NEW MEXICO FIRST

NEW MEXICO TOWN HALLS

WATER: LIFEBLOOD OF NEW MEXICO

Report of the
SECOND NEW MEXICO TOWN HALL
May 15-18, 1988
Angel Fire, New Mexico

POST OFFICE BOX 25387 ALBUQUERQUE, NEW MEXICO 87125 505/242-3205

New Mexico First is a private nonprofit organization established in 1986 to "provide a means for thorough consideration by the people of New Mexico of the fundamental public policy issues facing all New Mexicans." The organization will create, by research and discussion, an ever-increasing body of citizens accustomed to the process of issue analysis and its potential for positive impact in New Mexico. New Mexico First seeks to:

- Identify fundamental policy issues.
- Find positive solutions to the problems posed by these issues.
- Effect those solutions through dissemination of information.
- Identify, inform and motivate leaders for New Mexico.
- Create a statewide network of informed, caring New Mexicans.

New Mexico First is governed by a 50-member Board of Directors, elected from the membership and representative of New Mexico's geographic, ethnic and occupational diversity. Supported by tax-deductible annual membership dues, contributions and fees, New Mexico First will sponsor two Town Hall meetings each year, each focused on a single topic of statewide importance and each involving approximately 125 New Mexico citizens.

Town Hall participants, nominated by Board members and selected by the Executive Committee, also represent the state's diversity. They are provided with background research on the topic from one of New Mexico's six State universities, a critical contribution to the development of each Town Hall. The factual information in the research report, complemented by the diverse backgrounds of the participants, provides the framework for the discussion at a Town Hall, which follows a carefully developed process. Meeting for two days in small groups following the same discussion outline, then on the third day as a total body, the participants review, approve or amend and finally affirm the Town Hall report. Bound with the research, this official document is distributed to New Mexico First members and contributors, New Mexico legislators and other elected officials, the media and the general public.

Enactment of Town Hall findings is not a primary purpose of New Mexico First; the organization is not a lobbying group. Participants, through their leadership within their communities and throughout the State, will influence others and effect relevant changes at whatever level is most appropriate. Over the years ahead, by combining a visionary purpose with a practical format, these democratic forums will establish in New Mexico a tradition of discussion, cooperation, leadership development and consensus-building on issues critical to New Mexico's future — truly a "catalyst for positive action."

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Report of the Second New Mexico Town Hall

May 15-18, 1988

Continuing a tradition established in 1826 by Santa Fe ordinance mandating attention to water resources, the Second New Mexico Town Hall was held in Angel Fire, May 15-18, to address the topic — Water: Lifeblood of New Mexico.

New Mexico First, a non-profit, non-partisan organization, sponsors Town Halls semi-annually, bringing together citizens from throughout the state to discuss topics of statewide concern which merit the input of the general citizenry to better plan for the future. The Second Town Hall brought 74 participants from 28 locales to The Legends in Angel Fire to discuss water quality, appropriation and administration. The participants were varied in their personal and professional backgrounds and in the resources available to them in the many geographic areas represented. The participation of such a diverse group underscored the importance of the topic as one needing immediate attention on a local, state and national level.

Several issues were made clear. A state with substantial agricultural and mineral development traditions but increasing numbers of urban and industrial users needs to reassess priorities and allocations. Augmentation of existing water is unlikely in a climate where interstate competition is as great as intrastate. Both the quantity and quality of water must be addressed thoroughly to meet the needs of each area of the state. Although New Mexico traditionally has been at the forefront of water policy among the western states, we must reassess approaches and attitudes as we approach the 21st century.

The New Mexico Town Hall provides sufficient background and educational information so that participants may expand their knowledge about the topic undertaken. Participants use group discussion to formulate recommendations to take back to their communities and to appropriate legislative and policy-making boards for action and implementation. The purpose of this report, then, is to formally present the findings and proposals of the Town Hall participants.

This report should not become an addition to the library; it is meant to be used as a resource. It is the result of session deliberations during which participants, divided into five groups, addressed specific questions and reached consensus recommendations which were forwarded for compilation and editing. That draft was reviewed by the participants at a plenary session the morning of May

18, 1988, amended and adopted as the Report of the Town Hall. Though it may not reflect each participant's individual view, and though each may not subscribe in toto, the report reflects consensus.

SIGNIFICANT ISSUES AND THEIR SOCIAL AND CULTURAL EFFECTS

As residents of all regions of the state, participants in the second New Mexico Town Hall found that the discussion of regional needs and statewide issues regarding water gave them the opportunity to formulate recommendations which could benefit all New Mexicans. In that context, participants recognized the strong and unique tradition of New Mexico water law and water regulation.

The knowledge that a new era in water management and planning is inevitable in New Mexico, however, emphasized the importance of the Town Hall recommendations and the value of these recommendations to the future of our state. In the spirit of New Mexico First, the Second Town Hall confirmed the importance of long-term commitment to informed discussion about statewide issues by concerned citizens from throughout the state with the goal of consensus.

Orderly water management and communication of that managerial system to the public must be addressed by New Mexico in order to ensure the future. Our ability to manage water effectively is affected by: the lack of consistent local, regional, state and federal policies; the absence of coordinated implementation of policies; the lack of adequate staff and financial resources in public agencies; fragmentation of planning efforts; pervasive and costly litigation; and the difficulty of balancing competing users and uses.

Of equal concern to Town Hall participants is the impact of any change in water administration on that which is perceived as New Mexico's "Enchantment." Preservation of the rural cultural heritage based upon mineral development, agricultural traditions and natural environment is a priority in the context of increasing urbanization and economic development.

The state and its citizens are responsible for remaining good stewards of our water resources, refusing to abdicate the right of free will and self-determination relative to individual rights to water and for recognizing that the actions of an individual often have a long-range impact on the larger community.

To meet these challenges with minimal cultural impact is a goal. Recent amendments to New Mexico's water law incorporate public welfare and conservation considerations which should help protect cultural traditions by considering, as a point of departure, the historical and customary usage of water resources and the extent to which traditional values are adversely affected as a result of changes in the administration of water.

WATER QUALITY

Although New Mexico's water quality is generally perceived as good, it is a fragile resource. New Mexico Town Hall participants agreed that water quality should be a state priority.

Degradation of Water Quality

Different regions of the state suffer from different types of water quality degradation: septic tank pollution, underground storage tank leakage, oil and gas production contamination, land fills, mineral development, agricultural activities and illegal dumping. Adequate public education and enforcement of standards appropriate to different regions and to specific problems are necessary, not only to protect New Mexico from any further loss of quality, but to enhance the quality of water, as well.

At a minimum, the State should enforce the statewide standards which already exist. However, because the statewide standards do not take into account regional differences and unique hydrogeologic conditions, water quality protection regulations must be flexible enough to protect water quality in different hydrogeologic environments. To address this issue, regulations should be modified to allow for appropriate consideration of various degrees of vulnerability of specific aquifers. Certain health and toxicity standards, however, must not be compromised.

The Town Hall recommends immediate allocation of sufficient resources to the Environmental Improvement Division and other regulatory water agencies to ensure adequate enforcement and, as necessary, to provide for updating (recodifying) of regulations so that standards are realistic and applicable.

Education of the public is necessary to create a partnership between the beneficiaries of clean water and the regulators. Informed individuals can provide a cumulative benefical effect on water quality through positive personal practices. Further, an informed public and electorate is more likely to support necesary legislative appropriations and statutory/regulatory provision. In addition, some funding should be provided by fees and fines imposed through diligent enforcement, with said revenues earmarked for the appropriate regulatory agency.

Improved legislation and enforcement is not enough. For example, areas with septic tank pollution could benefit from organizing regional water and sanitation districts and other cooperative efforts. This Town Hall strongly believes that prevention is much more cost-effective than clean-up.

It was acknowledged that any use of water causes degradation, but degradation in some circumstances may be appropriate due to necessity or to economic benefit. For example, good-paying jobs may be an acceptable trade-off for limited water quality degradation if the water is available for futher use "downstream," and as long as public benefits outweigh public costs. If the degree of degradation creates unusuable water supplies or clean-up is economically impractical, additional degradation should not be allowed.

The water quality standards should be established first. Following that, the degradation guidelines should be developed from economic need and impact, not the reverse. It is necessary for the state to define acceptable degradation in various circumstances. That definition must consider economic benefit. Public awareness and understanding of the process of defining degradation must be accomplished. The standards for each region must be realistic and applicable to it.

Water Quality Standards for Specific Geographic and Environmentally Sensitive Areas

Participants agreed that water quality standards for specific areas may be established at levels more stringent than state standards after reliable technical evaluation and regional public input. Once set, these standards should only be modified after full evaluation for local, state, national and international purpose and impact.

Once appropriate standards for water quality are established along basin or hydrologic lines, new activities or uses which impact that standard would be evaluated to ensure that the water quality does not fall below the minimum standard. In the alternative, water users for new activities might agree to improve existing conditions elsewhere in the region to compensate for some degradation, so an overall balance in quality could be maintained.

The Water Quality Control Commission has adopted standards for environmentally sensitive surface water. Currently, standards apply statewide for groundwater, except for additional protection for those groundwaters feeding environmentally sensitive surface waters. More stringent quality standards should be applied in areas where groundwater is extrememly vulnerable to water degradation or where the threat of extreme toxicity is present. Less restrictive quality standards can be applied where the use does not require high standards and significant benefits accrue.

Clean-up and Cost Allocation

Critical issues identified are legislation and regulation, education and funding.

Legislation and Regulation

- Standards, particularly for waste disposal, pesticides and septic tank pollution need to be re-evaluated and upgraded with aggressive enforcement and realistic timetables for clean-up.
- Statutory provisions that would preclude avoidance of liability for clean-up should be pursued on the state and national level.
- Routine monitoring of potential contaminant resources should be required.

Education

- The public should be informed that the cost of clean-up is higher than the cost of prevention.
- The public should participate, at least regionally, in the prioritizing of necessary clean-up projects.
- Incentives for research and for technological improvements for clean-up should be created at colleges and universities.
- The Rio Grande Technology Foundation (Riotech) should be asked to develop a joint research and development program with its member universities and the two national laboratories in New Mexico, with the goal of developing commercially viable conversion of the State's saline water to a usuable state.
- The State should expand data gathering on geology and groundwater to provide a basis for understanding the extent of New Mexico's potential water resource, the existing problem areas and the degree of existing pollution.

Funding

- Existing problems should be prioritized based on need, cost and the degree of clean-up necessary — recognizing that higher quality is likely to carry higher cost.
- Creation by the state of a "superfund" for recovery of existing and untraceable point-source polluters is recommended. If point-source polluters are traceable, they should be held fully accountable for clean-up.
- Adequate funding for clean-up and prevention programs should be provided. Some funding should be provided by fees and fines imposed for investigation and enforcement by regulatory agencies.
- New Mexico should investigate federal funding available for clean-up.
- The Town Hall advocates federal and New Mexico state income tax exemption on interest payable on bonds issued by the state or by political subdivisions to fund water-related infrastructure and clean-up.
- Financial incentives should be considered for those pollution sources which initiate measures to prevent environmental contamination.

WATER — LIMITED SUPPLY AND GROWING DEMAND

The Town Hall agreed that conservation and reallocation are the primary methods for meeting the growing demand for water resulting from population increase and economic development. The State should adequately fund the Water Research, Conservation and Development Fund. The Fund should be available to defray costs of conservation, research and technology for conservation, and water projects beneficial to hydrological regions of New Mexico.

Conservation

The state should quantify, to the fullest extent possible, the potential for water resource loss attributable to existing obligations and, following this, implement realistic conservation requirements consistent with that information. Water can be saved or salvaged by strict adherence to existing regulations. Conservation should be encouraged through economic incentives.

New Mexico should permit owners the right to sell or lease to the state or other in-state users water which is conserved.

Research in the molecular life sciences should be encouraged to develop new, high-value, low-water-use crop plants.

Although conservation in domestic, municipal and industrial uses is an issue, these areas represent a substantially small percentage of use than does agriculture. Therefore, the percentage of savings will be less. Pricing available water to reflect its cost encourages conservation.

In addition, municipalities and water utilities should undertake educational programs that will inform people of the need for conservation and encourage change in patterns of personal use. Municipalities should also investigate and consider recycling water and enhancing the return flow from effluent systems. Research must continue to make these recycling programs cost effective.

Municipalities also should pass and enforce appropriate zoning and construction codes to encourage water-efficiency. Tax incentives at state and federal levels should be encouraged for innovative construction techniques which conserve water. Municipalities should discourage creation of unrealistic environments. These include extensive areas of nonindigenous grass and trees requiring excessive amounts of water to maintain. This does not mean that residential landscaping, greenbelt areas or public parks should be prohibited — only that they should be realistically planned.

Reallocation

Reallocation of water through open market competition is currently the best method for shifting the use of the available water supply. The existing water transfer system now includes public welfare considerations. These considerations should be used to protect values associated with historical and customary use of water.

The Town Hall recommends that the State pursue the benefits of regional planning within areas of common hydrologic and political interests. The state should provide continued funding and consultation to these regional planning efforts.

New Mexico has a large quantity of saline and brackish water. Given this, the state should encourage research and refinement to make desalinization cost-effective. Agricultural water blending, use of saline water for recreational purposes, as well as appropriate research and development toward marketable crops or industrial uses for brackish or saline water, should be promoted.

MINED GROUNDWATER — DEPLETION IN EXCESS OF SUPPLY

Depletion is an increasing problem for regions in which little or no recharge of the aquifer occurs. The results are increased cost of production and the exhaustion of a non-renewable resource. This regional problem will ultimately impact on the state as a whole. The Town Hall believes — because the costs of the solutions to this problem are high — that this problem should be the shared responsibility of the state and the regions affected and can only be adequately addressed by input from both.

The research report states, "in parts of the state, projected water demands are estimated to exceed the available supplies within the next 20 years." It also notes that "half of the fresh groundwater now being pumped is also being mined; that is, the amounts annually withdrawn exceed the recharge." Therefore, the Town Hall recommends that there should be a firm policy to reduce the annual rates of depletion through a comprehensive conservation program and through supply enhancement by groundwater recharge, especially in the most vulnerable areas or basins.

The Town Hall further recommends that local, private and public water interests identify their depletion problem and address their hydrological and political interests in common. The current system for regional water planning authorized by statute should be supported and given an opportunity to work.

An orderly approach to the depletion issue requires adequate data collection and distribution, planning by the regional units with state assistance and the enforcement of regulations that address depletion.

A thorough assessment of existing surface water and groundwater should be conducted. Discrepancies between physical amounts available and amounts remaining after legal and economic constraints are imposed should be defined. Once determined, all information should be available to the public.

The 40-year planning horizons on the local level are adequate. The state needs to adopt a similar mechanism. Every ten years, all plans should be reassessed and updated as appropriate.

Each affected region should investigate and evaluate the economic feasibility of importation of intrastate waters to reduce mining of groundwater. The state should undertake investigation of innovative transportation means such as use of pipelines or existing rights of way for transport of water intrastate.

INTERSTATE COMPETITION — HOW TO RESPOND

The Town Hall believes New Mexico should move quickly to appropriate unappropriated water wherever it exists, based on a definite use plan derived from regional and state planning efforts. Appropriation will give the state the control necessary for future needs. It is vital that the proprietary nature of water rights be preserved. The state should encourage appropriation for beneficial use by municipalities or other available in-state users of the water for future needs.

Interstate planning with neighboring states is suggested for consideration in an attempt to arrive at negotiated settlements and avoid protracted litigation. The state should, however, continue to litigate as appropriate to protect New Mexico's water.

WATER ADMINISTRATION AND MANAGEMENT

Goals of Water Management

The Town Hall agreed that a successful water management system should:

- Ensure the adequate quantity and quality of water based upon the needs of New Mexico and its citizens;
- Balance the current use of water with protection of the future quantity and quality of water;
- Perform all statutory duties on a timely basis and enforce all existing laws;
- Promote local, regional and statewide planning and policy development for water resources in New Mexico;
- Maintain the proprietary nature of water rights;
- Encourage conservation;
- Create a comprehensive database of all existing surface water and groundwater information, establish an open policy regarding its availability, and increase public awareness through dissemination of information;
- Encourage resolution of Indian, federal and interstate water claims;
- Develop an alternative dispute resolution mechanism to resolve water issues (e.g., arbitration, mediation or an administrative law judge system without appeal de novo to district court);
- Give consideration to the unique cultural heritage of New Mexico in determining water use;
- Give consideration to the potential economic impact on decisions made in the management and administration of the system;
- Create and fund a state "superfund" for clean-up and as a capital fund resource for use in funding cost-effective solutions to water problems;
- Give consideration to mainstream flow, recreation, fish and wildlife and aesthetic uses in the valuation of water;

- Promote water resources research and development efforts;
- Coordinate with economic development efforts to ensure that economic development and water supply and quantity are compatible.

State Level Water Management Structure

Strong consensus was reached by the Town Hall on the need for an appropriate planning policy and management structure, in lieu of the creation of "just another administrative agency." This management system should ensure public access to information and require that the management structure establish priorities.

Although no consensus was reached by the Town Hall as to the single most effective water management structure for the state, the following process is recommended:

1. Creation of a Task Force, with staffing, to suggest and analyze options regarding a future statewide water management organization to accomplish the goal of efficient use of New Mexico's water resources. The State Engineer or designee, the Secretary for Health and Environment or designee, and the Secretary for Energy, Minerals and Natural Resources or designee should be non-voting, ex-officio members. Among possible options, they should address:
   - the creation of a cabinet level Department of Water Resources,
   - the need for a constitutional amendment for creation of a Water Commission, and
   - the creation of a legislative standing interim committee on water resources.
2. Creation of a system for water management in lieu of a single administrative body. Necessary components of the system, though independent of one another, would appear to be:
   - Data gathering and analysis,
   - Planning,
   - A water rights allocation function,
   - A water quality regulatory function.

   These system components would be staffed through coordinating existing state agencies and regulatory bodies and their personnel, not by creating a new or reorganized administrative agency.

Regional Planning

The Town Hall recommends that regional planning groups based on hydrological and political interest should be created or identify themselves immediately to address their water needs and problems. One benefit to these regional planning groups will be to improve communication between the state and local levels of government relative to water planning.

A FINAL NOTE

New Mexico First will enhance the prospects of implementation of the recommendations of the Second Town Hall by:

- Presenting this Report to the Governor and elected and appointed leaders of New Mexico.
- Distributing the combined Research Report and Town Hall Report in final printed form to New Mexico First members, legislators, media representatives, libraries and interested citizens.
- Coordinating public presentations by participants on the subject of the Second Town Hall within their own communities to demonstrate the value of the organization and to recognize the participants' contributions to this important effort.

DISCUSSION OUTLINE

A key element responsible for the success of the Town Halls is the discussion outline. Suggested questions and issues are provided by the Research Committee and Research Team as the scope of the topic is developed and the background report formulated. In response to the research report, Town Hall participants also submit their suggestions. The Town Hall Committee consolidates the responses into an outline which will bring a logical order, that is objective and probing, and that will produce concrete ideas and recommendations about the topic. The final outline is then provided to the participants, discussion leaders and recorders to structure the panel discussions and guide the report developed at the Town Hall. The following outline was used for the Second New Mexico Town Hall on "Water: Lifeblood of New Mexico," May 15-18, 1988.

Session I

What do you think is the single most important water issue facing New Mexico today?

What do you think will be the most significant social and cultural effects if our current patterns of water use and water administration change?

Water Quality

New Mexico's water quality is generally considered to be relatively good, but there are a few exceptions. Between 1927 and 1986, 609 cases of ground water contamination were recorded in Albuquerque, Farmington, and the Southern High Plains of New Mexico from leaky gas tanks, PCB's, oil/gas, uranium tailings and landfills. Estimates are that non-point sources of pollutants will remain essentially the same from agricultural return flows (increased salinity content).

1. How do we keep from further degrading the quality of our water?
2. Should we allow degradation in some areas for specific reasons (for example, for economic development purposes)?
3. Should we have a category of water quality standards specifically designed to protect environmentally sensitive areas?
4. How should we clean up or otherwise deal with those areas in which the water quality is already degraded?

Session II

Limited Supply And Growing Demand

About 70 percent of New Mexico's water is used in agriculture. Municipal and industrial (M & I) demands for water will increase. Augmentation of current supplies is not likely in the foreseeable future. Therefore, the state must meet future water needs with its existing resources. If no new supplies are made available, what are the "best" ways to meet the growing needs? (Consider whether the method is cost-effective, practical, politically feasible, etc. The following are among the possible methods for dealing with a limited supply and growing demand).

- Conservation: Agricultural
  - Municipal
  - Industrial
- Reallocation: Water market
  - Condemnation
- Shifting of the current supplies from one area of the state to another (intra-state importation)
- Desalinization of saline water; use of saline water

Session III

Mined Ground Water

In the Texas Gulf, Central Closed and Southwest Closed basins, there is little or no surface water available. In less than 50 years, depletions will exceed supplies in the Upper Rio Grande, Pecos and Texas Gulf basins if economic conditions remain at current levels. If economic activity increases at a higher level, depletions will exceed supplies in less than 50 years in the Upper Colorado, Upper Rio Grande, Lower Rio Grande, Pecos and Texas Gulf basins.

1. Whose responsibility is it to deal with this problem?
   - Each local community?
   - Regional bodies?
   - The State of New Mexico?
   - A combination of the above?
2. What should be done now to deal with this problem? For example, you might want to consider the following:
   - Rate of mining water
   - Planning and planning horizon
   - Conservation
   - Importation

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Session III (continued)

Interstate Competition

There are 25.9 million acre-feet of "free" (unappropriated) water in New Mexico which could be available for use either within or outside New Mexico (estimate based on a 1986 report by C.T. DuMars, "State Appropriation of Unappropriated Ground Water: A Strategy for Insuring New Mexico a Water Future"). Surrounding states are looking to New Mexico for water.

1. What should be New Mexico's response to interstate competition for New Mexico's water?
   For example: Do nothing
   Sell it to out-of-state buyers
   Seek federal legislation
   Litigate
   Negotiate compacts with surrounding states

Session IV

Water Administration/Management

Currently, New Mexico (the State Engineer) inventories existing water supplies, issues permits and facilitates water rights transfers. In the past, the State Engineer has promoted construction of major water projects, all of which are **now complete.** The state has not engaged in comprehensive, long-term water planning. We have not had an entity, separate from the State Engineer, independently evaluating water allocation (competing uses) in New Mexico. The state does not have jurisdiction over water on Indian enclaves or water reserved by the federal government for federal lands. In addition to the State Engineer and the Interstate Stream Commission, there are several state-level agencies which have responsibility for some specific areas of water management (see the research report for list).

1. What should be the goals of a water management system?
   For example: Planning (and, in the process, balancing other goals)
   Efficient use of water resources
   Protection of cultural values related to water issue
   Protection of water quality
   Protection of recreational/aesthetic values of water
2. What are the options for the most effective water management structure at the state level? What are the strengths and weaknesses of each?
   For example: Single individual
   Commission — appointed vs. elected
   Combined water quality and water allocation agency
   Separation of administrative (regulatory) function
   Agency coordination
3. How should regional planning be conducted?

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WATER: LIFEBLOOD OF NEW MEXICO

Background Report by
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CHAPTER ONE: WATER AT ISSUE

INTRODUCTION

New Mexico's water issues, as varied as the landscape, are common to all its peoples. Many of these issues are not new; but persist in regions where water shortages are not uncommon. The most pressing water issues facing New Mexico will be further discussed in subsequent chapters.

ISSUE: Reconciling New and Historic Uses

How will New Mexico retain the historic, traditional, religious and community values of its water culture and accommodate progress in water development and use? New water demands for our growing cities and for recreation have resulted in transfers of water from agricultural to other uses. Water demands are likely to increase. Such transfers are perceived as endangering the cultural and social values of water. It is not likely that New Mexico will get more water to accommodate the needs; thus continued transfers can be expected along with increased opposition to such transfers.

New Mexico water rights law provides for consideration of the impacts of water transfers and new water rights on the **public welfare**. These public interest concerns have been felt by our neighbors as well. Both Colorado and Arizona have addressed massive transfers of water from rural areas to rapidly growing metropolitan areas. Rural advocates have tried to reduce the effect of water transfers through a number of strategies. One approach involved litigation to protect the interests of the remaining water users and of the general rural community. Another approach utilized local taxation to generate income to purchase water rights that would otherwise be transferred out of the local area.

ISSUE: Dealing with a Limited Supply

New Mexico is a **semiarid** state with a growing urban population. In parts of the state, projected water demands are estimated to exceed the available supplies within the next 20 years. This localized, but common imbalance between supply and demand defines many of New Mexico's water problems.

New Mexico has a little more than one million acre-feet a year of surface water available for **beneficial use**. This supply is virtually **fully appropriated**, meaning all rights to these waters are already claimed. As a result, additional appropriations on most of our interstate and intrastate streams are not possible, and new uses can only come about when existing water rights are retired.

In the coming decades it is unlikely that New Mexico will obtain any new surface water sources to significantly augment its current supply. Augmentation faces at least three obstacles: the geographic distance to new supplies; the unwillingness of the federal government to underwrite the continued development of new water supplies for the region, and the uncertainty of weather modification.

Other methods of augmenting the supply also are limited. The supply can be increased by reducing uses from thirsty non-agricultural plants, called **phreatophytes,** and channeling streams to reduce seepage. These actions, however, may change the environment that supports fish and wildlife habitat.

Efficient use in irrigation can be achieved but would require expensive technology. Even if it were not costly, legal restrictions prohibit the transfer of saved water to other uses. In May 1987, the Oregon state legislature enacted a bill allowing irrigators to use or market water they salvaged by upgrading their systems. This incentive to improve water use efficiency included a provision that up to 25 percent of the salvaged water be dedicated to the public to maintain instream flow.

Only one-fourth of New Mexico's 20 billion acre-feet of ground water is fresh water. About 90 percent of this fresh supply now lies within **declared ground water basins**. A basin is declared under the administrative authority of the State Engineer's office if development indicates the supply is in danger of being depleted due to current and/or projected withdrawals. Half of the fresh ground water now being pumped also is being mined — the amounts annually withdrawn exceed the **recharge**.

Arizona addressed this problem by enacting the 1980 Groundwater Management Act, but is now faced with additional problems resulting from ground water classification. Municipalities are bypassing the Type I water rights, which only allows water to be physically pumped and transported from the original acreage to the municipality, in favor of Type II water rights. Type II rights are flexible and more valuable because they may be purchased and the water diverted from any location within a designated area. In a ruling currently under appeal in the Colorado Supreme court, the Colorado District Court upheld an El Paso County policy that requires developers to identify a 300-year water supply as a condition of subdivision approval. In Utah, the state engineer announced a formal water budget policy for the Snyderville ground water basin east of Salt Lake City to address the overpumping of its ground water.

ISSUE: Protecting Water Quality

Water quality in New Mexico becomes increasingly important as demands on our limited supply increase. New Mexico law allows for reasonable degradation of its water as a consequence of beneficial use. As a result, loss of water quality is permitted as long as it does not unreasonably harm downstream or future users. In a water scarce state such as New Mexico, this policy allows maximum beneficial use of water and protects water rights.

Water quality is a broad term that includes aesthetic issues such as water clarity. Suspended sediments contribute to poor water quality and other water problems such as silt deposition in reservoirs. Maintenance of minimum low instream flows is extremely important in fish and wildlife habitat. Water quality may be adversely impacted at low flows by pollutant discharges because of the concentration effects.

Water quality degradation caused by man and by nature is a problem in many areas. While there is some information on pollution in New Mexico, the data is insufficient to determine the forms, amounts and impacts of many pollutants.

Ground water contamination is of special concern since, by its very nature, ground water is neither quickly replenished nor easily cleaned up. Ground water contamination in New Mexico is mainly associated with oil and gas production and storage.

Declining ground water levels can cause a decrease in water quality, and at the same time increase pumping costs. Declines in pumping levels have adversely influenced the social and economic future of a number of affected regions in New Mexico.

ISSUE: Meeting Future Demands

By the turn of the century, demands on New Mexico's limited water resources in many of the state's basins will exceed available supplies. Since augmentation of current supplies is not likely, the state must meet future water needs with existing resources. Demand will probably be met by transferring existing water rights from one use to another, predominately from agricultural to municipal and industrial uses.

Demand also can be reduced through new technology aimed at increasing conservation and through better water use efficiency, particularly in agriculture. Agriculture (including irrigation, reservoir evaporation, livestock water and stock pond evaporation) annually depletes about 90 percent of the fresh water withdrawals. Because of the potential for large savings, water conservation in agriculture is of paramount importance. However, agricultural conservation is not a simple option. For example, agricultural producers need incentives to encourage the adoption of new, and often expensive conservation technology. Who will pay for the development of this technology, and how will it be implemented? Agricultural conservation raises legal questions also. For example, can a farmer who has reduced water requirements through conservation sell or transfer this saved water to someone else?

ISSUE: Administering the Supply

In light of the realities of diminished supplies and the absence of new water, the extensive institutional network that manages New Mexico's water supply has begun to reassess the role and direction of the state's water management policies. In some areas the state has taken a fragmented approach to water management, if there is no one agency is responsible for water quality. The state also lacks coordination between land and water planning policies. It is important that local and regional entities be involved in water planning.

New Mexico's State agencies and water managers must consider the authority of the federal government concerning certain issues of water rights. The issue of federal reserved rights, for example, is relevant to public lands states like New Mexico because large quantities of water originate or flow through national forests, parks and the public domain. Approximately 46 percent of New Mexico's land is federally owned. When the federal government withdraws or reserves land from the public domain for a specific purpose, it contends it also reserves the amount of water necessary to fulfill that purpose. In addition, federal reserved rights can complicate state water planning because often the state lacks knowledge as to how much water the federal government can claim for each reservation.

Indian water rights, although under federal jurisdiction, must also be considered in the state's water resources picture. Although current studies of water uses have addressed the issue of Indian water requirements, the quantities involved are unknown and/or in dispute. This uncertainty also distorts water planning efforts.

New Mexico must manage its water resources and consider out-of-state demands. State law allows New Mexico ground water to be transported to another state for use. On the other hand, the law can restrict out-of-state transport if it is contrary to water conservation or the public welfare of New Mexicans. Under interstate compacts, it may not be legal to sell surface water rights for use in another state, but this has yet to be tested in the courts. Until there is resolution of these and other related issues, the amount of water the state actually has within its jurisdiction will remain uncertain. This uncertainty hinders both comprehensive planning and economic development.

ISSUE: Participating in the Water Market

As New Mexico's water supply moves toward the condition of full appropriation, demand will be satisfied increasingly through the water rights market. The state has recently adopted a plan to appropriate water to itself for reallocation on the water market. Entrance into the water market will introduce the state to a host of management options and policy controversies.

Through research and technology, New Mexico may be able to market its 15 billion acre-feet of "naturally" impaired ground water for commercial use. Although it is too saline to be used directly in industry, municipalities or conventional agriculture, scientific studies indicate it is technically feasible to use saline ground water, without desalination, to grow fish and shellfish. It is also possible to use saline water under certain greenhouse or hydroponic conditions, which could prove commercially feasible in developing new industries in the state water quality and other water problems such as silt deposition in reservoirs. Maintenance of minimum low instream flows is extremely important in fish and wildlife habitat. Water quality may be adversely impacted at low flows by pollutant discharges because of the concentration effects.

CHAPTER TWO: NEW MEXICO'S WATER CULTURE

INTRODUCTION

Water in New Mexico is difficult to discuss without first understanding the effect of New Mexico's varied cultures, which influence decisions and disputes about water resources. The cultural attitude toward water in modern day New Mexico is as complex and vigorous as the distinctly Southwestern heritage. While it is important to maintain the unique character of New Mexico's multi-cultural heritage, it is also imperative that all cultural groups work as one community in the public interest of the citizens.

THE CULTURAL WATER HERITAGE

Native American

The first inhabitants of the New World migrated to the plains of eastern New Mexico about 12,500 years ago, a time when the cooler, wetter climate of the plains supported thousands of huge springs, streams, shallow bogs and ponds called **playas** (Jennings 1974). These prehistoric hunters, called the Clovis people, came because the region was inhabited by mammoths and other large animals. The bones of these prehistoric beasts, along with the stone tools used to kill and butcher them, have been found at the Blackwater Draw site near Portales. The Blackwater Draw area was occupied for thousands of years, during which time the climate became drier and the water levels continually dropped. About 5,000 years ago, the Blackwater people began digging pits in the beds of former lakes in their search for more water, thus constructing the earliest known water works (aquifer wells).

These early hunters and gathers, including the Anasazi of northern New Mexico, were cultural and biological ancestors of today's Pueblo Indians. These Native Americans saw themselves in harmony with nature, and if nature was harsh and unpredictable, their response was either to accept the conditions, adapt to them, or move on to a more hospitable region (DuMars, O'Leary and Utton 1984).

Cultural adaptation to the water supply is illustrated by the different water practices of the "western" and "eastern" Pueblo Indians (Plog and Bates 1980). The western Puebloans lived in a semiarid region of mesas and canyons with few permanent streams. To cope with this harsh environment, they developed several farming techniques. Although flood-water farming was the primary practice, they also may have engaged in irrigation farming where feasible. They responded to their high-risk environment by diversifying their crops and planting methods. Farming was generally a family affair, requiring ingenuity and patience, but little investment in labor. All aspects of western Puebloan life evolved around religion, therefore when plagued by the uncertainty of the rains, with the resultant uncertainty of livelihood, they turned to the supernatural to explain and influence nature.

The eastern Puebloans inhabited the Rio Grande region where the soil was more suitable for farming and the water source more permanent. They built diversion systems and terraced their garden plots to control water and prevent erosion. The labor required to maintain these water works encouraged the development of centralized authority. Because the water supply was more secure, religious ceremonies of the eastern Puebloans were aimed at persuading the spirits to send health and well-being.

Today, Native Americans continue a reverence for water. Gerald Nailor, Picuris Pueblo leader, calls water "the Life Source, a gift of the Great Spirit" (Atencio 1987). Pueblo water rights today are considered separate from other Indian and non-Indian water rights. This unique status is in recognition of the history of the original inhabitants of New Mexico and the first users of the water (DuMars, O'Leary and Utton 1984).

Spanish

The Spaniards who conquered New Mexico in the 16th century viewed water as a divine instrument to be used in the conquest and Christianization of foreign lands. Access to water was essential to this mission (DuMars, O'Leary and Utton 1984). The Spaniards clearly recognized water as a source of power and used land and water grants to encourage settlement in captured frontiers (Meyer 1984). Because they saw natural resources as tools of Christianity, they developed the technology to implement their perspective. They brought to their new colony technological advances in ditch irrigation and their legal system of water control. Part of the legal process involved the formation of community irrigation ditches, called **acequias.** Often the construction of the community irrigation system was the first enterprise that brought the Indians under the command of the Spanish rulers. However, the Spanish fondness for town life and the concerted policy of bringing the Indian population together in missions strained the water supply almost everywhere. Although land was almost limitless, land with a reliable and permanent water source was scarce. Land disputes almost always involved contentions about water. Despite these obstacles, the Spaniards approached expansion and control of people and resources with a fervor that gave vitality to the Spanish culture (DuMars, O'Leary and Utton 1984).

Today, the acequia is a recognized political subdivision of the state (Brown and Ingram 1987), where Pueblo and Spanish beliefs intertwine. The feast of San Juan, for example, is celebrated in the San Juan Pueblo in honor of a Christian saint. The June 24th ritual also honors the power of the sun; the date coincides with the summer solstice. To Hispanics, the San Juan feast day marks the first day of the year when they again can go into the waters of the river. On that day water is thought to be sanctified and in turn blesses and purifies humans at the onset of the summer season (Atencio 1987).

Anglo

The influx of the Anglos in the 19th century and the resultant United States' claim on the New Mexico Territory in 1848 is a third influence on New Mexico's water heritage. The Anglos arrived in New Mexico from the humid eastern states where water was abundant and private water rights were tied to the ownership of land bordering a natural river or stream (Hutchins 1974). Their attitudes toward water rights ownership and natural resource abundance were in marked contrast to New Mexico's historic practice of water as a scarce and public natural resource.

Along with the appearance of the American settler, the Gold Rush and the Reclamation Act of 1902, came a new perspective — water as a commodity (DuMars, O'Leary and Utton 1984). There were resources to be had in the West: precious minerals, oil, gas, coal and even the dry, healthful climate. A prerequisite for acquiring these primary resources was water. If oil, gas and coal could be bought and sold, so could water. If someone else had already "discovered" it, the new settlers could buy it or trade for it.

Although these frontier entrepreneurs faced a water supply even more limited than their Indian and Spanish predecessors, they remained undaunted. Instead of existing in harmony with the environment, the Anglos challenged the land and its resources. Their solution to drought, for example, was to drill wells (DuMars, O'Leary and Utton 1984). In the last half of the 19th century and the first half of the 20th century, they devoted their energies to building massive irrigation projects and dams and took advantage of new technology to pump **ground water** (Harris 1984). Their collective mission, like that of the Indians and Spaniards, was to increase access to water.

