Water Resources Update
USGS Illinois Water Science Center Newsletter

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

Illinois Water Science Center
1201 W University Ave Ste 100
Urbana IL 61801-2347

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Compiled by D.M. Ayers

MESSAGE FROM THE DIRECTOR

On June 26, 2005, Illinois Governor Rod Blagojevich activated the State's Drought Response Task Force. This task force is made up of various agencies of State government along with Federal Agencies, such as the U.S. Geological Survey Illinois Water Science Center (USGS). Periodic meetings are held to assess various facets of the drought's impact on the State, including agriculture, water supply, ecosystem, economic, and public helath and to make any appropriate recommendations for action. Currently, drought conditions are present within the State, particularly west-central and northern Illinois. The Illinois State Water Survey reports that the northeast, northwest, and central climate divisions of the State have experienced their 2nd or 3rd driest March-September periods on record. (http://www.sws.uiuc.edu/hilites/drought/DTFSummary20050929.pdf)

The USGS streamflow-gaging stations are an integral part of the drought assessment for the State. One index of drought condition is to determine how the current streamflow compares with the historical record of streamflow at that location for that date or range of dates. This index of streamflow conditions is expressed in percentiles of streamflow. A percentile is a value on a scale of 100 that indicates the percent of a distriution that is equal to or below the value. For example, on the map of daily streamflow conditions to the right, a streamflow at the 90th percentile is equal to or greater than 90 percent of the flow values recorded on this day of the year during all years that measurements have been made. In general, a percentile between 25 and 75 percent is considered normal with percentiles less than 25 being below normal and tending toward hydrologic drought conditions as the percentile value decreases. As of October 2005, many locations in central and northern Illinois are experiencing record low flows for this time of the year as compared to the historical record (more than 90 years in some locations). The Illinois River, in particular, is experiencing record low flows due not only to the lack of precipitation in tributary basins but also due to the decrease in diversion from Lake Michigan. The Illinois River at Valley City had a flow of 3,090 cubic feet per second, which is 810 cubic feet per second lower than the previous minimum low flow for all the October 16's measured for the period of record (since 1938).

A map of real-time USGS streamflow percentiles for Illinois can be found at http://water.usgs.gov/cgi-bin/waterwatch?map_type=real&state=il.

Other USGS drought-related information for Illinois can be found on our home page http://il.water.usgs.gov/. Drought information for the State of Illinois Drought Response Task Force can be found at http://www.sws.uiuc.edu/hilites/drought/.

