United States Geological Survey
Water—Managing a National Resource

The USGS provides maps, reports, and information to help others meet their needs to manage, develop, and protect America's water, energy, mineral, and land resources. We help find natural resources needed to build tomorrow, and supply scientific understanding needed to help minimize or mitigate the effects of natural hazards and environmental damage caused by human activities. The results of our efforts touch the daily lives of almost every American.

As the Nation's leading earth science agency, the U.S. Geological Survey (USGS) provides information to educate and inform resource managers and the public to understand and manage water resources better. Scientific data and information from the USGS make it possible to understand and protect water for many uses—safe drinking water, habitat for fish and wildlife, rivers and streams for recreational activities, and water allocations among competing uses by industry, agriculture, and municipalities. Through the support of a national infrastructure that provides objective scientific data on which to base decisions, the USGS helps the Nation's water managers determine more efficient and effective uses of resources that will help ensure plentiful, clean water for current and future generations.

Information Online and on Time

Much of the hydrologic data collected by the USGS is provided directly to managers by way of satellite transmission. These realtime data are used for emergency response and management during hazards, such as floods, as well as for daily resource-management decisions. Resource managers in many Federal, State, county, and municipal agencies and industries use this satellite-transmitted data for daily operation of reservoirs, water-treatment plants, power-generation plants, and manufacturing facilities. Because the USGS has no regulatory responsibility, it is in a unique position in the Federal community to work with regulatory agencies, the regulated industry, and natural-resource managers to provide objective and nationally consistent streamflow and water-quality information to meet the diverse needs of many users simultaneously.

Flood Forecasting

The National Weather Service (NWS) uses data from 3,000 USGS streamflow stations to forecast river stages and flow conditions on major rivers and smaller streams in urban areas. The USGS coordinates the collection of streamflow and related data with the 13 NWS River Forecast Offices and ensures the availability of data at all times, but particularly during flood emergencies. During the Midwest floods in 1993, USGS field personnel made more than 2,000 visits to streamgaging stations in the flood-affected areas to verify that instruments were working and communicating properly, to make repairs as needed, and to make direct measurements of streamflow. The USGS met the unprecedented demand for timely and accurate water information because it could mobilize a work force from offices throughout the country that were trained in standard monitoring techniques and were familiar with the field equipment in place in the flooded areas.

The USGS has an infrastructure for providing consistent, high-quality water data in realtime by means of direct satellite transmission to meet the needs of many users without duplicating resources in each agency that needs information.

Reservoir Management

The U.S. Army Corps of Engineers (COE), the Bureau of Reclamation, and the Tennessee Valley Authority use realtime streamflow data extensively for daily management of the many reservoirs and powerplants for which they have operational responsibility. The COE uses data from about 1,600 stations to make management decisions concerning the 451 reservoirs it operates. The Bureau of Reclamation and the Tennessee Valley Authority use data from 47 stations for managing reservoirs and related facilities. The USGS has an infrastructure for providing consistent, high-quality water data in realtime by means of direct satellite transmission to meet the needs of many users without duplicating resources in each agency that needs information.

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In-Stream Management and Recreation

Data from USGS stations are used by many local agencies, utilities, and the general public for decisions ranging from when to withdraw water from a reservoir to whether it is safe to take a river-rafting trip. For example, the Delaware River Basin Commission uses USGS data to determine when additional freshwater releases are needed to control the salt front in the Delaware River Estuary. Control of the salt front prevents the intrusion of saltwater into the coastal plain aquifers that are the source of water supply for the large population center between Camden and Gloucester, New Jersey. Individual citizens also

depend on USGS river data to plan recreational pursuits, such as rafting, kayaking, and fishing. Realtime data from 18 stations in the Teton, the Salmon, and the Snake River Basins in Idaho are used by fishermen, boaters, and rafters. A station on the Black River at Watertown, New York, is equipped with an instrument that provides the current water level with a synthesized voice and is queried by the public by telephone as often as every 5 minutes.

Cooperative Efforts in Resource Management

In addition to the realtime data collection stations operated for emergency management and daily resource-management decisions, the USGS also operates a larger network of about 7,300 stations nationwide at which streamflow and, in some instances, water quality are measured. Under a Federal–State cooperative program, more than 600 State and local agencies participate in this monitoring program by cooperatively funding more than 50 percent of the total network. The USGS operates other components of the network by using funds provided by Federal agencies, such as the U.S. Army Corps of Engineers, to collect hydrologic data that are needed for planning and operating water-resources projects. Additionally, part of the network is funded by the USGS to support national programs of water-resources investigations; to collect data required by court decree, treaty or compact; and to conduct hydrologic research.

Information is maintained in nationally-consistent data bases and is equally available to all secondary users, including regulatory agencies, the regulated community, universities, natural-resource agencies, and consulting firms doing planning and design work.

