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Report to Congressional Requesters

July 2003

FRESHWATER SUPPLY

States' Views of How Federal Agencies Could Help Them Meet the Challenges of Expected Shortages

GAO-03-514

July 2003

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Highlights

Highlights of GAO-03-514, a report to Congressional Requesters

FRESHWATER SUPPLY

States' Views of How Federal Agencies Could Help Them Meet the Challenges of Expected Shortages

Why GAO Did This Study

The widespread drought conditions of 2002 focused attention on a critical national challenge: ensuring a sufficient freshwater supply to sustain quality of life and economic growth. States have primary responsibility for managing the allocation and use of water resources, but multiple federal agencies also play a role. For example, Interior's Bureau of Reclamation operates numerous water storage facilities, and the U.S. Geological Survey collects important surface and ground-water information.

GAO was asked to determine the current conditions and future trends for U.S. water availability and use, the likelihood of shortages and their potential consequences, and states' views on how federal activities could better support state water management efforts to meet future demands.

For this review, GAO conducted a web-based survey of water managers in the 50 states and received responses from 47 states; California, Michigan, and New Mexico did not participate.

www.gao.gov/cgi-bin/getrpt?GAO-03-514.

To view the full report, including the scope and methodology, click on the link above. For more information, contact Barry Hill at (202) 512-9775 or hillb@gao.gov.

What GAO Found

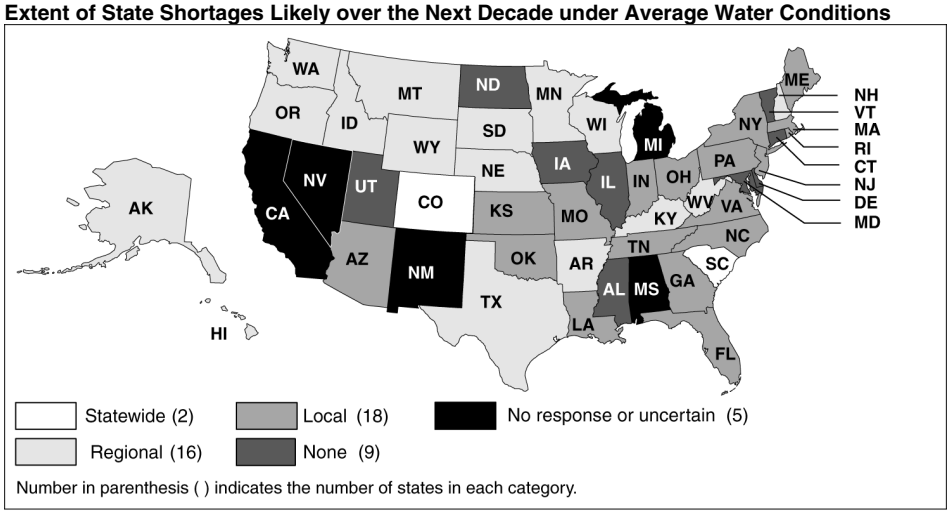
National water availability and use has not been comprehensively assessed in 25 years, but current trends indicate that demands on the nation's supplies are growing. In particular, the nation's capacity for storing surface-water is limited and ground-water is being depleted. At the same time, growing population and pressures to keep water instream for fisheries and the environment place new demands on the freshwater supply. The potential effects of climate change also create uncertainty about future water availability and use.

State water managers expect freshwater shortages in the near future, and the consequences may be severe. Even under normal conditions, water managers in 36 states anticipate shortages in localities, regions, or statewide in the next 10 years. Drought conditions will exacerbate shortage impacts. When water shortages occur, economic impacts to sectors such as agriculture can be in the billions of dollars. Water shortages also harm the environment. For example, diminished flows reduced the Florida Everglades to half its original size. Finally, water shortages cause social discord when users compete for limited supplies.

State water managers ranked federal actions that could best help states meet their water resource needs. They preferred: (1) financial assistance to increase storage and distribution capacity; (2) water data from more locations; (3) more flexibility in complying with or administering federal environmental laws; (4) better coordinated federal participation in water-management agreements; and (5) more consultation with states on federal or tribal use of water rights. Federal officials identified agency activities that support state preferences.

While not making recommendations, GAO encourages federal officials to review the results of our state survey and consider opportunities to better support state water management efforts. We provided copies of this report to the seven departments and agencies discussed within. They concurred with our findings and provided technical clarifications, which we incorporated as appropriate.

Extent of State Shortages Likely over the Next Decade under Average Water Conditions



Source: GAO analysis of state water managers' responses to GAO survey.

Contents

Transmittal Letter 1

Executive Summary 3
Purpose 3
Background 4
Results in Brief 5
Principal Findings 7
Agency Comments and Our Evaluation 11

Chapter 1 Introduction 12
Water Is an Abundant and Renewable Resource but Not Always Readily Available 12
The Federal Government Has Authority to Manage Water Resources but Recognizes State Authorities 19
State Laws Governing Water Allocation and Use Generally Follow Two Basic Doctrines 21
Multiple Federal Agencies Have Water Management Responsibilities 26
Objectives, Scope, and Methodology 41

Chapter 2 Freshwater Availability and Use Is Difficult to Forecast, but Trends Raise Concerns about Meeting Future Needs 44
National Water Availability and Use Has Not Been Assessed in Decades 44
Trends in Water Availability and Use Raise Concerns about the Nation's Ability to Meet Future Needs 48

Chapter 3 Expected Freshwater Shortages May Harm the Economy, the Environment, and Communities 64
State Water Managers Expect Shortages within 10 Years 64
Freshwater Shortages Have Severe Economic, Environmental, and Social Consequences 67

Chapter 4 Federal Activities Could Further Support State Water Management Efforts

	76
Conclusions	88
Agency Comments and Our Evaluation	89

Appendixes

Appendix I:	**GAO Analysis of Our Survey of the Effects of Federal Activities on State Water Availability, Management, and Use**	90
Appendix II:	**Comments from the Department of the Interior**	109
Appendix III:	**GAO Contacts and Staff Acknowledgments**	110

Figures

Figure 1:	Water Sources, Volumes, and Percentages of Total Water	12
Figure 2:	The Hydrologic Cycle	14
Figure 3:	Percent Time in Severe and Extreme Drought Nationwide, 1895 to 1995	16
Figure 4:	Drought Conditions across the Nation as of July 23, 2002	18
Figure 5:	Doctrines Used by States to Govern Surface-Water Allocation	23
Figure 6:	Doctrines Used by States to Govern Ground-Water Allocation	25
Figure 7:	Overview of Federal Activities	27
Figure 8:	Reclamation's Hoover Dam and the Corps' Eufaula Lake Water Storage Facilities	29
Figure 9:	USGS' Nationwide Streamgage Network	33
Figure 10:	Number of Listed Threatened and Endangered Species by State, as of March 2003	36
Figure 11:	Colorado River Basin Crosses Seven State Borders	38
Figure 12:	Federal and Tribal Lands in the United States	40
Figure 13:	Trends in Water Withdrawals by Use Category, 1950-1995	45
Figure 14:	Projections of United States Water Use for 2000	47
Figure 15:	Number and Capacity of Large Reservoirs Completed by Decade	49

Figure 16: Estimated Percentage of Population Using Ground-Water as Drinking Water in 1995 by State 51
Figure 17: Changes in Ground-Water Levels in the High Plains Aquifer from before Irrigation Pumping to 1999 53
Figure 18: Sinkhole in West-Central Florida Caused by Development of a New Irrigation Well 54
Figure 19: Land Subsidence in South-Central Arizona 55
Figure 20: States' Population Growth from 1995 to 2025 58
Figure 21: Total Freshwater Withdrawals by County, 1995 59
Figure 22: Extent of State Shortages Likely over the Next Decade under Average Water Conditions 65
Figure 23: The Everglades—Past and Present 71
Figure 24: Competition for Water in the Klamath Basin 74

Abbreviations

USDA U.S. Department of Agriculture
USGS U.S. Geological Survey

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United States General Accounting Office
Washington, D.C. 20548

July 9, 2003

The Honorable Pete V. Domenici
Chairman
Committee on Energy and Natural Resources
United States Senate

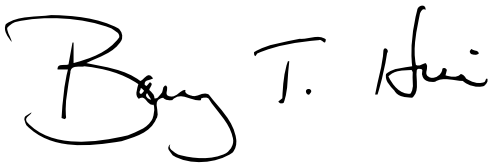
The Honorable James M. Jeffords
Ranking Minority Member
Committee on Environment and Public Works
United States Senate

The Honorable Mike Crapo
Chairman
The Honorable Bob Graham
Ranking Minority Member
Subcommittee on Fisheries, Wildlife, and Water
Committee on Environment and Public Works
United States Senate

In response to your requests, this report identifies current conditions and future trends for U.S. water availability and use, the likelihood of shortages and their potential consequences, and state views on how federal activities could better support state water management efforts to meet future needs. While we are not making a specific recommendation, we encourage Agriculture, Commerce, Energy, Homeland Security, Interior, Corps, and Environmental Protection Agency officials to review the results of our state survey and consider modifications to their plans, policies, or activities as appropriate to better support state efforts to meet their future water needs.

We will send copies of this report to the Secretaries of Agriculture, Commerce, Energy, Homeland Security, and Interior; the Assistant Secretary of the Army for Civil Works; and the Administrator of the Environmental Protection Agency. We will also send copies to the states that participated in our review. This report will also be available on GAO's Web site at http://www.gao.gov.

Please contact me at (202) 512-3841 if you or your staff have any questions. Major contributors to this report are listed in appendix III.



Barry T. Hill
Director, Natural Resources
and Environment

Executive Summary

Purpose

The widespread drought conditions of 2002 focused attention on a critical challenge for the United States—ensuring a sufficient freshwater supply to sustain quality of life and economic growth. Yet droughts are only one element of this complex issue. Water availability and use depend on many factors, such as the ability to store and distribute water, demographics, and social values. Across the nation, there is increasing competition to meet the freshwater needs of growing cities and suburbs, farms, industries, recreation and wildlife.

States are primarily responsible for managing the allocation and use of freshwater supplies. However, federal laws provide for control over the use of water in specific cases, such as on federal lands or in interstate commerce. Many federal agencies engage in activities, such as operating large water storage facilities and administering federal environmental protection laws, that influence state decisions. Federal agencies generally coordinate their activities with the states and complement state efforts to manage water supplies. On occasion, however, these activities conflict with state or other user objectives, such as when the need to leave water in a river to protect fish under federal environmental laws affects the delivery of irrigation water to farmers.

To assist congressional understanding of the range and complexity of freshwater supply issues, the Chairman of the Senate Committee on Energy and Natural Resources, the Ranking Member of the Senate Committee on Environment and Public Works, and the Chairman and Ranking Member of the Subcommittee on Fisheries, Wildlife, and Water, Senate Committee on Environment and Public Works asked GAO to identify (1) current conditions and future trends for U.S. water availability and use, (2) the likelihood of shortages and their potential consequences, and (3) state views on how federal activities could better support state water management efforts to meet future demands. To conduct this review, we focused on water supply and generally assumed a continuation of existing quantity allocations and current pricing conditions. Among other things, GAO conducted a Web-based 50-state survey of state water managers and obtained responses from 47 states; California, Michigan, and New Mexico did not participate. GAO also met with state water managers in seven geographically dispersed states—Arizona, Florida, Georgia, Illinois, Pennsylvania, Virginia, and Washington. GAO's complete scope and methodology is described in chapter 1.

Background

Freshwater flows abundantly in the nation's lakes, rivers, streams, and underground aquifers. However, because of climatic conditions and other factors, water is not always available when and where it is needed or in the amount desired. Users with different interests and objectives, such as agricultural irrigation or municipal water supply, must share the available water, and users may not always get the amount of water they need or want, particularly in times of shortage. Competition for water and the potential for conflict grow as the number of users increases and/or the amount of available water decreases, and conflicts can extend across state or national borders.

Federal, state, local, tribal, and private interests share responsibility for developing and managing the nation's water resources within a complex web of federal and state laws, regulations and contractual obligations. State laws predominantly govern the allocation and use of water. The federal government has recognized the primacy of states' laws regarding water allocation and use in numerous acts, such as the Reclamation Act and the Clean Water Act, and the Supreme Court has ruled that states' laws govern the control, appropriation, use, and distribution of federal reclamation project water.

Federal agencies engage in five basic categories of activities that influence state water resource management decisions:

- Constructing, operating and maintaining water storage infrastructure, primarily through the U.S. Army Corps of Engineers (Corps) and the Department of the Interior's (Interior) Bureau of Reclamation (Reclamation).

- Collecting and disseminating data on water availability and use, primarily through Interior's U.S. Geological Survey (USGS).

- Administering clean water and wildlife protection laws, primarily through agencies such as the Environmental Protection Agency, the Department of Commerce's (Commerce) National Marine Fisheries Service, and Interior's U.S. Fish and Wildlife Service.

- Assisting in the development and implementation of water management compacts and treaties, often involving multiple federal agencies.

- Managing water resources on federal lands by, for example, Interior's Bureau of Land Management and the U.S. Department of Agriculture's (USDA) Forest Service, and protecting tribal water rights by Interior's Bureau of Indian Affairs.

Results in Brief

The last comprehensive national water availability and use assessment, completed 25 years ago, identified critical problems, such as shortages and conflicts among users. Future water availability and use is difficult to predict. For example, while USDA's 1999 forecast of future water use—not availability—projects a rise in total withdrawals of only 7 percent by 2040, it also warns of the tenuous nature of such projections. If the most important and uncertain assumptions used in USDA's projection, such as a decrease in irrigated acreage, fail to materialize, water use may be substantially above the estimate. Current trends indicate that demands on the nation's water resources are growing. While the nation's capacity for storing surface-water is limited and ground-water is being depleted, demands for freshwater are growing as the population increases, and pressures increase to keep water instream for fisheries, wildlife habitat, recreation, and scenic enjoyment. For example, ground-water supplies have been significantly depleted in many parts of the country, most notably in the High Plains aquifer underlying eight western states, which in some areas now holds less than half of the water held prior to commencement of ground-water pumping. Meanwhile, according to Bureau of the Census projections, the southwestern states of California, New Mexico, Arizona, and Nevada, states that are already taxing their current water supplies, are each expected to see their population increase by more than 50 percent from 1995 to 2025. Furthermore, the potential effects of climate change create additional uncertainty about future water availability and use. For example, less snow pack as a result of climate change could harm states that rely extensively on melted snow runoff for their freshwater supply.

State water managers expect freshwater shortages in the near future, and their consequences could be severe. According to the results of GAO's survey, even under normal water conditions, water managers in 36 states anticipate water shortages in localities, regions, or statewide within the next 10 years. Under drought conditions, 46 managers expect shortages in the next 10 years. Such shortages may be accompanied by severe economic, environmental, and social impacts. While no studies have measured the total economic impact of shortages, recent shortages have resulted in damages to specific segments of the economy. For example, in the summer of 1998, a drought that ranged from Texas to the Carolinas

resulted in an estimated $6 to $9 billion in losses to the agriculture and ranching sectors. Water shortages can also result in environmental losses: damages to plant and animal species, wildlife habitat, and water quality. For example, diminished flows into the Florida Everglades have resulted in significantly reduced habitat for the wildlife population and a 90 percent reduction in the population of wading birds. Water shortages can also raise social concerns, such as conflicts between water users, reduced quality of life, and give rise to the perception of inequities in the distribution of disaster relief assistance. Many of these impacts are evident in the federally-operated Klamath Project—dams, reservoirs, and associated facilities—that sits on the California-Oregon border. Here, under drought conditions, several federal agencies—including Reclamation, the Fish and Wildlife Service, and the National Marine Fisheries Service—are trying to balance the water needs of, among others, irrigators, who receive water from the project, and endangered fish, which must have sufficient water to survive. In 2002, thousands of fish died while water was delivered for agricultural irrigation; the prior year, farmers experienced crop losses while water was used to maintain stream flows for fish.

In responding to our Web-based survey, state water managers identified the potential federal actions that would most help them meet their states' water needs. Water managers from 47 states ranked their preferences within each of the five basic categories of federal activities. First, state water managers favored more federal financial assistance to plan and construct additional state water storage and distribution capacity and also favored more consultation with the states regarding the operation of federal storage facilities. Second, state managers favored having federal agencies collect water data in more locations to help them determine how much water is available. Third, state managers favored federal efforts to provide flexibility in how they comply with or administer federal environmental laws as well as consultation on these laws' development, revision, and implementation. Fourth, state managers favored improving coordination of federal agencies' participation with the states in water management agreements and increasing technical assistance to states in developing and implementing them. Finally, state managers favored more consultation with states on how federal agencies or tribal governments use their water rights, and increased financial and technical assistance to determine the amount of federal water rights. Federal officials identified current activities within each of these areas that support state efforts and explained that while some state preferences, such as funding for storage construction, would require congressional authorization, others can be

addressed through ongoing efforts to enhance communication and cooperation. Appendix I contains the results of the survey.

Principal Findings

Water Availability and Use Trends Raise Concerns about Meeting Future Needs

The U.S. Water Resources Council completed the most recent, comprehensive, national water availability and use assessment in 1978.[1] That assessment found that parts of the nation had inadequate water supplies and growing demand, resulting in water shortages and conflicts among users. The most recent forecast of future water use—but not availability—is USDA's 1999 estimate for 2040. This forecast projects a rise in total withdrawals of only 7 percent despite a 41-percent increase in the nation's population. Yet the forecast also warns of the tenuous nature of such projections. For example, if the most important and uncertain assumptions used in USDA's projection, such as irrigated acreage, fail to decrease as assumed, water use may be substantially above the estimate.

Current trends—such as declining ground-water levels and increasing population—indicate that the freshwater supply is reaching its limits in some locations while freshwater demand is increasing. Specifically, the building of new, large reservoir projects has tapered off, limiting the amount of surface-water storage, and the storage that exists is threatened by age and sedimentation. Significant ground-water depletion has already occurred in many areas of the country; in some cases the depletion has permanently reduced an aquifer's storage capacity or allowed saltwater to intrude into freshwater sources. Tremendous population growth, driving increases in the use of the public water supply, is anticipated in the Western and Southern states, areas that are already taxing existing supplies. Demand to leave water in streams for environmental, recreational and water quality purposes add to supply concerns. Finally, some experts expect that climate change will affect water supply conditions in all regions of the country, either through increased demands associated with higher temperatures or changes in supply because of new precipitation or runoff patterns.

[1] The Council, established by the Water Resources Planning Act in 1965 (P.L. 89-80), comprising the heads of several federal departments and agencies, such as Interior and the Environmental Protection Agency, has not been funded since 1983.

State Water Managers Expect Freshwater Shortages in the Near Future, Which May Have Severe Consequences

Under normal water conditions, state water managers in 36 states anticipate water shortages locally, regionally, or statewide within the next 10 years, according to GAO's survey. Under drought conditions, the number grows to 46. Water managers expect these shortages because of depleted ground-water, inadequate access to surface-water, and growing populations, among other conditions, and despite ongoing actions to address their current and future water needs, such as: planning to prepare for and respond to droughts; assessing and monitoring water availability and withdrawals; and implementing water management strategies, such as joint management of surface and ground-water resources. In addition, water managers are reducing or reallocating water use, and developing or enhancing supplies by increasing water storage capacity, or less conventionally, seeding clouds to increase winter precipitation and developing saltwater desalination operations to produce freshwater.

If the anticipated water shortages actually occur, they could have severe economic, environmental and social impacts. The nationwide economic costs of water shortages are not known because the costs of shortages are difficult to measure. However, Commerce's National Oceanic and Atmospheric Administration has identified eight water shortages from drought or heat waves, each resulting in $1 billion or more in monetary losses over the past 20 years. For example, the largest shortage resulted in an estimated $40 billion in damages to the economies of the Central and Eastern United States in the summer of 1988. Water shortages can also have environmental impacts, damaging plant and animal species, wildlife habitat, and water quality. The Florida Everglades experience illustrates how dramatically reduced water flows can alter an ecological system. In 1948, following a major drought and heavy flooding, the Congress authorized the Central and Southern Florida Project—an extensive system of over 1,700 miles of canals and levees and 16 major pump stations—to prevent flooding, provide drainage, and supply water to South Florida residents. This re-engineering of the natural hydrologic environment reduced the Everglades to about half its original size and resulted in losses of native wildlife species and their critical habitat. In social terms, water shortages can create conflicts between water users, reduce quality of life, and create perceptions of inequities in the distribution of impacts and disaster relief. Federal experiences in operating the Klamath Project on the California-Oregon border, illustrate the conflicts that can arise when shortages occur. Farmers who rely on irrigation water from the project claim that Reclamation's attempts in 2001 to manage water for fish survival resulted in crop losses, while environmentalist, fishermen, and tribal representatives claim that subsequent actions by Reclamation in 2002 to

provide water for farmers resulted in low river flows, contributing to the death of more than 30,000 fish. As a result, litigation over river flows is ongoing, and federal and state legislation has been enacted to address the financial damages of the various parties.

State Water Managers Identified Potential Federal Actions to Help Them Meet Future Challenges

To identify potential federal actions to help states address their water challenges, GAO sought the views and suggestions of state water managers. Water managers from 47 states ranked actions federal agencies could take within five basic categories of federal activities:

- **Planning, constructing, operating, and maintaining water storage and distribution facilities.** State water managers reported their highest priority was more federal financial assistance to plan and construct their state's freshwater storage and distribution systems and also favored having more input in federal facilities operations. For example, over the next 10 years, 26 states are likely to add storage capacity, and 18 are likely to add distribution capacity. Consequently, water managers in 22 states said that more federal financial assistance would be most useful in helping their state meet its water storage and distribution needs. Reclamation and Corps officials understand the states' need for financial assistance for storage and distribution projects, and provide financial assistance on a project-by-project basis, as Congress authorizes and appropriates funds.

- **Collecting and sharing water data.** According to 37 states, federal agencies' data are important to their ability to determine the amount of available water. Managers in 39 states ranked expanding the number of federal data collection points, such as streamgage sites, as the most useful federal action to help their state meet its water information needs. Officials at USGS, USDA's Natural Resources Conservation Service, and Commerce's National Weather Service have ongoing efforts and/or plans to expand or improve their data collection programs.

- **Administering federal environmental protection laws.** According to 23 state water managers, more flexibility in how they comply with or administer federal environmental laws would help states meet their obligations under the laws while also meeting their water management goals. The managers cited instances in which they believed that federal environmental laws had restricted the state's ability to develop new storage capacity, distribute water, or meet the needs of offstream users. Officials from the Environmental Protection Agency, the Fish and

Wildlife Service, and the National Marine Fisheries Service said they try to accommodate state concerns about federal environmental laws, but were obligated to ensure that the laws are complied with and administered as Congress intended. However, they also stated that their agencies use the flexibility they have under current law to help the states administer or comply with federal environmental laws.

- **Participating in water-management agreements.** In the 29 states that participate in an interstate or international water-management agreement, state water managers ranked better coordination of federal agencies' participation in the agreements as the most useful among potential federal actions to help states develop, enforce, and implement such agreements. Seven of these managers said that federal agencies had not fulfilled their responsibilities under interstate or international agreements during the last 5 years. In these cases, the managers pointed out that lack of coordinated federal actions—such as the failure to establish federal priorities in a river basin—have created uncertainty for state participants in water-management agreements. Reclamation and Corps officials stated that in most cases they have fulfilled their responsibilities under water-management agreements, but occasionally circumstances outside their control, such as funding, prevent them from carrying out these responsibilities. Nevertheless, these officials stated, their participation in water-management agreements could be improved through their ongoing efforts to enhance coordination and communication with states and other water resource stakeholders, thus assisting in the implementation of water-management agreements.

- **Managing water rights for federal and tribal lands.** Of the 31 state managers reporting that federal agencies or tribal governments claim or hold water rights (either state granted or federal reserved) in their state, 12 reported that the most helpful potential federal action would be to consult more with the states on federal or tribal use of these rights, and 16 indicated that their state had experienced a conflict within the last 5 years between a federal agency's use of its water rights and the state's water management goals. For example, a federal agency had challenged the state over ground-water rights the state had issued to users because the withdrawals threatened federal surface-water rights. Disputes related to a federal agency's use of state-granted rights are typically heard in state water courts, where the federal agency receives no preference over any other water right holder.

While states have principal authority for water management, federal activities and laws affect or influence virtually every water management activity undertaken by states. Although the state managers value the many contributions of federal agencies to their efforts to ensure adequate water supplies, they also indicate that federal activities could better support their efforts in a number of areas. The information we collected from state water managers should be useful to the federal agencies in determining how their activities affect states and how they can be more supportive of state efforts to meet their future water needs. While we are not making a specific recommendation, we encourage Agriculture, Commerce, Energy, Homeland Security, Interior, Corps, and Environmental Protection Agency officials to review the results of our state survey and consider modifications to their plans, policies, or activities as appropriate to better support state efforts to meet their future water needs.

Appendix I contains the full survey results.

