LONG-RANGE PLANS FOR HYDROLOGIC INVESTIGATIONS IN NEW MEXICO

by H. L. Case, III, and G. E. Welder

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WILLIAM P. CLARK, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
Water Resources Division
505 Marquette NW, Room 720
Albuquerque, New Mexico 87102

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ABSTRACT

Solutions to future water-resources problems in New Mexico will require water-information users to have accurate hydrologic data and interpretations available during the decision process. The purpose of this report is to briefly describe projects that will address and assist in providing solutions to these problems.

Objectives of the eight hydrologic-data-collection projects presented in this report include continuing to identify future data needs; conducting an analysis of the water-quality, ground-water, and surface-water observation networks; and entering all available current and historical hydrologic data into the U.S. Geological Survey Water Data Storage and Retrieval System (WATSTORE). Objectives of areal-appraisal studies include evaluating the water resources in the Gallup-Grants-Zuni-Acoma Sag area and on the eastern flank of the Sandia and Manzano Mountains in Bernalillo County. Potential projects for basin assessments include quantifying the ground-water/surface-water relationships on rivers with flows governed by compacts and an investigation of the water resources of the Estancia Basin. Projects that will assist in the evaluation of energy-related activities include describing the effects of resaturation of coal mines and of milling operations on the quality and quantity of ground and surface water.

Activities that need to be undertaken to assist in addressing waste-disposal problems include the evaluation of the hydrologic factors influencing the feasibility of cleanup at the Albuquerque South Valley "superfund" site and the establishment of a monitoring network at the Waste Isolation Pilot Plant project near Carlsbad. Scientific methods that need to be developed include: (1) the testing of analytical techniques for estimating site-specific conditions with the results of digital hydrologic models, and (2) the determination of the influence of recharge from ephemeral streams on alluvial aquifers. Quantified surface-water/ground-water interaction information is needed by water managers charged with comprehensive water management of the Rio Grande system. Information services that need to be accomplished include conducting question-answer sessions on hydrology at local levels and preparing a nontechnical report describing the hydrology of the southern Mesilla Basin for the lay reader.

INTRODUCTION

The need for water-resources information in New Mexico is constantly changing as the availability, use, and management of water changes. Urban and industrial development, new water-management practices, depletion of existing supplies, and innovative water-resources technology all change the type and frequency of information required by water-resources planners. Local and Federal budget constraints require program planners to ensure that limited monetary and human resources are directed towards solving the most critical water problems and obtaining the maximum results possible for the effort expended.

The purpose of this plan is to describe the studies that the U.S. Geological Survey believes are needed to help answer future questions by water-resources planners in New Mexico, and that are consistent with priorities of the Department of Interior and local needs. By identifying potential problems and studies, this plan also provides a mechanism for other Federal, State, and local agencies to contribute their expertise, advice, and resources towards developing a comprehensive and efficient approach for solving the problems.

Active projects in the New Mexico District are funded in cooperation with the New Mexico State Engineer Office, Highway Department, Bureau of Mines, Pecos River Commission, Rio Grande Compact Commission, Albuquerque Metropolitan Arroyo and Flood Control Authority, City of Albuquerque, City of Alamogordo, City of Las Cruces, the Environmental Improvement Division, Santa Fe Metropolitan Water Board, Zuni Pueblo, and the Alamo Band Navajo Tribe. Federal cooperators are the Bureau of Reclamation, National Park Service, Bureau of Land Management, Bureau of Indian Affairs, White Sands Missile Range, Department of Energy, Corps of Engineers, and Holloman Air Force Base.

Potential investigators for the programs outlined in this report are not limited to the personnel of the U.S. Geological Survey. By identifying a project need, it is being said that: (a) The information needs to be obtained; (b) the objectives of the study are consistent with the mission of the U.S. Geological Survey; and (c) the personnel and technical capabilities to meet the objectives are, or can be, available within the New Mexico District.

The ideas and subsequent studies (Program Steps) discussed in this plan are products of special and ongoing program review sessions with State cooperators and internal indentification by New Mexico District personnel. The Steps were grouped into broad categories of need and scientific discipline that are referred to as Program Elements. Many active and planned projects (Program Steps) may need to be successfully completed in order to achieve the long-range goals identified for the Program Elements.

Many of the Program Steps (projects) identified could logically be placed in other Program Elements than those shown. In fact, all Steps do contribute to overall knowledge and, hence, to all Program Elements.

In addition, this listing reflects the "best guess" of needs based on today's problems. As water problems change, so will the emphasis on individual Steps and Elements within this plan. Therefore, this plan should not be viewed as a binding project-by-project priority commitment for future studies. Rather, it is a guide for development of programs in a logical sequence. As such, it is intended to be periodically reviewed, changed, and restructured as problems change and as the general level of water knowledge increases. Indeed, this document represents the revision of a plan developed by the New Mexico District in 1980 that covered 1980 to 1984. By viewing the program and water-information needs as a whole, however, we have attempted to identify those activities that should endure in spite of changing emphases.

The authors wish to thank the personnel of the New Mexico State Engineer Office and the Environmental Improvement Division for their perspective and input during the formulation of the ideas that are included in this plan. In addition, their review of the plan and the review by personnel of the New Mexico Bureau of Mines are greatly appreciated.

PROGRAM ELEMENTS

Hydrologic-data collection and processing

The accuracy of interpretive studies is dependent on the type and quality of hydrologic data available or collected. Water-level, water-quality, and water-use data provide the cornerstone for hydrologic investigations. The need for collection of specific hydrologic data is often indicated during the first phase of a study; such data collection is the logical "next step" towards a better understanding of a hydrologic system. The proper type of data can be invaluable in narrowing the range of uncertainty in results of hydrologic investigations.

In the future, all phases of hydrologic-data collection must continue to reflect the need for efficient use of personnel, travel, and other resources. To meet high-priority changing needs, existing and future data-collection programs will have to be reviewed frequently and coordinated with other data-collection and investigative agencies.

Current surface-water data-collection activities in New Mexico include measuring stream discharge at approximately 227 gaging stations, stage and contents for 25 lakes and reservoirs, and gage height at 135 crest-stage partial-record stations. Water-levels are recorded at 91 "Federal network" observation wells. Water-quality data are collected at 89 gaging stations, 6 partial-record stations, 1 reservoir, 44 springs, and 293 wells (U.S. Geological Survey, 1982 Water Resources Data, New Mexico, Water Year 1981: U.S. Geological Survey water-data report NM-81-1, 704 p.). Water levels are measured periodically in approximately 5,000 wells as part of a cooperative program with the New Mexico State Engineer Office. Water-use data are collected for every county in New Mexico (Sorensen, E. F., 1982, Water use by categories in New Mexico counties and river basins, and irrigated acreage in 1980: New Mexico State Engineer Technical Report 44, 51 p.).

Goal -- Continue to collect and disseminate information on the water resources of New Mexico through the most efficient use of available money and manpower.

Program Steps -- (Planned or needed new projects. See table 1)

1. Identify data needs and coordinate data collection -- The U.S. Geological Survey views this Step as a continuing process. The 1982 Water Conference (April 5 and 6, 1983) provided a forum for the exchange of data needs for local, State, and Federal agencies. The identification and collection of hydrologic data must continue to be flexible and responsive to changing needs, but must also provide a consistent baseline for monitoring long-term trends and changes.

2. Conduct a network analysis for the collection of surface-water, ground-water, and water-quality data -- A scientific, statistically valid analysis of frequency and areal distribution of data collected is needed to ensure that meaningful data are collected and personnel and limited monetary resources are efficiently utilized.

3. Enter historic, current, and future hydrologic data in WATSTORE -- This Step reflects a commitment to organize and centralize hydrologic data in the New Mexico District. Specific activities in this Step include evaluating the District's technical files, entering historic water-quality data, and continuing the conversion and entry of water-well records into the ground-water site-inventory (GWSI) data base. The processing of data in OMNIANA (the former New Mexico District "in-house" ground-water data-storage system) into GWSI is also part of this Step.

4. Collect borehole-geophysical log information -- This Step includes collecting existing logs and using the New Mexico District logger to obtain additional borehole-geophysical logs from key new and existing wells. "Logging" existing holes provides a relatively inexpensive method for determining the lithology and geometry of aquifers and confining beds. Borehole-geophysical logs supply valuable information on the "third dimension" of hydrologic investigations, which often must be estimated because of a lack of data.

5. Obtain aquifer-test data -- Numerous aquifer tests have been conducted in New Mexico. These data need to be gathered, evaluated, and placed in one location. A bibliography of existing aquifer tests may be prepared. With a "first generation" of digital models having been developed for selected areas of New Mexico, a need for vertical-hydraulic-head data has been identified. In addition, new aquifer tests are needed to provide data about the hydraulic properties of most aquifers and confining beds in New Mexico. Aquifer tests need to be conducted whenever the resources and potential for obtaining interpretable data exist.

6. Conduct a statewide municipal water-quality survey -- The purpose of this Step is to ensure that water-quality data for aquifers providing water to municipal systems are available for informed management. Organic, toxic, and trace-element concentrations in water from these aquifers need to be determined. Periodic comprehensive sampling of municipal water supplies also provides a quantitative basis for evaluating natural or man-induced changes in water quality.

7. Test for organics in the vadose zone -- This Step is critical for areas, such as the South Valley of Albuquerque, where surface sources of organic pollution are postulated. The organics may be "trapped" by clay and silt lenses above the water table.

8. Expand the precipitation-quality observation network -- As industrial and muncipal developments in the Southwest increase, changes in the quality of precipitation (including snowfall) might occur. One factor influencing the quality of surface water and ground water is the "initial" quality of the water before it contacts the earth's surface. A program is needed to monitor selected ions in precipitation for background information in several areas of the State.

