WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN TEXAS-- FISCAL YEARS 1985-86

Compiled by Alicia A. Mitchell

U.S. GEOLOGICAL SURVEY
Open-File Report 86-602

Austin, Texas
1987

UNITED STATES DEPARTMENT OF THE INTERIOR

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MESSAGE FROM THE DISTRICT CHIEF

The Water Resources Division of the U.S. Geological Survey has neither regulatory nor developmental authority. Instead, it has the principal responsibility within the Federal Government of providing hydrologic information and appraising the Nation's water resources. Hydrologic information and results of water-resources appraisals conducted by the Geological Survey are made available equally to all interested parties and contribute to descriptions of the location, quantity, quality, and use of water resources and to predictions of the effects of water development on the future availability and quality of water supplies. Planners and managers use this information to locate, design, and operate water-supply facilities such as reservoirs, well fields, and water-treatment plants; to identify effective strategies for protecting the quality of water resources from contamination by toxic or noxious wastes and for locating, designing, and operating waste-disposal facilities; and to allocate available water resources on the basis of court decrees, interstate compacts, international treaties, and water law.

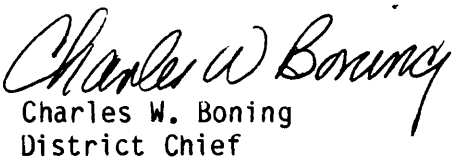
To accomplish its responsibility of providing hydrologic information, the Texas District of the Geological Survey, in cooperation with more than 70 Federal, State, and local agencies, has established and operates a vast Statewide program for the collection and analysis of hydrologic, water-use, and related information, including the quantity and quality of surface and ground water, and precipitation. In addition to these activities, the Geological Survey plans and conducts a wide variety of cooperative and Federally-funded investigative projects in Texas in order to address high priority water-resources issues and problems in the State and to develop a better understanding of the impact of human activities and natural phenomena on hydrologic systems.

Texas is not without major water-quantity and quality problems. Rapid industrialization and population growth have resulted in steadily increasing water requirements and water-quality problems. In much of the State, available storage capacity in existing surface-water reservoirs is barely sufficient to meet water demands during critical droughts. Extensive development of ground water has resulted in severe problems in some areas. In the Texas High Plains, the rate of water use from the High Plains (Ogallala) aquifer greatly exceeds the rate of natural recharge. In the Houston-Galveston area, large-scale pumpage of ground water has resulted in land-surface subsidence. In these and other areas, large-scale pumpage also is increasing the potential for saline-water intrusion.

Water-quality problems, both natural and man-made, affect a significant part of the State's surface-water resources. Problems of naturally occurring salinity are particularly severe in headwater reaches of the Red, Colorado, Brazos, and Pecos Rivers. In some areas, this problem may be aggravated by the disposal of brines resulting from the production of oil and gas. In other reaches downstream from densely populated urban centers, such as Dallas, Fort Worth, Houston, and San Antonio, urban runoff and the inflow of waste effluents are degrading the quality of water in streams and reservoirs. In the past several years, the issue of both ground- and surface-water quality has greatly expanded in Texas. Entities are becoming increasingly concerned about problems related to toxic substances in subsurface disposal sites, effects of municipal

and industrial effluents in streams and reservoirs, potential impacts of oil and gas development, quality of recharge water to aquifers, potential intrusion of salinewater due to large scale pumpage, and quality of urban and agricultural runoff.

Within the constraints of diminishing State and Federal funds, the Texas District is striving to maintain an adequate hydrologic data program and to strengthen the investigative program in order to address the priority water-resources issues and problems in the State.



Charles W. Boning
District Chief
U.S. Geological Survey
Austin, Texas

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY

IN TEXAS--FISCAL YEARS 1985-86

Compiled by
Alicia A. Mitchell

U.S. GEOLOGICAL SURVEY ORIGIN

The U.S. Geological Survey (USGS) was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to conduct the systematic and scientific classification of the public lands, and examination of the geological structure, mineral resources, and products of national domain. An integral part of that original mission includes publishing and disseminating the earth-science information needed to understand, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

Since 1879, the research and fact-finding role of the USGS has grown and been modified to meet the changing needs of the Nation it serves. As part of that evolution, the USGS has become the Federal Government's largest earth-science research agency, the Nation's largest civilian mapmaking agency, the primary source of data on the Nation's surface- and ground-water resources, and the employer of the largest number of professional earth scientists. Today's programs serve a diversity of needs and users. Programs include:

- Conducting detailed assessments of the energy and mineral potential of the Nation's land and offshore areas.
- Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.
- Conducting research on the geologic structure of the Nation.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.
- Conducting topographic surveys of the Nation and preparing topographic and thematic maps and related cartographic products.
- Developing and producing digital cartographic data bases and products.
- Collecting data on a routine basis to determine the quantity, quality, and use of surface and ground water.
- Conducting water-resources appraisals in order to describe the consequences of alternative plans for developing land and water resources.
- Conducting research in hydraulics and hydrology and coordinating all Federal water-data acquisition.
- Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural resources planning and management.
- Providing earth-science information through an extensive publications program and a network of public access points.

Along with its continuing commitment to meet the growing and changing earth-science information needs of the Nation, the USGS remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation--providing "earth science in the public service."

BASIC MISSION AND PROGRAM OF THE WATER RESOURCES DIVISION

The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States.

This is accomplished, in large part, through cooperation with other Federal and non-Federal agencies, by:

- Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.
- Conducting analytical and interpretive water-resource appraisals describing the occurrence, availability, and the physical, chemical, and biological characteristics of surface and ground water.
- Conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress, either natural or manmade.
- Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases.
- Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground waters.
- Providing scientific and technical assistance in hydrologic fields to other Federal, State, and local agencies, to licensees of the Federal Power Commission, and to international agencies on behalf of the Department of State.

TEXAS DISTRICT

Water-resources activities in Texas include collecting of hydrologic data, performing interpretive studies, and conducting research. This report describes the activities of the Water Resources Division of the U.S. Geological Survey in Texas for fiscal years (October to September) 1985 to 1986.

The Geological Survey's activities related to water resources in Texas are under the general direction of Charles W. Boning, District Chief. The Texas District Office is in the Federal Building, 300 East Eighth Street, Austin, Texas 78701. The program is executed by professional, technical, and administrative staffs in the Austin District Office; Fort Worth, Houston, San Angelo, San Antonio, and Wichita Falls Subdistrict Offices; and Austin and El Paso Field Headquarters Offices. An organizational chart of the Texas District is shown in figure 1.

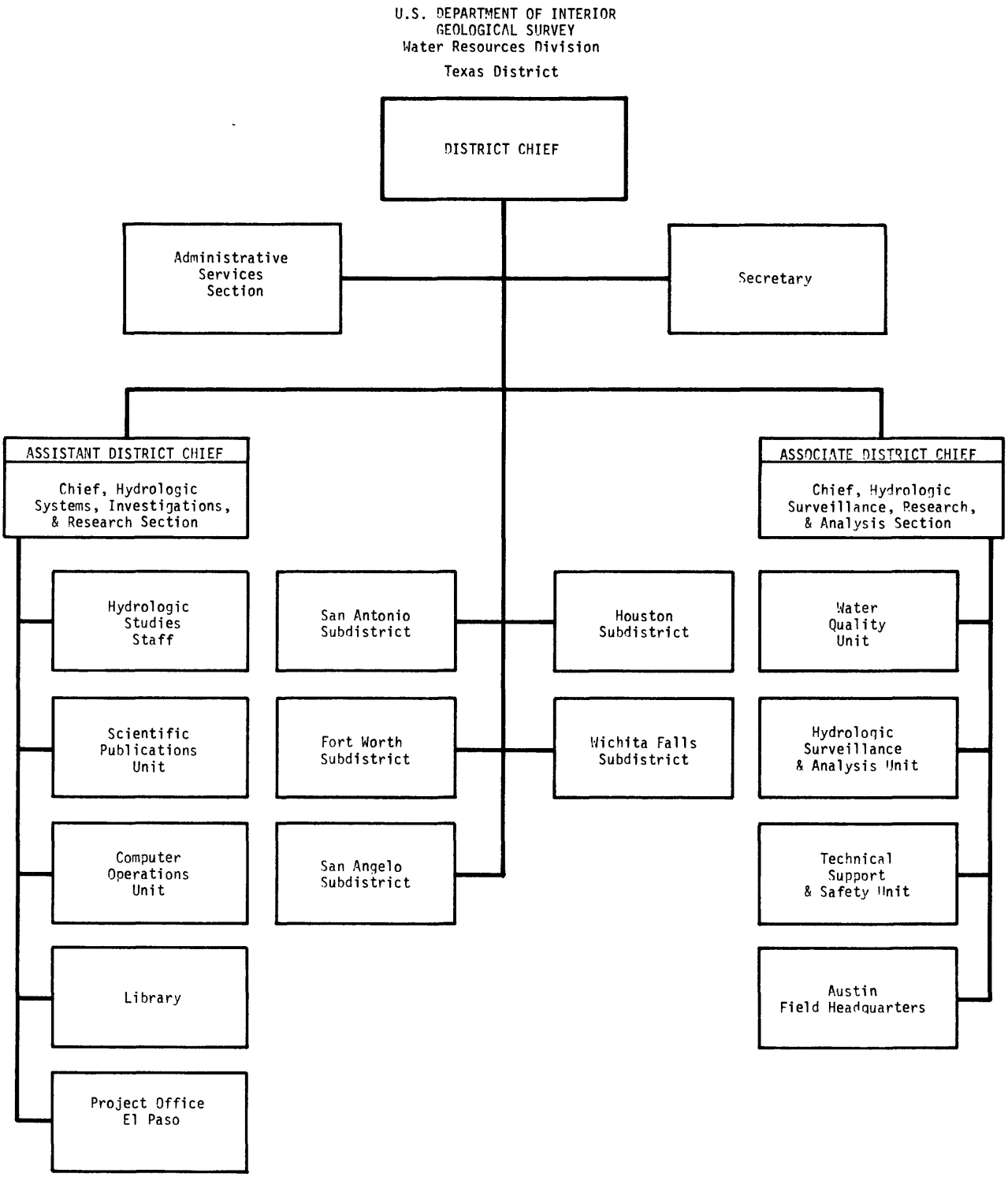


Figure 1.--Organizational chart of the Texas District.

Copies of published and unpublished records, hydrologic data, and some reports may be requested from or through the District Office. Information regarding provisional records of stream discharge prior to publication and other hydrologic data collected within their respective areas may be obtained from the Subdistrict Offices in San Angelo, San Antonio, Fort Worth, Houston, and Wichita Falls, and Field Headquarters in Austin and El Paso. Requests for information should be addressed as follows:

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Cooperating Agencies

The collection of water-resources data and the conduct of interpretive hydrologic investigations are accomplished in cooperation with Federal, State, and local agencies. Those agencies cooperating with the Texas District of the Geological Survey during fiscal years 1985-86 are:

Federal

International Boundary and Water Commission, United States and Mexico, U.S. Section
National Park Service
U.S. Bureau of Reclamation
U.S. Army Corps of Engineers, Fort Worth District, Texas
U.S. Army Corps of Engineers, Galveston District, Texas
U.S. Army Corps of Engineers, Tulsa District, Oklahoma
U.S. Army, Fort Bliss, Texas
Federal Emergency Management Agency

State

Texas Water Commission. Larry R. Soward, Executive Director; Paul Hopkins, Chairman; Ralph Roming and John O. Houchins, Commissioners.