Today, the Anglo view of water as a commodity governs the way **water rights** are transferred from one use to another and from one user to another. In addition, the cultural value of water is beginning to be considered in these transfers.

THE INFLUENCE OF CULTURE ON DEVELOPMENT

Historical Development

The early development of New Mexico's water resources was a gradual process dependent upon the availability of the resource and the needs of the area. The Puebloans irrigated their fields primarily from streams or storage reservoirs. These systems were built, used and regulated by the entire community. This system is still basically followed by the Puebloans today, as well as in most of the state's rural Hispanic villages (DuMars, O'Leary and Utton 1984). During the Spanish period the small rural communities that served the farming colonies were patterned after the older Indian

Pueblos, and somewhat after the feudal villages of medieval Europe (Sorensen and Lindford 1967). People lived in villages and cooperatively farmed surrounding lands. Farming required construction and maintenance of irrigation ditches and out of necessity the community ditch became a communal enterprise (Sorensen and Lindford 1967). Acequia associations were typically the first governments in many areas.

The Anglo period of water development accelerated after the Civil War when immigrants began settling the Rio Grande Valley. Irrigation intensified and the grazing industry emerged, causing dramatic changes in the water supply. By 1880 every piece of irrigable land was under development and people began to complain of water shortages (Hatch 1987). Shortages began to occur in other regions and the competition for water intensified. In some areas along the Rio Grande, however, flood control was the primary water problem. Albuquerque, for example, remained flood prone until construction of the Middle Rio Grande Conservancy District.

During the Anglo development period, New Mexico's rich mineral resources also attracted those eager to mine its gold, silver and copper. Further mineral and petroleum discoveries in the first half of the 20th century contributed to the economic growth of the state (U.S. Bureau of Reclamation 1985). These extractive industries also made demands on the state's water resources.

In 1891, flowing artesian ground water was discovered and by the turn of the century this source of water was being used for irrigation (Sorensen and Lindford 1967). By 1925 more than 1,400 **artesian wells** were in operation, mostly in eastern and southeastern New Mexico. Soon, however, water levels began to decline and wells began to fail. The severity of the declines finally resulted in the enactment of the state's ground water law in 1931. No new artesian irrigation has been permitted since that date.

Reclamation Era

Traditionally, water projects in the West have been concerned with irrigation development. The 1902 Reclamation Act was a major milestone in New Mexico's water development history. The legislation authorized the U.S. Bureau of Reclamation to begin construction of dams on the Rio Grande and Pecos River. When the Pecos River Project was completed in 1907, the citizens of Carlsbad enthusiastically celebrated July Fourth that year with a "water carnival" instead of fireworks (Beck 1962). The completion of Elephant Butte Dam in 1916 allowed farmers in New Mexico and Texas to bring 160,000 acres of farm land under irrigation. At the time of its completion, Elephant Butte Reservoir was the largest manmade lake in the world (U.S. Bureau of Reclamation 1985). The Bureau of Reclamation also constructed the irrigation and drainage works in the Middle Rio Grande Conservancy District (Mutz 1987). That project, which serves the Albuquerque region, was completed in 1935.

The Reclamation Era, however, was not as welcome among the rural Indian and Hispanic water users. Economists F. Lee Brown and Helen Ingram write in their book, Water and Poverty in the Southwest, that during the 100-year development period, the region's rural poor neither benefitted from, nor effectively participated in, decisions involving river compacts, dam or reclamation project construction or most other major water events (Brown and Ingram 1987). In some respects, development has actually harmed those interests. Many of the water storage facilities and delivery systems built in New Mexico's Upper Rio Grande region mainly benefitted interests outside the region.

The massive San Juan-Chama Project and the Navajo Indian Irrigation Project, both authorized in 1962, brought an end to the Reclamation Era. The authorizations were the result of years of negotiations among the New Mexico Interstate Stream Commission, the State Engineer Office and the Navajo nation for water allocated to New Mexico under the 1949 Upper Colorado River Compact (Clark 1987a). Under the **interstate compact,** the amount of San Juan water available to non-Indians was based upon an amount calculated after the Indian allocation was met (Clark 1987a). The San Juan and its tributaries were the major surface supply for Navajo, Ute and Jicarilla Apache reservations in New Mexico. State Engineer John Bliss, in negotiations on the project in the 1950s, acknowledged the claims of the Indians, but also noted that it was vital to New Mexico's economic future that San Juan project water be diverted for use in the Rio Grande Basin.

The San Juan-Chama Project in 1966 resulted in what became known as the Aamodt suit. With the prospective addition of new water to the basin came ambiguities associated with unresolved water entitlement claims, both within predominantly Hispanic communities and between Pueblo and Hispanic Anglo water users (Brown and Ingram 1987). The result of these clashes has been protracted and expensive **litigation** accompanied by a highly charged, emotional disruption of the Hispanic, Anglo and Indian communities in the region.

Today, the Navajo Indian Irrigation Project consists of 110,630 acres of irrigated farm land and 508,000 acre-feet of water allocated to the Navajo nation. Water from the San Juan also powers the Four Corners generating plant on the Navajo reservation. The San Juan-Chama Project transports water from the San Juan Basin to the Rio Grande Basin for various uses including municipal, irrigation and recreation. The city of Albuquerque, for example, has contracted for 48,200 acre-feet a year of project water.

From Development to Management

The era that saw the development of large water projects has given way to one of water reallocation and management. In this current climate, with no new water available, more attention is being given to uses that are economically beneficial (Ingram 1987). The cultural implications for such changes are complex.

Shifts away from agricultural uses, while not expected on a large scale, also will mean changes for New Mexico's traditional water users, often Indians and Hispanics whose family farms provide only supplemental incomes. Until a recent change in the law, which considers the **public welfare** in water rights transactions, an agricultural water right could be sold or transferred for another type of use regardless of that use as long as the sale or transfer would not harm existing rights.

Though traditional water users recognize the need for continued economic growth, they also believe development should include options that are consistent with the cultural values of Pueblo tribes and Hispanic rural settlements, including the need to retain water rights for traditional uses (The Course of Upper Rio Grande Waters: A Declaration of Concerns 1985). For these users, agriculture is an important part of their lifestyles, although it may be a part-time activity (Brown and Ingram 1987). Water is perceived to be an essential element in the preservation of Hispanic culture and the desire to preserve that culture is of paramount concern. As dramatized in John Nichols' The Milagro Beanfield War, threats to the cultural links to water generate strong community reaction (Nichols 1974).

The cultural link between agriculture and water is just as strong in the agricultural regions of southern and eastern New Mexico. Members of the Elephant Butte Irrigation District (EBID) view El Paso's applications to drill wells in Dona Ana County and pump that water across the state line to Texas as a threat to both economic and social foundations. William Saad, EBID manager, testified in the application hearing that "the only thing that makes this district strong is the water that's available to it" (Saad 1987b).

Farmers in the Pecos River Valley face a more immediate threat. Under a U.S. Supreme Court decree, New Mexico owes Texas 340,100 acre-feet as a past debt and another 10,000 acre-feet a year to bring it into future compliance with the Pecos River Compact. Pecos farmers may have to **retire water rights** on irrigated farmland to pay the debt. Although their ties to the land are more recent than those of the traditional water users in northern New Mexico, the threat to family farming and ranching enterprises has a profound social and economic effect on the region.

Because New Mexico is considered a rural state, **municipal uses** of water are only about 6 percent of the total. By comparison, urban demands in Texas account for 16 percent of the total (Kaiser 1986). However, population growth will continue to increase its demands on the water supply (Wilson 1986). Today the state's population centers are scattered along the major river valleys. In 1985, 58 percent of the state's population lived in the Rio Grande Basin, concentrated mainly in Albuquerque and Santa Fe; an additional 15 percent of the state's residents lived in the

Pecos River Basin (Peach and Williams 1987). Of New Mexico's 1.4 million population, 71 percent live in urban communities (Wilson 1986).

Major social and cultural disruptions occur when water is quickly and heavily transferred from agricultural to urban uses. Phoenix, Arizona's recent acquisition of agricultural water for urban use illustrates the problem. Phoenix, Scottsdale and other central Arizona cities purchased large tracts of farmland in La Paz County, Arizona, with the intention of pumping La Paz ground water to their cities (Nunn 1988). La Paz citizens became concerned about the economic and social consequences of these large purchases and formed rural water defense groups. Albuquerque's acquisition of San Juan-Chama water has proceeded without major disruption primarily because it has acquired "new" water.

The recreation industry is the newcomer to New Mexico's water community. In 1986, the state's travel, tourism and recreation industry produced $1.9 billion (Findling 1987). Recreational development highlights social and cultural differences because it introduces new demands into the water use profile. Those in the water recreation industry contend that because the industry brings economic benefits to the state, **instream use** should be recognized as a legitimate water right (Findling 1987). Critics of recreational development, however, protest that resort communities are developed at the expense of the environment and the native community (Atencio 1987).

CHAPTER THREE: MANAGING NEW MEXICO'S WATER

INTRODUCTION

New Mexico can be proud of its water management heritage. The 1907 surface water code became a model for water rights administration in several western states. In 1931 the state was also at the forefront when it enacted its ground water code, and it was one of the first states to conjunctively manage surface and ground water. Although water management is largely defined by statutory law, the interpretation of that law is influenced by managers, supply and demand, the water market, and public attitude.

NEW MEXICO'S WATER MANAGERS

The State Engineer

The position of state engineer is unique to the **prior appropriation** states of the West where it is necessary to have a public administrator manage the water for the public good. By statute, the state engineer must be a registered professional engineer, who is appointed by the governor and confirmed by the New Mexico Senate (NMSA 72-2-1). The State Engineer is responsible for the general supervision of the state's water resources, including their measurement, appropriation and distribution.

New Mexico has had three territorial engineers (before statehood) and 13 state engineers (State Engineer Report 1956). Although it is not unusual for a western state engineer to hold office for several years, none has served longer than the current New Mexico state engineer, Steve Reynolds. Since taking office in August 1955, he has become the singularly most powerful water manager in the state. Although his authority and responsibilities are set forth in the statutes, he also has broad discretionary powers in applying those laws. For example, Reynolds, as state engineer and hearing officer, presided over the hearing to determine whether the city of El Paso, Texas, would receive approval of its well applications. Although his decision was based on testimony and evidence, he had the sole authority to decide whether or not El Paso would be allowed to pump ground water in New Mexico and transport it to Texas. Although the list of lawsuits filed against Reynolds as state engineer indicates that not everyone agrees with his decisions, he is the acknowledged technical, legal and political expert on New Mexico's water resources.

During the past 33 years Reynolds has built a powerful and capable water domain. Reynolds' retirement, which has not been announced, and the identity of his successor have become the subject of widespread speculation. Previous actions taken at the direction of the statutes will, of course, serve as a guide for the new state engineer.

Water Agencies

Numerous organizations with authority ranging from advisory to judicial influence and control water resources administration in New Mexico. At the local level, many associations exercise considerable administrative control over water. State-level agencies are charged by statute with varying responsibilities including the administration of water rights, protection of the water quality, and the provision of public recreational facilities. The federal government also exercises administrative control over the management of waters within the state. The U.S. Environmental Protection Agency (EPA), regulates certain aspects of water quality in New Mexico. Federal regulations also come into play regarding water resources management on federal reservations.

Informal groups can influence water resources administration through public opinion and public participation. These organizations may include environmentalists, recreational users, and citizens' groups.

Municipalities.

Municipalities throughout New Mexico are concerned with meeting the water needs of the municipality and its residents while safeguarding water quality and providing flood control. The laws governing municipal water resources administration are constantly being modified and tested in court. In 1985 New Mexico law began allowing municipalities, counties and public utilities to plan for and hold only those water rights which could be beneficially used within 40 years (NMSA 72-1-9). Aside from meeting the requirements of the "40-year rule," each municipality generally manages its water based on its own needs. A study by Folk-Williams, Fry and Hilgendorf (1985) demonstrates the diversity of water management systems in the West. The three New Mexico cities studied were Albuquerque, Gallup and Santa Fe.

The city of Albuquerque owns the municipal water supply, which is managed by the Water Resources Department. The city will not serve an area unless it is subject to annexation, with the two large exceptions of the South Valley and the North Valley. Currently, any developer within or outside the city limits who wishes to be annexed is required to get a water availability statement from the Water Resources Department. The city has a joint powers agreement with Bernalillo County to serve areas of the county in need of domestic water service. The county has no water rights or delivery system of its own. The service area of the Middle Rio Grande Conservancy District also runs through the city along both sides of the Rio Grande. The city serves residential customers within the district service area on land that has been developed or on land that is still agricultural but needs a domestic supply. The city holds water rights from the San Juan-Chama Project.

Gallup's mayor and city council administer the city's municipal water system and are responsible for making water policy. The city's growth management plan adopted in 1984 is applicable only to lands adjacent to the city. Annexation requires that land be contiguous with the city boundaries. Gallup employs a person to coordinate city and county growth decisions. As of 1985, however, the county had no growth plan, no master plan, no land use plan, and no zoning laws. Historically, the county has acquiesced in city annexation decisions, objecting only if the city annexed land, such as an industrial park, that would reduce the county's tax base.

The Santa Fe water system is owned and operated under a franchise agreement by a Public Service Company of New Mexico subsidiary (Sangre de Cristo Water Company), making Santa Fe one of the few cities of its size in the West with a privately owned water company. Water rates are regulated by the state Public Service Commission. The city and county share jurisdiction over the "extraterritorial zone," which is the area lying outside but within five miles of current municipal boundaries. In 1980 Santa Fe County adopted an ordinance requiring future population growth in the county to be supported by adequate long-term water availability.

Local Regulatory Agencies

Several agencies with local or regional constituents operate under either state or federal authority. For example, irrigation and conservancy districts and, on a smaller scale, community ditch and water users associations, are local groups operating under state regulations for the mutual benefit of their members. Although they are political subdivisions of the state, they may be subject to federal regulation. The members share the right to use and the cost of transporting the water. Governing boards determine the policies of these organizations. The more widely known agencies are listed below (Harris 1986, Clark 1987a).

Community Ditch Associations are the most numerous and widely scattered of all water distributing organizations, numbering into the hundreds and active on every stream system in the state. In 1965 the Legislature declared acequias and community ditch associations to be political subdivisions of the state.

Water Users Associations, also called mutual ditch companies, have endured in New Mexico to a limited degree despite efforts to convert them to the more formal irrigation districts. Their original purpose was to provide a form of organization capable of contracting with the federal government for reclamation projects. They are not organized for profit and their sole asset is their distribution system. They differ from irrigation districts in that they are voluntary and have fewer powers.

Irrigation Districts, though not federal agencies, were authorized by the federal government to collect construction costs and operating and maintenance charges from individual members to pay the U.S. Bureau of Reclamation for irrigation construction projects. Some districts, having paid the initial construction debt, have assumed the operations and maintenance responsibilities from the

Bureau of Reclamation (Saad 1987a). The principal purpose of an irrigation district is to provide water and service to irrigated farming.

Conservancy Districts provide irrigation services and flood and drainage control.

Soil and Water Conservation Districts cover most of the agricultural acreage in the state. The districts develop and execute plans and programs relating to any phase of water conservation and water usage. They also concern themselves with flood prevention, flood control, erosion prevention and control, and floodwater and sediment damages.

State Regulatory Agencies

State agencies are created by the state legislature and are governed by state law in structure, authority, responsibility and limitations. The following are the key state agencies that deal with water.

The New Mexico Environmental Improvement Division (EID) is responsible for the environmental management and consumer protection of the state's residents. Under this mandate, the EID collects information on surface and ground water quality, community water supplies, and municipal and industrial effluent quality. The EID performs most functions at the state level that the EPA performs at the national level. The head of the EID is appointed by the Secretary of Health and Environment with the approval of the governor.

The Water Quality Control Commission regulates a variety of activities and substances that may cause unacceptable degradation of water quality. The commission is composed of the directors of several state agencies and one member from the general public. The commission does not have a technical staff separate from the EID.

The New Mexico Department of Game and Fish collects water quality information relating to dissolved oxygen, pH, and water temperature for many of the waters in which fish plantings occur. The Department has fishery data on most of the state's waters.

The Interstate Stream Commission is delegated broad general powers in the protection, conservation and development of the waters and stream systems of New Mexico, both interstate and intrastate. The commission is authorized to negotiate compacts with other states to settle interstate controversies and to enter into other negotiations leading to equitable division and distribution of waters in the interstate stream system. Commissioners on the ISC are appointed by the governor and represent either major irrigation districts or river basins (NMSA 72-14-1).

The New Mexico Oil Conservation Division is responsible for protecting drinking water from the potentially harmful effects of oil and gas drilling and production operations. It regulates the injection of fluids for the secondary enhanced recovery of oil, the underground storage of natural gas and the disposition of salt water produced in conjunction with oil and gas. The division also regulates the drilling and production of geothermal resources on private and state lands. The head of the OCD is appointed by the Secretary of Energy, Minerals and Natural Resources.

The New Mexico State Engineer's Office is charged with general supervision, measurement, appropriation and distribution of New Mexico's water in accordance with the laws of the state. The legal authority of this office is discussed in chapter four.

Federal Regulatory Agencies

Federal agencies have wide ranging authority over certain waters and water development projects within the state. Those agencies and their authorities are listed below.

The U.S. Army Corps of Engineers operates seven major reservoirs in New Mexico. These reservoirs supply water and provide recreation in addition to fulfilling their primary purpose of flood control. The corps conducts planning and design studies for flood control and related water resource functions on all river basins in the state. The corps provides communities with technical assistance and floodplain management services other than construction.

The U.S. Bureau of Indian Affairs is responsible for protecting water rights of New Mexico's Indian tribes. The BIA administers 7.5 million acres of tribal, federal and individual lands in the state.

The U.S. Bureau of Land Management's responsibilities in water resources and watershed management include the protection, maintenance and improvement of soil and water conditions on 13 million acres of public lands in New Mexico. Its water resources program includes inventories and investigations of surface and ground water characteristics and problems, water rights and rehabilitation of watersheds having accelerated erosion and runoff problems.

U.S. Bureau of Reclamation projects in New Mexico provide the state with hydroelectricity, flood control, water quality improvement, river regulation, fish and wildlife conservation and recreation. Reclamation projects in New Mexico include 12 storage dams and reservoirs and 522 miles of canals and pipelines.

The U.S. Environmental Protection Agency is responsible for safe drinking water regulations and the protection of ground and surface water resources.

The U.S. Fish and Wildlife Service analyzes the impact of water resources development projects on fish and wildlife resources and recommends measures to offset the impact.

The U.S. Forest Service manages New Mexico's five national forests to maintain favorable conditions of water flow and to preserve oil productivity.

The Water Resources Division of the U.S. Geological Survey, New Mexico District, investigates the occurrence, quantity, quality, distribution, and movement of the state's water resources. The USGS coordinates the federal water-data acquisition activities within the state.

The goal of the U.S. Park Service is to ensure that water quality and water quantity, as they exist in the natural ecosystem of the park, are not altered significantly by neighboring users. The responsibilities of the service include the development of water wells, aquifer testing, and erosion and flood control on park land.

The Soil Conservation Service, (SCS) under its Snow Survey Program, forecasts spring runoff from snowmelt throughout the western United States. Streamflow regulation and water management, in general, depend upon these forecasts, which are published monthly by the SCS.

Agency Coordination

Since World War II, and particularly since 1960, New Mexico has restructured older institutions and created new ones in attempts to protect the limited water resources and to provide for orderly development and use (Clark 1987a). This restructuring has been motivated by federal incentives and local conditions. The accomplishment of both state and federal goals has been achieved largely by controls exercised through state agencies, political subdivisions and local water institutions.

These groups, whether private, state, or federal, must cooperate in their management programs. This cooperation can be accomplished through formal procedures evidenced by the joint efforts of the Elephant Butte Irrigation District and the U.S. Bureau of Reclamation. The two agencies work together to maintain the extensive irrigation system run by the district and served by the Bureau's reservoir. Cooperation also can be of an informal nature, as was the case when the city of Albuquerque agreed to accommodate summer weekend rafters by releasing city water to raise flows to rafting levels in the Rio Chama between El Vado and Abiquiu (Daves 1987).

PUBLIC PARTICIPATION

New Mexicans discuss water like most people discuss the weather. However, talking about water does not necessarily imply knowledge. To understand the complexity of water in New Mexico, one person must maneuver through a maze of social, legal and technical issues. There are some simpler avenues by which a citizen can find information, voice his opinion and bring about change.

The Public Participant

Activists in the late 1960s and early 1970s targeted the environmental policy area as one that should be more accountable to the general public. Public participation in environmental policy formation eventually became part of federal law. Those concerned with environmental policies must consider public participation as part of the democratic process.

A study by Lovrich and Pierce (1983) demonstrated that public participation, particularly through interest groups, is central to the water policy process. They found that those who participated in such groups were more likely to be better informed and better educated. Although the study speculated that the complexity of water resources issues required a higher educational level, the authors believed that participation itself was an educational experience. They found also that people were more likely to participate if they had an identifiable stake in water policy outcomes, and if they were dissatisfied with water resources policies.

Avenues for Participation

Public Hearings

State agencies dealing with water regularly hold hearings that are open to the public. These hearings are especially important because rules and regulations often are set at this level. Anyone can submit either a written statement or present testimony for these public hearings. The Interstate Stream Commission, the Water Quality Control Commission and the Oil Conservation Division, for example, hold monthly public hearings.

The public also can be a part of the decision-making process when a bill is introduced into the Legislature. All bills are first presented at a committee hearing, which is open to the public. At that time, anyone can make a statement about the bill under consideration.

State Representatives

The governor appoints all cabinet secretaries and approves other appointments. As the state's top administrator, the governor plays a key role in decisions affecting water resources. Since taking office in 1987, Gov. Garrey Carruthers has held some 20 Town Meetings statewide on a variety of topics. The public has the opportunity to talk with the governor and his cabinet members at these meetings. Cabinet members hold office hours prior to each meeting during which time citizens may discuss issues with a cabinet member. Each letter to the governor is answered either by the governor or the appropriate cabinet secretary. The lieutenant governor also responds to inquiries. The Constituency Services Office in the governor's office serves as a referral source for all inquiries.

Legislators, as elected representatives of the public, are to be responsive to the wishes of the public. Legislators introduce bills, approve appointments, and pass or fail legislation. Legislators are direct, effective agents of public participation.

Public Meetings

Most meetings and conferences sponsored by state agencies are open to the public. Though some meetings may be too technical for the general public, they are reliable sources of current information on water resources. The Annual New Mexico Water Conference, for example, has served as a forum for water issues since 1956. Each year the conference focuses on a water topic directly relevant to New Mexico. Although the conference usually features at least one technical topic. its main emphasis is on relaying water information to the general public.

MANAGING THE RESOURCE

Water Supply

Long ago New Mexico moved from the practice of developing new water supplies to meet its demands to a system of managing a fixed and sometimes declining water supply. Management under these conditions requires manipulating the supply to meet demands. This most often means transferring water from one use to another. Irrigated agriculture and urban demand are the two primary water users in the state. Conservation practices, vegetation and soils also affect the water supply.

Irrigated Agriculture

Irrigated agriculture, the dominant water user in each western state, continues to consume more than 90 percent of western water (El-Ashry and Gibbons 1987). Direct agricultural consumption in New Mexico represents 68 percent of the total annual use; indirect water losses, such as evaporation from reservoirs dedicated to agricultural water storage, increase the total agricultural-related consumption to more than 90 percent. The development of the state's supply for agricultural purposes reached its peak with the construction of several large reservoirs (Elephant Butte, Caballo and Conchas) in the first half of the century. Since then, the various irrigation districts have continued to make improvements in their water delivery systems, such as lining ditches and improving pumping efficiencies. The effects of these management efforts have been to increase water deliveries and to reduce irrigation costs. Strategies for increasing the available supply through water importation have not proved feasible from either a cost or management standpoint.

Municipal Supplies

Although New Mexico's urban population accounts for only 6 percent of the state's total water use, the percentage will increase as the population increases. New Mexico's population was the eighth fastest growing in the nation between 1980 and 1986, although it still ranked 37th in total population (Burgess, Brizius and Foster 1987). Recreational demand for water has grown along with population growth, and the value placed on instream flow for fishing, swimming, and boating has increased accordingly (El-Ashry and Gibbons 1987).

The city of Albuquerque, through its purchase of San Juan-Chama water rights has assured that city of a municipal water supply for decades. El Paso, Texas, has turned to New Mexico in its search for a new source of water to meet its municipal needs. Whether or not it will succeed in its quest has yet to be decided in the courts. Several major cities in the Southwest, including Tucson, are now mining ground water aquifers to meet their demands.

Soil Conservation/Vegetation and Soils

Soil conservation practices have a major effect on reducing the volume and rate of runoff from high intensity rainfalls. These practices also have acted to limit soil erosion. Federal and state programs to implement conservation practices have been so effective that the annual discharge of some stream systems in New Mexico has changed significantly during the past 30 years.

A variety of management techniques has been employed to control erosion, and to increase the amount of water that seeps into the soil. For example, "pitting" uses a device that makes small holes in the soil to catch rainfall and runoff. Hickey and Dortignac (1963) evaluated this technique during a three-year period on shale-derived soils near Cuba, New Mexico, and found that runoff decreased 10 percent with no noticeable difference with respect to erosion. Rauzi, Lang and Becker (1962) studied this technique on sandy loam, and discovered that infiltration rates increased two to four times. Once pitted, soils continue to increase infiltration rates for about ten years (Barns, Anderson and Heerwagen 1958).

Contour furrowing is another practice designed to retain surface runoff on site. Contour furrows increase infiltration and forage production, but are ineffective if placed more than ten feet apart (Hubbard and Smoliak 1953), and can have an effect for as long as 35 years. Contour trenches are effective only if they are used in conjunction with revegetation efforts (Branson et al. 1981).

Small reservoir construction is a good technique for reducing floods and sediment yield (Allen and Welch 1971), and has proved effective in reducing channel dimensions (Branson et al. 1981).

Vegetation will affect the quantity of water available because of differences in consumptive use. Vegetation also helps protect soils from erosion and acts as an anchor. Vegetation type also can determine soil chemistry, which may play a key role in determining how much water goes into the soil, and how much runs off.

Phreatophytes, such as salt cedar, willow, cottonwood and saltgrass, draw from limited ground water supplies. These plants cover an estimated 15.6 million acres in 17 western states, and transpire 25 million acre-feet of water annually (Robinson 1958). Few of the techniques used to control phreatophytes have been successful.

To some degree, soil characteristics will determine water absorption; clay soils do not absorb water as readily as sandy soils. In turn, a gravelly, sandy soil will permit more water to percolate to the ground water table. Land use and soil conservation practices have a marked effect of both vegetation and soil characteristics which in turn, influence the volume, location, timing and quality of water resources.

Conservation

Until the 1960s, those who lived in regions where water was abundant and reliable tended to view water, like air, as a free natural resource. The tendency was to keep the price very low. As a result, there was no incentive to conserve water, and it was used with "magnificent wastefulness" (Boulding 1974). New Mexico's water law, which requires water to be put to beneficial use, considered that requirement to be conservation in and of itself. No one beneficial use was given priority over another. However, the assumption that an acre-foot is an **acre-foot** (325,851 gallons) without regard to its use may change as the supply becomes more limited and the demand more competitive (Boulding 1974). New Mexico law prohibits the "willful waste" of water. As with beneficial use, the law broadly defines willful waste, leaving the responsibility of its interpretation to the state engineer.

Depending on the administration, the federal government has at times supplemented the state's passive approach to conservation. The Carter administration, for example, encouraged water conservation by integrating it as a condition of various federal grant and loan programs and by providing technical assistance to individuals through existing agencies (Clark 1987a). Water conservation also appears to be a natural extension of New Mexico's move from water development toward water management. A 1984 survey of New Mexico residents' attitudes toward water management found that 40 percent of the respondents believed that increasing water prices and offering tax incentives would be successful conservation methods (DeYoung et al. 1984).

As with non-renewable energy sources, water soon may be cheaper to conserve than produce (Boulding 1974). The city of El Paso Texas, has discovered just that. In its efforts to expand its water supply, El Paso is converting 4.4 million gallons a day of the city's wastewater into drinkable water (Knorr 1988). The city's Hueco Bolson Recharge Project recycles its treated wastewater by reinjecting it into the Hueco Bolson aquifer where it is mixed with the fresh ground water before being pumped again for use. The most practical solution for meeting the state's water needs is to reduce and restructure demand. That reduction can be accomplished through water conservation practices, pricing structures and increased education.

Agricultural Water Conservation

Increases in irrigation efficiency could release water for other sectors without significantly reducing agricultural output or accelerating land retirement. For example, a 10 percent increase in agricultural water use efficiency would double the water available for urban uses (El-Ashry and Gibbons 1987). Unfortunately, legal and institutional barriers to water conservation and water markets are numerous. If a farmer increases irrigation efficiency, the quantity of water saved cannot be sold or applied to new land. Instead, it must remain in the ditch or stream for use by the next senior appropriator. California, however, recently passed a law allowing the sale of conserved and salvaged water.

One unintended incentive to water conservation in irrigated agriculture can be the high energy cost for pumping. When oil prices are up, many New Mexico farmers reduce irrigation water usage or turn to dryland farming rather than pay the costs of pumping ground water.

Municipal Water Conservation

New Mexico's water law, which specifies the conditions for new ground water appropriations, requires that the state engineer consider the conservation of water in making decisions on the amount of water allocated to the new use. The implication of this rule is that municipal and public water suppliers must make an effort to ensure that urban demands are not wasteful and excessive. In recent years, conservation efforts have been successful in the southwestern communities of Tucson, Arizona, and Austin, Texas, in reducing urban water use. Water pricing also has been used as a tool to encourage conservation.

Until 1978 Albuquerque had a declining rate structure, which meant that the price for water decreased as more water was used (Folk-Williams, Fry and Hilgendorf 1985). The city's current water price is based on a fixed monthly charge, varying according to meter size, with industrial users paying more than twice the rate of residential, commercial and institutional users. The city has not determined whether or not there has been any conservation resulting from rate changes, but city officials claim a modest reduction in demand. The city also has a water-waste ordinance that provides the means to fine people who let water run off their property into the street. The city is now in the process of developing a water resources management plan for the city's water supply system (Otto 1988). The city of Gallup has abandoned its declining rate scale in favor of a flat rate (Folk-Williams, Fry and Hilgendorf 1985). Through the McKinley County Council of Governments, Gallup initiated a public awareness campaign concerning the city's water problems and distributed voluntary conservation packets to most of its residents. The effort was estimated to have reduced per capita consumption from 160 gallons to about 150 gallons a day. The 1982 program served as a model for the New Mexico "Save Our Water" project, which was used in communities throughout the state.

Santa Fe's water rates are among the highest of any city of comparable size in the Southwest (Folk-Williams, Fry and Hilgendorf 1985). Since 1973, the Santa Fe City Code has contained provisions concerning water conservation measures. A Water Conservation Committee (WCC) is responsible for implementing a conservation program for the city and county, including an educational program mandated by the New Mexico Public Service Commission. The WCC has conducted a conservation program patterned after the Gallup project that emphasized residential water use reduction. The WCC and Santa Fe's water utility company conceived a special project for installing water conservation devices in government housing occupied by senior citizens, low-income residents, and in facilities for the handicapped.

Water Quality

New Mexico's history of concern over water quality goes back to an 1826 Santa Fe ordinance forbidding residents from engaging in "filthy practices" that might ruin drinking water those downstream. Those who were caught were fined four "reales" (Meyer 1984). Surface water quality management in New Mexico also has state and federal aspects. The state establishes standards for state and interstate streams, assesses the quality of surface waters, adopts regulations, and takes actions to protect and maintain surface water quality. Irrigated agriculture, municipal treatment and hazardous wastes are areas in which water quality management is especially important. Today, both the state of New Mexico and the federal government play significant roles in water quality management (New Mexico Water Quality Control Commission 1988). New Mexico's ground water protection program was well-established before most of the federal legislation and regulations addressing ground water quality were adopted. State regulations controlling the disposal of oil field brines in order to protect ground water quality have been in effect since 1969. A comprehensive ground water quality program applicable to most other types of discharges was in effect in 1977. There are also various other state laws and regulations affecting ground water quality management. The challenge has been to incorporate in its programs beneficial aspects of federal programs without disruption of state programs already in place.

Municipal Wastewater Treatment

Concern about water quality did not come into focus beyond the community level until the mid-1950s when a major effort using state and federal funds was initiated to build needed municipal wastewater treatment plants. In the 1960s both the federal and state governments enacted water quality legislation. The comprehensive 1972 Federal Water Pollution Control Act, was the capstone legislation which set the nations's current water quality programs in motion.

Since 1972, more than $175 million in federal funds, $35 million in state funds, and at least $35 million in local funds have been spent on the construction of municipal wastewater treatment plants (New Mexico Water Quality Control Commission 1988). Wastewater construction was the major expenditure in the state and federal surface water budget in 1987, which totaled $1.2 million. New Mexico also has provided $66 million in special appropriations for wastewater facility construction since 1972. These funds are independent of the construction grant program. This program is being phased out and grants will not be offered after September 1988.

Improved management of surface waters between 1977 and 1985 has resulted in a 34 percent decrease in the waste-load discharged to surface waters despite an accompanying 30 percent increase in volume of generated waste (New Mexico Water Quality Control Commission 1988). The improved treatment and reduction of discharged waste-load can be attributed to several components of the water quality management program. These include the community wastewater construction grants program, the state wastewater operator certification and training program, and the enforcement actions taken by the state and the EPA against permit violators.

The National Safe Drinking Water Act of 1974 fits into the overall environmental movement, but with the primary aim of protecting the public health. In response to the federal mandate, New Mexico created agencies such as the Environmental Improvement Division to implement those federal policies applicable to the state (Clark 1987a). When the "new federalism" of the Reagan administration was instituted, federal grants under the Clean Water Act for municipal wastewater treatment plant construction were first reduced and then eliminated. The program will be converted into a loan system at the end of fiscal 1988. While the campaign for clean water has opponents who contend either that water quality controls are too costly or the problem has been overstated (Clark 1987a), a 1980 study shows that New Mexico residents favor such controls. Of those surveyed, 62 percent believed that state government should handle New Mexico water pollution problems (Pratt and Martin 1980). The same percentage also wanted a voice in environmental planning for water resources.

Irrigated Agriculture Water Quality

Water quality problems occur in two areas of irrigated agriculture. First, ground water quality degradation can be caused by overpumping an aquifer to such an extent as to cause salt water intrusion from nearby saline aquifers. Techniques that may circumvent salt-water intrusion include:

1) pumping water from the saline aquifer source to reduce pressure on that aquifer and to retard or stop migration toward the area of encroachment;
2) reducing the pumping of fresh water in the area of encroachment;
3) rearranging the well distribution pattern in the area of encroachment; and
4) injecting fresh water along the zone of encroachment to increase the pressure in the fresh water aquifer.

Secondly, salinity increases from irrigation **return flow** is of concern. In the process of plant growth, approximately two-thirds of the water applied through irrigation is lost to evaporation. However, virtually all of the salts in the water supply are concentrated in the residual one-third of the water volume. The residual minerals from irrigation increase the salinity content of both surface water and ground water. The U.S. Congress has included specific language in the 1978 amendment to the Federal Water Pollution Control Act to exempt irrigation return flow from permit requirements that regulate all other sources of water quality degradation. New Mexico's Water Quality Act contains provisions to the effect that water quality degradation associated with the reasonable use of water is not considered to be a source of pollution, but is the natural consequence of beneficial consumptive use.

In the 1970s a number of studies were conducted on the nature and extent of water quality changes related to irrigated agriculture in the western states. Some of these studies addressed New Mexico's water quality and identified methods for reducing or limiting adverse effects of irrigation return flow (Gelhar and McLin 1979; Wierenga et al. 1972; Wierenga 1973). Most of these control methods are associated with improved irrigation practices and as a result are site and crop specific. There has been a continuing effort to improve water use efficiencies and water conservation through implementation of these methods, particularly improved irrigation scheduling.

Toxic and Potentially Hazardous Wastes

The process for preventing new pollution from current oil and gas production is more effective than coping with historical pollution problems. Although the past practice of disposing these wastes to unlined pits has been regulated since 1960, the effects of these practices still persist (New Mexico Water Quality Control Commission 1988). The Water Quality Control Commission (WQCC) recommends better monitoring and production techniques to control present discharges.

Discharges from individual domestic septic systems are regulated under the Environmental Improvement Act. Septic tanks and cesspools are responsible for more instances of known ground water contamination in New Mexico than any other source. Although more stringent regulations were adopted in 1985 to prevent further contamination, the hazards to ground water from pre-1985 septic systems is considered to be substantial. Disposal of septage, the accumulated solids in septic tanks, remains a serious problem. Regulatory amendments to correct these deficiencies are now being developed.