Areal appraisals

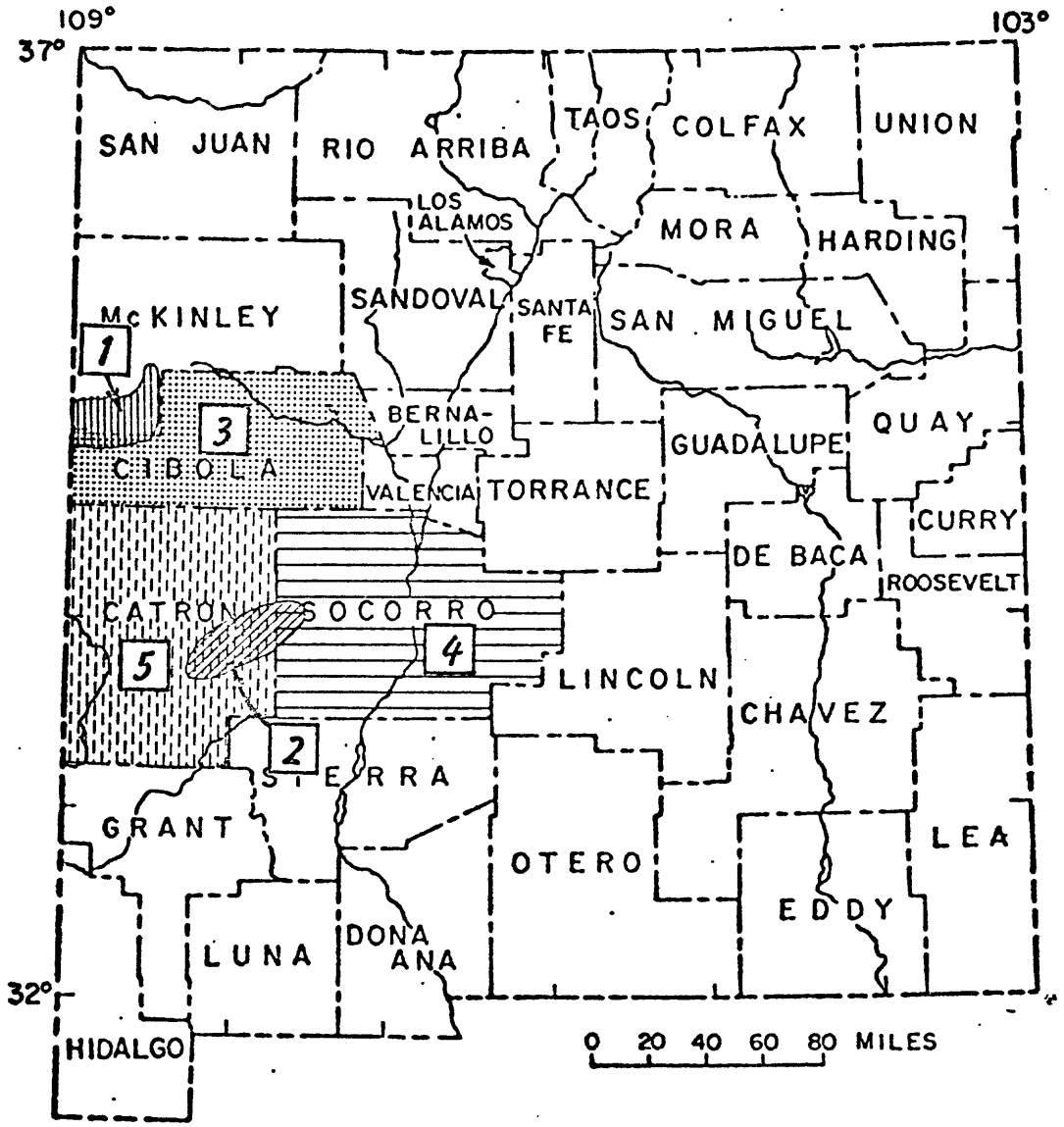
Areal appraisals may provide reconnaissance or detailed pictures of the State's water resources and are useful precursors to more detailed modeling and problem-solving efforts. They may include preliminary models of large areas in order to reduce the range of uncertainty in parts of the water budget. Study areas may include parts of a county, a county, or several counties. Because the natural flow of water is not governed by political boundaries, areal appraisals provide a mechanism for studying a hydrologic system without ignoring the realities of political boundaries.

Current areal studies being conducted by the New Mexico District (fig. 1) include studies of the water resources of the Zuni Tribal lands and the Plains of San Agustin. Water-resources investigations for Cibola, Socorro, and Catron Counties are also underway.

Goal -- Identify geographic areas requiring water-resources investigations, and conduct studies in these areas emphazing hydrologic rather than political boundaries.

Program Steps --

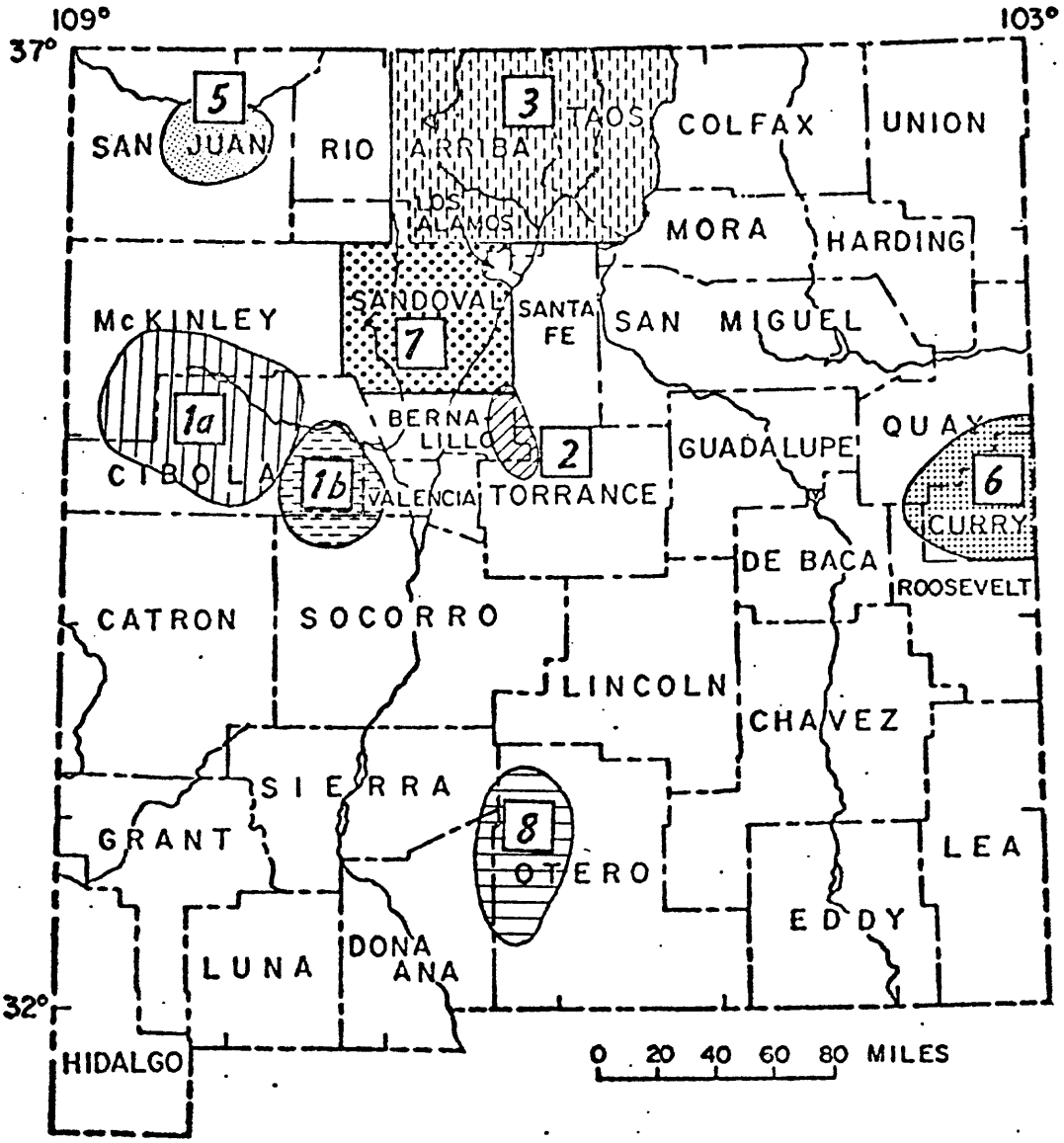
1. Evaluate water resources of the Glorieta-San Andres aquifer system in the Gallup-Grants-Zuni-Acoma Sag area (fig. 2) -- Development by muncipal, domestic, and industrial water users in this area (fig. 2) is increasing. The effects of increased withdrawals on the quality and quantity of existing supplies need to be investigated. Hydrologic data, including water levels, aquifer and confining-bed hydraulic properties and thicknesses, and vertical-hydraulic gradients, are needed to better conceptualize the hydrologic system and quantify the effects of its development.



EXPLANATION

1. Zuni Tribal Lands
2. San Agustin Plains
3. Cibola County
4. Socorro County
5. Catron County

Fig. 1. Locations of Areal-Appraisal Study Areas, Active Projects 1983



EXPLANATION

1. (a) San Andres-Glorieta Aquifer of Zuni Uplift
2. (b) San Andres-Glorieta Aquifer of Acoma Sag
3. Sandia-Manzano Mountains
4. Water Quality in Aquifers Above Mineral Deposits (Statewide)
5. Hydrologic Effects of Navajo Indian Irrigation Project
6. Curry and Quay Counties, Ogallala Aquifer
7. Sandoval County
8. Saltwater Encroachment, Tularosa Basin

Fig. 2. Locations of Areal-Appraisal Study Areas, Planned or Suggested Projects

2. Evaluate water resources of the area on the eastern flank of the Sandia and Manzano Mountains in Bernalillo County (fig. 2) -- Development in this area is expected to continue. The effect of increased demand on the quality and quantity of water in the area needs to be quantified to provide county planners with information for evaluating requests for development.