Texas Water Development Board. Charles E. Nemir, Executive Administrator: Louis A. Beecherl, Jr., Chariman; George W. McCleskey, Vice Chairman; Glen E. Roney, Stuart S. Coleman, Lonnie A. "Bo" Pilgrim, and Louie Welch, Members.

Texas Parks and Wildlife Department. Charles D. Travis, Executive Director; Edwin L. Cox, Jr., Chairman; William M. Wheless, III, Vice Chairman; Bob Armstrong, George R. Bolin, William O. Braecklein, William L. Graham, Richard R. Morrison, III, and Dr. Ray E. Santos, Commissioners.

Pecos River Commission. William E. Hale, Commissioner representing the United States and Chairman; B. L. Moody, Commissioner representing Texas; and W. Gerrels, Commissioner representing New Mexico.

Sabine River Compact Administration. J. B. Furrh, Jr., Commissioner representing the United States and Chairman; Raymond J. Palmer and Marty J. Chalbert for Louisiana; and J. T. McMahon and David V. Cardner for Texas.

Local

City of:

Abilene	Clyde	Houston
Alice	Corpus Christi	Lubbock
Arlington	Gainesville	Nacogdoches
Austin	Garland	Runaway Bay
Carrollton	Georgetown	San Angelo
Cleburne	Graham	Wichita Falls

Athens Municipal Water Authority
Bexar-Medina-Atascosa Counties Water Improvement District No. 1
Bistone Municipal Water Supply District
Brazos River Authority
City Public Service Board of San Antonio
Coastal Industrial Water Authority
Colorado River Municpal Water District
Dallas County
Dallas/Fort Worth Airport
Dallas Public Works Department

Dallas Water Utilities Department
Edwards Underground Water District
El Paso Public Service Board
Fort Bend County
Franklin County Water District
Galveston County
Greenbelt Muncipal and Industrial Water Authority
Guadalupe-Blanco River Authority
Harris County Flood Control District
Harris-Galveston Coastal Subsidence District
Lower Colorado River Authority
Lower Neches Valley Authority
Mackenzie Municipal Water Authority
North Central Texas Municipal Water Authority
Northeast Texas Municipal Water District
Orange County
Red Bluff Water Power Control District
Reeves County Water Improvement District No. 1
Sabine River Authority of Texas
San Antonio Engineering Department
San Antonio City Water Board
San Antonio Department of Waste Water Management
San Antonio River Authority
San Jacinto River Authority
Tarrant County Water Control and Improvement District No. 1
Titus County Fresh Water Supply District No. 1
Trinity River Authority
Upper Guadalupe River Authority
Upper Neches River Municipal Water Authority
Upper Trinity Basin Water Quality Compact
West Central Texas Municipal Water District
Wichita County Water Improvement District No. 2
Willow Fork Drainage District
Wood County

Continuing Hydrologic-Data Collection Programs

Hydrologic-data stations at selected locations throughout Texas are used by the Geological Survey to collect records of stream discharge and stage, reservoir and lake storage, ground-water levels, well and spring discharge, quality of surface and ground water, and suspended sediment loads. Each year, new stations are added and others are terminated; thus, the Water Resources Division has both a current and historical file of hydrologic data for the State. All data collected are stored in the Geological Survey's WATSTORE (National Water Data Storage and Retrieval System) and are available on request. These data can be retrieved in machine-readable form or in the form of computer-printed tables or graphs, statistical summaries, and digital plots. Assistance in the acquisition of information from WATSTORE can be obtained from the District Chief, Water Resources Division in Austin.

The number and type of hydrologic-data stations in Texas during 1985 and 1986 are given in table 1. All active (January 1986) streamflow, reservoir-content, and daily- or continuous-streamflow or reservoir water-quality stations

are shown in plate 1. In addition to the stream-gaging stations, the Geological Survey operates 42 continuous-precipitation stations throughout the State for investigative studies. Some hydrologic data also are collected for short periods of time in support of investigative studies. These data are published in interpretative reports and are not included in the continuing programs.

The International Boundary and Water Commission, United States and Mexico, operates all streamflow stations on the Rio Grande and near the mouth of its principal tributaries at and downstream from El Paso, Texas. Records collected at these stations are published in an annual bulletin by the Commission and may be obtained from the International Boundary and Water Commission, United States Section, P. O. Box 20003, El Paso, Texas 79998.

Continuing hydrologic data programs are summarized in the following pages. Location maps are shown where appropriate.

Table 1.--Hydrologic-data stations, 1985-86

Station classification	Years 1985	1986
Surface-water stations		
Continuous record		
Discharge and stage	404	386
Stage only	32	23
Tide level	11	2
Partial record		
Crest stage	10	10
Periodic discharge through range in stage	2	8
Flood hydrograph	31	38
Flood profile	15	11
Low flow	89	87
Lake and reservoir-stage and contents	89	87
Water-quality stations		
Continuous water quality	34	38
Continuous water temperature	34	38
Daily chemical quality	48	46
Daily sediment	3	3
Periodic stations		
Chemical quality	199	206
Organic quality	133	128
Biological quality	89	89
Pesticides	55	61
Sediment	39	37

Table 1.--Hydrologic-data stations, 1985-86--Continued

Station classification	Years 1985	1986
Observation wells		
Continuous measurement		
Houston area	7	7
San Antonio-Austin area	16	25
El Paso area	6	8
Orange and adjacent counties	2	2
Periodic measurement		
Houston area	643	645
San Antonio-Austin area	65	65
El Paso area	300	300
Orange and adjacent counties	100	100
Subsidence		
Houston area	13	13

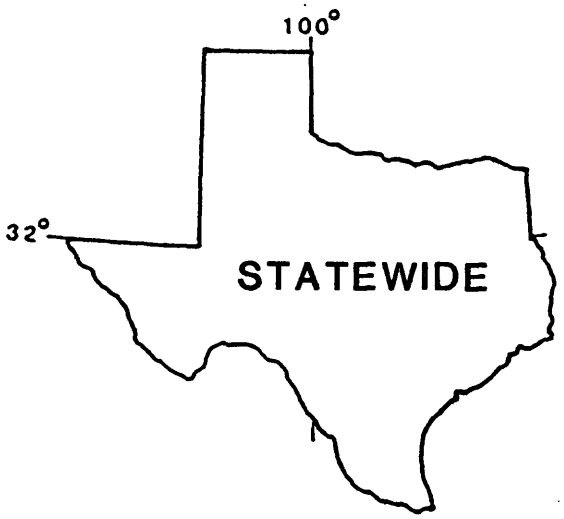
TX 00-001 SURFACE-WATER DATA PROGRAM

COOPERATING AGENCIES : Most of the agencies shown in the list of cooperators.

PROJECT CHIEFS: Jack Rawson and B. C. Massey, District Office, Austin

PERIOD OF PROJECT : Continuing

LOCATION : Statewide



Program: Under the surface-water data program, involving many local, State, and Federal agencies, data are collected for use in surveillance, planning, design, hazard warning, operation, and management in water-related fields such as water supply, hydroelectric power, flood control, irrigation, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water-resources development. Data are collected to satisfy needs for current purposes such as assessments, compact and legal requirements, and research or hydrologic studies. The program also supports studies to define the statistical properties of, and trends in, the occurrence of water in streams, lakes, estuaries, etc. Partial-record gaging is used instead of complete record gaging where it serves data needs. The adequacy of the hydrologic network is reviewed annually and modified as necessary to meet data needs and funding constraints. Table 1 shows minor changes in the program that were made during 1985-86. Surface-water records are computed on a continuing basis and the data are published annually.

A three-phase network analysis is being conducted. In the first phase of the study, completed in 1984, data uses and funding for present stations were analyzed. In the second phase, completed in 1986, determinations were made on the feasibility of providing information for specific locations without operating gaging stations. In the third phase, the strategies considered for minimizing the uncertainty in streamflow information will be evaluated. Uncertainty functions will be computed for a representative sample of stations in order to relate a realistic value of error to the frequency of discharge measurements. The causes for lost stage records will be documented. Completion of the third phase was scheduled for the end of fiscal year 1986.

Reports in preparation:

U.S. Geological Survey, 1987, Water resources data for Texas, 1986, Arkansas River, Red River, Sabine River, Neches River, and Trinity River basins and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 86-1.

Reports in preparation:--Continued

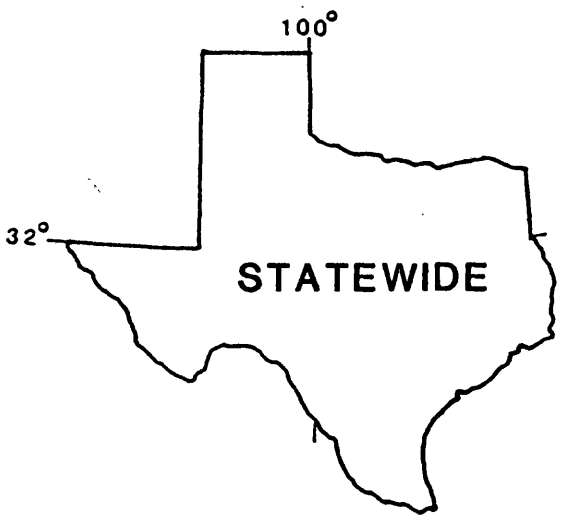
U.S. Geological Survey, 1987, Water resources data for Texas, 1986, San Jacinto River, Brazos River, and San Bernard River basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 86-2.
------ 1987, Water resources data for Texas, 1986, Colorado River, Lavaca River, Guadalupe River, Nueces River, and Rio Grande basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 86-3.

Reports published, 1985-86:

Carrillo, E. R., Buckner, H. D., and Rawson, Jack, 1985, Index of surface-water stations in Texas, January 1985: U.S. Geological Survey Open-File Report 85-185, 17 p.
------ 1986, Index of surface-water stations in Texas, January 1986: U.S. Geological Survey Open-File Report 86-235, 16 p.
Grozier, R. U., and Land, L. F., 1985, Water-resources activities of the U.S. Geological Survey in Texas--Fiscal years 1982-84: U.S. Geological Survey Open-File Report 85-346, 60 p.
Massey, Bernard C., 1985, Texas stream-gaging program: An analysis of data uses and funding: U.S. Geological Survey Open-File Report 85-084, 40 p.
U.S. Geological Survey, 1985, Water-resources data for Texas, 1984, Arkansas River, Red River, Sabine River, Neches River, and Trinity River basins and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 84-1, 485 p.
------ 1985, Water-resources data for Texas, 1984, San Jacinto River, Brazos River, and San Bernard River basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 84-2, 427 p.
------ 1985, Water-resources data for Texas, 1984, Colorado River, Lavaca River, Guadalupe River, Nueces River, and Rio Grande basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 84-3, 429 p.
------ 1986, Water resources data for Texas, 1985, Arkansas River, Red River, Sabine River, Neches River, and Trinity River basins and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 85-1, 462 p.
------ 1986, Water resources data for Texas, 1985, San Jacinto River, Brazos River, and San Bernard River basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 85-2, 428 p.
------ 1986, Water resources data for Texas, 1985, Colorado River, Lavaca River, Guadalupe River, Nueces River, and Rio Grande basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 85-3, 446 p.

