14868 ~~14858~~ ~~14891~~

BY THE COMPTROLLER GENERAL 113294

Report To The Congress

OF THE UNITED STATES

Ground Water Overdrafting Must Be Controlled

Many areas of the Nation suffer from problems caused by ground water overdrafting--the extracting of more ground water than will be replenished over a long period of time. Overdrafting can cause

--land subsidence,

--saltwater intrusion into freshwater aquifers,

--reduced surface water flows,

--increased energy consumption, and

--disruption of social and economic activities.

GAO recommends that the Congress direct the Departments of Agriculture, the Army, and the Interior to require that affected States and communities implement or have plans to implement a program for controlling ground water pumping and a conservation program before the start of federally funded water resources or ground water mitigation projects.

UNITED STATES GENERAL ACCOUNTING OFFICE

CED-80-96
SEPTEMBER 12, 1980

For sale by:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

Telephone (202) 783-3238

Members of Congress; heads of Federal, State, and local government agencies; members of the press; and libraries can obtain GAO documents from:

U.S. General Accounting Office
Document Handling and Information
Services Facility
P.O. Box 6015
Gaithersburg, Md. 20760

Telephone (202) 275-6241

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-199994

To the President of the Senate and the
Speaker of the House of Representatives

This report describes the numerous problems associated with ground water overdrafting in many areas of the Nation and discusses the need for the Federal Government to discourage continued uncontrolled overdrafting.

We made our review to determine the seriousness of the overdrafting problems in States and communities that have not implemented ground water controls. The information in this report may be useful to the Congress in considering the authorization of future water resources projects.

We are sending copies of the report to appropriate House and Senate committees; representatives and senators from States mentioned in the report; the Director, Office of Management and Budget; and the heads of departments and agencies concerned with water or energy. We will also make copies available to interested organizations as appropriate and to others upon request.

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

GROUND WATER OVERDRAFTING MUST BE CONTROLLED

D I G E S T

The demand for water in many areas of the Nation is being met by overdrafting ground water--extracting more ground water than will be replenished over a long period of time. Presently, ground water supplies about 20 percent of all freshwater used in the United States.

Overdrafting is not necessarily bad; it can be employed temporarily during droughts without serious consequences. But when it continues indefinitely, the resulting problems may ultimately affect the Nation's ability to meet ever-increasing demands for food and other agricultural products.

PROBLEMS CAUSED BY OVERDRAFTING

Overdrafting is most serious in the arid and semiarid Western States where irrigation of crops accounts for over half of all ground water use. Several problems can result from overdrafting.

When large amounts of water are extracted from underground, surface and subsurface soils tend to compact and settle. Subsidence caused by overdrafting has caused millions of dollars in damage to surface structures in Arizona, California, and Texas. (See p. 3.)

In coastal areas where ground water levels are lowered by overdrafting, the normal flow of freshwater to the ocean is reversed. Saltwater moves into areas where only freshwater previously existed. In inland aquifers, intrusion may occur when saltwater migrates vertically and horizontally into freshwater aquifers. Even a small amount of saltwater can seriously impair the future use of an aquifer as a water supply source. The Environmental Protection Agency reported in

CED-80-96

1973 that 42 of the 50 States have reported significant saltwater intrusion problems. Florida, California, and Texas are the most seriously affected States. (See p. 4.)

In some areas surface streams and rivers are geologically interrelated with the underlying ground water aquifers. Extracting ground water in such areas may reduce surface flows which have already been legally committed to surface water users. Colorado and New Mexico have been faced with this situation. (See p. 6.)

When a ground water aquifer is continually overdrafted, the level of the aquifer declines and more energy is required to pump the water from greater depths. Increased energy consumption is a problem experienced by ground water users in all areas of the Nation where overdrafting occurs. (See p. 7.)

When ground water is depleted by overdrafting in areas where surface supplies are inadequate or unavailable, agricultural land must be dry farmed--watered only by precipitation--or abandoned. Such occurrences directly affect agriculture and related industries, resulting in local recession, economic and social dislocation, and a general weakening of important sectors of the national economy. Ultimately, the Nation's ability to provide food and other agricultural products may be affected. (See pp. 7 to 10.)

GROUND WATER MANAGEMENT

The President's water policy statement of June 1978 noted that the States should manage water resources, and a Presidential memorandum of July 1978 emphasized that the States are principally responsible for protecting streams and preventing ground water depletion. Federal agencies have assisted State and local water managers through data gathering and research.

Ground water management is generally aimed at regulating ground water withdrawals and

water use. More intensive management generally occurs only after a locality has been faced with ground water overdraft problems.

Some States, such as Colorado, New Mexico, and Florida, have generally succeeded in controlling overdraft of their underground aquifers. Their success is attributable to (1) laws restricting the amount of ground water which can be pumped from a ground water basin and (2) water conservation programs. However, other States--for example, California and Arizona--currently impose little if any control on the use of ground water and both States suffer serious overdraft problems.

FEDERAL INVOLVEMENT

The Federal Government directly manages ground water resources only on Federal lands. However, it has assisted States with overdraft problems by constructing multipurpose water development projects to replace or supplement ground water. Examples are the Central Arizona Project ($1.5 billion) and the Central Valley Project, California ($3.5 billion).

RECOMMENDATION TO THE CONGRESS

GAO recommends that the Congress direct the Departments of the Interior, Agriculture, and the Army to require, before start of construction on any water resources or ground water depletion mitigation project, that the affected State or community implement or have specific plans to implement

--a program or some means for controlling ground water pumping and

--a water conservation program.

GAO recognizes that because of the uniqueness of local ground water situations, determination of compliance must be made on a case-by-case basis.

AGENCY COMMENTS AND GAO's EVALUATION

The Department of the Interior, which is responsible for the construction of some of the Nation's largest and most costly Federal water resources projects, disagreed with GAO's draft report. It believes the report is based on a misunderstanding of ground water principles and an oversimplification of the problems. Interior further believes the recommendation is vague. The Department of the Army, which is also responsible for water resources construction projects, said the report presented an overall assessment of the problem in a reasonable and accurate manner. However, it expressed reservations as to the effectiveness of the recommendation. California, Colorado, New Mexico, and Arizona--some of the States most affected by overdrafting--generally agreed with the report and provided some technical comments. (See apps. IV to VII.)

GAO's analysis was based on several well-documented overdraft cases in various areas of the Nation. Its recommendations are based on the fact that those States and communities that have succeeded somewhat in reducing overdraft problems have done so by controlling ground water pumping and by implementing water conservation programs. (See pp. 25 and 26.)

Contents

ABBREVIATIONS

GAO	General Accounting Office
OWRT	Office of Water Research and Technology
USGS	U.S. Geological Survey

CHAPTER 1

INTRODUCTION

Our water supply has two primary sources--surface water and underground supplies. Surface water comes from rivers, streams, lakes, and ponds. Ground water comes from subsurface reservoirs called aquifers, which can store nearly 20 times the volume of the Nation's surface water. Ground water provides about 20 percent of the water used in the United States. Dependence on ground water, however, varies from locality to locality. For instance, ground water provides 62 percent of the total water used in Arizona but only 2 percent in Montana.

Because of its characteristic good quality, ground water is an important drinking water source. About 80 percent of this country's municipal water systems are supplied by ground water wells. These systems serve about 30 percent of the U.S. population. Another 10 million families have individual well systems. Ground water is the water source for nearly all of this country's rural population.

The greatest use of ground water, however, is for irrigated agriculture, primarily in the arid and semiarid Western States. Texas and California are the largest users of ground water. In 1970 the amount of ground water withdrawn in California was about 20.5 million acre-feet, 1/ of which about 18 million acre-feet were for irrigation. In 1970 Texas withdrew about 10.3 million acre-feet of ground water, of which 8.8 million acre-feet were for irrigation.

OVERDRAFT OF GROUND WATER AQUIFERS

Population growth, municipal and industrial expansion, recreation, power generation, environmental concerns, and agriculture all compete for a share of the Nation's water supply. Many areas of the country do not have enough water for all of their demands. In many instances the difference between supply and demand is being met by overdrafting ground water aquifers.

Overdrafting is the extraction of ground water in excess of the net recharge 2/ of the aquifer over a long period of

---

1/The amount of water needed to cover 1 acre of ground to a depth of 1 foot.

2/Recharge is the addition of water to the aquifer by natural or artificial processes.

wet and dry years constituting a climatic cycle. Overdrafting is not necessarily bad. It can be temporarily employed by water resources managers to mitigate the impacts of a drought, or it can be employed as a basis for economic development as long as alternative surface supplies can eventually be obtained to sustain the economic development.

However, if continued indefinitely, overdrafting can deplete an aquifer and may ultimately result in serious economic and social consequences. Overdrafting is most serious in Arizona, California, New Mexico, Texas, Oklahoma, Colorado, Nebraska, and Kansas.

SCOPE AND METHODOLOGY

We discussed ground water overdrafting with Federal, State, and local officials who have dealt with ground water management problems. Specifically, we talked to officials of the Department of Agriculture, the Department of the Interior's Water and Power Resources Service, and the Corps of Engineers of the Department of the Army; and State officials from Arizona, California, Colorado, Florida, Maryland, New Mexico, and Utah. For local perspectives on the issue, we contacted officials at the Orange County Water District (California), Public Service Company of New Mexico, Santa Clara Valley Water District (California), Southwest Florida Water Management District, and Westlands Water District (California). We solicited the views of agricultural economists who have studied the effects of overdrafting at Oklahoma State University, Texas A&M University, Texas Tech, and the University of California (Davis). We also solicited the views of water law experts at the University of Arizona and the University of Florida.

This study is primarily based on our past reviews; 1/ discussions with academicians and Federal, State, and local government officials; and various government reports.

1/"Ground Water: An Overview" (CED-77-69, 6-21-77) and "Better Water Management and Conservation Possible--But Constraints Need To Be Overcome" (CED-79-1, 10-31-78).

CHAPTER 2

PROBLEMS ASSOCIATED WITH GROUND WATER OVERDRAFTING

Effects of overdrafting vary from one area to another depending on geological and hydrological conditions. Continued long-term overdrafting, however, generally results in one or more of the following problems: (1) land subsidence, (2) saltwater intrusion, (3) reduced flow of surface streams and rivers, (4) increased energy consumption, and (5) social and economic disruption.

LAND SUBSIDENCE

Land subsidence occurs when large amounts of water (or other liquids such as petroleum) are extracted from underground aquifers, leaving a void into which the surrounding surface and subsurface soils tend to compact and settle. In California, Texas, and Arizona land subsidence has already caused costly structural damage, reduced property values, and made areas more vulnerable to floods.