Hydrocarbon leaks and spills occur more often than any other type of spill or leak in New Mexico (New Mexico Water Quality Control Commission 1988). The number of cases of ground water pollution by gasoline and other hydrocarbons has increased sharply in the last few years. These cases are due both to leaks from underground tanks and to surface leaks and spills. The EID has proved effective in inducing responsible parties to enter settlement agreements to plan and begin aquifer cleanups. Most of the cleanups will take many years.

Pollution prevention has proved the most practical of all New Mexico's many water pollution control programs. Cleanup is more expensive, often costing hundreds of thousands of dollars and taking many years. Sometimes cleanup is impossible at any price. Therefore, it is much more effective and much less expensive in the long run to ensure that adequate resources are devoted to water pollution prevention.

PLANNING, MARKETING AND RESEARCH

Planning

New Mexico has no formal statewide water plan. Instead, it has relied on an appraisal of present and future water requirements as an informal guide to managing its water resources. The State has taken this approach based on the belief that most of the state's water resources are already developed or appropriated and that much of future planning will revolve around improved management and changes in water use rather than large scale new developments (U.S. Bureau of Reclamation 1976). The last full-scale appraisal was completed in 1976. However, a report on water use in New Mexico was published in 1986 (Wilson 1986), which updates some of the information in the previous assessment.

Though New Mexico has developed a surface water plan through the State Engineer's Office by the construction of reservoirs and the regulation of that supply, it has not made provisions to guarantee regions sufficient future water supplies from ground water, for state support of the development of regional water supply systems, or for possible interstate exchanges (DuMars et al. 1986). In a series of community meetings held throughout the state, DuMars found that in most rural areas people are unsure of their water future. They are unsure of the mechanisms to acquire water rights, of how long their water supplies will last, or of the leadership provided by the Legislature in this area (DuMars et al. 1986).

Other, more formal groups have stated that the underlying problem in water transfers is the lack of comprehensive planning beyond the city and county level (The Course of Upper Rio Grande Waters: A Declaration of Concerns 1985). These groups contend that a state water plan would balance the competing water needs of development, traditional water users, and environmental protection.

In a 1984 survey on preferences for managing New Mexico's waters, 55 percent of the general public respondents believed water planning should be left up to the water experts (DeYoung et al. 1984). Thirty-nine percent disagreed, indicating instead that the public should be involved in developing water resources plans.

A more formal approach to water planning has been suggested by a team of researchers commissioned by the New Mexico Legislature to determine whether or not the state should enter the water market by appropriating ground water to itself (DuMars et al. 1986). The team recommended that each of the state's hydrologic basins be eligible for funding to determine their long-range water needs. The team also recommended that water projects be developed in those areas of the state where water shortages already exist or will exist in the near future.

The Legislature approved both recommendations and designated the Interstate Stream Commission to coordinate regional water planning and implement state appropriation of unappropriated ground water. The state has recently awarded funds to Santa Fe, San Juan County and the Eastern Plains Council of Governments for water planning. The city of Albuquerque is also conducting water planning studies.

Marketing

Under New Mexico law, water rights can be bought, sold or leased on the market. When new supplies were available and water development projects were federally financed, it was easier and cheaper to apply for and receive new appropriative rights than to purchase existing rights from established users (Brown and Ingram 1987). As the water supply in a basin becomes fully appropriated, prices for water rights increase. In the Santa Fe area, for example, water rights have sold for as high as $10,000 an acre-foot.

Market-driven reallocation of water can encounter strong opposition. Brown and Ingram (1987) write that past subsidies to irrigated agriculture carry built-in notions of inequity. They contend that it is inequitable to many people for a farmer who has benefitted from public subsidies to profit from the increased value of water in the marketplace. Arizona's 1980 ground water code places strong reliance in meeting its objectives on governmental regulation and planning rather than on the marketplace (Brown and Ingram 1987). Arizona's code revolutionized the management of ground water in that state by forcefully inserting state authority into the water allocation process in the areas with declining ground water.

Traditional water users also view the water market with caution. Hispanics in the Upper Rio Grande, for example, are seeing water rights in their communities bid away to nontraditional uses. The water rights associated with their low-value, high-water use crops such as alfalfa are particularly attractive in a more competitive market (Brown and Ingram 1987).

The New Mexico Legislature has approved a plan in which the state will participate actively in water marketing by appropriating ground water rights to itself (DuMars et al. 1986). Those rights would then be made available for a variety of uses. In the long-term, ownership of those rights would allow the state to implement long-range planning. Within New Mexico, water rights would be made available to areas of the state with the greatest need. The state may use the water to create regional water development projects and to guarantee a certain water supply for new industry. In addition, water rights may be leased on the short-term interstate market. DuMars et al. (1986) have identified five cities in Colorado, Texas and Arizona as potential customers for water leased from New Mexico for interstate transfer. DuMars maintains that by entering the water market, the state also will be able to preserve key sectors of the economy that contribute to New Mexico's society and culture. For example, the state, through its participation in the marketplace, would be able to better ensure preservation of the state's best agricultural lands, wildlife refuges and other fundamental resources.

Research

Research is a critical detail in the overall water resources picture. Through research, more water-efficient crops have been developed that could lessen the burden on the water supply. Research has explored new uses for **saline water** that may bring new industry to New Mexico. Research has designed innovative ways for New Mexico to administer its water resources.

New Mexico's water requirements for research have been dictated largely by legislative action at the federal and state levels (Clark 1987b). Congress encouraged the pursuit of research when it passed the Morrill Act in 1862 mandating states to "teach such branches of learning as are related to agriculture and the mechanic arts." The 1887 Hatch Act, applicable to both and territories, established "agricultural experiment stations" at land grant colleges.

Although water research was a byproduct of projects funded under the Hatch Act and subsequent legislation, water research was not targeted specifically for funding until the 1960s. By then, growing concern over the quality and the quantity of water for the increasing demands on the nation's supply underscored an absence of basic data, particularly at the regional level. The federal Water Resources Research Act of 1964 appropriated funds to each state to maintain qualified water resources research institutes. New Mexico was one of the first 14 states selected under the institute program.

The major agencies within the state that provide funding for water research are the New Mexico Water Resources Research Institute, the New Mexico Game and Fish Department, the Energy, Minerals and Natural Resources Department, the New Mexico Environmental Improvement Division, the U.S. Forest Service, the Interstate Stream Commission, and the New Mexico Research and Development Institute. The state's universities also conduct water research through a variety of state and federal funding agencies.

CHAPTER FOUR: WATER LAW

HISTORY

Most of the western states including New Mexico, expressly rejected the **riparian doctrine** followed in the eastern states. That system of water law allows landowners adjoining lakes and rivers to withdraw reasonable amounts of water as long as it does not impair the rights of those downstream. New Mexico instead constitutionally adopted the concept of prior appropriation. This system of water law was the outgrowth of Mexican civil law, Mormon irrigation practices in Utah, and federal policy during the expansion of the western United States which began in the mid-19th century (R. Clark 1967). Although the definition of prior appropriation varies somewhat from state to state, it has always contained two essential principles:

1. The first user (**appropriator**) in time has the right to take (**diversion**) and use water; and
2. that right remains valid as long as the appropriator puts the water to beneficial use.

At least ten western state constitutions acknowledge the appropriation system based upon beneficial use, as do numerous western state laws and the Federal Reclamation Act (43 U.S.C. 372, 1976). However, there is debate over the physical acts that are sufficient to constitute an appropriation and the definition of beneficial use (R. Clark 1967). Most prior appropriation jurisdictions recognize beneficial use as the basis, the measure, and the limit of the right to use water. The common theme in all these states is that beneficial use means application of water to a lawful purpose, which is useful to the appropriator and at the same time is a use consistent with the general public interest in having water utilized to its maximum.

Beneficial use refers to the amount of water actually used, or **depleted,** not to water appropriated to be used. If an appropriator ceases using water beneficially for long enough, the water becomes available to other appropriators.

The prior appropriation doctrine is tailored to the geography and climate in the western United States, where water is a precious commodity in scarce supply. The basic principle behind the prior appropriation doctrine is that if it is no longer economically or geographically feasible for an individual to use his water rights, persons who will use the water in a profitable manner should have the opportunity to do so (R. Clark 1967).

An example of how this system operates may be helpful. The day a person diverts water from a stream or from the ground becomes his "priority date." More priority dates are assigned as more people use the water source until it is fully "appropriated" — all of the water available is taken — or even until it is "over-appropriated" — a circumstance where people wish to use more water than is available for distribution. When there is insufficient water in a stream to meet the demand, the person with the oldest water right is entitled to his full amount regardless of his geographical location. When that user is finished, the next person in time is allocated his amount, and so on, until the entire supply is exhausted. Thus, those with the newest rights on an over-appropriated stream get no water in times of scarcity. In terms of economic theory, those newest right holders, if they are willing to pay the price, will go to the older water user and buy his water right. In this manner, water will, at least theoretically, be continually transferred to the use that will generate the most revenue. Whether this system actually functions this way or not is the subject of unending debate, especially among economists.

The western states' prior appropriation treatment of ground water has not been as consistent as their treatment of **surface water.** Many courts and legislatures steadfastly deny the hydrological relationship between water in the ground and water flowing on the surface in stream beds (R. Clark 1975). The state of New Mexico, on the other hand, acknowledges this relationship.

ALLOCATION OF GROUND WATER IN NEW MEXICO

New Mexico is a prior appropriation state (Trambley v. Luterman 1891), even with respect to its ground water. The riparian doctrine has never been the law (N.M. Const. Art 16). The legislature has declared water in underground streams, channels, artesian basins, lakes and reservoirs having reasonably ascertainable boundaries to be public water subject to appropriation for beneficial use (NMSA 72-12-1, 1978). Since all of the underground water and natural streams in New Mexico belong, in effect, to the state as trustee for the people, no individual owns the water (NMSA 72-1-1). However, one may acquire a real property right (New Mexico Prods. Co. v. New Mexico Power Co. 1937) to divert water consistent with the procedures under state law (Snow v. Abalos 1914), up to the amount which can be put to a beneficial use. New Mexico law recognizes that even though beneficial use is the measure of one's water rights, if one uses reasonable diligence in developing his water right, he is entitled to the expanded flow resulting from his efforts when his works are completed (N.M. Const. art. 16 2; Keeney v. Carillo 1883).

New Mexico has not limited statutorily what constitutes a beneficial use. The term has been construed to include irrigation and recreational fishing (State ex rel. State Game Comm'n v. Red River Valley Co. 1945) and other traditional western uses such as stock watering (First State Bank v. McNew, 1928) when the water is actually diverted.

Irrigation rights are appurtenant to the irrigated land, but these rights can be severed from the land and transferred to another purpose if the transfer follows the procedures set by New Mexico law (NMSA 72-5-23, Repl. 1968).

Although an individual may assign his water rights to another, such an assignment is binding only between those two parties unless the procedures of the state engineer are followed.

THE CHIEF WATER ADMINISTRATOR — THE STATE ENGINEER

New Mexico law charges the state engineer with the administration of all matters relating to the appropriation, transfer, and distribution of water (NMSA 72-2-1). The state engineer must approve all new appropriations of water for beneficial use and all changes in the place or manner of existing uses. Water rights that were acquired prior to the creation of state engineer's jurisdiction, though governed by the law of prior appropriation, are free from the state engineer's control. If they are transferred, they become subject to the state engineer's jurisdiction.

The state engineer has the power to appoint water masters to apportion water consistent with priorities, to install head gates and meters for measuring the quantity of water being used, and to determine beneficial use.

One water right owner can sell his water right to another who may elect to change the point of diversion, storage or use without losing his priority date. This can only be done, however, with approval of the state engineer. The state engineer must publish the proposed changes and, before allowing such a transfer, determine that no foreseeable detriment exists to other present right holders. A few community ditches that begun operating prior to 1907 are not governed by the state engineer's jurisdiction when uses change (NMSA 72-5-22, 72-5-24, 72-5-25).

One aspect of New Mexico case law which serves to facilitate transfers is that one who has been party to a court proceeding in which his rights were adjudicated and who later wants to transfer that right, can rely on the previous **adjudication** as the measure of his water right. He need not prove that he has put this amount of water to beneficial use. The existence of the previous adjudication will sustain his claim absent evidence to the contrary (W.S. Ranch Co. v. Kaiser Steel Corp. 1968).

New Mexico first regulated ground water in 1931. As amended, the law now makes all water in a ground water **basin,** declared to be such by the state engineer, the property of the public subject to appropriation for beneficial use (NMSA 72-12-18, 1978). The state engineer has no jurisdiction, however, even in a ground water basin, to prohibit wells for nominal personal domestic use. Most areas of the state have been declared underground water basins (figure 4-1). In the remaining open areas the state engineer has no jurisdiction. If one wishes to appropriate ground water in a declared ground water basin, he must apply to the state engineer, who may grant a permit after determining that unappropriated water exists and that the proposed appropriation will not impair the existing water rights of others. Though the potential appropriator has the burden of proving the absence of impairment, the state engineer must perform an independent investigation. Figure 4-2 outlines the application process for obtaining a water right.

Ground water rights can be sold or transferred. The transfer can be of both location and purpose. The state engineer has allowed limited transfers from surface appropriations to ground water appropriations. To make such a transfer, the transferror has the burden of showing that other users' water rights will not be impaired. The statute imposes an independent obligation on the state engineer to make a similar determination before granting the application.

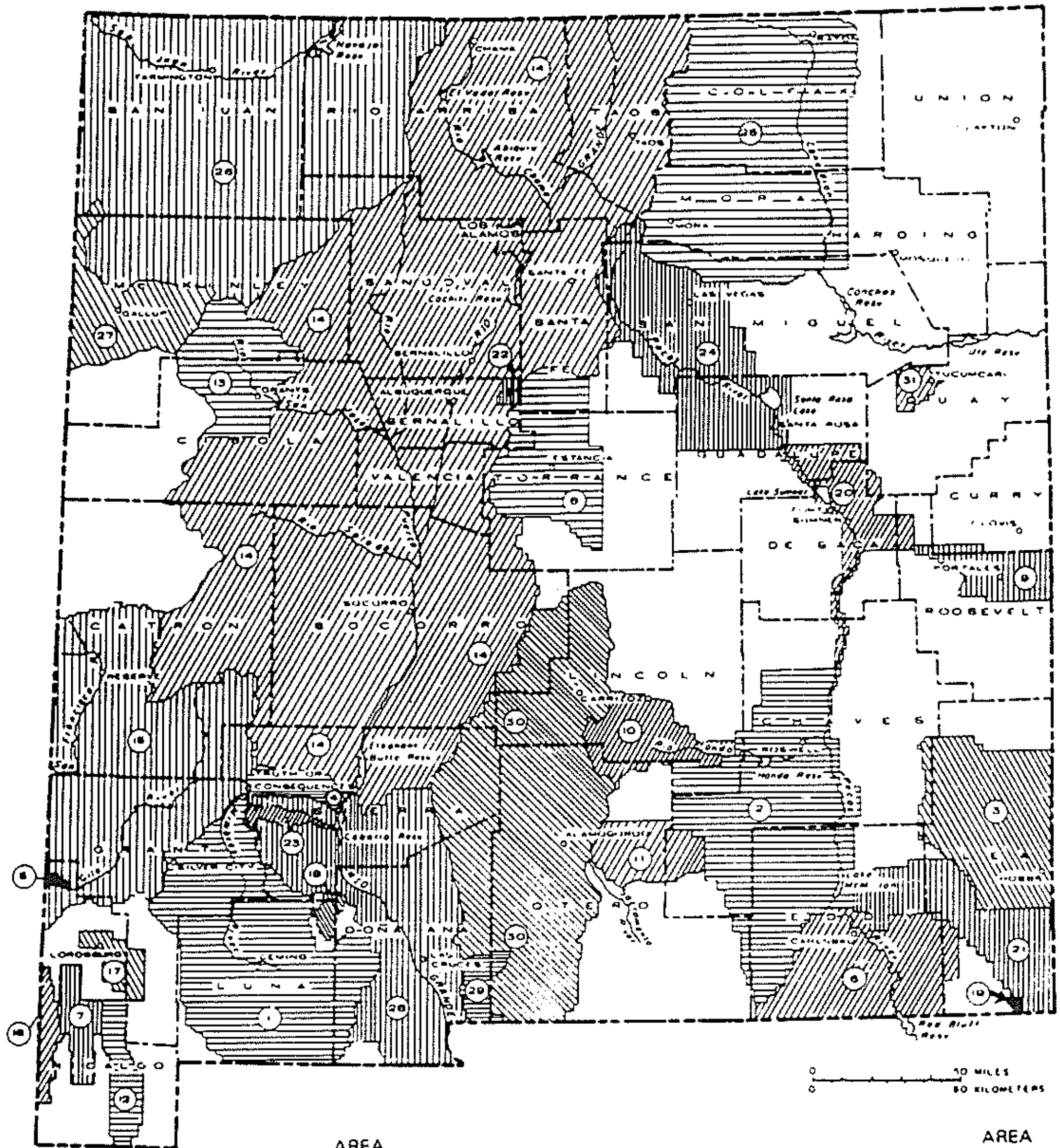
By statute, an owner forfeits water right if he fails to apply water to beneficial use for a period of four years and if he continues not to use the water for one year after the state engineer notifies him of the proposed forfeiture. These statutes do not allow forfeiture when a reasonable cause has brought about nonuse. Prior to 1965, there was no requirement of notice from the state engineer and the additional one-year waiting period (NMSA 72-5-28, 72-118, 1978). In addition to statutory forfeiture, water rights can also be abandoned in New Mexico if both the intent to abandon and nonuse occur. Intent to abandon is extremely difficult to prove (State ex rel. Reynolds v. South Springs Co. 1969). The law is unclear concerning whether or not one can lose his water right due to adverse possession, but this result seems extremely unlikely (Martinez v. Mundy 1956). An underlying principle that runs through the New Mexico cases is that the courts traditionally have not favored forfeiture of water rights. When a court finds a reason or legitimate excuse for nonuse, the original holder's rights generally will be upheld (Chavez v. Gutierrez 1950, New Mexico Prods. Co. v. New Mexico Power Co. 1937).

NEW MEXICO INTERSTATE COMPACTS

Although the U.S. Constitution forbids alliances and treaties between states, it does permit states to enter into agreements, or compacts, with the consent of the U.S. Congress. Compacts may supersede state laws and constitutions and are preferable to judicial procedures in resolving interstate water conflicts. Compacts generally have the flexibility to meet changing physical and economic conditions. After a compact is approved by the governor of each state involved, it is sent to the U.S. Congress for approval and then to the president where it is signed into law. New Mexico is a party to nine interstate compacts.

Colorado River Compact

New Mexico's first interstate compact was the Colorado River Compact (NMSA 72-15-5, Repl. 1985). Ratified in 1922, the compact includes New Mexico, Arizona, California, Colorado, Nevada, Utah, and Wyoming. The compact was formed to: provide the equitable division and apportionment of the Colorado River system; establish the relative importance of different beneficial uses of water; promote inter-state comity; remove causes of present and future controversies; and secure the expeditious agricultural and industrial development of the Colorado River Basin, the storage of its waters and the protec-tion of life and property from floods.



BASIN	AREA IN SQUARE MI.
1. MIMBRES VALLEY	4,279
2. ROSWELL	4,281
3. LEA COUNTY	2,180
4. HOT SPRINGS	284
5. VIRDEN VALLEY	19
6. CARLSBAD	1,965
7. ANIMAS	426
8. ESTANCIA	1,724
9. PORTALES	628
10. HONDO	901
11. PENASCO	723
12. PLAYAS VALLEY	515
13. BLUEWATER	1,318
14. RIO GRANDE	26,209
15. GILA – SAN FRANCISCO	5,659
16. SAN SIMON	263
17. LORDSBURG VALLEY	329
18. NUTT-HOCKETT	133
19. JAL	15
20. FORT SUMNER	1,059
21. CAPITAN	1,550
22. SANDIA	73
23. LAS ANIMAS CREEK	131
24. UPPER PECOS	2,708
25. CANADIAN RIVER	5,825
26. SAN JUAN	9,727
27. GALLUP	1,439
28. LOWER RIO GRANDE	3,858
29. HUECO	255
30. TULAROSA	6,070
31. TUCUMCARI	177
	84,723

Figure 4-1. Declared Ground Water Basins in New Mexico as of June 30, 1987.

Source: State Engineer Report (1987)

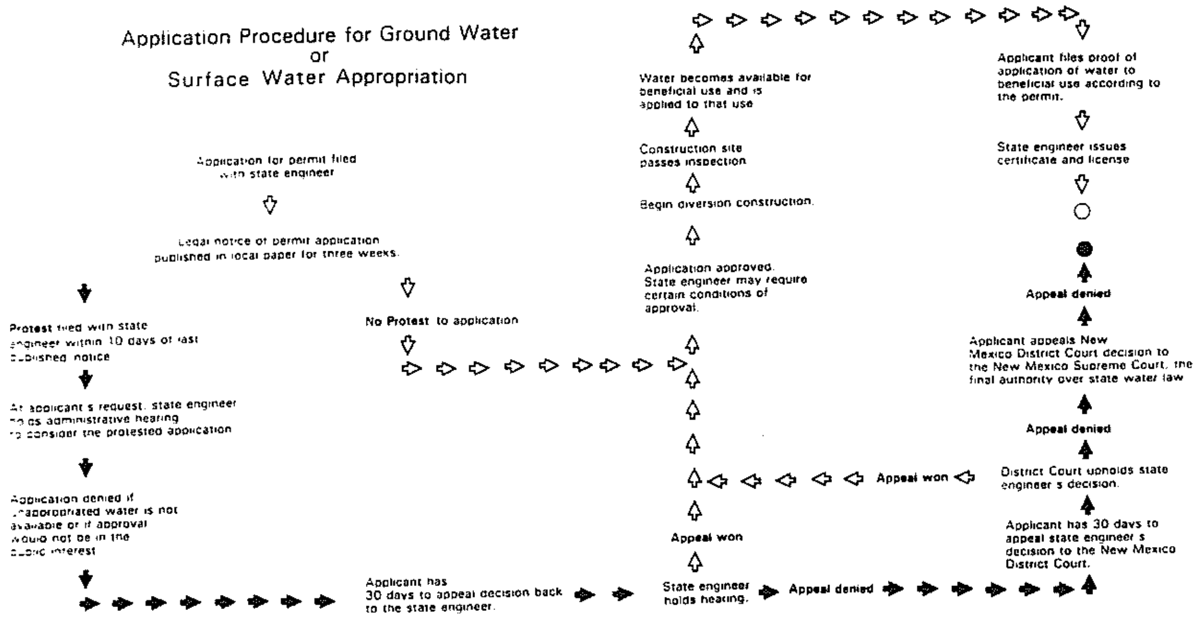


Figure 4-2. Application procedure for water rights.

Source: Harris (1984)

Agricultural. domestic use and consumption are addressed as the dominant purposes of the compact.

The Colorado River Basin is divided into two basins. **Apportionment** of the use of part of the water of the Colorado River system was made to each basin with the provision that further equitable apportionments may be made. Exclusive beneficial consumptive use of 7.5 million acre-feet of water a year was apportioned from the Colorado River system in perpetuity to the upper and lower basins respectively. This includes all water necessary for the supply of any existing rights. In addition, the lower basin was given the right to increase its beneficial consumptive use of the Colorado River waters by one million acre-feet a year.

Upper Colorado River Basin Compact

In 1949 the Upper Colorado River Basin Compact between New Mexico. Arizona, Colorado, Utah. and Wyoming was enacted (NMSA 72-15-26, Repl. 1985). The compact appor-tioned consumptive use of water from the upper Colorado River system in perpetuity to the states. Arizona was apportioned the consumptive use of 50,000 acre-feet of water a year. The remaining states were apportioned the following percentages of the total quantity of consumptive use a year:

Colorado	51.75%
New Mexico	11.25%
Utah	23.00%
Wyoming	14.00%

La Plata River Compact

Colorado and New Mexico are the La Plata River Compact parties (NMSA 72-15-16, Repl. 1985). The La Plata River Compact was enacted in 1923 to provide for equitable distribution of the La Plata River waters, to remove causes of present and future controversy between the parties with respect to the river, and for considerations of interstate comity. The compact required Colorado to establish and maintain two permanent stream-gaging stations on the river to measure and record its flow.

Between February 15 and December 1 each state has the right to use all water within its boundaries on each day when the mean daily flow at the Interstate Station is 100 cubic feet per second or more. On the remaining days of the year, Colorado is required to deliver a quantity of water equivalent to one half the mean flow at the Hesperus station for the preceding day, but not to exceed 100 cubic feet per second.

When the river flow is low, the New Mexico and Colorado state engineers may distribute all the river waters successively to the lands in each state in alternating periods, rotating between the two states for as long as they feel it necessary. New Mexico is not entitled to receive, nor is Colorado required to deliver, water if it is not necessary for beneficial use.

Rio Grande Compact

Colorado, Texas and New Mexico entered into the Rio Grande Compact in 1939 (NMSA 72-15-23, Repl. 1985). The compact's purpose was to remove all present and future controversy between citizens of the three states and between the citizens of these states and another state with respect to use of the Rio Grande waters above Fort Quitman, Texas. Other purposes included considerations of state comity and effecting an equitable apportionment of the Rio Grande waters.

Under the Rio Grande Compact Commission's direction, a stream-gaging station with an automatic water-stage recorder for various points on the Rio Grande, and two points on the Conejos River, the Los Pios river, and the San Antonio River was established. The compact provided that Colorado deliver water in the Rio Grande at the Colorado-New Mexico state line and that New Mexico deliver water in the Rio Grande at San Marcial, New Mexico.

Costilla Creek Compact

Costilla Creek is a Rio Grande tributary which rises on the western slope of the Sangre de Cristo mountain range in the extreme southeastern corner of Costilla County, Colorado. It flows in a general westerly direction crossing the boundary three times above its confluence with the New Mexico Rio Grande.

New Mexico enacted, and Colorado ratified, the Costilla Creek Compact in 1945 (NMSA 72-15-10, Repl. 1985). Congress approved it in 1946. The compact was formed to provide equitable division and apportionment of Costilla Creek waters, promote interstate comity, and remove causes of present and future interstate controversies. Further purposes included the promotion of integrated irrigation; adjustment of conflicting jurisdictions over irrigation works and facilities; equalization of the benefits of water from Costilla Creek; and placement of the beneficial application of water diverted from Costilla Creek for irrigation by the two states on a common basis.

New Mexico and Colorado are allocated specific amounts of water for beneficial use in various areas adjacent to Costilla Creek. The surplus is divided between the states. Additional storage is also divided in half between the states.

The amended Costilla Creek Compact was enacted in 1963 with congressional approval the same year (NMSA 72-15-13, Repl. 1985).

Pecos River Compact

The Pecos River is a Rio Grande tributary that rises in north-central New Mexico and flows in a southerly direction through New Mexico and Texas joining the Rio Grande near Langtry, Texas. New Mexico and Texas enacted the Pecos River Compact in 1949 (NMSA 72-15-19, Repl. 1985). Its purposes are equitable division and apportionment of Pecos River waters; promotion of interstate comity; removal of causes of present and future controversies; security and protection present development within the states; facilitation of the construction of works for the salvage of water; implementation of more efficient use of water; and protection of life and property from floods.

Under the compact, New Mexico cannot deplete the flow of the Pecos River at the New Mexico-Texas state line below an amount that will give Texas a quantity of water equivalent to that available to Texas under **withdrawal** conditions as they existed in 1947 — known as the "1947 condition". Further, the beneficial consumptive use of the Delaware River waters are apportioned to Texas. Beneficial consumptive use of water salvaged in New Mexico through the construction and operation of a U.S. project or by joint undertakings of Texas and New Mexico is apportioned 43% to Texas and 57% to New Mexico. Non-beneficially consumed water recovered is apportioned to New Mexico but is not to have the effect of diminishing the quantity of water available to Texas under the "1947 condition." Any water salvaged in Texas is apportioned to Texas. Beneficial consumptive use of unappropriated flood waters is apportioned equally to Texas and New Mexico.

Canadian River Compact

The Canadian River is a tributary of the Arkansas River which rises in northeastern New Mexico and flows in an easterly direction through New Mexico, Texas, and Oklahoma. It includes the North Canadian and all other Canadian River tributaries. New Mexico, Texas and Oklahoma enacted the Canadian River Compact in 1951 (NMSA 72-15-2, Repl. 1985). The compact's purposes are the promotion of interstate comity; removal of causes of present and future controversy; security and protection of present developments within the states; provision for the construction of additional works for the conservation of the waters of the Canadian River.

The compact allows Oklahoma free and unrestricted use of all waters of the Canadian River in Oklahoma. New Mexico is allowed free and unrestricted use of all waters originating in the drainage basin of the Canadian River above Conchas Dam, subject to limitations on the storage of water. Texas has free and unrestricted use of all waters of the Canadian River in Texas subject to limitations on the storage of water.

Animas-La Plata Project Compact

New Mexico and Colorado enacted the Animas-La Plata Project Compact in 1969 (NMSA 72-15-1, Repl. 1985). The compact was formed to implement the operation of the Animas-La Plata federal reclamation "Colorado-New Mexico" project, proposed under the Colorado River Storage Project Act. The compact also promotes interstate comity.

The compact provided the right to store and divert water in Colorado and New Mexico from the

La Plata and Animas river systems (including return flow to the La Plata River from Animas River diversions) for New Mexico's use under the Animas-La Plata federal reclamation project. These waters are valid and of equal priority with the rights granted by decree of the Colorado state courts for Colorado water use if New Mexico use is within the water allocations made to it by Articles III and XIV of the Upper Colorado River Basin Compact.

UNITED STATES-MEXICO TREATIES

The United States and Mexico enacted water treaties in 1906, 1933, and 1944 which directly affected New Mexico water law.

1906 Rio Grande Convention Treaty

The purpose of the 1906 Rio Grande Convention Treaty was to provide equitable distribution between the United States and Mexico of the Rio Grande waters for irrigation purposes (34 Stat. 2953). The treaty required that the United States deliver to Mexico 60,000 acre-feet of water annually. The delivery was to be in the Rio Grande bed above the city of Juarez, Mexico at the point where the headworks of the Acequia Madre then existed.

1933 Rio Grande Rectification Convention Treaty

The 1933 Rio Grande Rectification Convention Treaty was enacted as an international plan between the United States and Mexico for removal of the flood menace of the Rio Grande from the El Paso-Juarez Valley (48 Stat. 1621). The International Boundary and Water Commission was charged with the direction and inspection of the work. The plan consisted of straightening the Rio Grande channel and confining it between two parallel levees. In addition, the plan included the construction of a flood retention dam 22 miles below Elephant Butte on the Rio Grande, creating reservoir storage of 100,000 acre-feet. The El Paso-Juarez Valley flood flow was reduced by use of the reservoir (Witmer 1968).

The treaty proposed that benefits derived from the straightened and rectified channel be shared by the two governments, in affording flood protection and in permitting cultivation, improvement, and settlement of larger areas adjoining the Rio Grande than possible under the meandering river conditions. Since the United States derived greater benefit from the rectification works, the pro rated cost of the works was defrayed in the proportion of 88 percent by the United States and 12 percent by the Mexican states.

1944 Rio Grande, Colorado and Tijuana Rivers Treaty

The latest treaty enacted between the United States and Mexico was the 1944 Rio Grande, Colorado, and Tijuana Rivers Treaty (59 Stat. 1219). The treaty was formed to extend prior agreement between the two countries to allow regulation of the Rio Grande, Tijuana, and

Colorado rivers for additional purposes beyond navigation.

The Rio Grande waters between Fort Quitman, Texas, and the Gulf of Mexico were allotted between the two countries based on varying river conditions. The treaty further provided that Mexico could compensate for any deficiencies caused from drought or serious accident to the hydraulic systems on the measured Mexican tributaries in the following five-years following enactment.

Mexico was allotted a guaranteed annual quantity of 1,500,000 acre-feet of Colorado River water to be delivered by the United States. If additional surplus quantities arrived at the Mexican points of diversion in excess of the amount necessary to supply the United States and Mexico's guaranteed quantity of 1.5 million acre-feet, the treaty required the United States to deliver additional Colorado River system waters to Mexico up to 1.7 million acre-feet per year. The treaty provides for equitable distribution of the Tijuana River to be determined by the commission and submitted to both governments for their approval. The two governments agreed further to construct dams, reservoirs and flood control works as needed.

SIGNIFICANT ONGOING LEGAL CASES

A number of significant legal cases are pending in New Mexico which will have a dramatic impact on the state. The following cases may have significant impact.

Texas v. New Mexico (462 U.S. 554 1987) involves an interpretation of the Pecos River Compact. The compact requires that New Mexico retain no more water from the river in New Mexico for its beneficial use than it could utilize under withdrawal conditions as they existed in 1947. After a great deal of litigation in an original action in the U.S. Supreme Court brought by Texas against New Mexico, the court has ruled that New Mexico has been delivering less water to Texas under the compact than it is obligated to deliver. The master ruled that New Mexico has underdelivered an average 10,000 acre-feet a year for the last 34 years for a total water debt of approximately 340,000 acre-feet. The Supreme Court has also ruled that New Mexico must cease its underdeliveries and pay back this debt to Texas. One scenario would suggest that New Mexico is obligated to deliver 34,000 acre-feet of water to Texas every year for the next ten years, and, in addition, cease making underdeliveries. This can require New Mexico to cease using up to 10,000 acre-feet of water in perpetuity in the future. The issues presently pending before the special master revolve around the question of how New Mexico could cease to underdeliver in the future and pay back its past debt. New Mexico argues that the state should have the option of paying back the debt in dollars rather than in water.

El Paso v. Reynolds (597 F. Supp. 694 D. N.M. 1984) involves El Paso's attempt to take massive amounts of ground water from the Lower Rio Grande and Hueco basins and utilize it for domestic consumption for 150-200 years. The case has been in Federal Court twice and El Paso is now seeking a federal injunction against the state engineer ordering him to grant its water rights permits. The procedural history of the matter is tortured, but the essentials follow: New Mexico's statute prohibiting transportation of water in interstate commerce was struck down as unconstitutional. The New Mexico Legislature amended the statute to allow transfers out-of-state, including to El Paso, if the transfer was consistent with the public welfare and conservation of water. A hearing was held before the state engineer on El Paso's applications in the Hueco Basin. The state engineer at the close of the hearings dismissed all of El Paso's applications, both in the Hueco and the Lower Rio Grande, because El Paso's water needs were insufficient to justify granting the applications. More specifically, he found that New Mexico law allows municipalities to appropriate only water for a 40-year planning horizon and that El Paso had sufficient water in Texas to meet its needs for 40 years. El Paso has appealed his decision to the state district court in New Mexico and has also challenged his ruling in federal court as invidiously discriminatory and as carrying out a policy of unconstitutional economic protectionism prohibited by the U.S. Constitution.

State ex rel. Reynolds v. Aamodt (U.S. District Court #Civ-6639 M, April 20, 1966) is one of many cases concerning the water rights of Indian tribes in New Mexico. Considering streams north of Santa Fe and tributary to the main stream of the Rio Grande, this case is unique because it addresses particular kinds of water rights that are common to Indian Pueblos from Taos to Isleta. The case, begun in 1966, is currently on appeal to the Tenth Circuit Court of Appeals. At issue are the rights of senior water rights holders, all of whom can trace their water use to dates prior to New Mexico's statehood. Thus, the laws of Spain and Mexico have been studied and analyzed to determine which group has the better right to water — Spanish settlers or the Indian Pueblo. The federal court has struggled with this question and concluded that traditional water rights doctrine does not apply, but that the rights originate in Spanish and Mexican law. The court has also ruled that the Indian Pueblos have a priority under Spanish and Mexican law over non-Indians. However, thus precedence is based on a balance, and not a strict priority system as we know it today. The court has also rejected more expansive Indian claims that each tribe is entitled to sufficient water to irrigate every practicably irrigable acre on the reservation. It is clear that the outcome of this case will be important to the Rio Grande Valley.

The case of In the Matter of Howard Sleeper, et al. (Rio Arriba County Cause No. RA 84-53 [C]), raises very significant issues for New Mexico's water market. New Mexico water law traditionally has assumed that water rights are property rights and can be sold and transferred to another so long as use at the new place of location does not impair vested water rights. This rule may have been changed as an outgrowth of the El Paso litigation. The statutes were amended to also require the state engineer to evaluate changed potential uses of water to determine if the new use is consistent with the public welfare.

Because the state engineer must evaluate transfers and determine if they are consistent with the public welfare, a natural question arises — What is the "public welfare?" In a recent case, an individual on an acequia sought to sell his right to a user who proposed to use it for a commercial purpose connected with the development of a ski area. Users of the acequia protested the transfer on the grounds that it would be inconsistent with the public welfare because it would destroy their traditional agricultural way of life and the jobs it created would be menial. Although the state engineer denied the protest, the State District Court reversed that decision, finding it inconsistent with the public interest to allow transfer to the commercial user because it would be part of a "distinct pattern of destruction of the local culture."