TX 00-002 GROUND-WATER DATA PROGRAM

COOPERATING AGENCIES : U.S. Bureau of Reclamation, U.S. Army, Fort Bliss, Texas Water Development Board, City of Houston, Edwards Underground Water District, El Paso Public Service Board, Harris-Galveston Subsidence District, Orange County, San Antonio City Water Board



PROJECT CHIEF: Jack Rawson, District Office, Austin

PERIOD OF PROJECT : Continuing

LOCATION : Statewide

Program: Water levels in wells, discharge of springs and wells, and water-quality data are key characteristics in monitoring ground-water conditions and trends. The continuing hydrologic data from local subprojects TX 00-00210 (Houston ground water), TX 00-00211 (El Paso ground water), TX 00-00213 (San Antonio ground water), TX 00-00222 (Orange County ground water), and TX 00-00263 (Subsidence, Houston area) are collected, compiled, and reported under project TX 00-002 ground-water data program (table 1).

Also included in this program, but not described in detail, are short-term and limited data-collection and investigative activities. These are ground-water conditions at Fort Bliss, Texas, hydraulic connection between the Rio Grande and the ground-water system in Mesilla basin, ground-water conditions in the vicinity of Fort Hood, and potential land-surface subsidence in the El Paso area. The statewide ground-water monitoring program is operated by the Texas Water Development Board. These data are available from the Board.

Reports in preparation: None

Reports released, 1985-86:

Dorsey, Michael D., 1985, Hydrologic and chemical data for the Big Brown lignite mine area, Freestone County, Texas: U.S. Geological Survey Open-File Report 85-338, 16 p.

Land, L. F., and Armstrong, C. A., 1985, A preliminary assessment of land-surface subsidence in the El Paso area, Texas: U.S. Geological Survey Water-Resources Investigations Report 85-4155, 96 p.

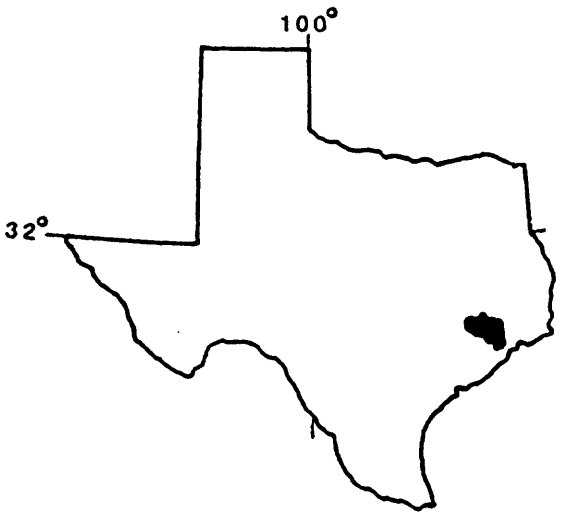
TX 00-00210 GROUND-WATER STUDIES IN THE GREATER HOUSTON AREA

COOPERATING AGENCY : City of Houston

PROJECT CHIEF: James F. Williams, III, Subdistrict Office, Houston

PERIOD OF PROJECT : Continuous since December 1930

LOCATION : Southeast Texas



Problem: Continued ground-water withdrawals in the Houston area cause lower ground-water levels, water-quality changes, and subsidence in heavily pumped localities. Ground-water data are needed to keep abreast of development and to provide data and understanding needed for future planning.

Objective: To provide current up-to-date information on the status of freshwater in the aquifers underlying the greater Houston area and to relate water development and water-quality changes to development in the area.

Approach: Operate and maintain a ground-water level network; inventory new large-diameter wells; inventory annual municipal, industrial, and irrigation pumpage; collect water samples for chemical analysis; continue publication of data; analyze and interpret data; and define cause and effect relationships.

Progress: Hydrologic data have been collected throughout the designated network. Maps of water-level changes and altitudes of the potentiometric surfaces of the Chicot and Evangeline aquifers have been published annually. Five-year updates (1980-84) of data collected have been compiled and published.

Plans: Continue the collection of water-level, new well, and pumpage data. Water samples will be collected annually from 40 wells in areas near salt domes analyzed for chloride, and specific conductance measured. Maps of water-level changes and potentiometric altitudes will be prepared annually. A 5-year update (1980-84) describing the effects of ground-water development is being prepared. Water-level and well-schedule data will be entered into the WATSTORE data system.

Reports in preparation:

Williams, James F., III, Coplin, L. S., Ranzau, C. E., Jr., Lind. W. B., Bonnet, C. W., and Locke, G. L., 1986, Records of wells, drillers' logs, water-level measurements, and chemical analyses of ground water in Harris and Galveston Counties, Texas, 1980-84: U.S. Geological Survey Open-File Report.

Williams, James F., III, and Ranzau, C. E., Jr., 1986, Ground-water withdrawals and changes in water levels, and subsidence in the Houston district, Texas, 1980-84: U.S. Geological Survey Open-File Report.

Reports published, 1985-86:

Williams, James F., III, Coplin, L. S., Ranzau, C. E., Jr., and Lind, W. B., 1986, Records of wells, drillers' logs, water-level measurements, and chemical analyses of ground-water in Chambers, Liberty, and Montgomery Counties, Texas, 1980-84: U.S. Geological Survey Open-File Report 86-57, 37 p.

Williams, James F., III, Ranzau, C. E., Jr., and Coplin, L. S., 1986, Approximate altitude of water levels in the Chicot and Evangeline aquifers in the Houston area, Texas, Spring 1986: U.S. Geological Survey Open-File Report 86-306.

Williams, James F., III, Ranzau, C. E., Jr., Lind, W. B., and Coplin, L. S., 1986, Records of wells, drillers' logs, water-level measurements, and chemical analyses of ground water in Brazoria, Fort Bend, and Waller Counties, Texas, 1980-84: U.S. Geological Survey Open-File Report 86-68, 50 p.

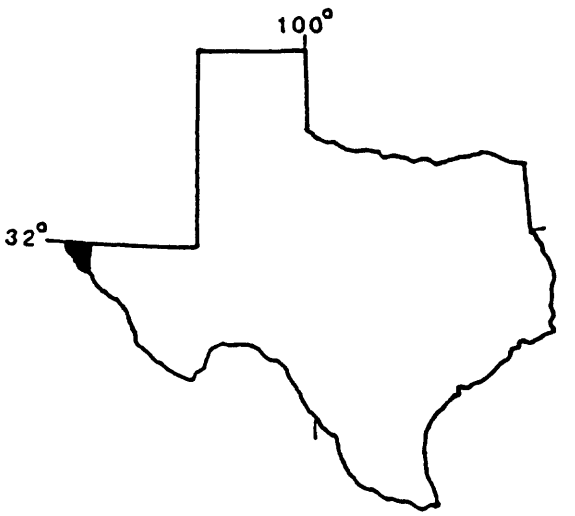
TX 00-00211 GROUND-WATER STUDIES IN THE EL PASO AREA

COOPERATING AGENCY : El Paso Public Service Board

PROJECT CHIEF: Donald E. White, Project Office, El Paso

PERIOD OF PROJECT : Continuous since January 1930

LOCATION : West Texas



Problem: Supplying water for the continued growth in El Paso, Ciudad Juarez, Mexico, and Fort Bliss Military Reservation is stressing the ground-water resources from which the majority of their water supplies are obtained. The potential for salinewater encroachment and land-surface subsidence is increasing with increased pumping from the Hueco bolson and Mesilla bolson aquifers.

Objective: To provide current information on the quantity and quality of water in the aquifers underlying the greater El Paso area.

Approach: Operate and maintain a ground-water level network, with modifications as appropriate; inventory new large diameter wells; collect water samples for chemical analysis; determine withdrawals; and publish the data.

Progress: Hydrologic data have been collected throughout the area.

Plans: Continue the collection of water-level, water-quality, new-well, and pumpage data. Prepare a data summary report to present the data collected since the last summary data report.

Reports in preparation:

White, D. E., Hydrologic data summary of ground-water data in the El Paso area, Texas, 1977-86: U.S. Geological Survey Open-File Report.

Reports published, 1985-86: None.

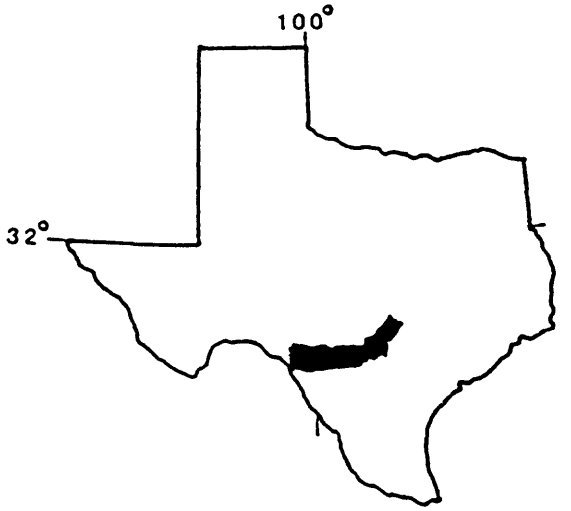
TX 00-00213 GROUND-WATER STUDIES OF THE SAN ANTONIO AREA AND BALCONES FAULT ZONE

COOPERATING AGENCIES : Edwards Underground Water District

PROJECT CHIEF: Richard D. Reeves, Subdistrict Office, San Antonio

PERIOD OF PROJECT : Continuous since January 1949

LOCATION : South central Texas



Problem: The Edwards aquifer supplies nearly all of the water in the six-county area from Brackettville in Kinney County to Kyle in Hays County, an area about 180 miles long and from 5 to 40 miles wide. Because the Edwards aquifer supplies large quantities of water for irrigation and is the sole source of water for approximately 1.5 million people, it has been designated by the U.S. Environmental Protection Agency as a sole-source aquifer. Projected growth and increasing water demands on the aquifer may cause water levels to decline until virtually all spring flows cease. Increased pumpage from the aquifer also may result in the encroachment of mineralized water into its freshwater zone. In addition, rapid urban development in or adjacent to the recharge area will increase the possibilities for pollutants to enter the aquifer. Consequently, a broad ground-water and water-quality data base is essential for present and long-range planning for the development and management of the aquifer.

Objective: To appraise quantitatively the ground-water resources in the Edwards and associated limestones, to continue to investigate the cause-effect relationships operating in the Edwards aquifer, and to determine the extent of contamination.

Approach: The following approach is used: Measuring water levels; compiling and analyzing water-stage records; collecting and compiling records of rainfall; inventorying municipal, industrial, military, and irrigation pumpage and spring discharge; determining recharge to the Edwards aquifer; collecting water samples for chemical and tritium analyses and inorganic, biologic, pesticide, and minor element determinations; and mapping subsurface geology.

Progress: Hydrologic data were collected and compiled from a network of stream-gaging stations and wells as scheduled. Monitoring to date has not shown any significant change in the quality of ground water throughout most of the aquifer. There are, however, localized areas contaminated by trace concentrations of organic compounds. The extent and number of localized areas of contamination can be expected to increase as urban development alters the quality of

runoff in the recharge zone of the aquifer. Because of concern that increased withdrawals from the aquifer may result in the encroachment of mineralized water in the freshwater zone of the aquifer, a program was begun in 1984 to resample wells along the "bad-water" line in order to detect changes in water quality as the potentiometric head in the aquifer changes.

Plans: Plans include the following activities: Collecting water-level and pumpage data, inventorying wells, and geologic mapping; collecting water samples to determine the possible pollution of water in the aquifer from urban development and from the encroachment of mineralized water into the freshwater zone; preparing a basic-data report; and entering current and historic data into the Survey's computerized data base WASTORE.