3. Evaluate water resources of Taos and Rio Arriba Counties (fig. 2) -- The recreational activities of this area are placing increased stress on the quality and quantity of the water supply. A reconnaissance of the water resources is needed, and the effects of development in high-use recreation areas (Taos, Rio Costilla, Red River) need to be identified.

4. Determine the quality of water in aquifers overlying mineral-production zones in areas of intense energy development -- Current State regulations require "casing off" of selected water-bearing units in oil and gas production areas. An updated evaluation of the quality of water in these units could be used by the regulating agencies and industrial users in determining the effect of current and planned "casing off" practices.

5. Evaluate the effect on water resources of the Navajo Indian Irrigation Project (fig. 2) -- The irrigation project is currently applying large amounts of San Juan River water to sediments in an area of the San Juan Basin. The effects on the quantity and quality of water in the shallow-water system need to be studied. The potential for "salt-loading" in the soils also needs to be monitored and evaluated.

6. Determine effects of water withdrawals in Curry and Quay Counties (Northern High Plains, fig. 2) -- Water-level declines in the Ogallala aquifer in this area continue. The geographic distribution and rates of declines based upon large-scale management practices need to be determined.

7. Evaluate the water resources of Sandoval County (fig. 2) -- Existing hydrologic conditions, particularly in the Santo Domingo area and in the eastern part of the San Juan Basin, need to be defined.

8. Locate the freshwater salt water interface in the southern Tularosa Basin (fig. 2) -- Continued demand on the limited freshwater resource of the area creates the potential for encroachment of saline water into wells that currently produce freshwater. Application of solute-transport models can assist in the evaluation of potential movement (laterally and vertically) of dissolved constituents in the subsurface.

Basin assessments

Basin assessments are studies of the hydrology of areas that are bounded by topographic drainage divides. They may include an entire major river basin, a smaller tributary basin, or an interior basin (bolson). These studies can yield qualitative or quantitative information on surface- and ground-water resources, depending on the scope of the investigation.

Precipitation-runoff relations, stream gains and losses, effects of ground-water withdrawals on streams, land-use effects on streamflow, changes in sediment load, and quality of water are subjects that may be evaluated in basin assessments.

Basin assessments are needed:

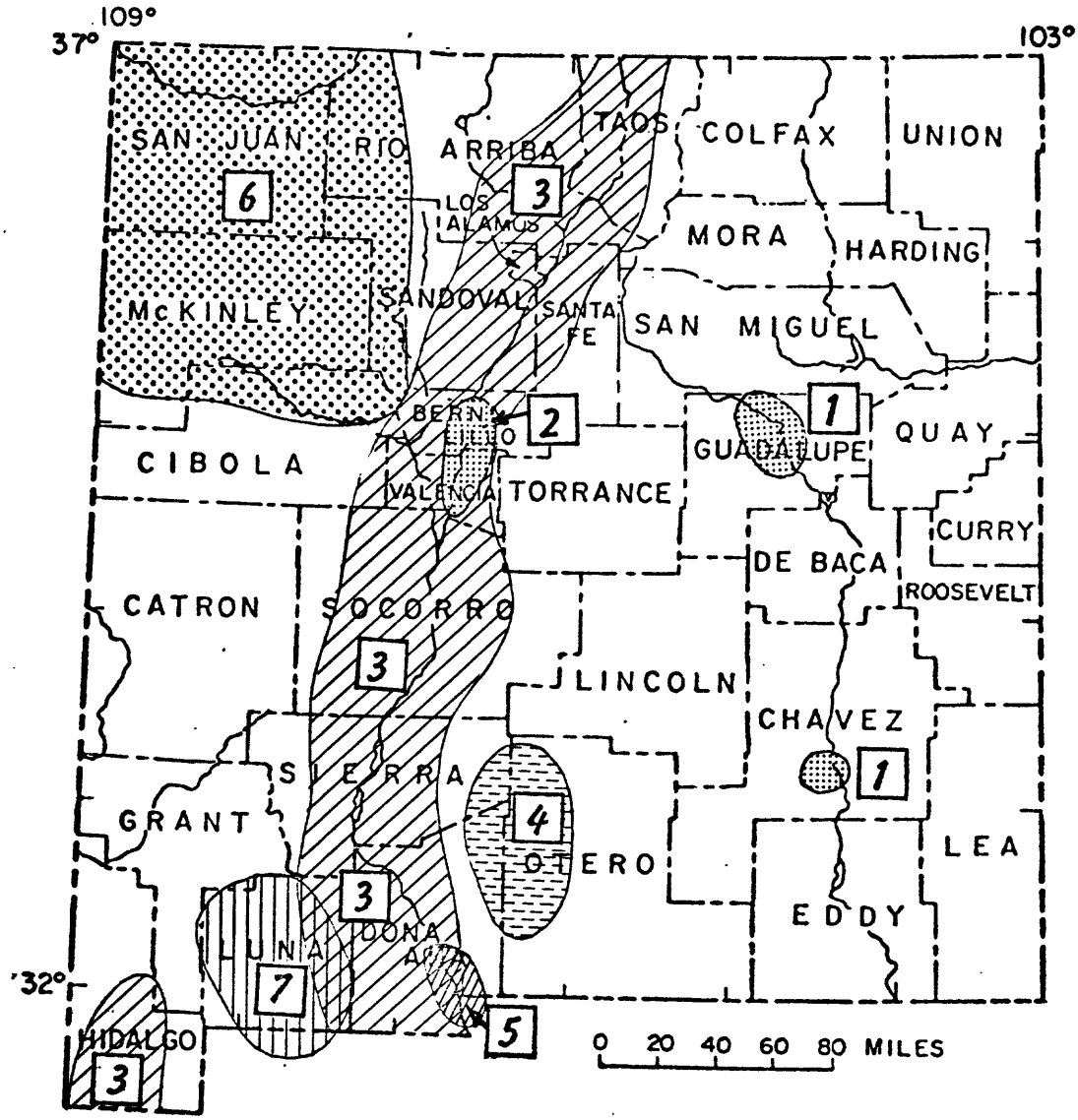
1. To describe the water resources and availability of water in a river basin;
2. To provide information for determining the amount of water that can be utilized for agricultural and other uses at a particular time;
3. To provide information for determining the effects of industrial, agricultural, and energy-related development on the quality of ground water and surface water;
4. To provide information for predicting floods and the location of areas vulnerable to flooding;
5. To provide information that can be used in the design of structures that must be flood resistant, such as bridges, dams, and levees;
6. To provide information on sediment transport and deposition by streams; and
7. To provide hydrologic data needed for the conservation of fish and wildlife.

The locations of active basin-assessment projects in New Mexico are shown in figure 3. Projects are currently in progress in parts of the Pecos and Rio Grande Basins. The Southwest Alluvial Basin (SWAB) Regional Aquifer System Analysis is concentrating efforts in the Albuquerque-Belen, Socorro, Mesilla, Palomas-Engle, and Animas Basins. A water-resources investigation, including surface geophysical studies, is underway in the Tularosa Basin. The geohydrology of the Mimbres basin and effects of development on the ground-water resources of the San Juan Basin are also being studied. A new effort, in addition to the SWAB studies, is attempting to quantify vertical-gradients and the river-aquifer relationship in the southern Mesilla Basin.

Goal -- Identify, conceptualize, and quantify the components of water budgets for the major bolsons and river basins in New Mexico.

Program Steps --

1. Study the ground-water/surface-water interaction and effect on streamflow -- The effect of ground-water withdrawals on flow in rivers that are subject to legal constraints should continue to be quantified. In addition, the effect of future withdrawals on river flows and existing ground-water users will have to be known (predicted) in order for regulating agencies to make informed management decisions. A corollary to this is to better quantify the recharge effects of river flow on the ground-water system.



EXPLANATION

1. Parts of Pecos River Basin
2. Parts of Rio Grande Basin
3. Southwest Alluvial Basins (SWAB)
4. Tularosa Basin, Geophysical Studies
5. Southern Mesilla Basin
6. San Juan Basin Ground Water
7. Mimbres Basin Ground Water

Fig. 3. Locations of Basin-Assessment Study Areas, Active Projects 1983

2. Evaluate the water resources in the Estancia Basin (fig. 4) -- The Estancia Basin contains a complex aquifer system that includes the Madera Formation, Glorieta Sandstone, and alluvium. A quantitative study of the basin will result in a better conceptualization of the flow system, determination of quantity of water available, and improved prediction of effects of present and future development. This is a complimentary effort to the Areal Assessment Step regarding the east slope of the Sandia/Manzano Mountains.

3. Assess water quality in the middle Rio Grande area (fig. 4) -- Past and present studies of the middle Rio Grande area have concentrated on the quantity of water and have only generally described the quality of water. A study that will identify variations in ground-water quality (areally and vertically) and variations in streamflow quality will enable planners to make informed decisions regarding future development.

4. Quantify surface-water/ground-water interaction in the Gila River Basin (fig. 4) -- Studies of the effects of ground-water development in the Gila River Basin on the flow in the Gila River are needed to evaluate the effects of changing water-use patterns, potential construction of surface-water impoundments, and alternative conjunctive-use management of the river/aquifer system.