California

California, the Nation's largest user of ground water, will overdraft an estimated 2.5 million acre-feet of ground water in 1980. In the same year, water users are expected to overdraft about 1.7 million acre-feet in the intensively irrigated San Joaquin Valley alone. As a result of past overdrafting, over 5,000 square miles of land in the valley has already sunk as much as 29 feet. Because of legal, institutional, and physical constraints, California has been unable to solve this problem.

The Delta Mendota Canal is an example of subsidence damage in the San Joaquin Valley. The Water and Power Resources Service had to restore the canal to its original design capability after substantial damage resulted from land subsidence. Between June 1975 and September 1976, the Resources Service awarded six contracts totaling about $3.7 million for rehabilitating federally constructed water projects in the valley. The largest contract was awarded on October 24, 1975, for about $2 million; another contract for about $1.5 million was awarded on November 4, 1975. The contracts were for rehabilitation on 25 miles of the canal.

Texas

Texas, the Nation's second largest user of ground water, has a serious subsidence problem covering a 3,000-square-mile area. In the Houston-Galveston area, subsidence has cracked buildings, disrupted pavements, and caused damage to well casings and submergence of coastal lowlands. The Army Corps of Engineers reported that at high tide seawater from Galveston Bay flows through a residential area near Houston because the area has sunk about 8 feet since 1945. Some homes have already been abandoned in one of the area's subdivisions. In response to a recommendation by the Corps of Engineers, the Congress authorized (Public Law 94-587, dated October 22, 1976) the expenditure of $15,680,000 to buy out homeowners and convert the area into a park.

Arizona

Arizona, the Nation's sixth largest user of ground water, overdrafts more than 2 million acre-feet of ground water per year. Extensive overdrafting caused a 120-square-mile area between Phoenix and Tucson to subside more than 7 feet between 1952 and 1977. Subsidence has damaged highways, railroads, utilities, irrigation storage and distribution systems, sewage disposal facilities, recreation facilities, and private residences. While actual dollar losses have been small because the area is thinly populated, more extensive losses are possible because of continuing urban development.

SALTWATER INTRUSION

Saltwater intrusion is the movement of saline water into freshwater aquifers. Most intrusion is caused by (1) withdrawing freshwater faster than it is replaced by nature or reducing the amount of freshwater going into the aquifer, which allows saline water to move into an area where only freshwater previously existed, (2) destroying natural barriers that formerly separated bodies of fresh and saline waters, or (3) disposing of waste saline water. The Environmental Protection Agency has reported that most coastal areas of the Nation have experienced significant saltwater intrusion problems.

Seawater intrusion of coastal aquifers

Under natural conditions, fresh ground water in coastal aquifers is discharged into the ocean at or seaward of the coastline and a balance exists between the fresh ground water and saltwater pressing in from the sea. When ground water levels are lowered by overdrafting, natural drainage, or

the impediment of natural recharge by construction or other activities, the freshwater flow to the ocean is reduced. The saltwater then tends to underride the less dense freshwater and thus may move into areas where only freshwater previously existed.

A small amount of intrusion can seriously affect an aquifer's use as a water supply source. Because of the high salt content of seawater, as little as 2 percent of it mixed with fresh ground water can make a portion of an aquifer unusable under current drinking water standards.

Coastal aquifers can also be contaminated by landward migration of seawater into rivers and streams. Reduction of streamflow or deepening of channels may allow the seawater to move inland.

Saline water intrusion of inland aquifers

Large quantities of saline water exist in the United States. Most of the Nation's largest sources of fresh ground water are in close proximity to natural bodies of saline ground water. Intrusion may occur when saline water migrates vertically or horizontally into freshwater aquifers due to man-induced changes in the hydrologic pressure or when saline water is transferred vertically through wells.

Severity of the problem

Saltwater intrusion is a problem in all coastal areas and is widespread in inland areas. Forty-two States have reported significant saltwater intrusion problems. The seriousness of the problem usually depends on the degree of urban and industrial development; heavy development leads to increased withdrawal of ground water. Florida is the most seriously affected State, followed by California, Texas, New York, and Hawaii.

The movement of poor quality water into freshwater supplies is generally considered a more serious problem than ground water depletion. Because of the relatively slow movement of ground water, saltwater intrusion may harm water quality for years under the most favorable circumstances, or many decades in other cases. For example, wells may have to be abandoned even though ample supplies of water are in the aquifer. Declining water tables may stabilize or rise if pumping is reduced, but dissolved contaminants may be difficult or impossible to remove.

REDUCED FLOW OF SURFACE STREAMS AND RIVERS

In some areas ground water aquifers supply water to surface streams and rivers. Extracting ground water in such an area may reduce surface water supplies that have already been legally committed to surface water users.

New Mexico and Colorado

New Mexico and Colorado have the problem of reduced surface flows. For example, in 1956 the State Engineer of New Mexico declared the Rio Grande River Basin a critical ground water area and closed the basin to additional water users. Proposed agricultural development threatened to reduce the flow of the Rio Grande, a flow already fully committed to surface water users. However, agricultural interests and expanding communities opposed the State Engineer, and the State Legislature attempted to reverse the closure. The State Supreme Court in 1963 supported the State Engineer's action. Current State policy requires the purchase and retirement of sufficient surface rights before additional ground water can be extracted.

New Mexico has been flexible in accommodating requests by additional water users. For example, the Public Service Company of New Mexico, which supplies water for Santa Fe, needs additional water. Around 1970 the State Engineer approved the company's proposed withdrawal of ground water from the Rio Grande Basin on the condition that it offset the potential effect on streamflow by (1) importing surface water to the Rio Grande Basin or (2) purchasing and retiring surface water rights. The company decided to import water from the Federal San Juan-Chama Project, which is located outside the Rio Grande Basin.

Colorado has attacked the problem somewhat differently by passing legislation to protect existing surface supply water users from ground water pumpers. The expanded ground water pumping near many of Colorado's major rivers had reduced surface flows over a number of years, and many surface water users became concerned. As a result, the State enacted the Water Right Determination and Administration Act of 1969, which allowed water users to draw on either surface flows or the aquifers that supply them, but limited ground water pumping to preserve the rights of users with existing rights. The act allows pumpers to increase the amount of water extracted only if other water users' rights are protected.

INCREASED ENERGY CONSUMPTION

When a ground water aquifer is continually overdrafted, the level of the aquifer declines and more energy is required to pump the water from greater depths. Increased energy consumption and higher costs are problems in all areas where overdrafting occurs. For instance, during World War II ground water existed at a depth of about 45 feet in Kern County, an agricultural area in California's San Joaquin Valley. However, by 1976 ground water in that area had dropped to a depth of about 200 feet. During the 1940s, irrigating a 160-acre parcel to a level of 3 acre-feet per acre would have required about 23,000 kilowatt hours of electrical energy annually, or about 48 barrels of oil, to pump the water. In 1976 irrigating the same area would require about 100,000 kilowatt hours annually, or about 211 barrels of oil.

SOCIAL AND ECONOMIC DISRUPTION

Continued depletion of ground water resources ultimately leads to resource exhaustion. When ground water resources are nearing exhaustion, irrigation must be limited to the acreage supportable by surface supplies and the safe yield of ground water aquifers. Where surface supplies are inadequate or unavailable and natural recharging of ground water aquifers is minimal, agricultural land must be dry farmed--watered only by rainfall--or abandoned.

If ground water resources are completely depleted over a wide area, the economic consequences would be extremely serious. Agriculture as well as directly or indirectly related industries would be affected, resulting in local recessions, economic and social dislocations, and a general weakening of important sectors of the regional economy.

High Plains region of western Texas and eastern New Mexico

The High Plains region of Texas and New Mexico is probably the best known and most unique area of ground water overdrafting in the United States because of its geographical size, its large dependence on ground water, and its lack of an alternative water supply. Thus, conservation and planned use of the ground water resources are more important than in areas where alternative supplies are available.

The Ogallala Formation, an interstate aquifer system, underlies virtually all of the northern High Plains in Texas and about 22,000 of the 25,000 square miles of Texas' southern High Plains. The aquifer extends into New Mexico,

Colorado, Oklahoma, Kansas, and Nebraska. The sole source of recharge to the Ogallala aquifer is a negligible amount of precipitation. Withdrawals are especially large in the major irrigation areas in the northern part of the southern High Plains and in areas to the south where municipal and industrial water supplies are pumped.

A June 1975 U.S. Geological Survey (USGS) document reported that ground water withdrawals in the southern High Plains of Texas in recent years have been averaging 7 to 8 million acre-feet per year and that the rate of recharge has been perhaps 140,000 to 150,000 acre-feet per year. Extensive water conservation has been underway to slow the withdrawal rate. The Texas Water Plan of November 1968 predicted, however, that if by 1985:

> "* * * a supplemental surface supply of water has not reached the High Plains, this vast area will have begun an area-wide retrogression to dryland farming which will have profound economic consequences throughout the State."

Studies by Texas A&M University predict a potential demand for enough water to irrigate 6.7 million acres in the southern High Plains alone if water could be made available at reasonable costs. Unless water is imported from outside the area, however, the studies predict that irrigation will begin a severe decline by 1985. According to the studies, available ground water will likely support only 2.2 million irrigated acres in 2020.

In April 1975 the Department of the Interior issued a report entitled "Critical Water Problems Facing the Eleven Western States," which stated that the irrigation-based agricultural economy of the western Texas-eastern New Mexico area is threatened by rapidly declining ground water supplies. The report stated that irrigation will start to decline about 1980 and that "significant social and economic dislocations will occur with this decline in irrigation activity."

To formulate a strategy for overcoming these problems, the Congress authorized in 1976 (Public Law 94-587, sec. 193) the Department of Commerce and the Economic Development Administration to make an economic adjustment study of the area. The High Plains Project will cost approximately $6 million and is scheduled for completion by March 31, 1982. Under the act the Corps of Engineers was also authorized to conduct a feasibility study of water transfer into the High Plains.

Potential problem areas in other parts of the High Plains

Situations similar to that of western Texas-eastern New Mexico are developing in other parts of the High Plains. USGS reported that hydrological conditions in the southern High Plains in Texas and New Mexico are typical of the High Plains region as a whole. USGS noted that although the rest of the High Plains area is not as heavily developed as the Texas and New Mexico area, the region as a whole will likely show similar development trends, particularly if development is not regulated by law. USGS further stated that

> "* * * current and projected effects of development in the Southern High Plains demonstrate the effects that might be anticipated in other areas of ground-water mining (extraction at rates so in excess of replenishment that water levels decline persistently)."