Agency Comments and Our Evaluation

We provided copies of our draft report to the Departments of Agriculture, Commerce, Energy, Homeland Security, and the Interior; the U.S. Army Corps of Engineers, and the Environmental Protection Agency. The Department of the Interior concurred with our findings and provided technical clarifications, which we incorporated as appropriate. Interior's complete letter is in appendix II. The other departments and agencies concurred with our findings and provided technical clarifications, which we incorporated as appropriate. They did not provide formal, written comments.

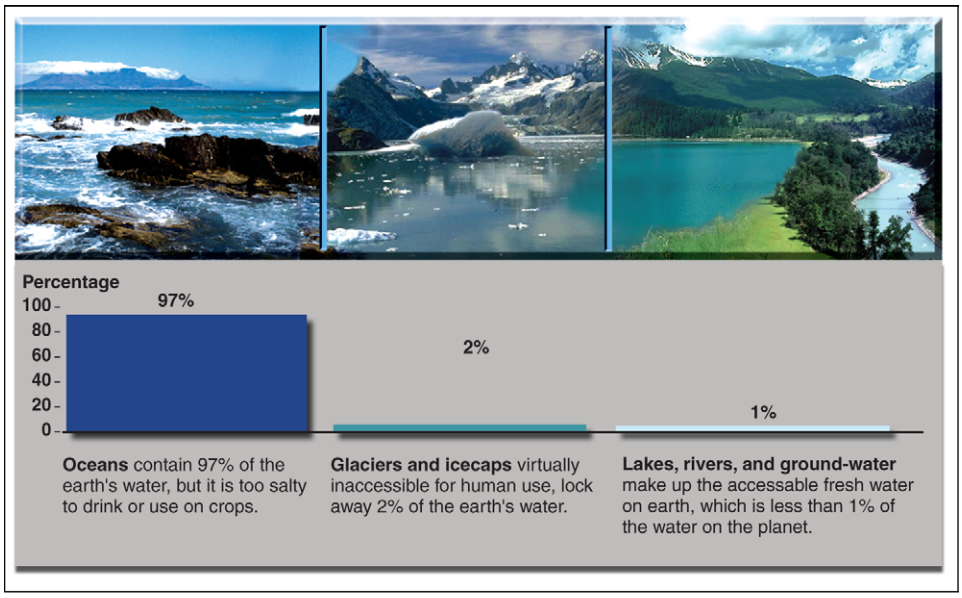
Introduction

Freshwater flows abundantly through the nation's lakes, rivers, streams and underground aquifers. Nature regularly renews this precious resource, but users do not always have access to freshwater when and where they need it, and in the amount they need. To make more water available and usable throughout the United States, federal agencies have built massive water storage projects and engage in other water development, management, and regulatory activities. Federal agencies have control over water use in some cases, such as on federal lands or in interstate commerce, but state laws predominantly govern water allocation and use.

Water Is an Abundant and Renewable Resource but Not Always Readily Available

Water is one of the earth's most abundant resources—covering about 70 percent of the earth's surface. However, accessible freshwater makes up less than 1 percent of the earth's water. As shown in figure 1, about 97 percent of the water on the planet is in the oceans and too salty to drink or to use to grow crops. Another 2 percent is locked away in glaciers and icecaps, virtually inaccessible for human use.

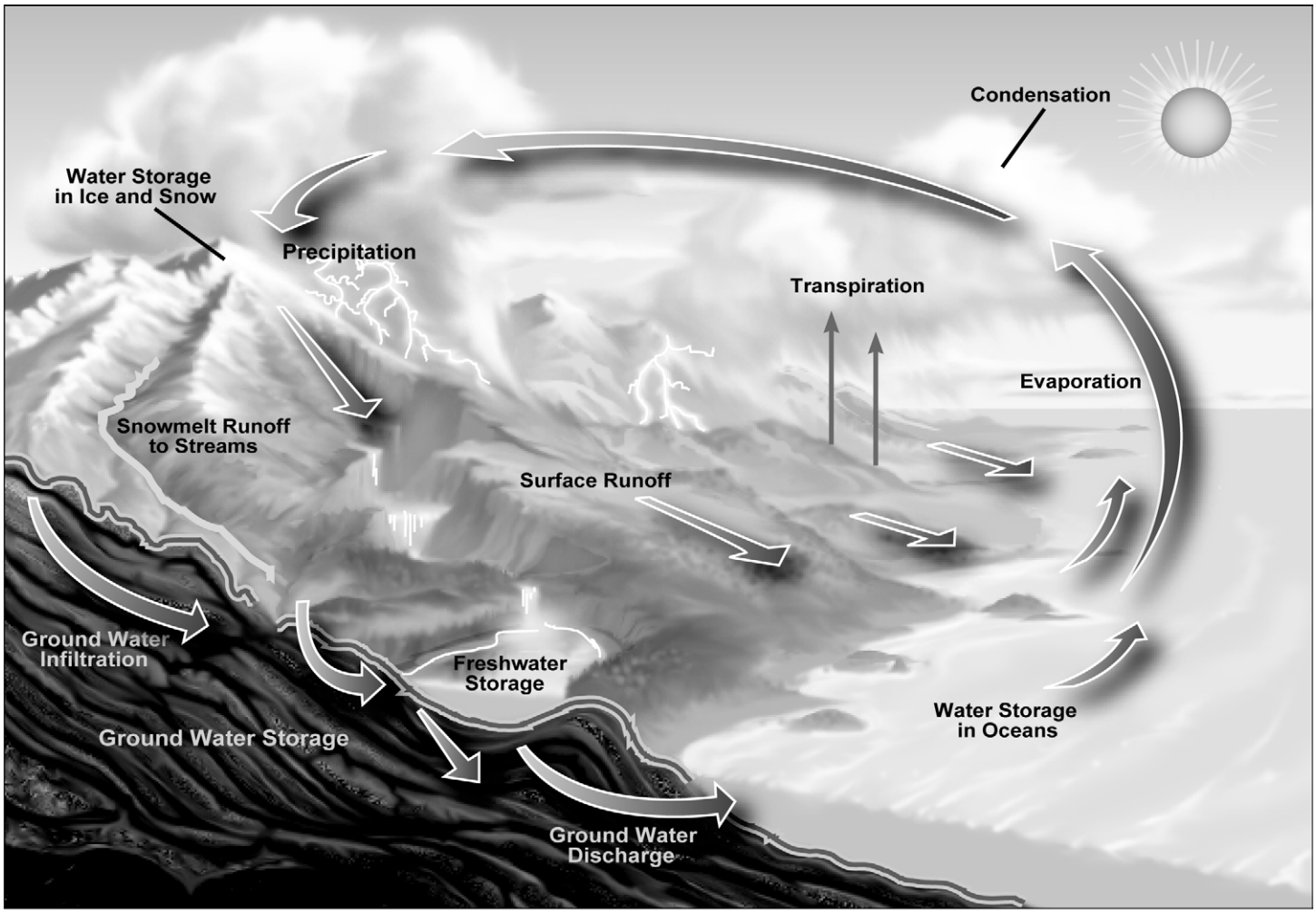
Figure 1: Water Sources, Volumes, and Percentages of Total Water



Source: USGS (data) and Art Explosion (photos); GAO (analysis).

Water is also a renewable resource—the water that was here a million years ago is still here today, continuously moving back and forth between the earth's surface and atmosphere through the hydrologic cycle, as figure 2 shows. In this cycle, evaporation occurs when the sun heats water in rivers, lakes, or the oceans, turning it into vapor or steam that enters the atmosphere and forms clouds. The evaporative process removes salts and other impurities that may be picked up either naturally or as a result of human use. When the water returns to earth as rain, it runs into streams, rivers, lakes, and finally the ocean. Some of the rain soaks below the earth's surface into aquifers composed of water-saturated permeable material such as sand, gravel, and soil, where it is stored as ground-water. When water returns to earth from the atmosphere as snow, it usually remains atop the ground until it melts, and then it follows the same path as rain. Some snow may turn into ice and glaciers, which can hold the water for hundreds of years before melting. The replenishment rates for these sources vary considerably—water in rivers is completely renewed every 16 days on average, but the renewal periods for glaciers, ground-water, and the largest lakes can run to hundreds or thousands of years.

Figure 2: The Hydrologic Cycle



Source: USGS.

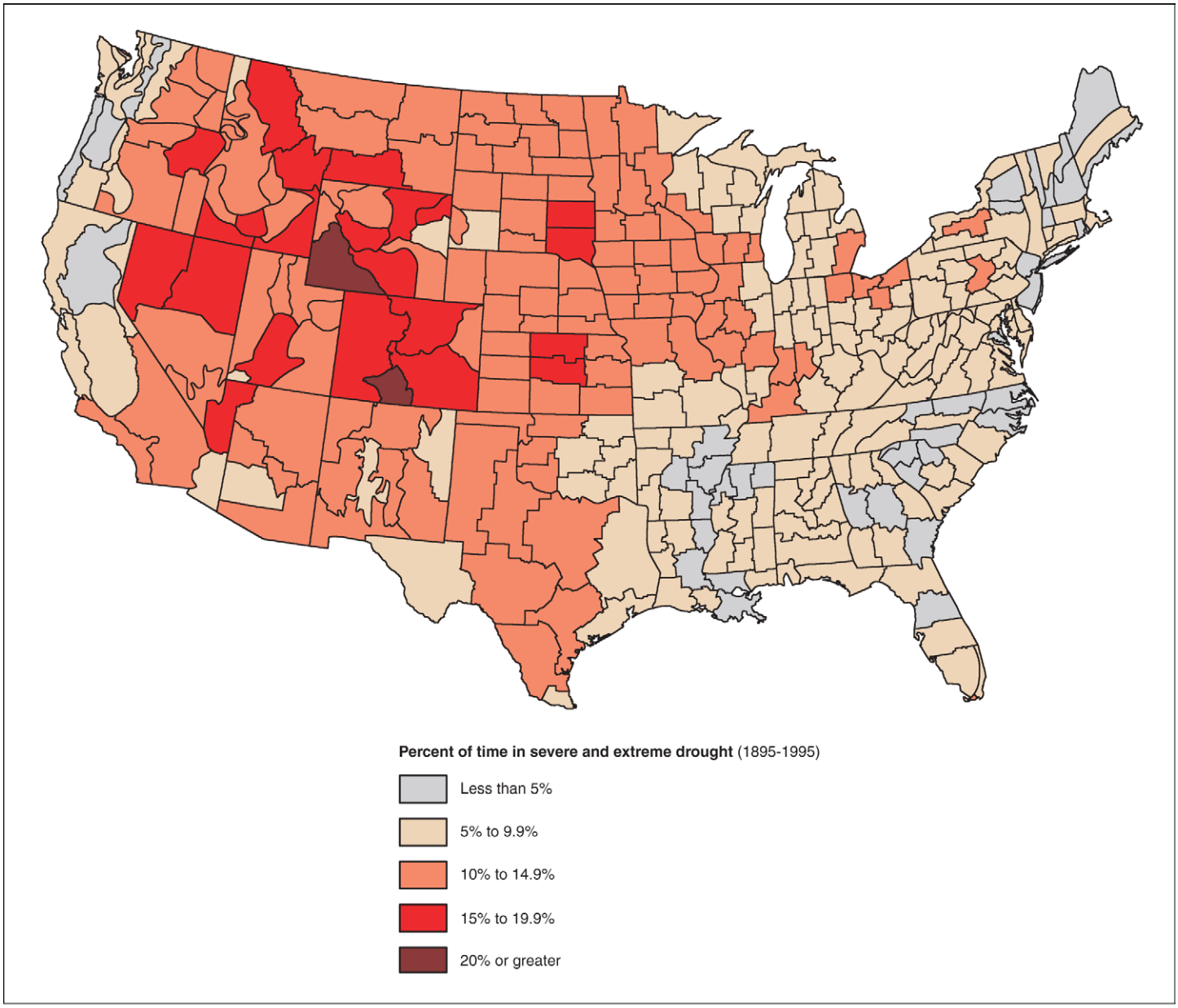
The United States has plentiful water resources. Rainfall averages nearly 30 inches annually, or 4,200 billion gallons per day throughout the continental 48 states. Two-thirds of the rainfall rapidly evaporates back to the atmosphere, but the remaining one-third flows into the nation's lakes, rivers, aquifers, and eventually to the ocean. These flows provide a potential renewable supply of about 1,400 billion gallons per day, or about 14 times the U. S. Geological Survey's (USGS) most recent estimate of daily consumptive use—the amount of water withdrawn from, but not immediately returned to, a usable water source.[1] Much larger quantities of freshwater are stored in the nation's surface and ground-water reservoirs. Reservoirs created by the damming of rivers can store about 280,000 billion gallons of water, lakes can hold larger quantities, and aquifers within 2,500 feet of the earth's surface hold water estimated to be at least 100 times reservoir capacity.

Despite the abundance and renewability of the water supply, variability in the hydrologic cycle creates uncertainty in the timing, location and reliability of supplies. For example, while rainfall averages 30 inches annually nationwide, the average for specific areas of the country generally increases from west to east, from less than 1 inch in some desert areas in the Southwest to more than 60 inches in parts of the Southeast. Drought and flood are a normal, recurring part of the hydrologic cycle. Meteorological droughts, identified by a lack of measured precipitation, are difficult to predict and can last months, years, or decades.[2] As shown in figure 3, at least some part of the United States has experienced severe or extreme drought conditions every year since 1896. Therefore, regions will encounter periods when supplies are relatively plentiful, or even excessive, as well as periods of shortage or extreme drought.

[1] USGS fully defines consumptive use as water that has evaporated, transpired (e.g., from vegetation), incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment.

[2] While meteorological measurements are the first indicators of drought, other definitions of drought exist. For example, *agricultural drought* occurs when there is not enough moisture in the soil to meet the needs of a particular crop at a particular time, *hydrological drought* refers to deficiencies in water supplies, and *socioeconomic drought* is associated with supply and demand for water as an economic good.

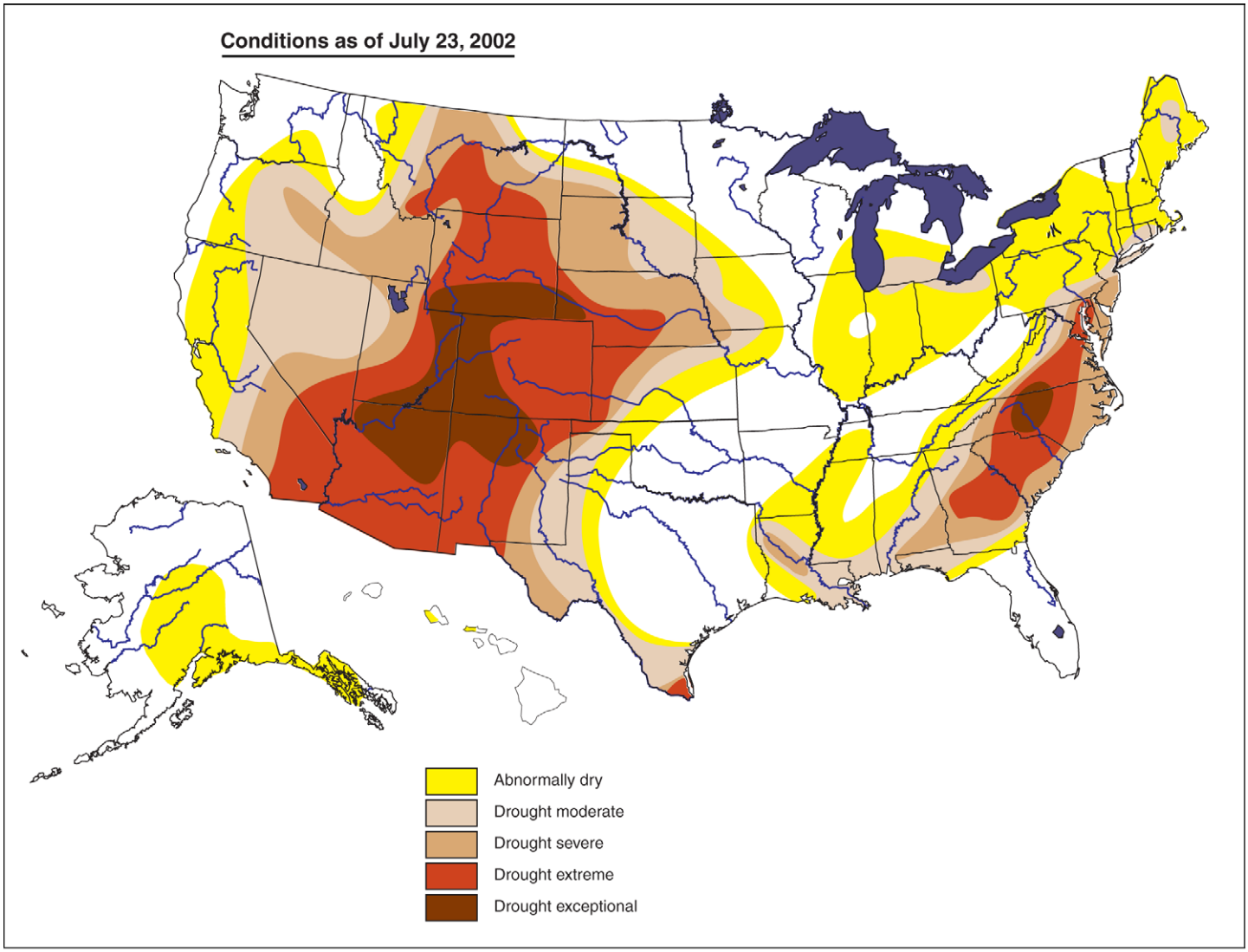
Figure 3: Percent Time in Severe and Extreme Drought Nationwide, 1895 to 1995



Source: National Drought Mitigation Center, University of Nebraska-Lincoln.

The variability in water availability was evident during 2002, when the United States had warmer than normal temperatures and below-average precipitation, which led to persistent or worsening drought throughout much of the nation. As the year began, moderate to extreme drought covered one-third of the nation and expanded to cover more than half of the nation during the summer, as shown in figure 4. Subsequently, heavy rainfall during July in Texas alleviated some of the drought conditions but led to widespread flooding. In addition, above average rainfall from September through November brought significant drought relief to the Southeast, where more than 4 years of drought had affected much of the region from Georgia to Virginia. However, severe drought conditions persisted over most of the interior Western states and the central and northern plains, with abnormal dryness across the Midwest through the end of the year.

Figure 4: Drought Conditions across the Nation as of July 23, 2002



Source: National Drought Mitigation Center, University of Nebraska-Lincoln; U.S. Department of Agriculture; and National Oceanic and Atmospheric Administration.

Water resource issues tend to be local or regional. Water flows naturally within river basins. USGS recognizes 352 river-basins in the United States that typically encompass 5,000 to 20,000 square miles. However, even within river basins, the availability of water resources varies. Sharing the water within basins is usually possible, but poses challenges because water ignores jurisdictional boundaries and these jurisdictions may have competing interests. Therefore, distributing water from where it is to where it is needed may require the coordination of local, regional, state, federal, and even foreign interests.

Transferring water from one basin to another is even more complicated, since water generally cannot be moved between basins unless transfer facilities (i.e., canals, pipelines, and pumps) are constructed. Moreover, in most cases, river basin boundaries do not coincide with those of major underground aquifer systems. For this reason, numerous entities are involved in the many aspects of water resource planning, management, regulation, and development, and solutions to water-management problems are often not easily found.

The Federal Government Has Authority to Manage Water Resources but Recognizes State Authorities

The federal government has authority to manage water resources, but it recognizes the states' authority to allocate and use water within their jurisdictions. Federal authority is derived from several constitutional sources, among them the Commerce Clause[3] and the Property Clause.[4] The Commerce Clause permits federal regulation of water that may be involved in or may affect interstate commerce,[5] including efforts to preserve the navigability of waterways.[6] The Property Clause permits federal regulation of water as necessary for the beneficial use of federal property.[7] In addition,

[3] U.S. Const. art. I, §8, cl. 3.

[4] U.S. Const. art. IV, §3, cl. 2.

[5] *See e.g., United States v. Byrd*, 609 F.2d 1204, 1210 (7th Cir. 1977); *Utah v. Marsh*, 740 F. 2d 799, 803 (10th Cir. 1984).

[6] *United States v. Rio Grande Irrigation Co.,* 174 U.S. 690, 703 (1898).

[7] *Id.*

under the Compact Clause of the Constitution, states cannot enter into agreements, or compacts, with each other—including those for the management of interstate waters—without the consent of Congress.[8]

Federal laws often require federal agencies engaged in water resource management activities to defer to state laws or cooperate with state officials in implementing federal laws. For example, under the Reclamation Act, the Bureau of Reclamation (Reclamation), within the Department of the Interior, must defer to and comply with state laws governing the control, appropriation, use, or distribution of water unless applying the state's law would be inconsistent with an explicit congressional directive regarding the project.[9] Similarly, the Water Supply Act of 1958 recognizes nonfederal interests in water supply development. The act states:

"It is declared to be the policy of the Congress to recognize the primary responsibilities of the States and local interests in developing water supplies for domestic, municipal, industrial, and other purposes and that the Federal Government should participate and cooperate with States and local interests in developing such water supplies in connection with...Federal navigation, flood control, irrigation, or multiple purpose projects."[10]

Other federal laws have affirmed this recognition.[11]

[8] U.S. Const. art. I, §10, cl. 3.

[9] 43 U.S.C. § 383; *California v. United States,* 438 U.S. 645 (1978).

[10] 43 U.S.C. § 390b.

[11] *See, e.g.*, the McCarran Amendment, 43 U.S.C. § 666, which waives U.S. sovereign immunity and allows the federal government to be sued in state court to determine its rights to the use of water in a river system or other source. Both the Clean Water Act, as amended, 33 U.S.C. § 1251(g) *et seq.*, and the Endangered Species Act, 16 U.S.C. § 1531 *et seq.*, state that it is the policy of Congress that federal agencies cooperate with state and local agencies to resolve water resource issues.

Consequently, federal agencies have traditionally followed a policy of deferring to the states for managing and allocating water resources. Officials of federal agencies involved in water resources management recently reiterated that their role is providing assistance while recognizing state primacy for water allocation. For example, in November 2001 testimony before the Senate Committee on Environment and Public Works, the Assistant Secretary of the Army for Civil Works stated:

"I want to emphasize that Corps involvement in water supply is founded in deference to state water rights. During the enactment of the Flood Control Act of 1944, Congress made clear that we do not own the water stored in our projects...Our policy is to continue our commitment to consistency with state water law...we must respect the primacy of state water law."

The Commissioner of the Bureau of Reclamation echoed this approach in his testimony at the same hearing, stating that it is important to emphasize the primary responsibility of local water users in developing and financing water projects, with Reclamation playing the important roles of maintaining infrastructure and applying expertise to help locals meet water needs. Specifically addressing Western water challenges in August 2002, he stated:

"As in the past, Reclamation will continue to honor State water rights...working with the states, our partners and all water users to leverage resources, to work at collaborative problem solving and to develop long-term solutions."

State Laws Governing Water Allocation and Use Generally Follow Two Basic Doctrines

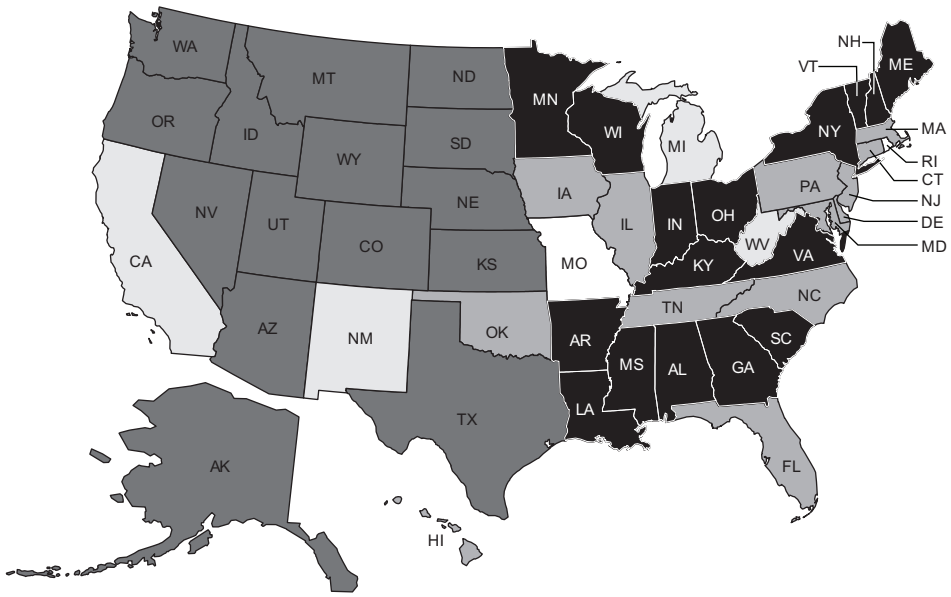
The variety of state water laws relating to the allocation and use of water can generally be traced to two basic doctrines: the riparian doctrine and the prior appropriation doctrine. Under the riparian doctrine, water rights are linked to land ownership—owners of land bordering a waterway have a right to use the water that flows past the land for any reasonable purpose. Landowners may, at any time, use water flowing past the land even if they have never done so before; all landowners have an equal right to use the water and no one gains a greater right through prior use. In contrast, the prior appropriation doctrine does not link water rights with land ownership. Water rights are instead linked to priority and beneficial water use—parties who obtain water rights first generally have seniority for the use of water over those who obtain rights later, and rights holders must put the water to beneficial use or abandon their right to use the water. Simply put, "first in time, first in right" and "use it or lose it." When there is a water shortage, under the riparian doctrine all water users share the shortage in

proportion to their rights, while under the prior appropriation doctrine, shortages fall on those who last obtained a legal right to use the water.