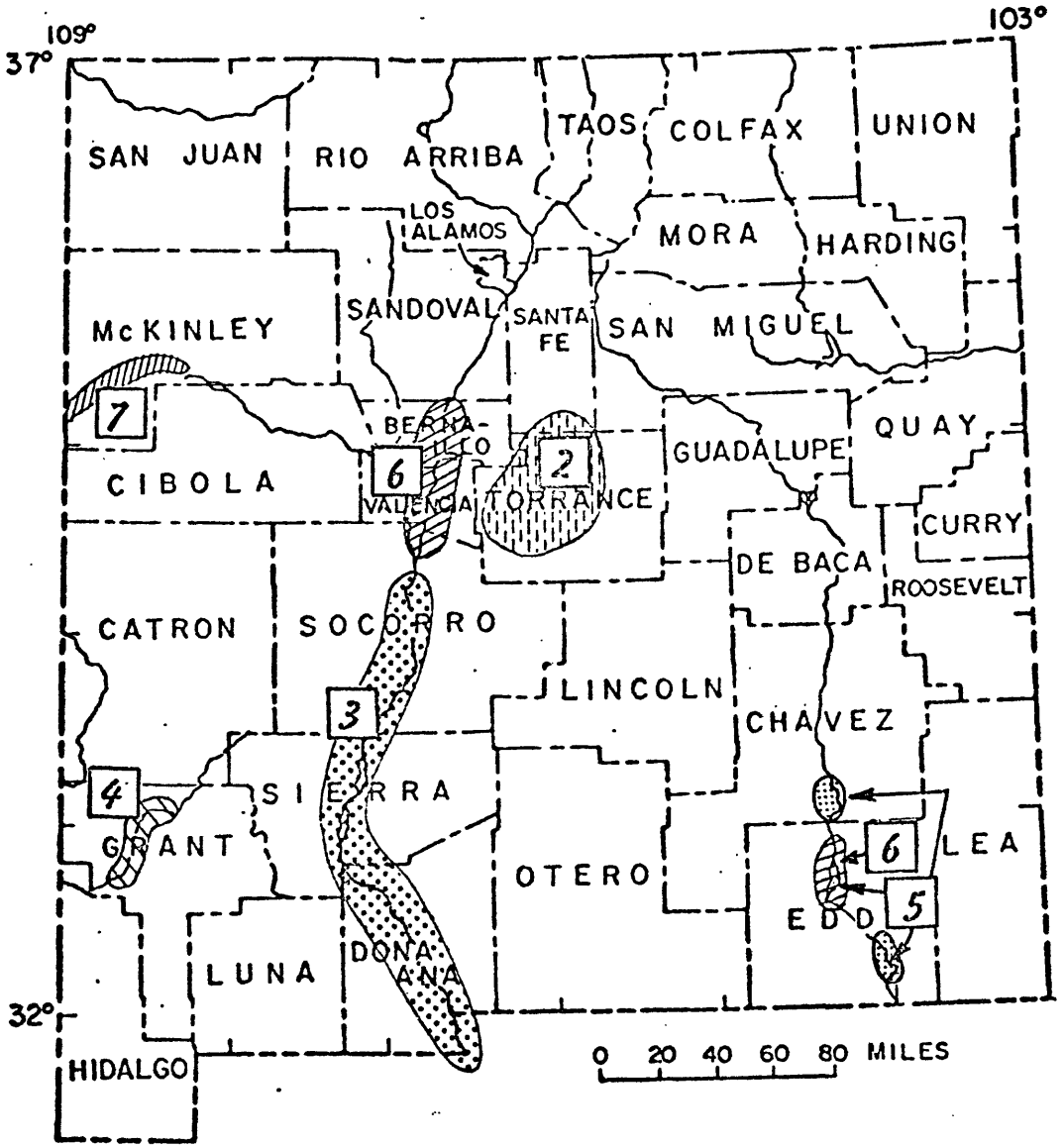
5. Study streamflow quantity and quality of the Pecos River (fig. 4) -- The effects of changing land use and industrial development on the quality and quantity of flow in the Pecos River need to be evaluated. Such studies could include channel losses, reservoir-bank storage, water-quality changes in specific reaches, water budgets, and ground-water/surface-water interaction. Specific areas to be studied include the Roswell area, Brantley damsite, and Malaga Bend.

6. Identify depth of the freshwater/saltwater interface in the Roswell and Albuquerque-Belen Basins (fig. 4) -- The vertical and areal extent of freshwater in these basins needs to be determined. Changes in extent and depth due to present and future development will have to be evaluated.

7. Study water quality in the Puerco River and aquifers in the basin (fig. 4) -- The extent of any possible aquifer contamination caused by a tailings-pond breach and the hydrologic processes involved in constituent migration need to be further defined. An evaluation of the effectiveness of the clean-up operation that already has been conducted on the Puerco riverbed needs to be assessed.

Fossil-fuel and mineral extraction

The studies in this Program Element evaluate the effects of energy-related activities on the hydrologic system. These activities include oil and gas exploration, coal, copper, and uranium mining, and geothermal development.



EXPLANATION

1. Ground-Water/Surface-Water Interaction (Numerous Areas)
2. Estancia Basin
3. Middle Rio Grande Water Quality
4. Gila River Basin
5. Pecos River Studies: Roswell, Brantley, Malaga
6. Albuquerque-Belen, Roswell Basin Freshwater/Saltwater
7. Puerco River Water Quality

Fig. 4. Locations of Basin-Assessment Study Areas, Planned or Suggested Projects

Active fossil fuel and mineral extraction projects currently under investigation by the New Mexico District are shown in figure 5.

The U.S. Geological Survey is currently involved in surface-water, ground-water, and rainfall/runoff modeling in coal-lease areas of northwestern New Mexico. The effects of coal development on the San Juan River are also being studied. The resaturation of Mariano Lake uranium mine, and the subsequent effects on the quality and water levels of the ground-water system, is being evaluated. The effects of dewatering the Phillips Mine on the quantity and quality of flow in Kim-me-ni-oli Wash, an ephemeral stream, are being quantified. In addition, the U.S. Geological Survey is assisting the Bureau of Land Management in evaluating the processes and requirements for adequate monitoring networks for in situ uranium-leaching mining operations. The effects of potential geothermal development on water resources in the Jemez Mountains area are also being studied.

Goal -- Provide water quality and quantity data and interpretations for informed evaluations of the effects of energy-related activities on the State's water resources.

Program Steps --

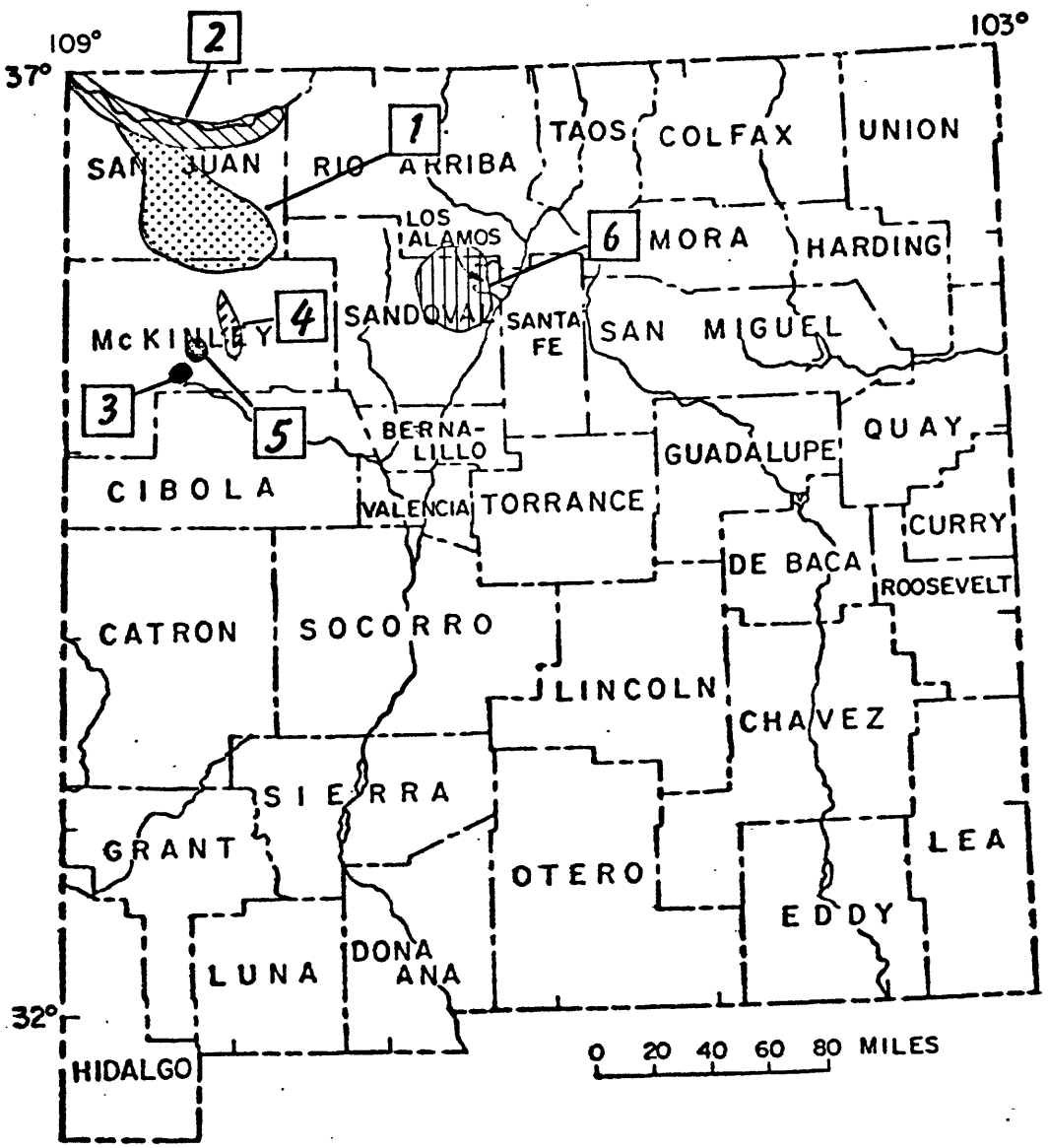
1. Evaluate the effects caused by resaturation of coal mines (fig. 6) -- Studies within this Step include the evaluation of impacts of surface coal mines on ground water and processes active in reclaimed coal areas. The effects of backfilling coal mines and resaturation on the quality of water near the mines need to be investigated.