A 1963 USGS paper entitled "The Role of Ground Water in the National Water Situation" stated that the situation in western Kansas (about three-fifths of the State) was similar to that in the southern High Plains of Texas in the 1930s and 1940s. Withdrawals of ground water for irrigation exceed the rate of natural recharge in much of the area. Continued withdrawals at the current rate will likely deplete the ground water supply and seriously affect the area's economy. The paper also stated that all of the High Plains region, except perhaps the Sand Hills of Nebraska, ultimately face the same decisions as the southern High Plains of Texas. State officials of Colorado told us that ground water levels are declining most rapidly in the eastern areas of the State, which are mostly in the High Plains.

Arizona and California

Arizona and California may face a similar future. Like the Texas High Plains, Arizona and the San Joaquin Valley in California have developed economies that depend heavily on ground water. Ground water has been the most important factor supporting recent economic growth in the southern part of Arizona, and many areas depend totally on ground water. In California the Director of the Department of Water Resources painted a bleak picture of the State's future if ground water is not managed and new supplies are not developed:

> "* * * under this assumption, use would be almost 20 percent more than our presently available dependable supplies. This scenario would be disastrous to California. With this large disparity

> between supply and demand, shortages and disruptions of the economy would not be confined only to infrequent critically dry years * * *."

The director went on to say that unless the Federal and State governments work to solve this problem, the San Joaquin Valley could face a crisis within the next two decades.

CHAPTER 3

OBSTACLES TO SOLVING THE OVERDRAFT PROBLEM

Water resource managers are trying to manage their water supplies and solve the problems related to overdrafting. But their efforts are often ineffective because of legal, institutional, and physical constraints.

LEGAL AND INSTITUTIONAL PROBLEMS

Since ground water rights are either ill defined or are limited only by historical usage, the right to use ground water is unclear. The problem is that existing methods for defining water rights are piecemeal, cumbersome, and often inequitable. Attempts to control surface and ground water supplies are often hampered because water rights are ill defined.

State laws sometimes fail to indicate the limit of a user's right to ground water. For example, California law is inconsistent about the amount of water landowners may obtain from ground water underlying their land. California ground water users generally have a right to their "correlative share" 1/ of the total supply. But if ground water users take more than their share of the supply, they may acquire a right under State law to the amount of water they take.

Ground water rights have been determined for users in a few southern California ground water basins, but for most of the region, including the entire San Joaquin Valley, ground water rights are virtually undefined. The December 1978 report of the Governor's Commission to Review California Water Rights Law noted that:

> "At this time, a ground water user in a basin which has not previously been adjudicated [that is, where rights have not been defined by the courts]

1/Owners of land overlying a ground water basin have the first right to withdraw water for reasonable and beneficial use on their overlying lands. The right of each owner is equal and correlative to the right of all other owners similarly situated, and, in case of insufficient water to fully supply the requirements of all, the available supply must be equitably apportioned.

can have only a very uncertain idea of what his right actually is."

Arizona law restricts the expansion of irrigation in designated critical ground water areas and regulates the shipment of water within or from these areas but does nothing to stop the present rate of depletion or to restrict existing ground water uses.

It is fairly well accepted that Indian reservations and the Federal Government have some rights to water supply underlying their lands, but the exact nature of these rights has not been determined. As a result, Western State administrators and potential water users do not know how much water is available for new uses or how much would revert to Federal and Indian owners if they exercised their rights. Economies that depend on these water supplies could be seriously threatened by the Federal Government's and Indian tribes' undetermined but potentially extensive rights.

Existing water rights can be defined through adjudication and/or interstate compacts. Adjudication, however, often defines water rights on a piecemeal basis, and both adjudication and interstate compact procedures can be cumbersome. The American Society of Civil Engineers has noted that:

> "In most jurisdictions, the only sure method of defining the extent and nature of a water right is through litigation. Yet most of the historic adjudicated rights the manager will encounter arose from limited lawsuits involving two, or a very few, water users in some limited area. The judgments involved are seldom binding upon the broad range of water-right claimants who may be included within the hydrologic unit to be managed * * * adjudications of all rights in a basin are rare. Yet, in the absence of general adjudication, the inventory of rights is often a chancy endeavor."

Even where adjudication is attempted, the process may be cumbersome and time consuming. Incomplete or obsolete records, the large number of parties involved, high legal costs, and the high risk of losing may complicate and drag out the proceedings. For example, a prolonged Mojave Water Agency action initiated in 1966 to adjudicate water rights was finally dismissed after 10 years. Studying hydrological conditions, identifying parties to the suit, attempting to negotiate a water management plan, and setting an expeditious trial date took up the first 5 years of the adjudication

process. By November 1970, 88 percent of the parties had either agreed to a stipulated judgment or had defaulted. In subsequent years, members of the agency's board of directors favoring adjudication were gradually replaced by those who opposed it. By the time the agency requested that the case be dismissed in 1976, over 700 pumpers were parties to the suit. The action reportedly cost the agency over $500,000.

Interstate compacts are also a cumbersome mechanism for defining water rights because they typically require the approval of State legislatures and Governors. Furthermore, because States are constitutionally barred from entering into treaties, interstate compacts must be approved by the Congress and the President.

Efforts to promote basinwide and statewide control of water resources are sometimes hampered because water users with ill-defined or unlimited rights are not willing to accept outside control. For example, a 1947 bill introduced in the Arizona Legislature to make ground water subject to appropriation by permit was opposed by (1) ranchers and farmers who had recently invested in acreage in ground water areas and their suppliers and (2) inhabitants of areas where ground water supplies were not being depleted.

Similarly, proposals to mandate ground water management or limit expanded agricultural acreage in California was not enacted either in the 1978-79 or 1979-80 sessions. The proposals were opposed by agricultural interests; the Association of California Water Agencies; and large cities, notably Los Angeles, which rely partly on ground water to meet public water needs.

Local pressure also has stymied ground water development in the Metropolitan Washington area. For example, a Corps of Engineers study on ground water in two Maryland aquifers was halted when the State of Maryland asked that the study be discontinued. Residents apparently feared the Federal Government would take control of their ground water and pressured the State to have the study stopped.

PHYSICAL CONSTRAINTS

Ideally, water managers can solve overdrafting problems by shifting use to surface water supplies and by replenishing depleted ground water supplies. In some cases, however, surface flows are negligible and natural replenishment of ground water is limited. In much of the area served by the Ogallala aquifer (see p. 8), replenishment is minimal because (1) the area receives little rain, (2) the geological formations above the underground reservoirs are impermeable, (3) underground flows carry the ground water out of the area, and (4) surface flows are almost nonexistent.

Water managers in two of the States served by the Ogallala aquifer recognize that ground water in these areas is limited. Their plans are geared toward estimating an acceptable time frame for exhausting usable ground water supplies.

CHAPTER 4

APPROACHES TO SOLVING OVERDRAFT PROBLEMS IN SELECTED AREAS

Some States and local water resource managers have responded to ground water problems by (1) vesting control of all water resources in a single basinwide entity, (2) managing ground and surface waters as if they were a single resource, and (3) implementing water conservation programs. Where it has occurred, joint management of surface and ground waters has helped managers deal with such problems as land subsidence, saltwater intrusion, and reduced surface flow. The following sections briefly describe approaches that water resource managers are using to solve overdraft problems in various parts of the Nation.

SANTA CLARA VALLEY WATER DISTRICT

The Santa Clara Valley Water District has a history of overdrafting and land subsidence due to inadequate precipitation--14 inches in an average winter--to support extensive economic and population growth. To replenish the valley's ground water basin, the district has adopted numerous surface and ground water conservation and management measures. For example, the district constructed eight dams to capture winter floodwaters and replenish the ground water basin after a 1933 geological report identified subsidence in parts of the valley floor. Ground water levels were restored between 1937 and 1942. While rapid growth has at times resulted in inadequate ground water replenishment, further subsidence has been avoided since 1969 when the district began to use deliveries from the State Water Project to restore water levels.

In addition to halting subsidence, the district has used underground storage space in the aquifer to conserve water for use during dry periods. This underground water supply enabled most of the valley to face the serious droughts of 1976 and 1977 with minimal difficulty.

The district manages the entire basin through its legal control of water pricing. It also imports water and operates an extensive ground water replenishment system. While the district has no legal authority to limit ground water pumping, users of large quantities of ground water have cooperated and pumping has not yet caused a problem.

ORANGE COUNTY WATER DISTRICT

California's Orange County Water District was created by State legislation in 1933 to protect and manage Orange County's ground water basin, which had been overdrafted by excessive pumping and the diversion of Santa Ana River water by upstream users. Because of the declining water table, the district has been concerned over the possible intrusion of saltwater into its fresh ground water supplies. By using imported water supplies for ground water replenishment and saltwater barriers, however, the district has been able to protect and preserve its ground water resources despite continued growth.

The district recognized the potential for saltwater intrusion as early as 1925, and in 1956 it found that saltwater had intruded as far as 3-1/2 miles inland. Contributing factors were continued growth, the district's transition from an agricultural to an urban economy, and the end of an extended period of above average rainfall.

Since that time, the district has used several facilities to conserve and replenish the overdrafted underground reservoirs. The district has also acquired extensive lands for percolating 1/ water to the underground. The district's recharge facilities cover a total of 1,100 acres and are designed to percolate up to 300,000 acre-feet annually. Anaheim Lake, for example, covers 70 acres and uses water from the Santa Ana River, the Colorado River, and the State Water Project to replenish the underground reservoirs.

Furthermore, the district uses wells to inject water into land adjacent to the ocean. One such saltwater barrier straddles the border between Los Angeles and Orange Counties. Two of the 17 wells are located in Orange County, and the district pays a pro rata share of the cost of maintaining all the wells and injecting about 5,000 acre-feet of water each year.

In another large barrier, seven wells located about a mile inland extract saline water and return it to the ocean through flood control channels. At the same time, 23 wells inject about 23,000 acre-feet of water into underground aquifers each year. Most of the injected water comes from treated sewage, thus preserving as much drinkable water as possible for other uses.

1/A method of recharging a ground water aquifer with excess surface flows.

FLORIDA

Demands from irrigated agriculture, tourism, and high water loss from the soils occur during the dry winter months in Florida. Before 1972, high demands sometimes resulted in overdrafting and saltwater intrusion. As a result of a record-breaking drought and legislative support for environmental protection, the Florida Legislature passed a law in 1972 vesting control of virtually all the State's water in what is now the State Department of Environmental Regulation and the various water management districts. The only exception to State control was water taken by individuals for domestic use.

Through the act, the Department of Environmental Regulation or the various water management districts obtained sweeping powers. These powers included the right to (1) require permits, (2) restrict water use, (3) inspect dams and ground water wells to ensure compliance with appropriate regulations, (4) revoke permits for violations, and (5) restrict or prohibit water use during a declared emergency.

Implementation of these provisions has tended to stabilize ground water levels in Florida's coastal aquifers. By placing restrictions on water use, the State has been able to control seasonal overdrafting and reduce the threat of saltwater intrusion.