Historical Records Assist Planners

The USGS has collected and analyzed hydrologic data for more than 100 years; these data constitute a major part of the total historical record of the Nation's water resources. The stream monitoring program provides the United States and its trust territories with a continuous, well-documented, and broad-based source of credible and consistent water data with which to guide management, policy, and regulatory decisions at all levels of government. These data may be used for a variety of purposes ranging from the long-term management of flood plains to the design of highway bridges and culverts; from pollution prevention to maintenance of navigation facilities; and for balancing water allocations, commonly across state boundaries, for municipal, industrial, and agricultural uses.

Planners and designers of water-control facilities, such as dams and canals, and engineering features, such as bridges, increasingly need to consider what may happen in the future. Data are needed not solely in terms of specific past events, such as floods, but in terms of the probability of future occurrence. For example, many highway bridges are designed on the basis of the flood that will be exceeded on the average of once in 50 years. Storage reservoirs are designed on the basis of the probability of deficiency of storage for an intended use, such as municipal water supply or irrigation of agricultural land. The long-term data record maintained by the USGS, with the support of many cooperating agencies, provides the statistics needed to estimate probability of future floods and droughts and the data to verify models used to simulate what might happen in the future.

The use and value of USGS streamflow data was documented in comments by William J. Carroll, President-Elect of the American Society of Civil Engineers, to the Subcommittee on Interior and Related Agencies, March 10, 1988:

> We believe that the U.S.G.S. basic water quantity data collection activities are essential, because the value of hydrologic data increases with both the length and continuity of the record; the logical responsibility of the Federal Government, because the States cannot possibly assume the support and leadership role of U.S.G.S. for interstate water systems; cost-effective, because coordinated water data collection eliminates overlapping and duplicative efforts. These data are critical to a wide range of activities, including reservoir operation; water quality and supply studies; water law court decisions; wastewater treatment discharges into streams; drainage structures for highways, bridges and culverts; flood insurance and management studies; detention pond studies for urban runoff control; planning and design of hydroelectric projects; water basin planning and investigation; forensic analysis; environmental impact analysis; and ice forecasting, jam and control studies. How can engineers devise optimum responses, and design the most cost-effective facilities, if they have incomplete and inadequate hydrologic data?

Ground Water—The Hidden Resource

Ground water, which resides in aquifers below the surface of the Earth, is among the Nation's most important natural resources. Ground water is the source of about 40 percent of the water used for public supply. It provides drinking water for more than 97 percent of the rural population who do not have access to public water-supply systems. Even some major cities, such as San Antonio, Texas, rely solely on ground water for all their needs. Between 30 and 40 percent of the water used for agriculture comes from ground water. Withdrawals of ground water are expected to rise in the coming century as the population increases and available sites for surface reservoirs become more limited.

USGS investigations are able to meet the needs of many parties without each entity having to fund separate and sometimes conflicting studies.

New Technologies Assist Managers

The USGS provides much of the technology and ground-water information used by resource managers for developing long-range plans and making informed decisions about this valuable and limited resource. Recent technical developments include a mathematical model that has become the national standard for simulating the flow of ground-water and the

movement of contaminants, techniques to identify and date ground water that are useful in characterizing the susceptibility of aquifers to contamination, and widely used geochemi-cal models that can be used to predict the movement and fate of inorganic contaminants in ground water.

Consistent Data for Multiple Uses

Ground-water data are collected and analyzed by personnel at about 200 USGS field offices throughout the 50 States, Puerto Rico, and the trust territories. This infrastructure includes a nationwide network of observation wells that, in 1994, included 32,000 wells measured for water level and 5,800 wells sampled for water quality. This information is maintained in nationally consistent data bases and is equally available to all secondary users, including regulatory agencies, the regulated community, universities, natural-resource agencies, and consulting firms doing planning and design work.

Water Supply

Through partnerships with more than 1,100 State, regional, and local agencies under a Federal–State cooperative program, the USGS investigates the availability of ground water to meet current and projected demands for municipalities, industry, and agriculture. For example, the Southwest Florida Water Management District uses ground-water-flow models developed and calibrated by the USGS to determine whether additional withdrawals from existing or proposed wells can be made without causing adverse effects on other ground-water users, lake levels, and wetlands. Critical input for the models includes aquifer characteristics and water-use information provided by previous USGS studies that were supported by many different agencies in Florida. The ongoing programs of the USGS and the use of consistent methods and data systems have enabled the cooperating agencies to obtain valuable products for decisionmaking at minimal additional cost.

Saltwater Intrusion

The concentration of population centers in coastal areas, including resort communities on barrier islands, has created numerous problems. Withdrawals of ground water at Hilton Head Island, South Carolina, and Savannah, Georgia, have caused saltwater to encroach on freshwater aquifers. Saltwater in the aquifer under Port Royal Sound is moving toward public water-supply wells that serve Hilton Head Island. The USGS, in cooperation with the South Carolina Department of Natural Resources, determined the location of the saltwater/freshwater interface and developed computer models to simulate movement of fresh and salty ground water. Results will be used by the States of South Carolina and Georgia and by public service districts on Hilton Head Island to design management strategies to retard the encroachment of saltwater. The USGS's nationwide network of monitoring stations makes it possible to undertake investigations of resources, such as the freshwater resources of Hilton Head Island, that involve more than one State.