For managing surface-water allocation and use, Eastern states generally adhere to riparian doctrine principles and Western states generally adhere to prior appropriation doctrine principles. We obtained information on the water management doctrines of 47 states from our 50-state Web-based survey of state water managers. As shown in figure 5, 16 states follow either common-law riparian or regulated riparian (state permitted) doctrine, 15 states follow prior appropriation doctrine, 13 states follow other doctrines, and 2 states do not regulate surface-water allocation.[12]

[12] Three states did not respond to our survey, and one state was uncertain.

Figure 5: Doctrines Used by States to Govern Surface-Water Allocation



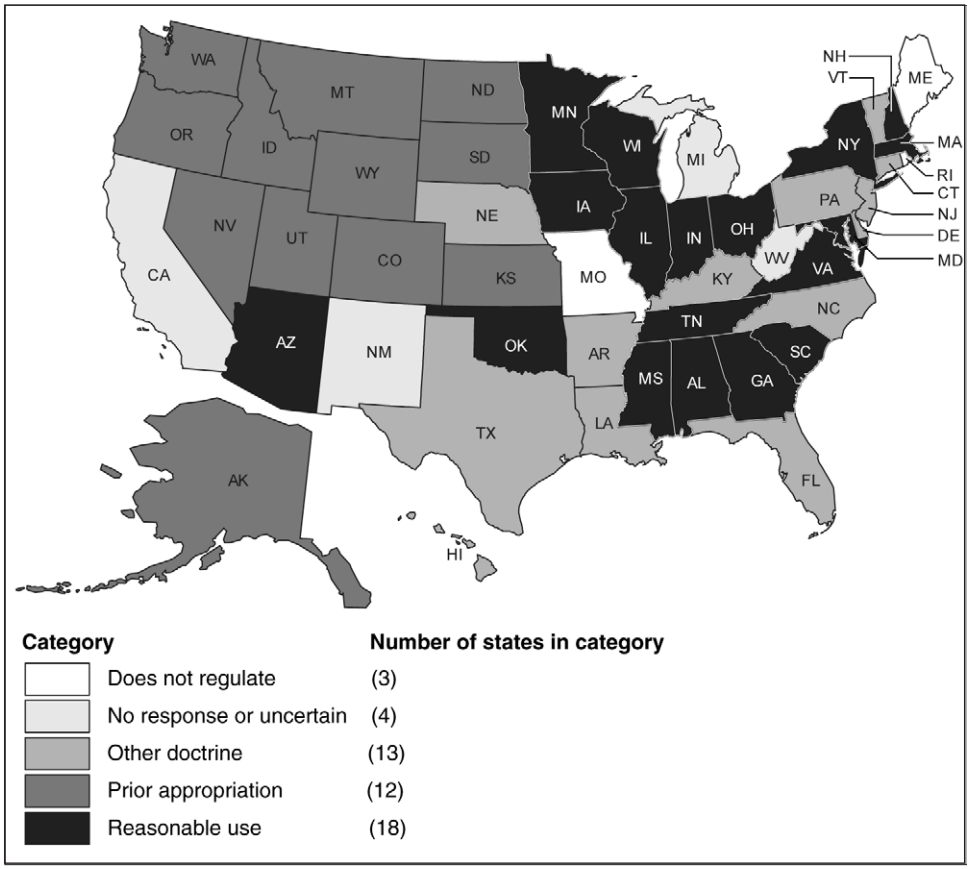
Category	Number of states in category
Does not regulate	(2)
No response or uncertain	(4)
Other doctrine	(13)
Prior appropriation	(15)
Riparian	(16)

Source: GAO analysis of state water managers' responses to GAO survey.

Special rules apply to allocating ground-water rights, but most state approaches reflect the principals of prior appropriation or riparian doctrines, with some modifications that recognize the unique nature of ground-water. As shown in figure 6, 18 states follow the riparian-derived doctrine of reasonable use; 12 states follow the prior appropriation doctrine; 13 states follow other approaches, such as granting rights to water beneath property to the landowners (absolute ownership) or dividing rights among landowners based on acreage (correlative rights); and 3 states do not regulate ground-water allocation.[13]

[13] Three states did not respond to our survey, and one state was uncertain.

Figure 6: Doctrines Used by States to Govern Ground-Water Allocation

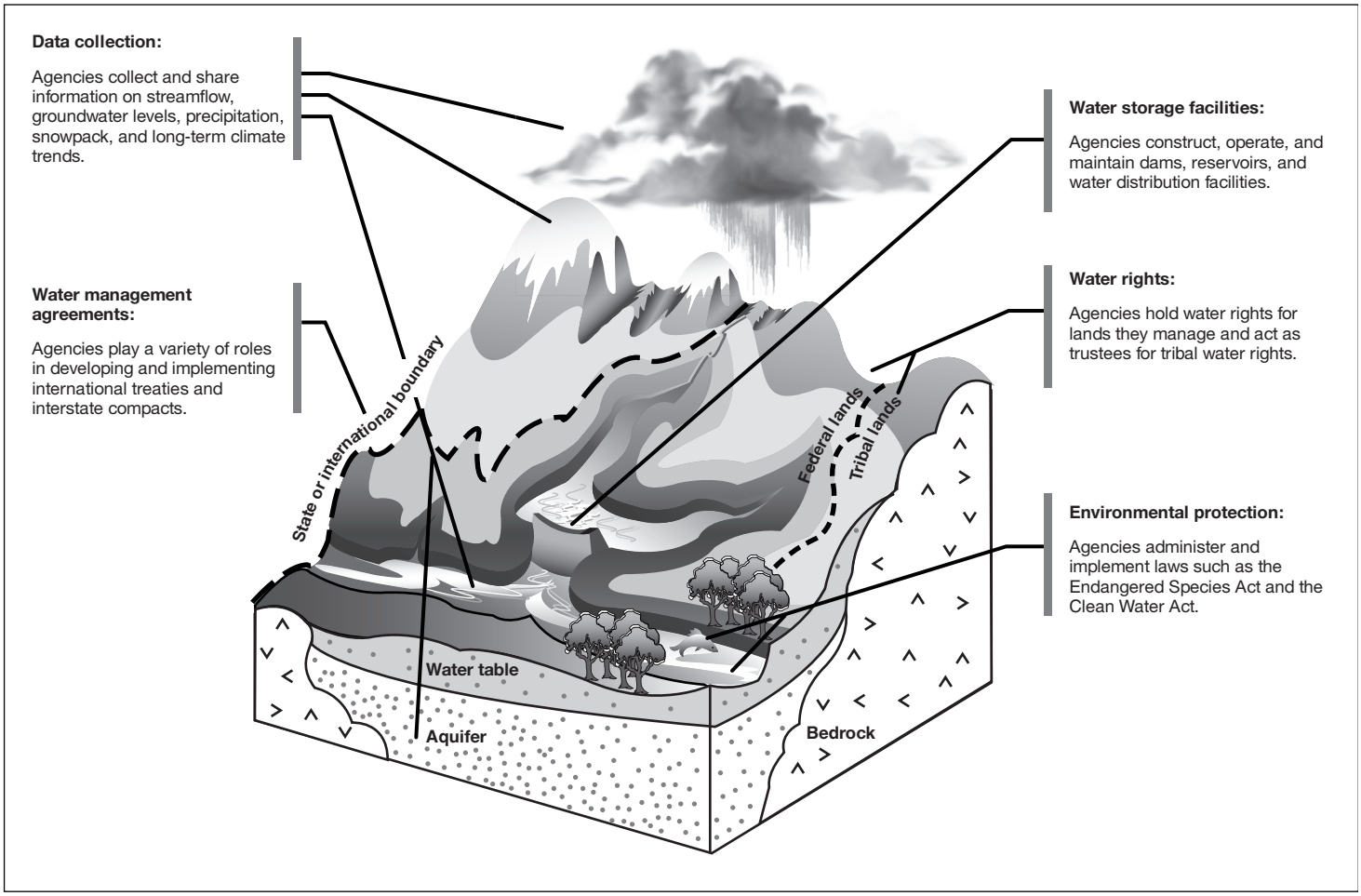


Source: GAO analysis of state water managers' responses to GAO survey.

Multiple Federal Agencies Have Water Management Responsibilities

Many federal agencies play a role in managing the nation's freshwater resources, as shown in figure 7. They build, operate and maintain large storage and distribution facilities; collect and share water availability and use data; administer clean water and environmental protection laws; assist in developing and implementing water-management agreements and treaties; and act as trustees for federal and tribal water rights. In performing these activities, each federal agency attempts to coordinate with other federal agencies and state water managers and users.

Figure 7: Overview of Federal Activities



Source: GAO.

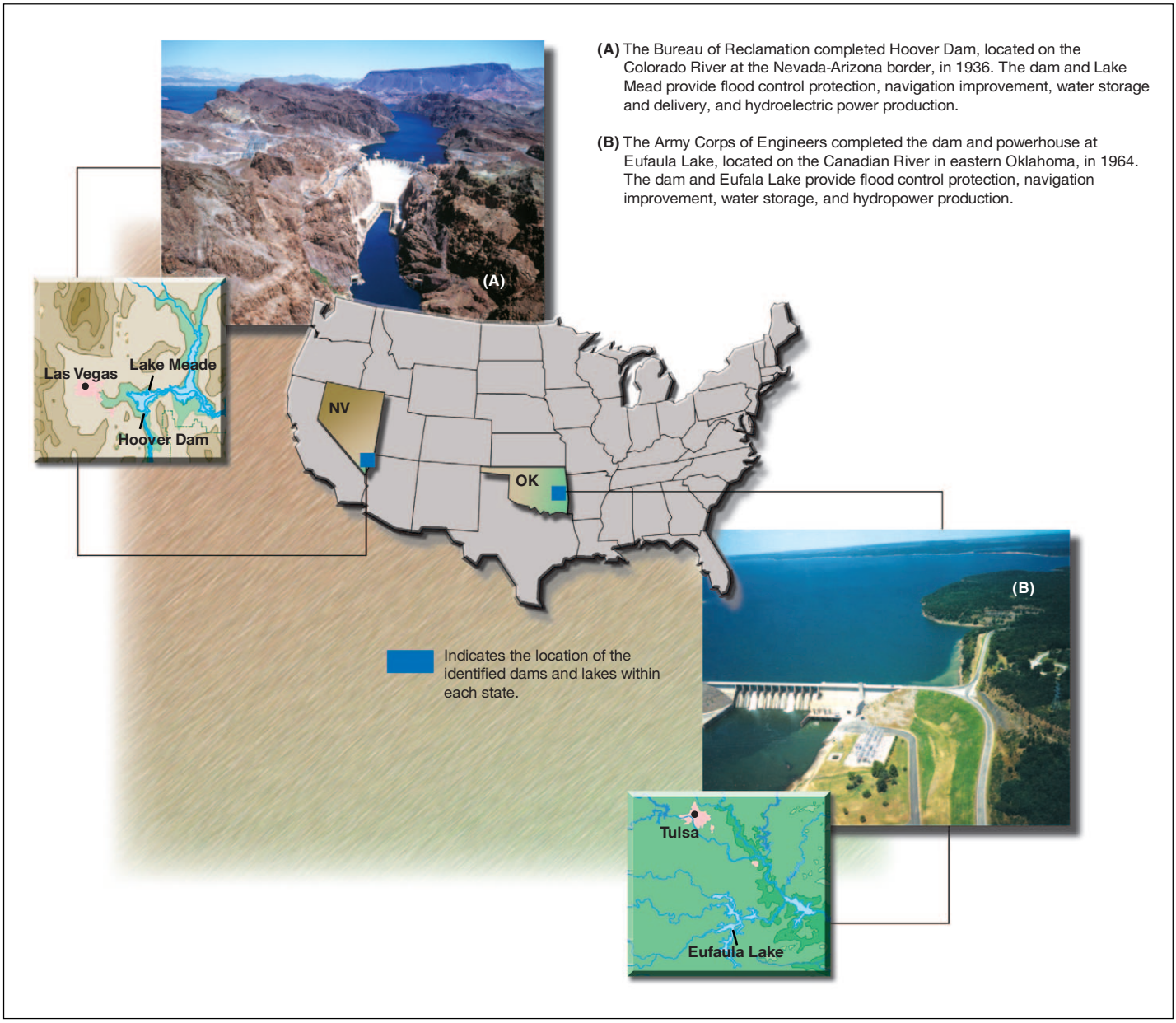
Reclamation and the Corps of Engineers Manage Large Water Storage Facilities

Reclamation and the Corps of Engineers construct, operate, and maintain large facilities to store and manage untreated water, such as Reclamation's Hoover Dam in Arizona and the Corps' Eufaula Lake in Oklahoma (see fig. 8).[14] While federal facilities compose only about 5 percent of the estimated 80,000 dams in the nation, they include many of the largest storage facilities, holding huge quantities of water for a wide variety of purposes, such as irrigation, industrial and municipal uses.[15] Reclamation's water delivery quantities are usually specified under long-term contracts at subsidized prices, while the Corps provides water storage space in reservoirs under long-term contracts.

[14] For information on national needs for drinking water and wastewater infrastructure, see U.S. General Accounting Office, *Water Infrastructure: Information on Financing, Capital Planning, and Privatization*, GAO-02-764 (Washington, D.C., May 5, 1999).

[15] Other federal agencies have facility management responsibilities not directly related to water storage and distribution. For example, the Federal Emergency Management Agency within the Department of Homeland Security is responsible for coordinating dam safety efforts, and the Federal Energy Regulatory Commission—an independent five-member commission appointed by the President and confirmed by the Senate—licenses and regulates non-federal hydropower projects.

Figure 8: Reclamation's Hoover Dam and the Corps' Eufaula Lake Water Storage Facilities



Sources: Bureau of Reclamation and U.S. Army Corps of Engineers (photos and captions); MapArt and Art Explosion (topographical and U.S. maps).

Reclamation has constructed irrigation, water storage, and distribution facilities throughout the 17 Western states. Today, these facilities serve many additional purposes, including municipal and industrial water supplies, power generation, recreation, and flood control. Reclamation manages about 348 reservoirs, with a total storage capacity of 245 million acre-feet of water, and approximately 250 diversion dams that provide water to approximately 9 million acres of farmland and nearly 31 million people.[16] Reclamation also manages about 18,000 miles of water delivery facilities and operates a variety of additional facilities, such as pumps and structures for fish passage, to meet the needs of water users.

Reclamation no longer operates and maintains all of the facilities that it has built. It has transferred operation and maintenance responsibilities for many of the facilities it owns—primarily to irrigation districts.[17] Typically, Reclamation has retained operation and maintenance responsibilities for water facilities that are large, serve multiple purposes, or control water diversions across state or international boundaries. Reclamation currently has only one ongoing water storage or distribution construction project: the Animas-La Plata project in Southwest Colorado and Northwest New Mexico, which will store and deliver water to two Indian tribes and others for irrigation, municipal and industrial uses.[18] Congress has authorized but not funded additional Reclamation water resources projects, such as the Dixie Project in Utah, which was originally authorized in 1964.

Through its Civil Works Program, the Corps constructed and now operates and maintains water storage facilities across the nation.[19] Corps projects originally were intended to control floods and provide for navigation, but Congress has since expanded the agency's mandate to store water for some municipal, industrial, irrigation, recreation, and/or hydropower uses. Today, the Corps manages 541 reservoirs with a total storage capacity of

[16] An acre-foot is the amount needed to cover an acre of land with 1 foot of water, sufficient to meet the needs of a family of four for 1 year.

[17] According to the Reclamation officials, the agency has transferred operation and maintenance responsibilities for 415 water storage and delivery facilities since Reclamation constructed them.

[18] For more information, see U.S. General Accounting Office, *Animas-La Plata Project: Status and Legislative Framework,* GAO/RCED-96-1 (Washington, D.C., Nov. 17, 1995).

[19] Unlike Reclamation, the Corps does not own or operate water distribution facilities.

330 million acre-feet, of which about 15 percent is jointly used for irrigation and other purposes, and another 3 percent for municipal and industrial uses. Although municipal, industrial, and agricultural water supply storage is a small portion of total storage capacity, the Corps estimates that the facilities supply water to nearly 10 million people in 115 cities. The Corps has rarely undertaken construction of new water storage facilities since the 1980s. In accordance with the 1986 Water Resources Development Act, the Corps has transferred to non-federal interests the operation and maintenance responsibilities for the one storage facility it has constructed since 1986.

In addition to Reclamation and the Corps, federal agencies responsible for managing natural resources—such as USDA's Forest Service, and Interior's Bureau of Land Management, Fish and Wildlife Service, and National Park Service—also construct water facilities on their lands to support their agencies' objectives, and authorize the construction of facilities by other parties on their lands.[20] Interior's Bureau of Indian Affairs, acting as trustee for tribal interests, authorizes similar facilities on tribal lands. The dams on these federal or tribal lands are typically much smaller than those operated by Reclamation and the Corps; many are not inventoried unless they meet certain size or hazard criteria. More specifically:

- Forest Service lands contain about 2,350 inventoried dams to provide water for many purposes such as fire suppression, livestock, recreation, and fish habitat;

- Bureau of Land Management lands contain about 1,160 dams, primarily providing water for livestock and wildlife;

- the Fish and Wildlife Service has an estimated 15,000 water storage and distribution facilities, primarily to provide water for fisheries as well as for waterfowl and migratory bird habitat;

- the National Park Service has 451 dams within its boundaries to manage water for habitat, fire suppression, flood control and recreation; and

[20] Non-federal parties also construct and operate water storage projects on federal lands. Federal natural resource agencies issue permits for these activities. For example, the National Park Service issued a permit to the City of San Francisco to construct and operate, within the Yosemite National Park, Hetch Hetchy reservoir, the primary water source for the city.

- the Bureau of Indian Affairs owns an estimated 500 to 1,000 dams that control flood and erosion and manage water for irrigation, flood control, stockwater, and recreation.

Several Agencies Collect and Share Water Data

Several federal agencies collect and distribute information on water availability and use including surface-water, ground-water, rainfall, and snowpack. Interior's USGS is primarily responsible for collecting, analyzing, and sharing data on water availability and use. It collects, analyzes, and shares information on surface-water availability, ground-water availability, and water use through four programs:

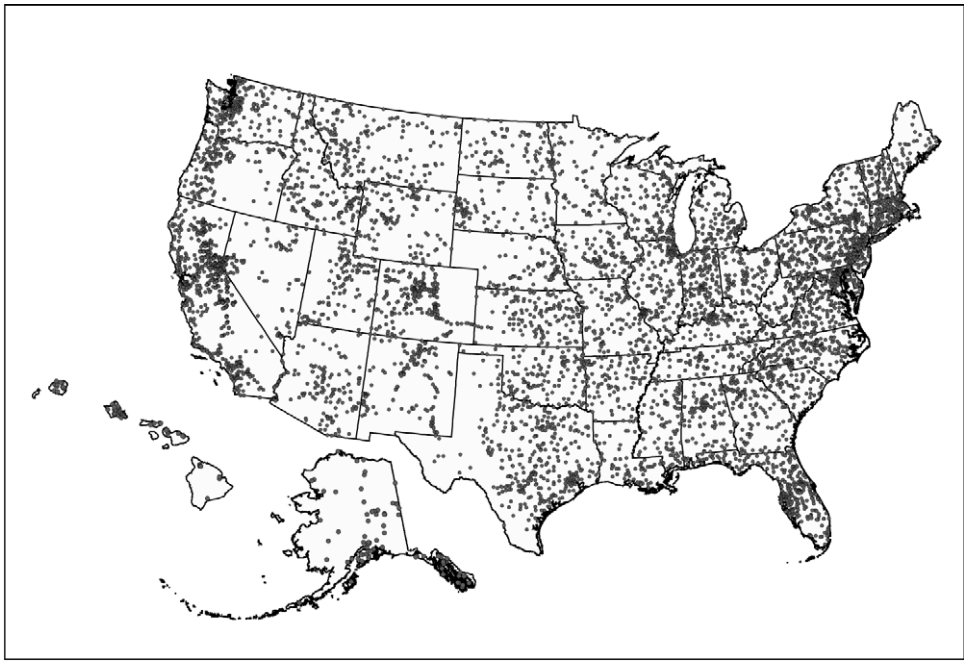
- The National Streamflow Information Program collects surface-water availability data through its national streamgage network, which continuously measures the level and flow of rivers and streams at 7,000 stations nationwide, as shown in figure 9, for distribution on the Internet.

- The Ground-Water Resources Program collects information from about 600 continuous ground-water-monitoring stations in 39 states and Puerto Rico for distribution on the Internet. In addition, the agency manually collects ground-water data intermittently in thousands of locations; compiling and reporting this data can take months.

- The National Water Use Information Program compiles extensive national water use data collected from states every 5 years for the purpose of establishing long-term water use trends.

- The Cooperative Water Program is a collaborative program with states and other entities to collect and share surface and ground-water data.

Figure 9: USGS' Nationwide Streamgage Network



Source: USGS.

Commerce's National Weather Service and USDA's Natural Resources Conservation Service combine their data, together with USGS streamgage data, to forecast water supplies and floods. They post water supply forecasts twice a month on the Internet, and they provide daily, and sometimes hourly, flood forecast information to water storage facility management agencies and other interested parties through arranged communication channels. The National Weather Service measures rainfall with over 10,000 gages nationwide, providing data for weather and climate forecasts; it also collects snowfall data in cities and rural areas. The Natural Resources Conservation Service operates 670 automated, high-elevation snow and climate measurement sites in 12 states; these sites use advanced radio technology to report data on the Internet about once each day. The agency also periodically conducts manual surveys at about 1,000 other stations; it supplies data from these sites to federal and non-federal water managers who request it.

Federal agencies often collect water data or conduct water resources research in support of their own responsibilities. For example, both the National Park Service and the Forest Service collect streamflow data to supplement USGS' streamgage information; the Bureau of Indian Affairs conducts some research on water availability on tribal lands as a part of the agency's trust responsibilities to tribes; Reclamation and the Corps collect data on reservoir levels and water flows through their facilities; and Agriculture's Agricultural Research Service and Cooperative State Research Education and Extension Service conduct and fund water quantity and quality research.

Several Agencies Administer Clean Water and Environmental Protection Laws

Several federal agencies administer clean water and environmental protection laws that affect water resource management. The Environmental Protection Agency administers the Clean Water Act, as amended—the nation's principal federal law regulating surface-water quality. States and localities play a significant role in its implementation. Under the act, among other things, municipal or industrial parties that discharge pollutants must meet the regulatory requirements for pollution control.[21] The Environmental Protection Agency administers a permit system that requires control of discharges to meet technology and/or water quality based requirements. In addition, the act requires parties that dispose of dredge or fill material in the nation's waters, including wetlands, to obtain a permit from the Corps.[22] Furthermore, the act requires states to develop and implement programs to control non-point sources of pollution, which include run off from chemicals used in agriculture and from urban areas.[23] The Clean Water Act can affect available water supplies, for example, by reducing offstream use or return flows to address water quality concerns.

[21] 33 U.S.C. §1311(a).

[22] 33 U.S.C. §1344(a), (d).

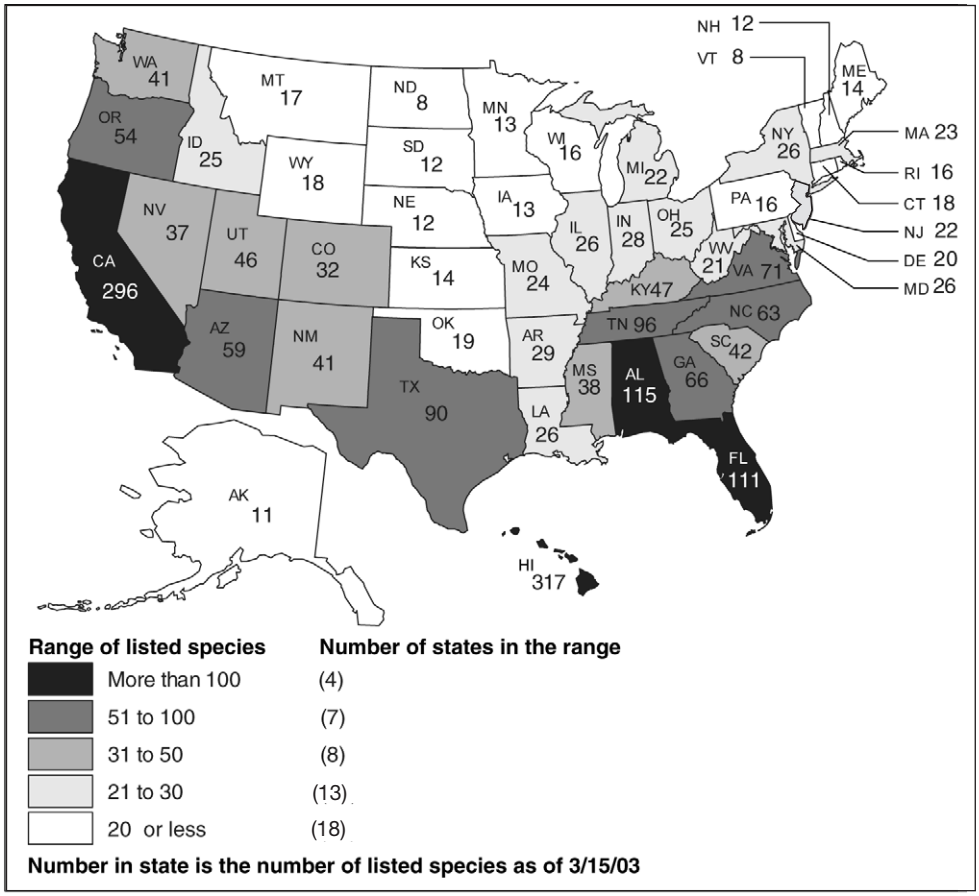
[23] 33 U.S.C. §1329.