Robert R. Holmes, Jr., PhD, P.E.
Director, USGS Illinois Water Science Center

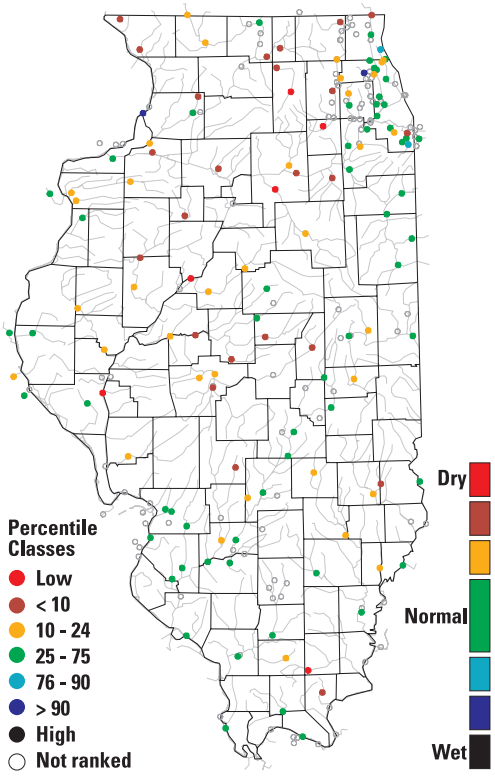
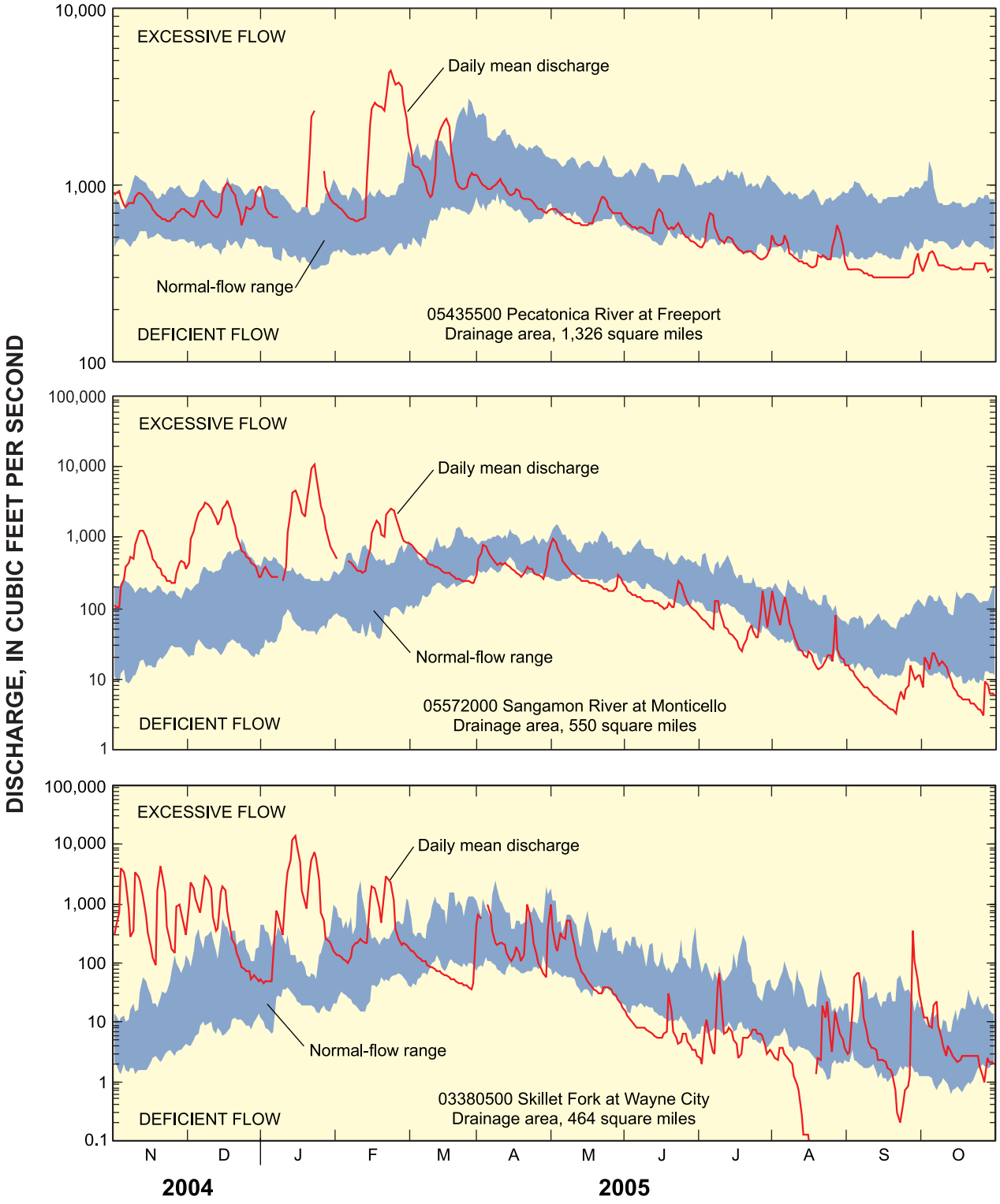


TABLE OF CONTENTS



Daily mean discharge from November 1, 2004 through October 31, 2005 compared with percentile distribution of mean daily discharges for the 30-year period, 1961-90, for 3 representative streamgaging stations. A daily mean discharge is in the deficient-flow if its value is less than or equal to the 25th percentile, in the normal-flow range if its value is between 25th and 75th percentiles, and in the excessive-flow range if its value is equal to or greater than the 75th percentile.