Water Allocation

Information from other USGS groundwater investigations are used for allocating water among multiple users and resolving water disputes. These investigations meet the needs of many parties without each entity having to fund separate studies that sometimes have conflicting results. One example is the allocation of water in the lower Colorado River valley. Water in the lower Colorado River is apportioned among the States of Arizona, California, and Nevada by a U.S. Supreme Court decree. The Decree applies to the water in the river and to "water drawn from the mainstream by underground pumping". To aid the Bureau of Reclamation in implementing the Decree, the USGS developed a method to identify wells that yield water that will be replaced by water from the river. The criteria to identify wells that pump Colorado River water, which are recognized by all affected parties, were based on hydrologic principles, records of existing wells, and results of previous USGS studies.

The ongoing programs of the USGS and the use of consistent methods and data systems have enabled the cooperating agencies to obtain valuable products for decisionmaking at minimal additional cost.

Ground-Water Contamination

Assessing the potential for contamination of ground water and remediation of contaminated sites is another area in which the USGS supports its Federal, State and local agency partners. At a small, isolated spill of gasoline in Galloway Township, New Jersey, the USGS modified a ground-water-flow model to apply it to vapor flow above the water table. This model can be used to determine the optimal placement of wells and pumping rates so that contaminants can be extracted with the greatest efficiency at many remediation sites across the country. The ongoing research and long-term partnerships with many different agencies have enabled the USGS to study contaminated sites; to improve understanding of the physical, chemical, and biological processes occurring at these sites; and to develop additional technology that will reduce the cost of environmental regulation and cleanup.

Water Quality–Quality of Life

The USGS capability to provide nationally consistent water-quality information is unique. It is the only organization with the infrastructure and scientific resources to provide information on water quality in major rivers and ground water throughout the Nation. The USGS has performed this task for the past 100 years. Through a national assessment program, designed to study water quality in representative basins covering more than 50 percent of the Nation, the USGS documents the improvement or degradation in water quality with time, defines local and regional differences in water quality, explains causes of any observed changes in water quality, and addresses issues of national concern, such as agricultural contamination. Water-quality information collected by the USGS is used for the protection of drinking water and human and aquatic health, improved understanding and implementation of water-quality regulations, and characterization and remediation of contamination.

Nonpoint-Source Pollution and Health Advisories

The USGS approaches most studies by interpreting existing data and assessing fac-

tors and processes that affect water-quality conditions so that areas most vulnerable to contamination are identified and prioritized. This information is critical for identifying areas most likely to be adversely affected and optimizing resources required for monitoring nonpoint-source contamination. In addition, USGS information helps assess whether regulations and legislation, such as the Clean Water Act, the Safe Drinking Water Act, and the Farm Bill, can be targeted to specific water-quality constituents in sensitive hydrologic settings or regions of the Nation. For example, on the basis of USGS analysis of the distribution of the herbicide atrazine, which is used primarily on corn and soybeans, the Kansas State Board of Agriculture established the first Inland Pesticide Management Area in the Nation; it is designed to decrease the amount of atrazine that enters surface water used as a water-supply source.

Water-quality information collected by the USGS is used for the protection of drinking water and human health, improved understanding and implementation of water-quality regulations, and the assessment and remediation of contamination.

In the mid-1980's, there was growing concern that ground-water sources in the Midwest might be contaminated by herbicides. A USGS assessment based on samples from shallow wells in corn and soybean fields across 12 Midwestern States found that herbicide concentrations did not exceed the U.S. Environmental Protection Agency maximum contaminant or health advisory levels in drinking water. These results not only calmed fears, but also saved substantial monitoring and regulatory costs for State agencies responsible for protecting public water supplies.

In 1994, the Washington State Department of Health issued a public health statement on health effects that may result from consumption of fish caught from streams in the Yakima River Basin. The advisory was based on USGS studies of DDT in agricultural soil, stream water, stream sediment, and fish tissue. Understanding the scope and cause of the problem enabled the State to develop an appropriate management response.

Bioremediation

The USGS investigates the viability of natural and enhanced bioremediation techniques to degrade organic compounds in the subsurface that can impair water quality. Studies by the USGS have shown that microorganisms naturally present in the soils are active consumers of fuel-derived toxic compounds and can transform the compounds into harmless carbon dioxide. Bioremediation is a cost-effective strategy that could save the Nation millions of dollars in cleaning up existing environmental contamination.

Protecting Chesapeake Bay

Since 1993, the USGS has collected information on the amount of nutrients, metals, and pesticides entering Chesapeake Bay from major tributaries. This information is used to support water-quality models that are being developed by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency for use in the protection of the Bay. Recent USGS studies on ground water quality have shown that the inflow of ground water to this immense estuary might be equivalent to that of a major tributary, such as the James River. This information will be very important in designing monitoring plans and protection strategies for the overall water resources of the Bay.

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Additional earth science information can be found by accessing the USGS "Home Page" on the World Wide Web at "http://www.usgs.gov".

For more information on all USGS reports and products (including maps, images, and computerized data), call 1-800-USA-MAPS.

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