Reports in preparation:

Burchett, Charles R., Rettman, Paul L., and Boning, Charles W., 1986, The Edwards aquifer, extremely productive, but....a sole source water supply for San Antonio and surrounding counties in south-central Texas (pending publication by the Edwards Underground Water District).

Ozuna, G. B., 1986, Compilation of hydrologic data for the Edwards aquifer, San Antonio area, Texas, 1985, with 1934-85 summary: Edwards Underground Water District Bulletin.

Roddy, W. R., Water-quality of the Edwards aquifer system in the San Antonio area: U.S. Geological Survey Water Resources Investigations Report.

Reports published, 1985-86:

Perez, Roberto, 1986, Potential for updip movement of saline water in the Edwards aquifer, San Antonio, Texas: U.S. Geological Survey Water-Resources Investigations Report 86-4032, 21 p.

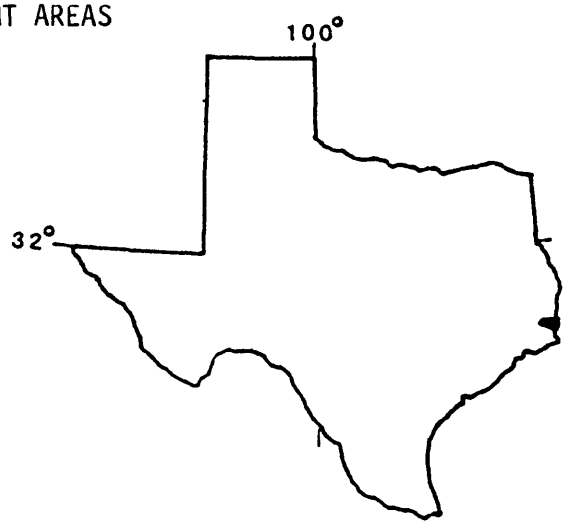
Reeves, R. D., Maclay, R. W., and Ozuna, G. B., 1984, Records of ground-water recharge, discharge, water levels, and chemical quality of water for the Edwards aquifer in the San Antonio area, Texas, 1934-81: Edwards Underground Water District Bulletin 41, 135 p.

Reeves, R. D., and Ozuna, G. B., 1985, Records of ground-water recharge, discharge, water levels, and chemical quality of water for the Edwards aquifer in the San Antonio area, Texas, 1934-82: Edwards Underground Water District Bulletin 42, 131 p.

------ 1986, Compilation of hydrologic data for the Edwards aquifer in the San Antonio area, Texas, 1983-84, with 1934-84 summary: Edwards Underground Water District Bulletin 43-44, 235 p.

Wells, Frank, 1985, Statistical summary of water-quality data collected from selected wells and springs in the Edwards aquifer near San Antonio, Texas: U.S. Geological Survey Open-File Report 85-182, 162 p.

TX 00-00222 GROUND-WATER STUDIES IN ORANGE COUNTY AND ADJACENT AREAS



COOPERATING AGENCY : Orange County

PROJECT CHIEF: Charles W. Bonnet, Subdistrict Office, Houston

PERIOD OF PROJECT : Continuous since September 1967.

LOCATION : East Texas

Problem: Pumpage of ground water for industrial and municipal use in Orange County has resulted in saltwater encroachment in some heavily pumped areas. A continued program of ground-water data collection is needed to define the areas impacted and to provide data for guidance in future development of ground water in the county and prevention of saltwater intrusion.

Objective: To collect and analyze ground-water data in the Orange County area and provide the county with current, up-to-date information on its ground-water resources; and to monitor the freshwater-saltwater interface.

Approach: Operate and maintain a network of observation wells for monitoring changes in water levels and changes in chemical quality, especially chlorides; inventory all new, large-capacity wells and compile drillers' logs; conduct an annual inventory of pumpage for municipal and industrial use; continue publication of data and correlate current data with previously collected data.

Progress: Water samples were collected from observation wells in the fall of each year and analyzed to determine changes in chemical properties. Nonpumping water levels were measured in the spring, and pumping water levels were measured in the fall. The annual pumpage inventory was conducted, and the inventory of new wells was continued.

Plans: Continue data collection with emphasis on saltwater encroachment, which is the principal ground-water problem in the study area.

Reports in preparation: Bonnet, C. W., and Williams, James F., III, Development of ground-water resources in the Orange County area, Texas and Louisiana, 1980-85: U.S. Geological Survey Water Resources Investigations Report

Reports published, 1985-86: None.

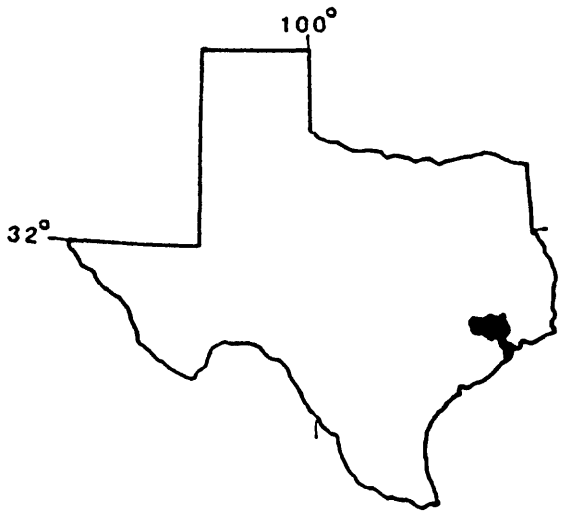
TX 00-00263 SUBSIDENCE STUDIES ALONG THE TEXAS GULF COAST

COOPERATING AGENCY : Harris-Galveston Coastal Subsidence District

PROJECT CHIEF: James F. Williams, III, Subdistrict Office, Houston

PERIOD OF PROJECT : Continuous since October 1976

LOCATION : Southeast Texas



Problem: A large part of the Texas Gulf Coast is experiencing land-surface subsidence. In the northern part of the Gulf Coast, an area of about 1,355 square miles has subsided 1 foot or more since 1943. The area of maximum subsidence is near Pasadena where 9 feet of subsidence occurred between 1943 and 1978. As a result of subsidence, some low-lying areas along Galveston Bay are subject to inundation by normal tides, and an even larger part of the region may be subject to catastrophic flooding by hurricane tides. Recent faulting has been related to ground-water withdrawal. Subsidence and faulting may be altering drainage patterns in upland watersheds.

Objectives: To determine the magnitude and extent of land-surface subsidence due to the withdrawals of ground water and to determine the possible relationship between faulting, land-surface subsidence, and drainage changes at elevations not subject to flooding by tidal waters.

Approach: Continue the data-collection and research effort including the following: Data collection at the network of extensiometers; annual resurveying of the network of marks to measure horizontal strain and preliminary analysis of these data; updating specific unit-compaction values, investigating the relationship of aquifer conditions and ground-water withdrawals; and determining changes in drainage patterns.

Progress: Data have been collected to measure compaction, horizontal strain, and changes in stress at a network of sites. A comprehensive report has been prepared describing subsidence to 1980.

Plans: Hydrologic, horizontal survey, and extensometer data collection will be continued to better define the relationship between ground-water withdrawal and land-surface subsidence. Analysis of horizontal strain data and localized subsidence effects on drainage is planned.

Reports in preparation: None.

Reports published, 1985-86:

Fisher, J. C., and Grozier, R. U., 1985, Chemical and physical characteristics of water in estuaries of Texas, October 1978-September 1983: U.S. Geological Survey Open-File Report 85-408, 243 p.

Williams, James F., III, and Ranzau, C. E., Jr., 1985, Approximate water-level changes in wells in the Chicot and Evangeline aquifers, 1977-85 and 1984-85, and measured compaction 1973-85, in the Houston-Galveston region, Texas: U.S. Geological Survey Open-File Report 85-158, 6 sheets.

------ 1986, Approximate changes in water-levels in wells in the Chicot and Evangeline aquifers, 1977-86 and 1985-86, and measured compaction 1973-86, in the Houston-Galveston region, Texas: U.S. Geological Survey Open-File Report 86-135, 7 sheets.

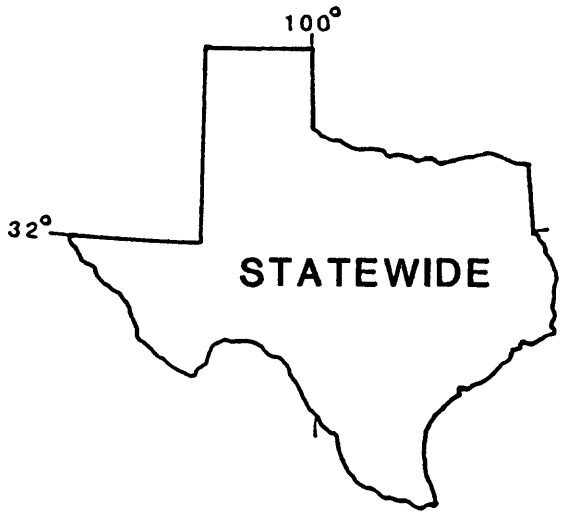
TX 00-003 QUALITY OF WATER DATA PROGRAM

COOPERATING AGENCIES : Most of the agencies shown in the list of cooperators

PROJECT CHIEF: Frank Wells, District Office, Austin

PERIOD OF PROJECT : Continuous

LOCATION : Statewide



Program: Data collected for the water-quality program is used to help inventory, assess, and plan the proper development, management, and utilization of the water resources of the State. Rapid economic growth, population expansion, and increasing use of water for municipal, industrial, and agricultural purposes could cause the quality of the State's water to be degraded. Changes in atmospheric composition due to increased use of fossil fuels may lead to acid precipitation and alteration of the quality of runoff. Continuing development of areas around lakes and reservoirs may result in increases of nutrients, eutrophication, and related nuisance conditions. Thirty-four of the approximately 200 water-quality monitoring sites are part of the NASQAN (National Stream-Quality Accounting Network), which is used to detect nationwide trends in water quality throughout the United States.

Water-quality samples are obtained from a network of observation wells to determine the chemical characteristics of ground water in the principal aquifers and to monitor the possible contamination of these aquifers.

The adequacy of the continuing water-quality data program is reviewed annually and modified as necessary to provide a baseline of selected chemical, biological, and physical data required to satisfy local, State, and national needs.

Reports in preparation:

Liscum, Fred, Goss, R. L., Paul, E. M., Effects on water quality due to flood-water detention by Barker and Addicks Reservoirs, Houston, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports published, 1985-86:

Wells, Frank C., and Bourden, Kristin C., 1985, Summary of statistical and trend analysis of selected water-quality data collected near Big Thicket National Preserve, Southeast, Texas, U.S. Geological Survey Open-File Report 85-183, 11 p.

Reports published, 1985-86:

Wells, Frank C., Rawson, Jack, and Shelby, Wanda J., 1986, Areal and temporal variations in the quality of surface water in hydrologic accounting unit 120301, upper Trinity River basin, Texas: U.S. Geological Survey Water-Resources Investigations Report 85-4318, 135 p.

Wells, Frank C., Schertz, Terry L., and Flugrath, Marvin W., 1984, Effects of October 1981 flood in the quantity and quality of water in selected streams and reservoirs in the Brazos River basin, Texas: U.S. Geological Survey Water-Resources Investigations Report 84-4055, 119 p.