Interior's Fish and Wildlife Service and Commerce's National Marine Fisheries Service are responsible for administering the Endangered Species Act. This act requires federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed species of plant or animal or adversely modify or destroy designated critical habitat.[24] The Fish and Wildlife Service is responsible for administering the act for land and freshwater species, and the National Marine Fisheries Service is responsible for marine species, including Pacific salmon, which spend part of their lifespans in freshwater. To implement the act, the agencies identify endangered or threatened species and their critical habitats, develop and implement recovery plans for those species, and consult with other federal agencies on the impact that their proposed activities may have on those species. If the Fish and Wildlife Service or National Marine Fisheries Service finds that an agency's proposed activity will jeopardize an endangered or threatened species, then a "reasonable and prudent alternative" must be identified to ensure the species is not jeopardized.[25] Numerous endangered species rely on the nation's waters, as shown in figure 10. The Endangered Species Act can affect water management activities, for example, by necessitating certain stream flow levels to avoid jeopardizing listed species or critical habitat.

[24] 16 U.S.C. §1536(a)(2).

[25] 16 U.S.C. §1536(a)(3)(a).

Figure 10: Number of Listed Threatened and Endangered Species by State, as of March 2003

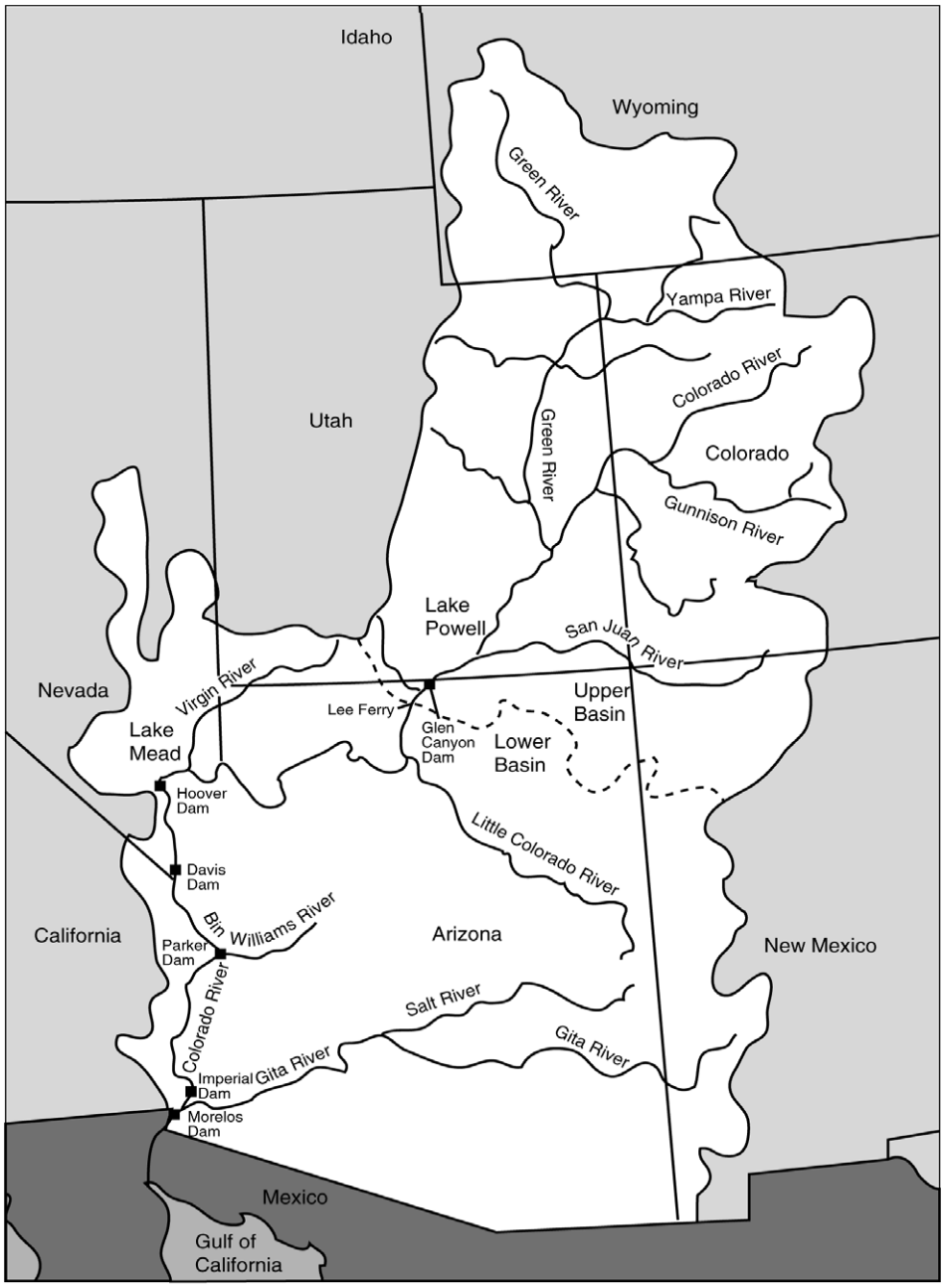


Sources: U.S. Fish and Wildlife Service (data) and GAO (analysis).

Agencies Help Develop and Implement Water-Management Agreements

States enter into agreements—interstate compacts—to address water allocation, quality, and other issues on rivers and lakes that cross state borders. According to the Fish and Wildlife Service, at least 26 interstate compacts address river water allocation between two or more states; 7 address water pollution issues; and 7 address general water resource issues, including flood control. Federal agencies may assist in developing and implementing these compacts, provide technical assistance, participate in and consult with oversight bodies, develop river operating plans, act as stewards of tribal and public natural resources, and enforce compacts. For example, the Supreme Court appointed the Secretary of Interior as the River Master responsible for implementing the water allocation formula of the 1922 Colorado River Compact. Under the compact, the states of the Upper Colorado River Basin (Colorado, New Mexico, Utah, and Wyoming), as shown in figure 11, are required to deliver to the states of the Lower Basin (Arizona, California, and Nevada) a minimum of 75 million acre-feet of water over 10-year periods.

Figure 11: Colorado River Basin Crosses Seven State Borders



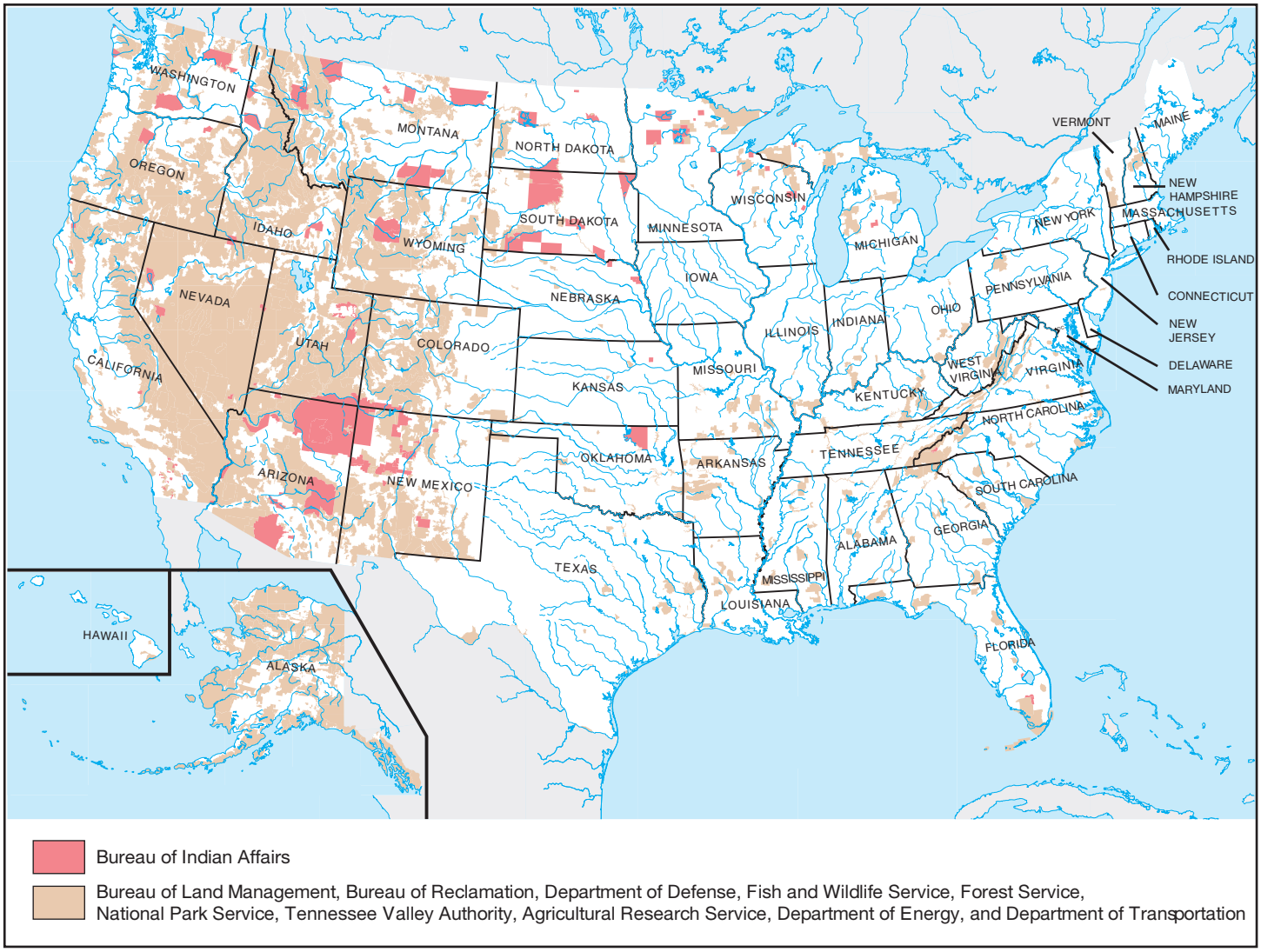
Source: Bureau of Reclamation.

Through international treaties with Canada and Mexico, the United States can coordinate activities such as water allocation, flood control, water quality, and power generation activities, as well as resolve water related disputes along the nations' international borders. The 1909 Boundary Water Treaty established the International Joint Commission of the United States and Canada, and the 1944 Water Treaty with Mexico provided the International Boundary and Water Commission with the authority to carry out the treaty. These bi-national commissions help the member nations coordinate water management activities, monitor water resources, and resolve disputes. For example, the International Boundary Water Commission recently facilitated an agreement between Mexico and the United States regarding Mexico's water debt under the treaty.

Agencies Are Responsible for Federal and Tribal Water Rights

Numerous federal natural resources management agencies and the Bureau of Indian Affairs are trustees for the water rights of federal and tribal lands. The states grant the great majority of water rights to these agencies, but the agencies also have federal reserved rights. The federal government has reserved water rights to fulfill the purposes of federal lands such as national forests, national parks, and wildlife refuges and for tribal lands. Federal lands account for 655 million acres, or 29 percent, of U.S. lands, primarily in the Western states as shown in figure 12.

Figure 12: Federal and Tribal Lands in the United States



Source: National Atlas of the United States.

The exact number and amount of federal reserved rights are not known. However, Bureau of Land Management officials estimate that 20 percent of the agency's water rights are federally reserved, largely for underground springs. The Fish and Wildlife Service estimated that it has very few federally reserved rights: almost all water rights for their activities are state granted. A Forest Service official estimated that half of the service's water rights are federally reserved. The National Park Service relies on both federal reserved and state granted rights, depending on the specific park circumstances.

The Bureau of Indian Affairs, as trustee for tribal resources in the United States, has the primary statutory responsibility for protecting tribal water rights. The Supreme Court has found that water rights in a quantity sufficient to fulfill the purposes of the reservations are implied when the United States establishes reservation lands for a tribe.[26] Tribes typically use water rights to ensure water is available for irrigation, hydropower, domestic use, stockwatering, industrial development and the maintenance of instream flows for rivers.

Objectives, Scope, and Methodology

To assist congressional deliberations on freshwater supply issues, we identified (1) the current conditions and future trends for U.S. water availability and use, (2) the likelihood of shortages and their potential consequences, and (3) state views on how federal activities could better support state water management efforts to meet future demands.

To identify the current conditions and future trends for U.S. water availability and use, we met with federal officials and collected and analyzed documentation from Reclamation, USGS, the Bureau of Indian Affairs, Bureau of Land Management, National Park Service, and Fish and Wildlife Services within the Department of the Interior; the Natural Resources Conservation Service, Forest Service, Rural Utilities Service, Agriculture Research Service, Economic Research Service, and Cooperative State Research, Education, and Extension Service within the Department of Agriculture; the National Weather Service and National Marine Fisheries Service within the Department of Commerce; the Army Corps of Engineers within the Department of Defense; the Federal Emergency Management Agency within the Department of

[26] *Winters v. United States,* 207 U.S. 564 (1908).

Homeland Security; the Environmental Protection Agency; and the Federal Energy Regulatory Commission. Although rising demands and environmental pressures have encouraged discussions of market based solutions, we assumed a continuation of current pricing and quantity allocation practices in our discussion of supply and demand trends and water shortages.

We analyzed the reports of past federal water commissions, including the U.S. Water Resources Council, National Water Commission, and the Western Water Policy Review Advisory Commission, and nonfederal organizations, such as the Western States Water Council and American Water Works Association. We also analyzed National Research Council, Congressional Research Service, and our own reports.

To determine the likelihood of shortages and their potential consequences, we analyzed water shortage impact information from the National Drought Mitigation Center at the University of Nebraska-Lincoln, the National Oceanic and Atmospheric Administration's National Climatic Data Center, and from the states. We did not assess the accuracy of the various estimates of the economic impacts of water shortages. We obtained information from Congressional Research Service reports, our own reports, and analyzed media accounts of water shortages. We obtained the views of state water managers regarding the likelihood of water shortages using a Web-based survey of managers in the 50 states.

To obtain states' views on how federal activities could better support state water management efforts to meet future demands, we conducted a Web-based survey of state water managers in the 50 states. We developed the survey questions by reviewing documents and by talking with officials from the federal agencies listed above and the state water managers in three state offices—Arizona, Illinois, and Pennsylvania. The questionnaire contained 56 questions that asked about state water management; collection and dissemination of state water quantity data by federal agencies; federal water storage and conveyance within their state; the effects of federal environmental laws on state water management; the effects of interstate compacts and international treaties on state water management; and the effects of federal and tribal rights to water on state water management.

We pretested the content and format of the questionnaire with state water managers in Georgia, Florida, Virginia, and Washington. During the pretest we asked the state managers questions to determine whether

(1) the survey questions were clear, (2) the terms used were precise, (3) the questionnaire placed an undue burden on the respondents, and (4) the questions were unbiased. We also assessed the usability of the Web-based format. We made changes to the content and format of the final questionnaire based on pretest results.

We posted the questionnaire on GAO's survey Web site. State water managers were notified of the survey with an E-mail message sent before the survey was available. When the survey was activated, an E-mail message informed the state water managers of its availability and provided a link that respondents could click on to access the survey. This E-mail message also contained a unique user name and password that allowed each respondent to log on and fill out their own questionnaire. To maximize our response rate we sent reminder E-mails, contacted non-respondents by telephone, and mailed follow-up letters to non-respondents.

Questionnaires were completed by state water officials in 47 states (California, Michigan, and New Mexico did not participate) for a response rate of 94 percent. We performed analyses to identify inconsistencies and potential errors in the data and contacted respondents via telephone and E-mail to resolve these discrepancies. We did not conduct in-depth assessments of the state water official's responses. A technical specialist reviewed all computer programs for analyses of the survey data. Aggregated responses of the survey are in appendix I.

We conducted our work from March 2002 through May 2003 in accordance with generally accepted government auditing standards.

Freshwater Availability and Use Is Difficult to Forecast, but Trends Raise Concerns about Meeting Future Needs

No federal entity has comprehensively assessed the availability and use of freshwater to meet the nation's needs in 25 years. While forecasting water use is notoriously difficult, numerous signs indicate that our freshwater supply is reaching its limits. Surface-water storage capacity is strained and ground-water is being depleted as demands for freshwater increase because of population growth and pressures to keep water instream for environmental protection purposes. The potential effects of climate change create additional uncertainty about the future availability and use of water.

National Water Availability and Use Has Not Been Assessed in Decades

National water availability and use was last comprehensively assessed in 1978.[1] The U.S. Water Resources Council, established by the Water Resources Planning Act in 1965,[2] assessed the status of the nation's water resources—both surface-water and ground-water—and reported in 1968 and 1978 on their adequacy to meet present and future water requirements. The 1978 assessment described how the nation's freshwater resources were extensively developed to satisfy a wide variety of users and how competition for water had created critical problems, such as shortages resulting from poorly distributed supplies and conflicts among users. The Council has not been funded since 1983.

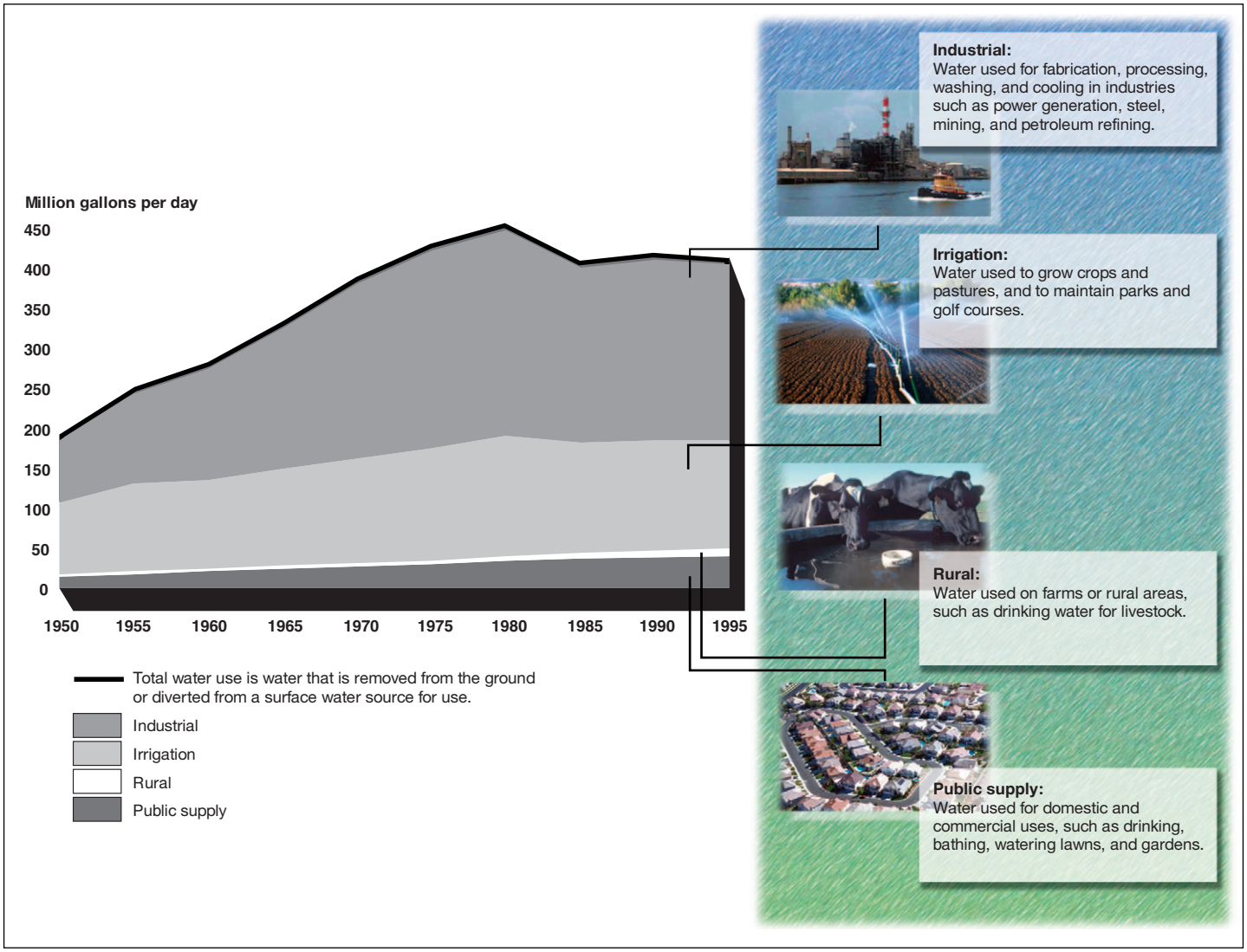
While water availability shortages have occurred as expected, total water use actually declined nearly 9 percent between 1980 and 1995, according to USGS. [3] As figure 13 shows, after continual increases in use from 1960 to 1980, total use began declining in 1980.

[1] In its 2002 report to Congress, USGS described the concepts for a national assessment of freshwater availability and use. (*Report to Congress: Concepts for National Assessment of Water Availability and Use*, Circular 1223, 2002.)

[2] Pub. L. No. 89-80, 79 Stat. 244 (1965).

[3] 1995 is the most recent data available; USGS' 2000 national water use information is not yet ready for publication.

Figure 13: Trends in Water Withdrawals by Use Category, 1950-1995



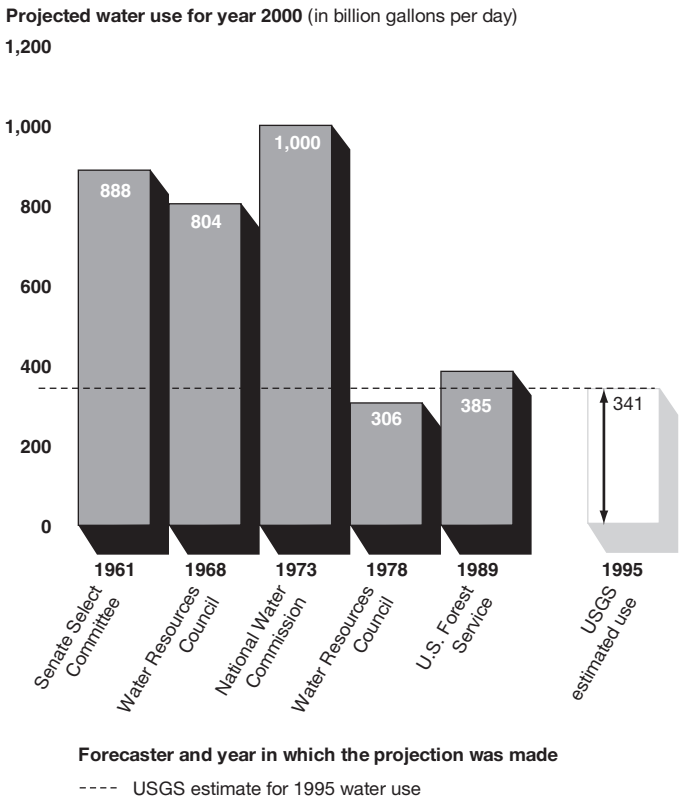
Sources: USGS (chart data and top photo), Natural Resources Conservation Service (photos), and GAO (analysis).

The reasons for the decrease in actual use illustrate why forecasting water use is so difficult. According to USGS, most of the increase from 1950 to 1980 was due to expanded irrigation and hydropower generation. In the 1980s, more efficient irrigation techniques, coupled with new technologies that lowered industrial use, helped ease demand more than anticipated and returned more water to the nation's waterways and aquifers. Water use also declined because of enhanced public awareness and many states' conservation programs. Only public supply and rural use, driven by population growth and livestock needs, respectively, continued to grow after 1980. Accordingly, a 1999 USDA study found that past water use projections for 2000 show consistently large differences among the forecasts and large discrepancies between projected and actual water use (fig. 14).[4] Key factors influencing some of the excessive projections include overestimating population increases, not accounting for technological advances, not anticipating the introduction of environmental laws, and underestimating the impact of conservation efforts.[5]

[4] Brown, Thomas C. 1999. *Past and Future Freshwater Use in the United States: A Technical Document Supporting the 2000 USDA Forest Service RPA Assessment.*

[5] Various agencies, such as the Environmental Protection Agency, have programs that provide technical assistance to states, water districts, and water users for efficiency, conservation, and reuse efforts.