The case of State ex rel Reynolds v. Mendenhall (68 N.M. 467, 362 P.2d 998 1961), decided many years ago, illustrates the position that persons who sink wells before the state engineer asserts jurisdiction over the ground water have the right to continue developing their rights to meet their future needs if they do so with reasonable diligence. Municipalities and other public entities such as universities have drilled wells before the basin was declared, which they have yet to fully develop even though they have a clear demand for the water in the future. A significant question for New Mexico will be the degree to which under the Mendenhall case, public entities will be allowed to fully develop their wells as their demands continue to grow.

NEW MEXICO STREAM ADJUDICATION SUITS

There are thirteen lawsuits pending, involving 23,000 defendants for the adjudication of New Mexico water rights. Six of the suits involve Indian or **Pueblo water rights.** Adjudication is particularly divisive because it often pits neighbor against neighbor in establishing priority dates. The suits are a cause of tensions concerning issues of Indian and reserved water rights.

SPECIAL INTEREST DEMANDS

Public Trust Doctrine

There is a long standing debate about the proper balance between the private interest and the public trust. The public trust doctrine originated from the widespread practice of using navigable waters as public highways and fishing grounds. These interests were "preserved for the benefit of the public" (Hunter 1921) and accordingly, property used for these purposes was distinguished from general public property, which a sovereign could routinely grant to private owners.

The doctrine evolved early in its history to cover a broad array of interests including railroad rights of way, highways, streets, as well as tidelands and the beds of navigable waters. Recently, some courts have explicitly included in the public trust the right to fish, hunt, bathe, swim, and the preservation of trust lands "in their natural state, so that they may serve as ecological units for scientific study as open space, and as environments which provide food and habitat for birds and marine life, and which favorably affect the scenery and climate of the area" (Marks v. Whitney 1971).

States continue to move gradually toward greater recognition of public water rights, although in most cases they are junior to established uses. Several western states expressly include public rights in their statutory definition of beneficial use. In 1915, Oregon became the first western state to recognize recreational and scenic values of water when it set aside several waterfalls from appropriation (O.R.S. 538.200, 1915). In 1928, California constitutionalized modern notions of public interest through the concept of reasonable use: "...general welfare requires...that the waste or unreasonable use...of water be prevented, and that the conservation of such water is to be exercised...in the interest of the people and the public welfare" (Cal. Const. art. X, sec. 2).

The constitutions of eight western states, including New Mexico, recognize public rights in water and implicitly recognize that extractive water development is in the public interest. The constitutions either state that water is the property of the public or declare the appropriation of water to be a public use. Only the Alaska and California constitutions make strong, express provisions for the protection of fish and wildlife. In Colorado, beneficial use includes the appropriation of minimum flows "as required to preserve the natural environment to a reasonable degree" (Colo. Rev. Stat. 37-92-103[4], upheld in Colorado River Water Conservation District v. Colorado Water Conservation Board 1979). New Mexico, along with a handful of other western states, has not recognized the public trust doctrine as embodied in the California decisions of National Audubon Society v. Superior Court of Alpine County (1983). These cases may allow a governmental agency to invoke the public trust and diminish or otherwise alter the existing usage in order to provide water flow and quality levels to protect the public interest (Domenici 1988).

New Mexico has neither adopted nor rejected these specific public trust arguments. However, the public welfare provisions in the appropriation, transfer, and change of location permit procedure closely resemble the public trust language. A governmental entity easily could promote public trust-like values within the existing New Mexico statutory framework on permit applications (Domenici 1988).

A critical question is whether or not an existing use actually may be curtailed when the existing user does not apply for a permit but merely desires to maintain a continuing use. The California decisions indicate that the state administrative body may infringe upon and curtail existing usages outside of the permit process. There is no New Mexico authority that would allow governmental bodies to accomplish this type of public trust curtailment (Domenici 1988).

The broadly defined public welfare standard is incorporated in each of the permitting procedures involving appropriations, transfer, and change of location for ground and surface waters in New Mexico. The standard may also provide a basis for denying applications that would adversely impact existing water rights users and other parties who have standing to challenge the proposed permit. Ample precedent from other states, impairment decisions, and the broad public interest statement allow protestors to argue that a change of location, transfer, or new appropriation would be against the public interest.

Federal Reserved Rights Doctrine

The **federal reserved rights doctrine** has been a source of uncertainty and disagreement between federal and state governments about whether the state or the federal government controls water rights on federal reserved lands. Federal reservations include Indian lands as well as most national parks, forests and military reservations.

When Congress designated these reservations under federal authority, it was unwilling to legislate its authority over the water on those lands. Because Congress left the matter of control open to interpretation, the courts became the instrument of definition. The courts constructed the theory of federal reserved rights case-by-case beginning in 1899. In the Rio Grande Dam case (U.S. 1899), the court found that Congress had not waived its superior authority under the Commerce Clause to protect navigation despite the fact that it had acquiesced in the recognition of the prior appropriation doctrine in the western states.

Clark (1987a) noted that the change in federal policy from rapid disposition to reservation of public lands, coupled with increased federal activity in their development, inevitably led to the reexamination of Congressional intent in recognizing operation of the doctrine of prior appropriation in the western states. When the nation's lawmakers turned toward comprehensive planning based on a broader definition of beneficial use, it became necessary to determine if Congress had relinquished control over waters on the public domain to the western states while retaining a proprietary interest in the land only.

As long as the policy of placing public lands into private hands as quickly as possible was followed, the severing of jurisdiction over public lands from their water was not a problem since once title passed from the government to the individual, control was reunited as both land and water rights would be subject to state law.

Congress altered this policy by withdrawing more and more of the public domain from private entry, and as it moved toward direct federal participation in furthering the purposes for which lands were reserved, the separation of control over water from control over land became apparent. If state law prevailed, it was within the power of the state to invalidate the national objectives by limiting the amount of water available for their accomplishment (Clark 1987a). However, if the federal government retained its right to reserve unappropriated waters for use on its lands, it could exert tremendous influence on the course of state economic development.

The western states resisted federal attempts to limit states' authority to control the distribution and use of waters within their borders. Most of the remaining public lands were in these states where water set the limits of growth, and where the federal government engaged in the most intense water-related activity (Clark 1987a).

The western states based their resistance on two beliefs. The first was the Jeffersonian interpretation of the constitution emphasizing that states delegated certain powers to the federal government and that those not delegated were retained by the states. This view has been refuted. The second belief relied on federal actions that indicated that the central government voluntarily surrendered control over public domain waters.

The controversy over construction of Elephant Butte Dam was the harbinger of the inevitable conflict between federal and state governments concerning who controlled the waters on the public domain. In its decision concerning the Rio Grande Dam and Irrigation Company's right to build a dam and appropriate waters from the river, the court concluded that western states' control of waters within their borders was limited.

It was found that in the absence of specific Congressional authority, a state cannot legislatively destroy the right of the United States, the owner of lands bordering on a stream, to the continued flow of its waters for the beneficial uses of the government property. States' control is limited further by the superior power of the general government to secure the uninterrupted navigability of all navigable streams within the limits of the United States (United States v. Rio Grande Dam & Irrigation Co. 1899).

Ten years later the U.S. Supreme Court reviewed the rights of parties in a case concerning the Fort Belknap Indian Reservation and settlers who subsequently appropriated water above the reservation in conformity with the laws of Montana and in accordance with the Desert Land Act. This was the first case to articulate the reserved rights doctrine that holds that when Congress, or the president, reserves land for particular purposes, it also reserves, by implication, sufficient unappropriated water to accomplish the purposes of the reservation. Because the case involved an Indian reservation, for many years it was believed the doctrine applied only to such lands.

Subsequent rulings from 1954 to 1968 expanded the **Winters doctrine** to: 1) include other federal reservations, 2) clarify that the amount of water implicitly reserved was the amount necessary to fulfill the purpose of the reservation, and 3) limit the amount necessary to fulfill the purpose of the reservation.

These cases make clear that the federal power to reserve water is constitutionally grounded in the property clause and the commerce clause, and that inconsistent state law may be preempted under the supremacy clause. However, this shows only that Congress has the power to reserve water, not that it has chosen to do so. The reserved rights theory fills the gap when Congress is silent on the issue.

Although the federal reserved rights doctrine is technically no more than a statement of congressional intent, the routine application of the doctrine has caused some to wonder if the doctrine is really one of federal common law. A fundamental element of the federal reserved rights doctrine is that the water right is awarded a priority date tied to the date of reservation. This is so even when the actual use begins some time later, and private appropriators subsequent to the reservation are, thereby, made junior to the federal right.

Whether the reserved rights doctrine is viewed as a laissez faire Congressional management technique or as a rule established through legal precedent, Congress has the power to change the doctrine.

Although Congress has thus far shied away from the issue of authority over water on federal reservations, there are indications that those days are over. The California Wilderness Act of 1984 and the Great Basin National Park Act of 1986 both contain language that explicitly rejects new reserved rights: "Nothing in [this act] shall be construed to reserve any water...to establish a new express or implied reservation to the United States of any water or water-related right...".

This change appears timely, because at least one court has shown some impatience with Congress' unwillingness to grapple with the water issue: "When Congress passed MUSYA (Multiple Use Sustained Yield Act), it was aware of the reserved rights doctrine. Congress, however, chose not to reserve additional water explicitly. In the face of its silence, we must assume that Congress intended the federal government to proceed like any other appropriator and to apply for or purchase water rights when there was a need for water," (U.S. v. Denver 1982). Other conclusions could be drawn from congressional silence, however, continued silence results in continued controversy and litigation.

Although Congress has rejected a general federal water law, its deference to state water law has been equivocal. It has refused to let states determine their own rights, and has introduced reform and conformity within western state allocation systems, particularly in instream flow management and environmental protection. At the same time, the federal reserved rights doctrine has had undeniably disruptive effects on western water administration. This may best be remedied by gradual, not hasty, quantification.

Public Welfare

Consideration of the public welfare value of water resources is a recent addition to New Mexico water rights law. A 1983 law allowed New Mexico ground water to be transported for use outside the state under certain conditions as long as the application for water is not "detrimental to the public welfare of the citizens of New Mexico" (NMSA 72-12B-1).

In earlier times, the concern for public welfare emphasized immediacy. However, since the 1960s when the era of federally subsidized water projects was ending emphasis on water use has shifted from immediacy to efficiency. It has become increasingly important to allocate water efficiently (Ingram 1987).

Public welfare is defined partially by whether or not water is important to a community. In arid regions there is no more fundamental source of anxiety to those familiar with the natural environment than the prospect of water shortage (Brown and Ingram 1987). That anxiety was expressed at the hearing on El Paso's well application in the Hueco Bolson. One resident testified, "Nobody is going to throw us off the land, but we sure can't stay on it without water" (Wright 1987).

Some believe that those with strong community and social ties to water distribution have more valid claims on the water than those with only economic interests. The durability of the acequia system in northern New Mexico is dependent upon on local autonomy in management in compliance with local customs and traditions (Brown and Ingram 1987). Individuals are bound to the community through their participation in water matters; identifying their dams and ditches by the names of ancestors who, through the centuries, helped maintain them. Although each dam carries an identification number, ditch riders in southern New Mexico also name their check dams after local farmers and landmarks.

CHAPTER FIVE: NEW MEXICO'S WATER SUPPLY

INTRODUCTION

Surface Water

New Mexico's climate ranges from arid to **semiarid** and surface water is in scarce supply. Although a significant part of New Mexico's irrigated agriculture uses surface water as a source, only 7 percent of the population depends upon surface water for its domestic water needs (Moody, Chase and Aaronson 1985). Most of the small streams flow intermittently, except in the state's mountainous areas. Flows of the larger rivers, such as the Rio Grande, the Pecos and the San Juan are controlled by reservoir releases. These reservoirs have been constructed to reduce stream-flow variability, reduce the severity of floods, control and remove sediments, and assure water deliveries. Smaller reservoirs have been developed for recreation and fish and wildlife habitat. Most of New Mexico's surface water supply long has been **fully appropriated** for use under the water rights system. Major water issues in New Mexico are typically related to the scarcity and variability of streamflow. The surface supply available for use during an average year is almost 2 million acre-feet. Table 5-1 provides a summary of New Mexico's surface and ground water supply available for use by basins on an annual average. The figures in this table are approximate and represent the author's best estimate based on the review of many literature sources. They are based, in part, on the assumption that the future uses of ground water will not adversely affect the available surface flows. They should be used with care since they do not represent any official accounting of the available supply.

Ground Water

Ground water sources supply almost one-half of the water used in New Mexico; more than 90 percent of New Mexico's 1.4 million people draw their domestic supply from wells (Moody, Chase and Aaronson 1984). This might suggest that acceptable ground water supplies are ubiquitous. It is true that ground water is found throughout the state, but usable quantities of good-quality ground water are not evenly distributed. Water levels are declining in parts of New Mexico because of excessive withdrawals and low **recharge** rates common in many of New Mexico's ground water basins. **Ground water mining** may have both economic and adverse quality consequences. Mining typically refers to the withdrawal of water from an aquifer far in excess of recharge.

Two types of ground water systems are found in New Mexico: those that are recharged directly from the channel of a major stream or river, and those aquifers thatare recharged by areal precipitation on the watershed. Pumping water from a stream connected aquifer may deplete the flow in the river and interfere with surface water rights of downstream users. In New Mexico,

Table 5-1. Surface and Ground Water Available for Depletion in New Mexico by Basin for the Years 1985 and 2030.

River Basin	1985 Surface	1985 Ground	1985 Total	2030 Surface	2030 Ground	2030 Total
	(approximate values in thousands of acre-feet)					
Arkansas/White/Red	312	112	424	312	112	424
Texas Gulf	2	340	342	2	150	152
Pecos	200	235	435	200	235	435
Central Closed	10	205	215	10	205	215
Upper Rio Grande	300	95	395	300	95	395
Lower Rio Grande	342	80	422	342	80	422
Upper Colorado	670	4	674	670	4	674
Lower Colorado	95	62	157	95	62	157
Southwest Closed	11	176	187	11	176	187
Total	1,942	1,309	3,251	1,942	1,119	3,061

aquifers that are not connected to a major stream are typically mined because of the very limited amount of recharge obtained from area precipitation. For example, the Ogallala Formation in eastern New Mexico records a recharge rate of less than one-half inch to one-inch a year. Most aquifers in New Mexico have a gradient or slope so that water moves down-slope, typically at the very slow rate of feet per year or tens of feet per year.

Table 5-1 estimates the average ground water supply available for consumptive use in each of New Mexico's major basins. In some cases these estimates are based on the sustainable long-term yields of fresh water from the various ground water basins at rates that will not further adversely impact surface flows. In other cases, the listed value is an estimate of the available reserves of acceptable quality as they might be mined and the reserve depleted over the 40-year period from 1990 to 2030. Again these figures are approximated and should be used with care.

DIVISION OF THE STATE INTO DRAINAGE BASINS

Of the state's nine major **drainage basins,** the Southwest and Central Closed basins may be characterized as closed basins with no external drainage, the Texas Gulf has no significant streams that flow annually and the remaining five Rio Grande, Pecos, Upper Colorado, Lower Colorado, and

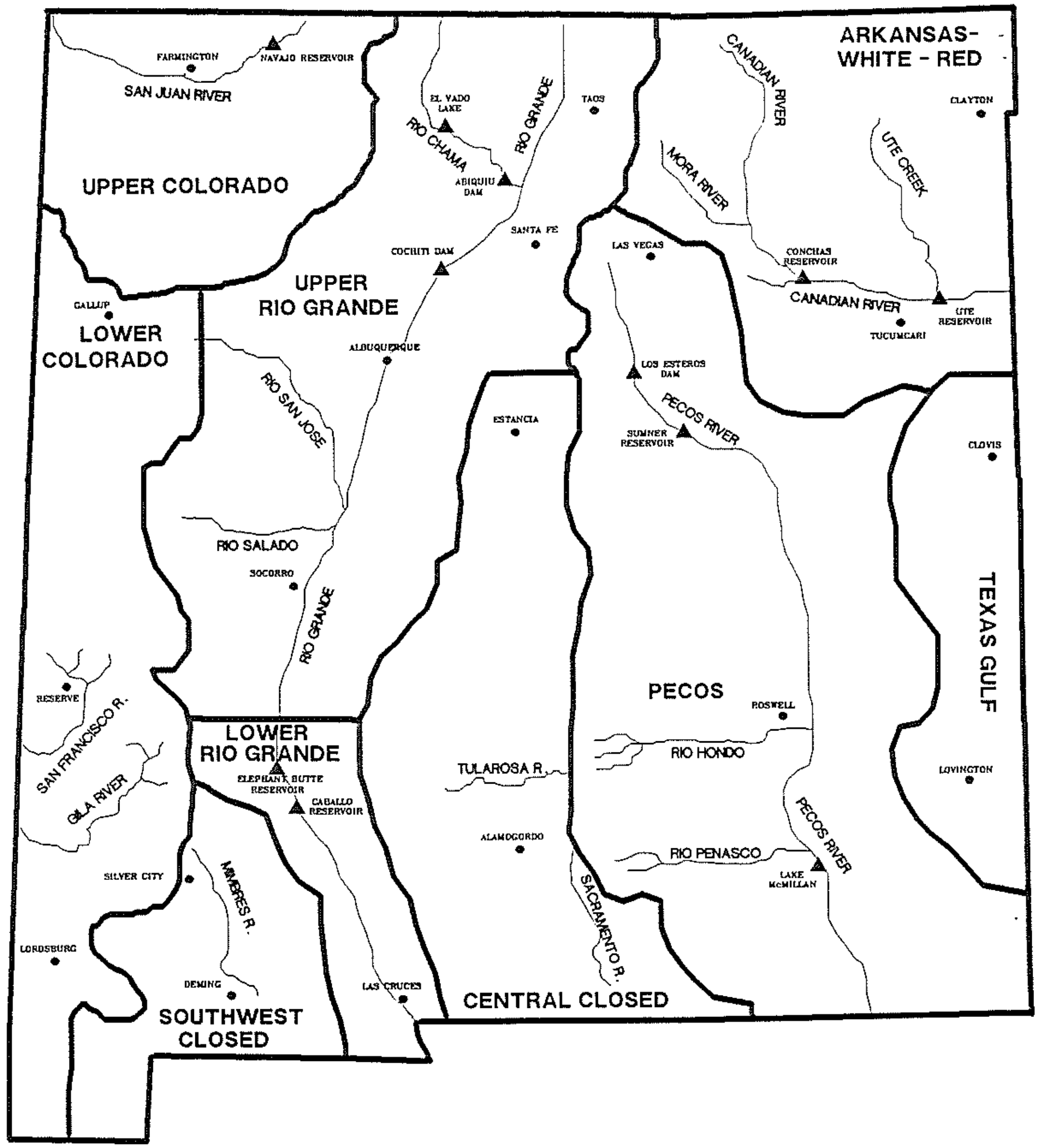


Figure 5-1. **New Mexico's River Basins.**

the Arkansas-White-Red River system support streams that carry water out of New Mexico into downstream states (Figure 5-1).

For explanatory purposes, the Rio Grande has been subdivided into an upper and lower basin. The management procedures dictated by the Rio Grande Compact divide the river's annual surface water supply into an upper and lower basin at Elephant Butte Reservoir. Below this point, the Bureau of Reclamation's Rio Grande Project Operating Plan, the river's annual flows among Texas, New Mexico and Mexico. A discussion of the available water supply in each of these major basins is provided in the sections that follow.

Much of the discussion of quality in this chapter concerns the concentration of dissolved salts in a particular water supply. When evaluating the impact of quality on a water supply, one may consider waters with less than 1,000 mg/l of total dissolved solids (TDS) acceptable for both domestic and agricultural purposes. Slightly saline water (water with dissolved solids of 1,000 to 3,000 mg/l) is marginally acceptable as a source of supply. When slightly saline waters are used for irrigation, marked reductions in crop yields may result. When slightly saline water is used as a community drinking water source, complaints on water taste are common, particularly from new residents. When both slightly saline and fresh water sources are available, blending may be a possible approach.

Upper Rio Grande Basin

Overview of the Upper Rio Grande Basin

The Rio Grande is New Mexico's longest river system and its total available water resources exceed those of other basins (table 5-1). The Rio Grande Basin is vastly important; it is the backbone for transportation and communication systems within the state. The water resources of the Upper Rio Grande Basin are sufficient to sustain the growth of the state's largest city, Albuquerque. In addition irrigated agriculture and municipal and domestic supplies, the Upper Rio Grande Basin's watershed and reservoirs are valued aesthetically and provide broad-based recreational opportunities. The river is a major waterfowl flyway and feeding area.

Description of the Upper Rio Grande Basin

The Upper Rio Grande Basin drains more than 25,000 square-miles in Colorado and New Mexico above Elephant Butte Reservoir, the terminus of the Upper Rio Grande Basin. The major streams in the basin are the Rio Grande, originating in Colorado, the Rio Chama, the Rio San Jose and the Rio Salado (figure 5-1). In its run from the state line to the upper end of Elephant Butte, elevations along the river channel drop from 7,200 feet to approximately 4,400 feet. The river channel varies from reaches where it flows in a narrow gorge (below Taos) to reaches with wide meandering channels (Belen to Socorro). Precipitation in the Upper Rio Grande Basin consists of snow in the winter, particularly above 7,000 feet and rain and thunderstorms in the summer. Both snow-pack and rainfall are subject to wide annual variations. Precipitation is a function of elevation and increases markedly away from the river valley toward the mountains that lie on either or both sides of the valley. Annual precipitation ranges from an average of 10 to 12 inches a year in valley areas to 20 to 24 inches in the northern mountains. The percentage of the precipitation that runs off the watersheds is also a function of elevation; high yields, approximately 20 percent of the precipitation, can be expected in the northern high mountains, decreasing to 10 and 5 percent in a southward, down-basin direction.

Surface Water in the Upper Rio Grande Basin

Flow in the Rio Grande from Colorado is about 300,000 acre-feet a year. Water from the Colorado River system, diverted from tributaries of the San Juan River in New Mexico is another Rio Grande Basin source. The project, which began deliveries into the Rio Chama in the early 1970s, adds about 110,000 acre-feet of water to the flow in the Rio Grande annually for use under contract with the Bureau of Reclamation.

The Rio Chama and the Rio Grande join just above Espaola; the combined average annual flows for these two rivers as they merge is about 900,000 acre-feet a year. This figure is also an estimate of the volume of water flowing past Otowi Bridge and into Cochiti Reservoir, about 30 miles downstream. Otowi Bridge is the point at which flows in the Rio Grande are measured for apportionment under the Rio Grande Compact.

The flow reaching Elephant Butte Reservoir is quite variable. The annual flow past San Marcial, at the upper end of the reservoir, varied from less than a 250,000 acre-feet to almost 1.5 million in the period 1974 to 1984. In this short time, four years registered annual flows of more than 1 million acre-feet and four registered flows of less than 1.5 million acre-feet. This is a good example of the need for storage in large surface reservoirs to smooth out annual fluctuations in order to develop a reliable supply for downstream use.

The Rio Grande Compact

The surface water supply available for consumptive use in the Upper Rio Grande Basin is constrained by the 1939 Rio Grande Compact. The United States-Mexico Treaty of 1906 obligates the United States to deliver 60,000 acre-feet a year to Mexico. The compact contains provisions for Mexico to share with Texas and New Mexico in shortages caused by prolonged drought or by a failure in the United States irrigation system.

The compact also calls for Colorado to deliver water annually to New Mexico based on a complicated relationship of flows in several streams that are tributary to the Rio Grande in Colorado and on changes in water stored in certain reservoirs. In 1986 (Rio Grande Compact

Commission 1986), the flow in the river from Colorado was 804,200 acre-feet with the scheduled compact delivery of only 714,000 acre-feet. This was an excellent water year with stream flow twice as high as normal.

Similarly, New Mexico must make water deliveries under the compact for use in south-central New Mexico, Texas, and Mexico. The amount of water that must be delivered to Elephant Butte Reservoir under the compact is computed each year as a percentage of the flow in the river at Otowi Bridge, just above the upper end of Cochiti Reservoir. The compact requires that New Mexico ensure that a larger percentage of the annual flow reaches Elephant Butte in good water years than in low-flow years. Under normal runoff conditions, about 60% of the flow at Otowi Bridge must reach Elephant Butte under the compact. The normal flow into Elephant Butte Reservoir is slightly more than 700,000 acre-feet a year.

The Texas share of the water delivered to Elephant Butte is computed annually as a percentage of the diversions possible from the releases from Caballo Reservoir. This percentage is based on the irrigated acreage in each state; Texas receives approximately 43 percent of the United States diversions from the river with New Mexico receiving the balance. From time to time both Colorado and New Mexico have fallen into debt under the compact. In the early 1980s, the accumulated debt owed by Colorado exceeded 600,000 acre-feet with New Mexico owing approximately 150,000 acre-feet. All debts were eliminated under compact rules when Elephant Butte filled and water flowed over the spillway in 1985.

Storage-waters in Upper Rio Grande Basin reservoirs is also subject to the terms of the Rio Grande Compact. The compact prohibits storage in any of these basins when the volume of water stored in Elephant Butte drops below a specified level. This, and other criteria in the compact, have acted in the past to restrict the volume of water held in storage in the Upper Rio Grande. Storage of San Juan-Chama water is not affected by the compact.

Reservoirs in the Upper Rio Grande Basin

A large number of flood control and storage reservoirs are located in the Upper Rio Grande Basin. They include Heron, El Vado, Abiquiu and Cochiti Reservoirs, and a number of off-stream dams such as those on the Galisteo and the Jemez. The federal government authorized each of these structures for specified purposes and approved uses ranging from flood control and sediment control to water supply for recreation, irrigation, and municipal-industrial uses.

Ground Water in the Upper Rio Grande Basin

The Upper Rio Grande Basin, as declared by the state engineer, includes an area of approximately 26,000 square miles, covering about the same area as the surface drainage system. The Basin also includes the 73-square mile Sandia Basin and the 1,000 square-mile Bluewater Basin. While there has been extensive development of ground water supplies from various uses in the Rio Grande Basin, the depletions now total less than 100,000 acre-feet a year. Utilization of the ground water resources of the Upper Rio Grande will continue, but because of the close relationship between the surface flow in the river and recharge to the ground water system, agreements on the retirement of existing surface water rights must be reached with the state engineer before new ground water rights will be granted. The state engineer has allowed new ground water developments in the Basin provided the immediate and all potential effects on the flow of the Rio Grande are offset by the eventual retirement of usage under existing rights. As some of the potential effects of a new well on the flow in the river may not be manifested for many years, the state engineer has allowed new appropriators to schedule the retirement of surface rights over a long period of time to match the effects of a new well on flow in the Rio Grande.

The ground water system in the Upper Rio Grande Basin is very important as it is the source of supply for a number of municipalities including Albuquerque, Belen, Espanola, Taos, Grants and Socorro. Ground water along the Rio Grande is found in the deep alluvial valley sediments. The valley fill runs north to south along the river and varies in depth and width. Except for a few isolated places, water quality is good and well yields are adequate for municipal and/or industrial supply.

The Sunshine Valley, located northwest of Taos near the Colorado border is another ground water source of interest in the Upper Rio Grande Basin. The rapid development of irrigation wells in the Sunshine Valley in the late 1940s and early 1950s prompted interest due to shallow water tables and highcapacity wells. A study done in the mid-1950s found that the ground water system was closely linked to the flow in the Rio Grande and that continued development of wells in the valley would result in a comparable depletion in the flow of the river (Winograd 1959). As a result, the state engineer declared the basin to control and limit further impacts on the river.

Lower Rio Grande Basin

Overview of the Lower Rio Grande Basin

The irrigated agriculture of the Mesilla Valley, one of New Mexico's most productive areas, is sustained by the surface supply impounded annually in Elephant Butte and Caballo reservoirs. The ground water of the Lower Rio Grande Basin is a source of water for more than 100,000 people. It also serves as a source of supplemental water for irrigation, particularly during years of below normal runoff into Elephant Butte. The surface water supply available for use is about 342,000 acre-feet a year; the ground water supply available annually is about 80,000 acre-feet a year.

Description of the Lower Rio Grande Basin

The Lower Rio Grande Basin extends from Elephant Butte Reservoir to the Texas line near El

Paso. This part of the Rio Grande Basin yields an additional drainage area of about 4,000 square-miles (figure 5-1). Nearly all of the precipitation in the Lower Rio Grande Basin comes from rainfall except in the mountains along the western edge of the drainage area. The average annual rainfall in the valley area is only about 8 inches a year, and varies from a few high years of 17 and 18 inches to a number of years with 5 and 6 inches of precipitation. Almost no usable runoff is generated in the Basin as only 5 percent of the rainfall becomes runoff and most of this occurs as a result of summer thunderstorms.

Reservoirs in the Lower Rio Grande Basin

A number of flood control dams and holding basins in the Lower Rio Grande Basin are ungated and designed to permit gradual, unregulated releases. The two major reservoirs are Elephant Butte and Caballo. Almost 500,000 acre-feet of the original storage available in Elephant Butte Reservoir has been lost to silt accumulation. A hydro-electric power plant operates in conjunction with releases from Elephant Butte, and generated almost 100 million kilowatt-hours of power in 1984 (U.S.Bureau of Reclamation 1984a).

Surface Water in the Lower Rio Grande Basin

The available surface water supply comes almost exclusively from stream flow into Elephant Butte. Water is often stored for more than one year and, due to higher temperatures in southern New Mexico, the evaporation losses can be significant.

The surface supply is regulated by releases from Elephant Butte and Caballo dams. The Bureau of Reclamation built both these structures as part of the Rio Grande Project.

Early each year, the Bureau of Reclamation estimates the potential surface water supply available for the upcoming irrigation season based on actual storage in the two reservoirs and snow-pack measurements and anticipated spring runoff. The bureau notifies the irrigation districts in Texas and New Mexico and the water is divided by allowing each district to make certain diversions of the releases from Caballo Reservoir. Based on historic relationships, a release of 780,000 acre-feet of water from Caballo is required to generate a full-project supply of three acre-feet of water applied per acre irrigated. A full annual supply has rarely been obtained since the early 1950s.

In good years, releases from Caballo Dam are about 650,000 acre-feet, which permits diversions from the river of about 470,000 acre-feet in New Mexico, 270,000 acre feet in Texas and 60,000 acre-feet to Mexico under an international treaty. Drain return flows, spills and local storm runoff make up the difference between supply from Caballo and the total diversions. The volume of the surface supply available for consumptive use in New Mexico is about 420,000 acre-feet a year; this includes 270,000 acre-feet needed for a full supply by the Elephant Butte Irrigation District and the water lost to evaporation from Elephant Butte and Caballo reservoirs (150,000 acre-feet a year).

Ground Water in the Lower Rio Grande Basin

The Mesilla Bolson is the principal ground water reservoir in the Lower Rio Grande Basin. Although the physical boundaries of the **Bolson** are not totally agreed upon, general consensus exists (Peterson, Khaleel and Hawley 1984).

The Mesilla Valley, as it runs from north of Las Cruces to the narrows in the Rio Grande above El Paso, is the heart of the Bolson. The Bolson is hydrologically linked to the river, the water-supply canals, and the irrigated lands that lie in the valley area. All three serve as recharge sources, and the irrigation drain system acts as a running point for the discharge from the shallow ground water. The valley varies in width from one to six miles and has an average width of three to four miles over its 50-mile length. The shallow ground water is in an alluvial zone that is 60 to 100 feet thick and lies below the river and its flood plain. The Bolson consists of areas that each have different water supply characteristics. The principal ground water areas are the valley lands and its farms, and the mesa lands, particularly the West Mesa, which is 100 to 300 feet higher than the river and parallel to it as it runs from northwest to southeast. The deposits in these two areas are well suited to development of wells because of favorable aquifer characteristics. There are many wells, both in the valley and on the mesa lands, with yields in excess of 1,000 gallons per minute. Some of these wells belong to the cities of El Paso and Las Cruces, the new community of Santa Teresa, and to farmers who also have surface water rights from the Elephant Butte Irrigation District.

Water quality is somewhat variable throughout the Bolson and at vertical depths. The shallow ground water that enters the irrigation drains on the east side of the valley is quite poor as it represents seepage from **alluvial fans** that have eroded from the mountains east of the river. The quality of the water in the west-side drains is not as poor, and is probably mostly irrigation return flow. Deep wells in the valley area and on the West Mesa produce water that is acceptable for both municipal and farm use. Zones of saline ground water are located near the El Paso narrows and upstream to Anthony.

The total dissolved solids content of some of the poorer wells in this area are as high as 25,000 mg/l. As previously stated, waters with a total dissolved solids content of more than 1,000 mg/l are not generally acceptable for agricultural and community uses.

Pecos River Basin

Overview of the Pecos River Basin

Located in northcentral New Mexico, the Pecos River and its watershed are important for their recreational and wildlife habitat aspects. Irrigated agriculture is practiced north of I-40, but total productivity is limited. The major uses of the Pecos water resources are ground water irrigation in the Roswell area and surface water irrigation near Carlsbad. There are also recreational uses in the southern part of the Pecos River Basin in the high mountains near Ruidoso. By compact, New Mexico and Texas both have rights to the use of part of the surface flows in the Pecos River.

Description of the Pecos River Basin

The headwaters of the Pecos River lie in the eastern slopes of the Sangre de Cristo Mountains in north central New Mexico (figure 5-1). In a distance of 160 miles, elevations decline from 13,000 feet at South Truchas Peak to 4,300 feet at Lake Sumner.

Half the streamflow in the Pecos and its tributaries originates in the high mountains to the west of the main river channel as it moves downstream. Precipitation is much greater in these mountain areas than along the river channel.

The water yield from the mountainous areas is a function of snow pack and elevation. Snowfalls can range from 340 inches at 12,000 feet to 200 inches at 10,000 feet and 85 inches at 8,000 feet. In the northern mountains, runoff may be as high as 20 percent of precipitation, decreasing to 5 percent in the downslope direction. Runoff is as little as one and two percent of precipitation received at lower elevations in the south central portion of the Pecos River Basin. This area yields little streamflow, except during occasional thunderstorms, as rainfall rates are low.

Surface Water in the Pecos River Basin

The Pecos River and its tributaries yield an average 600,000 acre-feet a year, but only about 200,000 acre-feet is available for use in New Mexico. The remainder of the water supply either goes to Texas under the Pecos River Compact (about 240,000 acre-feet a year) or is lost to non-beneficial uses. An active federal project to control phreatophytes on 50,000 acres in the Pecos drainage may reduce these losses in the future.

Reservoirs in the Pecos River Basin

The Pecos River flow is controlled by a number of flood control and storage reservoirs. The farthest upstream is near Las Vegas, and is used principally for water-flow migration and recreation. The first major dam on the Pecos is Los Esteros just above Santa Rosa. The reservoir has a capacity of about 440,000 acre-feet, which is dedicated to flood and sediment control and irrigation water storage. The Carlsbad Irrigation District (CID) has the option of storing water here or further downstream in Lake Sumner or at Brantly Dam, a new structure now under construction. Provisions have been made for the maintenance of a permanent recreation pool at Santa Rosa Lake, but protests by the CID and the state of Texas have delayed its establishment.

The dam at Lake Sumner is an earthfill structure built by the Bureau of Reclamation in the middle 1930s. It has a capacity of 100,000 acre-feet, part of which is allocated to the storage of irrigation water and the remaining to flood control.

Construction began on Brantly Dam in 1984 and is scheduled to be completed in 1988. It is just downstream from and will replace McMillan Dam below Artesia, a potentially dangerous and leaky structure. Brantly will have a recreational pool of 2,000 acre-feet, a sediment storage pool of 56,000 acre-feet, irrigation storage capacity of 150,000 acre-feet, and flood storage of almost 350,000 acre-feet. The irrigation water storage capacity will be used by the CID.

A number of small dams are located on Pecos River tributaries that drain the high mountains west of Roswell and Artesia. A few of these structures are for irrigation, but most are for flood control, or recreational and municipal uses.

Ground Water in the Pecos River Basin

The state engineer has declared eight ground water basins in the Pecos drainage. In each case the Basin was declared to protect the rights of existing surface and ground water users. The existing ground water depletions in the Pecos are about 235,000 acre-feet a year, and it is unlikely that new, significant water resources developments will take place. However, it is conceivable that new limited appropriations will be approved by the state engineer in some of the declared basins.

The Roswell Artesian Basin is the most important sub-basin in the Pecos drainage and one of the first established by the state engineer. The hydrologic setting is quite complex as both fresh and saline water are found in close proximity.

The fresh waters of the Roswell ground water reservoir are withdrawn from two principal aquifers: a deep semi-confined, limestone aquifer of the Permian period, and the other a free-surface, shallow aquifer in the valley fill.