NEW MEXICO AND COLORADO

As discussed in chapter 2, New Mexico and Colorado were faced with reduced surface flows due to increased ground water pumping. In both States, the problem is being handled successfully because a single entity had basinwide authority to control water use.

CALIFORNIA AND ARIZONA

Both Arizona and California recognize the seriousness of their overdraft problems and have studied various solutions. Arizona established a Ground Water Management Study Commission to (1) review existing ground water law, (2) study and evaluate ground water conditions, use, and alternatives, and (3) recommend legislation for the best development, use, and conservation of ground water. After we completed our field work on this report, the State of Arizona enacted a comprehensive ground water management law which, according to the Executive Director of the Arizona Water Commission, requires safe-yield pumping of ground water by year 2025 in

the State's major urban basins. This is to be accomplished through water conservation and the purchase and retirement of agricultural uses.

In California the Governor's Commission to Review California Water Rights Law was created in 1977 to review existing water rights law, evaluate proposals for modifications in this law, and recommend appropriate legislation. The commission's recommendations on ground water management were introduced in the California Senate in December 1978. That bill was not passed in the 1978-79 session. A similar bill introduced in the 1979-80 session was not enacted.

CHAPTER 5

FEDERAL INVOLVEMENT IN WATER MANAGEMENT

Existing Federal policy recognizes the paramount responsibility of States in managing water resources. The President's water policy message in June 1978 noted that the States are the focal point of water resources management, and a Presidential memorandum of July 1978 emphasized that States have the principal responsibility for protecting instream flows and preventing ground water depletion.

The Federal Government provides assistance to State and local government agencies with management responsibilities. Its major contributions are (1) providing data and technical assistance and (2) constructing multipurpose water resources projects. In further recognition of the importance of ground water and as a result of the Presidential water policy message, the Federal Government established a special ground water task force in 1978.

DATA AND TECHNICAL ASSISTANCE

U.S. Geological Survey

USGS, within the Department of the Interior, provides data and technical assistance for ground water management through its Federal/State Cooperative Program. Under this program, the Federal Government and over 500 State and local agencies share the cost of USGS investigations and research programed in collaboration with State and local agencies. These cooperative projects are designed to provide continuing appraisals of water quantity and quality and to improve hydrological information and understanding. The program makes project results available to Federal, State, and local agencies for use in developing, utilizing, conserving, and managing water and land resources. More than half of the water resources data gathered in the United States, except for stream gauging, is provided by the Cooperative Program.

Other USGS activities include monitoring changes in ground water due to coal and oil shale mining, subsurface waste storage, and the availability of deep ground water supplies from the Madison aquifer of the northern Great Plains. USGS also evaluates geological, physical, chemical, and biological methods of artificially recharging aquifers to provide (1) information on methods of predicting the relative success of proposed artificial recharge facilities in different environments and (2) guidelines for determining effective

treatment and operating procedures at recharge facilities. About one-third of USGS' projects directly relate to ground water.

Office of Water Research and Technology

The Office of Water Research and Technology (OWRT) directs a variety of research and technology development activities directed toward water-related problems. OWRT is also responsible for coordinating Department of the Interior water research.

OWRT performs its water research and development activities through contracts and grants. Under title I of the Water and Resources Development Act of 1978 (Public Law 95-467), OWRT provides noncompetitive annual funds allotments to support one university water resources research and technology institute in each State and in Puerto Rico, the District of Columbia, and other specified jurisdictions. The act authorizes $175,000 in allotments, for fiscal year 1980, to each institute and $8.5 million for competitive matching grants to the institutes on a dollar-for-dollar matching basis for research including ground water depletion, pollution, land subsidence, ground water quality, and water use efficiency. These institutes play a major role in providing information to ground water managers within their respective regions.

Another program under title I provides support for work focused on national water problems. This program is open to industry, non-Federal Government agencies, scientists, and others.

Agricultural Research Service

The Science and Education Administration-Agricultural Research within the Department of Agriculture performs water resources research at research centers across the Nation. It also has seven experimental watersheds where it examines the complete water cycle, including ground water. Ground water projects have included artificial recharge research for Fresno, California (a ground water-dependent city); the southern High Plains of Texas; and Phoenix, Arizona. Another project was a study of how ground water quality in Fresno is affected by recharge from overirrigation. Two other projects were related to ground water as a source of discharge to streams. The service is also doing some cooperative work with the Bureau of Land Management on recharging ground water on certain public lands.

MULTIPURPOSE WATER RESOURCES PROJECTS

The Water and Power Resources Service of the Department of the Interior and the Army's Corps of Engineers are the two Federal agencies primarily involved in the construction of multipurpose water resources projects. The projects generally consist of dams, reservoirs, and water conveyance systems. The projects, which require large Federal expenditures, are often needed to replace or supplement ground water in areas that have been seriously overdrafted. Examples are the Central Arizona Project ($1.5 billion) and the Central Valley Project in California ($3.5 billion).

For both areas overdraft problems had developed apparently because the population and economies of the areas developed at higher rates than could be supported by the existing water supply. Once such developments had occurred, crisis-oriented solutions had to be considered which involved large Federal expenditures and required assistance. In fact, California is currently looking to the Federal Government for more aid in solving its overdrafting problems.

Central Arizona Project

The Federal Central Arizona Project will include the construction of canals to carry water from the Colorado River to Phoenix and to Tucson. The Governor of Arizona testified on April 1, 1976, before a congressional committee 1/ examining the need for the project that:

--Arizona has a water emergency.

--The water overdraft in the Phoenix area (population 1.2 million) is two and one-half times greater than the replenishment of that water.

--The water overdraft in Tucson, the largest city in the Nation that depends strictly on wells, is five times greater than the amount of recharge or replenishment of water.

--Approximately 1,000 square miles of land has subsided 2-1/2 feet because of overdrafting.

1/"Hearing Before the Senate Committee on Appropriations, Public Works for Water and Power Development and Energy Research--Part 7."

--The act authorizing the project specifies that no project water may be delivered to develop new agricultural lands, except on Indian reservations in the project service area.

The Commissioner of the Bureau of Reclamation described the Central Arizona Project as "primarily a rescue type of operation."

Central Valley Project

The Federal Central Valley Project is a large, multipurpose project in California consisting of 19 dams and related water conveyance systems and hydroelectric generating plants. The project's primary purpose is to provide irrigation water to the Sacramento and San Joaquin Valleys. The project was needed because, among other things, the existing ground water supply was not adequate to support the area's level of irrigation farming. For instance, in requesting authorization for the project's San Luis Unit (serving the Westlands Water District), the Department of the Interior stated that ground water levels had been declining an average of about 10 feet per year and that, in some places, ground water levels had been falling 20 feet per year. According to advocates of the San Luis Unit, the approximately 572,000 acres served by the Westlands Water District would be fit for growing only sagebrush without the project.

Because of the seriousness of continued overdrafting in California, the Congress is currently considering a several million dollar feasibility study to enlarge Shasta Dam, the key dam of the Central Valley Project. One proposal being considered is to raise the existing dam 200 feet at an estimated cost of $1.4 billion. Another proposal calls for an additional dam at a projected cost of $2.6 billion.

GROUND WATER TASK FORCE ON FEDERAL/STATE COOPERATION

The President's water policy message of June 6, 1978, addressed the Nation's ground water problems, and a Presidential memorandum issued July 12, 1978, directed Federal agencies to implement water policy initiatives on environmental quality and water resources management. One of 19 task forces established to implement various Presidential directives dealt with the issue "Ground Water Supply--Federal/State Cooperation."

The task force's two major concerns were consideration of ground water resources in Federal water planning and expanded Federal cooperation with the States in resolving ground

water problems. The task force concluded that (1) ground water resources are not adequately considered in the Federal water-planning process and (2) Federal assistance programs and cooperative efforts with State and local governments need to be improved.

The task force recommended:

--Expanded Federal guidelines, specifying incorporation of ground water in water-planning processes, and guidelines for preparation of special ground water assessment as a requirement to each Federal water project planning document submitted for authorization and funding.

--Joint evaluation and planning of surface and ground water in the planning process.

--Organizational and staff improvements to accommodate expanded ground water planning efforts.

--Federal-State cooperation and assistance in resolving ground water issues.

--Formation of a National Ground Water Advisory Commission.

A summary of the task force report and its recommendations is included as an appendix to this report.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATION

Ground water overdrafting and the problems it can bring--including land subsidence, saltwater intrusion, and increased energy consumption--are becoming a fact of life in many parts of the Nation. Many aquifers, once depleted, can never be fully restored. As a result, those communities dependent on ground water face eventual hardships unless arrangements can be made for shipping water from water surplus areas. However, States and communities guard their water rights zealously, making such solutions difficult to achieve.

The options remaining for such communities are few, invariably result in economic and social disruption, and therefore are difficult to face up to. One option is to restrict water consumption to the normal replenishable supply. Implementing this decision requires a community to direct current water users to reduce or stop entirely their water consumption. This option is distasteful to most communities and politically difficult to carry out.

The remaining option--eventual depletion--implies that at some time in the future the community will simply run out of water. Communities may decide to postpone the situation by adopting growth restrictions. On the other hand, some communities will simply do nothing.

Some State and local agencies have faced the consequences of continued overdrafting. They have dealt successfully with legal and institutional constraints by (1) placing control of water management in a single entity and (2) jointly managing ground and surface water supplies.

Federal policy recognizes that water management is a State responsibility. The Federal Government, however, has assisted State and local water managers by providing data and technical assistance and by constructing multipurpose water resources projects.

Water is an important national resource and should be well managed. The uncontrolled, long-term overdrafting of the Nation's ground water aquifers is not, in our opinion, sound water management. Overdrafting can result not only in social and economic disruption to affected communities but also in the need for the Federal Government to construct expensive water resources projects.

For these reasons, we believe the Federal Government should discourage uncontrolled ground water overdrafting.

RECOMMENDATION TO THE CONGRESS

Because water resources and ground water depletion mitigation projects are individually authorized, we recommend that the Congress direct the Departments of the Interior, Agriculture, and the Army to require, before start of construction on any such projects, that the affected State or community implement or have specific plans to implement

--a program or other means for controlling ground water pumping and

--an active water conservation program.

We recognize that because of the uniqueness of local ground water situations, determination of compliance must be made on a case-by-case basis.

AGENCY COMMENTS AND OUR EVALUATION

The Department of the Interior stated that our analysis and recommendation is based on a misunderstanding of the basic principles of ground water hydrology; our recommendation is general and vague, giving no indication of what is intended or desired; and the report has taken an overly simplified view of a very complex, long-standing problem. (See app. II.) The Department of the Interior, which is responsible for the construction of some of the Nation's largest and most costly Federal water resources projects, saw little merit in our draft report and offered few constructive comments to help resolve the serious problem of overdraft affecting many areas of the Nation.