Figure 14: Projections of United States Water Use for 2000



Sources: U.S. Forest Service (data), USGS (data), and GAO (analysis).

The most recent water use—but not availability—forecast is the USDA's 1999 projection for 2040, which identifies a rise in total water use of only 7 percent despite a 41-percent increase in the nation's population. However, the agency includes a warning about the tenuous nature of such projections. For example, irrigated acreage is one of the most important yet uncertain assumptions in the projection. If irrigated acreage does not drop in most Western river basins as assumed, use may be substantially above the estimate. As such, there are compelling reasons for concern regarding the future availability of freshwater to meet the nation's growing demands.

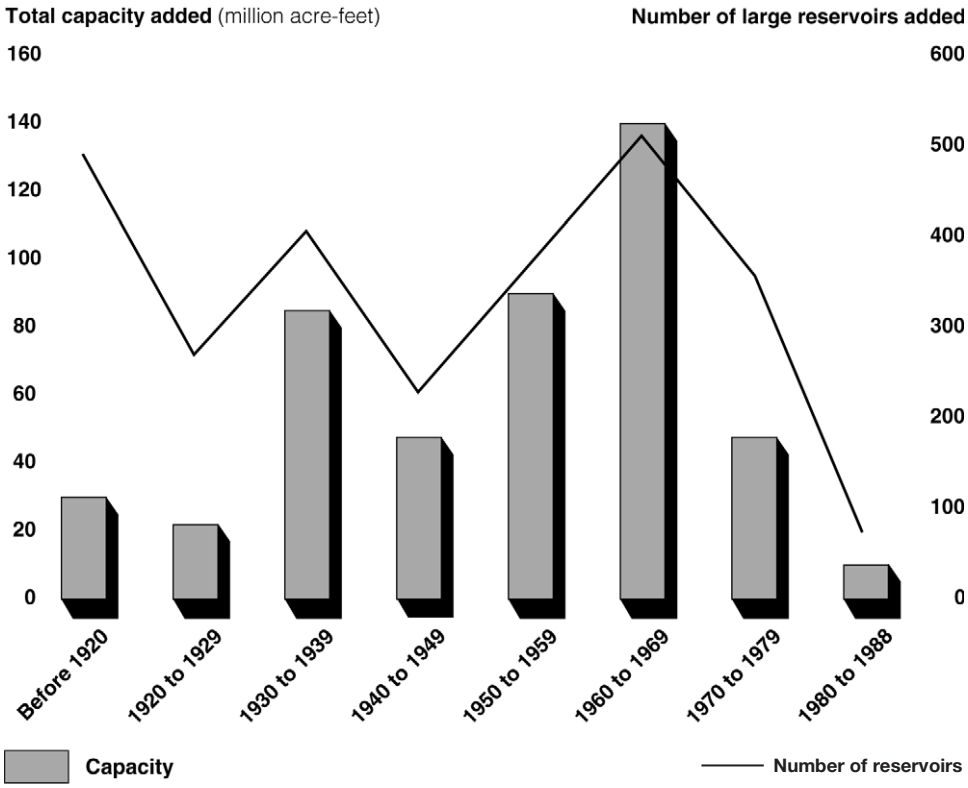
Trends in Water Availability and Use Raise Concerns about the Nation's Ability to Meet Future Needs

While the nation does not have a current assessment of water availability and use, current trends raise concerns about the nation's ability to meet future needs. Numerous signs point to the danger that our freshwater supply is reaching its limits. These indicators include constraints on surface storage capacity and depletion of ground-water resources at the same time as demands for freshwater are on the rise. Increased demand comes from a growing population and pressures to keep water instream for fisheries, wildlife habitat, recreation, and scenic enjoyment. The potential effects of climate change create additional uncertainty about future water availability and use.

Surface Storage Construction and Maintenance Is Declining

The construction of large reservoirs in the United States has slowed markedly since peaking during the 1960s, as shown in figure 15. Reclamation has only one large water storage project underway—Animas-La Plata in Colorado and New Mexico; the Corps has none. Furthermore, because of the high cost and ecological impact of reservoirs and dams, researchers and agency officials generally agree that it is unlikely that the construction of such large-scale projects will be at the forefront in meeting future water needs.

Figure 15: Number and Capacity of Large Reservoirs Completed by Decade



Sources: USGS (data) and GAO (analysis).

Available evidence also indicates that existing reservoirs may not able to continue storing water at current levels. Many of the federal and nonfederal dams that support storage reservoirs are aging and in need of repair. The American Society of Engineers has rated over 2,000 dams as unsafe, and nearly 10,000 as having high hazard potential, according to the Federal Emergency Management Agency's fiscal year 2001-2002 report to Congress on the National Dam Safety Program. According to Reclamation officials, approximately 50 percent of Reclamation's dams were built before 1950, and many of these before the development of current engineering standards. Reclamation recognizes that upgrading and maintaining existing infrastructure is vital to ensuring dependable supplies of water, and anticipates that future costs to rehabilitate Reclamation's infrastructure will be substantial. The Corps estimates it has a critical maintenance

backlog of $884 million, largely for dredging waterways and repairing structures such as locks, dams, and breakwaters. While the direct impact on water supply is not clear, extensive maintenance and repair will be needed in future years to ensure the continued viability of the water management infrastructure.

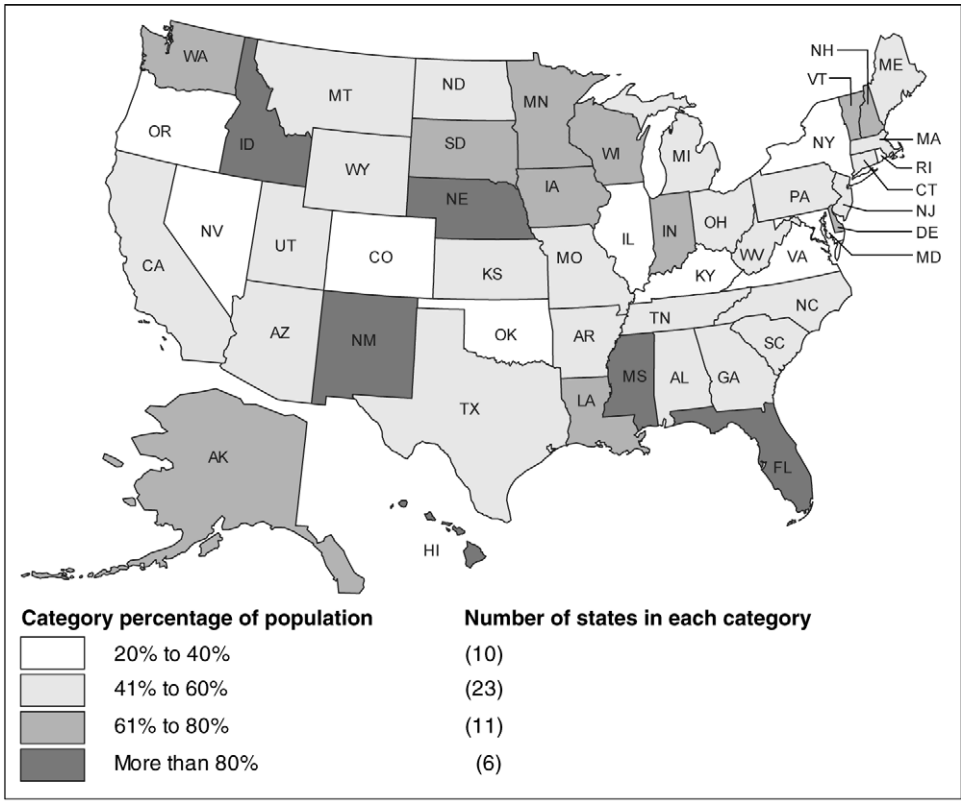
Moreover, the amount of water available for use from these reservoirs is continually being reduced by sedimentation—the flow of soil, rock and other natural materials into reservoirs. Over time, sedimentation can significantly reduce reservoir water storage capacities. According to a 1995 Resources for the Future report,[6] the total reduction resulting from the buildup of sediment is estimated at about 1.5 million acre-feet per year. For example, USGS' reservoir sedimentation studies in Kansas found that decreases in water-storage capacity from sedimentation ranged from less than 5 percent to about 50 percent at various locations.

Ground-Water Is Being Depleted

As shown in figure 16, ground-water is a major source of drinking water in every state. It provides about 40 percent of the nation's public water supply, and more than 40 million people—including 97 percent of the rural population—supply their own drinking water from domestic wells. Ground-water is also the source of about 37 percent of the water used for irrigation and livestock, is a major contributor to flow in many streams and rivers, and has a strong influence on river and wetland habitats for plants and animals.

[6] Resources for the Future, established in 1952, conducts independent research on environmental and natural resource issues.

Figure 16: Estimated Percentage of Population Using Ground-Water as Drinking Water in 1995 by State



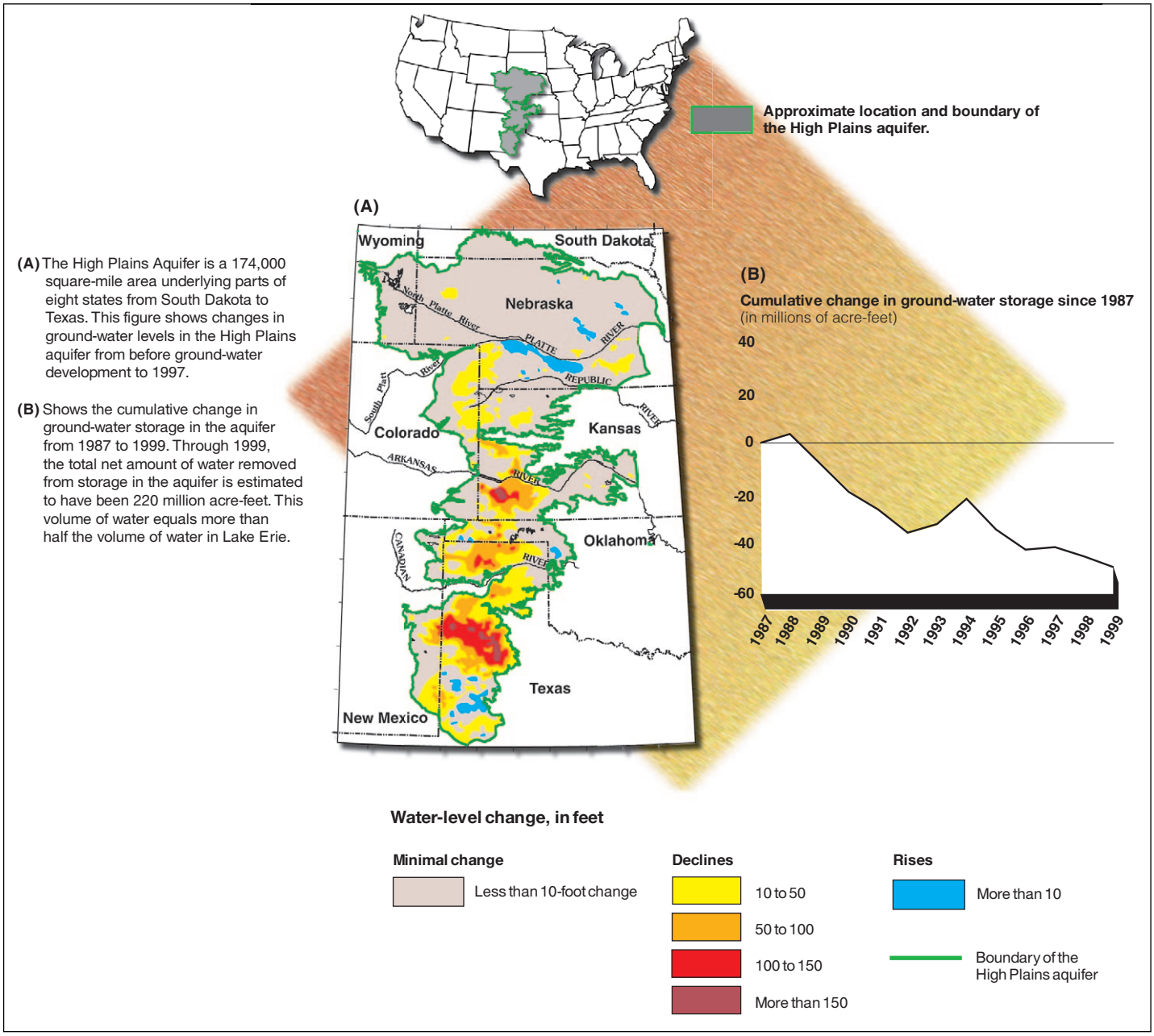
Sources: USGS (data) and GAO (analysis).

Ground-water depletion is occurring across the nation. According to USGS, ground-water depletion may be related to the slowed construction of surface reservoirs in recent years—as surface-water resources become fully developed and allocated, ground-water commonly offers the only available source for new development. USGS has documented significant ground-water depletion in particular areas of the Southwest; the Sparta aquifer of Arkansas, Louisiana, and Mississippi; the Cambrian-Ordovician aquifer of the Chicago-Milwaukee area; and the High Plains aquifer (consisting largely of the Ogallala aquifer). The High Plains aquifer underlies a 174,000-square-mile region including parts of eight states (Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota,

Texas, and Wyoming) and supplies about 30 percent of all ground-water used nationwide for irrigation.

Ongoing water-level monitoring in the High Plains aquifer provides a well-documented example of the long-term depletion of ground-water resources. Ongoing monitoring, initiated in 1988, found that the intense use of ground-water has caused major declines in the water level and reduced the ground-water remaining in storage in some areas to a level that makes the aquifer no longer economical to use. As shown in figure 17, the changes are particularly evident in the central and southern High Plains, where more than half of the ground-water that was available before pumping started has been depleted. Through 1999, an estimated 220 million acre-feet have been removed from storage in the aquifer—or more than half the volume of water in Lake Erie. Water levels continue to decline in many areas of the aquifer, but the rate of decline has slowed during the past 2 decades in some areas. The decline is attributed to decreases in irrigated acreage, improvements in irrigation and cultivation practices, and above-normal precipitation and groundwater recharge during the period.

Figure 17: Changes in Ground-Water Levels in the High Plains Aquifer from before Irrigation Pumping to 1999



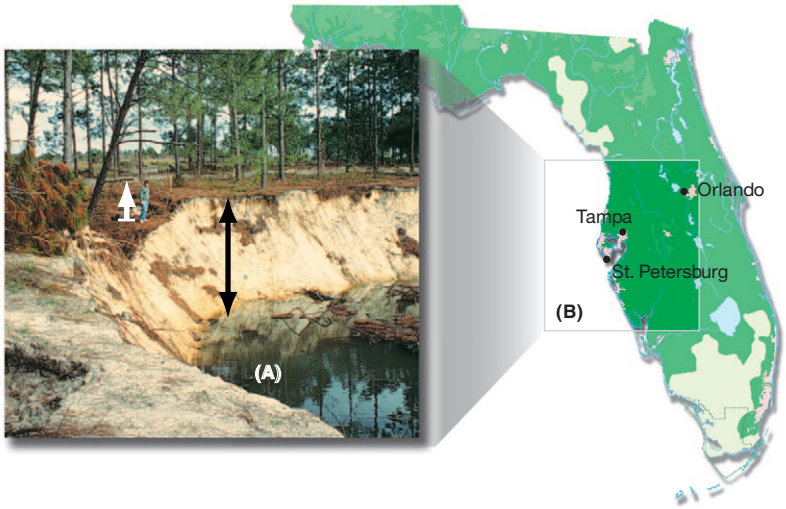
(A) The High Plains Aquifer is a 174,000 square-mile area underlying parts of eight states from South Dakota to Texas. This figure shows changes in ground-water levels in the High Plains aquifer from before ground-water development to 1997.

(B) Shows the cumulative change in ground-water storage in the aquifer from 1987 to 1999. Through 1999, the total net amount of water removed from storage in the aquifer is estimated to have been 220 million acre-feet. This volume of water equals more than half the volume of water in Lake Erie.

Sources: USGS (data) and GAO (analysis).

Ground-water depletion has, in some cases, resulted in land subsidence and a permanent reduction of an aquifer's water storage capacity. According to USGS, many areas across the United States have experienced subsidence, a decline in land-surface elevation caused by the removal of subsurface support through the withdrawal of ground-water. Subsidence can severely damage structures such as wells, buildings, and highways, and creates problems in the design and operation of facilities for drainage, flood protection, and water distribution. Furthermore, the compaction of aquifer materials that causes subsidence can result in a permanent reduction of 10 to 30 percent of the storage capacity of some aquifer systems. In the arid Southwest, subsidence shows as deep fissures or "cracks" in the earth's surface, while in the humid East, subsidence is evidenced by "sinkholes." Figure 18 shows a sinkhole in west-central Florida caused by drilling for a new irrigation well.

Figure 18: Sinkhole in West-Central Florida Caused by Development of a New Irrigation Well

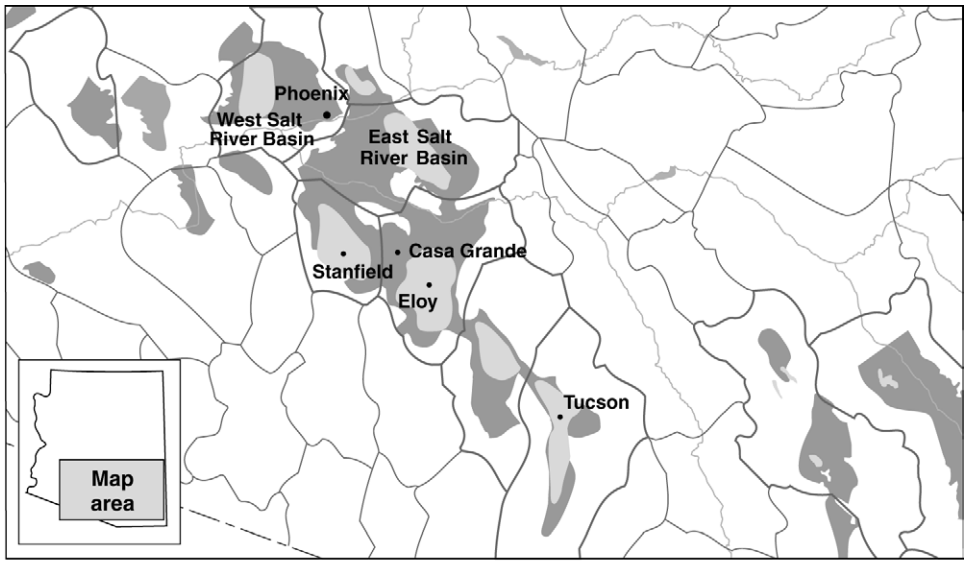


Development of a new irrigation well in west-central Florida **(B)** triggered the sinkhole in the photo above **(A)**. A person (near the white arrow) stands next to this sinkhole to give an idea as to its relative size.

Sources: USGS (photo and caption), Map Art (map), and GAO (analysis).

USGS has extensively examined land subsidence in south-central Arizona. Ground-water pumping for agriculture in the aquifers serving the basins of south-central Arizona began in the late 1800s, and by the 1940s many of the basins had undergone intensive ground-water pumping. Ground-water depletion has been widespread over these basins, as shown in figure 19, and some water-level declines have exceeded 300 feet. These declines have resulted in regional subsidence, exceeding 10 feet in some areas.

Figure 19: Land Subsidence in South-Central Arizona



Explanation

Land areas affected by subsidence

Water-level decline greater than 100 feet

Source: USGS.

Depleting aquifers in many coastal areas may also result in saltwater intrusion, making the water unusable for drinking, irrigation, and other purposes requiring freshwater. According to USGS, incidences of saltwater intrusion have been documented in almost all coastal states, especially along the Atlantic coast—affecting areas from Miami, Florida, to Cape Cod, Massachusetts. In particular, saltwater intrusion is occurring in:

- Florida, in the Jacksonville, Tampa, and Miami areas;
- Georgia and South Carolina, in the Brunswick and Savannah areas, and on Hilton Head Island, respectively; and
- New Jersey, in parts of Atlantic, Gloucester, Monmouth, Cape May, Ocean, and Salem Counties.

The threat of saltwater intrusion is also present in much of the interior of the country, where deep saline water underlies the freshwater. For example, ground-water withdrawals from the alluvial aquifer for irrigation near Brinkley, Arkansas, have caused upward movement of saline water from the underlying Sparta aquifer into the alluvial aquifer.

Projected Population Growth Will Increase Freshwater Demands

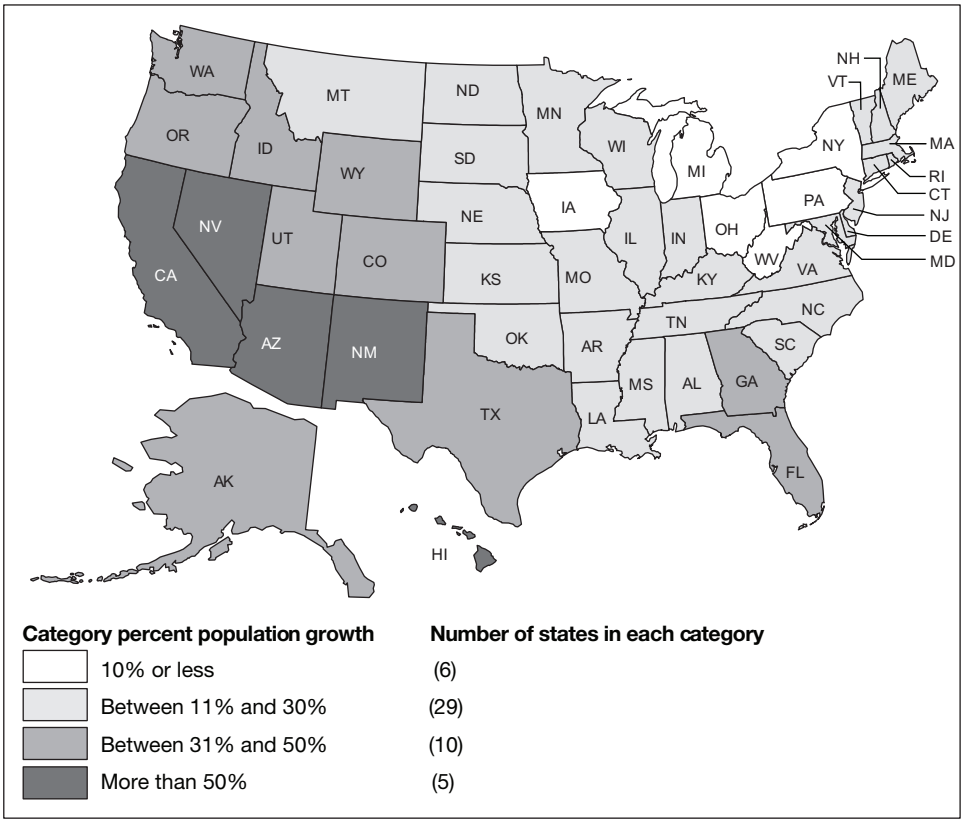
The U.S. Bureau of the Census projects substantial population growth by 2025 in areas of the nation where demand is already stressing the water supply. This growth could threaten the water supply even further. According to USGS, population growth drives increases in the use of the public water supply.[7] Indeed, public use increased by 4 percent while population increased by 7 percent from 1990 to 1995. The difference in rates indicates the success of conservation in lowering per-capita use, from 184 gallons per day in 1990 to 179 gallons per day 1995. Whether conservation will continue to lower per capita use and at what rate is unknown.

[7] Other factors that influence the demand for water include the price of water, the price of other goods (such as, the price of energy used in water pumps and the price of goods produced using water), income, instream demands for habitat and other ecological needs, and climate.

According to the Bureau of the Census' 1997 projections, net population change through 2025 will be most evident in three states—California, Texas, and Florida—each of which is projected to gain more than 6 million persons.[8] These three states will account for 45 percent of the net population change in the United States. California, the most populous state, with 12 percent of the nation's population in 1995, is expected to have 15 percent of the nation's population by 2025. As shown in figure 20, Western and Southern states will not only have the largest net growth but will also grow at the fastest rates. California is expected to grow faster than any other state after 2000, with an estimated 56-percent growth rate between 1995 and 2025.

[8] Net population change is births minus deaths plus net migration.

