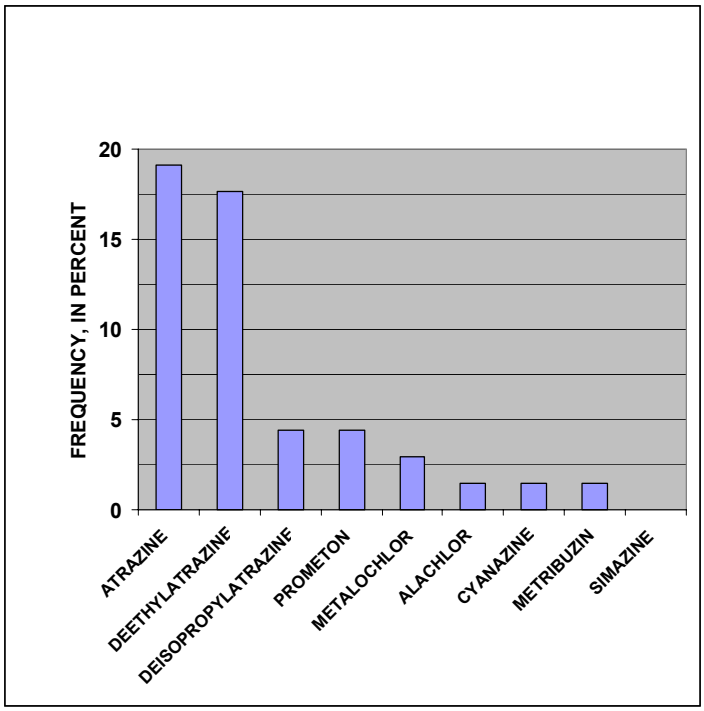

Figure 2. Frequency of herbicides and atrazine-transformation products detected in samples from 68 Illinois wells for the Midcontinent Herbicide Initiative study, 1991.

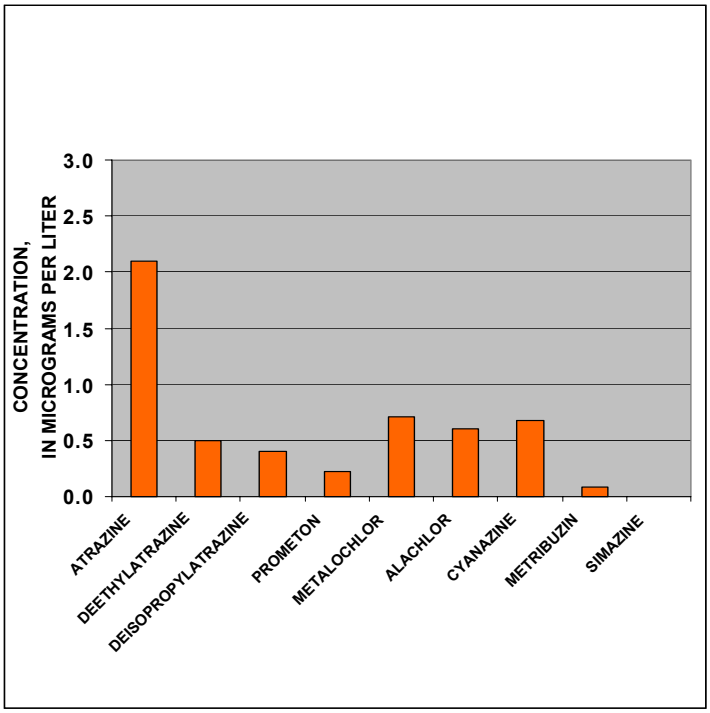

Figure 3. Maximum concentrations of herbicides and atrazine-transformation products detected in samples from 68 Illinois wells for the Midcontinent Herbicide Initiative study, 1991 (maximum contaminant levels for atrazine and alachlor are 3 and 2 micrograms per liter, respectively).

COOPERATOR SPOTLIGHT

U.S. ENVIRONMENTAL PROTECTION AGENCY

The U.S. Environmental Protection Agency (USEPA) cooperates with the Illinois District of the U.S. Geological Survey (USGS) on a variety of projects. Illinois District scientists have assisted the USEPA with the collection and interpretation of hydrogeologic and water-quality data at various waste-disposal sites in Illinois and with studies of regional hydrogeology and water quality in Illinois, Indiana, and Wisconsin. Illinois District assistance to the USEPA also has included cooperative investigations designed to assess the utility of a variety of technologies for the characterization of hydrogeology and water quality in fractured-rock aquifers. Hydrogeologic and water-quality data provided by the USGS are used by the USEPA to make decisions on the efficacy of aquifer remediation, industrial redevelopment, and the remediation of abandoned hazardous waste sites.

The USEPA is the Nation's and the world's leading agency for preservation and restoration of the quality of our air, water, and land. The USEPA began in 1970 with the passage of the Clean Air Act and was expanded upon passage of the Clean Water Act in 1972; the Resource Conservation and Recovery Act of 1976; and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

The mission of the USEPA is to protect human health and safeguard the natural environment. As part of this mission, the USEPA seeks to—

- reduce the ongoing release of toxic substances into the environment;
- promote sustainable urban environments, including the redevelopment of Brownfield sites; protect people at risk, especially children and environmental justice communities; clean up contaminated soil, sediment, water, and air;
- protect and restore critical ecosystems

by a variety of means, including monitoring concentrations of chemicals of concern in air, water, soils, and sediments, setting standards for the allowable concentrations of chemicals of concern in environmental media; regulating the discharge of chemicals of concern to the environment; and enforcing remediation of sites where chemicals of concern pose a threat to human health and the environment.