Determining Resistance Coefficients for Illinois Streams

by

Teresa M. Halfar, Civil Engineer

The USGS Illinois Water Science Center, in cooperation with the Illinois Department of Natural Resources, Office of Water Resources (IDNR-OWR), has been collecting and analyzing data to assess streamflow-resistance coefficients for Illinois streams since 2000. A resistance coefficient is a measure of friction, in terms of either momentum or energy losses, from roughness factors along the flow boundary in resisting the flow. Flow-resistance coefficients, such as Manning's n (n-value), are used in a wide range of hydraulic and hydrologic analyses. The results of these analyses affect the design, operation, and management of water-resources projects. However, despite advancements in hydrodynamic theories and data-collection practices, in general, the determination of flow-resistance coefficients in a natural environment is still a challenge to engineers. Manning's n is selected for presentation in this study because it is the most widely used resistance coefficient in the United States and because it gives reasonable results over a range of flow conditions. The primary goal of this study is to develop a method to assist users in estimating n-values for sites of interest throughout Illinois. The purpose of this article is to give a brief description of the background and progress to date (July 2005) of this study.

Site-selection criteria for determining n-values in Illinois include bed and bank material, channel cross-sectional geometry, longitudinal profile, channel alignment, and the associated characteristics of the drainage basin in which the channel is located. For a given stream, a representative reach is identified first. Then, one or more study reaches within the representative reach are selected according to the consistency of surface roughness and channel geometry, whether a reach contains abrupt expansion and/or contraction sections, and the feasibility of setting measurement points so that sufficient reach length is secured for measuring distinct water-surface slope. For practical reasons, sites near USGS streamflow-gaging stations have been given first priority for site selection.

Streamflow measurements, along with simultaneous measure of water-surface elevations at two or more fixed points in a study reach for slope calculation, were made at each study site. Data were collected over a range of stage, but did not exceed bankful flow. Photographs of streams were taken at the time of the measurement to help illustrate channel hydraulic properties that affect the magnitude of the n-value for a given stage. In addition, ancillary data including site information, photographs of low-flow conditions, cross-sectional data (at least three cross sections), and bed-material data were collected to assist in the analysis. Streamflow measurements were made using either the conventional current-meter method or acoustic Doppler current profiler (ADCP) method.

As of July 2005, a total of 177 n-values have been determined for 37 study sites throughout the State. Data and results are presented in a format similar to Barnes (1967) and are available at http:il.water.usgs.gov/proj/nvalues/index.htm. The format is useful for data interpretation and comparison of n-values to sites with similar hydrologic and geomorphic characteristics. The n-values presented are reach-wise, based on the energy concept, and applicable to one-dimensional flow computations. All n-values presented were determined from field data. The primary data set consists of natural and constructed channels in Illinois, in both rural and urban settings. Users can link to "Site Descriptions" and view the list of current study sites, the range in n-values per site, and site photos of low-flow conditions. Each site name links to the individual data tables and visual presentations. Users can download the report in a PDF format or link to other reports on the same topics published by other USGS Water Science Centers.

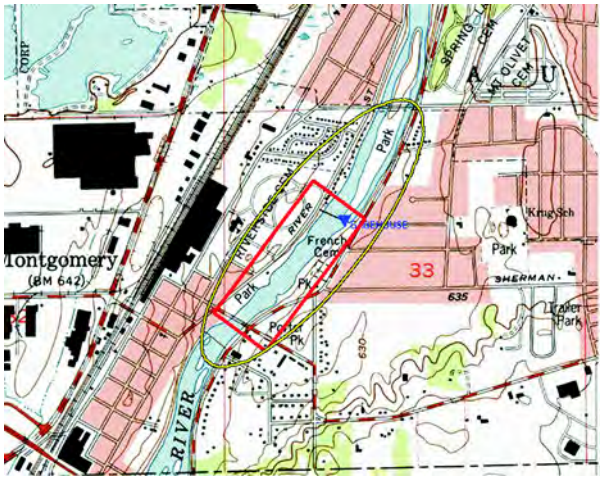
Four types of images are prepared for presenting the field data (see page 3). Examples of graphics and data table available on the Web page are shown below. The location of the study site is identified on the USGS quadrangle map. An aerial photo, which clearly shows the study site, is used for illustrating the characteristics of the study reach. Representative corss-sectional shapes are presented for reviewing the geometric factors. Locations of the cross sections are identified on the aerial photograph. Bed and bank materials can be visualized during low-flow conditions. Whenever possible, photographs of the channel were taken at the time of each n-values survey. Ideally, four to five measurements under a wide range of flow conditions, with accompanying photographs are needed for a study site. The site photographs are annotated in the office with site name, view, data, and flow conditions. Later, the computed n-value is added to the corresponding photo. Photographs like these can be used to assist in understanding bed and bank, flow, and channel conditions. Mean values of the hydraulic properties, averaged among the cross sections used in each study reach, are reported as the reach-wise properties and are listed in the table along with the computed n-values. In addition to the images and data table, nine headers are included in the data presentation for describing the channel, study reach, and site characteristics.