Upper Colorado River Basin

Overview of the Upper Colorado River Basin

The San Juan River and its tributaries are second only to the Rio Grande in providing water resources of the state (figure 5-1). The large stream flow from Colorado into New Mexico is the basis of the basin's water supply. There is almost no usable ground water resource available. With the help of the Bureau of Reclamation, New Mexico is developing all of its allowable share of the Upper Colorado River Basin surface water supply. The surface water available for use in New Mexico is more than 670,000 acre-feet a year.

Description of the Upper Colorado River Basin

The San Juan Mountains in Colorado rise to more than 14,000 feet and provide snow melt that feeds the San Juan River. Snow pack accumulations can exceed 100 inches in the high mountains and remain until late summer before melting completely. Precipitation on the New Mexico portion of the watershed is 10 to 20 inches a year in the upper reaches of the San Juan and 6 to 10 inches at the lower elevations. At Pagosa Springs, Colorado (elevation 7,238) near the New Mexico line, the average annual rainfall is 20 inches; at Farmington (elevation 5,395) the rainfall is 8 inches a year. Evaporation rates also are related to elevation: 30 inches a year on the areas above 7,000 feet and up to 60 inches a year in the lower reaches of the San Juan.

Surface Water in the Upper Colorado River Basin

Streams in the Upper Colorado River Basin in New Mexico originate in Colorado. The four principal Basin rivers are the La Plata, the Animas, the San Juan and the Navajo. The Piedra and Los Pios rivers enter Navajo Reservoir above the state line. In New Mexico the basin includes an area of almost 10,000 square miles with the San Juan River as its the major stream. Some very large arroyos originate in the high mesas southeast of Farmington and Aztec. Although these washes do not run annually, they can carry high flood flows for relatively short periods.

Runoff caused by precipitation is quite high for the Colorado mountains, more than 10 inches a year. Runoff from precipitation on New Mexico watersheds of the basin averages less than one inch a year. As a result, most of the stream flow in the San Juan comes from Colorado, about 70 percent during the snow-melt period of April to July.

Much of the water in the San Juan River could not be used prior to the construction of Navajo Dam because of the seasonal nature of the discharge and its year to year variability. All of the unregulated flows of the San Juan and Animas rivers were subject to court adjudication in 1948 and the rights to use the surface waters was fully allocated. The federal act that provided construction of new water development structures on the Colorado River system, including Navajo Dam, resulted in making additional water available under contract from the Bureau of Reclamation. The bureau has acquired six separate water rights from the state that total more than 1 million acre-feet a year (Black and Veatch 1982). A readjudication of the surface rights of the San Juan is now underway by the New Mexico state engineer.

Reservoirs in the Upper Colorado River Basin

Navajo Dam is the only large reservoir in the Upper Colorado River Basin in New Mexico. It receives almost 1 million acre-feet a year from the San Juan and its tributaries. The reservoir's capacity, 1.7 million acre-feet, makes it the second largest in the state. The dam was started in the late 1950s and storage was initiated in 1963. This Bureau of Reclamation project is designed to provide storage for irrigation water for the Hammond and Navajo Irrigation Projects. It also stores water for municipal and industrial uses, fish and wildlife habitat, recreation, flood control and power generation.

The Upper Colorado River Compact

The 1923 Colorado River Compact provided for the apportionment of the flows in the Colorado River between the upper and lower Basin states. The compact allows the upper basin states to use water to the extent that it will not result in the cumulative flows (in the Colorado at Lee Ferry, Arizona) to be less than 7.5 million acre-feet in consecutive ten-year periods.

Under the United States-Mexico water agreements on the Colorado, Mexico is to receive 1.5 million acre-feet a year of water that meets specified water quality criteria. The upper division states have based their plans for water resources development on ensuring that water of appropriate quantity and quality will flow past Lee Ferry to meet all compact requirements. New Mexico's share of the allowable consumptive use in the Upper Colorado is 11.25 percent. The New Mexico Interstate Stream Commission has set the allowable consumptive use in the state at 727,000 acre-feet a year. This figure includes 58,000 acre-feet annually for instream losses. The balance, or the allowable depletion by beneficial uses, cannot exceed 669,000 acre-feet a year (Black and Veatch 1981). If the stream flow in the upper basin is less than that needed to meet the criteria of an average annual flow of 750,000 acre-feet at Lee Ferry, New Mexico's share may be less than this amount.

Ground Water in the Upper Colorado River Basin

The New Mexico state engineer has declared the entire Basin as part of the San Juan ground water basin. In general, the quantity and quality of the supply available from the various basin aquifers is quite poor.

The valley fill in the stream channels is the most reliable source of good quality ground water as it is recharged by the surface flow. Saturated alluvium occurs in most stream channels and the thickness is typically about 50 feet; however, valley fill in excess of 100 feet may occur. The dissolved solids concentrations (TDS) range from 1,000 to 4,000 mg/l in the Farmington area to less than 1000 mg/l in the Aztec area. Wells closer to rivers have better quality than those farther away. Yields are low in most valley-fill wells, but wells of up to 500 gpm have been obtained at Farmington.

Lower Colorado River Basin

Overview of the Lower Colorado River Basin

The Lower Colorado country is beautiful and the water supply is used for recreational purposes. The major streams in the basin, the Gila and the San Francisco, are not regulated by dams and there are no major reservoirs in the Basin.

Description of the Lower Colorado River Basin

The Lower Colorado River system extends along the west side of the state from Gallup, south past Lordsburg to the United States-Mexico line (figure 5-1). The Gila River is the largest river in New Mexico in this drainage system. A number of smaller streams flow into Arizona that are a part of the Lower Colorado: the Rio Puerco, the Zuni River, the Little Colorado River, the San Francisco River and San Simon Creek. The total drainage area is approximately 11,000 square-miles. It is difficult to characterize the basin because of the variability found in elevation (from 4,000 to 10,000 feet), in precipitation (from over 24 inches a year to 10 inches), in evaporation and in growing-season.

Surface Water in the Lower Colorado River Basin

The surface water supply of the Lower Colorado River system available for use in New Mexico is about 95,000 acre-feet a year. Most of this flow is generated by the Gila River.

The smaller streams in the Lower Colorado drainage can carry significant quantities of storm runoff from New Mexico. Development for all purposes is hampered by interstate agreements, court decrees and, more importantly, by the variability of their discharge.

The Gila and the San Francisco rivers now carry unused water into Arizona: the average annual flow in the Gila at the state line is about 130,000 acre-feet and on the San Francisco, a slightly more than 50,000 acre-feet a year. New Mexico has been constrained from consumptive use of this water by a series of court decisions including the Globe Equity Decree. The Colorado River Basin Project Act of 1968 authorized the Central Arizona Project (CAP), which made additional water available for consumptive use in New Mexico. Section 304 of Public Law 90-537 states that the Secretary of Interior shall offer to contract with new water users in New Mexico for amounts that will permit consumptive use of water not to exceed an annual average, in any ten consecutive years, of 18,000 acre-feet including reservoir evaporation. The U.S. Bureau of Reclamation and the state have studied the location of a number of dam sites, on and off the Gila River, where the supply could be stored. For various reasons, neither an acceptable site, nor a combination of dams and reservoirs, has been found. A lack of demonstrated current demand for the water supply also is a problem. The bureau project has been postponed pending a reappraisal of needs.

Ground Water in the Lower Colorado River Basin

Three declared sub-basins exist in the Lower Colorado drainage: the Gila-San Francisco, the Virden Valley, and the San Simon. There has not been extensive ground water development either in the Gila drainage or on the San Francisco. These two basins have been declared to protect the flow in these stream systems from further consumptive use. There has been some ground water used for irrigation in the Gila Valley and additional wells along the river have been considered as a means of capturing some of the new supply made available to the state under the Central Arizona Project.

The San Simon is a broad, flat valley that is shared by Arizona and New Mexico and irrigation from ground water sources occurs in both. The state engineer declared the basin in 1957 and some water-level monitoring has been maintained. Increases and declines in the ground water table have been noted; in a 1975-1980 comparison (State Engineer Report 1983), water levels in about as many wells went up as went down.

Arkansas-White-Red River Basin

Overview of the Arkansas-White-Red River Basin

The Arkansas-White-Red River Basin is a series of streams that drains the northeastern quadrant of New Mexico. The water resources of the Basin are used for every possible purpose: recreation in the mountainous areas and in fishing lakes such as Clayton, water fowl habitat, municipal supplies, industrial water in the coal-mining country near Raton and irrigated agriculture. Useful ground water is not plentiful, but some surface water is still available from the reservoir through contracts with the New Mexico Interstate Stream Commission. The average surface water supply available for use in the Basin is about 312,000 acre-feet a year and the ground water supply is approximately 112,000 acre-feet a year.

Description of the Arkansas-White-Red River Basin

The Canadian River is the only major river in the northeastern quadrant of New Mexico (figure 5-1). However, a number of smaller streams leave the state to join various tributaries of the Arkansas river system, which is a part of the lower Mississippi River Basin. The sub-basins of the AWR in New Mexico are the Canadian, Purgatory, Dry Cimarron, Carrizozo, North Canadian and Carrizozo Creek. Each of these streams is north of the Canadian River, which originates on the eastern slopes of the Rocky Mountains in north central New Mexico. The Canadian River is the only perennial stream. The Red River drains a small part of New Mexico to the south of the Canadian near Tucumcari; arroyos in the area include Frio Draw and Tierra Blanca Creek. The AWR basin covers 17,000 square miles in the state; the Canadian River has a drainage area of almost 13,000 square miles of this area. Rainfall on most of the watershed is about 14 to 16 inches a year, but precipitation in the mountains areas can be 20 to 24 inches a year.

Surface Water in the Arkansas-White-Red River Basin

One of the principal tributaries of the Canadian River Basin is the Vermejo River, which originates in Colorado, drains part of the Maxwell land grant and joins the Canadian River south of Raton, New Mexico. It has an average annual flow of about 13,000 acre-feet as it leaves the

Maxwell land grant. The Cimarron River carries snow melt from the mountains east of Taos into the Canadian River.

The Mora River is another branch of the Canadian that drains the north central mountains of the state. The Mora River is used for irrigation and recreational fishing. The average annual flow in the Mora at Shoemaker is about 40,000 acre-feet a year from a contributing watershed of more than 1,000 square miles.

After its union with the Mora, the Canadian River continues south into the upper reaches of Conchas Reservoir. After providing irrigation for approximately 56,000 acres, the Canadian River near Sanchez (about 30 miles above the dam at Conchas) has an average annual flow of almost 133,000 acre-feet per year. The Conchas River lies to the south of the Mora and the Canadian and it discharges directly into Conchas Reservoir. It yields about 10,000 acre-feet a year from 500 square miles of watershed.

The annual water supply available to the irrigation project that uses the water stored by Conchas Dam is about 150,000 acre-feet a year from 7,000 square miles of drainage area. Evaporation from Conchas and canal losses reduce the volume available for the 35,000 acres irrigated near Tucumcari. In the 1986 water year, about 60,000 acre-feet were diverted into the Conchas canal for project use.

Flood flows on the Canadian and on Ute Creek, which flows into the Canadian near Logan, went unused for many years after the construction of Conchas Dam in 1938-39. Ute Dam was built near Logan in 1962 to trap these flood flows in New Mexico. Major modifications in 1983-84 increased the capacity by providing a gated-spillway. The maximum design capacity is about 440,000 acre-feet when the spillway is fully flowing.

Reservoirs in the Arkansas-White-Red River Basin

A number of small man-made lakes are located in the AWR basin in New Mexico. There are two small municipal water supply lakes near Raton and some shallow Bureau of Reclamation structures above Springer. The total evaporation from these and other water bodies on the AWR is estimated to be about 70,000 acre-feet a year.

Ground Water in the Arkansas-White-Red River Basin

With the exception of the almost 6,000 square-mile Canadian ground water basin, and a very small area near Tucumcari, the state engineer has not found it necessary to control appropriation of ground water in the balance of the AWR Basin (an area of just over 17,000 square miles). The two reasons for this absence of regulatory action are: the population in the basin is relatively small and the resulting domestic demand is also quite low; and the availability of aquifers that yield relatively large quantities of fresh water is also sparse. There are, of course, local exceptions to this statement such as the areas near Capulin and Clayton. The Entrada Sandstone near Tucumcari provides acceptable water for municipal use. Quality is a constraint in the AWR Basin as waters of high sulfates and relatively-high total dissolved solids (1,000 to 3,000 mg/1) is not uncommon.

Although there are locally available ground water sources, there is no regional aquifer that can provide significant quantities of water. There is about 112,000 acre-feet a year of fresh water available in the basin.

Central Closed Basin

Overview of the Central Closed Basin

The Central **Closed Basin** is a large, sparsely settled area that occupies much of the central portion of the state. This Basin has no major river, but does have a very large ground water reserve. The valley fills in both the Tularosa and the Estancia basins have both fresh and saline ground water available for use.

Description of the Central Closed Basin

The Central Closed Basin runs north from the Texas-New Mexico line, two-thirds of the way up the middle-spine of the state (figure 5-1). It parallels the Rio Grande and lies to the east of that stream system. The Central Closed Basin has no main drainage system, nor is there a river that cuts across the basin. As implied by its name, there is no surface water discharge from the Basin.

The Central Closed Basin has four sub-units: the Tularosa Basin, the Jornada Del Muerto, the Salt Basin, and the Estancia Basin. The two major sub-basins are the Tularosa and the Estancia; both include one or more ground water areas that have been declared by the New Mexico state engineer.

Elevations in Tularosa drainage are as high as 10,000 feet in the Sacramento Mountains that form the eastern flank of the basin, to 4,000 feet in the basin floor. The growing season is 210 days and the freeze-free days extend from early April to early November. Precipitation ranges from 25 inches in the mountains to 10 inches a year in the central valley. Evaporation rates are high: 70 to 75 inches a year. Winter snows at higher elevations are the source of the stream flow in the Tularosa River; the average flow in this stream is about 10,000 acre-feet a year. As the Tularosa flows downstream, it accumulates dissolved solids so that its use for irrigation, where it enters the valley floor, is marginal. Several similar mountain streams that originate in the Sacramento and Capitan mountains are used for irrigation, but none are significant. However, it should be noted that summer thunderstorms can yield large volumes of runoff that flow out on the Basin floor.

Though elevations in the Estancia Basin are more uniform, they are still relatively high (6,000 to 8,000 feet) so that the growing season is short (140 to 160 days in the valley area). Some surface runoff occurs during "good" snow years and after an occasional summer storm. This water ends in a series of playas at the southern end of the Basin near Estancia. The largest of these is the Laguna del Perro. This lake is relatively shallow and has variable dimensions depending on the frequency of runoff-yielding precipitation. Water quality in the lake is not acceptable for most purposes, but could be used to grow algae, which can be used as a feed and energy source. (Lansford et al. 1986b).

Ground Water in the Central Closed Basin

The available surface water supply of the Estancia and the Tularosa basins is quite limited and the quality is poor in places. The total surface water resources of the Central Closed Basin is only 2,000 acre-feet a year. There are ground waters of appropriate quality available in both sub-basins.

The Tularosa Basin valley is a significant source of saline water and ground water of usable quality. The areal expanse is great (over 6,000 square miles), and the thickness of the basin fill (up to 8,000 feet in places) provides a vast volume for water storage. An estimated 140 million acre-feet of water is in storage, 98 percent of which is very saline (greater than 35,000 mg/1 TDS) (USBR 1984b).

Fresh water (less than 1,000 mg/1 TDS) is also found in the Basin in pockets along the mountain fronts on the east and west sides of the valley and in thin layers that overlie the more saline zones. This volume is not insignificant: about 10 million acre-feet in storage. The availability of most of these fresh-water zones is fair to good, so that wells producing 700 to 1,000 gallons a minute can be developed.

A significant volume of "slightly saline" water (1,000 to 3,000 mg/ TDS) is also found at the transition from fresh water to more saline zones (McLean 1970). Parts of the basin-fill that contain slightly saline waters are quite thick (1,500 to 2,500 feet) and the water depth is relatively shallow (50 to 200 feet). Well-yields become poorer as the water becomes more saline; wells producing in the slightly saline zone typically yield at least 300 gallons a minute while zones where the salt concentration is greater that 10,000 mg/ may only produce 50 to 100 gpm.

Estancia alluvial valley-fill provides a ground water source that covers about 300 square miles; the total drainage basin includes an area of more than 2,000 square-miles. The water quality is quite variable. The saline zone is the result of evaporation from the lakes and playas at the lower end of the basin. This slightly saline zone runs from the surface to a depth of 50 feet or less and extends over less than a third of the valley lands. The water depth is greater in the fresh water zones, but wells yielding up to 1,000 gpm can be developed in parts of the Basin. The ground water reserves in the basin are probably about 2 to 3 million acre-feet of water.

Surface Water in the Central Closed Basin

A number of ephemeral streams discharge into the Tularosa Basin from the mountains that flank the valley lands to the east and west. Because of the higher elevations and more massive nature, the Sacramento Mountains on the east yield greater surface flows than do the San Andres Mountains on the west. Almost no perennial streams come out of the Sacramento Mountains and none regularly discharge into the valley floor.

The major exception is the Tularosa River that carries snow melt from the Sacramento Mountains and occasional flood flows. It is a relatively uniform flowing stream for New Mexico. For example, in 1986 there were many days when the flow was about 20 cubic feet per second (Beal and Gold 1986). The discharge from mountain springs is responsible for this steady flow. At Bent, 12 miles east of the village of Tularosa, the average annual flow in the creek is about 7,800 acre-feet. The quality in the Tularosa is acceptable for both irrigation and community use, but total dissolved solids (almost 1,000 mg/1) is on the high-side (Beal and Gold 1986).

The surface flows in the Estancia Basin drain into the playa lakes. None of these is perennial and some have no well-defined channel system. The total amount of surface water available in the Southwest Closed Basin is 10,000 acre-feet a year.

Texas Gulf Basin

Overview of the Texas Gulf Basin

The Texas Gulf Basin runs along the eastern side of New Mexico from just south of Tucumcari at the top of the Basin to the southeast corner of the state. There are no rivers or streams that drain the area, and yet there is a significant water resource in the basin, the Ogallala aquifer.

The Ogallala Formation is a regional aquifer made of deposition of the weathering and erosion products from the Rocky Mountains that were transported eastward by flood waters millions of years ago. As the streams carrying these materials left the mountain reaches, they entered low-gradient, flatter areas and deposition occurred to form broad plains that ran west to east from the Rockies to Nebraska and north to south a distance of 800 miles or so. The eastside communities of Clovis, Portales, Lovington, and Hobbs have long used this extensive ground water system as a source of supply as have the farmers who practice irrigated agriculture in the basin. Unfortunately, the rate of recharge of the aquifer has been significantly lower than is the rate of annual withdrawals. As a consequence, ground water levels are declining and the obtainable yields from some of the area farm wells are no longer sufficient for efficient irrigation practices.

Description of the Texas Gulf Basin

The Texas Gulf Basin is part of the High Plains area of the United States that runs from West

Texas to South Dakota and includes all or part of five New Mexico counties: Quay, Curry, Roosevelt, Chaves, and Lea. The water supply of the basin is dominated by the principal aquifer that underlies the basin, the Ogallala (figure 5-1). The history of the formation of the Ogallala and its areal extent are of great regional importance.

The climate of the High Plains is semiarid in New Mexico with the evaporation (60 inches a year) greatly exceeding the average annual rainfall (14 to 16 inches). Rainfall is highly variable and occurs mostly during the summer months. For example, at one station annual precipitation has been from 6 inches to 25 inches. Temperatures are also highly variable; winter daytime temperatures may range from below zero to 80o and up.

Surface Water in the Texas Gulf Basin

The surface drainage system is poorly developed or non-existent along New Mexico's eastside below the Canadian River. Playas, shallow natural depressions that collect localized drainage for irrigation and stock watering, are the only surface water bodies in the Basin. The playas contain water only after major rainfalls, which may be months or years apart. Although most playas are small (a few acres), some include hundreds of acres.

Ground Water in the Texas Gulf Basin

The Ogallala today is a water-table aquifer that yields sufficient quantities from wells to be an acceptable source of supply for both municipal and agricultural purposes. An average irrigation well will produce 500 gallons per minute. Depths to ground water depend on location in the Basin, as deep as 350 to 450 feet in places, but the aquifer is relatively close to the surface in many of the farming areas so that lifts of 50 feet or less are not uncommon. A water depth of 100 feet might be considered typical. Water quality is quite good although there are areas where the water contains borderline concentrations of nitrates (the maximum allowable for drinking water is 40 mg/1).

In general, the water table slopes gently to the east as does the land surface. One of the most important characteristics of the Ogallala is the existence of valleys in the top of the beds where the formation materials were originally deposited. These variations in relief now determine the thickness of the water bearing Ogallala materials. The Ogallala in New Mexico is being mined as withdrawals exceed aquifer recharge. Playas may play an important role in the recharge process, but most of the water collected in these shallow bodies is lost to evaporation. Areal recharge may be as little as one-half inch a year (Camp, Dresser and McKee 1982). Recharge is greatest in the sandy area (near Portales) and lowest in those places where caliche formations are near the surface (southeastern section of the Basin).

The decline in ground water levels has ranged from a few feet to more than 50 feet in places.

The lowering of the water table creates two problems; the pumping lifts have increased and the thickness of the saturated zone has diminished, thereby reducing well yields. Both of these factors adversely effect farm costs.

Southwest Closed Basin

Overview of the Southwest Closed Basin

The Southwest Closed Basin does have a significant reserve water resource in the form of the ground water in the alluvial valley-fills. The largest of its sub-basins and the one with the greatest recharge is the Mimbres Basin in the Deming area. All of the sub-basins are being mined and all have been declared by the state engineer. Water levels in most of the sub-basins have declined below their original levels.

Description of the Southwest Closed Basin

The Southwest Closed Basin is located in the southwest corner of New Mexico and includes all or parts of five counties: Luna, Hidalgo, Grant, Sierra and Dona Ana (figure 5-1).

The Southwest Closed Basin (8,420 square miles) includes a number of sub-basins that drain the mountain ranges that present a marked topographic contrast to the flat valley areas that lie between, and parallel to, the many mountain groups that form the back-drop of almost every vista in the Basin. The largest of these is the Mimbres River and its tributaries (4,515 sq. mi.) which carry snowmelt from the high mountains of the Black Range (9,000 feet at the peaks) and runoff from the Pinos Altos Mountains. The Mimbres follows a well-defined channel as it flows south, but it spreads and seeps into the valley floor as it comes to the end of its run, just north of Deming. Major flood-flows are reported to spread and run all the way to the Mexican border before they disappear into the broad expanse of flat lands (Doty 1968) that are characteristic of the valley areas in the Basin.

Of the other sub-basins, only the Animas flows in a distinct channel. As the Animas moves north, out of the Peloncillo Mountains, it too spreads across the valley lands where it ends in broad playas near Animas. The other sub-basins are: the Hachita that drains the Big Hatchet Mountains and part of the Animas Mountains in the south central portion of the basin; the Playas Basin just to the east and one range over from the Animas Valley; the Wamel; and the San Luis Basin.

With the exception of the Mimbres, most of the runoff in the Basin occurs as a result of thunderstorms and most of the precipitation comes during the summer. Snowfall does occur throughout the Basin at higher elevations. Precipitation is quite erratic. For example, over a 44-year period at Columbus on the Mexican border, annual rainfall ranged from less than 4 inches to more than 19 inches. At Deming, summer rainfall has ranged from one-half inch to more than 4 inches per month. The average precipitation for the basin is about 10 to 11 inches a year.

Surface Water in the Southwest Closed Basin

The usable surface water supply for the Basin is about 11,000 acre-feet a year. Essentially, all of this water is from the Mimbres River where the average annual yield at the village of Mimbres is almost 15,000 acre-feet (Beal and Gold 1986). The Mimbres flow is used for irrigation, but it is also lost from the stream channel to ground water recharge. Nearly 50 miles downstream at Faywood, the flow has diminished to an average of about 12,000 acre-feet a year (Doty 1968). There is a small recreational lake at Bear Canyon near the village of Mimbres, but for all practical purposes the stream is unregulated until it dissipates into the lowlands near Deming.

Ground Water in the Southwest Closed Basin

There is relatively good ground water (less than 1,000 mg/1 total dissolved solids) in each of the valley areas in the sub-basins that make up the Southwest Closed Basin. Ground water is found in the bolson deposits that have been eroded from the mountain ranges that flank each of these valleys.

Doty (1968) estimated the total fresh ground water resources of the Southwest Closed Basin to be almost 180 million acre-feet that is recharged at a rate of just 45,000 acre-feet a year from precipitation on the watershed and flow. Ground water is now being "mined" in most of the sub-basins, but there is some natural discharge in the form of springs and seepage into playas from the ground water system.

The actual amount of water that could be taken from the various sub-basins over a long period is subject to conjecture because of the many unknown factors. Doty (1968) notes that not all of the ground water reserves can be recovered. One of the factors would be the allowable rate of decline in ground water levels. The average annual ground water supply available for use in the Southwest Closed Basin is estimated at 176,000 acre-feet a year.

OTHER WATER RELATED RESOURCES

Wetlands

Wetlands in New Mexico are important wintering grounds for many species of ducks and geese. The Bosque del Apache National Wildlife Refuge is the major wintering grounds for most species and is a critical winter habitat for greater sandhill cranes (Bellrose 1980), and the endangered whooping cranes. In recent years the number of waterfowl using New Mexico fly-ways has steadily increased. In 1972, 12,000 snow geese wintered at Bosque del Apache. Those numbers increased to a high of 75,000 in 1987. Important wetland areas occur all along the Rio Grande, particularly in the Bosque del Apache south of Socorro. Other wetland areas of importance are scattered throughout the state; for example, those north of Springer on the Canadian River and those near Roswell on the Pecos River.

Fisheries

New Mexico is fortunate in that it is a state with many cold and warm water fisheries. Cold waters include Navajo, El Vado, Abiquiu, Costilla, Eagle Nest, Charette, Conchas, Cochiti, Bluewater, Quemado, Santa Rosa and Storrie lakes. The most important cold water fish species are rainbow and brown trout, although brook trout and native Rio Grande cutthroat do occur in some cold waters. Another native trout is the Gila trout, now on the threatened and endangered species list. The Department of Game and Fish and other agencies have been working on the Gila trout's reintroduction into streams in the Gila Wilderness, which are scheduled to open for fishing in 1989. Warm-water fisheries, while fewer in number, are well-known in the state. They include Elephant Butte, Caballo, Bataan and McMillan lakes. Species found in these waters include bass, crappie, sunfish, walleye, pike, catfish, suckers and carp.

CHAPTER SIX: WATER DEMANDS IN NEW MEXICO

SUMMARY

To determine alternative future water depletions, three population projections to 2030 were developed: 1) conservative growth, 2) potential growth; and 3) optimistic growth. Two scenarios were developed for the population projections — Scenario A held agricultural water depletions constant at the 1985 level over time and Scenario B permitted agricultural water depletions to increase over time as they did in the late 1970s.

New Mexico's water use outlook as projected to 2030 looks promising for Scenario A for all of the population projections. New Mexico's water depletions will not exceed the supply before 2030. If New Mexico's depletions follow the trend of Scenario B then the demand will exceed the supply by 2030 under all of the population projections.

Future economic scenarios will likely be somewhere between Scenario A and Scenario B, but where along this continuum is uncertain. The state of New Mexico probably cannot survive economically based on projections from Scenario A nor does it have the water resources for Scenario B. However, any significant increases above the Scenario A level projections, will come at the expense of some sectors with agriculture as the most likely candidate.

INTRODUCTION

Current uses of water in New Mexico, as well as potential future water uses, will be estimated. This will be done by developing estimates for current and future water use in each county by river basin in New Mexico. These long-range projections will be conjectural in nature and constitute no more than an outline of different water futures that New Mexico might face. Later in this chapter, these water use estimates will be brought together with existing supply figures to project possible times of future water scarcity.

Water depletion is the foundation for any discussion of water use. Depletion is a term meaning water withdrawn that is no longer available for use because it has been evaporated, transpired, incorporated into products or crops, consumed by man or livestock, or otherwise removed. Water use is also measured as a withdrawal, or the amount that is diverted from its source. The distinction between the two terms is important because some water uses may divert a great deal of water, but actually may consume or deplete only a small amount. The water use figures developed here will refer to depletions.

The water use figures on depletion were taken from a 1986 report by the State Engineer Office (SEO) (Wilson 1986). The information presented here will differ from the 1986 Wilson report in that it combines the 13 water use categories into five:

1) Agriculture — irrigated agriculture, livestock, stockpond evaporation; 2) Municipal — urban, rural; 3) Industrial — commercial, industrial, military; 4) Minerals and Power; and 5) Evaporation — reservoir, fish and wildlife, recreation. It also uses slightly different basin boundaries. An increase in population is a good indication of economic growth. Additional people or employment of unemployed people will be required to fill new jobs created through economic development. In this analysis, it will be assumed that new jobs will require additional population growth.

To determine alternative future water depletions, three population projection will be developed: 1) conservative growth; 2) potential growth; and 3) optimistic growth. The conservative growth population projection will be adopted from a recent publication by the Bureau of Business and Economic Research (BBER 1987) of the University of New Mexico. The BBER report projected population to the year 2010. For purposes of this report, population estimates for 2020 and 2030 will be trended forward by a straightline method from 2010 to 2030. The data in the BBER report provided population estimates on a county level. The county data will be estimated by subdividing relevant counties into their respective basins similar to the way depletions will be handled.

The potential population projections will be adapted from a recent New Mexico State University report by Peach and Williams (1987). Peach and Williams presented population estimates by county for every five years from 1980 to 2020. Peach and Williams used a different methodology than BBER, which resulted in higher population estimates than those presented by BBER. The projection between 2020 and 2030 and county level data will be aggregated into river basins by the same technique used for the BBER projection.

The optimistic growth population projection took the BBER projections and increased them 20 percent beginning in the year 2000. The rationale for the 20 percent increase was arrived at after discussions with BBER personnel and personal judgment.

Water depletions for each of the three population projections will be based on the 1985 depletions. Depletions per person will remain at the 1985 levels for the **municipal, industrial, minerals** and **power, recreation** and **fish** and **wildlife** sectors. The per capita depletion coefficients will be used in conjunction with the population projection to estimate future water depletions by water use category. **Reservoir evaporation** will be held to the average of the past 20 years. The mid-1980s were very wet years and most of the reservoirs were at or near capacity, which produced a very high evaporation estimate for 1985. Therefore, in typical years, reservoir evaporation would be grossly overestimated.

Two scenarios will be presented for the population projections. The first scenario (A) will hold agricultural depletions constant at the 1985 level over time. The second scenario (B) will permit agricultural depletions to increase at the same rate as the other economic sectors. The second scenario could be representative of the conditions and projections of a high-growth economy that prevailed during the late 1970s and early 1980s. During this period, water depletions were much higher than in 1985. The agricultural, mineral and power sectors were growing at a fast rate. If these sectors were to recover to growth levels experienced earlier, then Scenario B projections might be more valid.

Finally, the impacts of a 10 percent reduction in depletion through conservation will be outlined. The 10 percent reduction in depletion categories will be estimated for all except reservoir evaporation. Research has shown that attempting to reduce reservoir evaporation is almost an impossible task because of the joint-use nature of reservoirs, such as for water-based recreation and storage for irrigation.

CURRENT WATER DEPLETIONS

Estimates of current water depletions will be presented by the five water use categories for the state followed by estimates by river basin and county. Tables presenting the water depletions by the five water use categories are presented in a report by Lansford et al. (1988) for the state and river basins.

State

Water depletions in New Mexico from 1970 to 1985 reflected the state's economic health during that period. From 1970 through 1980, there was an increase in water depletions. However, from 1980 to 1985, there was a significant decrease (400,000 acre-feet) in the statewide depletions (figure 6-1). The late 1970s and early 1980s represented the greatest era of economic activity in the history of New Mexico. As indicated by depletions, the agricultural, and mineral and power sectors were at the height of economic activity. Since the early to mid-1980s, these sectors have been in an economic slump and therefore, their depletions were down. The 1985 statewide depletions by the five water use categories are presented in figure 6-2.

- **Agricultural depletions accounted for 68% (1.5 million acre-feet) of the total depletions.**
- **Evaporation depletions accounted for 21% (451,300 acre-feet) of the total depletions.**
- **Municipal depletions accounted for 6% (137,900 acre-feet) of the total depletions.**
- **Mineral and Power depletions accounted for 4% (87,900 acre-feet) of the total depletions.**
- **Industrial depletions accounted for less than 1% (12,000 acre-feet) of the total depletions.**

Although agriculture still accounted for about 68 percent of the total depletions in 1985, irrigated acreage decreased by nearly 90,000 acres between 1980 and 1985. Farming has not been profitable during the 1980s. Also, the crop-mix changed with a higher percentage of low water-using crops being grown in 1985 than 1980, thereby reducing depletions.

During the 1970-1985 period, municipal water depletions steadily increased due almost entirely to

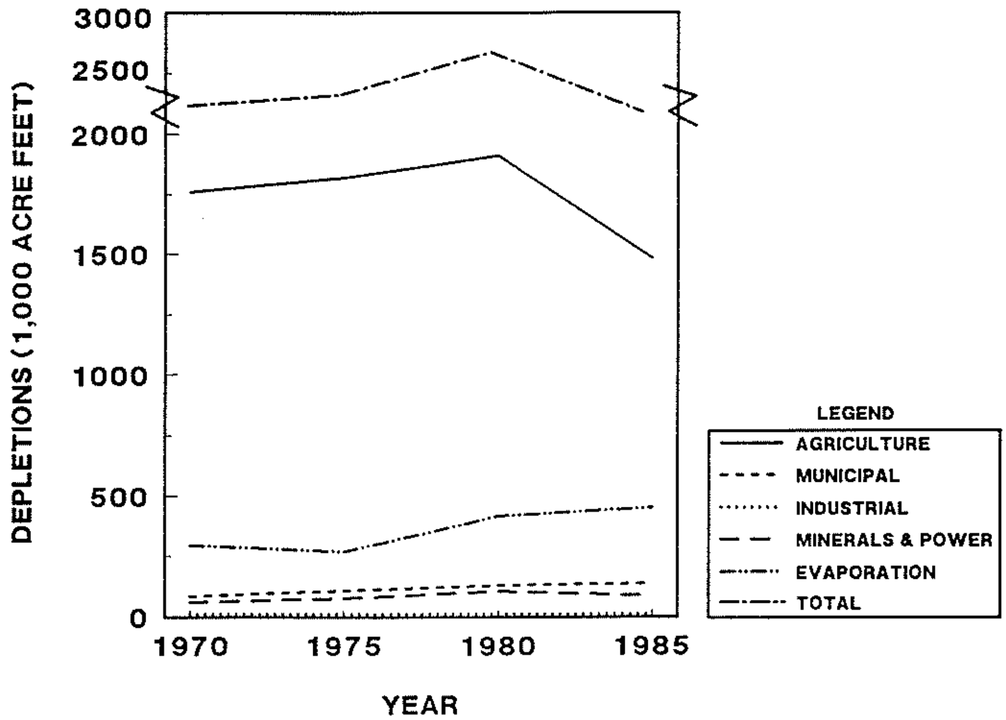


Figure 6-1. Water Depletions in New Mexico by Category, 1970-1985.

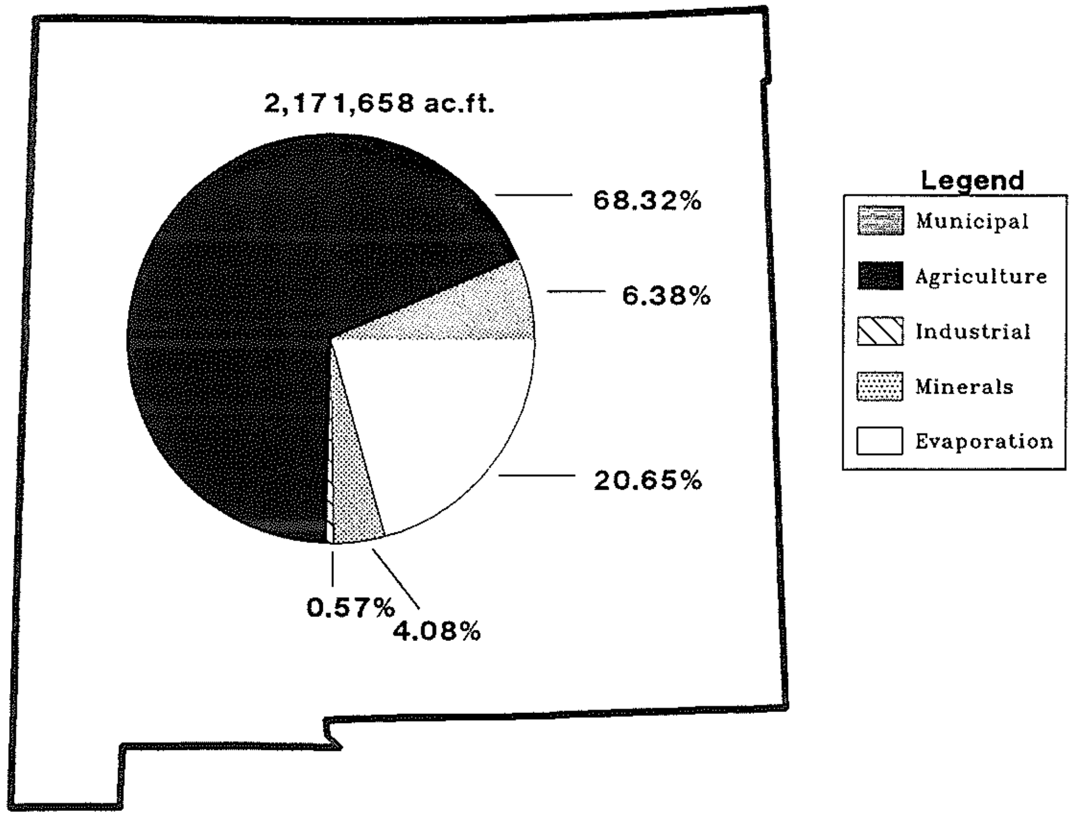


Figure 6-2. Summary of Water Depletions in New Mexico, 1985.

population growth (table 6-1). In 1985, the annual per capita water depletions for municipalities (urban and rural) was estimated to be about 31,000 gallons.