2. Evaluate the effects of milling operations located on flood plains -- Milling operations may be located on alluvial flood plains that consist of permeable material. The effects on the quality of ground water and surface water near the mill sites need to be determined. The hydrologic processes and monitoring requirements at these sites need to be identified.

3. Describe quality of water in the Grants Mineral Belt area (fig. 6) -- Energy development, at some level, will continue in this area. Before effects of additional activities can be quantified, "background" conditions must be known. It is imperative that water-quality variations, areally and vertically, be described and monitored on a periodic basis.

4. Evaluate the quality of ground water and surface water in the Silver City area (fig. 6) -- Development of mineral resources and milling in the Silver City area have taken place for years. The effects of past, present, and future development on the quality of water in the surface-water and ground-water systems need to be described.

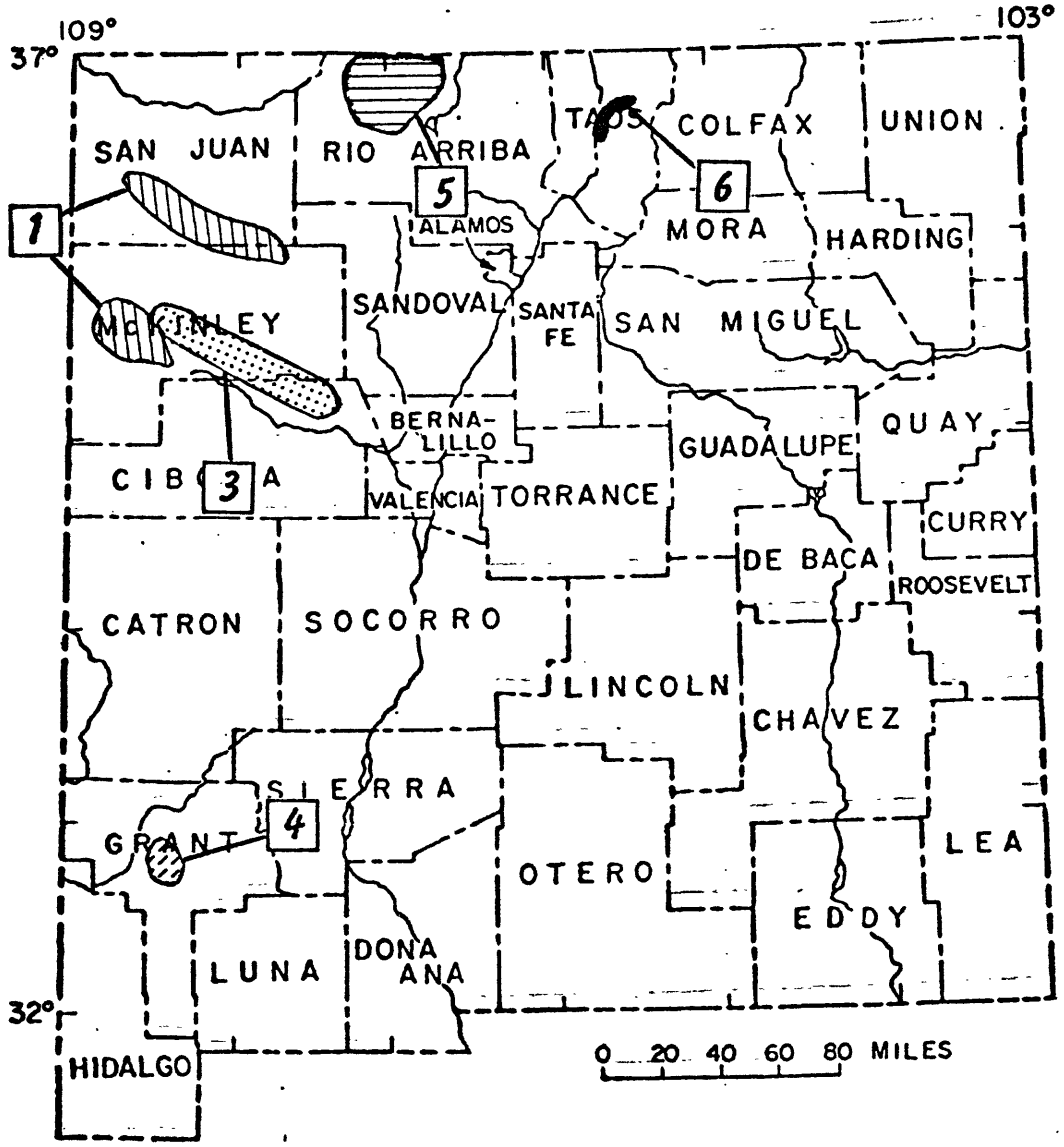
5. Describe the occurrence and effects of acid precipitation in the Four Corners area (fig. 6) -- Current water-quality conditions in mountain lakes and streams both west (for background data) and east of the area need to be determined. The quality of precipitation, the chemical changes in precipitation, and the water-quality changes in streams and lakes need to be evaluated.



EXPLANATION

1. RF/RO Model Coal Leases, San Juan Basin
2. Effects of Coal Development on San Juan River
3. Resaturation of Mariano Lake Uranium Mine
4. Effects of Mine Dewatering on Kim-Me-Ni-Oli Wash
5. Hydrology of In Situ Uranium-Leaching Mining
6. Jemez Geothermal Studies

Fig. 5. Locations of Fossil-Fuel and Mineral Extraction Study Areas Active Projects 1983



EXPLANATION

1. Resaturation of Coal Mines
2. Effects of Mill Tailings (Selected Areas)
3. Quality of Water in Grants Mineral Belt
4. Quality of Water in Silver City Area
5. Acid Rain, Four Corners Area
6. Quality of Water Near Questa

Fig. 6. Locations of Fossil-Fuel and Mineral Extraction Study Areas, Planned or Suggested Projects

6. Evaluate the effects of mining near Questa (fig. 6) -- The quality of ground water and surface water (Rio Grande and Red River) in the area needs to be described and the ground-water/surface-water relationship quantified. The processes active in the hydrologic system and the effects of mining molybdenum and associated minerals in the area need to be conceptualized and described.

Waste disposal

Activities within this Element include the processes involved with the disposal of domestic, municipal, industrial, radioactive, and hazardous wastes.

The U.S. Geological Survey currently is describing the hydrology in the Waste Isolation Pilot Plant (WIPP) area (fig. 7) and serving as an advisor to the Department of Energy on WIPP-related hydrologic matters.

Goal -- Identify and obtain the data and provide the interpretations necessary for informed evaluation of the effects of waste disposal on the quality of waters in New Mexico.

Program Steps --

1. Evaluate the hydrologic factors affecting the feasibility and assessment of the potential for clean-up at the Albuquerque South Valley "superfund" site (fig. 7) -- The Albuquerque South Valley has been designated as a priority "superfund" site by the U.S. Environmental Protection Agency. The extent of contamination, hydrology of the area of the site, effects of ground-water withdrawals, influence of vertical-hydraulic-head gradients, and relationship of ground water to the Rio Grande need to be quantified.

2. Establish a long-term monitoring program at the WIPP facility (fig. 7) -- Upon authorization to construct the facility, a network for long-term monitoring of water levels and water quality in the principal hydrologic units in the area needs to be established. An observation network based on an informed concept of the hydrologic system could provide the necessary information with the most efficient distribution of data-collection sites. An efficient observation network will result in considerable cost savings without sacrificing the monitoring capability.

3. Perform time-of-travel studies on all streams crossing identified hazardous-waste transportation routes (fig. 7) -- A potential exists for "spills" of hazardous wastes along transportation routes. Authorities will have to know the timeframes involved for the downstream movement of these wastes. Time-of-travel studies conducted before any spills occur will provide useful information for management decisions during times of potential crises. The subsequent transfer value to other semiarid areas should also be investigated.

4. Evaluate the hydrology in areas with hydrocarbon contamination -- Hydrocarbons in ground water have been identified in the southwest valley of Albuquerque (fig. 7). The extent of contamination, potential rates and direction of flow, and mineralogy of sediments in the area need to be defined.

5. Study the effects of landfill and feedlot sites on the quality and quantity of ground water -- Landfill sites in Albuquerque (fig. 7) may be located on permeable material near sources of potable water. The effects of leaching and the rates of movement in the ground-water system in these areas need to be described. Feedlots are another potential source of ground-water contamination. Programs for monitoring the changes in ground-water quality near feedlots need to be developed.

6. Quantify the denitrification potential of soils in the middle Rio Grande Basin (fig. 7) -- Current regulations about spacing and design of septic systems are based upon assumed denitrification potentials. The influence of hydrology on the ability of soils in the area to denitrify waste from septic systems needs to be evaluated.

Scientific-methods development

New problems often require new methods and/or improved instrumentation for the development of new approaches. "Old" problems may require innovative techniques using improved "state-of-the-art" tools for evaluation. This Program Element attempts to recognize research needs that could be conducted at the "field" level in an applied situation.