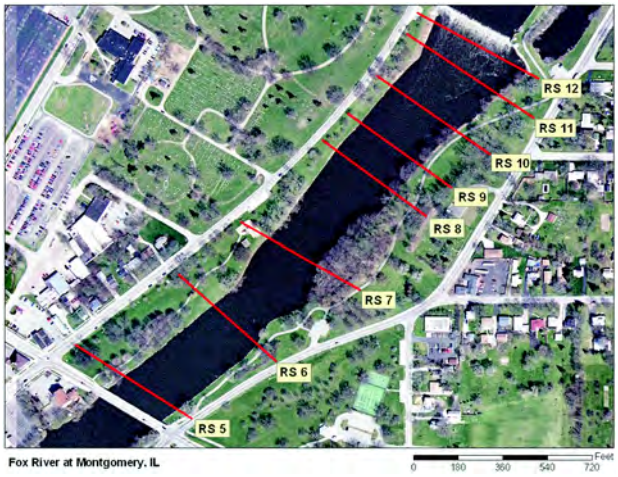
Planned future work includes identifying and developing study sites on small streams in urban areas, both natural and constructed channels, for additional data collection. A search engine will be developed to search the database for streams in a predetermined range of n-values, for example, or to find streams based on certain channel characteristics specified by the user. Users will be able to access a list of various equations, calculate an n-value from known hydraulic properties, and then search the database for streams with that value.

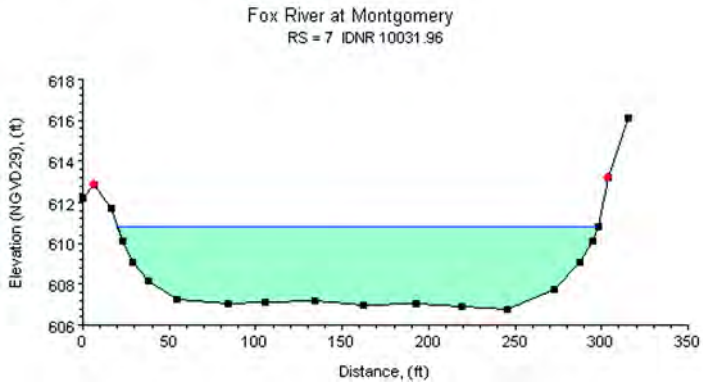
For additional information concerning this study, please go to the Web site listed previously or contact the USGS Illinois Water Science Center.

Reference Cited

Barnes, H.H., 1967, Roughness Characteristics of Natural Channels: U.S. Geological Survey Water-Supply Paper 1849, 213 p.







05551540 Fox River at Montgomery, IL
Low flow, looking Downstream from dam
09/28/04

05551540 Fox River at Montgomery, IL
Looking Downstream from dam
05/19/04

Date of Observation	Discharge (ft^3/s)	Average Cross-Section Area (ft^2)	Hydraulic Radius (ft)	Mean Velocity (ft/s)	Slope	Coefficient of Roughness *n*
7/9/2004	1440.0	895.2	3.10	1.68	0.000328	0.033
3/26/2004	2230.0	1141.1	3.82	2.02	0.000371	0.032
12/11/2003	2360.0	1168.5	3.90	2.09	0.000348	0.031
5/19/2004	4640.0	1518.0	4.89	3.14	0.000290	0.022
5/21/2004	4790.0	1608.0	5.13	3.07	0.000386	0.026

Average Hydraulic Parameters and Computed *n*-Values

EMPLOYEE SPOTLIGHT

TERESA M. HALFAR (CIVIL ENGINEER)

Teresa Halfar began her career as a hydrologist at an early age. As a child growing up in rural, small-town Illinois, she spent many happy hours with her brothers disrupting the flow of Salt Creek by constructing dams in the stream out of river rock, tree branches, and clay. From those humble beginnings, she eventually found her way to the USGS.