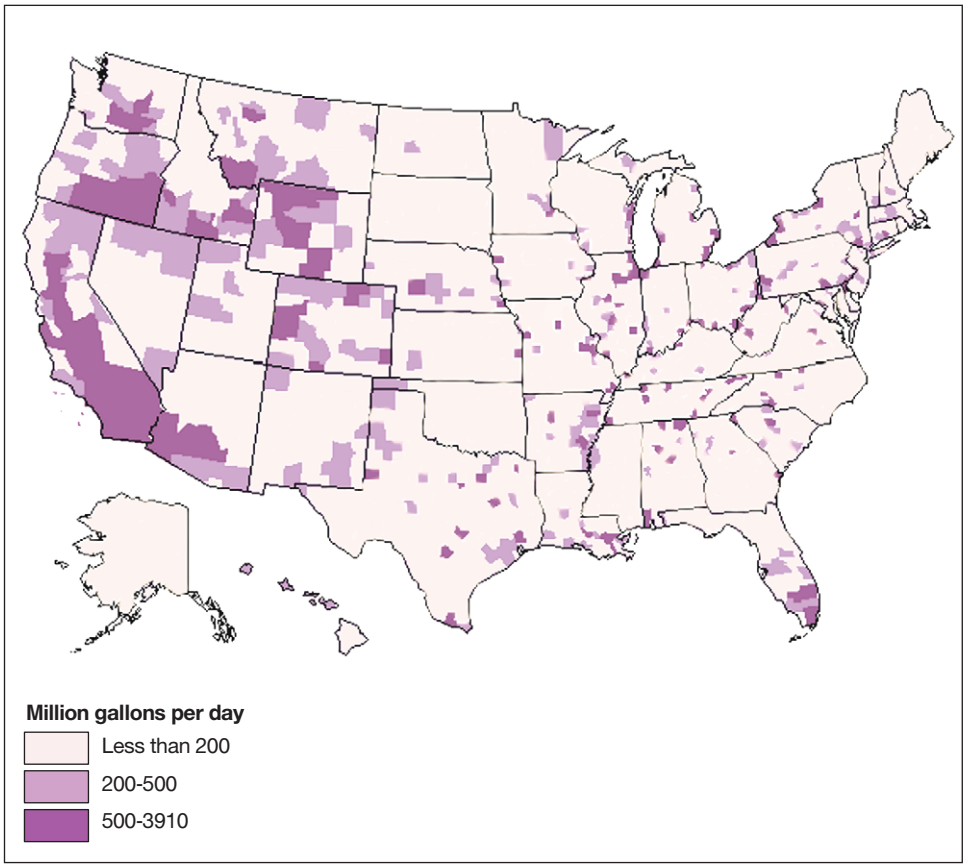
Figure 20: States' Population Growth from 1995 to 2025



Source: U.S. Census Bureau.

Many of the states that are growing the most or at the fastest rates are also those that are currently stressing freshwater supplies. Figure 21 shows total freshwater use in the United States in 1995, by county, in million gallons used per day, and illustrates that many of the states that are expected to grow the most or the fastest—California, Nevada, Arizona, New Mexico, Florida, and Texas—also include significant areas that are already using water at among the greatest daily rates in the nation. In some of these same areas of high water use, the consumptive use of water nears or exceeds the renewable water supply, indicating that all or most of the water that is available is used. For example, according to USGS, in the Lower Colorado River basin, covering most of Arizona and significant parts of Nevada and New Mexico, the population consumed 10.6 billion gallons per day, but the renewable supply is only 10.3 billion gallons per day.

Figure 21: Total Freshwater Withdrawals by County, 1995



Source: USGS.

Western states are already experiencing the effects of this anticipated growth. For example, due to ongoing population growth and the effects of recent drought, several Colorado River basin states, such as New Mexico and Arizona, are demanding that California, one of the biggest users of Colorado River water, adhere to the 1922 Colorado River Compact. For many years Southern California had been using Colorado River water that was not used by the other states, and had come to rely on this water to meet the demands of its users. After prolonged negotiations, the California users, such as irrigation and municipal water districts, could not agree on a plan to reduce their Colorado River water use. As a result, Reclamation has begun limiting California to its legal entitlement of 4.4 million acre feet of

Colorado River water annually. State users are continuing to discuss a potential water-sharing agreement, and stored water is expected to prevent immediate severe impacts. However, Southern California water users have begun considering alternative supplies, such as obtaining water from Northern California water right holders, storing water in surface reservoirs and underground aquifers, and building desalination facilities to turn ocean water into freshwater.

Based on recent media reports, many metropolitan areas in other parts of the nation are also experiencing the impact of population growth on water supply. For example:

- Atlanta, Georgia, the fourth fastest growing metropolitan area in the United States from 1990 to 2000, is recovering from a prolonged drought and is exploring ways to meet increased demand due to population growth.

- Chicago, Illinois, the seventh fastest growing metropolitan area between 1990 and 2000, has experienced significant ground-water depletion.

- Tampa, Florida, another area experiencing high population growth, began operating a new desalination plant in early 2003 to produce 25 million gallons of drinking water daily. This technology is seldom used in the United States owing to the relatively high cost of desalting water.

- Denver, Colorado, officials have proposed strict water conservation measures for 2003 because of anticipated water shortages; measures include limits on landscape watering and the amount of grass that can be planted at new homes.

- New York City's water supply reached its most worrisome levels in more than 30 years during 2002, resulting in a drought emergency declaration for the city and four upstate counties. More than 9 million residents experienced water restrictions. The states of New Jersey, Pennsylvania, Maryland, Maine, and New Hampshire also enacted water restrictions.

Growing Demand to Leave Water Instream Affects Offstream Availability

Over the past 30 years, the nation has increasingly emphasized protecting the environment. Among other things, the public places higher value on leaving water instream for endangered species, recreation, and scenic enjoyment, which may limit the use of existing water supplies and the development of new supplies. Federal laws such as the Endangered Species Act and the Wild and Scenic Rivers Act reflect these environmental values. However, when water is left instream to protect wetlands, fisheries, and endangered species or to preserve the wild and scenic status of a river, it cannot be simultaneously available for traditional offstream uses such as irrigation and municipal and industrial supply.

Under the Endangered Species Act, plants and animals may be listed as threatened or endangered, depending on the risk of extinction. Once a species is listed, powerful legal tools are available to help the species recover and to protect its habitat. Implementation of the Endangered Species Act resulted in immediate challenges for water resource managers. For example, the Tellico Dam, on the Little Tennessee River was already under construction when Congress enacted the Endangered Species Act in 1973. Construction of the dam, which provides flood control, hydropower and water supply, was challenged under the act to prevent jeopardizing the endangered snail darter—a species of fish. In 1979, Congress specifically exempted the project from the Endangered Species Act, allowing the project to be completed.[9] Subsequently, the snail darter was found in other locations and reclassified as threatened.

More recently, in the Klamath River Basin on the California-Oregon border, Reclamation's actions to comply with the Endangered Species Act by leaving water instream resulted in losses to traditional offstream users. After consulting with the Fish and Wildlife Service and the National Marine Fisheries Service about the operation of the Klamath Project in 2001, an acute drought year, Reclamation allocated nearly all the project water to the protection of endangered species in the Klamath River (Coho salmon) and the reservoir (two species of sucker fish). While this action met Reclamation's obligations under the Endangered Species Act not to jeopardize any endangered species, Reclamation could not then meet its contractual water delivery obligations to irrigators, who consequently experienced crop losses. The potential for future conflicts over the

[9] Energy and Water Development Appropriations Act, Pub. L. No. 96-69, 93 Stat. 437 (1980).

implementation of the Endangered Species Act is strong as competition grows between instream and offstream water demands.

The Wild and Scenic Rivers Act provides protection for a designated river or segment by limiting the future licensing of dams, reservoirs and other water projects on, or adversely affecting, protected segments.[10] Conflict can arise over how much water should remain in rivers to maintain their wild and scenic values and over whom should decide the proper amount of water. Environmentalists and boaters may prefer high, strong flows in wild and scenic stretches, while others stress the need for water to be available above and below wild and scenic segments for farming and other economic development, potentially reducing flows. For example, in August 2002, addressing the issue of water in the Salmon River, the Idaho Supreme Court ordered federal and state officials to participate in formal mediation, with consultation from environmental, industry and local government representatives, to determine the quantities of water to be legally reserved for all six wild and scenic rivers in Idaho. The court ordered the state and the Forest Service to reach a compromise on water allocation; if they do not, the case will be returned to state water court.

Climate Change Makes Future Supply and Demand Conditions Uncertain

Uncertainties regarding potential reductions in water availability also result from the natural variations of the hydrologic cycle and the possibility that greenhouse gasses, such as man-made concentrations of carbon dioxide and other gasses in the atmosphere, might warm the earth and thereby alter the cycle. According to the U.S. Global Change Research Program, composed of federal and nonfederal representatives, water supply conditions in all regions of the United States are likely to be affected by climate change in the future, either through increased demands associated with higher temperatures or changes in supply because of changes in precipitation and runoff patterns.

A 2002 federal interagency report summarized climate and precipitation changes for the contiguous United States during the past century and expected changes over the next century.[11] The report noted that for the past century, warming amounted to about 1 degree Fahrenheit, and that

[10] The National Park Service, Bureau of Land Management, Forest Service, and Fish and Wildlife Service, all manage designated rivers.

[11] U.S. Department of State, *U.S. Climate Action Report 2002,* Washington, D.C., May 2002.

total annual precipitation increased by an estimated 5 to 10 percent. While most regions experienced greater precipitation, parts of the upper Great Plains and the Rocky Mountains had less precipitation. For the next century, the report noted the following likely changes—average temperature increases of 3 to 9 degrees Fahrenheit across the nation, increased precipitation and evaporation, and more frequent occurrences of unusual warmth and extreme wet and dry conditions.

The U.S. Global Change Research Program, which coordinates federal agencies' climate research activities, concludes that climate change will pose many challenges to water supply management in future years. Program research indicates that changes in the amount, timing, and distribution of rain, snowfall and runoff are probable, leading to changes in water availability as well as in competition for water resources. Precipitation is very likely to continue to increase on average, especially in the nation's middle and northern areas, with much of the increase coming in the form of heavy downpours, which are not as easily absorbed for storage in underground aquifers. Snowpack, which serves as natural water storage in mountainous regions and northern portions of the United States, gradually releases its water in spring and summer; however, snowpack is very likely to decrease as the climate warms, despite increasing precipitation. It is very likely that more precipitation will fall as rain, and that snowpack will develop later and melt earlier. As a result, peak stream flows will very likely come earlier in the spring, and summer flows will be reduced. Potential impacts of these changes include an increased possibility of flooding in winter and early spring and more shortages in the summer.

Expected Freshwater Shortages May Harm the Economy, the Environment, and Communities

Freshwater shortages are likely in the near future and their impact on the economy, environment, and communities may be severe.[1] Under normal water conditions, state water managers in 36 states anticipate water shortages in localities, regions, or statewide within the next 10 years. Under drought conditions, 46 state water managers expect shortages. While no studies have measured the total economic impacts of shortages, recent shortages have resulted in billions of dollars in damages to specific segments of the economy, such as agriculture. Water shortages can also damage plant and animal species, wildlife habitat, and water quality. Moreover, water shortages can harm the nation's social fabric, for example, by creating conflicts between water users, reducing the quality of life, and creating perceptions of inequitable treatment among communities due to varying levels of water availability or relief for water shortage impacts.

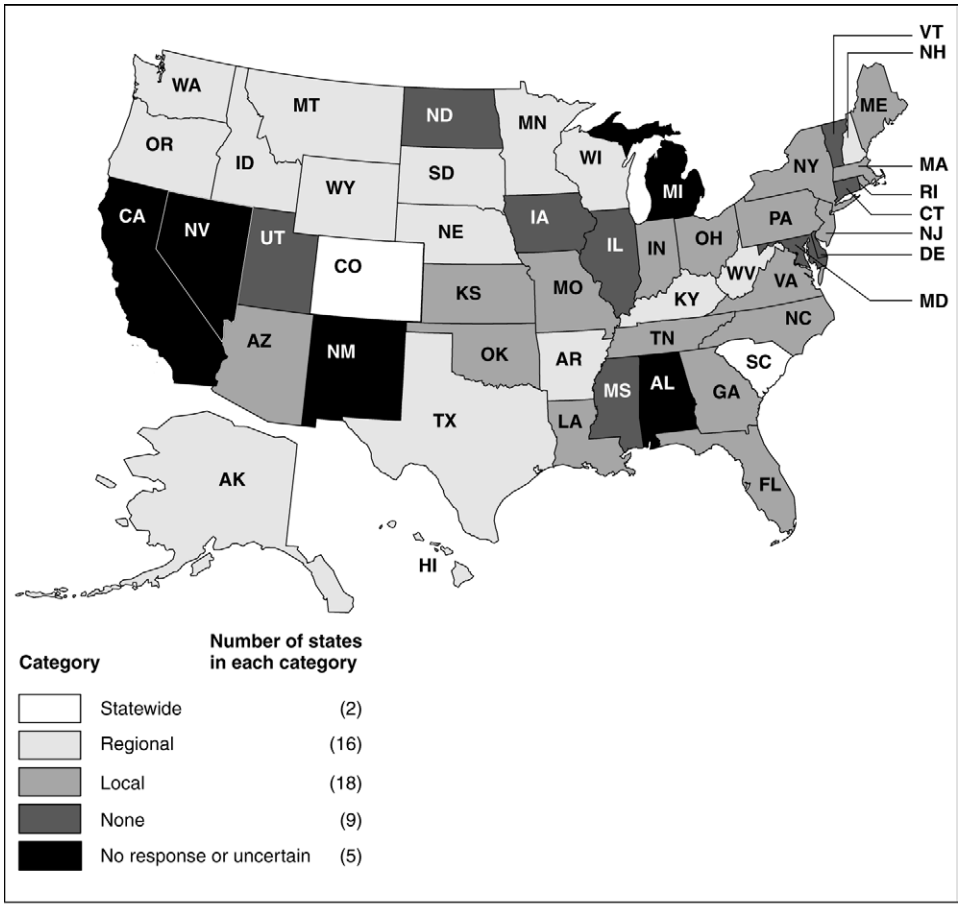
State Water Managers Expect Shortages within 10 Years

Consistent with the water availability and use trends, state water managers expect water shortages in the near future. According to our survey of state water managers, 36 of 47 states expect some portion of their state to experience shortages under average water conditions within the next 10 years.[2] As shown in figure 22, 18 state managers expect shortages to occur in one or more localized areas, while 18 state managers expect regional or statewide shortages. Water managers indicated that their states are vulnerable to shortages because they do not always have the infrastructure to store and distribute water where and when it is needed, they rely on diminishing ground-water resources, or because population growth has outpaced existing storage capacity in some regions of the state.

[1] Shortages are at prevailing water prices; we did not consider the potential effects of changes in water prices for this review.

[2] Based on discussions with state water managers during survey pretests, we asked managers to use the last 10 to 20 years to determine average water conditions for their state.

Figure 22: Extent of State Shortages Likely over the Next Decade under Average Water Conditions



Source: GAO analysis of state water managers' responses to GAO survey.

The probability of shortages increases and the effects broaden under drought conditions. According to 46 of the 47 water managers, their states are likely to experience shortages within the next 10 years under drought conditions. Water managers in 6 states predict the shortages to occur in one or more localized areas within their state, 29 managers predict shortages in one or more regions in their state, and 11 managers predict statewide shortages.

States expect these shortages despite their efforts to prepare. Recognizing the challenges ahead, state water managers reported that state, regional, and/or local authorities are planning for their current and future water needs:

- **Drought preparedness and response planning.** Twenty-three states have a drought preparedness plan to reduce drought vulnerability, and 41 states have a drought response plan to provide assistance to those affected by drought.

- **Assessing and monitoring water availability and use.** Forty-four states are monitoring water availability and use by, for example, measuring streamflows or water withdrawals.

- **Implementing water management strategies.** Thirty-eight states are coordinating the management of surface and ground-water resources to help meet their current and future water needs.

- **Reducing or reallocating water use.** Forty states are taking actions to conserve water, and 15 states are allowing voluntary water transfers among users, allowing water to be bought and sold or leased.

- **Developing or enhancing supplies.** Some states are undertaking scientific or technological approaches—eight western states are using cloud seeding to increase precipitation within the state, and nine coastal states are developing saltwater desalination operations to make freshwater.

Freshwater Shortages Have Severe Economic, Environmental, and Social Consequences

Shortages of freshwater may harm not only a local area, but also multiple regions and sectors of the economy for many years. Water shortages can also damage the environment and create conflicts between water users.

Water Shortages Can Cause Billions of Dollars in Economic Damages

No estimates are available on the total economic costs of water shortages to the nation. However, adequate supplies of water must be available to produce goods and provide services, and shortages can create both direct and indirect problems. For example, shortages reduce crop, rangeland, and forest productivity; increase fire hazards; increase mortality rates for livestock and wildlife; and damage wildlife and fish habitat. In 2003, alone, Congress provided an additional $3.1 billion in appropriations to offset agricultural losses. Water shortages also have indirect impacts. For example, reductions in crop, rangeland, and forest productivity reduces income for farmers and agribusiness, increases prices for food, contributes to higher unemployment, increases foreclosures on banks loans to farmers and businesses, and requires more spending for disaster relief.

While national estimates are not available, regional and state estimates provide some insight into the severity of water shortages. According to a 2000 report on extreme weather events from the National Oceanic and Atmospheric Administration,[3] eight water shortages from drought or heat waves had each resulted in $1 billion or more in monetary losses over the past 20 years in various states. The more significant of the economic impacts included were:

- $6 to $9 billion in losses for the agriculture and ranching sectors of Texas/Oklahoma and eastward to the Carolinas in the summer of 1998,
- $5 billion in economic damages in Texas and Oklahoma from fall 1995 to summer 1996,

[3] The National Oceanic and Atmospheric Administration's National Climatic Data Center is responsible for monitoring and assessing the earth's climate and is the world's largest repository of weather data. The center gathers water shortage related information including economic impact data.

- $40 billion in damages to the economies of the Central and Eastern United States in summer 1988, and

- $20 billion in economic damages to the Central and Eastern United States from June to September 1980.

River basin commissions and states also reported recent drought-related economic losses of hundreds of millions of dollars. For example, the Susquehanna River Basin Commission,[4] reported that, as a result of the 1999 drought, 34 counties in New York State declared an agricultural disaster with losses of about $2.5 billion, and it estimated Pennsylvania crop losses at $500 million, with some farmers losing as much as 70 to 100 percent of their crops. The Commission also reported that other water-dependent industries, such as nurseries, suffered significant losses and electrical power plants had trouble getting sufficient water supplies to meet operational needs because of low stream flows. Similarly, in December 2001, the Washington State Department of Ecology estimated that the 2001 drought cost between $270 million to $400 million in damages to agricultural production, a loss of 4,600 to 7,500 agricultural jobs, and placed at risk an additional 950 to 1,400 jobs in the food processing, wholesaling, trucking, warehousing, and transportation services sectors. Finally, persistent drought conditions could also put at risk another 4,500 to 6,000 jobs in the construction, retail, and service sectors, among others.

In addition to lost economic productivity, droughts also increase federal and state government expenditures. For example, Washington State paid almost $8 million in drought related expenditures to obtain water for several irrigation districts, maintain stream flow in critical fish-bearing streams, and to monitor stream flows. In addition, the state paid $1 million to the Bonneville Power Administration, which markets electrical power in the Pacific Northwest, to offset losses in power-generating revenues.

While the most commonly estimated economic impacts of water shortages occur in agriculture and related sectors, less obvious sectors of the economy are also affected.

[4] The Susquehanna River Basin Commission coordinates water resources efforts of the states of Maryland, New York, and Pennsylvania and the federal government to administer water resources in the Susquehanna River Basin.

- In March 2002, New Jersey declared a state of water emergency (rainfall in 35 of the past 49 months had been below normal, with 8 of the last 12 significantly below normal). Among other things, the state suspended the distribution of water for construction or use by any new building, dwelling, or structure in three south New Jersey townships. The pace of development in these townships threatened to damage the ecological and water supply capability of the local aquifer system. The monetary losses resulting from this suspension are difficult to quantify, but, at a minimum, building suppliers and other construction-related sectors lost revenues, and local municipalities lost tax revenues.

- In February 2003, the Southern Nevada Water Authority approved a plan to restrict water use in the Las Vegas Valley during an ongoing drought. Residents and businesses, such as golf courses, will be required to curtail water use. For example, golf courses will be required to use no more than 7 acre-feet of water per year. According to an operator of three golf courses, he will have to remove 90 acres of grass at an estimated cost of $500,000.

Some organizations are developing estimates of the economic impacts of droughts. For example:

- University of Georgia researchers have developed an economic model to measure the potential economic impacts of a drought for the 20-county regional economy in southwest Georgia. Using this model, the researchers estimated that each $1 million decline in agricultural production results in an additional $700,000 decline in other economic segments, for a total loss of $1.7 million. In addition, for each job lost in agriculture, 1.4 jobs are lost in other economic sectors, for a total of 2.4 jobs lost.

- Texas requires regional water planning groups to evaluate the social and economic impacts of not meeting regional needs for water supply. For example, a regional group for Northeastern Texas projected that by 2010 unmet regional water needs would result in 93,000 fewer jobs, 199,000 fewer people, and about a 13 percent loss in personal income. Based on these regional reports, in 2002, the Texas Water Development Board reported that if the state does not ensure it has enough water to meet projected needs, it will have 7.4 million fewer jobs, 13.8 million fewer people, and 38 percent less income within the state by 2050.

Water Shortages Damage the Environment

Water shortages can result in environmental losses—damages to plant and animal species, wildlife habitat and air and water quality. Following a water shortage, some conditions quickly return to normal, while other effects may linger or change conditions permanently. The Florida Everglades experience illustrates the effects that reduced water flows can have on an ecological system.

Following periods of major drought in the 1930s and 1940s and heavy flooding in 1947, Congress authorized in 1948 the Central and Southern Florida Project—an extensive system of over 1,700 miles of canals and levees and 16 major pump stations—to prevent flooding and saltwater intrusion into the aquifer underlying the wetlands, as well as to provide drainage and supply water to the residents of South Florida. Some drained areas became farmland, while others became heavily urbanized. These engineering changes, coupled with agricultural and industrial activities and urbanization, have reduced the Everglades to about half its original size, as shown in figure 23, and damaged the environment. For example, the population of wading birds once numbered in the millions, has fallen by 90 percent in recent decades. Moreover, some scientists believe that the reduced flow of freshwater into Florida Bay may be hastening its environmental decline. An effort to restore the Everglades is currently underway involving numerous federal, state, tribal and local entities. The current estimated costs, which are shared equally by federal agencies and the state, for activities in the South Florida ecosystem restoration initiative—including the three goals of getting the water right, restoring, preserving and protecting natural habitats, and fostering the compatibility of the built and natural systems—are $14.8 billion.

Figure 23: The Everglades—Past and Present

Past

Historically, the natural areas of the Everglades extended well north of Lake Okeechobee and south to Florida Bay and the Gulf of Mexico.

Present

Today, the bulk of the natural areas remaining in the ecosystem primarily include the Everglades National Park and Big Cypress National Preserve, as well as state water conservation areas.[a]

Natural areas of the Everglades

Source: South Florida Water Management District.

[a]Other smaller natural areas are dispersed throughout South Florida, such as national wildlife refuges and state, local, or privately owned lands, but are not shown in the figure.

Water Shortages Can Cause Social Discord

Water shortages can raise a number of concerns for communities, such as:

- Conflicts arising between various water users, managers, and government entities due to competition for scarce water resources;
- Threats to the lifestyles of individuals whose livelihoods depend on water, such as farmers and commercial fishermen; and
- Feelings of undue burden from a shortage, such as feelings of unfair treatment in the amount or timing of relief efforts by government entities.

The experiences in the Klamath River Basin, on the California-Oregon border, illustrate how these concerns can play out. In 2001, severe drought in the Klamath River Basin exacerbated conflicts among numerous interests: farmers who rely on water for irrigation, commercial fishermen who rely on salmon spawned in the river for their livelihood, environmental groups interested in protecting endangered species, and Native American tribes with long-standing cultural, fishing and water rights interests. In April 2001, Reclamation announced that it would not be able to supply water to farmers in the majority of the basin so that the limited supplies could be used to protect endangered or threatened species under the Endangered Species Act.[5] Many farmers claimed to have suffered crop losses as a result of restricted water deliveries and protested the decision in public demonstrations; some individuals unlawfully opened water control gates. Farmers viewed the diversion of water as breaking the federal government's long-standing promise to provide water and land for farming and as harming the agriculture based culture that had developed in the area since the project was initiated in the early 1900s.

Subsequent to the National Academy of Sciences' February 2002 review of the scientific support for minimum lake and river flows, Reclamation developed a 10-year operating plan to comply with the requirements of the Endangered Species Act while also allowing water deliveries to irrigators. However, in September 2002 as many as 30,000 adult salmon and steelhead died while returning to the Klamath and Trinity Rivers to spawn. California State Department of Fish and Game officials and others argue that low

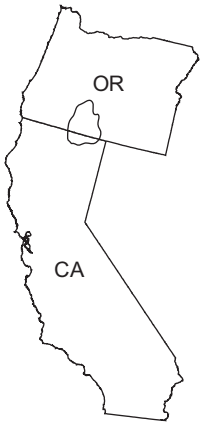
[5] Reclamation operates a federal water supply project in the Upper Basin that has provided water for irrigation to farmers for nearly 100 years.

river flows and high water temperature may have stressed the salmon and made them more susceptible to disease. Consequently, according to local media accounts, the environmentalists, Indian tribal leaders, and commercial fishermen now claim that the government is catering to farmers and ignoring their concerns (see fig. 24). The result has been on going litigation over river flows and legislation to address the financial damages of the various parties. Although the Klamath water supply issues were made more acute by the severe drought, the conflicts over who gets water will continue because demands are greater than current supplies.