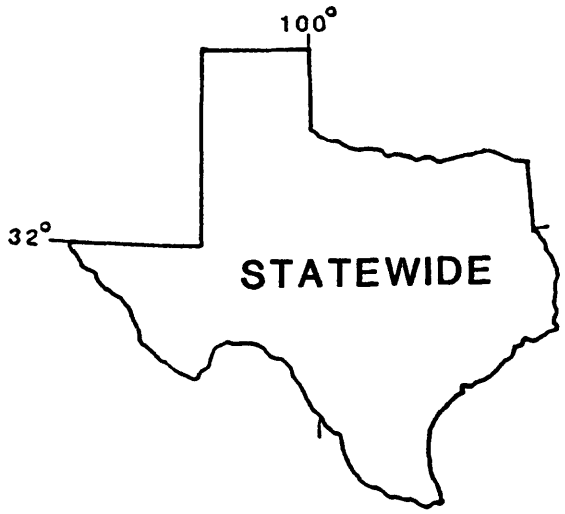
TX 00-004 SEDIMENT DATA PROGRAM

COOPERATING AGENCIES: U.S. Army Corps of Engineers, Lower Colorado River Authority

CHIEF : Freeman L. Andrews, District Office, Austin

PERIOD OF PROJECT : Continuous

LOCATION : Statewide



Program: Data collected in the sediment data continuing program involving other Federal agencies and local cooperators, are used for inventorying and defining sediment concentrations and discharges in rivers and streams. Rapid economic growth, population expansion, brush clearing, construction, and changes in land use could cause a change in the averages and trends in concentration, discharge, and particle size of sediment being transported by the rivers and streams. Sediment data are obtained from a network of about 41 stations, under varying flow conditions, to define particle size distribution of suspended sediment and bed material.

This continuing sediment data program is reviewed annually and modified as necessary to provide a base for specific studies by Federal, State, and local agencies.

Reports in preparation:

U.S. Geological Survey, 1987, Water resources data for Texas, 1986, Arkansas River, Red River, Sabine River, Neches River, and Trinity River basins and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 86-1.

------ 1987, Water resources data for Texas, 1986, San Jacinto River, Brazos River, and San Bernard River basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 86-2.

------ 1987, Water resources data for Texas, 1986, Colorado River, Lavaca River, Guadalupe River, Nueces River, and Rio Grande basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 86-3.

Reports published, 1985-86:

U.S. Geological Survey, 1985, Water-resources data for Texas, 1984, Arkansas River, Red River, Sabine River, Neches River, and Trinity River basins and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 84-1, 485 p.

Reports published, 1985-86:--Continued

U.S. Geological Survey, 1985, Water-resources data for Texas, 1984, San Jacinto River, Brazos River, and San Bernard River basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 84-2, 427 p.
------ 1985, Water-resources data for Texas, 1984, Colorado River, Lavaca River, Guadalupe River, Nueces River, and Rio Grande basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 84-3, 429 p.
------ 1986, Water resources data for Texas, 1985, Arkansas River, Red River, Sabine River, Neches River, and Trinity River basins and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 85-1, 462 p.
------ 1986, Water resources data for Texas, 1985, San Jacinto River, Brazos River, and San Bernard River basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 85-2, 428 p.
------ 1986, Water resources data for Texas, 1985, Colorado River, Lavaca River, Guadalupe River, Nueces River, and Rio Grande basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 85-3, 446 p.

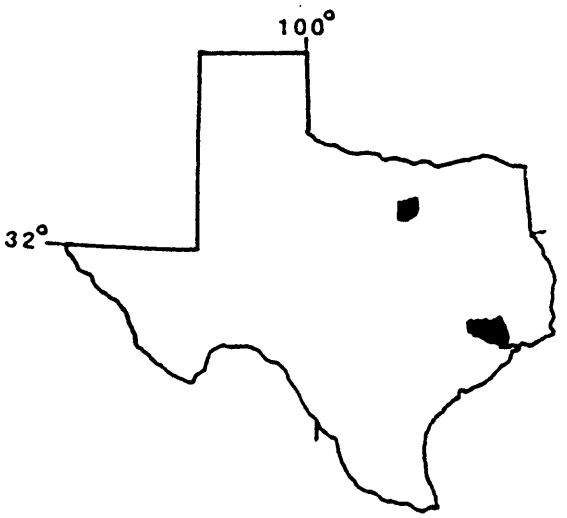
TX 00-005 NATIONAL TRENDS NETWORK STATIONS

COOPERATING AGENCY: Federal

CHIEF : Frank C. Wells, District Office, Austin

PERIOD OF PROJECT : Continuous since 1983

LOCATION : Northeast central and southeast central Texas



Problem: There is a potential for damage to the environment from acid rain and more knowledge of precipitation chemistry and resulting effects on the environment in the Nation are necessary to help avert future problems.

Objective: The primary objectives of this project are to determine variations in atmospheric deposition that occur on a week-to-week basis, and collect wet and dry deposition products for analysis of elements and compounds that can contribute to the chemical composition of surface waters.

Approach: Monitoring stations will be established as part of the National Trends Network. Personnel will maintain stations, make onsite measurements, process samples, and submit samples to an analytical laboratory. Data retrievals will be verified and a report on the results will be prepared.

Progress: Two monitoring stations have been established in the Fort Worth Subdistrict and in the Houston Subdistrict. The data are collected on a weekly basis.

Plans: Plans are to continue to collect data from the two sites and transmit samples of atmospheric deposition to the laboratory for analysis. Reports will be prepared at the regional and national levels.

Reports in preparation: None.

Reports published, 1985-86: None.

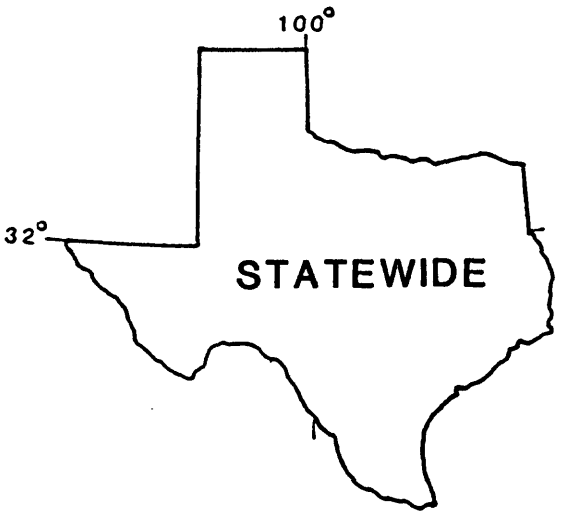
TX 00-006 FLOOD INVESTIGATIONS

COOPERATING AGENCY : Federal Emergency Management Agency

PROJECT CHIEF: B. C. Massey, District Office, Austin

PERIOD OF PROJECT : Continuing

LOCATION : Statewide



Problem: The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 provides a flood insurance program. The Federal Emergency Management Agency (FEMA) needs to know the extent of flooding for given recurrence intervals in selected areas to determine applicable flood insurance premium rates.

Objectives: To conduct the necessary hydrologic and hydraulic evaluations and studies of areas assigned by FEMA and to report the results.

Approach: To conduct the necessary evaluations by making surveys by ground or photogrammetric methods and applying appropriate engineering techniques. Determine flood-discharge frequency relationships using historical information. Determine water-surface profiles using step-backwater streamflow models or by other acceptable methods. Furnish the results in reports to FEMA.

Progress: The Liberty County Federal Insurance Study was completed and submitted to FEMA in November 1985. A less-detailed flood insurance study is now in progress for Hood County. This study began July 1, 1985, and is scheduled for completion by January 1, 1987. Field data collection is complete and data is being coded for the step-backwater computer program.

Plans: The work effort in the next few months will be directed toward completing the hydraulic computations and preparing the maps.

Reports in progress: None.

Reports published, 1985-86: None.

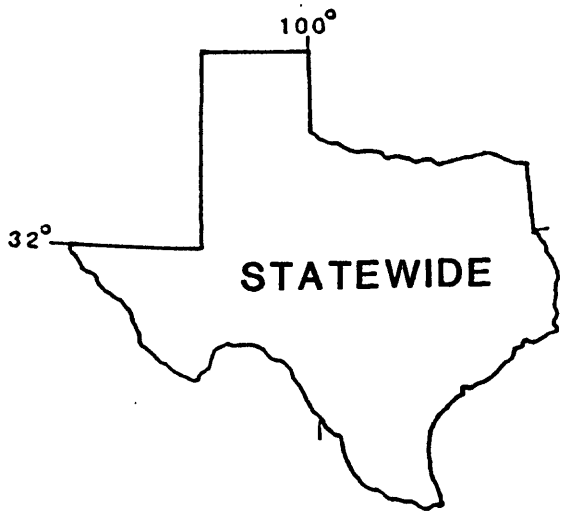
TX 78-007 TEXAS WATER-USE DATA PROGRAM

COOPERATING AGENCIES : Texas Water Development Board, Federal

PROJECT CHIEF: Raymond M. Slade, District Office, Austin

PERIOD OF PROJECT : Continuing

LOCATION : Statewide



Problem: Texas waters are undergoing increasing demands for domestic, industrial, agricultural, and other uses, and concerns for greater protection of water quality are increasing. Adequate information on uses of water, to complement that being collected to describe the quantity and quality of water, will ultimately aid decision makers in resolving many critical water problems such as resource allocation, environmental impact, energy development, and resource development.

Objectives: The primary objective of this project is to transfer water-use data from the Texas Water Development Board (TWDB) computerized data base to the USGS National Water-Use Data System (NWUDS). A secondary objective is to continue a program at the State level that collects and compiles water-use data and develop and operate a State-level computer data handling system to disseminate data to local users. A third objective is to estimate 1985 water use for 12 categories for inclusion in a report on water use in the United States.

Approach: The project responsibilities are divided between the USGS and TWDB. Direction, management, and standards development to meet the national needs will be the responsibility of the USGS while the State needs will be the responsibility of the TWDB. The major operational responsibilities of the USGS include developing computer software for reformatting and recoding the water-use data from TWDB computer tapes for loading to NWUDS and loading the data set to NWUDS for a recent and complete year. The major operational responsibility of the TWDB is to copy selected water-use data to computer tape(s) from existing TWDB data files.

Progress: The TWDB has continued the annual data collection and compilation program for various categories of water use except irrigation. Water use for irrigation is determined every fifth year with 1984 being the year for estimation. Annually, the TWDB has prepared a computerized data tape for use by the USGS.

Plans: The TWDB is continuing to collect water-use data by identified categories. The Geological Survey is responsible for estimating 1985 water use by categories identified in NWUDS for inclusion in a Geological Survey report which will present water use by States. The Geological Survey will also prepare an atlas for publication which will present the latest available water use data.

Reports in preparation:

Barber, N. L., and Slade, R. M., Jr., Estimated water use in Texas, 1985: U.S. Geological Survey Hydrologic Investigations Atlas.

Reports published, 1985-86: None.

Hydrologic Investigative and Research Programs

To accomplish the mission of conducting analytical and interpretive water-resources appraisals and basic and problem-oriented research, the Geological Survey conducts the hydrologic investigative and research programs. These programs may concentrate on either the ground-water, surface-water, or quality of water disciplines or integrate any combination of them. Often specialized data-collection efforts are part of the individual program. The areal extent for a study ranges from a county or smaller area to several states. These programs generally are 1 to 5 years in duration, but may last over 10 years if substantial data collection is required. Each program is concluded with one or more interpretive reports. Often intermediate data reports are published.