Teresa started working at the USGS as a student in 1998, while attending the University of Illinois in Urbana/Champaign. After completing her B.S. in Civil Engineering in the Environmental Hydrology and Hydraulic Systems program, Teresa began her career in earnest as a hydrologist with the USGS Illinois Water Science Center.

Presently, Teresa is a member of the Surface-Water Investigations Section of the USGS Illinois Water Science Center. Her work activities include collecting and processing hydrologic data as part of the national streamflow-gaging network and assisting in special project work related to surface water. She is currently part of the team collecting and analyzing data in order to assess streamflow resistance coefficients for Illinois streams described in the previous article. She also is involved with steady and unsteady one-dimensional hydraulic modeling in northeastern Illinois.

In addition to her work as a hydrologist at the Science Center, Teresa enjoys the distinction of being a soldier in the Illinois Army National Guard. She holds the rank of staff sergeant and is a member of the Headquarters and Headquarters Detachment, 634th Forward Support Battalion, 66th Infantry Brigade, 35th Infantry Division. Her unit was activated during the Great Flood of 1993 to provide emergency support and levee security. In September, Teresa's National Guard Unit was activated to help with Hurricane Katrina relief activities.

Teresa Halfar lives in Champaign with her husband Marty and daughter Jessica. She and her family enjoy hiking, camping, trail running, and, of course, disrupting the flow of small streams by constructing dams out of river rock, tree branches, and clay.

The Future of Streamflow Gaging in Illinois

by
Gary P. Johnson
Chief, Hydrologic Data Collection and Analysis Section

The USGS operates more than 7,000 streamflow-gaging stations on rivers throughout the Nation. Because of the importance of the streamflow-gaging program, the USGS continues to be at the forefront of a systematic effort in search of new technologies tha may enable the direct, continuous, non-contact measurement of open-channel streamflow. These new technologies have the potential to reduce the costs, improve the accuracy, and reduce the hazards associated with conventional streamflow-gaging methods (fig.1).

One USGS program, called Hydro-21, was initiated to provide vision and leadership at the USGS for identifying and evaluating new technologies and methods that might have potential to completely change the paradigm in the streamflow-gaging program. A broad spectrum of techniques, including acoustics, image methods, laser, and radar, is being considered. USGS Research Hydrologist Dr. John Costa (Vancouver, Washington) discussed Hydro-21 at the Governor's Conference on the Management of the Illinois River System in Peoria, Illinois in October 2005. Dr. Costa talked about an experiment in Washington State where USGS personnel measured surface velocities using a pulsed Doppler radar and river depth using ground-penetrating radar (GPR). Both radars were mounted on a helicopter and flown over rivers in a series of approximately 1-minute passes from 2 to 15 meters above the water surface. The magnitude of the uncertainty in velocity and depth measurements indicates that the method error is in the range of 5 percent. The results of this experiement indicate that helicopter-mounted radar can make rapid, accurate streamflow measurements needed in

Figure 1. USGS Hydrologic Technician Phil Dennis making a conventional discharge measurement using a 4-wheel base, sounding weight, and spinning-cup current meter on the Boneyard Creek at Urbana, Illinois (University of Illinois Campus).

remote locations and during major floods (fig. 1). In addition, GPR experiments were conducted with the GPR antenna suspended above the water surface from a bridge. Traverses were made across stream channels to collect radar-profile plots of the stream bed. Initial tests indicate that GPR is capable of producing a reasonably accurate (+/- 20 percent) stream-channel profile and streamflow far more quickly than conventional streamflow-gaging methods (fig. 1), while avoiding the problems and hazards associated with placing instruments in the water (fig.2). More information on Hydro-21 is available at http://or.water.usgs.gov/hydro21/index/shtml.