Figure 24: Competition for Water in the Klamath Basin

(A) In May 2001, supporters of Klamath Basin farmers formed a "bucket brigade" by standing shoulder to shoulder and passing buckets of water from the Link River to a canal used to deliver water for irrigation.

(B) In April 2002, supporters of providing water for fish and wildlife within the Klamath Basin advocate their position.



Sources: (A) California Farm Bureau Federation (photo and caption). (B) Bureau of Reclamation (photos and caption). GAO analysi s.

The competition for water is by no means unique to the Klamath Basin. Similar conflicts are brewing in other areas, such as the Columbia and Snake River System in the Northwest, the San Joaquin and Sacramento Basins in California, the Missouri River System in the Northern Plains states, the Middle Rio Grande in New Mexico, and the Florida Everglades. Recognizing the potential for conflict due to water shortages, in May 2003, Interior proposed concentrating federal financial and technical assistance in key western watersheds and in critical research and development such as conservation and desalination to help predict, prevent, and alleviate future water supply conflicts.[6]

[6] U.S. Department of Interior, *Water 2025: Preventing Crises and Conflict,* Washington, D.C., May 2003.

Federal Activities Could Further Support State Water Management Efforts

To identify potential federal actions to help states address their water management challenges, we sought the views and suggestions of state water managers. We also asked federal officials to identify their current activities in each of these categories and the extent to which they can support state preferences for assistance. Water managers from 47 states ranked actions federal agencies could take within five basic categories of activities:[1]

- **Planning, constructing, operating, and maintaining water storage and distribution facilities.** The most helpful potential federal action was to provide more federal financial assistance to plan and construct additional state water storage and distribution capacity; states also favored more consultation on the operation of federal water storage and distribution systems.

- **Collecting and sharing water data.** Collecting water data at more locations would be most useful, compared with actions to improve the accuracy, timeliness, access, format, or analyses of the data.

- **Administering federal environmental protection laws.** The most beneficial potential federal actions were (1) more state flexibility in how they comply with or administer federal environmental laws and (2) more consultation with the states on these laws' development, revision, and implementation.

- **Participating in water-management agreements.** The highest preferences were increasing federal agencies' coordination with, and technical assistance to, the states in developing and implementing these agreements.

- **Managing water rights for federal and tribal lands.** The most helpful potential actions were (1) more consultation with states on how federal agencies or tribal governments use their water rights, (2) increased financial and technical assistance to determine how much water federal agencies and tribes are entitled to, and (3) better coordinated participation among federal agencies and tribes in the establishment and use of their water rights.

[1] State water managers in 47 states responded to our survey; California, Michigan, and New Mexico did not participate.

Appendix I contains the detailed results of the survey.

States Preferred More Financial Assistance to Increase Water Storage and Distribution Capacity and Consultation on Federal Storage Operations

In terms of water storage and distribution capacity, state water managers reported their highest priority was more federal financial assistance to plan and construct the state's freshwater storage and distribution systems. According to our survey, over the next 10 years, 26 states are likely to add storage capacity, and 18 are likely to add distribution capacity. The additional storage and distribution capacity will be used to meet a variety of needs, such as augmenting local supplies, connecting water systems, and developing ground-water storage. Consequently, water managers in 22 states said that more federal financial assistance would be most useful in helping their state meet its water storage and distribution needs. For example, of the 26 states that are likely to add storage capacity, 16 plan to seek federal assistance, as do 14 of the 18 states that are likely to add distribution capacity. Estimated costs to add this storage and conveyance capacity could be in the billions of dollars for each state if built as planned. For example, Texas estimated in its 2002 State Water Plan the capital costs of water supply projects over the next 50 years, including the addition of 8 major reservoirs, to be $17.9 billion.

Reclamation and Corps officials understand the states' need for financial assistance for storage and distribution projects, and provide financial assistance on a project-by-project basis, as the Congress authorizes and appropriates funds. Current authorized and funded water projects include Reclamation's Animas-La Plata project in southwest Colorado and northwest New Mexico for storing and distributing water in these states at a cost of about $700 million, and the Corps' and the state of Florida's participation in the estimated $14.8 billion effort to restore the Florida Everglades. Reclamation and Corps officials were not aware of any state requests directly to them to provide financial assistance to plan or construct new state storage or distribution projects, with the exception of projects under the ongoing CALFED program.[2]

State water managers also favored more consultation on the operation of federal water storage facilities. While federal agencies develop plans to

[2] In fiscal year 2003, Congress provided $23 million in funding to Reclamation's Central Valley Project for activities that support the California Bay-Delta Restoration Program (CALFED), including investigations of water storage opportunities and ongoing reservoir planning activities.

govern the operations of each facility, changes in water availability, such as a drought, and new or changing demands for water, such as a new endangered species listing or residential development, can alter the state's water management goals in a river basin. State managers sometimes pursue a change in the operations of a federal water storage facility to better help the state meet its multiple water management goals. State water managers in 29 states said they had worked with federal water project managers within the last 5 years to obtain changes in federal operations to better meet their state's water management goals. The state managers requested changes in federal operations to help balance instream water uses—that is, environmental, recreation, hydropower production, and navigation uses—with offstream water uses, such as municipal water supply and irrigation. For example, one western state asked Reclamation to modify facility operations to benefit fish spawning, while several states requested changes to Corps facility operations to support the states' water management goals—for example, to improve water quality, recreation, and minimize flooding impacts.

Reclamation and Corps officials told us their agencies currently work with state water managers on a daily basis to meet the needs of water users affected by their facilities. Furthermore, they are making efforts to consult more with the states and thereby prevent future conflicts related to their operations. According to a Reclamation official, operators at the agency's facilities annually share operations plans with state water managers and other stakeholders to review the previous year's operations and solicit their views on the need for changes to meet new or increased demands. Furthermore, Reclamation plans to identify river basins with the greatest potential for future conflict between water users and environmental needs and to develop future operating plans with input from all users. Officials said they are trying to prevent water management crises on the scale of those that have occurred in the Klamath, Columbia, Middle Rio Grande, and Colorado River basins and avoid costly litigation. A Corps' official stated that the Portland, Oregon, district office holds a daily public briefing in its reservoir control room to describe conditions in the entire Columbia Basin, and the Corps shares its operating plans annually with the states.

While Reclamation and Corps officials welcome state water managers' views on operations, the agencies are not always able to accommodate state requests when the request would prevent or limit the agency's ability to meet its obligations under laws or contracts. For example, Reclamation officials said they must consider the authorized purpose of the facility, the agency's contractual obligations for water delivery, environmental

regulations, and the requirements of state law when considering a state request. In addition, federal officials said they could not honor some requests because modifying facility operations to meet the needs of one water user may adversely affect water availability for other water users. For example, Reclamation received a request from one state to change facility operations to increase water flows for downstream rafting in the spring; however, another state said the additional release would decrease the quality of recreational fishing. Once the states agreed on a compromise, Reclamation modified its releases to meet the water needs of both users. Corps officials shared similar experiences. For example, a state requested that the Corps store more water in a flood control reservoir. The Corps asked the state if it was willing to accept responsibility for the environmental impacts of flooding more area behind the reservoir. The state agreed and the Corps adjusted the annual operating plan.

States Believe They Would Benefit from Federal Data Collection in More Locations

State water managers placed a high value on data collected under federal programs to support the states' ability to complete specific water management activities. For example:

- 37 states reported that federal agencies' data are important to their ability to determine the amount of available surface-water,
- 22 states reported that the federal data are important to their planning for environmental mitigation or restoration activities, and
- 14 of the 29 states that participate in interstate or international water-management agreements reported that federal data are important to monitoring the terms of the agreements.

To supplement the data collected under federal programs, some states also collect their own water data. However, in some circumstances, data collected under federal programs may be more credible and consistent than the state data, according to state water managers. For example, one state water manager said his state participates in the USGS Cooperative Program because other states with which it manages shared waters consider USGS-collected information more credible than the state-collected information. Another state manager said that consistent, long-term, federal data collection is extremely valuable and cannot be replicated by the state. Furthermore, according to USGS and state officials, state and locally collected data is not always comparable because collection practices are not standardized.

Water managers in 39 states ranked expanding the number of data collection points for federal agencies as the most useful action to help their state meet its water information needs. Specifically, state managers reported that the addition of more monitoring stations to measure stream flow, aquifer levels, and snow pack depths would help states decide, for example, whether to allow additional water withdrawals from particular sources. State managers suggested more monitoring locations are particularly needed in rural areas, where water is shared among multiple states, or areas needing increased water flows to meet environmental protection needs. For example, one state manager said more monitoring stations are needed on the smaller tributaries, where the needs of endangered or threatened fish are in conflict with traditional offstream uses.

Officials at the USGS, the Natural Resources Conservation Service, and the National Weather Service, each have ongoing efforts and/or plans to improve their data collection programs. However, they need to do so within current funding levels. USGS—the agency primarily responsible for water data collection and analysis—officials said the agency continually examines how to allocate its resources to meet its national responsibilities while also helping states. According to agency officials, USGS and the states generally agree on which water sources to monitor; however, the agency and the states sometimes differ on how many locations to monitor for a particular source. Disagreement occurs because USGS' monitoring stations are widely distributed to meet its nationwide responsibilities, rather than concentrated to benefit a particular state.

To meet demand for more data and more sophisticated water supply forecasts, Natural Resources Conservation Service officials say they need to double the current number of snow pack monitoring stations and water supply forecasting activities. Specifically, the agency has identified the need to automate and expand reporting on snow pack data in the Great Lakes and the Northeast, as it does for the West. Finally, officials at the National Weather Service said they plan to automate rainfall data reporting, which will make these data more readily accessible, but they have no plans to expand data collection locations.

According to USGS, Natural Resources Conservation Service and National Weather Service officials, obtaining additional funding is their primary barrier to expanding or automating data collection. To address funding limitations, they have developed collaborative relationships to accept data from other entities, including states and universities, and make these data

available to users on their web sites. Because data quality is a concern under this process, the federal agencies must verify that the entities' data collection practices meet federal standards before accepting the data. To help ensure quality, the agencies participate in interagency work groups that set standards for federal water data collection and dissemination, such as the Advisory Committee on Water Information.

States Favor More Flexibility in How They Comply with or Administer Federal Environmental Laws and More Opportunities for Comment

Federal laws such as the Endangered Species Act and the Clean Water Act provide important protections to the nation's wildlife and natural resources. The Endangered Species Act provides protection and assists the recovery of threatened or endangered plant and animal species and their critical habitat, and the Clean Water Act requires improvements to water quality and the prevention of discharges of pollutants into our nation's waters.

The implementation of these laws can also affect state water management goals and objectives. For example, the Endangered Species Act can create a demand to leave water instream to ensure that species or critical habitat are not jeopardized, thus competing with traditional offstream water demands, such as irrigation, municipal, and industrial uses. When demand is high among traditional users or supplies are limited, fulfilling the demands created by federal environmental laws can be challenging for some state managers.

According to our survey, the impacts of federal environmental protection laws on state water managers vary, depending on the particular water demands and uses within each state. For example, while 25 state water managers reported that the Clean Water Act increased water availability for instream purposes, managers offered diverse views of the law's effects on offstream availability. Managers in 11 states reported that the Clean Water Act's water quality impacts increased water availability for offstream uses, such as drinking water, while managers in 18 states reported that the law decreased offstream water availability, for example, because of the need to leave water instream to maintain water quality standards. Similarly, 26 state managers reported that the Endangered Species Act tended to decrease the amount of water available for offstream uses, but managers were more evenly divided on whether the law has made more water available for instream uses. For example, managers in 16 states reported that the Endangered Species Act has helped increase water availability for instream uses, such as maintaining fish habitat, while 9 managers reported

decreased availability because the law limited water availability for hydropower production, another instream water use.

Overall, 23 state water managers ranked having more flexibility in how they comply with or administer federal environmental laws as the most useful among potential actions that would help states meet the requirements of federal environmental protection laws while also meeting water management goals. Because the effects of the laws are so varied, we did not identify a consensus regarding the specific elements of compliance or administration of these laws that required more flexibility. However, state water managers described instances in which they believed that federal environmental laws restricted the state's ability to develop new water storage capacity, distribute water, or meet the needs of offstream users.

Federal officials from the Environmental Protection Agency, the Fish and Wildlife Service, and the National Marine Fisheries Service, agreed that while they try to accommodate state concerns about federal environmental laws, the amount of flexibility they can provide is limited by their obligation to ensure that the laws are complied with and administered as Congress intended. However, officials cited examples of current and planned efforts to use the flexibility they have under current law to help the states comply with or administer federal environmental laws likes the Clean Water Act and Endangered Species Act. For example, Environmental Protection Agency officials said they are assessing ways to make their water quality programs more efficient and effective, which may result in more flexibility for the states. National Marine Fisheries Service and Fish and Wildlife Service officials said they already have considerable flexibility under the Endangered Species Act to accommodate state-developed water management plans that also meet the needs of listed threatened or endangered species. Officials of both the services said they encourage states to work cooperatively with them to develop water management plans.

In 17 states, water managers also said they would like federal agencies to seek more state advice on developing, revising, and implementing federal environmental laws. Specifically, three state managers made the following suggestions:

- Congress and federal agencies should seek states' input when reauthorizing the Endangered Species Act.[3]

- Federal agencies should recognize and support states' species recovery plans; this could help agencies to develop federal recovery plans that are better coordinated with state activities.

- States should peer review federal agencies' science and decisions, thus better balancing state and federal viewpoints.

Regarding federal actions to seek more state advice, federal agency officials cited several examples of ongoing and planned efforts to enhance their working relationships and reduce conflicts with state agencies and other stakeholders. The Fish and Wildlife Service and National Marine Fisheries Service have existing joint policies to use the expertise and solicit the participation of states in the recovery planning process, and to solicit peer review of draft recovery plans. Agency officials commonly cited the use of river basin-wide agreements as an example of efforts to formally bring together state, federal, and other stakeholders to address important issues, such as providing certainty in water supplies while protecting wildlife habitats and preventing additional threatened or endangered species listings or protecting water quality. Officials of several agencies cited examples of successful cooperative agreements used in the California Bay-Delta, Upper Colorado River Basin, Snake River Basin, and in the Lemhi and Upper Salmon River Basins. According to a Fish and Wildlife Service official, such agreements signal enhanced efforts at developing relationships, sharing information, and getting advice from the states. According to officials, the Environmental Protection Agency hopes to facilitate cooperative relationships, for example, by awarding grants to states to explore comprehensive solutions at the watershed level. Reclamation officials cited planned actions to prevent federal/state conflicts regarding environmental issues. For example, the agency plans

[3] Endangered Species Act reauthorization has been on the legislative agenda since authorization expired in 1992, and bills have been introduced in each Congress to address various aspects of endangered species protection.

to provide more staff training on the purpose, processes, and requirements of the Endangered Species Act in order to ensure clarity regarding the act's requirements and the agency's responsibilities.

State Managers Would Gain from Improved Coordination of Federal Participation in Interstate or International Water-Management Agreements

State water managers in the 29 of 47 states that participate in an interstate or international water-management agreement ranked better coordination of federal agency participation with the state in the agreements as most useful among potential federal actions to help states in the development, enforcement, and implementation of such agreements. While many states said that federal agencies had fulfilled their responsibilities under interstate or international agreements during the last 5 years, seven state managers said that one or more agencies had not. These seven managers, and others, described instances in which they believe that federal agencies have not met their responsibilities under water-management agreements, such as:

- Ignoring obligations under participation agreements, such as the Corps not paying its river basin commission membership dues.
- Mismanaging existing river management facilities and failing to construct needed water storage facilities, such as projects for storing Colorado River water.
- Inadequately enforcing the water allocation terms of international treaties by not vigorously enforcing the terms of the U.S. water-management treaty with Mexico.
- Not resolving federal river basin priorities, thus creating uncertainty for state compact participants regarding federal actions.

Officials from Reclamation and the Corps stated that in most cases they have fulfilled their responsibilities under water-management agreements, but occasionally circumstances outside their control prevent them from carrying out their responsibilities. For example, in the case of the Corps not paying its river basin commission dues, Corps officials indicated that congressional appropriations language specifies that the federal government should no longer contribute financially to the annual expenses of these commissions. A Corps official stated that the agency has little funding available for efforts to coordinate activities under compacts, and moreover, other federal agencies have not approached the Corps to engage in coordination efforts. A Reclamation official acknowledged that he had

encountered barriers to coordination with other federal agencies—for example, federal agency officials are sometimes unwilling to sacrifice relationships they have developed with stakeholders in the interest of improving coordination among all parties.

Nevertheless, Reclamation and Corps officials stated that their participation in water-management agreements could be improved through their ongoing efforts to enhance coordination and communication with states and other water resource stakeholders. For example, Reclamation plans to facilitate meetings and assist water management projects in basins where the greatest potential for conflict exists among water users and environmental uses, thus laying the groundwork for the development of future water-management agreements. These efforts are similar to those officials described to assist the states and other stakeholders to allow more input into the operation of federal storage facilities.

States also ranked as important increased technical assistance to develop or implement water-management agreements. Of the 29 states in our survey that already participate in water-management agreements, 11 said they plan to propose, negotiate, or participate in a new water-management agreement within the next 5 years. For example, one state manager suggested federal assistance would be helpful in establishing a compact for managing water from an underground aquifer with another state. Another state water manager suggested that the state would benefit from assistance in the form of federal studies on water availability, use, and demand on sources shared between the United States and Canada.

Water management agencies do not have specific programs or funds to assist states in developing or implementing water-management agreements, according to agency officials. However, Reclamation and Corps officials pointed out that the federal agencies do assist in implementing agreements through the ongoing operation of federal water projects within the compact river basins, helping to ensure that the agreement terms are met. For example, Corps officials pointed to efforts by 10 federal agencies to assist in implementing agreements in the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint river basins located in Alabama, Florida, and Georgia. Furthermore, to help implement the water management treaty with Mexico, a National Weather Service official said the agency provides forecasting tools to Mexico to help facilitate accurate water supply forecasting on both sides of the border.

States Favored Having More Influence on the Use of Federal and Tribal Water Rights as Well as Greater Federal Efforts to Define These Rights

Of the 31 state managers reporting that federal agencies or tribal governments claim or hold water rights (either state granted or federal reserved) in their state, 12 reported that the most helpful potential federal action would be to consult more with the states on federal or tribal use of these rights. Sixteen of these water managers indicated that their state had experienced a conflict within the last 5 years between how a federal agency used its water rights and the state's water management goals. State water managers reported conflicts with 13 different agencies, such as Reclamation, the Forest Service, the Park Service, and the Bureau of Land Management. State managers also described instances of federal agencies challenging state decisions to grant water rights to others. For example:

- In one state, Reclamation challenged the state over ground-water rights it had issued to users because the withdrawals threatened federal surface-water rights.

- Similarly, a tribe sued the same state to stop issuance of ground-water rights potentially impacting water availability for tribal lands. According to state officials, both cases were settled by agreement.

- Another manager reported that the state and a federal agency disagreed on whether a federal lands leaseholder or the federal agency should hold the water right for water held in small storage facilities on federal lands. The court awarded the right to the leaseholder, despite federal concerns over future use of the water on its lands.

According to officials from the federal resource management agencies and Reclamation, the agencies exercise their state-granted water rights in accordance with state water laws and the agencies try to coordinate with the states over their use of water under federal reserved rights. National Park Service, Bureau of Land Management, and Forest Service officials said their agencies typically seek state-granted water rights for offstream uses of water on their lands, such as camp and picnic grounds or livestock watering. Typically, disputes related to federal agency use of state-granted rights are heard in state water courts where the federal agencies receive no preference over any other water right holder. Officials provided several examples of how their agencies work with the states and non-federal water users to minimize disputes. A National Park Service official said his agency seeks to reach mutually acceptable compromises with other water users, even though the other users' rights are often junior to the federal reserved rights. A Bureau of Land Management official said while his agency has federal reserved rights to water in a certain state, the agency also applies

for state rights because the state does not recognize the agency's federal reserved water right.

State water managers also favored increased financial and technical assistance to states to adjudicate water rights (the determination of the legal rights and priorities of all persons for a particular source as of a certain time) for federal agencies and tribal governments. Federal agencies and tribes may be entitled to water rights that would deprive others of water they have been using for many years. Until adjudicated or determined by the courts, the extent of such rights is unknown. Consequently, water managers, particularly those in Western states, are concerned about the unquantified water rights for federal and tribal lands, as well as the costs of quantifying these rights through adjudication. For example, 14 state water managers said quantifying federal reserved water rights is important to their state's ability to manage its water; similarly, 12 state water managers said quantifying tribal water rights is important.

To reduce uncertainty regarding water rights, some western states are conducting general adjudications to formally quantify and order by priority all rights claimed. These adjudications include determinations of federal water rights, which, since the McCarran Amendment was enacted in 1952, have been within the states' jurisdictions.[4] This process of establishing the priority system is complicated and costly, and federal claims are often the largest and most difficult to adjudicate. For example, according to the Western States Water Council, 400 of the 700 claims being adjudicated in the Klamath Basin are federal claims. While all other water users claiming rights must pay filing fees to the state for the adjudication of these rights, the federal government does not, according to a Supreme Court ruling.

[4] Pub. L. No. 82-495, §208, 66 Stat. 549, 560 (1952); see chapter 1, footnote 11, for more information on the McCarran Amendment.

Federal agency officials confirmed that the total quantity of water rights for federal and tribal lands is not known. While state and federal courts have settled some federal claims since the McCarran Amendment was enacted, a substantial majority of tribal and federal water rights have not yet been quantified. Currently, adjudications of tribal, federal, and other parties' water rights are underway in many states.[5] For example, the U.S. Forest Service is participating in 43 adjudications and the National Park Service in 45, according to agency officials. As of March 2003, the Bureau of Indian Affairs reported it has settled 20 water rights cases, but most tribal rights are still unquantified.

According to officials, the federal resource management agencies file claims in accordance with state rules and abide by the results of the state adjudications. However, federal law prohibits the agencies from paying adjudication filing fees. A National Park Service official said it might be preferable to have a compromise between the two extremes of having the federal government pay millions of dollars to adjudicate every one of its water rights and paying nothing. This official notes that adjudications are in the federal interest—having water rights quantified creates more certainty for federal planning and decision-making.

Conclusions

While states have principal authority for water management, federal activities and laws affect or influence virtually every water management activity undertaken by states. With limited supplies and growing demands, state water managers face the challenge of future water shortages and their potentially severe consequences. Although the state managers value the many contributions of federal agencies to their efforts to ensure adequate water supplies, they also indicate that federal activities could better support their efforts in a number of areas. In some of these areas—such as providing funding for more state storage and distribution capacity or more flexibility in how states comply with federal environmental laws—federal agencies are limited in what they can do. However, in other areas—such as seeking increased state input to federal facility operations or enhancing coordination with states—more supportive federal actions may not necessarily involve new authority or significant expenditures. Slight shifts of federal priorities or renewed emphasis on matters that impact state efforts might be sufficient to help states better manage their water

[5] For any water right holder, including federal agencies, participation in adjudication involves submitting a claim for the amount, location, and use of water.

resources. The information we collected from state water managers should be useful to agencies in determining how their activities affect states and how they can be more supportive of state efforts to meet their future water needs. While we are not making a specific recommendation, we encourage Agriculture, Commerce, Energy, Homeland Security, Interior, Corps, and Environmental Protection Agency officials to review the results of our state survey and consider modifications to their plans, policies, or activities as appropriate to better support state efforts to meet their future water needs.

Agency Comments and Our Evaluation

We provided copies of our draft report to the Departments of Agriculture, Commerce, Energy, Homeland Security, and the Interior; the U.S. Army Corps of Engineers, and the Environmental Protection Agency. The Department of the Interior concurred with our findings and wrote that the report provides valuable information to federal agencies for improving interactions with state water managers and will be helpful to state and local resource managers in identifying federal activities and plans that support water management efforts at all levels of government. Interior also provided technical clarifications, which we incorporated as appropriate. Interior's complete letter is in appendix II. The other departments and agencies concurred with our findings and provided technical clarifications, which we incorporated as appropriate. They did not provide formal, written comments.

GAO Analysis of Our Survey of the Effects of Federal Activities on State Water Availability, Management, and Use

To obtain states' views on how federal activities could better support state water management efforts to meet future demands, we conducted a Web-based survey of state water managers in the 50 states. We developed the survey questions by reviewing documents and by talking with officials from the federal agencies listed on pages 42 and 43 and the state water managers in three state offices-Arizona, Illinois, and Pennsylvania. The questionnaire contained 56 questions that asked about state water management; collection and dissemination of state water quantity data by federal agencies; federal water storage and conveyance within their state; the effects of federal environmental laws on state water management; the effects of interstate compacts and international treaties on state water management; and the effects of federal and tribal rights to water on state water management.