The second largest depletion fluctuations were registered in the mineral and power sectors (figure 6-1). The reason for those trends were the state of economy in minerals, including oil and gas, in the 1970s. Rapid development occurred in these sectors especially in oil, gas, and uranium in the mid-1970s and early 1980s. However, during the 1980s, the production of primary minerals (including oil and gas) has been significantly reduced, therefore water use has decreased. Nearly all of the uranium mines and processing facilities have closed down and oil and gas exploration and development have almost ceased. Many low-volume producing oil and gas wells have been abandoned. Even production has been reduced. In addition, the water depletions for the power sector were decreased by about 10 percent between 1980 and 1985 due to reduced economic activity, and some obsolete power plants in New Mexico are being phased out. The electricity is being supplied from generating plants outside of New Mexico.

Evaporation increased from 295,800 acre-feet in 1970 to 451,300 acre-feet in 1985 (figure 6-1), reflecting the state's above average precipitation during the 1980s. Most of the reservoirs were at or near capacity during the mid-1980s and as the surface area of the reservoirs increased, so did evaporation.

RIVER BASINS

Depletions are presented for nine river basins in the following sections (figure 6-3). They are presented in the following order: Upper Colorado River Basin, Lower Colorado River Basin, Southwest Closed Basin, Upper Rio Grande Basin, Lower Rio Grande Basin, Central Closed Basin, Pecos River Basin, Arkansas-White-Red Basin, and the Texas Gulf Basin.

Upper Colorado River Basin

Nearly 99 percent of the 1985 depletions for the Upper Colorado River Basin were from surface water sources in the Upper Colorado River Basin (Wilson 1986). Small quantities of ground water were used for rural, domestic, livestock, minerals, and recreation purposes.

* **Agricultural depletions accounted for 72% (213,600 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 13% (40,300 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 13% (38,500 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 2% (6,900 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (200 acre-feet) of the total depletions.**

With the recent development of the Navajo Indian Irrigation Project (NIIP) in San Juan County, this Basin has become one of the important irrigated agriculture regions in the state. During 1976, water was delivered for the first 9,200 acres on the project. Since then, water has been delivered to an additional

37,400 acres. Plans for the NIIP include 110,000 irrigated acres when fully implemented. Depletions for agriculture are exceeded only in the Pecos River and the Texas Gulf Basins. The principal crops grown in the Upper Colorado River Basin were alfalfa, corn, pasture, wheat, dry beans, and potatoes.

Table 6-1. Water Depletions in New Mexico by Category, 1970-1985.

Water Use Category	1970*	1975**	1980#	1985##
	----- thousands of acre-feet -----			
Agriculture	1,760.5	1,820.1	1,910.4	1,482.7
Municipal	84.9	107.5	129.9	137.9
Industrial	12.9	12.1	12.0	12.0
Minerals and Power	61.3	77.0	105.6	87.9
Evaporation	295.8	270.2	416.0	451.3
Total	2,215.4	2,286.9	2,573	2,171.8

* Source: Bureau of Reclamation (1976)

** Source: Sorensen (1977)

\# Source: Sorensen (1982)

\## Source: Wilson (1986)

Lower Colorado River Basin

The Lower Colorado River Basin has the lowest depletions of all the basins in New Mexico. Much of the lower portion of the Basin (Gila and San Francisco river basins) are under a federal adjudication decree. In these basins, surface and conjunctive ground water use is monitored closely by the SEO. There are no major reservoirs in this basin.

* **Agricultural depletions accounted for 52% (25,400 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 28% (13,400 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 12% (6,000 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 7% (3,400 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (200 acre-feet) of the total depletions.**

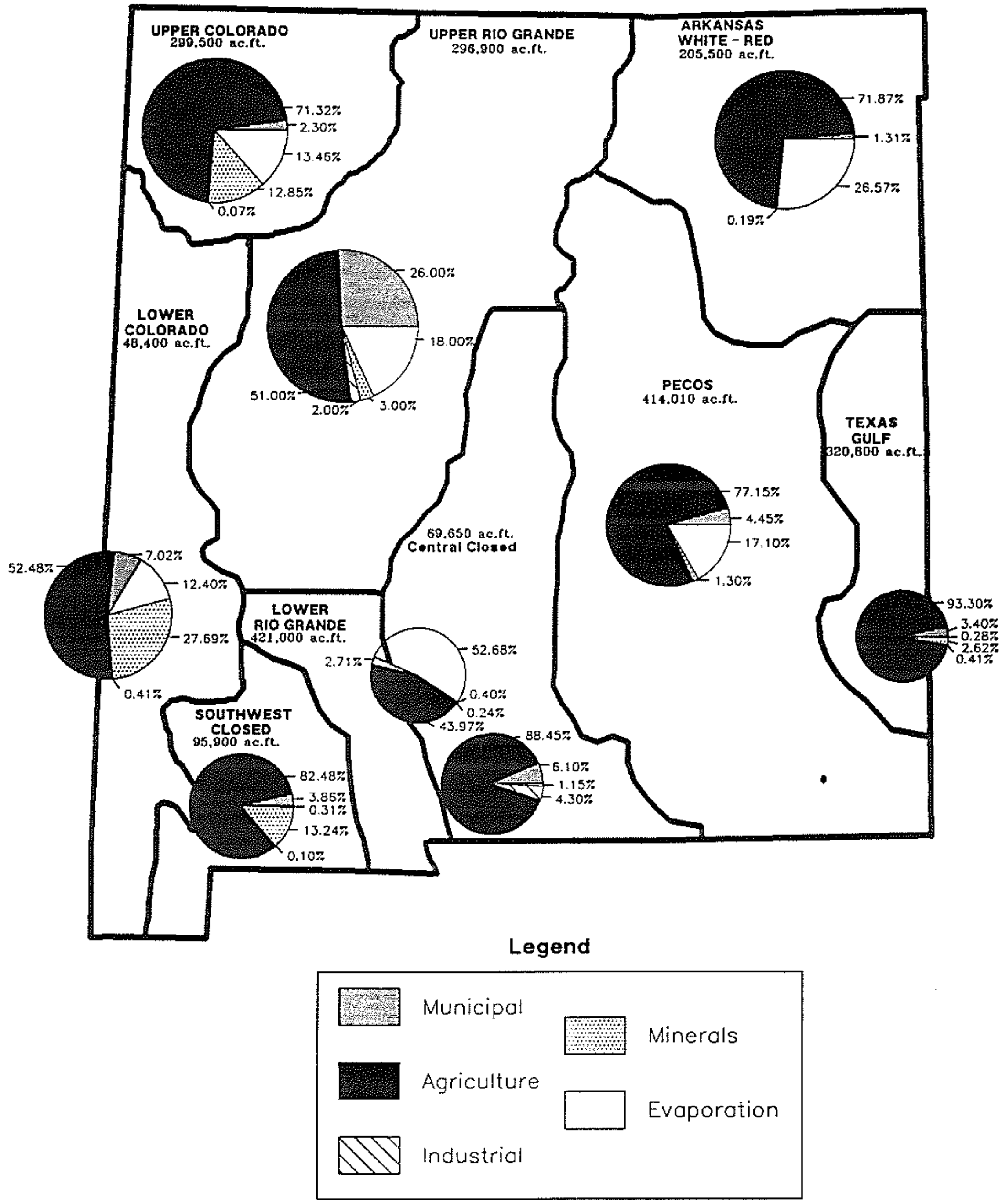


Figure 6-3. Water Depletions in New Mexico by River Basins, 1985.

Nearly all of the irrigated croplands were located in the southern portion of the basin (Catron and Hidalgo counties). Ground water was the most important source of water for irrigation. Nearly all of the ground water depletions were in Hidalgo County. The principal crops grown in the Basin were low-value crops such as cotton, grain sorghum, and corn.

Southwest Closed Basin

About 80 percent of the 1985 depletions in the Southwest Closed Basin were from ground water sources. All of the surface water depletions were for agricultural purposes.

* **Agricultural depletions accounted for 82% (79,100 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 13% (12,700 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 4% (3,700 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for less than 1% (300 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (100 acre-feet) of the total depletions.**

Some 10,000 acres of native pasture in the Mimbres Basin in Luna County were irrigated with surface water from the Mimbres River. The Southwest Closed Basin encompassed about 3.3 percent of the state population in 1985, but only 2.8 percent of the state's municipal depletions.

Upper Rio Grande Basin

The Upper Rio Grande Basin had the fifth highest depletions of all the basins in New Mexico. Total depletions were estimated at about 297,000 acre-feet in 1985.

* **Agricultural depletions accounted for 51% (151,800 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 26% (77,000 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 18% (54,000 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 3% (8,500 acre-feet) of the total depletions.**
* **Industrial depletions accounted for 2% (5,600 acre-feet) of the total depletions.**

The irrigated cropland was located primarily along the Rio Grande, the Rio Chama, the Jemez, the Rio Puerco, and the Rio San Jose. Surface water was the primary source of water for irrigation accounting for about 85 percent of the irrigation depletions. The lack of supplemental ground water presented a major problem during periods of low flows in the rivers. The cropping plan reflected this problem primarily producing low-value crops such as pasture, alfalfa, native pastures, corn, and small grains. However, some high-value crops were being produced in Rio Arriba, Bernalillo, and Valencia counties.

The Upper Rio Grande Basin had the largest municipal depletions of all the basins because of the Albuquerque Metropolitan area. This basin accounted for about 56 percent of the total municipal depletions in the state. The population of the basin accounted for about 49 percent of the total state population; therefore, the annual municipal depletion of 35,500 gallons per person was well above the state average of 31,000 gallons per person.

Lower Rio Grande Basin

Approximately 88 percent of the depletions for 1985 in the Lower Rio Grande Basin were from surface water sources. Agriculture and municipalities were large users of ground water. Small quantities of ground water were used for industrial, minerals, and recreation purposes.

* **Evaporation depletions accounted for 53% (221,800 acre-feet) of the total depletions.**
* **Agricultural depletions accounted for 44% (185,100 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 3% (11,400 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for less than 1% (1,700 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (1,000 acre-feet) of the total depletions.**

Evaporation was the largest source of depletion of water in the Lower Rio Grande Basin accounting for about 53 percent of total depletions. Because of its southernmost location and the presence of Elephant Butte and Caballo reservoirs, this basin ranked first in terms of evaporation among the state's nine river basins in New Mexico.

The Lower Rio Grande Basin was an important agricultural region in New Mexico producing about 70 percent of the high-value crops in New Mexico. The important irrigated crops in the Basin in 1985 were alfalfa, pecans, cotton, chile, lettuce, onions, and wheat. Agricultural depletions account for about 44 percent of the total.

Central Closed Basin

The Central Closed Basin had the second lowest depletions of all the basins in New Mexico.

* **Agricultural depletions accounted for 88% (61,600 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 6% (4,500 acre-feet) of the total depletions.**
* **Industrial depletions accounted for 4% (3,000 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for less than 1%(500 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 0% (20 acre-feet) of the total depletions.**

The Central Closed Basin includes several small rivers and major streams that feed the ground water basin. The major economic activity was primarily centered in southern Santa Fe County and northern Torrance County around the towns of Moriarty and Estancia in the northern part of the Basin, and in Otero County and southeastern Doa Ana County around the cities of Alamogordo, Las Cruces, and El Paso, Texas, in the southern part of the Basin.

Pecos River Basin

The Pecos River Basin had the second highest depletions in the state, surpassed only by the Lower Rio Grande Basin.

* **Agricultural depletions accounted for 77% (320,100 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 17% (70,200 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 4% (18,000 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 1% (4,800 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (800 acre-feet) of the total depletions.**

The Pecos River Basin had the largest agricultural depletions of all the basins. The majority of the irrigated cropland was located primarily along the Pecos River in Chaves and Eddy counties; the Rio Hondo and Rio Penasco in Lincoln, Chaves, Otero, and Eddy counties.

Arkansas-White-Red River Basin

About 56 percent of the depletions in the Arkansas-White-Red (AWR) Basin for 1985 were from surface water sources. Small quantities of ground water were used for municipal and recreational purposes.

* **Agricultural depletions accounted for 72% (147,700 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 27% (54,600 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 1% (2,700 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for less than 1% (400 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (100 acre-feet) of the total depletions.**

The AWR is an important agricultural region in New Mexico. The important irrigated crops in the basin in 1985 were corn, grain sorghum, and wheat.

Texas Gulf Basin

More than 99 percent of the depletions in the Texas Gulf Basin for 1985 were from ground water sources. There are no rivers or major streams in the Texas Gulf Basin. Agriculture, municipal, and minerals were the top three water users in the Basin. Small quantities of ground water were used for industrial and recreational purposes.

* **Agricultural depletions accounted for 93% (299,300 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 3% (10,900 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 3% (8,400 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (1,300 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for less than 1% (900 acre-feet) of the total depletions.**

Counties

Depletions by the water use categories for each New Mexico county are presented in four regional graphs — Northwest (figure 6-4), Northeast (figure 6-5), Southwest (figure 6-6), and Southeast (figure 6-7).

San Juan County had the highest depletions at 296,200 acre-feet followed by Sierra County at 237,200 acre-feet, Dona Ana County at 190,700 acre-feet, Chaves at 161,700 acre-feet, and Roosevelt with 134,300 acre-feet. The above counties typically had large reservoirs (San Juan and Sierra) and were among the counties with the largest agricultural depletions. Sierra County had the highest evaporation at 219,000 acre-feet, followed by Guadalupe at 27,875 acre-feet and San Miguel at 43,238 acre-feet. Counties with the highest agricultural depletions were San Juan with 211,500 acre-feet, Doa Ana with 174,400 acre-feet, Chaves with 148,600 acre-feet, Roosevelt with 131,800 acre-feet, and Curry with 122,600 acre-feet.

The five counties with the least total depletions were Los Alamos (2,650 acre-feet), Harding (5,200 acre-feet), Lincoln (14,500 acre-feet), McKinley (19,400 acre-feet), and Mora (20,200 acre-feet). The above counties typically were among the counties with below average population, lack of reservoirs, and low agricultural depletions.

POPULATION PROJECTIONS

To determine alternative future water depletions, three population projections were developed: 1) conservative growth, 2) potential growth; and 3) optimistic growth. The population projections for each are presented graphically in figures 6-8.

PROJECTED DEPLETIONS

A detailed analysis of the three alternative population projections was completed and reported in a Water Resources Research Institute report by Lansford et al. (1988). There were little differences in depletions among the three population projections because there was little difference among population projections. The major differences were among scenarios. Consequently, in the interest of simplicity and readability, only future depletions for the middle "potential" population projections will be presented in this chapter.

State

Scenario A

The state's water depletions will not exceed supply by 2030 (table 6-2). At the rate that depletions are increasing, the state has enough total water supplies to last for an additional 40 to 50 years. However, this large surplus is somewhat misleading since much of this surplus will be located in basins with low economic potential and population projections, such as the Lower Colorado, Southwest Closed, Central Closed, and the AWR basins.

The state depletions were estimated at 2.2 million acre-feet in 1985. Under this scenario, they are estimated to increase to 2.3 million acre-feet in 2030 (table 6-2). The total supply of water for depletions was estimated to be 3.2 million acre-feet in 1985 and is expected to decrease slowly to 3.1 million in 2030 due to ground water mining in the Texas Gulf Basin (table 6-2).

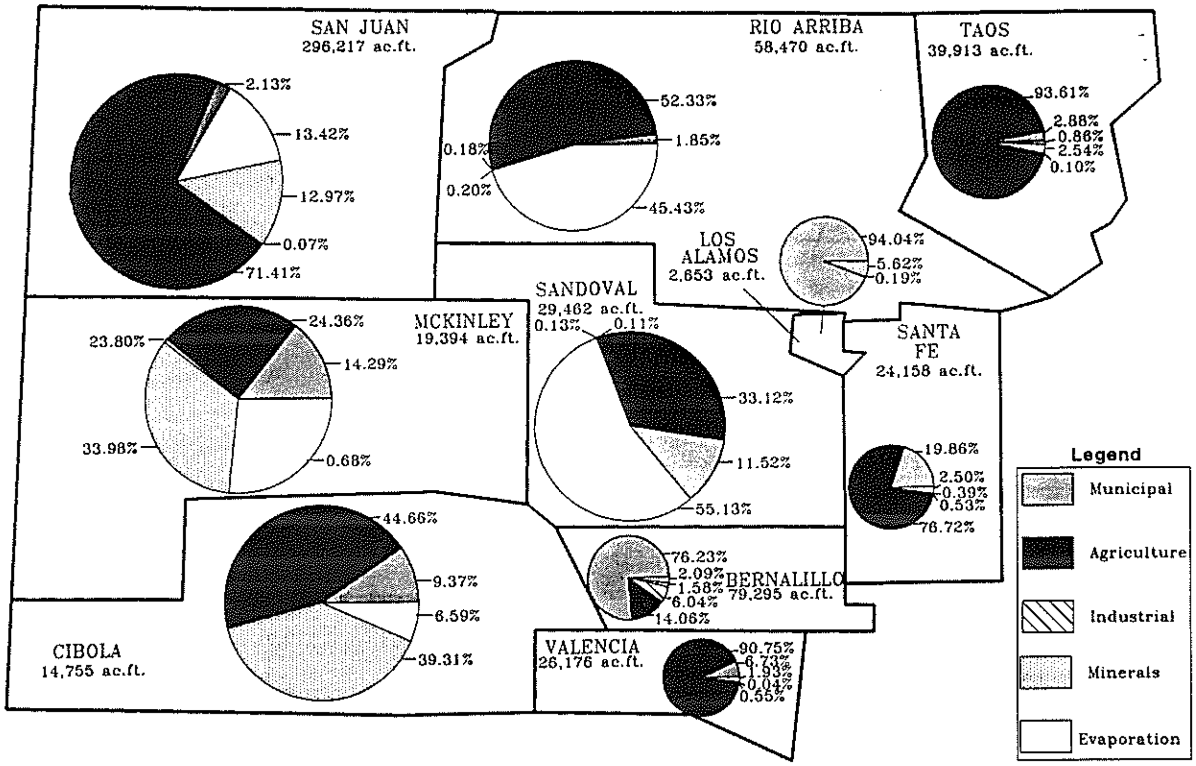


Figure 6-4. Water Depletions by County in Northwest Region, 1985.

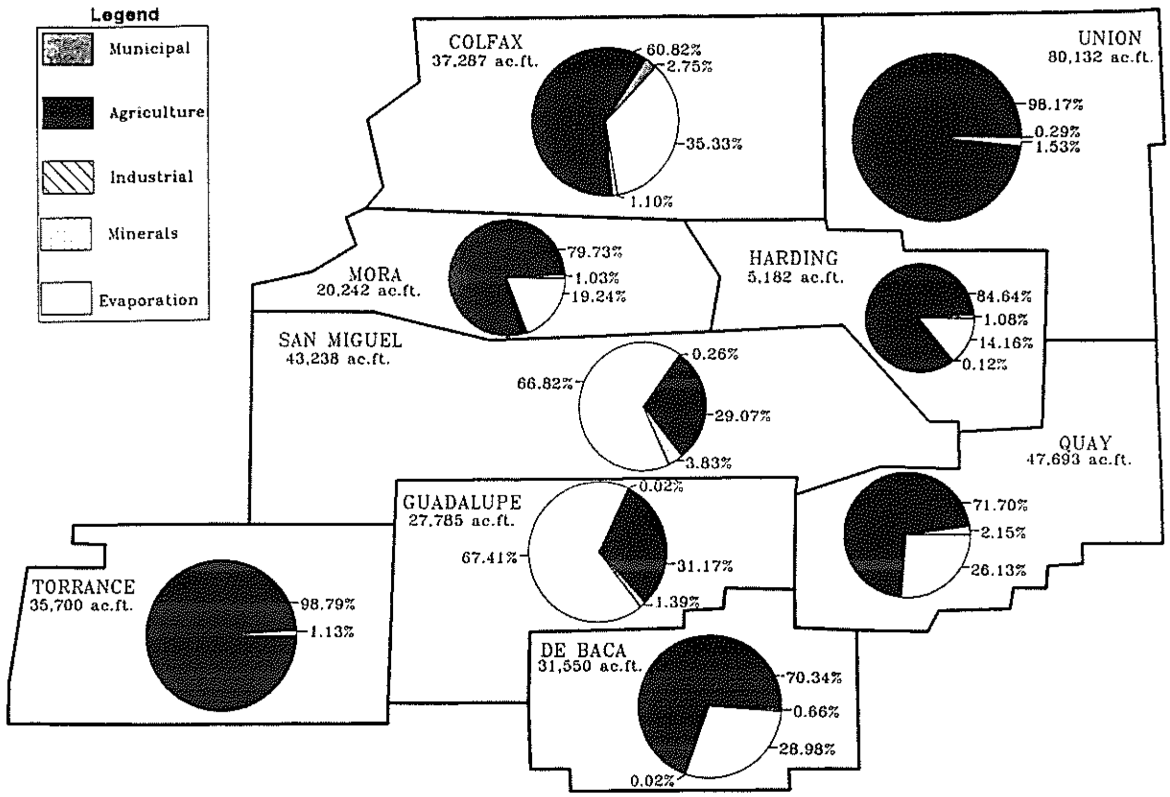


Figure 6-5. Water Depletions by County in Northeast Region, 1985.

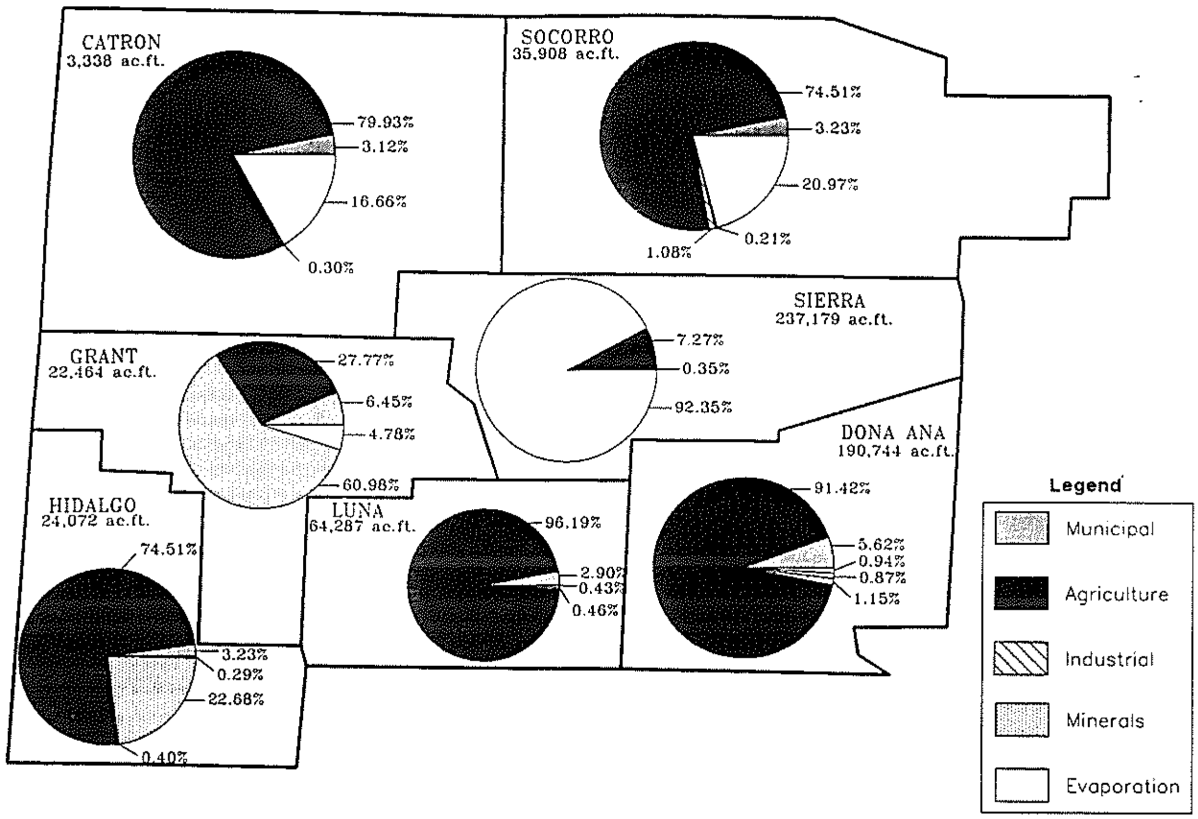


Figure 6-6. Water Depletions by County in Southwest Region, 1985.

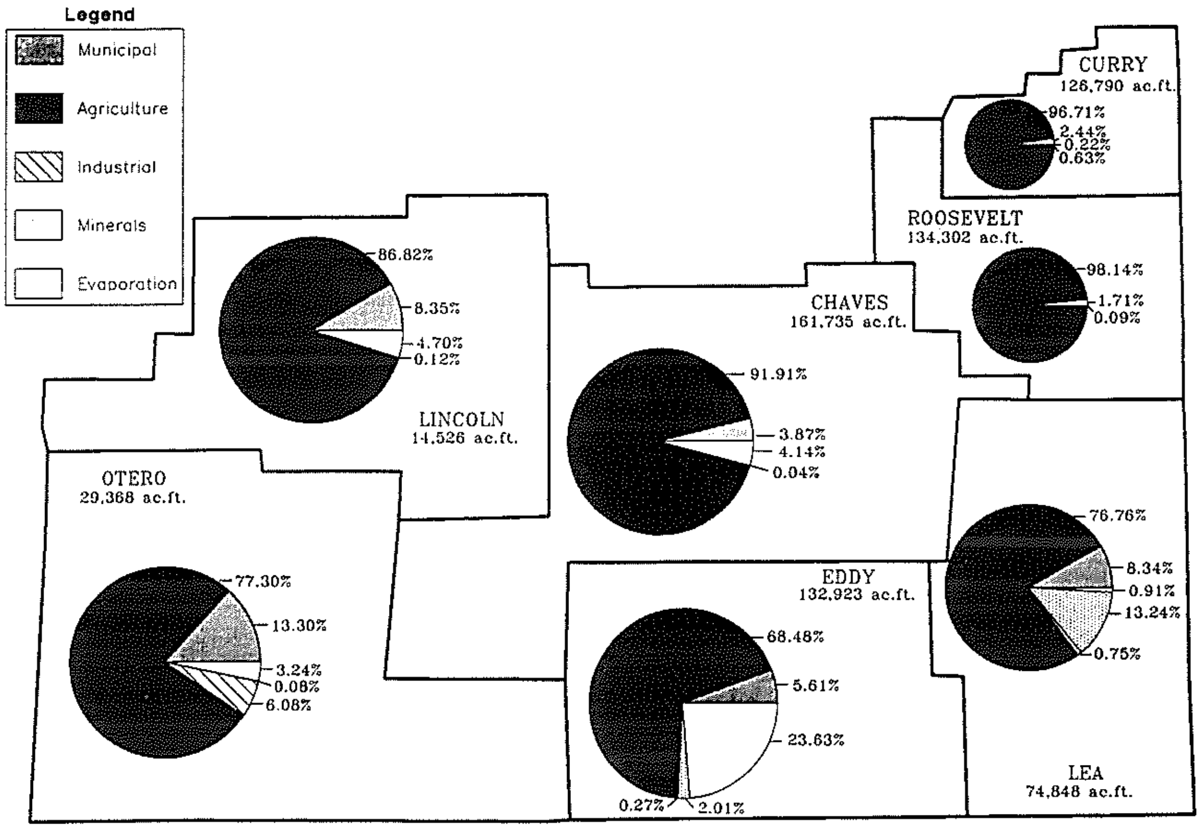


Figure 6-7. **Water Depletions by County in Southeast Region, 1985.**

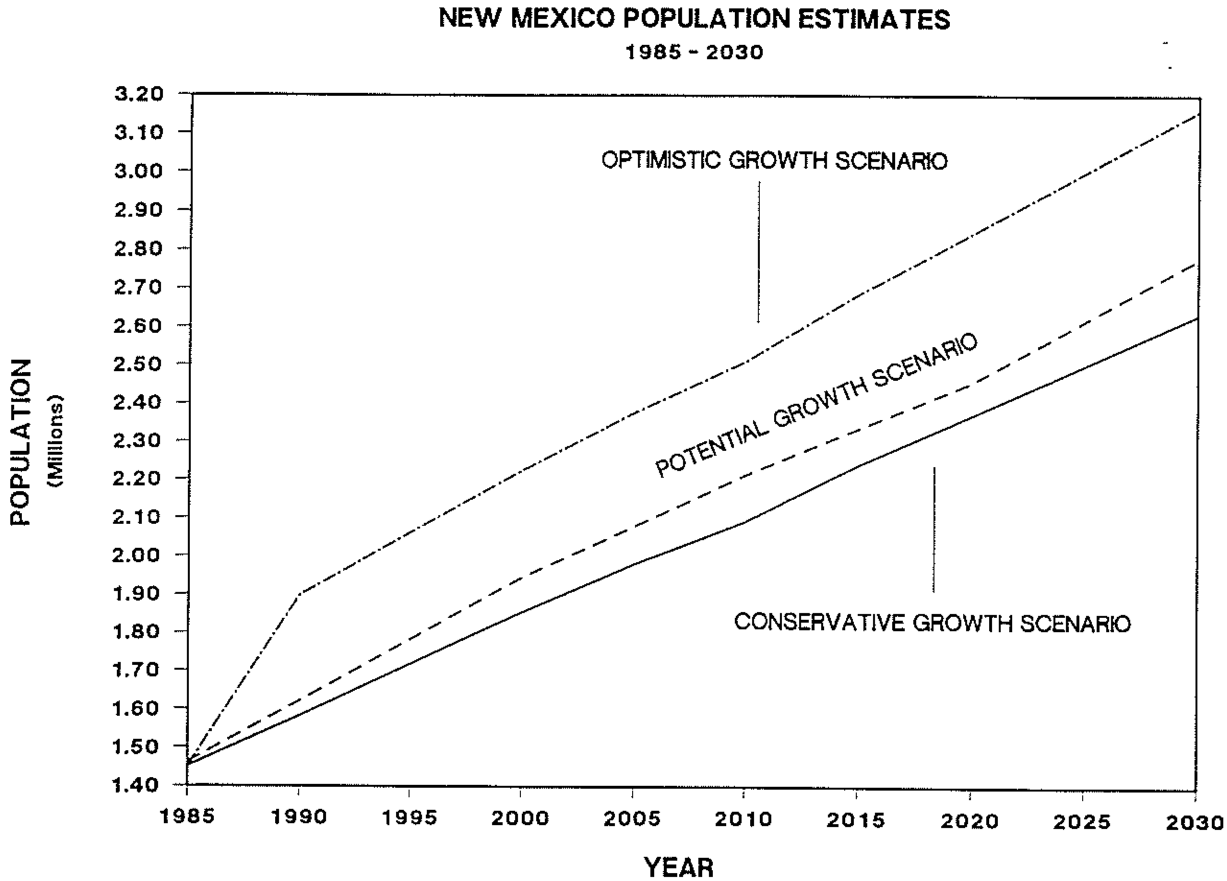


Figure 6-8. **New Mexico Population Projections by Growth Scenarios.**

* **Agricultural depletions accounted for 64% (1.5 million acre-feet of the total depletions.**
* **Evaporation depletions accounted for 16% (365,400 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 11% (260,100 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 8% (197,300 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (22,000 acre-feet) of the total depletions.**

Scenario B

If depletions had been permitted to grow at about the same rate as occurred in the late 1970s, then statewide depletions would exceed supply between 2010 and 2020. The statewide water depletions, in 2030, were estimated at 3.8 million acre-feet (table 6-2).

* **Agricultural depletions accounted for 78% (2.9 million acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 10% (365,400 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 6% (260,100 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 5% (197,300 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (22,000 acre-feet) of the total depletions.**

Upper Colorado River Basin

Scenario A

Based on the projected depletions, it appears that in the Upper Colorado River Basin supply will exceed depletions in 2030 by 303,000 acre-feet. Depletions in 2030 account for 55 percent of the available supply. This surplus should continue beyond the year 2200. The total supply of water available for depletions in the basin was estimated to be 674,000 acre-feet over the period of this analysis (figure 6-9). The depletions in the Upper Colorado River Basin were estimated at about 300,000 acre-feet in 1985 and are expected to increase to 371,000 acre-feet in 2030 (figure 6-9). The population projection under this scenario is expected to be about 11,600 persons less than under the Conservative Population Projection. The BBER recently revised the population projection upward for northwestern New Mexico because of the potential for a faster than expected recovery in the minerals and energy sector of the economy.

* **Agricultural depletions accounted for 58% (213,600 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 28% (105,400 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 9% (32,500 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 5% (18,900 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (600 acre-feet) of the total depletions.**

Scenario B

Depletions under this scenario will exceed supplies before 2030. Total depletions in 2020 were estimated to be 645,100 acre-feet and are expected to increase to 741,600 acre-feet in 2030

Table 6-2. Water Depletions by Water Use Category, New Mexico, Potential Growth Scenario, 1985-2030.

	Depletions				
Water Use Category	1985	2000	2010	2020	2030
	----- thousands of acre-feet -----				
	Scenario A				
Agricultural	1,483.8	1,483.8	1,483.8	1,483.8	1,483.8
Municipal	138.6	183.6	208.4	229.9	260.1
Industrial	12.4	16.0	17.9	19.6	22.0
Minerals	88.5	124.3	148.5	173.6	197.3
Evaporation	448.5	350.3	355.2	359.7	365.4
Total	2,171.7	2,158.0	2,213.7	2,266.6	2,328.5
Supply	3,249.0	3,235.0	3,174.0	3,149.0	3,124.0
	Scenario B				
Agricultural	1,483.8	1,985.7	2,301.5	2,615.0	2,947.2
Municipal	138.6	183.6	208.4	229.9	260.1
Industrial	12.4	16.0	17.9	19.6	22.0
Minerals	88.5	124.3	148.5	173.6	197.3
Evaporation	448.5	350.3	355.2	359.7	365.4
Total	2,171.7	2,659.9	3,031.5	3,397.9	3,791.9
Supply	3,249.0	3,235.0	3,174.0	3,149.0	3,791.9

(figure 6-10). This may be the more likely scenario if the Navajo Indian Irrigation Project is fully developed during the 45-year period of this analysis.

Approximately 50,000 acres of irrigated cropland has been developed on NIIP, with approximately 60,000 acres yet to be developed.

* **Agricultural depletions accounted for 79% (584,200 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 14% (105,400 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 4% (32,500 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 3% (18,900 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (600 acre-feet) of the total depletions.**

Lower Colorado River Basin

Scenario A

Supply will exceed water depletions in 2030. A surplus of 303,000 acre-feet will continue through the year 2200. Depletions, in 2030, account for about 42Ç of the available water supply. The total supply of water available for depletions in the Basin was estimated to be 157,000 acre-feet over the period of this analysis (figure 6-9). The depletions in the Lower Colorado River Basin were estimated at about 48,400 acre-feet in 1985 (figure 6-9) and are expected to increase to 66,400 acre-feet in 2030.

- **Mineral and power depletions accounted for 42% (27,600 acre-feet) of the total depletions.**
- **Agricultural depletions accounted for 38% (25,400 acre-feet) of the total depletions.**
- **Municipal depletions accounted for 10% (6,900 acre-feet) of the total depletions.**
- **Evaporation depletions accounted for 9% (6,000 acre-feet) of the total depletions.**
- **Industrial depletions accounted for about 1% (500 acre-feet) of the total depletions.**

Scenario B

Supply under this scenario will exceed depletions in 2030. Total depletions, in 2030, were estimated to be 93,200 acre-feet (figure 6-10). Under this scenario, the break-even point between depletions and supplies is near the year 2100.