We have made some revisions to clarify certain points (see p. 32), but believe our position is well supported. Our analysis is based on several well-documented overdraft situations in various areas of the Nation and discussions with Federal, State, and local officials and other experts. Our recommendation is based on the fact that those States and communities that have achieved some success in dealing with overdraft problems have done so by controlling ground water pumping and by implementing water conservation programs.

Our recommendation is intended to permit State and local water resources managers considerable leeway in implementing ground water control and conservation programs. Furthermore, overdraft problems vary significantly from one area to another and one specific recommendation applicable to all does not appear reasonable or prudent. We have clarified it by recognizing that compliance with the recommendation must be determined on a case-by-case basis.

The Department of the Army and some of the States most affected by overdraft--namely, California, Colorado, and New Mexico--commented that our draft report generally presented an accurate picture of the overdraft problem and offered suggestions to improve our final report. (See apps. III through VI.)

The Department of Army, however, commented that our recommendation could increase overdrafting and that withholding of water resources projects pending resolution of a problem--involving legal, social, economic and political factors--is not appropriate. The Army suggested we require Federal agencies to examine overdrafting carefully before starting construction projects (see p. 40). We assume that the Army's concern is that some areas, rather than instituting a program to control pumping, will elect to do without Federal projects, thereby possibly increasing their ground water pumping. We believe that Federal water projects should be used as incentives to achieve sound management of the Nation's water resources when States or localities are otherwise reluctant to adopt needed controls.

The letters commenting on our draft report and our responses are in appendixes II through VII.

APPENDIX I

SUMMARY FROM "GROUND WATER SUPPLY--
FEDERAL/STATE COOPERATION, REPORT
OF TASK FORCE 2b," JUNE 4, 1979

Both the nature of occurrence of the ground-water resource and the issues surrounding it are complex, posing difficult husbandry and conservation problems of broad public concern. Though hidden from view, the resource is intimately interrelated with streamflow and other surface water, the environment, and the land. Ground-water problems are addressed in a Presidential Memorandum issued July 12, 1978, which transmitted to Federal agencies directives intended to implement water-policy initiatives concerning environmental quality and water-resources management.

This is the final report of Task Force 2b, Ground Water Supply -- Federal-State Cooperation, one of 19 task forces established to aid implementation of various Presidential directives. The two primary thrusts of this Task Force effort are (1) improved consideration of the ground-water resource in Federal water planning, and (2) expanded Federal cooperation and mutual assistance with the States in the resolution of problems associated with the ground-water resource. Several other task forces have been assigned water-resources issues that involve consideration of additional more-specific aspects of the ground-water resources.

With respect to Federal planning, the Task Force concluded that the ground-water resources are only weakly considered in the Federal water-planning processes, and the report proposes eight measures for improvement. They are intended to apply to both structural and nonstructural programs and projects. Among them are recommendations for additions to the language of the *Principles and Standards*, to the P&S *Manual of Procedures* now being developed, and to *Agency Procedures and Guidelines*, specifying incorporation of ground water in water-planning processes; and, guidelines for preparation of the special *ground-water assessment* specified in the Presidential Memorandum as a required addition to each Federal water project planning document submitted for

APPENDIX I

authorization and funding. Inasmuch as deterioration of ground-water quality constitutes loss of supply, quality protection and management should be a full-fledged consideration in all appropriate Federal water and water-related planning and program design, and the Task Force advises that this requirement be stipulated in official agency planning procedures. In addition, the report promotes the conjunctive consideration of ground-water quality and quantity and environmental relationships in the planning process, and total water-resources evaluation where practicable, including conjunctive evaluation and planning of surface- and ground-water resources.

The report also presents recommendations for organizational and staff improvements to accommodate the proposed expanded ground-water planning efforts. It advises that ground-water technology and availability of information be assessed in the early stages of planning and that steps be taken to meet additional requirements. The report notes, however, that although deficiencies in techniques and data may be significant, many of today's problems relating to the ground-water resources stem from inadequate application of existing technology and knowledge or from indifference to the welfare of the resource.

With respect to Federal cooperation and mutual assistance with the States, the report contains six recommended measures. Among these is a proposal for active Federal agency promotion of conjunctive planning with local and State agencies and regional organizations in the resolution of mutual and interdependent issues surrounding the ground-water resources. The Task Force recommends that specific language to guide Federal agencies in establishment of formal planning interfaces with the States be incorporated into the *Principles and Standards* and implementing procedures. In the furtherance of improved planning, it recommends also that Federal agencies foster technology exchange and mutual staffing assistance with the States with respect to ground-water hydrology and legal, administrative, and economic management; and, that

APPENDIX I

agencies sponsor advanced educational opportunities in ground-water hydrology and water-resources planning and management for both State and Federal personnel as appropriate within their missions. The report also encourages States and the Federal agencies to re-examine policies, laws, regulations, and management and administrative practices that concern or impact on the ground-water resources in order to seek out opportunities for improvements beneficial to both State and national water goals.

The concluding recommendation is of a different nature from the others, and perhaps the most promising of them all -- the commissioning of a National Ground-Water Advisory Commission composed of eminent leaders of business, industry, agriculture, science, education, and government and supported by technical and clerical staff and operating funds. The proposal stems from the Task Force membership's conviction that the Nation may be at a crossroads with respect to the welfare and future of the ground-water resources, demanding wisdom and insights attainable only from methodical examination, organized communication, and reasoning conducted under an umbrella of reliable information. A 3-year life is recommended for the Commission.

The National Ground-Water Advisory Commission is viewed as an effective means for confronting squarely and fairly (1) the policy, legal, and management predicaments surrounding the ground-water resources, (2) their integrated role in land and water utilization and protection efforts, and (3) necessary fundamental steps to an improved national ground-water situation.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

JUN 4 1980

Mr. Henry Eschwege
Director, Community & Economic
Development Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

Thank you for the opportunity to comment on GAO's draft report entitled "Ground Water Overdrafting: A Problem That Must Be Controlled." The draft has been carefully reviewed by the U.S. Geological Survey, The Water and Power Resources Service, and the Office of Water Research and Technology; their detailed comments are enclosed.

We are primarily concerned that much of the analysis and subsequent recommendations are based on a misunderstanding of the basic principles of groundwater hydrology. Because of the authors' failure to explain fully their use of key terminology such as "overdrafting," and "safe yield," GAO appears to have concluded that any use of groundwater that disturbs or changes the natural equilibrium constitutes "overdrafting," or excess withdrawal. Thus defined, any groundwater withdrawal could be unacceptable. Excess or unmanaged withdrawal of groundwater can and does occur in certain areas, with deleterious effects; in fact, this situation has long been recognized. However, the principles outlined by GAO to identify and rectify these problems are simplistic, if not incorrect, and if applied by water management entities, would result in a blanket condemnation of nearly every activity involving groundwater extraction.

[GAO COMMENT: Our report is based on several well-documented cases where overdrafting has caused serious problems of one type or another. The term "overdrafting" is defined on page 1 of this report. Our report clearly states that there are occasions and situations where overdrafting is warranted or unavoidable. This is discussed on pages 1 and 14 of this report. The principles outlined in our report to identify and rectify overdraft problems are the very principles employed by water resource managers who have achieved some success in dealing with overdraft problems.]

The report's recommendation is very general and vague, giving no indication of what is intended or desired. Is the intent to restrict groundwater pumping to safe yield? If so, what should be done about the effects on food and fiber output and other essential economic activity that would be disrupted? While implementing a conservation program appears laudable, we believe it will be found that in most areas with serious overdrafting problems, water users have already implemented conservation measures simply because it is too expensive to waste the groundwater they are pumping. Moreover, the report's recommendation does not make clear what should be done beyond that which is already taking place. We would like to point out, for example, that all new repayment contracts associated with Water and Power Resources Service projects include water conservation provisions which would seem to implement at least part of the report's recommendation.

[GAO COMMENT: Our report points out that Federal policy recognizes the paramount responsibility of the States in managing water resources. Our recommendation, therefore, rather than being general and vague, is intended to permit State and local water resource managers considerable leeway in implementing ground water control and conservation programs. Furthermore, overdraft problems vary significantly from one area to another and one specific recommendation applicable to all does not appear reasonable or prudent.]

In sum, we believe the report has taken an overly simplified view of a very complex problem of long standing. The States and the Federal government have long been aware of overdrafting and together have been attempting to find possible solutions. We have spent three years working with Arizona, for example, and it appears that the State will soon be enacting groundwater law reforms--the result of intense negotiations to reach agreement among water users within the State. Even so, reform is not likely to bring groundwater use to safe yield levels within the foreseeable future. Pumping levels are too great to achieve that goal through conservation, even if all Central Arizona Project water supplies are used to reduce groundwater pumping. Thus, although it is certainly a step in the right direction, reform will not entirely solve Arizona's problem, indicating just how complex and difficult the overdrafting problem can be.

Once again we appreciate the opportunity to comment.

Sincerely,

Larry E. Meierotto
Assistant Secretary
for Policy, Budget,
and Administration

Enclosures

APPENDIX II

USGS COMMENTS ON DRAFT GAO REPORT

"Ground Water Overdrafting: A Problem That Must Be Controlled"

The bulk of these comments were provided by the Acting Chief of the Ground Water Branch, U.S. Geological Survey.

The subject report takes the position that ground-water overdraft must be controlled. However, it is difficult to control something which cannot be clearly defined. The definition of overdraft which the report offers is clearly inadequate; "overdraft," like "safe yield," can be defined only in terms of some specific impact which we wish to avoid and which can be measured accurately. For example, if drawdowns greater than 300 ft. or land subsidence greater than 1 foot were determined to be unacceptable, overdraft could be defined as the pumpage which would cause these impacts. Thus overdraft will vary from one situation to the next, depending upon the impacts which are considered tolerable and the pumpage required to cause those impacts.

[GAO COMMENT: We believe that overdrafting is inevitable but that pumping should be controlled so that the overdrafting which occurs will be planned and managed to minimize its adverse impacts. We have made several editorial changes to clarify our position. There are several definitions of overdrafting, including the one suggested by USGS. But the more common definition is the one we used, which is also used by the Water and Power Resources Service and was the definition used by the Water Resources Council in preparing the 2d National Assessment of the Nation's Water Resources and the National Water Commission in its final report to the President.]

The paper defines overdraft on page 1 as "the extraction of ground water in excess of the net recharge or safe yield of the ground-water basins"; it then cites cases of overdraft in various parts of the country and recommends various government policies in response to the situation. The entire approach is based on the assumption that overdraft can be clearly identified and defined--that we can know when, where, and to what extent it is taking place. In fact, this is seldom the case. The definition used in the text depends upon one's interpretation of the terms "recharge," "safe yield," and "ground-water basins," none of which are themselves defined.