In the USGS Illinois Water Science Center, we also are currently using and experimenting with various new technologies to facilitate more efficient, more accurate, and safer streamflow gaging. The Center now has 15 acoustic Doppler current profilers (ADCPs). These ADCPs make the old, extremely heavy and awkward sounding-weight and spinning-cup current meters used in conventional streamflow gaging almost obsolete. With the ADCPs, we now are able to collect more accurate streamflow data, in a safer manner that with conventional methods because appreciably less time is spent on bridges and boats. Also, we recently installed our first radar stage sensor in Illinois. This new radar unit meets USGS standards for accuracy and precision and recently became commercially available. Thus far, the unit has worked well and has the advantage of not being in direct contact with the stream. In addition, the radar unit is much easier to install than conventional pressure-system gages. Use of this unit should reduce maintenance (repair of and/or digging out of destroyed/buried orifice lines) and installation costs (fig.3).

USGS remains committed to providing high-quality streamflow data. As new technologies become available, USGS systematically tests these new technologies at the USGS Hydrologic Instrumentation Facility (HIF) in Bay St. Louis, Mississippi, to ensure sufficient accuracy and precision. Many new technologies show great promise. The USGS, when accuracy and precision are not sacrificed, will continue to apply and promote these new technologies that will make quality data collection safer and more economical.

Figure 2. Helicopter-mounted radar experiment. Note the two microwave antennas located just below the cabin on both sides, and the GPR antenna located in the rear middle of the helicopter.

Figure 3. Newly installed non-contact radar gage on Copper Slough near Champaign, Illinois. Note that none of the stage-sensing equipment comes in contact with the stream; thus, making installation and maintenance much easier.

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.

"I like this newsletter and would like to continue to receive it..."

"Excellent newsletter. Keep up the good work..."

"...appreciate your quick reply and your high quality publications!"

"...I came across one of your... website address... It's a well done and informative site..."

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USGS Illinois Water Science Center Publications

Listed below are publications that were published recently. Federal Fiscal Year (FY) covers October 1 through September 30. Our policy is to provide copies of our publications to requestors at no cost as long as the publication is in stock in the USGS Illinois Water Science Center. To obtain copies of the following, or any other USGS Illinois Water Science Center publication, you may contact Donna Ayers at (217) 344-0037, extension 3053 or by e-mail at dmayers@usgs.gov.

Reports also can be found at: *http://il.water.usgs.gov/pubs/search.html.*

FY 2005

SIR 2004-5103, Estimating Flood-Peak Discharge Magnitudes and Frequencies for Rural Streams in Illinois, by D.T. Soong, A.L. Ishii, J.B. Sharpe, and C.F. Avery

SIR 2004-5136, A Cross-Site Comparison of Methods Used for Hydrogeologic Characterization of the Galena-Platteville Aquifer in Illinois and Wisconsin, with Examples from Selected Superfund Sites, by R.T. Kay, P.C. Mills, C.P. Dunning, D.J. Yeskis, J.R. Ursic, and M. Vendl

OFR 2005-1020, Comparison of Potential Evapotranspiration Calculated by the LXPET (Lamoreux Potential Evapotranspiration) Program and by the WDMUtil (Watershed Data Management Utilitiy) Program, by E.A. Murphy

SIR 2005-5060, Evaluation of Measurements Collected with Multi-Parameter Continuous Water-Quality Monitors in Selected Illinois Streams, 2001-03, by G.E. Groschen and R.B. King

SIR 2005-5218, Physical, chemical, and biological responses to urbanization in the Fox and Des Plaines River Basins of northeastern Illinois and southeastern Wisconsin, by M.A. Harris, B.C. Scudder, F.A. Fitzpatrick, and T.L. Arnold (printing stage)

SIR 2005-5122, Surface-Water and Ground-Water Resources of Kendall County, Illinois, by R.T. Kay, P.C. Mills, J.L. Hogan, and T.L. Arnold

SIR 2005-5223, Framework for Regional Synthesis of Water-Quality Data for the Glacial Aquifer System in the United States, by K.L. Warner and T.L. Arnold (printing stage)