- **Agricultural depletions accounted for 56% (52,200 acre-feet) of the total depletions.**
- **Mineral and power depletions accounted for 30% (27,600 acre-feet) of the total depletions.**
- **Municipal depletions accounted for 7% (6,900 acre-feet) of the total depletions.**
- **Evaporation depletions accounted for 6% (6,000 acre-feet) of the total depletions.**
- **Industrial depletions accounted for about 1% (500 acre-feet) of the total depletions.**

Southwest Closed Basin

Scenario A

Supplies will exceed depletions in 2030 by 303,000 acre-feet. Depletions in 2030 account for about 58 percent of the available supply. This surplus should continue through 2200. The total supply of water available for depletions in the basin was estimated to be 187,000 acre-feet over the period of this analysis (figure 6-9). The depletions in the Southwest Closed Basin were estimated at about 95,900 acre-feet in 1985 and are expected to increase to 108,600 acre-feet in 2030 (figure 6-9).

- **Agricultural depletions accounted for 69% (79,100 acre-feet) of the total depletions.**
- **Mineral and power depletions accounted for 20% (22,400 acre-feet) of the total depletions.**
- **Municipal depletions accounted for 6% (6,500 acre-feet) of the total depletions.**
- **Evaporation depletions accounted for 5% (6,000 acre-feet) of the total depletions.**
- **Industrial depletions accounted for less than 1% (500 acre-feet) of the total depletions.**

Scenario B

Supply under this scenario will exceed depletion in 2030. Total depletions in 2030 were estimated to be 168,700 acre-feet (figure 6-10). Under this scenario, the break-even point between depletions and supplies is expected to be between 2040 and 2050.

* **Agricultural depletions accounted for 80% (139,200 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 13% (22,400 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 4% (6,500 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 3% (6,000 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (500 acre-feet) of the total depletions.**

Upper Rio Grande Basin

Scenario A

Supplies will exceed depletions in 2030 by 25,800 acre-feet. However, the basin's depletions will exceed supplies very shortly after 2040. The total supply of water available for depletions in the Basin was estimated to be 395,000 acre-feet over the period of this analysis (figure 6-11). The depletions in the Upper Rio Grande Basin were estimated at about 296,800 acre-feet in 1985 and are expected to increase to 369,200 acre-feet in 2030 (figure 6-11).

* **Agricultural depletions accounted for 41% (151,800 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 37% (135,300 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 16% (57,300 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 4% (14,900 acre-feet) of the total depletions.**
* **Industrial depletions accounted for 3% (9,900 acre-feet) of the total depletions.**

Scenario B

Depletions under this scenario will exceed supplies in 2030. Total depletions in 2010 were estimated to be 404,600 acre-feet, 431,900 acre-feet in 2020, and increase to 483,200 acre-feet in 2030 (figure 6-12).

* **Agricultural depletions accounted for 55% (265,800 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 28% (135,300 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 12% (57,300 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 3% (14,900 acre-feet) of the total depletions.**
* **Industrial depletions accounted for 2% (9,900 acre-feet) of the total depletions.**

Lower Rio Grande Basin

Scenario A

Supply will exceed depletions in 2030 by 44,000 acre-feet. However, the basin's depletions will exceed supplies very shortly after 2100. The total supply of water available for depletions in the

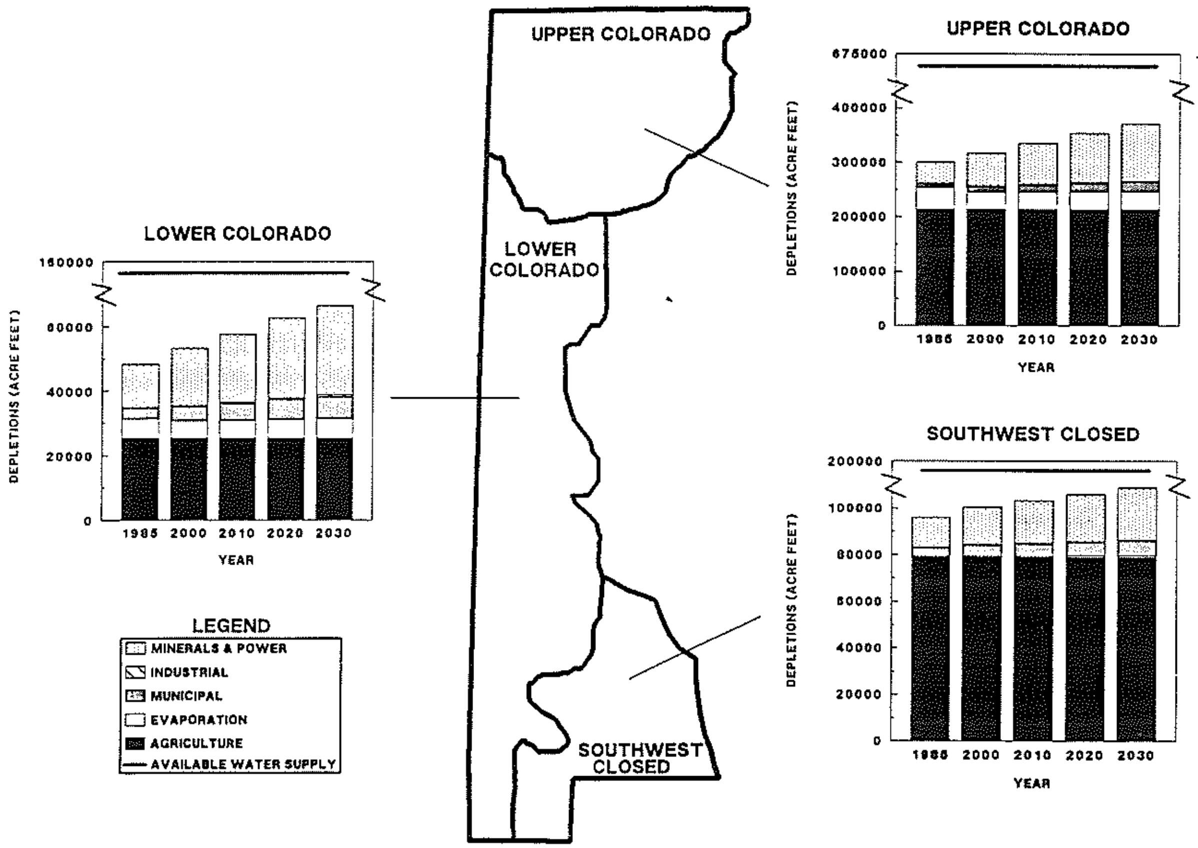


Figure 6-9. **Water Depletion Projections for Upper Colorado, Lower Colorado and Southwest Closed Basins, Potential Growth Projection, Scenario A.**

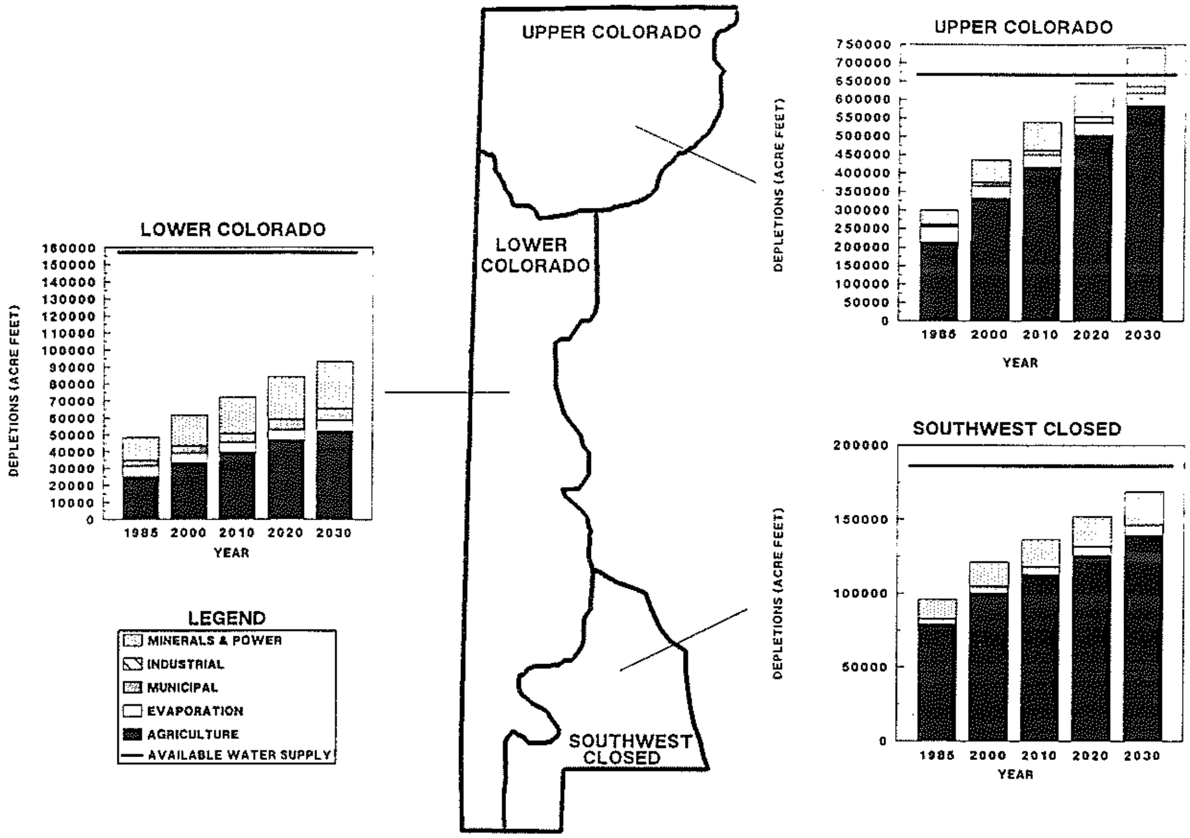


Figure 6-10. **Water Depletion Projections for Upper Colorado, Lower Colorado and Southwest Closed Basins, Potential Growth Projection, Scenario B.**

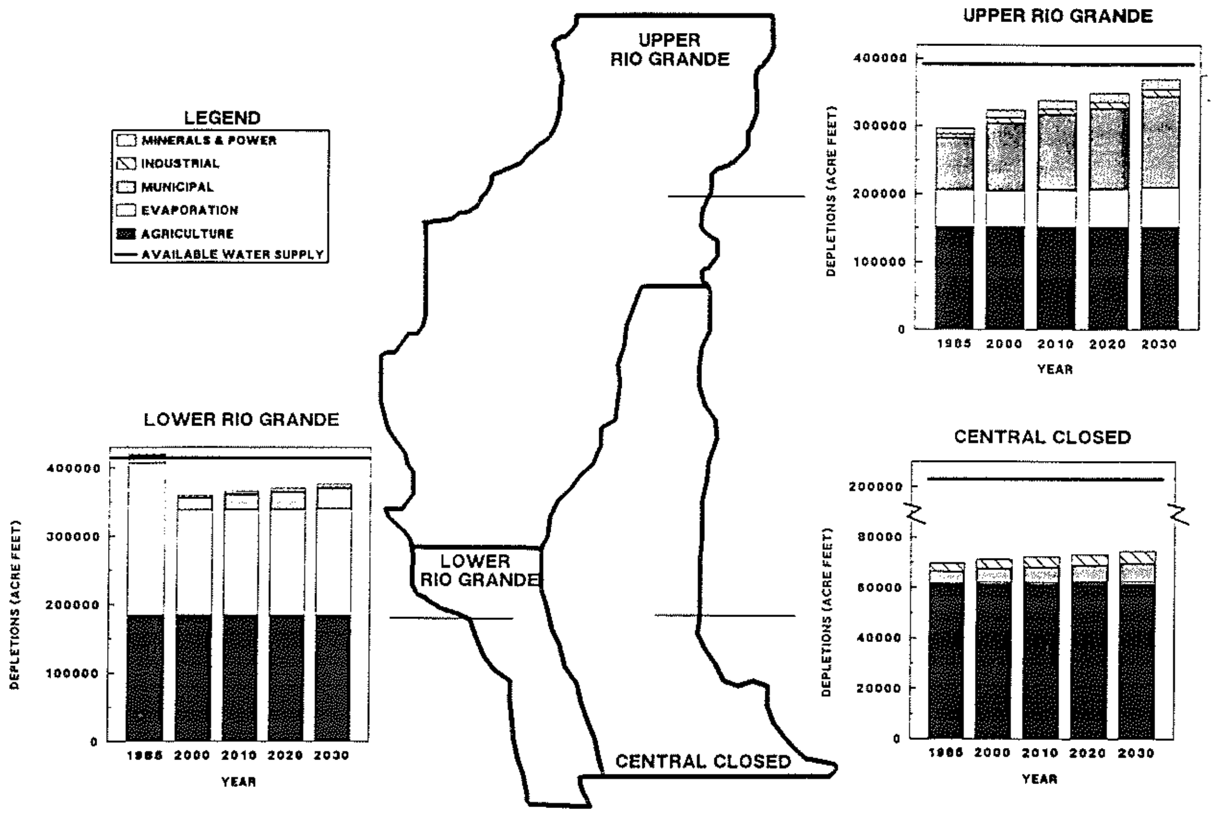


Figure 6-11. **Water Depletion Projections for Lower Rio Grande, Upper Rio Grande, and Central Closed Basins, Potential Growth Projection, Scenario A.**

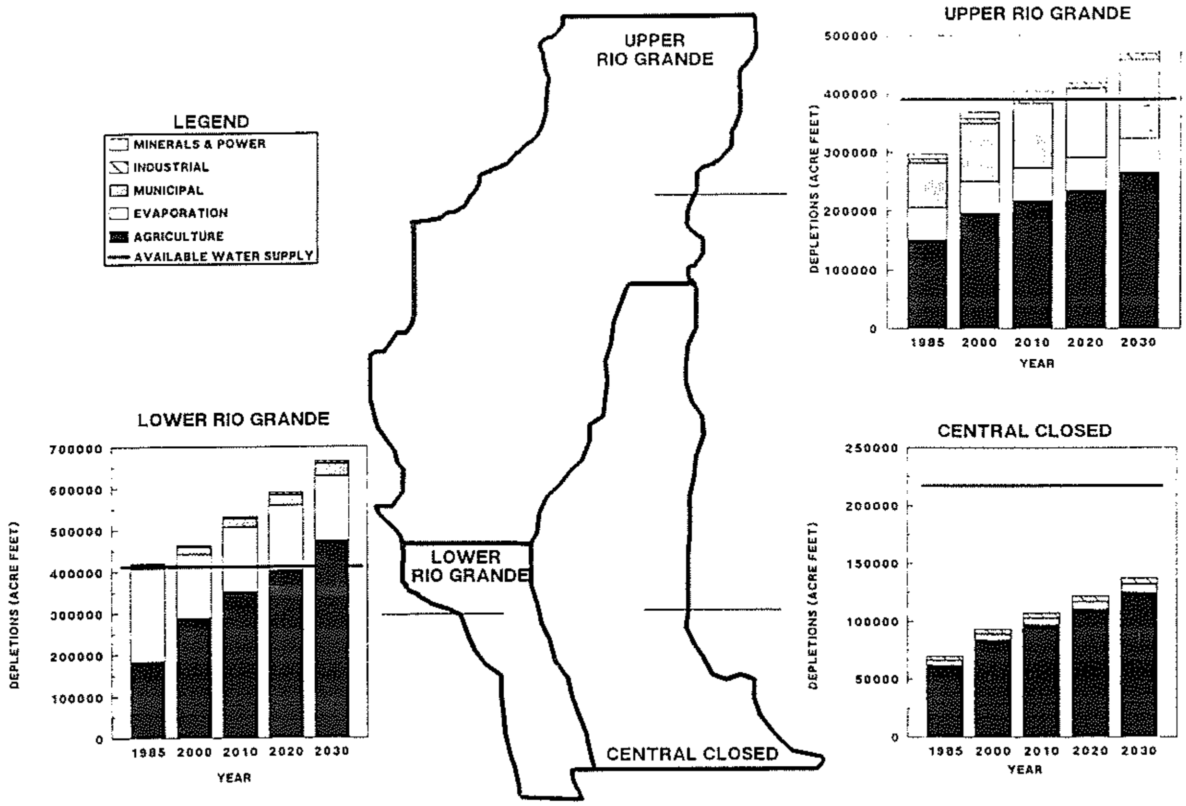


Figure 6-12. Water Depletion Projections for Lower Rio Grande, Upper Rio Grande, and Central Closed Basins, Potential Growth Projection, Scenario B.

basin was estimated to be 420,000 acre-feet over the period of this analysis (figure 6-11). The depletions in the Lower Rio Grande Basin were estimated at about 421,000 acre-feet in 1985 and are expected to decrease to 376,100 acre-feet in 2030 (figure 6-11). The decrease in depletions are due to the 67,100 acre-feet reduction in evaporation.

* **Agricultural depletions accounted for 49% (185,100 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 41% (154,700 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 8% (29,400 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for about 1% (4,400 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (2,500 acre-feet) of the total depletions.**

<u>Scenario B</u>

Depletions under this scenario will exceed supplies in 2030. Total depletions in 2030 were estimated to be 666,100 acre-feet (figure 6-12), which is 246,100 acre-feet above available supplies. Under this scenario, the break-even point between depletions and supplies is about 1995.

* **Agricultural depletions accounted for 71% (475,100 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 23% (154,700 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 4% (29,400 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for less than 1% (4,400 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (2,500 acre-feet) of the total depletions.**

Central Closed Basin

<u>Scenario A</u>

Supply will exceed depletions in 2030 by 140,600 acre-feet (figure 6-11). Depletions, in 2030 account for only about one-third of the available supply. This surplus should continue through the year 2200. The depletions in the Central Closed Basin were estimated at about 69,600 acre-feet in 1985 and are expected to increase to 74,400 acre-feet in 2030 (figure 6-11).

* **Agricultural depletions accounted for 83% (61,600 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 10% (7,300 acre-feet) of the total depletions.**
* **Industrial depletions accounted for 6% (4,700 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for less than 1% (800 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 0% (30 acre-feet) of the total depletions.**

<u>Scenario B</u>

Supplies under this scenario will exceed supplies in 2030. Total depletions in 2030 were estimated to be 137,200 acre-feet (figure 6-12). Under this scenario, the break-even point between depletions and supplies is more than 50 years beyond 2030.

* **Agricultural depletions accounted for 90% (124,400 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 5% (7,300 acre-feet) of the total depletions.**
* **Industrial depletions accounted for 3% (4,700 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for less than 1% (800 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 0% (30 acre-feet) of the total depletions.**

Pecos River Basin

Scenario A

Supply will exceed depletions in 2030 by 3,900 acre-feet. However, the Basin's depletions will exceed supplies by 2040. The total supply of water available for depletions in the basin was estimated to be 435,000 acre-feet over the period of this analysis (figure 6-13). The depletions in the Pecos River Basin were estimated at about 414,000 acre-feet in 1985 and are expected to increase to 431,100 acre-feet in 2030.

* **Agricultural depletions accounted for 74% (320,100 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 15% (65,500 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 8% (34,800 acre-feet) of the total depletions.**
* **Mineral and Power depletions accounted for 1% (9,100 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (1,600 acre-feet) of the total depletions.**

Scenario B

Depletions under this scenario will exceed supplies in 2030. Total depletions in 2030 were estimated to be 733,000 acre-feet (figure 6-14), which is 298,000 acre-feet above supplies. Under this scenario, the break-even point between depletions and supplies is between 1990 and 1995.

* **Agricultural depletions accounted for 85% (622,000 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 9% (65,500 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 5% (34,800 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 1% (9,100 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (1,600 acre-feet) of the total depletions.**

Arkansas-White-Red River Basin

Scenario A

Supply in 2030 will exceed depletions by 224,800 acre-feet. The total supply of water available for depletions in the Basin was estimated to be 424,000 acre-feet over the period of this analysis (figure 6-13). Depletions account for about 47 percent of the available supply. This surplus should continue beyond the year 2200. The depletions in the AWR Basin were estimated at about 205,500 acre-feet in 1985 and are expected to decrease to 199,200 acre-feet in 2030.

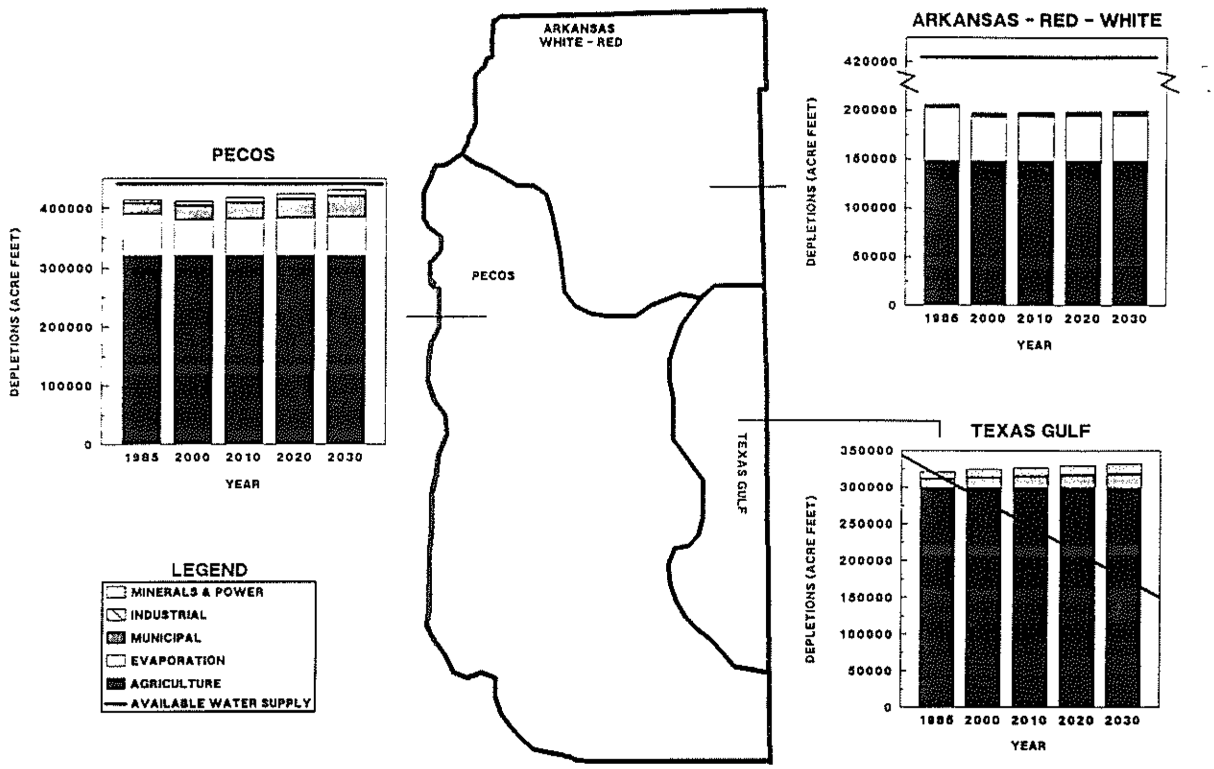


Figure 6-13. **Water Depletion Projections for Pecos, Texas Gulf, and Arkansas-White-Red Basins, Potential Growth Projection, Scenario A.**

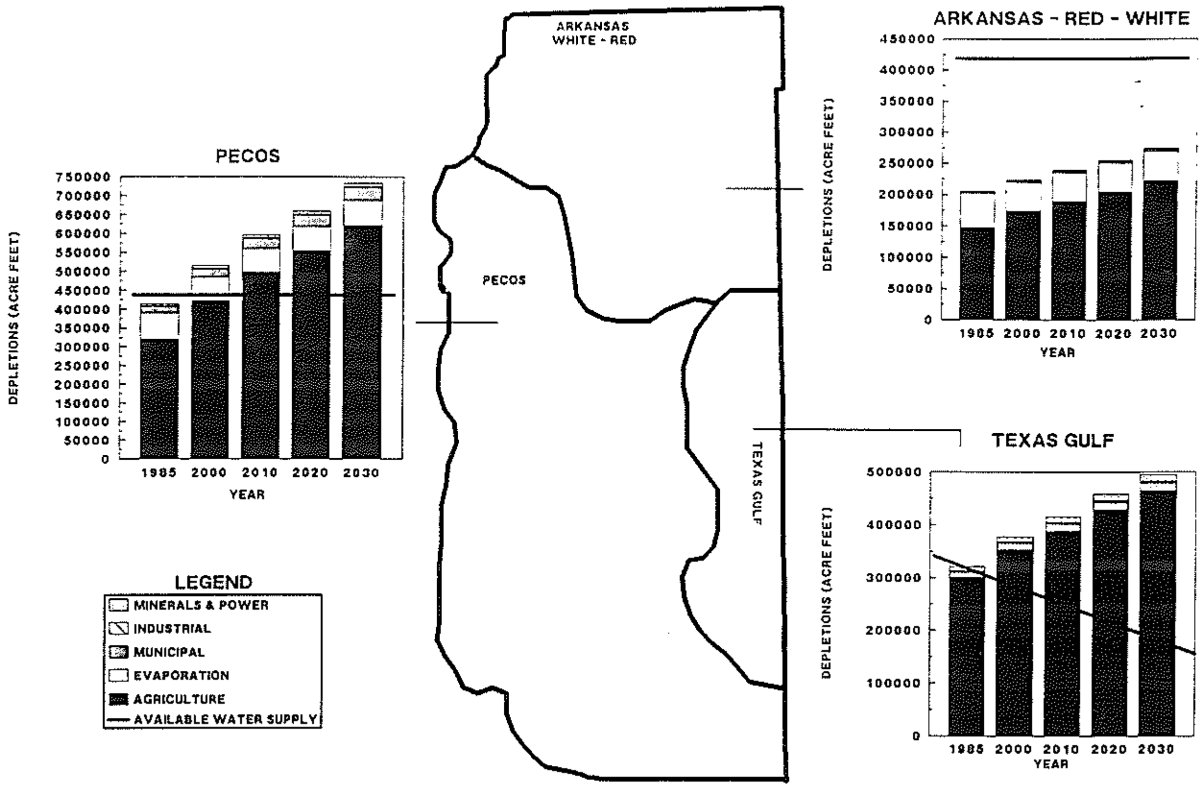


Figure 6-14. **Water Depletion Projections for Pecos, Texas Gulf, and Arkansas-White-Red Basins, Potential Growth Projection, Scenario B.**

* **Agricultural depletions accounted for 74% (147,700 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 23% (46,700 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 2% (4,100 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for less than 1% (600 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (150 acre-feet) of the total depletions.**

Scenario B

Supply under this scenario will exceed depletion in 2030. Total depletions in 2030 were estimated to be 273,700 acre-feet (figure 6-14). Under this scenario, the break-even point between depletions and supplies is estimated to be beyond the year 2100.

* **Agricultural depletions accounted for 81% (222,200 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for 17% (46,700 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 1% (4,100 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for less than 1% (600 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (150 acre-feet) of the total depletions.**

Texas Gulf Basin

Scenario A

The Texas Gulf Basin depletions will exceed supply prior to the turn of this century. The total supply of water available for depletions in the Basin was estimated to be 342,000 acre-feet in 1985, 328,000 in 2000, 217,000 in 2020 and 152,000 in 2030 (figure 6-13). The depletions in the Texas Gulf Basin were estimated at about 320,800 acre-feet in 1985 and are expected to increase to 332,500 acre-feet in 2030.

* **Agricultural depletions accounted for 90% (299,300 acre-feet) of the total depletions.**
* **Municipal depletions accounted for 5% (16,800 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 4% (13,000 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (2,000 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for less than 1% (1,400 acre-feet) of the total depletions.**

Scenario B

Depletions under this scenario will exceed supplies well before the turn of the century. Total depletions in the year 2000 were estimated to be 377,300 acre-feet which is about 49,300 acre-feet above supplies (figure 6-14). Total depletions in 2030 will increase to nearly 500,000 acre-feet.

* **Agricultural depletions accounted for 93% (462,000 acre-feet) of the total depletions.**

* **Municipal depletions accounted for 3% (16,800 acre-feet) of the total depletions.**
* **Mineral and power depletions accounted for 3% (13,000 acre-feet) of the total depletions.**
* **Industrial depletions accounted for less than 1% (2,000 acre-feet) of the total depletions.**
* **Evaporation depletions accounted for less than 1% (1,400 acre-feet) of the total depletions.**

CONSERVATION

It is reasonable to expect that a 10 percent reduction in depletions could be brought about either through improved irrigation technology or increased consumer education. To determine the effects of such conservation efforts for each scenario, an estimate of the impact of a 10 percent reduction in depletions was used for each of the population projections and for each of the depletion categories except reservoir evaporation.

In general, the conservation factor had little effect on the depletion percentages of the water use categories. Agricultural depletions continued to rank first, followed by evaporation, municipal, minerals and industrial.

Under Scenario A, where agricultural depletions are held constant, a 10 percent conservation had a corresponding effect on the supply. It was only when agricultural depletions were permitted to increase over time that conservation savings were more evident. In several basins including the Upper and Lower Rio Grande, conservation extended the supply by 10 years. However, 10 years was the maximum recorded for any basin.

IMPLICATIONS

Scenario A

New Mexico's water use outlook as projected to 2030 is promising if agricultural depletions do not increase and if water quality is not substantially decreased. If agricultural depletions remain constant over this period, all of the population projections predict that New Mexico's water depletions will not exceed the supply before 2030 (figure 6-15).

The state depletions were estimated at 2.2 million acre-feet in 1985. Under the potential population projection, total depletions were estimated to increase to 2.3 million acre-feet in 2030. Under the conservative population projection, total depletions were estimated to be about the same as for the potential population projection at 2.3 million acre-feet in 2030. Under the optimistic population projection, total depletions were estimated to increase to 2.4 million acre-feet in 2030, which is well below the water supply of 3.1 million in 2030.

An overall state water surplus can be misleading because it is equally important as to where these surpluses occur in the state. For example, expected surpluses of water are located in the Upper Colorado, the Lower Colorado, the Southwest Closed, the Central Closed, and the Arkansas-White-Red basins. Most of these basins typically have low population growth expectations.

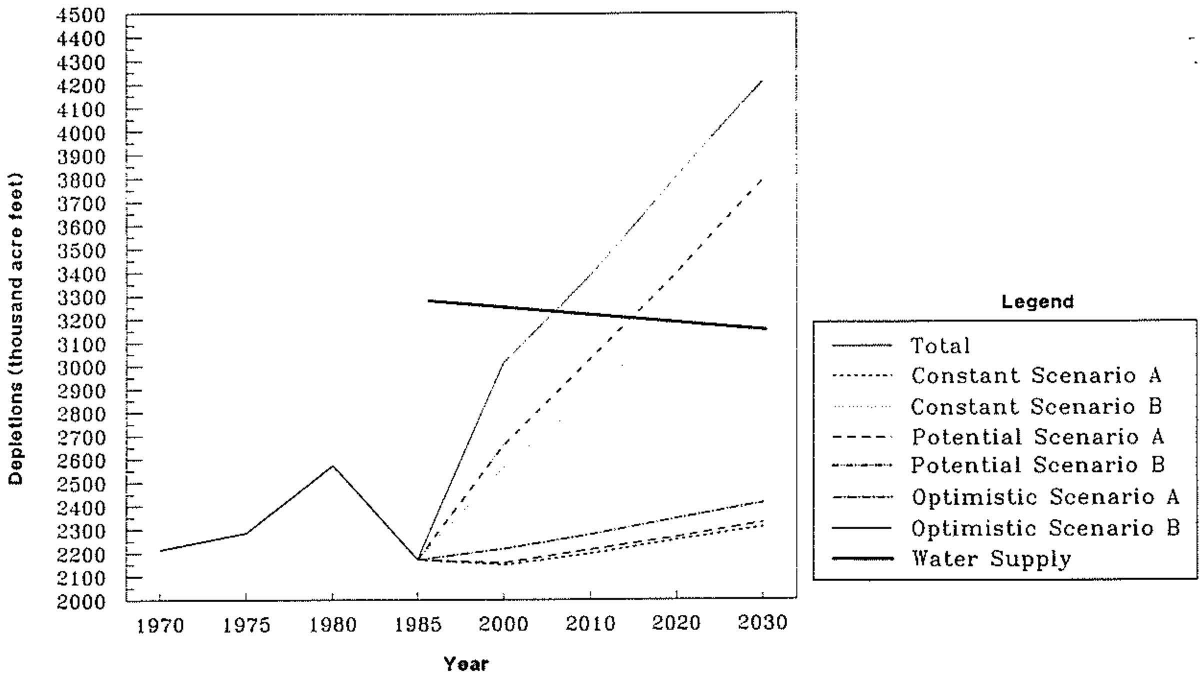


Figure 6-15. Water Depletions by Population Projection and Scenario for New Mexico, 1970-2030.

Figure 6-16 presents the expected time when water depletions will exceed supply by river basin and population projection for Scenario A. Under the potential population projection, only the Texas Gulf Basin is expected to have a deficit by the year 2030 (table 6-3). The Pecos and Upper Rio Grande basins are expected to have deficits by the year 2040 under the potential population projection. The rest of the basins will have sufficient supplies to carry them beyond the year 2060.

Under the conservative population projection, only the Texas Gulf Basin is expected to have a deficit by 2020 and the Upper Rio Grande by 2050 (figure 6-16). Under the optimistic population projection, depletions are expected to exceed supplies by 2030 in the Upper Rio Grande Basin, which is 10 years earlier than under the potential population projection and 20 years earlier than under the conservative population projection (table 6-3).

Scenario B

If New Mexico's depletions increase over time along the trends of the late 1970s, then the water use will exceed the supply by 2030 under all of the population projections (figure 6-15). The total supply of water for depletions was estimated to be 3.2 million acre-feet in 1985 and then slowly decrease to 3.1 million, in 2030, because of ground water mining in the Texas Gulf Basin. The state's water depletions will exceed supply by 2030 under all of the scenarios — conservative by 2020, potential by 2020, and optimistic by 2010 (figure 6-17).

Under the potential population projection, the Texas Gulf, Lower Rio Grande, and Pecos River basins are expected to have water deficits prior to the year 2000 (table 6-4). The Upper Colorado and the Upper Rio Grande are expected to have a water deficit between the years 2000 and 2030. The Southwest Closed Basin is expected to have a deficit by the year 2045. The rest of the basins (Lower Colorado, Central Closed and AWR) will have sufficient supplies to carry them beyond the year 2060.

However, some basins will have surpluses into the 22nd century and beyond. For example, these surpluses of water are located in the Upper Colorado, the Lower Colorado, the Southwest Closed, the Central Closed, and the AWR Basins. Most of these basins typically have low economic potential and thus, low population growth expectations.

The state depletions were estimated at 2.2 million acre-feet in 1985. Under the potential population projection, total depletions were estimated to increase to 3.8 million acre-feet in 2030. Under the conservative population projection, total depletions were estimated to increase to 3.6 million acre-feet in 2030. Under the optimistic population projection total depletions were estimated to increase to 4.2 million acre-feet in 2030.