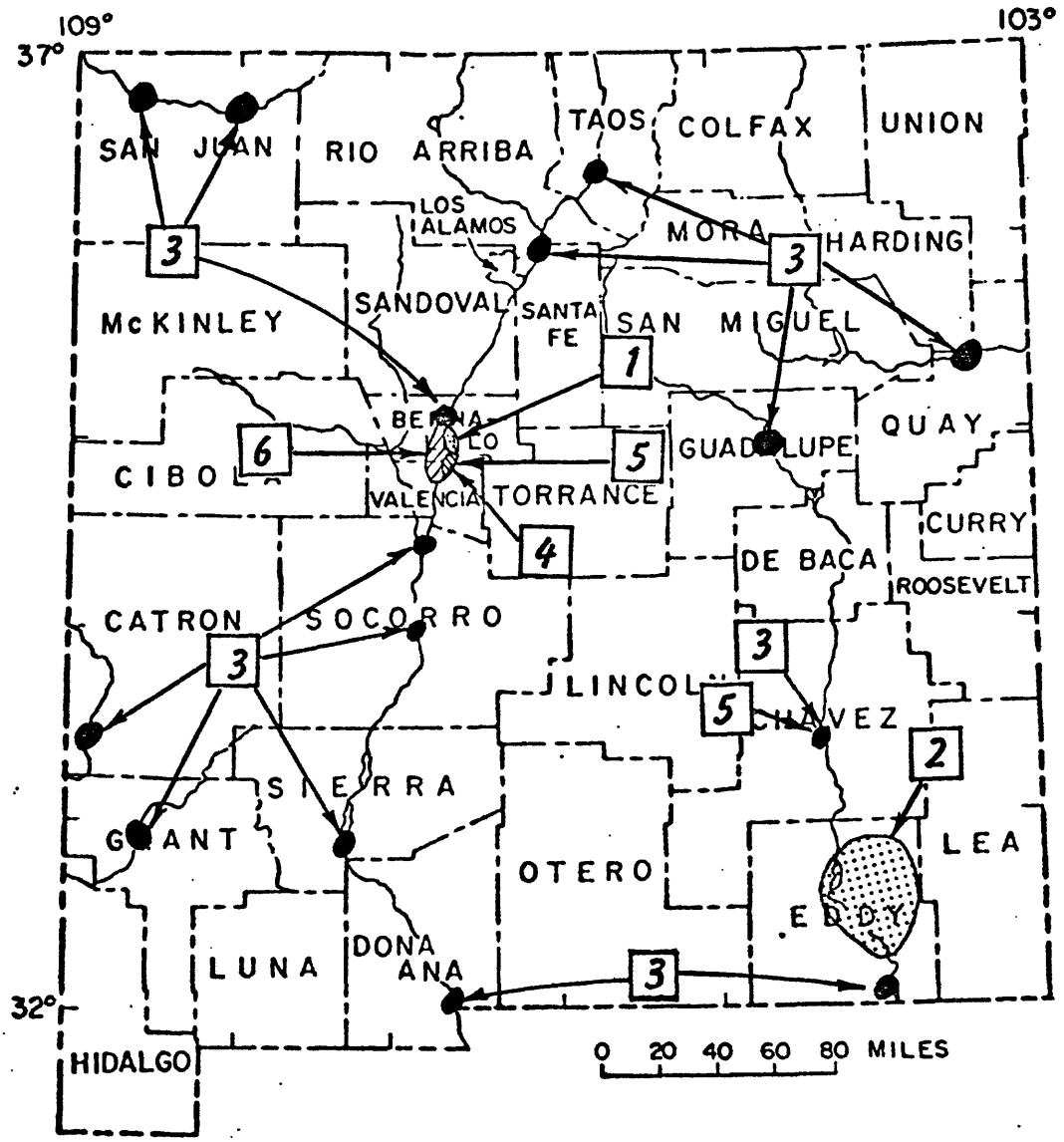
Current studies in the New Mexico District that either directly or indirectly are developing scientific methods include (1) the use of trend-analysis techniques to determine the effects of individual coal mines, and (2) development of monitoring criteria for in situ uranium-leachate mining. Both projects are applying the techniques to "real-world" field problems.

Goal -- Identify development needs and assist in the developing and testing of new instrumentation and techniques.

Program Steps --

1. Develop analytical techniques to aid in the use of the results of digital-model analyses -- Predicted effects from digital models are representative of the areas of the finite-difference or finite-element blocks. Water-resources planners and regulators often require site-specific effects that are more exact than the degree of detail available from the model analysis. Techniques, such as weighted averaging, and practical uses of digital-model results need to be investigated and documented.

2. Estimate recharge from, and study influence of, ephemeral streams on alluvial aquifers -- The location, quantity, and rate of recharge from ephemeral streams is important to studies of semiarid basins. The factors influencing recharge from ephemeral streams are essential elements of the hydrologic processes that are active in such environments.



EXPLANATION

1. Albuquerque South Valley "Superfund" Hydrologic Study
2. Long-term Monitoring Network at WIPP
3. Time-of-Travel for Hazardous-Waste Spills
4. Extent of Hydrocarbon Contamination
5. Effects of Landfill and Feedlot Sites
6. Denitrification Potential of Soils

Fig. 7. Locations of Waste-Disposal Study Areas, Active 1983, and Planned or Suggested Projects

3. Quantify the effects of gases in aquifers -- The presence of gases in aquifers may influence pH and other chemical constituent determinations. Research into methods of collection, identification, and effects of gases in water samples from aquifers is needed to better interpret the chemical analyses. This Step also needs to include development of in situ samplers for gases and radionuclides.

4. Standardize techniques for sensitivity analyses of digital-model results -- Statistically valid techniques for demonstrating sensitivity analysis need to be developed in order to permit comparisons of different models of similar areas. These techniques need to include methods demonstrating model sensitivity to boundary assumptions.

5. Develop solid-state recorders for monitoring fast-changing, deep and shallow water levels -- Recording "fast" water-level changes at depths greater than 700 feet below land surface may be critical in the analysis of aquifer-test data. Sensitive transducers connected to recorders that are capable of receiving rapidly transmitted signals are needed to provide these data in a timely manner.

Water-management appraisals

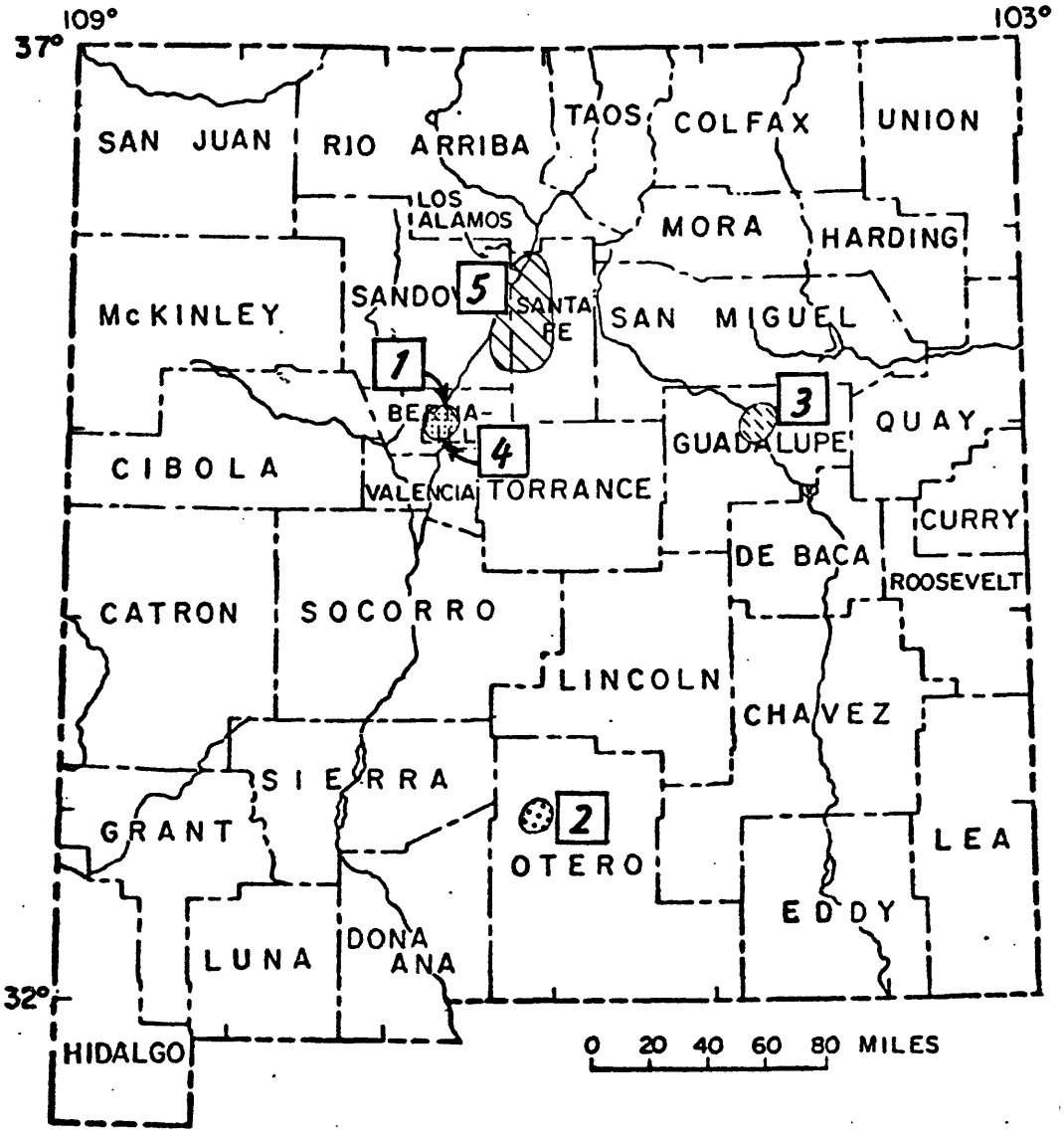
Water-resources development often is accompanied by new problems because no amount of planning and information acquisition can foresee all possible effects of that development. This Program Element includes projects specifically designed to provide information for management of water resources. This Element is presented in recognition that presently unforeseen problems will need to be addressed as high-priority items.