The investigative and research programs in Texas are described in the following pages.

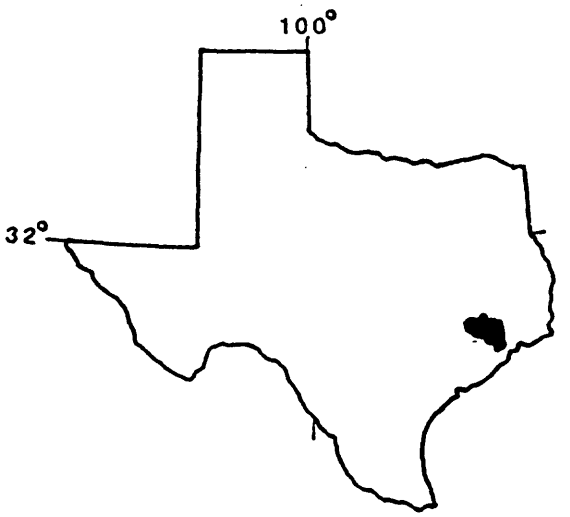
TX 65-028 URBAN HYDROLOGY STUDY IN THE HOUSTON METROPOLITAN AREA

COOPERATING AGENCIES : City of Houston; Harris County Flood Control District; U.S. Army Corps of Engineers, Galveston District

PROJECT CHIEF: Fred Liscum, Subdistrict Office, Houston

PERIOD OF PROJECT : July 1964 to September 1987

LOCATION : Southeast Texas



Problem: The city of Houston experiences severe flood problems associated with storm-water runoff. The quality of water discharged from urbanized areas is of concern also. Additional hydrologic data are needed to make adequate decisions for controlling peak runoff, for establishing land-use practices to minimize the adverse impacts of runoff water quality on receiving streams and assessing land-surface subsidence and urbanization on flooding magnitude and frequency.

Objectives: (1) To collect hydrologic data for studies to determine the effects of urbanization on flood discharge and total runoff with variations in rainfall patterns, rainfall intensity, and drainage areas; (2) to delineate actual floods to determine flood hazard areas; (3) to provide water-quality data for selected areas of differing land use from water samples collected during runoff events that differ by season and magnitude; (4) to establish techniques for predicting flood frequencies in an urbanizing area; and (5) to determine the effects of various land uses on the water quality of storm runoff.

Approach: Drainage basins with different hydrologic characteristics will be instrumented to collect simultaneous rainfall-runoff data. Field surveys will be conducted to determine areas affected by unusual floods. Water-quality samples will be collected in selected areas to reflect the relation between water quality, land use, season, and flood magnitude. Regression analyses will be used to determine possible relations between flood-peak magnitude or flood-runoff volumes and drainage-basin characteristics. Mathematical models will be used to determine the effects of urbanization in this coastal area.

Progress: Hydrologic data have been collected for 19 years at approximately 30 stations gaging flow from watersheds ranging from 0.1 to 182 square miles in size. Reconnaissance water-quality data were collected for 1968 to 1978. Beginning in 1979, detailed water-quality data were collected from stations with definable land uses. These data have been presented in data publications and analyzed in reports presenting techniques to predict flood frequencies and to estimate the quantity and quality of runoffs from this urbanizing area.

Plans: Most of the hydrologic data-collection effort came to an end in fiscal year 1984. Water-quality data at several sites where land use can be defined will continue to be collected. A report presenting the effects of urbanization on the surface-water hydrologic response of the area will be completed.

Future plans include reports on: (1) Statistical summary and review of the hydrologic data; (2) predicting contributions to receiving channel water quality from single land-use nonpoint sources; (3) techniques for predicting flood frequencies for small urban drainage areas less than 2.0 square miles in size; and (4) a final annual data report.

Reports in preparation:

Liscum, Fred, Effects of urbanization on surface-water hydrologic response in a coastal urban area, Houston, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Liscum, Fred, Bruchmiller, J. P., Brown, D. W., and Paul, E. M., Hydrologic data for urban studies in the Houston, Texas, metropolitan area, 1984: U.S. Geological Survey Open-File Report.

Reports published, 1985-86:

Liscum, Fred, 1986, Hydrologic data for urban studies in the Houston metropolitan area, Texas, 1983: U.S. Geological Survey Open-File Report 86-487, 287 p.

------ 1985, Hydrologic data for urban studies in the Houston, Texas, metropolitan area, 1981: U.S. Geological Survey Open-File Report 85-163, 296 p.

Liscum, Fred, Bruchmiller, J. P., Hutchison, J. S., and Paul, E. M., 1985, Hydrologic data for urban studies in the Houston, Texas, metropolitan area, 1982: U.S. Geological Survey Open-File Report 85-407, 252 p.

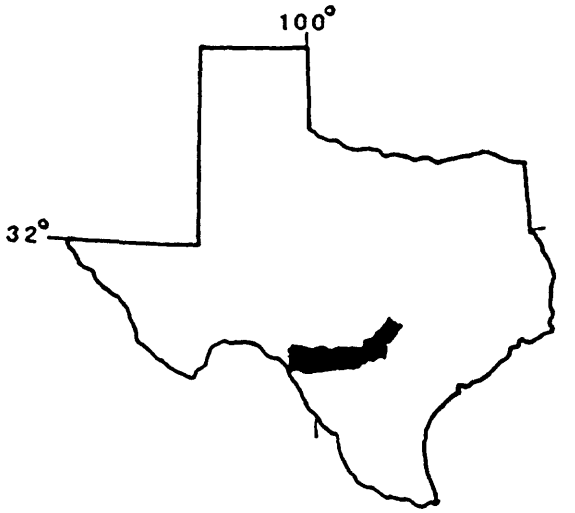
TX 70-032 LIMESTONE HYDROLOGY STUDY, SAN ANTONIO AREA

COOPERATING AGENCIES : San Antonio City Water Board, Texas Water Development Board

PROJECT CHIEF: Robert W. Maclay, Subdistrict Office, San Antonio

PERIOD OF PROJECT : October 1970 to September 1985

LOCATION : Southwest central Texas



Problem: The Edwards aquifer is the major source of water for over 1 million people in the San Antonio area. There is a need for detailed information concerning this aquifer which can be used by agencies concerned with water management. Some of the questions that need to be answered are: (1) What is the storage capacity of the Edwards aquifer reservoir at levels below the historic low water conditions; (2) to what extent will highly mineralized water move into the freshwater zone if water levels are lowered; (3) can management of the aquifer by selective pumping and/or recharge keep Comal and San Marcos Springs flowing at reasonable rates; (4) what are the possibilities for artificial recharge; and (5) what is the best way of integrating the use of ground water and surface water for the greatest dependable supply of water?

Objectives: The objectives of the Edwards aquifer research in the San Antonio area are as follows:

1. The documentation of a mathematical ground-water flow model of the Edwards aquifer in the San Antonio area to test hydrologic concepts and improve the understanding of the aquifer system.

2. The quantification of transmissivities and storage coefficients.

3. The development of a tool by which to evaluate the data-collection program.

Approach: Knowledge previously acquired on the nature of stratification of the Edwards Limestone, the areal distribution of the depositional regions of the lower Cretaceous rocks, and the locations of major vertical offsets of the Edwards along faults will be interpreted as to their hydrologic significance, and these interpretations are to be incorporated into the conceptual model of the aquifer.

The numerical modeling phase will consist of steady-state simulations of the eastern half, the western half, and the complete system. The model will be calibrated by comparing computed water levels with measured water levels for a

year (1973) when annual recharge approximately equaled annual discharge. Simulation of spring flow, water levels, and the water balance are used as the basis for evaluating the quality of calibration and the acceptance or rejection of hydrogeologic concepts. The effects of internal barriers, the validity of the model routing patterns of ground-water flow, the possible occurrence of leakage, and the appraisal of the input data are to be investigated using the mathematical model.

Project summary: The project has been completed. A numerical model of the Edwards aquifer in the San Antonio area that incorporated a representation of the anisotropic property of the aquifer caused by specific barrier faults was documented. The model demonstrated the highly significant effect of barrier faults on retaining ground-water storage within the unconfined aquifer and on the local direction of ground-water flow. Three major flow regions within the San Antonio area were identified using computer-generated flux vectors that represent magnitude and direction from each cell block.

The model tested concepts relating to specific structural controls on direction of ground-water flow and demonstrated the great significance of the Knippa gap on the control of ground-water flow from Uvalde and Medina Counties. Calibration of the model that incorporated a specific yield of 5 percent provided an acceptable solution of computed heads and springflows. The model studies indicated that additional underflow may occur to the Edwards aquifer from the Lower Glen Rose in the vicinity of the Haby Crossing fault in northeastern Medina County and in the vicinity of the Hueco Springs fault in Comal County. Model studies also indicated that unmeasured outflow of ground water from the aquifer may occur in the vicinity of Tom Nunn Hill east of the town of Uvalde.

Reports in progress:

Maclay, R. W., and Land, L. F., Simulation and expansion of storage and flow concepts of the Edwards aquifer in the San Antonio region, Texas: U.S. Geological Survey Water-Supply Paper.

Reports published, 1985-86:

Small, T. A., 1986, Hydrogeologic sections of the Edwards aquifer and its confining units in the San Antonio area: Water-Resources Investigations Report 85-4259, 52 p.

Maclay, R. W., Land, L. F., and Woodward, D. G., 1985, Geologic controls on ground-water flow in the Edwards aquifer in the San Antonio region, Texas: Abstract in program of the Southern Regional Ground Water Conference, San Antonio, Texas, Sept. 18-19, 1985.

------ 1985, Influence of barrier faults on ground-water flow in the Edwards aquifer, San Antonio region, Texas in Proceedings of the Association of Ground Water Scientists and Engineers, Southern Regional Ground Water Conference, September 18-19, 1985, San Antonio, Texas: National Water Well Association, 500 W. Wilson Bridge Rd., Worthington, Ohio, p. 1-13.

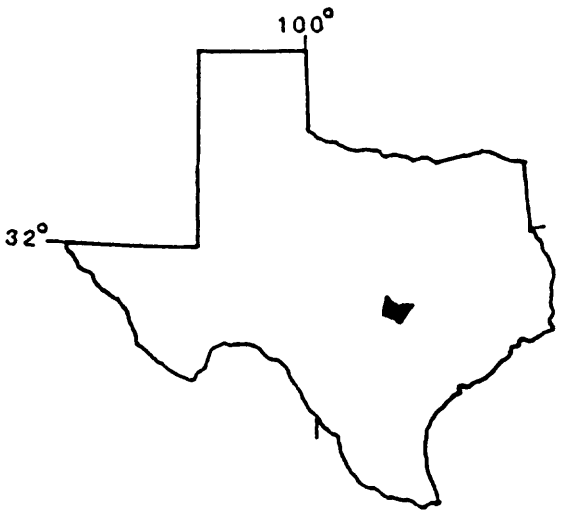
TX 75-060 URBAN HYDROLOGY STUDY IN THE AUSTIN METROPOLITAN AREA

COOPERATING AGENCY : City of Austin

PROJECT CHIEF: Raymond M. Slade, Jr., District Office, Austin

PERIOD OF PROJECT : Surface-water study, September 1974 to September 1986. Ground-water study, October 1978 to September 1983

LOCATION : Central Texas



Surface-Water Study:

Problem: Urban hydrology studies throughout the Nation have shown that: (1) increases in impervious cover resulting from urbanization generally tend to increase the magnitude and peak flows of surface runoff, and (2) the development of land tends to cause degradation of the quality of runoff. City officials are concerned about the possible adverse effects of increasing urbanization on the quantity and quality of storm runoff in the Austin area. Relationships between measures of urbanization (density, land use, etc.) and storm runoff volumes and rates, and water-quality characteristics are needed. This information is needed to help minimize the environmental impacts and to provide criteria for controlling urban flooding and water-quality degradation.