To access the Web-based survey and the results for each question go to GAO-03-834SP on the GAO Web site.

Q1. Has your state conducted an assessment of water availability, withdrawals, and/or consumption?

	Checked (percent)	Number of respondents
1. Water availability statewide (most or all regions of your state)	53.2	47
2. Water availability only for some regions or localities within your state	29.8	47
3. Water withdrawals statewide (most or all regions of your state)	76.6	47
4. Water withdrawals only for some regions or localities within your state	10.6	47
5. Water consumption statewide (most or all regions of your state)	51.1	47
6. Water consumption only for some regions or localities within your state	17.0	47
7. None of the above	8.5	47

Q2. Has your state conducted an assessment, either for all of your state or for portions of your state, of the economic and/or environmental effects of water shortages, including drought?

	Checked (percent)	Number of respondents
1. Actual economic effects of recent water shortages, including drought	25.5	47
2. Potential economic effects of future water shortages, including drought	25.5	47

	Checked (percent)	Number of respondents
3. Actual environmental effects of recent water shortages, including drought	17.0	47
4. Potential environmental effects of future water shortages, including drought	23.4	47
5. None of the above	53.2	47

Q3. Which of the following plans does your state have?

	Checked (percent)	Number of respondents
1. Drought preparedness plan(s)	48.9	47
2. Drought response plan(s)	87.2	47
3. State does not have either of the above plans	8.5	47
4. Uncertain about state plans	2.1	47

Q4. Did your state receive federal assistance for the development of its drought preparedness and/or response plan(s)?

Yes (percent)	No (percent)	Uncertain (percent)	Number of respondents
11.9	76.2	9.5	41

Q5. In the next 1-10 years which, if any, portions of your state, are likely to experience water shortages under average water conditions?

Entire state (most, or all, of your state) (percent)	One or more regions within your state (percent)	One or more small localized areas within your state (percent)	None of the above (percent)	Uncertain (percent)	Number of respondents
4.3	34.0	38.3	19.1	4.3	47

Q6. In the next 1-10 years which, if any, portions of your state, are likely to experience water shortages under drought conditions?

Entire state (most, or all, of your state) (percent)	One or more regions within your state (percent)	One or more small localized areas within your state (percent)	None of the above (percent)	Uncertain (percent)	Number of respondents
23.4	61.7	12.8	0.0	2.1	47

Q7. In the next 10-20 years which, if any, portions of your state, are likely to experience water shortages under average water conditions?

Entire state (most, or all, of your state) (percent)	One or more regions within your state (percent)	One or more small localized areas within your state (percent)	None of the above (percent)	Uncertain (percent)	Number of respondents
4.3	44.7	34.0	12.8	4.3	47

Q8. In the next 10-20 years which, if any, portions of your state, are likely to experience water shortages under drought conditions?

Entire state (most, or all, of your state) (percent)	One or more regions within your state (percent)	One or more small localized areas within your state (percent)	None of the above (percent)	Uncertain (percent)	Number of respondents
25.5	68.1	4.3	0.0	2.1	47

Q9. Which, if any, of the following actions are being taken by your state government and/or by regional or local authorities to address current and future water needs in your state?

	Checked (percent)	Number of respondents
1. Developing markets to allow voluntary water transfers among users	31.9	47
2. Developing new water supplies through reuse of reclaimed water	48.9	47
3. Developing new water supplies through recycling of storm water	10.6	47
4. Developing new water supplies using desalination (seawater or brackish ground water)	19.1	47
5. Encouraging, requiring, and/or providing incentives for water conservation	85.1	47
6. Improving vegetation management along streams and rivers to increase stream flow	42.6	47
7. Improving riparian buffers to enhance water quality and increase water quantity	70.2	47
8. Increasing storage capacity, including surface storage reservoirs or artificial groundwater recharge	63.8	47
9. Managing surface and ground water together (conjunctive management) so that these sources can be used in combination or alternately	80.9	47
10. Monitoring water availability and withdrawals within the state	93.6	47
11. Pursuing water price restructuring	29.8	47
12. Requiring local water agencies to conduct water availability assessments before approving new development or changes in land use	29.8	47
13. Using cloud seeding to induce precipitation where it might not occur naturally, or in greater quantities than might occur naturally	17.0	47
14. Using inter-basin transfer of water	59.6	47
15. Other actions being taken to address water needs (Please specify below.)	34.0	47

If answer 15 is checked (in Q9 above), please provide a brief description (of other actions being taken to address your state's water needs).

Providing description (percent)	Number of respondents
100	16

Q10. In general, what is the legal doctrine used by your state to govern the allocation of surface water?

Prior appropriation (percent)	Common-law riparian (percent)	Regulated riparian (percent)	A combination of prior appropriation and riparian (percent)	State does not regulate surface water allocation (percent)	Other (percent)	Uncertain (percent)	Number of respondents
31.9	14.9	19.1	6.4	4.3	21.3	2.1	47

If 'other' is checked (in Q10 above), please describe how your state governs the allocation and use of surface water.

Providing description (percent)	Number of respondents
100	10

Q11. In general, what is the legal doctrine used by your state to govern the allocation of ground water?

Correlative rights (percent)	Reasonable use (percent)	Prior appropriation (percent)	Absolute ownership (percent)	State does not regulate ground water allocation (percent)	Other (percent)	Uncertain (percent)	Number of respondents
6.4	38.3	25.5	2.1	6.4	19.1	2.1	47

If 'other' is checked (in Q11 above), please describe how your state governs the allocation and use of ground water.

Providing description (percent)	Number of respondents
100	9

Q12. Overall, about how much of your state's data on water availability and withdrawals is provided by federal agencies?

	Little or none (percent)	Less than half (percent)	About half (percent)	More than half (percent)	All or almost all (percent)	Uncertain (percent)	Number of respondents
a. Data on ground water availability	26.7	40.0	11.1	11.1	11.1	0.0	45
b. Data on ground water withdrawals	59.6	27.7	4.3	8.5	0.0	0.0	47
c. Data on surface water availability	13.0	10.9	28.3	30.4	15.2	2.2	46
d. Data on surface water withdrawals	63.8	21.3	6.4	6.4	2.1	0.0	47

Q13. Please provide the name(s) of the federal agency(ies) that provide water availability and/or withdrawal data to you.

Provided agency name(s) (percent)	Number of respondents
89.4	47

Q14. Overall, how important are data provided by federal agencies to your state's ability to complete each of the following activities?

	Very important (percent)	Somewhat important (percent)	Equally important and unimportant (percent)	Somewhat unimportant (percent)	Very unimportant (percent)	Number of respondents
a. To determine the quantity of available ground water	34.9	34.9	16.3	9.3	4.7	43
b. To determine the quantity of ground water withdrawals	13.2	15.8	18.4	28.9	23.7	38
c. To determine the quantity of available surface water	53.3	28.9	13.3	0.0	4.4	45
d. To determine the quantity of surface water withdrawals	8.1	18.9	21.6	27.0	24.3	37
e. To determine the quantity of consumptive water use	10.3	12.8	25.6	25.6	25.6	39
f. To assess the economic effects of water withdrawals	3.8	15.4	23.1	23.1	34.6	26
g. To assess the environmental effects of water withdrawals	17.5	32.5	15.0	25.0	10.0	40
h. To plan environmental mitigation or restoration	27.0	32.4	18.9	16.2	5.4	37
i. To monitor the terms of water allocation agreements that distribute water among multiple parties (such as states)	35.5	22.6	6.5	12.9	22.6	31

Q15. What type(s) of water quantity data, not currently being collected by the federal government, would be most useful in helping your state with its water management?

Providing answer (percent)	Number of respondents
74.5	47

Q16. Which actions, with respect to federal collection and dissemination of data, would be most useful to your state? Rank each of the following actions from most useful (1st) to least useful (6th).

	Mean Ranking	Number of respondents
a. Collect data at more locations	1.3	45
b. Improve the accuracy of data currently being collected	3.8	45
c. Improve the timeliness of dissemination	3.3	45
d. Improve access to data previously collected (for example, historical)	3.8	45
e. Provide data in a more usable format	4.4	45
f. Provide more analyses of data	4.3	45

Q17. Are there other actions federal agencies could take to improve their collection and dissemination of water quantity data?

Providing answer (percent)	Number of respondents
57.4	47

Q18. How much of your state's water is stored using facilities constructed, operated, or maintained by the federal government?

Little or none (percent)	Less than half (percent)	About half (percent)	More than half (percent)	All or almost all (percent)	Uncertain (percent)	Number of respondents
36.2	23.4	8.5	25.5	2.1	4.3	47

Q19. How likely is it that your state will add storage capacity within the next 10 years?

Very likely (percent)	Somewhat likely (percent)	Equally likely and unlikely (percent)	Somewhat unlikely (percent)	Very unlikely (percent)	Uncertain (percent)	Number of respondents
36.2	19.1	10.6	12.8	21.3	0.0	47

Q20. Has your state estimated the cost to add storage capacity?

Yes (percent)	No (percent)	Uncertain (percent)	Number of respondents
27.7	57.4	14.9	47

Q21. Does your state plan to seek federal assistance for the addition of storage capacity?

Definitely yes (percent)	Probably yes (percent)	Probably no (percent)	Definitely no (percent)	Uncertain (percent)	Number of respondents
23.9	30.4	23.9	4.3	17.4	46

Q22. What activities have federal agencies participated in during the past 5 years with respect to non-federal storage infrastructure in your state?

	Checked (percent)	Number of respondents
1. Planning of facilities	29.8	47
2. Reviewing plans for facilities	29.8	47
3. Operating and/or maintaining facilities	17.0	47
4. Constructing facilities	12.8	47
5. None of these activities	31.9	47
6. Uncertain	23.4	47

Q23. Within the last 5 years, has your state requested that a federal agency modify its operation of a federal storage facility to better meet the state's water management goals?

Yes, many times (percent)	Yes, a few times (percent)	Yes, but only once or twice (percent)	No (percent)	Our state does not have any federal storage facilities (percent)	Uncertain (percent)	Number of respondents
23.4	23.4	14.9	23.4	8.5	6.4	47

If 'yes' is checked (in Q23 above), please provide some examples of the types of changes requested and the agencies that you requested make the changes.

Providing examples (percent)	Number of respondents
86.2	29

Q24. How much of your state's water is conveyed using facilities (for example, an aqueduct or canal) constructed, operated, or maintained by the federal government?

Little or none (percent)	Less than half (percent)	About half (percent)	More than half (percent)	All or almost all (percent)	Uncertain (percent)	Number of respondents
68.1	19.1	2.1	8.5	0.0	2.1	47

Q25. How likely is it that your state will add conveyance capacity within the next 10 years?

Very likely (percent)	Somewhat likely (percent)	Equally likely and unlikely (percent)	Somewhat unlikely (percent)	Very unlikely (percent)	Uncertain (percent)	Number of respondents
25.5	12.8	2.1	10.6	36.2	12.8	47

Q26. Has your state estimated the cost to add conveyance capacity?

Yes (percent)	No (percent)	Uncertain (percent)	Number of respondents
19.1	74.5	6.4	47

Q27. Does your state plan to seek federal assistance for the addition of conveyance capacity?

Definitely yes (percent)	Probably yes (percent)	Probably no (percent)	Definitely no (percent)	Uncertain (percent)	Number of respondents
19.1	12.8	40.4	6.4	21.3	47

Q28. What activities have federal agencies participated in during the past 5 years with respect to non-federal conveyance infrastructure in your state?

	Checked (percent)	Number of respondents
1. Planning of facilities	29.8	47
2. Reviewing plans for facilities	31.9	47
3. Operating and/or maintaining facilities	4.3	47
4. Constructing facilities	10.6	47
5. None of these activities	44.7	47
6. Uncertain	17.0	47

Q29. Has the lack of maintenance (e.g., repair or rehabilitation) of federal storage or conveyance facilities reduced water availability in your state within the last 5 years?

Yes, many times (percent)	Yes, a few times (percent)	Yes, but only once or twice (percent)	No (percent)	Our state does not have any federal storage or conveyance facilities (percent)	Uncertain (percent)	Number of respondents
6.4	0.0	8.5	53.2	14.9	17.0	47

If 'yes' is checked (in Q29 above), please provide example(s) of poor maintenance and how it affected water availability in your state.

Providing examples (percent)	Number of respondents
85.7	7

Q30. Which actions would be most useful in helping your state meet its water management goals with respect to the storage and conveyance of water? Rank each of the following actions from most useful (1st) to least useful (6th).

	Mean Ranking	Number of respondents
a. Improve the maintenance of federal facilities	4.8	44
b. Increase federal technical assistance for the planning, construction, operation, or maintenance of state storage and conveyance infrastructure	3.5	44
c. Increase federal financial assistance for the planning and construction of state storage and conveyance infrastructure	1.9	44
d. Increase federal financial assistance for the operation and maintenance of state storage and conveyance infrastructure	3.4	44
e. Seek more state input in operation of federal storage facilities	3.4	44
f. Streamline federal review processes of proposed state storage and conveyance facilities	4.0	44

Q31. Are there other actions federal agencies could take to improve their participation in the planning, review, construction, operation, and/or maintenance of federal water storage and conveyance infrastructure?

Providing answer (percent)	Number of respondents
44.7	47

Q32. What effect has each of the federal laws listed below had on water availability, for in-stream purposes, in your state within the past 5 years?

	Greatly increased water availability (percent)	Somewhat increased water availability (percent)	Had no effect on water availability (percent)	Somewhat decreased water availability (percent)	Greatly decreased water availability (percent)	Uncertain (percent)	Number of respondents
a. Clean Water Act	14.9	38.3	29.8	6.4	0.0	10.6	47
b. Coastal Zone Management Act	2.5	15.0	65.0	2.5	0.0	15.0	40
c. Endangered Species Act	0.0	34.0	27.7	14.9	4.3	19.1	47
d. Federal Power Act	2.2	24.4	33.3	15.6	0.0	24.4	45
e. Fish and Wildlife Coordination Act	0.0	21.7	37.0	8.7	2.2	30.4	46
f. Rivers and Harbors Appropriation Act	0.0	7.3	56.1	7.3	0.0	29.3	41
g. Safe Drinking Water Act	6.4	19.1	44.7	14.9	0.0	14.9	47
h. Wild and Scenic Rivers Acts	0.0	10.9	56.5	6.5	4.3	21.7	46
i. Wilderness Act	0.0	2.2	68.9	2.2	2.2	24.4	45

Q33. What effect has each of the federal laws listed below had on water availability, for off-stream purposes, in your state within the past 5 years?

	Greatly increased water availability (percent)	Somewhat increased water availability (percent)	Had no effect on water availability (percent)	Somewhat decreased water availability (percent)	Greatly decreased water availability (percent)	Uncertain (percent)	Number of respondents
a. Clean Water Act	6.5	17.4	23.9	37.0	2.2	13.0	46
b. Coastal Zone Management Act	0.0	7.7	64.1	10.3	0.0	17.9	39
c. Endangered Species Act	0.0	2.2	26.1	50.0	6.5	15.2	46
d. Federal Power Act	0.0	8.9	40.0	22.2	0.0	28.9	45
e. Fish and Wildlife Coordination Act	0.0	2.3	32.6	30.2	2.3	32.6	43
f. Rivers and Harbors Appropriation Act	0.0	4.9	56.1	7.3	2.4	29.3	41
g. Safe Drinking Water Act	8.7	19.6	43.5	10.9	2.2	15.2	46
h. Wild and Scenic Rivers Act	0.0	2.3	52.3	18.2	4.5	22.7	44
i. Wilderness Act	0.0	0.0	66.7	2.4	2.4	28.6	42

Q34. Which actions would be most useful in helping your state fulfill the requirements of federal environmental laws while meeting its water management goals? Rank each of the following actions from most useful (1st) to least useful (4th).

	Mean Ranking	Number of respondents
a. Charge for the use of water from federal storage and conveyance facilities and use funds to help mitigate damage to environment from projects	4.0	46
b. Give the states more flexibility in compliance or administration of federal environmental laws	1.8	46
c. Improve coordination among federal agencies in implementing environmental laws	2.5	46
d. Seek more state input into development, revision and implementation of federal environmental laws	1.8	46

Q35. Are there other actions federal agencies could take to help your state fulfill the requirements of federal environmental laws?

Providing answer (percent)	Number of respondents
40.4	47

Q36. Does your state participate in an interstate compact or international treaty to allocate water among multiple parties?

Yes (percent)	No (percent)	Uncertain (percent)	Number of respondents
61.7	36.2	2.1	47

Q37. About how much of your state's water is affected by an interstate compact and/or international treaty?

Little or none (percent)	Less than half (percent)	About half (percent)	More than half (percent)	All or almost all (percent)	Uncertain (percent)	Number of respondents
20.7	44.8	0.0	31.0	3.4	0.0	29

Q38. Within the last 5 years, have any federal agencies participated in the development, implementation or enforcement of an interstate compact affecting water availability in your state?

	Checked (percent)	Number of respondents
1. Federal agency or agencies have participated in the development of an interstate compact(s)	17.2	29
2. Federal agency or agencies have participated in the implementation of an interstate compact(s)	58.6	29
3. Federal agency or agencies have participated in the enforcement of an interstate compact(s)	31.0	29
4. None of the above	17.2	29

Q39. Within the last 5 years, have any federal agencies participated in the development, implementation or enforcement of an international treaty affecting water availability in your state?

	Checked (percent)	Number of respondents
1. Federal agency or agencies have participated in the development of an international treaty(ies)	13.8	29
2. Federal agency or agencies have participated in the implementation of an international treaty(ies)	27.6	29
3. Federal agency or agencies have participated in the enforcement of an international treaty(ies)	27.6	29
4. None of the above	55.2	29

Q40. Within the last 5 years, have federal agencies participating in the development, implementation, or enforcement of an interstate compact(s) and/or international treaty(ies) affecting water allocation fulfilled their responsibilities?

All agencies have fulfilled all responsibilities (percent)	One or more agencies have not fulfilled their responsibilities (percent)	Uncertain (percent)	Number of respondents
50.0	26.9	23.1	26

If 'one or more agencies' is checked (in Q40 above), please specify the agency(ies) and briefly describe how often responsibilities have not been fulfilled.

Providing answer (percent)	Number of respondents
100	7

Q41. Does your state plan to propose, negotiate, or participate in a new interstate compact or international treaty within the next 5 years?

Definitely yes (percent)	Probably yes (percent)	Probably no (percent)	Definitely no (percent)	Uncertain (percent)	Number of respondents
13.8	24.1	37.9	13.8	10.3	29

Q42. Which actions would be most useful in helping your state with respect to the development, enforcement, and implementation of interstate compacts and international treaties? Rank order each of the following actions from most useful (1st) to least to the least useful (6th).

	Mean Ranking	Number of respondents
a. Better coordinate federal participation with the state	2.6	28
b. Better coordinate participation among federal agencies	2.8	28
c. Create a market-based allocation system for water shared by states	5.3	28
d. Develop alternative tools for resolving water allocation conflicts among states	3.0	28
e. Increase technical assistance to assist the states with development or implementation	2.8	28
f. Make it easier to amend or revise existing agreements	4.5	28

Q43. Are there other actions that would be useful in helping your state with respect to the development, enforcement, and implementation of interstate compacts and international treaties?

Providing answer (percent)	Number of respondents
41.4	29

Q44. Do any federal agencies hold or claim water rights in your state?

Yes	No	Uncertain	Number of respondents
51.1	31.9	17.0	47

Q45. Currently, about how much of your state's water is allocated to fulfill federal water rights?

Little or none (percent)	Less than half (percent)	About half (percent)	More than half (percent)	All or almost all (percent)	Uncertain (percent)	Number of respondents
50.0	37.5	0.0	4.2	0.0	8.3	24

Q46. If all federal claims to water in your state were quantified, about how much of your state's water would be allocated to fulfill these rights?

Little or none (percent)	Less than half (percent)	About half (percent)	More than half (percent)	All or almost all (percent)	Uncertain (percent)	Number of respondents
37.5	29.2	4.2	4.2	4.2	20.8	24

Q47. How important is the quantification of federal water rights to your state's ability to manage its water?

Very important (percent)	Somewhat important (percent)	Equally important and unimportant (percent)	Somewhat unimportant (percent)	Very unimportant (percent)	Uncertain (percent)	Number of respondents
29.2	29.2	12.5	12.5	16.7	0.0	24

Q48. Within the last five years, has your state experienced any conflict between how a federal agency employed its water rights and your state's water management goals?

Yes, many times (percent)	Yes, a few times (percent)	Yes, but only once or twice (percent)	No, our state has not experienced any conflict (percent)	Uncertain (percent)	Number of respondents
13.6	40.9	18.2	27.3	0.0	22

If 'yes' is checked (in Q48 above), please specify the agency(ies).

Providing answer (percent)	Number of respondents
93.8	16

Q49. Do any tribal governments hold or claim water rights in your state?

Yes (percent)	No (percent)	Uncertain (percent)	Number of respondents
52.2	41.3	6.5	46

Q50. Currently, about how much of your state's water is allocated to fulfill tribal water rights?

Little or none (percent)	Less than half (percent)	About half (percent)	More than half (percent)	All or almost all (percent)	Uncertain (percent)	Number of respondents
73.9	26.1	0.0	0.0	0.0	0.0	23

Q51. If all tribal claims to water in your state were quantified, about how much of your state's water would be allocated to fulfill these rights?

Little or none (percent)	Less than half (percent)	About half (percent)	More than half (percent)	All or almost all (percent)	Uncertain (percent)	Number of respondents
45.8	25.0	0.0	4.2	4.2	20.8	24

Q52. How important is the quantification of tribal water rights to your state's ability to manage its water?

Very important (percent)	Somewhat important (percent)	Equally important and unimportant (percent)	Somewhat unimportant (percent)	Very unimportant (percent)	Uncertain (percent)	Number of respondents
37.5	12.5	12.5	8.3	25.0	4.2	24

Q53. Within the last five years, has your state experienced any conflict between how a tribal government employed its water rights and the state's water management goals?

Yes, many times (percent)	Yes, a few times (percent)	Yes, but only once or twice (percent)	No, our state has not experienced any conflict (percent)	Uncertain (percent)	Number of respondents
4.3	26.1	21.7	39.1	8.7	23

If 'yes' is checked (in Q53 above), please specify the tribal government(s).

Writing comment (percent)	Number of respondents
83.3	12

Q55. Which actions would be most useful in helping your state fulfill federal and tribal rights to water while meeting your state's water management goals? Rank each of the following actions from most useful (1st) to least useful (6th).

	Mean Ranking	Number of respondents
a. Better coordinate participation among federal agencies in the establishment and use of federal or tribal water rights	3.0	25
b. Clarify federal policy on tribal governments' authority to sell water rights	4.1	25
c. Improve the efficiency of water use, including increasing conservation when applicable, on federal and tribal lands	4.7	25
d. Increase financial and technical assistance to states for adjudication of federal and tribal water rights	2.9	25
e. Seek more state input into the use of federal or tribal water rights and potential effects on state water management goals	2.2	25
f. Streamline federal processes to quantify federal or tribal water rights	4.1	25

Q56. Are there other actions that federal agencies could take to help your state fulfill federal and tribal rights to water while meeting your state's water management goals?

Providing answer (percent)	Number of respondents
38.7	31

Additional Comments: If you would like to make additional comments concerning any topic related to water availability, management, or use, please feel free to do so in the space provided.

Providing answer (percent)	Number of respondents
36.2	47

Note: Question 54 was not included because it was used only for navigation purposes in the Web-based questionnaire.

Comments from the Department of the Interior

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

JUN 10 2003

Mr. Barry T. Hill
Director, Natural Resources and Environment Team
U.S. General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Hill:

Thank you for providing the Department of the Interior (DOI) the opportunity to review and comment on the draft U.S. General Accounting Office (GAO) report entitled, "FRESHWATER SUPPLY: States' View of How Federal Agencies Could Help Them Meet the Challenges of Expected Shortages," (GAO-03-514) dated May 8, 2003. In general, we agree with the findings and the recommendations in the report.

The report appears to be accurate and represents a substantial effort on the part of the GAO staff involved in the review. We acknowledge the critical need for Federal-state partnerships in addressing the national challenge of ensuring adequate water supplies for all of our citizens. The report provides valuable information to Federal agencies for improving interactions with state water managers in addressing existing and potential water shortages across the country. The report will be helpful also to state and local resource managers in identifying Federal activities and plans that support water management efforts at all levels of Government. Finally, we are confident that information contained in this report will be of great value to Congressional committees in their deliberations on national water policy issues.

The enclosure provides specific comments from the U.S. Fish and Wildlife Service, U.S. Geological Survey, National Park Service, and the DOI's Office of Budget. We hope our comments will assist you in preparing the final report.

Sincerely,

P. Lynn Scarlett
Assistant Secretary - Policy,
Management and Budget

Enclosure

GAO Contacts and Staff Acknowledgments

GAO Contacts

Barry T. Hill (202) 512-3841
Keith Oleson (415) 904-2218

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