To meet its goals, USEPA is organized administratively into the Air, Water, Waste-Pesticides and Toxics, and Superfund Divisions and is organized geographically into 10 regions. Region V (Great Lakes) has responsibility for Illinois, Indiana, Minnesota, Michigan, Ohio, and Wisconsin. Region V also is the home of the Great Lakes National Program Office, which has the responsibility for monitoring, preservation, and restoration of the Great Lakes ecosystem. At the national level, the USEPA supports 3 national labs and 12 research centers. The labs and research centers support and conduct research to improve the scientific basis for decisions on national environmental issues including assessment of the impacts of contaminants and environmental stressors. For example, global warming, invasive species on human health and ecosystem integrity and developing cost-effective methods for assessing, reducing, and remediating releases of contaminants to the environment.

To meet its goals the USEPA also gives grants to State and local governmental bodies, Indian Tribes, and private organizations to promote clean air, water, and food; to prevent pollution; to reduce public-health risks in communities, homes, and ecosystems; and to reduce global and international environmental risks.

In 1986, the Illinois District, in cooperation with the USEPA, Region V, Office of Superfund, began studies of water quality and hydrogeology of specific hazardous waste sites in Illinois. A need was recognized for an areal characterization of the water quality and relation of water quality to the hydrogeology to resolve ground-water-contamination issues associated with the cleanup of many of the hazardous-waste sites and to protect public-water supplies. Therefore, the USGS and USEPA initiated ground-water-quality studies in 1991 in two areas of Illinois that extended into the neighboring States of Wisconsin and Indiana. One area included northern Illinois and southern and eastern Wisconsin and the other area included the Calumet region of northeastern Illinois and northwestern Indiana near Chicago. Innovative methods have been used for the characterization of flow and contaminant distribution in fractured rocks.

Outreach Activities

On Monday, March 18, 2002, the Illinois District represented the USGS at the annual Clean Water Celebration in Peoria, Illinois. The goal was to impress upon students the importance of thinking globally and acting locally. By increasing knowledge in the community and schools about the importance of water conservation and preservation, the Clean Water Celebration helps establish the human right to clean water and a healthy environment. About 3,000–4,000 Statewide and out-of-State junior and high-school students and teachers attended the event. The USGS theme was Water Resources of Illinois. A streamtable was displayed to demonstrate the process of river formation, land erosion, sedimentation, deposition, bridge scours, dams, and flooding. Students were asked how water affects our landscape and how streamflow effects land erosion. Moreover, the students had an opportunity to learn about the USGS and its mission. The younger students enjoyed the interactiveness of the display and were interested in dams and flooding. However, the older students were more interested in the technical aspects, such as water sampling and analysis. A number of students were involved in different organizations to help protect our water resources.

From the Mailbag

If you have comments about our newsletter or our Web site, please use the form on the back page. Comments also can be sent to dc_il@usgs.gov.

"Thank you very much for your response! The information is quite helpful to me as a fisherman. I used to drive anywhere from 10-30 miles to see if creeks were on the rise to fish. This website saves me time and money! Once again I appreciate your response!"

"Greetings: Thanks for the information you submitted...**it is exactly what we wanted**! Your help is really appreciated."

"Thank you so much for your reply to my inquiry on the Illinois and Michigan Canal. I appreciate the time you expended on my behalf."

Illinois District Publications

Listed below are publications that have been approved and are in the printing process. **Please note these reports currently are not available.** District policy is to provide copies of our publications to requestors at no cost as long as the publication is in stock in the District office. If you are interested in these publications, you can be added to the mailing list by contacting Donna Ayers at (217) 344-0037, extension 3053 or email at dmayers@usgs.gov. To obtain copies of any other Illinois District publication, you may contact Donna Ayers.

FY 2002

OFR 01-307, Geology, Hydrology, and Water Quality in the Vicinity of a Brownfield Redevelopment Site in Canton, Illinois, by R.T. Kay

OFR 01-459, Physical, Chemical, and Biological Methods and Data from the Urban Land-Use Gradient Study, Des Plaines and Fox River Basins, Illinois, 1999–2001, by D.L. Adolphson, T.L. Arnold, F.A. Fitzpatrick, M.A. Harris, K.D. Richards, B.C. Scudder, and J.S. Stewart

WRIR 01-4068, Habitat, Biota, and Sediment Characteristics at Selected Stations in the Lower Illinois River Basin, Illinois, 1995–98, by D.L. Adolphson, D.J. Fazio, and M.A. Harris

WRIR 01-4100, Hydrogeology and Simulation of Ground-Water Flow in the Aquifers Underlying Belvidere, Illinois, by P.C. Mills, J.E. Nazimek, K.J. Halford, and D.J. Yeskis

WRIR 01-4116, Estimated Water Withdrawals, Water Use, and Water Consumption in Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri, and Wisconsin, 1950–95, by R.T. Kay

WRIR 02-4062, Delineation of the Troy Bedrock Valley and Evaluation of Ground-Water Flow by Particle Tracking, Belvidere, Illinois, by P.C. Mills, K.J. Halford, and R.P. Cobb