[GAO COMMENT: Overdrafting has been clearly defined, and the areas of the Nation in which overdrafting of ground water is occurring have been identified both in USGS reports and in the 2d National Assessment of the Nation's Water Resources published by WRC. Definition of recharge has been added as a footnote on page 1.]

APPENDIX II

The report ascribes the hazards of salt water intrusion, land subsidence, reduced flow of surface streams, increased energy consumption, and social and economic disruption to ground-water "overdrafting". In this context "overdraft" is defined as the extraction of ground water in excess of the "net recharge" or "safe-yield". In actuality, however, those hazards are the natural and inevitable consequence of the act of pumping ground water; the fact of subsidence, and the fact of intrusion, etc., are the result of natural adjustments of the physical system to imposed stress, and have nothing whatever to do with "net recharge" to the aquifer or to "safe yield". Accordingly, the title of the report should concern pumping, not overdraft.

[GAO COMMENT: The title of the report is correct, using the definition of overdraft which is established on page 1 of the report.]

C. V. Theis, in his paper "The source of water derived from wells--essential factors controlling the response of an aquifer to development" outlined in very clear terms how a ground-water system reacts to pumpage. His major points were these:

1) Prior to development, most natural ground-water systems are in a condition of hydraulic equilibrium in which inflow (recharge) equals natural discharge.

2) Pumpage disrupts this natural equilibrium and always results in an immediate withdrawal of water from ground-water storage.

3) This withdrawal of water from storage sets up hydraulic gradients which spread through the ground-water system, changing the flow pattern so that water is diverted toward the pumping centers.

4) Ultimately, hydraulic gradients in areas of natural discharge from the ground-water system are changed, causing a reduction in that discharge; in some cases, these gradients may be reversed, causing recharge to enter the system in areas of former discharge.

5) Hydraulic gradients may also be changed in the original recharge areas, causing the recharge to increase. However, some forms of recharge may remain unchanged in response to pumpage.

6) As natural discharge decreases and as recharge increases, the rate of withdrawal of water from storage decreases. Ultimately, a new equilibrium may be achieved in which the pumpage is balanced by the increase in recharge and the decrease in natural discharge; further withdrawal from storage ceases, and further decline of water level ceases.

7) Both the decreases in natural discharge and the increases in recharge which can be effected are limited. If the pumpage exceeds the sum of the decrease in discharge and the increase in pumpage which it can ultimately generate, declining water levels will ultimately bring about a reduction in the pumping rate. In these cases a new equilibrium is also achieved, but it is an equilibrium in which the reduced rate of pumpage is balanced by the increases in recharge and decreases in discharge. Again, withdrawal from storage and decline of water levels cease at this new equilibrium.

APPENDIX II

8) At the final equilibrium, whatever the pumpage, a new flow regime exists in which some water that once discharged to streams and other natural outlets is diverted to well fields, and in which, possibly, there is more inflow to the ground-water system than there was prior to pumpage, and this additional inflow is also diverted to the well fields.

[GAO COMMENT: The above comments are a factual discussion of the hydrological effects of increased pumping. It should be noted, however, that achieving a final equilibrium is dependent upon achieving a fixed rate of pumping. A program for controlling pumping is one method of achieving a fixed rate of pumping.]

It is worth noting that in many cases the pumpage, or some part of it, is returned to the ground-water system or to the stream system after a cycle of use. For example, some of the water applied in irrigation normally percolates to the water table as recharge; where pumpage for municipal supply has diminished the natural discharge of ground water to a stream, much of that pumpage may be returned to the stream as treated sewage.

[GAO COMMENT: None required.]

The subject document does not appear to be based on an understanding of the principles which Theis outlined with such clarity. For example, the term "ground-water basin" is used in the definition of overdraft. If this means an area enclosed by ground-water divides, it becomes indefinable in pumping situations where ground-water divides migrate as hydraulic gradients change. The term "recharge" is also used, but no indication is given as to whether this refers to original recharge, to recharge under current levels of pumpage, or to recharge under projected levels of pumpage. The term "safe yield," which is also used, can be defined only in terms of a specified impact - for example, a certain amount of stream depletion - and the pumpage required to generate that impact. Without specifying the unsafe condition which is to be avoided, "safe yield" has no meaning.

[GAO COMMENT: Definition of recharge was added to page 1 and editorial changes were made to clarify the discussion.]

The discussion of seawater intrusion provides a specific example of the confusion attached to the report's concept of overdraft. This discussion leaves the impression that seawater intrusion is always bad. If this premise is accepted, no pumpage from any coastal aquifer can ever be acceptable. Under natural conditions an "interface" - that is, a narrow transition zone - separates fresh water from seawater in coastal aquifers. This interface normally extends both landward and seaward of the shoreline, rising from the base of the aquifer at its most landward point to the seafloor at its seaward extremity. Fresh ground-water discharges to the sea or to coastal surface-water features, such as marshes, bays and estuaries, above the interface. Any pumpage in a coastal aquifer reduces the discharge of fresh ground water and decreases fluid pressure along the interface. This in turn causes the interface to shift landward and upward. However, if a net flow of ground

APPENDIX II

water toward the sea continues, the movement of the interface represents only an adjustment toward a new equilibrium position. Eventually, with a sufficient density of pumpage, an equilibrium might be achieved in which most of the fresh water discharge to the sea was diverted to well fields. In this condition the interface would occupy a new position considerably landward and above its original position - in other words, there would have been a great deal of "seawater intrusion" as defined in the subject document. However, the new equilibrium would normally represent a healthier condition in terms of water supply than the original equilibrium, since in the new equilibrium the fresh water is salvaged for use, whereas under the original condition it was wasted to the sea.

[GAO COMMENT: We agree. We have not concluded or stated that seawater intrusion is always bad. We believe that those areas in which the community or State believe increased pumping will be advantageous to them should be allowed to increase their pumping. However, the amount of pumping should be controlled to ensure that the desired new equilibrium is achieved.]

In general, the report seems to take the position that all consequences of pumpage are bad and must be controlled in some way. Hydrologically, the report seem to equate overdraft with withdrawal of ground water from storage, since the effects which it mentions are consequences of withdrawal from storage, which in turn is always associated with pumpage. If overdraft is defined as anything which causes these consequences, all pumpage will qualify as overdraft. In effect, the report calls for pumpage at equilibrium, since only under equilibrium conditions are further drawdown, land subsidence, seawater intrusion and reduction in streamflow avoided. However, drawdown is a necessary prerequisite to the establishment of any pumping equilibrium, and a new period of drawdown is required to move from one pumping equilibrium to another, associated with higher pumpage. Unless a certain amount of drawdown, land subsidence, seawater intrusion, and streamflow reduction can be tolerated, an equilibrium in which these effects are stabilized cannot be achieved.

[GAO COMMENT: We did not take the position that all pumping was bad, nor did we mean to imply that it was. In fact the opposite is true, and on page i of the digest and page 2 of the report we state that even overdrafting is not necessarily bad.]

The assertion that "continued, long-term overdrafting"..."is not sound water management" is to argue that aquifers that receive scant recharge should not be pumped. The same argument would indicate that oil should be left in the ground because it is not replenished. It is not clear why the Federal Government should discourage the exploitation of any non-renewable resource - even if it happens to be water. And if the resource is replenished at some small rate, why should that rate necessarily limit the rate at which the resource is consumed?

[GAO COMMENT: We have made several editorial changes to clarify that we mean that uncontrolled overdrafting is a water management problem.]

APPENDIX II

Perhaps a more feasible approach to the control of ground-water "overdrafting," or to ground-water management in general, is to precede any proposed major development, or any anticipated period of general development, with an exhaustive hydrologic evaluation which will determine the impacts of that development. The public, its elected representatives, or the courts can then be presented with a clear statement of the cost and consequences of the development, and can decide whether or not they are justified by the value of the pumpage to the economy and to the general welfare. Regulations or policies which are couched in general terms and which do not recognize the different meanings which a term such as "overdraft" can take on, are certain to cause more problems and confusion than benefit.

[GAO COMMENT: We agree that exhaustive hydrologic studies may be needed in those areas in which overdrafting is occurring. We believe, however, that water management, including judgments of the acceptability of the impact of a water project on the general ground water situation, is the right and responsibility of State and local governments. We imagine many States and communities would make such studies when instituting a program to control ground water pumping.]

The recommended goals of conservation and control of ground-water pumping are laudable, but the technical, social, and economic problems inherent in the management of ground water cannot be addressed by remedies of such generality. Effective management of the water resources of the Nation will require sound technical analysis to identify achievable solutions to well-defined problems.

[GAO COMMENT: Our recommendations were general to allow the States and communities sufficient flexibility to design programs for controlling ground water pumping and water conservation which best meet their needs.]

An excellent start in that direction is provided by the 1973 National Water Commission Report "Water Policies for the Future," and the 1979 report of the "Groundwater Supply" task force on Federal Water Policy Initiatives. These reports contain a sound analysis of needed management concepts, and identify political, administrative, and technical mechanisms for achieving the goals identified in the GAO report.

[GAO COMMENT: We agree. It is important to note that Commission Recommendation Number 7-6 very closely parallels our recommendation. It states, "Any Federal agency seeking authorization of a Federal water project for an area having a usable ground water aquifer should describe and evaluate the ground water program of the area." Recommendation 7-7 describes a possible control program for areas with an overdrafting problem.]

APPENDIX II

Water and Power Resources Service
Specific Comments
on
GAO Report "Ground Water Overdrafting:
A Problem That Must Be Controlled"

1. Page i, paragraph 3 - The term overdrafting as used in this paragraph implies that short term utilization of groundwater in excess of recharge is overdrafting. The term overdrafting is only applied to situations where the long term groundwater pumping exceeds long term recharge in other sections of the report. Therefore, it should not apply to the situation described in this paragraph. Also, it should be noted that there is an additional situation where overdrafting is not necessarily bad. That situation occurs where overdrafting of the groundwater resource is utilized to help develop a stable economy which can then support the future development of expensive water projects to bring water into the area. This type of overdrafting has been successfully applied in several situations.

[GAO COMMENT: Although overdrafting is defined as a long-term event, the concept of extraction in excess of safe yield can be applied as a temporary measure.]

2. Page i, paragraph 5 - It is stated that the western States rely heavily on irrigated agriculture. It is true that the economies in some areas of the western States do depend to a large extent on irrigated agriculture. However, the Nation as a whole relys heavily on irrigated agriculture in the western States to provide food and fiber. This statement should be clarified.

[GAO COMMENT: This is true and has been recognized on page i of the digest.]

3. Page ii, paragraph 1 - The definition of land subsidence and its causes needs to be clarified. It is not only the compaction and settling of surface soils which cause subsidence,but in most instances it is primarily subsurface soils which consolidate and compact to cause subsidence.