Under the conservative population projection, the same relationships between depletions and supplies hold as for the potential population projection. Under the optimistic population projection,

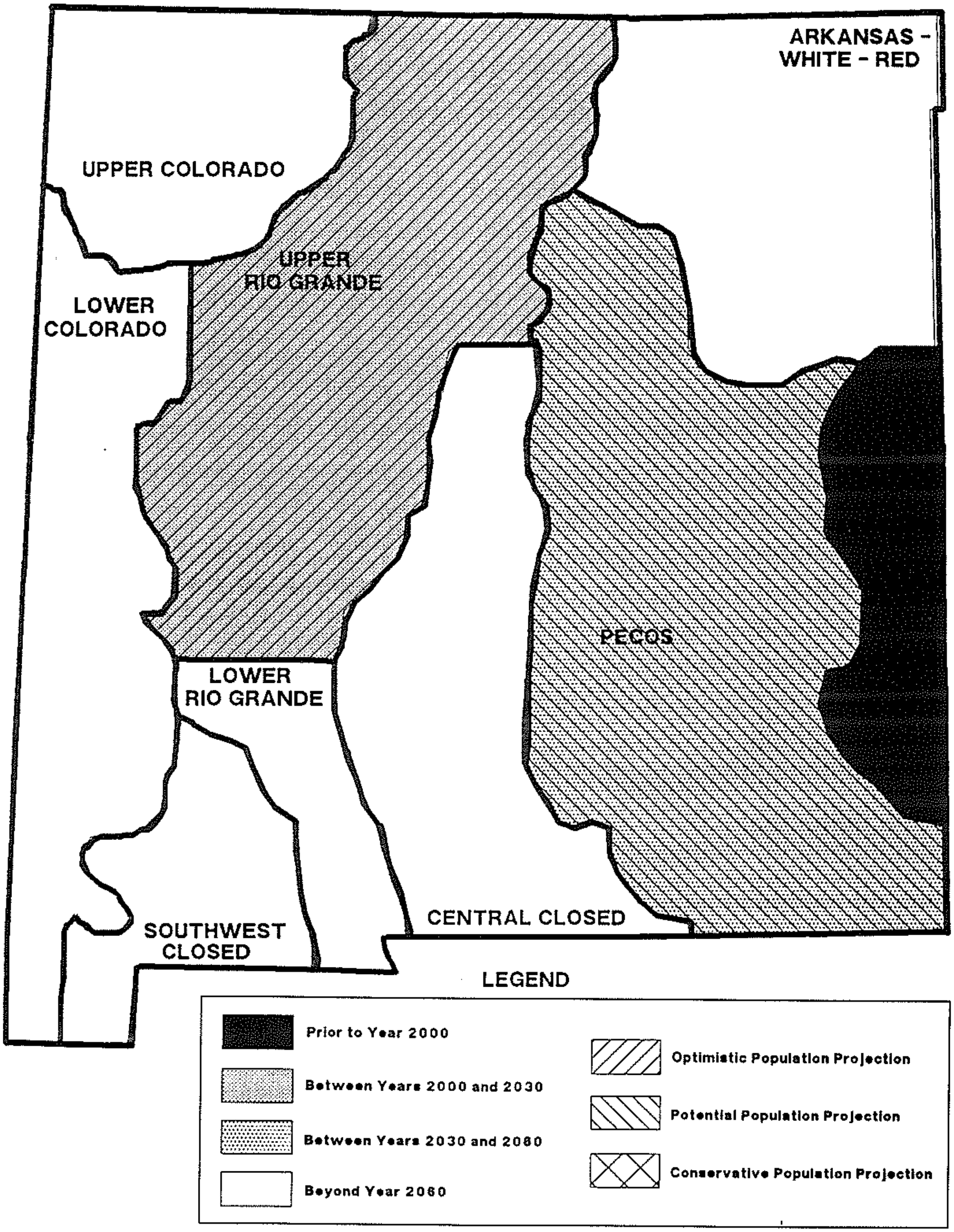


Figure 6-16. Year Water Depletions Exceed Water Supply by Population Projection and River Basin, Scenario A.

the Upper Rio Grande Basin is expected to join the Texas Gulf, Pecos River and Lower Rio Grande Basin, where depletions exceed supplies by the year 2000, and the Lower Colorado is expected to generate a deficit by 2060. The Central Closed and AWR basins are expected to have sufficient supplies to carry then beyond the year 2060 under the optimistic population projection (table 6-4).

Table 6-3. Year Water Depletions Exceed Water Supply by River Basin and Population Projection, Scenario A.

	Population Projection		
River Basin	Potential	Conservative	Optimistic
Upper Colorado	2060+	2060+	2060+
Lower Colorado	2060+	2060+	2060+
Southwest Closed	2060+	2060+	2060+
Upper Rio Grande	2040	2050	2030
Lower Rio Grande	2060+	2060+	2060+
Central Closed	2060+	2060+	2060+
Pecos	2040	2060+	2040
Arkansas-White-Red	2060+	2060+	2060+
Texas Gulf	1990	1990	1990

CONCLUSIONS

The state of New Mexico cannot survive economically in the long-run based on projections from Scenario A, nor does it have the water resources for Scenario B. The economy of the state of New Mexico has become stagnate in the 1980s. Water depletion projections based on a stagnant economy (Scenario A) is not wise. It is unlikely that the state of New Mexico can sustain a level of economic growth over a long period of time, such as prevailed in the late 1970s based on water availability and projected depletions. The trends for Scenario B are similar to that which would have prevailed had these projections been made in the late 1970s to early 1980s (figure 6-15). Future economic scenarios will likely be somewhere between Scenario A and Scenario B, but where along this continuum is uncertain. However, any significant increases above the 1985 Scenario A level projections, will come at the expense of some sector or sectors with agriculture as the most likely candidate in most river basins.

It is unlikely that many of the basins will have water supplies available for Scenario B water-use

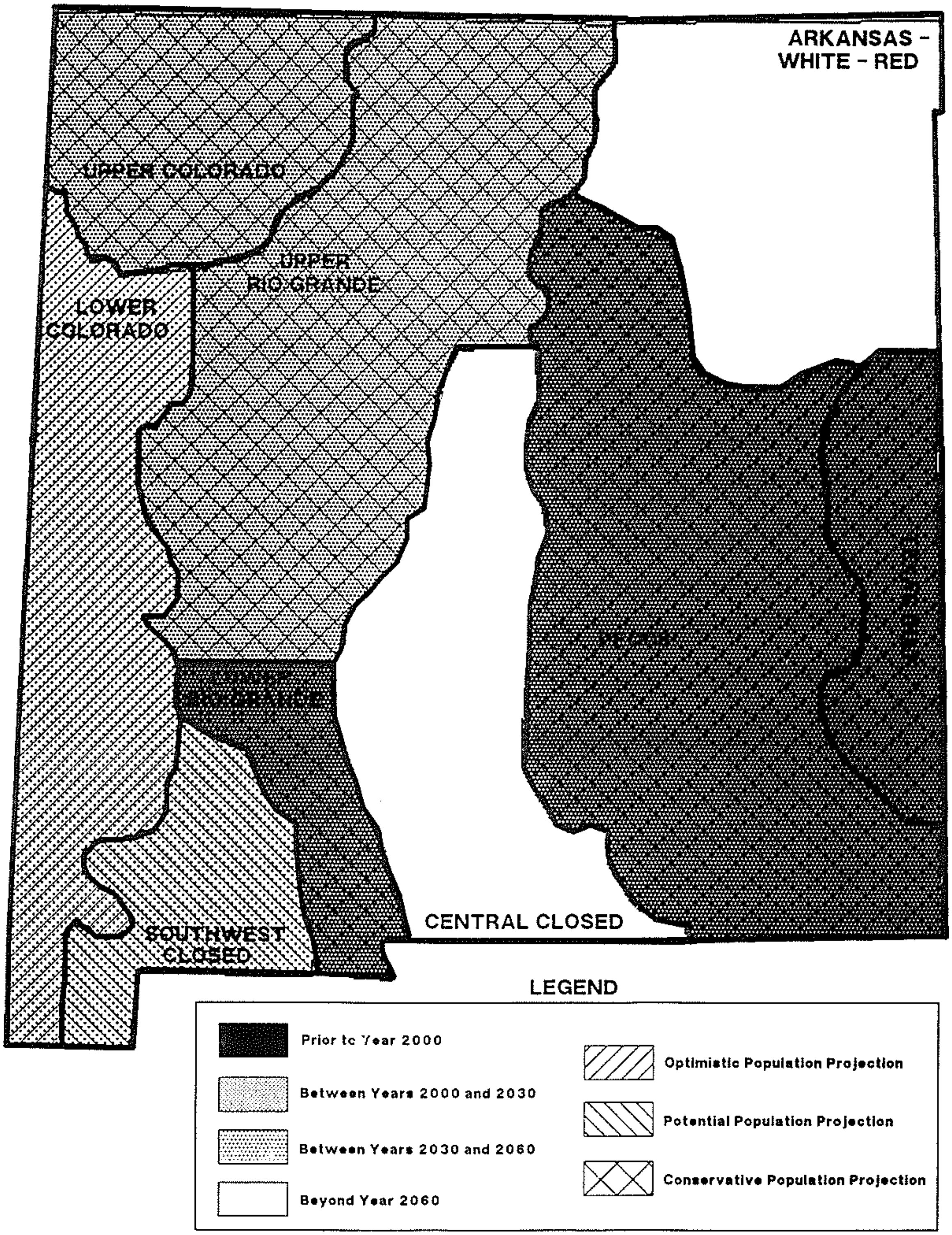


Figure 6-17. **Year Water Depletions Exceed Water Supply by Population Projection and River Basin, Scenario B.**

Table 6-4. Year Water Depletions Exceed Water Supply by River Basin and Population Projection, Scenario B.

	Population Projection		
River Basin	Potential	Conservative	Optimistic
Upper Colorado	2025	2025	2025
Lower Colorado	2060+	2060+	2060
Southwest Closed	2045	2060	2040
Upper Rio Grande	2010	2010	2000
Lower Rio Grande	1995	1995	1990
Central Closed	2060+	2060+	2060+
Pecos	1990	1995	1990
Arkansas-White-Red	2060+	2060+	2060+
Texas Gulf	1990	1990	1990

projections. The Texas Gulf Basin does not appear to have the water supplies available to sustain agricultural depletions at the 1985 level over time (figure 6-14). The Pecos River Basin, more than likely, does not have the water supplies to support much growth above the 1985 depletion levels (figure 6-14), nor does the Lower Rio Grande Basin (figure 6-12). Both of these basins are under litigation with the various entities of the state of Texas. The Upper Rio Grande does not have sufficient supplies of water for a growth pattern of Scenario B (figure 6-12). The Upper Colorado River Basin probably cannot support the level of depletions projection under Scenario B (figure 6-10). However, depletions are likely to continue to increase above the 1985 depletions because of the continued development of Navajo Indian Irrigation Project.

As a consequence of the above reasoning, there may be some middle ground. For example, the agricultural depletions in the Texas Gulf, Pecos River, Upper Rio Grande, and Lower Rio Grande basins could be held at the 1985 levels and the Upper Colorado Basin's agricultural depletions could be permitted to increase at half the rate as under Scenario B. The total depletions, under these assumptions, in 2030, would be 2.7 million acre-feet, which is about 400,000 acre-feet below the total state supply.

In the Upper Colorado River Basin, supply in 2030 would exceed depletions by about 118,000 acre-feet, about 26,000 acre-feet in the Upper Rio Grande, 44,000 acre-feet in the Lower Rio Grande, 39,000 acre-feet in the Pecos River and depletions would exceed supplies by 180,500 acre-feet in the Texas Gulf Basin. In the remaining basins (Lower Colorado, Southwest Closed, Central Closed and AWR), surpluses would remain the same as those presented in potential population projection, Scenario B (Lower Colorado, 63,800 acre-feet; Southwest Closed, 18,300 acre-feet; Central Closed, 77,800 acre-feet, and AWR, 150,300 acre-feet).

There is a need to develop institutions and methods for orderly transfer of water rights from one economic sector to another or from one basin to another.

IMPORTATION

Some individuals and firms have discussed and encouraged the exploration of very large water importation schemes — some from the Missouri River Basin, Lower Mississippi Basin, Pacific Northwest, and even Alaska. One of the major problems with these importation schemes is that New Mexico lies at the end of the pipeline in all of these schemes. The political, environmental, funding, and time requirements for planning and construction make such projects almost impractical. If we were to begin the planning for one of these projects today, it would take between 40 to 60 years before it could become a reality. A more reasonable approach might be intrastate, interbasin transfers. These projects would be more politically feasible and would require far less time in planning and construction. One project that has been in the planning stages for years is municipal water for eastern New Mexico cities in both the AWR and Texas Gulf Basin from the Ute Reservoir on the Canadian River in Quay County. For example, it may be possible to construct interbasin transfer facilities from the AWR for the Pecos River Basin. It may also be possible to construct interbasin transfer facilities from the Southwest Closed Basin to the Lower Rio Grande or Lower Colorado Basins or vice versa.

CHAPTER SEVEN: NEW MEXICO'S WATER QUALITY

INTRODUCTION

New Mexico has a demonstrated history of concern for its water resources and has sought to provide good regulatory processes to ensure that the state's water resources are protected and used wisely. Much of New Mexico's ground water protection program was well established before most of the federal legislation and regulations addressing ground water quality were adopted (Goad 1988). State regulations controlling the disposal of oil field brines to protect ground water quality have been in effect since 1969. The state Water Quality Act was adopted in 1967 and a comprehensive ground water quality program applicable to a broad range of discharges was in effect by 1977.

The state also has been progressive in building modern municipal wastewater treatment plants to improve the quality of effluent released into New Mexico's rivers. However, a few notable exceptions to this overall excellent record do exist. For example, treated sewage from Grants is discharged into the Rio San Jose and then flows into Acomita Lake on the Laguna Pueblo. These nutrient rich wastewaters have caused pollution problems in this small lake. Grants is now actively working on alternative treatment methods to prevent future pollution. Releases of chlorinated municipal wastewaters into streams can harmfully affect fish life. The New Mexico Environmental Improvement Division (EID) of the Department of Health and Environment, and the municipalities concerned, are working on these problems.

One major category of impaired water quality is a byproduct of nature, not man. Some of the state's 15 billion acre-feet of saline ground water is the result of the evaporation of ancient seas (Lansford et al. 1986a). Most of this water is not usable for either municipal or agricultural purposes. Recently, however, research has explored the feasibility of using these waters in energy production and for supplemental irrigation (Lansford et al. 1986a). Results from this research has shown that saline water may be an economic alternative to complete dependency on fresh water supplies. This chapter will not focus on saline water resources, but on other aspects of water quality.

GROUND WATER QUALITY

New Mexico's Regulatory Control Programs

Because of New Mexico's long-term concern over ground water quality, the state has developed one of the best protection programs in the United States. The 1967 New Mexico Water Quality Act established the Water Quality Control Commission (WQCC) and gave it the duties of adopting regulations to prevent water pollution. In 1977, the Commission adopted a statewide protection program with two primary goals: 1) setting ground water standards, and 2) requiring that a discharger demonstrate that those standards will not be violated at any place of present or future water use (Goad 1988).

New Mexico has developed a ground water protection strategy that is based on both numeric and narrative standards. Numeric standards have been established by the WQCC for 33 health related water contaminants, nine aesthetic related substances that cause problems such as taste and odor, and five chemicals that affect agriculture. The following is an example of a narrative standard adopted by the WQCC:

> A water contaminant or combination of water contaminants in concentration(s) which, upon exposure, ingestion, or assimilation either directly from the environment or indirectly by ingestion through food chains will unreasonably threaten to injure human health, or the health of animals or plants...

This system of descriptive rules and numeric standards has been well received and has proved to be a workable regulatory process.

The WQCC regulations are designed to protect all ground water in the state that has a current total dissolved solids (TDS) concentration of 10,000 mg/l or less, because these waters are considered to be a present and/or potential future source for domestic and agricultural water. The WQCC regulations protect ground waters to those standards required for the highest possible use. The Hazardous Waste Management Regulations ensure that all ground water in the state meet or exceed the state's drinking water standards. Ground waters with TDS concentrations greater than 10,000 mg/l currently are not protected by state regulations. However, if the need should become apparent, the WQCC could adopt rules that would provide protection.

Ground water problems typically are not caused by wastewater and solid and hazardous waste management facilities that are permitted to make a discharge to surface and/or ground water resources. Between 1927 and 1986, the state recorded 883 incidents of ground water contamination in New Mexico; almost all were caused by unregulated discharges (McQuillan and Keller 1988). Figure 7-1 shows the distribution of these cases by counties. Most of the recorded instances were in the population centers of the state, or in the oil and gas producing areas. Of these, only 54 have received some degree of remediation. Figure 7-2 shows documented cases of pollution of public water supplies in the state resulting from contamination during the 1927-1986 period.

In respect to hazardous wastes, the EID has the authority and responsibility to adopt regulations equivalent to those of the U.S. Environmental Protection Agency (EPA). The EID, for example, is in the process of locating and remediating hydrocarbon (gasoline) contamination from ground water throughout New Mexico. The problem is especially acute in Albuquerque where evidence of gasoline from storage tanks contamination has been found at 20 sites (McQuillan and Keller 1988).

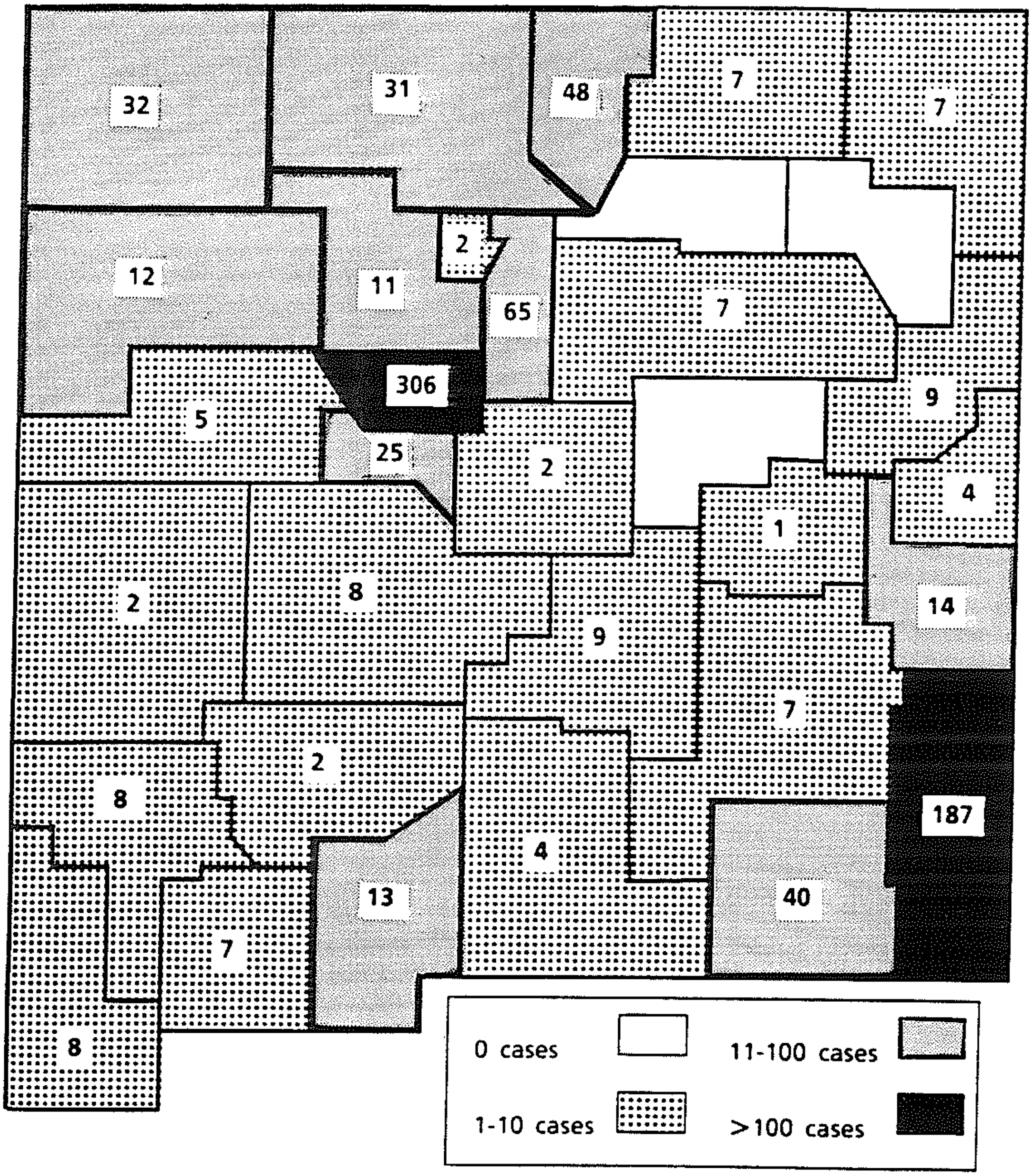


Figure 7-1. Ground Water Contamination (883 cases) by New Mexico County (1927-1986).

Source: McQuillan and Keller (1988)

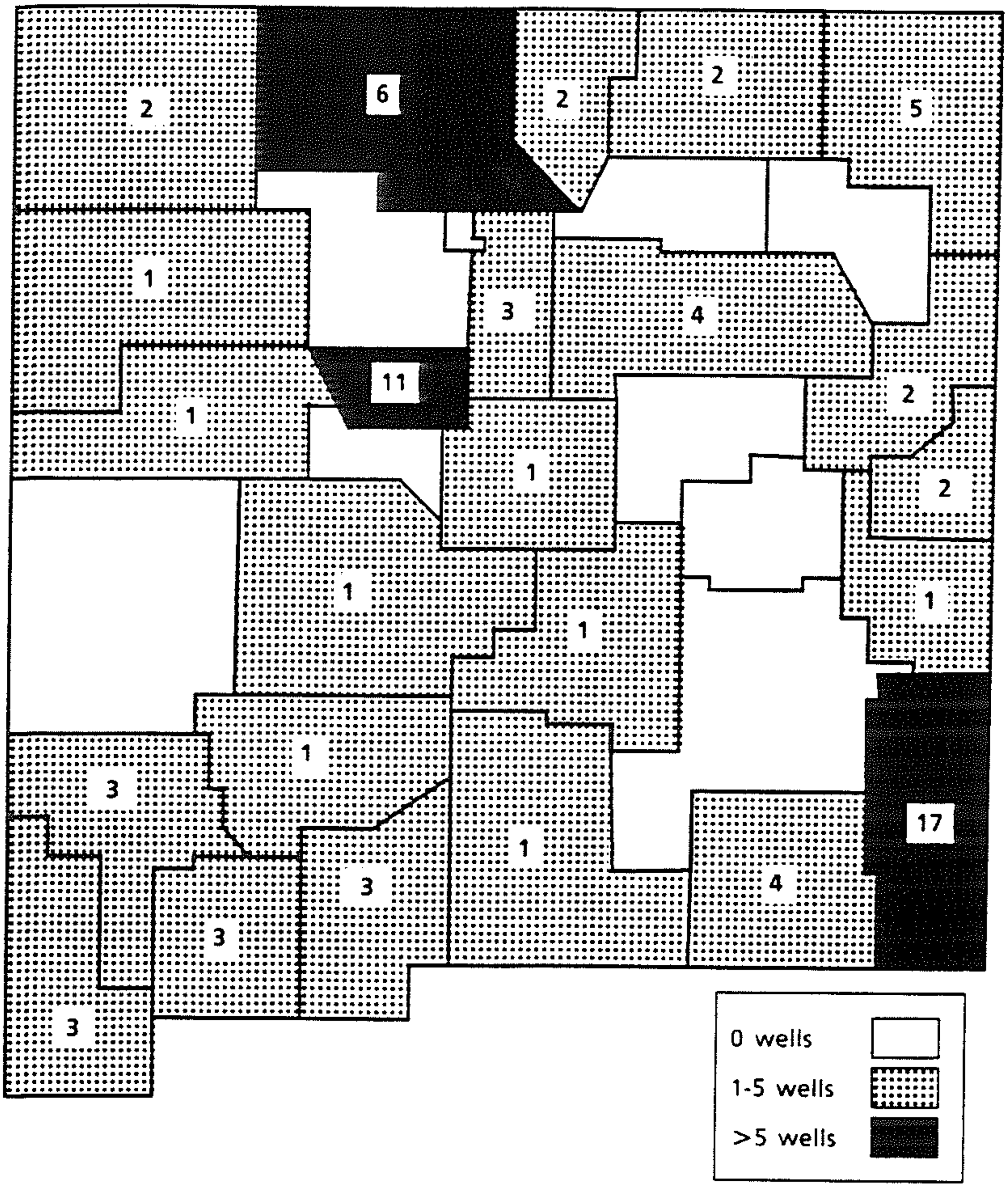


Figure 7-2. **Contaminated Public Water Supply (80 wells) by New Mexico County (1927-1986).**

Source: McQuillan and Keller (1988)

The New Mexico Oil Conservation Division regulates disposal of water produced from the oil and gas industry (Boyer 1988). The most common cause of oil field contamination is the past practice of disposing of produced water in unlined pits. Other causes include leaks of crude petroleum and/or produced waters from pipelines and well casings (McQuillan and Keller 1988).

New Mexico has a relatively low number of facilities (23) that are subject to permitting as sites where hazardous wastes are generated, stored, treated or disposed. Ground water pollution has been found at seven of these sites and corrective action has been, or is being taken at all sites.

In Albuquerque's San Jose area, for example, the EPA has directed a remedial investigation under the federal "Superfund" program. The San Jose area, located within an industrial and residential area, has been designated as the state's highest priority "Superfund" site because of the presence of hazardous substances, particularly in the ground water near the city's San Jose well field (Gallaher 1988).

Agriculture as a Source of Ground Water Pollution

When a crop is irrigated, part of the water is lost to plant growth and part of it evaporates in a process called **evapotranspiration.** A third component of the applied irrigation water, called irrigation return flow, finds its way to the stream system through the drains from the shallow ground water. Because the plants absorb very little of the dissolved salts, this water carries virtually all of the dissolved solids that were in the original irrigation supply. In turn, these residual minerals increase the total dissolved solids content of the shallow ground water and/or of a stream.

As a result of this process, irrigation return flow reaching New Mexico's rivers continue to degrade water quality downstream. Ground water quality is similarly impaired when irrigation water percolates downward to a principal aquifer.

Water soluble pesticides and herbicides from agriculture are another source of ground water pollution. A number of pesticides and pesticide decomposition byproducts have been detected in ground water in the United States as a result of "acceptable" application practices. This has not been the case in New Mexico.

Carbamate pesticides such as aldicarb, carbaryl, and carbofuran have caused ground water contamination in New York. Because New Mexico does not grow crops that require the massive uses of pesticides such as aldicarb, it has not been detected as a pollutant here. The EID and the N.M. Department of Agriculture are conducting a cooperative program to detect pesticides in ground water.

Septic Tank Effluent and Ground Water Quality

Septic tanks are another source of ground water contamination in New Mexico. Some 135,000 septic tanks in the state discharge 25 million gallons per day into the sub-soil. The state's Liquid

Waste Disposal Regulations cover residential septic tank discharges. The state uses various control measures such as depth to the water table, tank size, disposal-field dimensions and lot size to prevent contamination problems. Ground water contamination from septic tanks is usually from excessive nitrate concentrations in areas of dense residential development. Problems also arise due to microbiological contamination of nearby wells used for domestic purposes.

It should be noted, however, that the state is specifically prohibited from directly dictating land use as a means of environmental protection. Local governments have both the responsibility to protect public health and the authority to regulate land use. Three counties now have zoning ordinances that address ground water quality problems through their subdivision regulations.

Public Landfills and Septage Disposal

The potential for urban and suburban landfills to contaminate ground water has grown in recent years. Little is known about the composition of domestic solid wastes buried in landfills in the state. Constituents known to occur in landfill-leachates include chlorides, various forms of nitrogen, solvents and a large number of other organic contaminants. An Albuquerque survey of potentially hazardous wastes generated in city homes showed that more than half of the materials identified were disposed of in landfills, including more than 50,000 gallons of used motor oil per year.

Over the years, large quantities of septage (the accumulated solids that are pumped from septic tanks) have been disposed of in unlined pits at landfills in the state. In some cases septage has been contaminated with industrial wastes at the time of disposal. Septage haulers provide an essential service to rural home owners by periodically removing the accumulated solids. However, safe disposal of septage is a statewide problem that merits better regulation.

Ground Water Quality — Salinity

In many areas of New Mexico ground water is the only source of supply; ground waters are used by more than 90 percent of all public drinking water suppliers. An estimated 4.4 billion acre-feet of recoverable fresh and slightly saline water (1,000 to 3,000 mg/l TDS) is in underground storage in New Mexico. Although much of the state's usable ground water is of good quality, there are some concerns with respect to recharge by irrigation return flows and by salt water intrusion. Irrigation return flows can carry essentially all of the dissolved salts in the original irrigation water supply. Percolation of these residual waters to the shallow aquifer eventually will lead to serious degradation of the ground water quality.

In some areas of the state, such as in the Southwest Closed Basin and the Ogallala area, the amount of water used each year greatly exceeds the recharge; this results in declining ground water levels. As wells in these aquifers are extensively pumped, they become more vulnerable to salt-water intrusion from nearby saline zones in other aquifers. As the water level of a fresh-water well is lowered, the saline water from surrounding aquifers tends to migrate toward the higher quality well.

Surface Water Quality — Dissolved Solids

By and large, the quality of the water in New Mexico's rivers is quite good, particularly in the upper reaches of each of the stream systems. This is true for both organic and inorganic pollutants. Salinity, or the concentration of dissolved salts in water, is not a problem for either municipal or agricultural use until the concentration is greater than about 1,000 mg/l. Above this level water begins to taste salty to most users and crop yields begin to decline seriously.

Salinity resulting from irrigation return flow, plus that contributed by municipal wastewaters, cause the TDS content of New Mexico's streams to increase downstream. An example of this process is provided in table 7-1 where a ten-fold increase in TDS is indicated. This table shows the dissolved solids content in the flow of the Rio Grande at various stations for the winter months of January through March 1984. Note that for all of the cases given, except one (see entry for El Paso, January 1984; table 7-1), the dissolved solids content is below 1,000 mg/l. It should also be noted that both New Mexico's Water Quality Act and the Federal Clean Water Act recognize irrigation return flows as a reasonable consequence of the process of water use and are not subject to regulation as a source of pollution under normal circumstances.

The salinity of the surface flow in many New Mexico streams is also a function of the rate of flow. During periods of flood flow or of snowmelt, water quality is quite good and the dissolved solids content low. At low flows, the base flow comes predominantly from ground water discharge into the stream and, while the volume is small, the salinity is quite high. New Mexico's interstate stream standards are designed to take this natural relationship into account.

Surface Water Quality — Sediment

Erosion from farm lands remains a serious problem both in New Mexico and in the West despite the efforts made over the past 30 years to control this loss of resource. While some soil erosion is the result of wind action, water transport eventually takes place. Sediments have multiple effects on stream quality and on the uses of water. Table 7-1 illustrates the Rio Grande's increasing sediment load as it moves downstream. In New Mexico sediment causes waters to be turbid and to limit the fish habitat of many rivers and lakes. Sediments also preclude some recreational activities. Sediment is a detriment to irrigated agriculture and the capacity of reservoirs is reduced by sediments that are trapped (half of the capacity of Elephant Butte Reservoir has been lost). The four variables that determine the amount of erosion are climate, soil type and structure, topography and plant cover (Smith and Wischmeirer 1962). A few watersheds in New Mexico generate relatively large amounts of sediment per square mile of drainage area. These include the

Table 7-1. Dissolved Solids Content at Various Stations along the Rio Grande for January, February and/or March, 1984.

Water Quality Station	Dissolved Solids Content in mg/l
Near Lobatos, Colo.	140
Below Taos Junction Bridge	170
At Otowi Bridge	210
At Albuquerque	240
At San Marcial	473
At El Paso	1440 (January)
	861 (March)

Source: USGS (1984)

Rio Puerco, the Rio San Jose and the Rio Salado, which are all tributaries of the Rio Grande entering from the west between Albuquerque and Socorro. These perennial streams yield more than 1,000 tons of sediment per year per square mile of drainage area. Other tributaries of the Rio Grande that produce similar quantities of sediment annually are the Rio Chama, the Galisteo and the Jemez. Some examples of clearer streams that carry very little sediment are the Gila (65 tons per square mile per year) and the Rio Grande where it enters the state from Colorado (5 tons per year per square mile). The nature of the stream flow (thunderstorm runoff versus snow melt) and vegetation on the watershed appears to be the major differences in the cases cited, but soil types must also play a deciding role.

The amount of sediment carried by the stream system varies from year to year depending on the intensity of the rainfalls that cause major runoff events and the antecedent conditions. For example, during the drought years of the middle 1950s, there was relatively little rainfall and runoff in many of New Mexico's streams. Some of the largest sediment yields on record followed this period when heavier runoffs occurred in 1957 and 1958. This was true for the San Juan, Rio Grande and Mora rivers.

Erosion can be limited on most watersheds by the application of good conservation practices. The benefits take a long time to materialize, but once erosion is controlled water quality will improve. Continued emphasis must be placed on soil conservation on New Mexico arid watersheds.

GLOSSARY

Acequia: from Spanish, meaning a community irrigation ditch.

Acre-Foot: the quantity of water which will cover one acre of land to a depth of one foot; 43,560 cubic feet; equal to 325,851 gallons of water.

Adjudication: a formal court proceeding to determine the validity and extent of a water right.

Alluvial Fan: a low, outspread, relatively flat to gently sloping mass of loose rock material, shaped like an open fan, deposited by a stream at the place where it issues from a narrow mountain valley.

Apportionment: the division and distribution of water according to a plan.

Appropriator: a person who takes either surface water or ground water and applies it to a beneficial use.

Aquifer: a saturated underground geologic formation of rock or other porous material capable of storing water and transmitting it to wells or springs.

Artesian Well: a well tapping confined ground water. Water in the well rises above the level of the water table under artesian pressure, but does not necessarily reach the surface.

Basin: a physiographic feature or subsurface structure capable of collecting, storing, and discharging water by reason of its shape and characteristics.

Beneficial use: generally, all uses including agricultural, commercial, industrial and recreational are considered beneficial; the exception is willful waste of water.

Bolson: a term applied in the desert regions of the Southwest to an extensive, flat depression almost or completely surrounded by mountains from which drainage has no surface outlet.

Closed Basin: an enclosed area having no drainage outlets and from which water escapes only by evaporation, as in an arid region.

Declared Ground Water Basin: an area with definite hydrogeologic boundaries that has been designated by the state engineer to prevent the impairment of existing water rights and to ensure the orderly development of water rights.

Depletion: that part of a withdrawal that has been evaporated, transpired, incorporated into crops or products, consumed by man or livestock, or otherwise removed.

Diversion: a man-made construction that diverts water from its natural source for beneficial use.

Drainage Basin: the entire area drained by a stream or system of connecting streams so that all the stream flow originating in the area is discharged through a single outlet.

Evapotranspiration: loss of water from land through transpiration of plants and evaporation from the soil.

Fish and Wildlife Uses: includes evaporation from single purpose fish and wildlife reservoirs and lakes, irrigation of crops grown on wildlife refuges and water used in the operation of hatchery fish ladders.

Federal Reserved Rights Doctrine: water reserved for a particular use on a federal reservation; supersedes a state-granted water right.

Fully Appropriated: when all available water has been reserved for existing water rights.

Ground Water: water located below the surface of the earth, including underground streams.

Ground Water Mining: when water is being taken out of the ground water supply at a rate greatly exceeding the rate the supply is being replenished.

Industrial Uses: includes water used for self-supplied manufacturing and processing enterprises, and construction projects.

Instream Use: use of water that does not require withdrawal or diversion from its natural watercourse; for example, the use of water for navigation, recreation, and support of fish and wildlife.

Interstate Compact: an agreement made between two or more states, which is approved by Congress and the president, on the division of waters in rivers and streams that flow from one state into another.

Irrigated Agricultural Uses: includes all farm crops to which ground water or surface water was applied during the growing season. Does not include self-supplied nurseries and greenhouses, self-supplied golf courses or irrigation of crops grown on state and federal wildlife refuges.

Litigation: legal action.

Mineral Uses: includes water used by self-supplied extractive industries. Water used for sand and gravel washing, ready-mix concrete, oil and gas well drilling, secondary recovery of oil, natural gas compressor stations, oil refineries and gas processing plants is included in this category.

Municipal Uses: includes public and private water utilities in cities and densely steeled fringe areas which have a population of 2,500 inhabitants or more and self-supplied residences and mobile home parks within city limits. Does not include water used by self-supplied military installations.

Phreatophytes: a long-rooted plant that absorbs water from the water table or other permanent ground supply.

Playa: a dried up, vegetation free, flat area composed of thin, evenly stratified sheets of fine clay, silt or sand in which water accumulates and is quickly evaporated, usually leaving deposits of soluble salts.

Power Uses: includes all self-supplied power generating facilities.

Prior Appropriation: doctrine that entitles the first person who diverts water and puts it to beneficial use the right to that water; first in time, first in right.

Pueblo Water Right: the paramount right to the use of water in the pueblo limits for use of the city; supersedes state-granted water rights.

Public Welfare: broadly defined consideration to include cultural and community values.

Riparian Doctrine: the system of water law based on English common law allowing landowners adjoining lakes and rivers to withdraw "reasonable amounts" of water so long as downstream landowners are not unreasonably damaged.

Recharge: the addition of water to an aquifer by infiltration, either directly into the aquifer or indirectly by way of another rock formation; recharge may be artificial, as when water is injected through wells or spread over permeable surfaces for the purpose of recharging an aquifer.

Recreational Uses: includes self-supplied land based recreation in state and federal recreation areas; private campgrounds, recreational vehicle parks, organizational camps and resorts; evaporation from single purpose recreation lakes and ponds; and irrigation of self-supplied parks and golf courses.

Reservoir Evaporation: evaporation from reservoirs and lakes other than single purpose fish and wildlife or recreation reservoirs and lakes.

Retired Water Right: a right withdrawn from use.

Return Flow: water diverted for a use that finds its way back to its source of supply.

Saline Water: water having mineral content greater than 1,000 mg/l.

Semiarid: climate characterized by little yearly rainfall and by the growth of short grasses and shrubs.

Surface Water: all water located on the surface of the land.

Water Right: a legal right to take state waters for a beneficial purpose.

Winters Doctrine: cornerstone of American Indian Water Rights; implies a reservation of water for the Indians' present and future use and exempts Indian reservations from state water law.

Withdrawal: the quantity of water taken from a surface water or ground water supply. A diversion is the same as a withdrawal.

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