Active projects providing information to water managers (fig. 8) include the urban flood hydrology and water quality of urban runoff in the Albuquerque area. A preliminary evaluation of the effects of ground-water withdrawals in the Alamogordo area, the effects of leakage and bank storage at Santa Rosa Reservoir, and evaluation of urbanization effects on the ground water and surface water in the Albuquerque metropolitan area also are in progress. The effects of past, present, and potential future development in the Santa Fe basin are being studied with a digital model.

Goal -- Provide hydrologic information that will assist water-resources planners in solving water-development problems.

Program Steps --

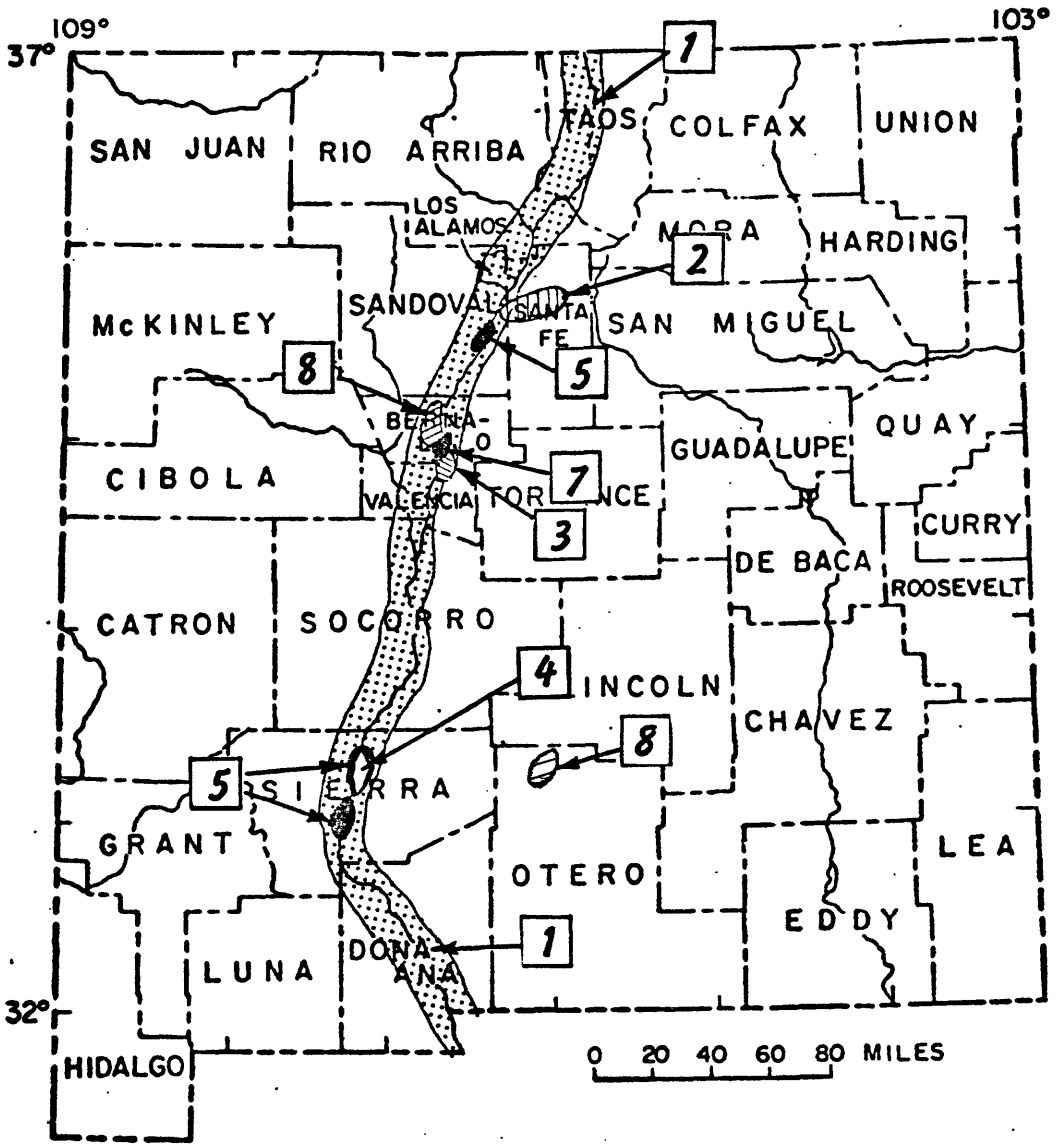
1. Develop a model of the Rio Grande basin (fig. 9) -- Continued municipal, industrial, and agricultural development throughout the Rio Grande basin will place an even greater stress on the hydrologic system. In order to utilize the existing water resources most efficiently, the interaction between recharge, discharge, urbanization, flow in the Rio Grande, and pumpage amounts and distribution will have to be understood. The factors influencing the hydrologic system will have to be quantified if a reasonable, comprehensive model, to be used by various water managers, is to be developed.



EXPLANATION

1. Albuquerque Flood Hydrology and Water-Quality Runoff
2. Effect of Withdrawals Near Alamogordo
3. Santa Rosa Reservoir Effects
4. Albuquerque Urbanization Effects on Ground and Surface Water
5. Santa Fe Model Study

Fig. 8. Locations of Water-Management Study Areas, Active Projects 1983



EXPLANATION

1. Rio Grande Basin Comprehensive Hydrologic Model
2. Effects of Santa Fe Urbanization on Return Flow to Rio Grande
3. Water-Quality Changes Near Small Communities
4. Effects of Recreational Development Near Elephant Butte Reservoir
5. Middle Rio Grande Reservoirs Effects
6. Remote Sensing and Water Use (Statewide)
7. Source of Nitrates in Albuquerque South Valley
8. Artificial Recharge Albuquerque West Mesa and Alamogordo

Fig. 9. Locations of Water-Management Study Areas, Planned or Suggested Projects

2. Determine the effects of urbanization on return flow to the Rio Grande near Santa Fe (fig. 9) -- Return-flow credits for ground-water withdrawals from the Rio Grande basin by Santa Fe have not been fully quantified. Urbanization may have affected the amount of water returning to the Rio Grande. The effects of paving, natural-drainage alteration, plastic-covered "rock" yards, sprinkler systems, and infiltration of treated effluent need to be determined. The ground-water/surface-water relationship in the Santa Fe metropolitan area needs to be described and quantified.

3. Determine the effects of urbanization on water quality near a "bedroom" community -- Population increases in "bedroom" communities that obtain their water from alluvial aquifer sources, such as Los Lunas (fig. 9), place a greater stress on the hydrologic system. The effects of septic systems, increased ground-water withdrawals, and alterations to surface drainages need to be understood in order for community planners to make informed decisions.

4. Investigate the effects of development near Elephant Butte Reservoir on the quality of water in the area (fig. 9) — Increased water use, drainage alterations, and installation of septic systems have occurred in the Elephant Butte Reservoir area. The effects of these changes on the quality of ground water and surface water in the area need to be investigated.

5. Determine the effects of reservoirs on the quality and quantity of flow in the middle Rio Grande (fig. 9) -- Changes may have occurred in ground-water flow and water quality due to construction of reservoirs at sites on the Rio Grande. Documentation of any such changes and the factors causing the changes may have transfer value to other proposed reservoir sites in similar hydrologic regimes.

6. Apply remote-sensing products to assist in quantifying water-use information -- Remote-sensing techniques have been used to identify urban areas and consumptive water use of irrigated plants. By adapting (if necessary) and applying these techniques to areas in New Mexico, more complete and detailed information may be possible at a relatively low expense.

7. Identify source(s) of nitrates in the Albuquerque South Valley - Mountainview area (fig. 9) -- Nitrate concentrations in excess of recommended public health limits have been noted for years. The source(s) of nitrates and the flow system (vertical and areal) need to be identified to aid in an informed evaluation of the extent of and potential solutions to the problem.

8. Evaluate the potential for artificial recharge in the Albuquerque West Mesa and Alamogordo areas (fig. 9) -- Artificial recharge may be a valuable means for decreasing pumping costs and increasing the availability of freshwater. Because the demand is expected to continue in these areas and because water supplies for recharge may be available, an evaluation of the hydrology is needed to further quantify the potential.

Information services

Program Steps within this Element include activities that disseminate data and provide the public with an understanding of the results of hydrologic studies. No set of data or interpretations can be of value until it reaches the proper user. The dissemination of information is as important as the collection and interpretation.

Current projects that are funded specifically for the dissemination of information are evaluating the water resources of the San Juan Basin (fig. 5) and Coal Area 62. A separate project for information distribution and program planning is also ongoing. Virtually every project in the New Mexico District will result in at least one report.

Goal -- Continue to provide water-resources information to the proper user(s) in a timely manner and in the most usable format.

Program Steps --

1. Define new program needs -- Efforts to regularly interact with selected water users will continue. This Step reflects a desire to develop programs that are designed to provide information for anticipated water problems consistent with U.S. Geological Survey goals.

2. Conduct hydrology question-answer sessions at local levels -- An interagency (Federal and State) team of water-resources specialists will meet with local citizen groups to explain the hydrology of the area, answer questions, talk about local concerns and present issues in a clear, nontechnical manner.

3. Prepare a report on the Mesilla basin for the lay reader -- Considerable local interest has been generated by the El Paso, Texas - New Mexico lawsuit. A report or pamphlet describing the hydrologic system and the factors influencing that system, the hydrologic issues, and the hydrologic unknowns or uncertainties is needed.