[GAO COMMENT: Definition of land subsidence was changed.]

4. Page iii, paragraph 4 - The statement that California and Arizona impose little if any control on the use of groundwater is untrue. While such control may not be applied uniformally throughout the two States there are areas within both States where groundwater use is strictly controlled.

[GAO COMMENT: Although areas within these States may provide some control, this discussion relates to State efforts.]

5. Page iv, paragraph 4 - The statement that the Federal Government has assisted States with overdraft problems by constructing multipurpose water development projects to provide water to replace groundwater is only partially true. Many such projects have been designed to optimize the use of both local groundwater and imported supplies and not necessarily to rescue the economy of an area.

[GAO COMMENT: We agree. Multipurpose projects by their very nature are designed to make optimum use of available water.]

6. Page 1, paragraph 1 - The statement should indicate that we obtain our water supply from two primary sources. Precipitation is actually a part of both surface and underground supplies and is not a separate source.

[GAO COMMENT: Change made to indicate that there are two primary sources.]

7. Page 1, paragraph 6 - Overdrafting as defined in this paragraph cannot be temporarily employed over short term drought periods. This paragraph should be clarified.

[GAO COMMENT: Although overdrafting is defined as a long-term event, the concept of extraction in excess of safe yield can be applied as a temporary measure.]

8. Page 2, paragraph 2 - It is true that overdrafting can ultimately result in economic and social disruption. However, if overdrafting is stopped or significantly reduced immediately, as seems to be the goal of GAO, then serious economic and social disruptions will occur immediately. The realistic approach is to recognize this dilemma and gradually attempt to reduce overdrafting through water conservation efforts and the development of supplemental surface supplies where possible.

[GAO COMMENT: We are not implying that it can be stopped or reduced immediately; however, we believe it should be controlled because of its serious consequences.]

9. Page 7, paragraph 4 - The second sentence should be revised to read "When recoverable groundwater resources are exausted irrigation . . ."

[GAO COMMENT: Regardless of the ground water's recoverability when supplies are exhausted, irrigation will be limited.]

10. Page 11, paragraph 2 - Federal lands and Indian reservations do not seem to have any bearing on the ideas expressed in this paragraph. Therefore, the first sentence should be revised as follows: "Since groundwater rights are either illdefined or are limited only by historical usage the ownership of groundwater is unclear."

[GAO COMMENT: The suggested change was made.]

11. Pages 15 through 17 - This chapter discusses approaches to solving unique and selective overdraft problems which are not representative of the overall general problems. However, it does indicate that the approaches to solving groundwater overdraft problems are very site specific and general approaches are not normally applicable. One basic problem which applies to most if not all overdraft areas which is not discussed in the report is the source of any water that can be obtained to replace the supplies presently derived from overdrafting.

[GAO COMMENT: Alternative supplies are discussed on pages 15, 16, 21, and 22 of the report.]

12. Page 20, paragraph 1 - It is stated that the Federal projects which are needed to replace or supplement groundwater in areas that have overdraft problems require large Federal expenditures. It should also be noted that while this statement is true these expenditures are repayed by either water users or hydropower benefits with only the nonreimbursable portions such as flood control, recreation and fish and wildlife costs being borne by the general taxpayer.

[GAO COMMENT: We agree that certain costs are reimbursable, but those that are not can be substantial when interest expenses are included.]

13. Page 21, paragraph 5 - This paragraph discusses activities which have taken place in Arizona in the past 2 or 3 years to attempt to alleviate groundwater overdraft problems. It should be updated to indicate that the Arizona Groundwater Management Study Commission has since prepared another report entitled "Concepts for Agreement-Integrated Package" dated March 6, 1980, and that the Governor of Arizona has called a special session of the State legislature to begin on June 4, 1980, to consider legislation to implement groundwater reform in Arizona.

[GAO COMMENT: Report was updated to reflect Arizona's new legislation.]

APPENDIX III

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, D.C. 20310

REPLY TO
ATTENTION OF

13 JUN 1980

Mr. Henry Eschwege
Director, Community and Economic
Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

This is in reply to your letter of May 9, 1980, to the Secretary of Defense regarding your draft report on "Ground Water Overdrafting - A Problem That Must Be Controlled," OSD Case #5432, GAO Code 085440.

The overall assessment of the problem has been presented in a reasonable and accurate manner. Your GAO draft report substantiates the earlier findings of the President's Water Resources Policy Task Force on "Ground Water Supply--Federal-State Cooperation," and the "Second National Water Assessment" prepared by the Water Resources Council.

The first recommendation could result in further overdrafting of ground water. Ground water overdrafting is a complex problem involving legal, social, economic and political factors. Withholding of water resources projects pending resolution of the problem is not considered appropriate. Instead, the Federal agencies should include the potential adverse impact of prospective projects on the ground water resources in its project formulation process. In determining the with and without project condition, the existence or non-existence of a state water conservation plan, and the implications thereof, ought to be fully developed. Furthermore, in the development and consideration of alternative plans, Federal agencies are to consider all reasonable alternatives, including those that would require changes in existing law. In this way, the Federal decision-makers can be made fully aware of, and take into consideration, the implications of Federal water resources projects where there are no adequate controls on ground water pumping or adequate water conservation programs. In addition, agency studies should treat ground and surface waters as a single resource to be utilized for promoting national economic development and enhancement of the environment.

[GAO COMMENT: See pages 21 through 23 for a discussion of these issues.]

APPENDIX III

Mr. Henry Eschwege

The recommendation with respect to water conservation is undefined. The Administration has proposed legislation to increase Federal financial assistance to states for the purpose of promoting water conservation tailored to each state's particular needs. Also, the Corps is implementing the President's water conservation policy by developing guidelines and procedures to assure that future projects providing water supply storage will be implemented only in conjunction with appropriate water conservation programs by the areas to be benefited by such projects.

[GAO COMMENT: Our recommendations were general to allow the States and communities sufficient flexibility to design programs for controlling ground water pumping and water conservation which best meet their needs.]

In summary, we have reservations as to the effectiveness of accomplishing the objectives of the report by limiting Federal water resources projects as proposed in the draft recommendations, and we believe that the full implementation of planning and policy directives now in effect could do much to alleviate the concerns you have expressed.

Sincerely,

Edward Lee Rogers
Deputy Assistant Secretary of the Army
(Civil Works)

[GAO COMMENT: We believe that withholding of authorization of water resources projects will provide the required incentive for States and local communities to control continued overdrafting.]

APPENDIX IV

STATE OF CALIFORNIA — RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF WATER RESOURCES
P.O. BOX 388
SACRAMENTO
95802
(916) 445-9248

JUN 12 1980

Mr. Henry Eschwege, Director
Community and Economic Development
Division
United States General Accounting
Office
General Accounting Office Building
441 G Street NW
Washington, DC 20548

Dear Mr. Eschwege:

We reviewed with interest your proposed draft report on "Ground Water Overdrafting: A Problem That Must Be Controlled". Your report is substantially correct and conveys very well the general status and condition of ground water in this United States. We do have some concerns with specific technical interpretations in your report and have noted them in an enclosed attachment.

The California Legislature has been considering a general ground water management law for the last several years. This year they are presently considering an individual ground water basin management district act for two specific basins. I have strongly supported the recommendations of our Governor's Commission to Review California Water Rights Law which would establish a statewide ground water management law for California. A bill embodying these recommendations failed passage in the 1980 Legislature, but I am hopeful such a bill will pass in the next few years.

Fortunately, we have active water conservation programs in many parts of California already and are initiating further demonstration projects in many parts of the State.

You may wish to investigate the current proposed revisions to the federal principles and standards for planning water projects. The latest additions published in The Federal Register on April 14, 1980, include some specific language on ground water which could be strengthened to accommodate the recommendations of your report.

Sincerely,

Ronald B. Robie
Director

Attachment

[GAO COMMENT: We made certain technical and editorial changes recommended by the State of California.]

COMMENTS ON
GENERAL ACCOUNTING OFFICE REPORT ON
"GROUND WATER OVERDRAFTING: A PROBLEM THAT MUST BE CONTROLLED"

Page ii

In the first paragraph dealing with land subsidence, the concept is not clearly stated. The phrase, "the surface soils tend to compact and settle" ties to the description on page 3 which says, "leaving a void into which the surrounding soils tend to compact and settle." The land subsidence which occurs in California and most alluvial areas is the result of a shifting and settling of soil particles while they are still saturated with water. No void is created and the soils are not surface soils; they are clay materials at depths of hundreds of feet. It is suggested that the following paragraph be substituted:

> "When large amounts of water are extracted from the underground, water pressure at depth is reduced and soil materials move closer together, causing the land surface to lower. Subsidence has caused millions of dollars of damage, etc."

Salt water intrusion into the fresh ground water aquifers can take place to some degree with "reduced" flow of fresh water to the ocean. However, in the second paragraph it should be noted that "often the normal flow of fresh water to the ocean is reversed and salt water moves into areas", etc.

The next sentence about intrusion into inland aquifers should read: "In inland aquifers, intrusion may occur when saline water migrates vertically or horizontally into fresh water aquifers." It is not only the upward migration from conate waters that is a problem within California. In fact, the most threatening movement of poor quality water in inland basins is horizontal.

[GAO COMMENT: The draft was revised to reflect the intent of suggested changes.]

Page iii

Within California overdraft has caused many of the problems cited in this report. When ground water becomes uneconomical to use because of depth of pumping, irrigation must then be limited to the acreage supportable by surface supplies and the ground water yield. It is suggested that you add that "ground water yield" to the second sentence.

The social and economic disruption that we anticipate in overdrafted areas in California would involve lands going out of production until the ground water use is equal to the safe yield. At that time, water levels would be down to a much lower level, but still at the economic pumping lift for those who continue irrigating on better soils.

[GAO COMMENT: We disagree with the suggestion that pumping will continue at the safe yield level after pumping becomes uneconomical. Eventually, recharge may be sufficient for this to occur, but not immediately.]

Page iv

At the end of the second full paragraph, the report indicates that the (California) commission's recommendations on ground water management are currently being considered by the State Legislature and the State Department of Water Resources. It is suggested that you delete "and the State's Department of Water Resources". I was on the Commission and fully concur in the Commission's comments. The recommendations are under consideration only by the State Legislature.

[GAO COMMENT: Reference deleted.]

Page 3

In the discussion on land subsidence, it is suggested that the phrase "leaving a void into which the surrounding soils tend to compact and settle" should be removed. Refer to comments on Page ii.

It is implicit that the rehabilitation contracts awarded by the Water and Power Resources Service were for work to correct problems in the Delta Mendota Canal were caused by subsidence. This should be made explicit.

[GAO COMMENT: Statements clarified to reflect the intent of the comments.]