Objectives: (1) To determine the magnitude and frequency of flood peaks; (2) to determine the effects of urban development and watershed characteristics on flood peaks; and (3) to determine the water-quality characteristics of selected watersheds with different land uses.

Approach: Drainage basins are instrumented to collect rainfall and runoff data; water-quality samples of runoff are being analyzed for nutrients, physical organic and inorganic compounds, indicator bacteria, inorganic chemical constituents, minor elements, and pesticides. Modeling and statistical techniques were used to develop a procedure for estimating flooding in ungaged watersheds. Statistical techniques are being used to relate water-quality characteristics to land use. This study is closely related to project TX 82-076.

Progress: Hydrologic and water-quality data have been gathered and published in annual data reports. A progress report which meets the first two objectives of this study was completed.

Plans: A report that meets the last objective is being prepared.

Reports in preparation:

Andrews, F. L., and others, Water quality of Lake Austin and Town Lake in the Austin area, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Gordon, J. D., Jr., and others, Hydrologic data for urban studies in the Austin metropolitan area, 1985: U.S. Geological Survey open-file Report.

Veenhuis, J. E., and Slade, R. M., Jr., Analysis of storm-runoff quality for five watersheds in the Austin area, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports published, 1985-86:

Gordon, J. D., Pate, D. L., Dorsey, M. E., 1985, Hydrologic data for urban studies in the Austin, Texas, metropolitan area, 1983: U.S. Geological Survey Open-File Report 85-172, 154 p.

------ 1985, Hydrologic data for urban studies in the Austin metropolitan area, Texas, 1984: U.S. Geological Survey Open-File Report 85-676, 92 p.

Veenhuis, J. E., 1986, The effects of urbanization on floods in the Austin metropolitan area, Texas: U.S. Geological Survey Water-Resources Investigations Report 86-4069, 66 p.

Ground-Water Study:

Problem: Barton Springs is a major recreational area. Specific ground-water information concerning recharge, storage, movement, and discharge is needed to provide criteria for regulating development within the aquifer area so that the ground-water resources can be preserved. Of particular interest is Barton Springs because it is a major recreational area, is the major point of discharge from the Edwards aquifer, and is a source of water for the city.

Objective: To appraise quantitatively the ground-water resources of the Edwards aquifer that relate to Barton Springs and to determine the effect of urbanization on the quality and quantity of the water in the Edwards aquifer.

Approach: Hydrologic characteristics of the aquifer are being determined by drilling test holes, inventorying geophysical and drillers' logs, measuring water levels, and inventorying pumpage and springs. Water-quality data from wells are collected to define areal and temporal variations in the ground-water quality. Mathematical modeling techniques were used to test and develop concepts and determine how the aquifer will respond to stresses. This study is closely related to projects TX 82-072 (discontinued), TX 84-089, and TX 85-093.

Project summary: Two reports present the results of this study. One report presents the hydrogeologic characteristics of the study area. The hydrogeologic framework, as well as data and information concerning recharge, ground-water movement, and discharge are described. The quality of recharge, ground water, and discharge waters is described also. The second report describes a ground-water model that was used to determine the hydraulic characteristics of the

aquifer. Population projections were used to estimate future water-use demands of the aquifer, which were used with the hydraulic characteristics to estimate future ground-water levels.

Reports in preparation: None.

Reports published, 1985-86:

Slade, R. M., Jr., Dorsey, M. E., and Stewart, S. L., 1986, Hydrology and water quality of the Edwards aquifer associated with Barton Springs in the Austin area, Texas: U.S. Geological Survey Water-Resources Investigations Report 86-4036, 117 p.

Slade, R. M., Jr., Ruiz, L. M., and Slagle, D. L., 1985, Simulation of the flow system of Barton Springs and associated Edwards aquifer in the Austin area, Texas: U.S. Geological Survey Water-Resources Investigations Report 85-4299, 49 p.

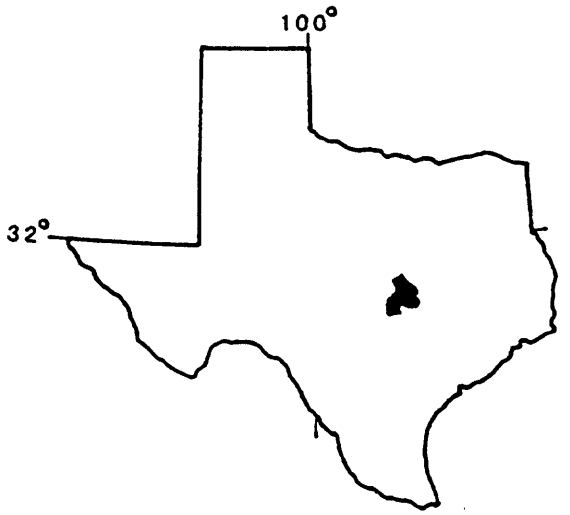
TX 78-067 GROUND-WATER RESOURCES OF THE EDWARDS AQUIFER SYSTEM
NORTHERN TRAVIS, SOUTHERN BELL, AND WILLIAMSON COUNTIES

COOPERATING AGENCY : Texas Water Development Board

PROJECT CHIEF: Raymond M. Slade, Jr., District Office, Austin

PERIOD OF PROJECT : March 1978 to September 1984

LOCATION : Central Texas



Problem: The Edwards aquifer in the three-county area is the principal source of water for Georgetown, Round Rock, and many other incorporated areas and is used by various commercial and industrial developments and rural residents. The aquifer is in an area of the very rapid population growth. As the need for development of the aquifer for water supplies becomes more pressing, it is necessary to understand the hydrologic system. Knowledge of expected response of the aquifer to potential stresses is needed to allow the opportunity to properly plan for development of the resource.

Objectives: To appraise quantitatively the ground-water resources of the Edwards aquifer system in northern Travis, southern Bell, and Williamson Counties, and to provide the data and criteria to assess potential stresses on the aquifer for present and long-range planning of water use and management.

Approach: To collect and analyze existing geologic and hydrologic data and refine previous geohydrologic evaluations and interpretations by measuring water levels in wells, pumpage, and spring discharge; drill new test wells and use borehole geophysical logging to provide detailed data on the subsurface geology; and collect water samples for inorganic chemical constituents, indicator bacteria, physical organics and inorganics, nutrients, pesticides, and minor element analysis. A ground-water flow model of the aquifer will be prepared as an aid to better understand and define the system.

Project Summary: Two reports present the results of this study. The first report presented the hydrogeologic framework of the study area, using hydrogeologic sections, structure, and thickness maps of the aquifer. Also presented are the water use, ground-water levels and charges in those levels, the quality of the ground water, and interrelationships of streamflow with the aquifer. The second report uses the information from the first report, along with some assumptions for recharge and subsurface discharge, to develop a mathematical model of the ground-water flow. The model is used to estimate transmissivities of the aquifer.

Reports in Preparation:

Slade, R. M., Jr., Boettner, W. L., and Slagle,, D. L., Simulation of the steady-state flow system of the Edwards aquifer in northern Travis, Williamson, and Bell Counties: U.S. Geological Survey Water-Resources Investigations Report.

Reports published, 1985-86:

Baker, E. T., Jr., Slade, R. M., Jr., Dorsey, M. E., Ruiz, L. M., and Duffin, G. L., 1986, Geohydrology of the Edwards aquifer in the Austin area, Texas: Texas Water Development Board Report 293, 216 p.

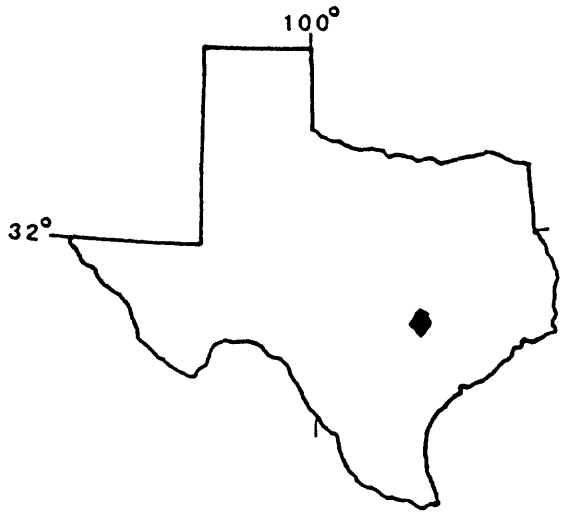
TX 79-070 HYDROLOGY OF CAMP SWIFT, A PROPOSED LIGNITE MINING SITE IN CENTRAL TEXAS

COOPERATING AGENCY : Department of the Interior

PROJECT CHIEF: E. T. Baker, Jr. District Office, Austin

PERIOD OF PROJECT : January 1979 to September 1982

LOCATION : Central Texas



Problem: Strip mining for lignite in the Camp Swift area in Bastrop County will require removal of up to 200 feet of overburden. Removal of the overburden and dewatering may diminish the quantity and quality of ground-water supplies to users surrounding Camp Swift. The hydraulic properties of the aquifers could be adversely impacted by stockpiled overburden and reclamation backfilling, and from chemical precipitates. Soluble salts, sediment, and mine water could affect the quality of water in Big Sandy Creek, and possibly the Colorado River. Hydrologic data and an assessment of the effects of strip mining are needed for making sound management decisions regarding this activity so that the impacts on the water resources will be minimized.

Objective: To collect hydrologic data for use in determining the effects of strip mining and associated operations on the various components of surface- and ground-water systems. To appraise quantitatively the ground-water and surface-water resources prior to mining operations and the availability of surface and ground water for lignite development. To determine the seasonal variations in the organic, inorganic, and sediment characteristics of surface runoff and areal variations in quality of ground water.

Approach: Big Sandy Creek watershed was instrumented to collect rainfall, runoff, sediment, and water-quality data. Basic geologic and hydrologic data were evaluated and interpretations refined by drilling test holes, geophysical logging, measuring water levels and aquifer performance, and water quality was analyzed from wells. Leaching tests were made on test hole cores, and the lignite was analyzed for ash, sulfur content, and trace metals.

Project summary: The Camp Swift area was studied to describe the hydrogeology and to provide baseline data of the ground-water and surface-water resources that would be affected by the strip mining of lignite. The investigation was centered on the 18-square-mile Camp Swift Military Reservation where a reported 80-100 million short tons of commercially minable lignite occurs within 200 feet of the land surface.

Ground-water data showed that water levels vary with depth of the well and that the water quality in the Calvert Bluff Formation, which contains the lignite, and in the Simsboro Formation, which is the major aquifer beneath the Calvert Bluff, is suitable for most domestic uses.

Big Sandy Creek, which crosses Camp Swift, generally has a base flow of less than 0.05 ft^3/s and occasionally is dry. Dogwood Creek, which originates on Camp Swift, usually is dry. Both streams have rapid changes in flow in response to rainfall. The quality of the water in both streams generally is good.

A lithologic examination of 255 feet of cored section that represents the overburden and the included lignite showed cyclic layering of fine sand, silt, clay, and lignite. A chemical analysis of the core provided an insight into the types of potential leachates that may result from the disruption of the overburden and lignite layers during the mining and reclamation stages.