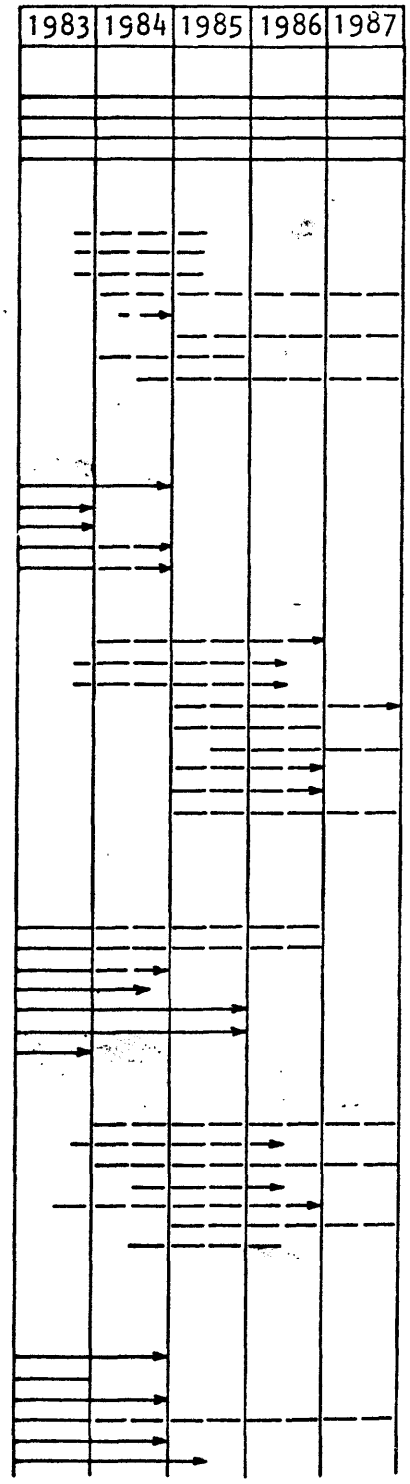
4. Prepare a report on scarcity of water in New Mexico for the lay reader -- A report or pamphlet presenting the water situation of the State in a perspective that is clear to a nontechnical person is needed. The methods and need for water conservation and a discussion of water-related problems will be presented.

SUMMARY

This plan presents projects and programs designed to obtain needed water information. Sections may have been outdated as soon as they were committed to paper, but the report will help focus on short-term efforts in the context of long-range needs. An evaluation of how these efforts are meeting these needs will be a continuing process.

TABLE 1

Time Frames for Active and Planned or Suggested Studies in the New Mexico (A solid line indicates an active project. A dashed line indicates a planned or suggested project or the extension of an active project. An arrowhead indicates the end of a project; no arrowhead indicates that the project is planned to be continued.



I. HYDROLOGIC-DATA COLLECTION AND PROCESSING

A. ACTIVE PROJECTS

1. SURFACE WATER
2. GROUND WATER
3. WATER QUALITY (CHEMICAL, SEDIMENT, BIOLOGICAL)
4. WATER USE

B. PLANNED OR SUGGESTED NEW PROJECTS

1. DATA NEEDS IDENTIFICATION AND DATA COLLECTION COORDINATION
2. NETWORK ANALYSIS OF SW, GW, AND QW
3. PROCESSING OF HYDROLOGIC DATA
4. GEOPHYSICAL LOGGING OF KEY WELLS
5. COMPILATION OF AQUIFER TEST DATA
6. MUNICIPAL WATER-QUALITY SURVEY
7. INVENTORY OF ORGANICS IN VADOSE ZONE
8. PRECIPITATION QUALITY NETWORK

II. AREAL APPRAISALS

A. ACTIVE PROJECTS

1. ZUNI TRIBAL LANDS
2. SAN AGUSTIN PLAINS
3. CIBOLA COUNTY
4. SOCORRO COUNTY
5. CATRON COUNTY

B. PLANNED OR SUGGESTED NEW PROJECTS

1. (a) SAN ANDRES - GLORIETA AQUIFER OF ZUNI UPLIFT
   (b) SAN ANDRES - GLORIETA AQUIFER OF ACOMA SAG
2. SANDIA - MANZANO MOUNTAINS
3. TAOS AND RIO ARRIBA COUNTIES
4. WATER QUALITY IN AQUIFERS ABOVE MINERAL DEPOSITS
5. HYDROLOGIC EFFECTS OF NAVAJO INDIAN IRRIGATION PROJECT
6. CURRY AND QUAY COUNTIES, OGALLALA AQUIFER
7. SANDOVAL COUNTY
8. SALTWATER ENCROACHMENT, TULAROSA BASIN

III. BASIN ASSESSMENTS

A. ACTIVE PROJECTS

1. PARTS OF PECOS RIVER BASIN
2. PARTS OF RIO GRANDE BASIN
3. SOUTHWEST ALLUVIAL BASINS (SWAB)
4. TULAROSA BASIN, GEOPHYSICAL STUDIES
5. SOUTHERN MESILLA BASIN
6. SAN JUAN BASIN GROUND WATER
7. MIMBRES BASIN GROUND WATER

B. PLANNED OR SUGGESTED NEW PROJECTS

1. GROUND-WATER/SURFACE-WATER INTERACTION
2. ESTANCIA BASIN
3. MIDDLE RIO GRANDE WATER QUALITY
4. GILA RIVER BASIN
5. PECOS RIVER STUDIES: ROSWELL, BRANTLEY, MALAGA
6. ALBUQUERQUE-BELEN, ROSWELL BASIN FRESHWATER/SALTWATER
7. PUERCO RIVER WATER QUALITY

IV. FOSSIL-FUEL AND MINERAL EXTRACTION

A. ACTIVE PROJECTS

1. RAINFALL/RUNOFF MODEL COAL LEASES, SAN JUAN BASIN
2. EFFECTS OF COAL DEVELOPMENT ON SAN JUAN RIVER
3. RESATURATION OF MARIANO LAKE URANIUM MINE
4. EFFECTS OF MINE DEWATERING ON KIM-ME-NI-OLI WASH
5. HYDROLOGY OF IN SITU URANIUM-LEACHING MINING
6. JEMEZ GEOTHERMAL STUDIES

B. PLANNED OR SUGGESTED NEW PROJECTS

1. RESATURATION OF COAL MINES
2. EFFECTS OF MILL TAILINGS
3. QUALITY OF WATER IN GRANTS MINERAL BELT
4. QUALITY OF WATER IN SILVER CITY AREA
5. ACID RAIN, FOUR CORNERS AREA
6. QUALITY OF WATER NEAR QUESTA

V. WASTE DISPOSAL

A. ACTIVE PROJECTS

1. WASTE ISOLATION PILOT PLANT (WIPP)

B. PLANNED OR SUGGESTED NEW PROJECTS

1. ALBUQUERQUE SOUTH VALLEY "SUPERFUND" HYDROLOGIC STUDY
2. LONG-TERM MONITORING NETWORK AT WIPP
3. TIME-OF-TRAVEL FOR HAZARDOUS-WASTE SPILLS
4. EXTENT OF HYDROCARBON CONTAMINATION
5. EFFECTS OF LANDFILL AND FEEDLOT SITES
6. DENITRIFICATION POTENTIAL OF SOILS

VI. SCIENTIFIC METHODS DEVELOPMENT

A. ACTIVE PROJECTS

1. TREND-ANALYSIS TECHNIQUES, EFFECTS OF COAL DEVELOPMENT
2. MONITORING CRITERIA FOR IN SITU MINING

B. PLANNED OR SUGGESTED NEW PROJECTS

1. DIGITAL MODEL ANALYTICAL TECHNIQUES
2. ESTIMATION OF RECHARGE FROM EPHEMERAL STREAMS
3. EFFECTS OF GASES IN AQUIFERS
4. SENSITIVITY ANALYSES OF DIGITAL MODELS
5. SOLID-STATE RECORDERS FOR RAPID WATER-LEVEL CHANGES

VII. WATER MANAGEMENT APPRAISALS

A. ACTIVE PROJECTS

1. ALBUQUERQUE FLOOD HYDROLOGY AND WATER-QUALITY RUNOFF
2. EFFECT OF WITHDRAWALS NEAR ALAMOGORDO
3. SANTA ROSA RESERVOIR EFFECTS
4. ALBUQUERQUE URBANIZATION EFFECTS ON GROUND AND SURFACE WATER
5. SANTA FE MODEL STUDY

B. PLANNED OR SUGGESTED NEW PROJECTS

1. RIO GRANDE BASIN COMPREHENSIVE HYDROLOGIC MODEL
2. EFFECTS OF SANTA FE URBANIZATION ON RETURN FLOW TO RIO GRANDE
3. WATER QUALITY CHANGES NEAR SMALL COMMUNITIES
4. EFFECTS OF RECREATIONAL DEVELOPMENT NEAR ELEPHANT BUTTE RESERVOIR
5. MIDDLE RIO GRANDE RESERVOIRS EFFECTS
6. REMOTE SENSING AND WATER USE
7. SOURCE OF NITRATES IN ALBUQUERQUE SOUTH VALLEY
8. ARTIFICIAL RECHARGE ALBUQUERQUE WEST MESA AND ALAMOGORDO

VIII. INFORMATION SERVICES

A. ACTIVE PROJECTS

1. WATER RESOURCES OF SAN JUAN BASIN
2. COAL AREA 62 WATER INFORMATION
3. ANNUAL PROGRAM REPORTS
4. PROJECT REPORTS

B. PLANNED OR SUGGESTED NEW PROJECTS

1. DEFINITION OF NEW WATER-PROGRAM NEEDS
2. PUBLIC QUESTION AND ANSWER SESSIONS
3. LAYMAN'S REPORT ON MESILLA BASIN
4. LAYMAN'S REPORT ON SCARCITY OF WATER IN PARTS OF NEW MEXICO