Page 5

In the paragraph on saline water intrusion of inland aquifers, the term "upward" should be replaced by "horizontally or vertically".

This change would then cover the cases where connate or poor quality water migrates upward into fresh water aquifers, the lateral or horizontal migration of poor quality waters into portions of the aquifer which were formally fresh, or downward migration of poor quality water from a shallow aquifer to deeper fresh water pumping zones.

[GAO COMMENT: Statement changed to reflect the intent of the comments.]

Page 11

The first paragraph under legal problems does not provide the reader with any information; it is unclear. It appears to refer only to federal lands and Indian reservations. It should be directly related, then, to the "uncertainty" caused by these rights, if that is the purpose of the paragraph.

California has no generally applicable statutory ground water law. All of California's ground water law is case law. Decisions of the appellate courts add to the principles used in settling ground water matters in California.

[GAO COMMENT: This paragraph was rewritten to clarify the point.]

Page 13

Omit last sentence in second paragraph. In certain cases, states may sign agreements without Congressional and Presidential approvals.

[GAO COMMENT: Statement changed to reflect the intent of the comment.]

Page 15

Solutions to overdraft problems in California, specifically those discussed on pages 15 and 16, i.e., Santa Clara Valley Water District and Orange County Water District, only provided solutions to overdraft problems because of the availability of imported water to make up the difference between the water demand and the available local supplies.

California does not have a history of solving an overdraft problem by cutting back pumping except by a court adjudication of several of the ground water basins in Southern California. In all such cases, the adjudication was accompanied by the availability of imported water for those users whose ground water rights were reduced.

[GAO COMMENT: None required.]

Page 21

At the end of the second paragraph under Central Valley Project, the new dam proposed at a cost of $2.6 billion is "offstream", not "downstream".

For clarification, the last paragraph should begin, "In California, the Governor's Commission...".

[GAO COMMENT: Statements changed to reflect the intent of the comments.]

Page 22

Note also that the Legislature did not enact any comprehensive bill in 1979-80 either.

[GAO COMMENT: Suggested change was made to indicate that the legislature did not enact any comprehensive bill in 1979-80.]

The bottom half of this page paraphrases in five items a total of 14 items detailed in the task force report. If the entire 14 cannot be paraphrased, it is unfair to select just those five which given an unbalanced picture of the task force's total package of recommendations.

[GAO COMMENT: A more detailed summary of the 14 recommendations was added as an appendix to the report.]

Page 22 (Continued)

The second paragraph under this heading, "Ground Water Task Force on Federal-State Cooperation", nicely characterizes the content of the task force report in emphasizing its two major concerns.

[GAO COMMENT: None required.]

APPENDIX V

RICHARD D. LAMM
Governor

J. A. DANIELSON
State Engineer

DIVISION OF WATER RESOURCES

Department of Natural Resources
1313 Sherman Street - Room 818
Denver, Colorado 80203
Administration (303) 839-3581
Ground Water (303) 839-3587

June 10, 1980

Mr. Henry Eschwege, Director
Community and Economic Development Division
U. S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

This is to acknowledge receipt of the draft report entitled "Ground Water Overdrafting: A Problem That Must Be Controlled". I appreciate the opportunity to comment upon this report prior to its submission to the Congress and hope that you find my comments useful.

In general, I agree with the two recommendations to Congress; however, I believe that the recommendations could be improved by revising them in the following manner:

-- Require, prior to start of construction of any water resources or ground water depletion mitigation project, the effected State or community to implement
(1) an effective ground water management program, and
(2) an active water conservation program to reduce ground water pumping.

The reasons for the suggested revisions are as follows:

1. A solution based upon simply controlling ground water pumping does not allow the State or community to include other means of ground water management to reduce the impact upon the affected aquifer. An example would be the use of artificial recharge programs to stabilize water levels in the aquifer and increase the safe yield of the aquifer. Several entities in Colorado have initiated artificial recharge programs and more are preparing to do so as the feasibility has been demonstrated in recent years through various programs including a demonstration project sponsored in part by this office.

2. I believe that water conservation programs can be both beneficial and non-beneficial, depending upon which area the emphasis is placed. Conservation directed toward controlling ground water pumping is desirable for several reasons including reducing aquifer over draft and reducing power consumption. However, conservation directed toward surface water use may actually be harmful in certain areas of Colorado where return flows to streams actually recharge alluvial aquifers and improve late irrigation season streamflows through accretions to the stream. Any reduction in return flows through a mandated conservation program would be injurious to the water users of the State and could not be tolerated.

I believe the Federal government can be very useful to State and local entities by improving the U. S. Geological Survey's Federal/State Cooperative Program. More and better data are needed by water resource managers in order to make proper decisions concerning ground water management. Also, technical assistance to smaller water using entities needs to be improved especially those who have minimal funds.

I trust that the above is of use to your agency and if you have additional questions, please feel free to contact me.

Very truly yours,

Jeris A. Danielson
State Engineer

JAD/HDS:mvf

cc: Monte Pascoe,Dept. of Natural Res.

[GAO COMMENT: The recommendations have been clarified and reflect Colorado's concern.]

APPENDIX VI

STATE OF NEW MEXICO

STATE ENGINEER OFFICE

SANTA FE

S. E. REYNOLDS
STATE ENGINEER

BATAAN MEMORIAL BUILDING
STATE CAPITOL
SANTA FE, NEW MEXICO 87501

June 13, 1980

Mr. Henry Eschwege, Director
Community and Economic Development Div.
United States General Accounting Office
Washington, D. C. 20548

Dear Mr. Eschwege:

Thank you for the opportunity to comment on your proposed draft report to the Congress entitled "Ground Water Overdrafting: A Problem that Must be Controlled."

In general, I find that the report is well prepared and informative. On page v of the Digest it is stated that "in view of the serious consequences of continued overdrafting, GAO believes that the Federal Government needs to discourage continued, long-term overdrafting and promote sound management of the Nation's ground water resources." It is New Mexico's position that it is not intrinsically evil to deplete ground water resources at a rate greater than the rate of recharge (groundwater mining) where the quantity in storage is far greater than the annual recharge and there is no intimate relationship to fully appropriated stream flows. The New Mexico Supreme Court in Mathers v. Texaco, Inc., 77 NM 239, sustained the State Engineer in his administration of the Lea County Underground Water Basin which is a groundwater mining situation. The Court found that the administration of a non-rechargeable basin, if the waters therein are to be applied to a beneficial use, requires the fixing of a rate of withdrawal which will result in a determination of the economic life of the basin at a selected time. A copy of the Supreme Court decision is enclosed for your review.

Please let me know if some further discussion of this matter would be helpful.

Sincerely,

S. E. Reynolds
State Engineer

SER:pt

[GAO COMMENT: On page i of the digest and page 2 of the report we state that overdrafting is not necessarily bad.]

APPENDIX VII

BRUCE BABBITT, GOVERNOR
Arizona Water Commission
222 NORTH CENTRAL AVENUE, SUITE 650
Phoenix, Arizona 85004
TELEPHONE (602) 255-1550

June 16, 1980

Mr. Henry Eschwege, Director
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

Your letter of May 9, 1980, transmitted for comment copies of the GAO proposed draft report to the Congress entitled, "Groundwater Overdrafting: A Problem That Must Be Controlled."

For the most part the report is well done and provides an adequate and accurate description of the problems facing the western states from groundwater overdraft. Specific comments on the report are as follows:

1. The report fails to recognize that in many groundwater basins of the Southwest the rate of annual recharge is essentially zero and that the only way an economy can be supported in such areas is either to mine the groundwater or to import the necessary supply.

[GAO COMMENT: The issue of limited supplies is discussed on page i of the digest and page 1 of the report.]

2. The report presents the overdraft problems for individual states or areas but does not aggregate the total situation or demonstrate the economic activities dependent upon overdraft. For example, the overdraft in the great plains and western states is estimated to be 22.5 million acre-feet per year, as reported in Volume 1 of "The Nation's Water Resources 1975-2000" by the U.S. Water Resources Council. Irrigated agriculture accounts for the majority of this depletion. The production from this segment of our agricultural economy represents a significant percentage of the Nation's output of food and fiber.

[GAO COMMENT: The importance of ground water to the economy is discussed on pages 1 and 7 through 10 of the report.]

APPENDIX VII

3. The report creates the impression that only federal projects have been constructed to provide water supplies. The Central Arizona Project and California Central Valley Project are featured predominantly; however, nonfederal projects such as the Metropolitan Water District of Southern California's Colorado River Aqueduct, the City of Los Angeles' Owens Valley Aqueduct and the California State Water Project are of the same magnitude as the federal project mentioned.

[GAO COMMENT: We recognize that others are concerned and have committed resources; however, our focus is on federally assisted projects.]

4. In the Digest portion of the report the statement is made that Arizona imposes little if any control on the use of groundwater. Although the State has admittedly not had a program designed to achieve a balance between supplies and uses, the critical groundwater laws of the State of Arizona have prevented expanded agricultural pumping from the groundwater aquifers in most of central Arizona. These controls have slowed the overdraft rate in much of the developed part of the State.

[GAO COMMENT: Although overdrafting may have been slowed, it is still a serious problem which needs to be managed.]

5. The report concludes that the Federal Government should discourage groundwater overdraft. While we agree that groundwater overdrafting should not be promoted, any policy based only on the presence or absence of overdraft would be inappropriate. Federal policy must be flexible enough to take into account the full context of water use and supply in each individual basin. Basins which are predominantly urban should be managed in such a manner that groundwater overdrafting be eliminated as soon as practicable with full consideration afforded all interests within the basin. In contrast, many basins in Arizona are remote, support only agricultural economies and have negligible recharge. We feel that the need to bring about a balance between supplies and uses is less urgent in these basins.

[GAO COMMENT: Our report points out that Federal policy recognizes the paramount responsibility of the States in managing water resources. Our recommendation, therefore, rather than being general and vague, is intended to permit State and local water resource managers considerable leeway in implementing ground water control and conservation programs. Furthermore, overdraft problems vary significantly from one area to another, and one specific recommendation applicable to all does not appear reasonable or prudent.]

APPENDIX VII

6. We would appreciate you noting in your report that on June 12, 1980, Arizona enacted a comprehensive groundwater management law which mandates safe yield pumping of groundwater by year 2025 in our major urban basins. This is to be accomplished through a program of mandatory water conservation followed in later years by the purchase and retirement of agricultural uses.

[GAO COMMENT: Suggested change was made on page 17 of the report.]

Thank you for the opportunity to comment on the report.

Sincerely,

Wesley E. Steiner
Executive Director

(085440)

AN EQUAL OPPORTUNITY EMPLOYER

UNITED STATES
GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
U. S. GENERAL ACCOUNTING OFFICE

THIRD CLASS