Report in preparation: None. Project is complete and has been terminated.

Reports published, 1985-86:

Gaylord, J. L., Slade, R. M., Jr., Ruiz, L. M., Welborn, C. T., and Baker, E. T., Jr., 1985, Water-resources appraisal of the Camp Swift lignite area, Central Texas: U.S. Geological Survey Water-Resources Investigations Report 84-4333, 164 p.

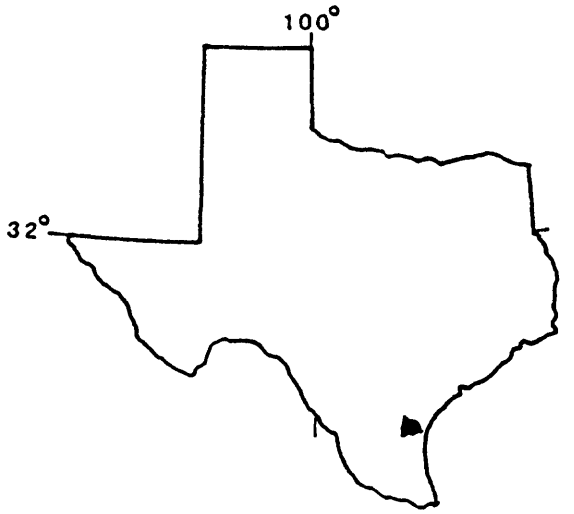
TX 82-074 ASSESSMENT OF FUTURE GROUND-WATER AVAILABILITY IN AN AREA SOUTHWEST OF CORPUS CHRISTI

COOPERATING AGENCY : Coastal Bend Council of Governments

PROJECT CHIEF: George Groschen, Subdistrict Office, San Antonio

PERIOD OF PROJECT : May 1982 to September 1984

LOCATION : South Texas



Problem: Ground-water supplies in the Coastal Bend area are heavily developed in local areas. As a result, some wells are yielding water of increasing salinity and have experienced large water-level declines. The study area extends from the Texas Coast to about 78 miles inland and from the Nueces River to about 65 miles south.

Objectives: The three major objectives are: (1) To document the current hydrologic conditions of the fresh ground-water resources in the study area; (2) to assess the continued availability of fresh ground water and the impact of the current ground-water development; and (3) to develop a means of assessing the fresh ground-water availability from various alternate ground-water development plans.

Approach: The first objective was met by collecting water-level and water-quality data from a large number of wells and publishing a report on the findings. In the second and third objectives a ground-water flow and solute-transport model of the ground-water system will be developed and utilized to assist in assessing historical ground-water development patterns and various future ground-water development plans.

Project Summary: The results indicate that there is less than 0.6 inch of recharge over the outcrop of the Evangeline aquifer. The quality of this water is highly variable and ranges from 9 to 1,900 mg/L in chloride concentration. There is also some cross-formational flow of water from deeper aquifers in the Evangeline outcrop area. The intensive pumping in the Kingsville area has drastically changed the natural coastward flow in the aquifer. Over most of the study region, flow in the Evangeline is toward the pumping center in Kingsville. There is also a minor pumping center about 20 miles southwest of Kingsville. Model results agree with the limited field data, indicating that no significant water-quality deterioration has occurred in historic time. Results of model-projected pumping simulations indicate that not much water-quality deterioration will occur under the estimates presented for future water use. The principal source of salinewater intrusion into the aquifer is from the Chicot aquifer that overlies the Evangeline and the intrusion from under the Gulf of Mexico will not be significant.

Reports published, 1985-86:

Groschen, G. E., 1985, Simulated effects of projected pumping on the availability of freshwater in the Evangeline aquifer in an area southwest of Corpus Christi, Texas: U.S. Geological Survey Water-Resources Investigations Report 85-4182, 103 p.

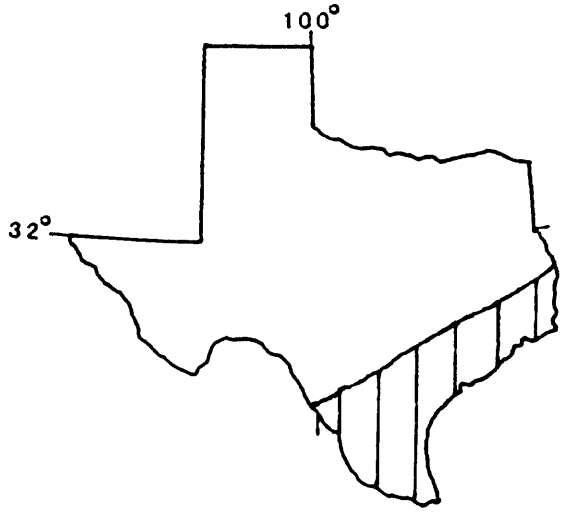
TX 82-075 WEST GULF COAST REGIONAL AQUIFER-SYSTEM ANALYSIS (RASA)--TEXAS AQUIFER SYSTEM

COOPERATING AGENCY : Federal

PROJECT CHIEF: Paul Ryder, District Office, Austin

PERIOD OF PROJECT : March 1982 to May 1988

LOCATION : Texas Gulf Coast



Problem: The Texas part of the West Gulf Coast (WGC) Regional Aquifer-System Analysis (RASA) has areas of large ground-water development that have problems associated with large declines of aquifer head, subsidence, and saltwater intrusion. Other areas within the Texas portion have significant potential for additional development of ground water, but the effects of large increases in projected developments are not known.

Objective: (1) In support of the multistate WGC-RASA program, the Texas District will contribute in the definition and determination of the interrelationship of the major and minor aquifer systems of Tertiary and Quarternary ages, (2) participate in the development of a computerized data base, (3) correlate the continuity of aquifers with adjacent states, (4) develop and calibrate ground-water flow models, and (5) estimate future water needs to estimate the aquifer's response to future withdrawals.

Approach: Identification and delineation of viable aquifers and confining-bed system shall be accomplished by (1) development of hydrologic sections, (2) review of published information, and (3) development of a data base and identification of aquifer parameters and confining-bed characteristics. These will be used to develop digital-computer models that will be coordinated on a regional scale (intra-State) and used as tools in the overall planning and management efforts of the area's ground-water resources.

Progress: Pumpage data for 1980 in the RASA files were updated to include depths of screened intervals. Potentiometric-surface maps (for 1980) of the aquifers of the Texas Coastal uplands were approved for publication as a hydrologic atlas. Four hydrostratigraphic sections along the dip of the rocks for the Texas area were completed.

Preliminary work was done to determine potentiometric surfaces of saline zones of aquifers from bottom-hole shut-in pressure data. Construction of three hydrologic sections along model grid rows, using land-surface data and layer thicknesses in the RASA data base are nearing completion.

Predevelopment potentiometric surface maps for RASA aquifer layers 3 through 11 were constructed and the data were entered into computer files for model use. Calibration of a 14-layer (9 aquifers and 5 confining beds) areal model representing predevelopment flow in the Texas Gulf Coastal Plain aquifer system was begun. The extent of the modeled area is approximately 175,000 square miles, which includes the Gulf Coastal Plain in Texas and in parts of Mexico and Louisiana, and offshore in the Gulf of Mexico. Altitude of the top of the aquifer system is as high as 870 feet above sea level in southern Uvalde County. The bottom of the aquifer system (top of the geopressured zone) is more than 15,000 feet below sea level near the Louisiana border. The Kuiper variable-density model was used to simulate the flow system. The aquifers contain water that ranges from fresh to brine.

Plans: Hydrostratigraphic dip (four) and strike (two) sections will be completed and a report submitted for review and approval. An areal predevelopment model of the Texas Gulf Coast aquifer system will be calibrated. Results of the model simulation will be included in a Water Resources Investigations report. Extensive use of PSTAT and SURFACE II is expected for data analysis and report illustrations.

Reports in preparation:

Baker, E. T., Jr., Stratigraphic and hydrogeologic framework of part of the Coastal Plain of Texas: U.S. Geological Survey Water Resources Investigations Report.

Garza, Sergio, Jones, B. D., and Baker, E. T., Jr., 1986, Approximate potentiometric surfaces for the aquifers of the Texas Coastal Uplands system, 1980: U.S. Geological Survey Hydrologic Investigations Atlas 86-W-0068.

Ryder, Paul D., Hydrology of predevelopment flow in the Texas Gulf Coast aquifer System: U.S. Geological Survey Water Resources Investigations Report.

Reports published, 1985-86: None.

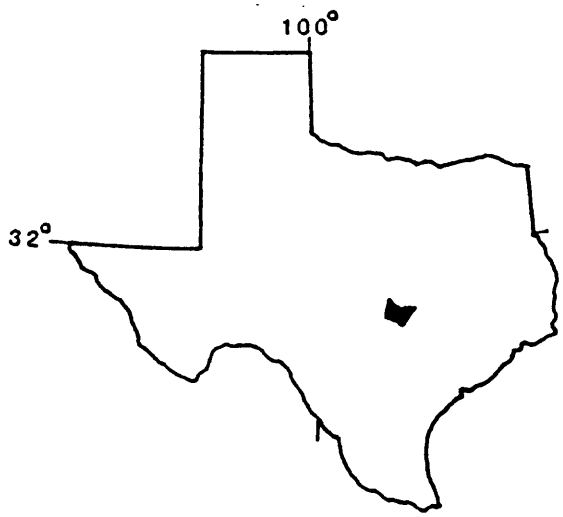
TX 82-076 EFFECTS OF ENGINEERING CONTROLS ON THE QUANTITY AND QUALITY OF URBAN RUNOFF IN AUSTIN

COOPERATIVE AGENCY : City of Austin

PROJECT CHIEF: C. T. Welborn, District Office, Austin

PERIOD OF PROJECT : October 1982 to September 1985

LOCATION : Central Texas



Problem: The development of urban areas alters the quantity and quality of runoff entering streams, lakes, reservoirs, and aquifers. Rapid urban development in the Austin metropolitan area is causing concern about the impairment of the quality of water in receiving streams, Lake Austin, Town Lake, and the Edwards aquifer. City of Austin requires that developers provide for engineering controls to reduce peak flows and to minimize the potential impairment of the quality of receiving waters by runoff from the development. Data are not adequate to determine the effectiveness of these engineering controls in improving the quality of storm-water runoff or the effects of these controls on peak discharges. Such data and determinations are needed by city planners and developers to determine the adequacy of present control designs and to plan future developments.

Objectives: This study will determine the quantity and quality of runoff from two urban developments, one of which is a multiple-family residential and the other a shopping center mall. The first objective is to obtain hydrologic data from very small watersheds with a predominantly single land use. The second objective is to determine the effectiveness of the engineering controls with respect to improving the quality of the storm runoff and the effectiveness of these controls on reducing peak flows.

Approach: Establish streamflow and water-sampling stations at the principle points of inflow and outflow from the engineering controls at each site. At each site, continuous rainfall and stage data were recorded and during selected periods water samples are collected. During each of three seasonal storm events, four discrete samples representing the inflow and outflow from each site were selected for analyses of chemical and physical parameters and indicator bacteria. Generally, the samples represent the first flush, one or more during rising stages, the peak, and one or more during receding stages. Concurrent water-quality data from the inflow and outflow stations from each site aid in defining the effects of engineering controls on the quality of water that reaches the receiving streams. Chronographic scans for organic compounds

were made on two samples collected from each of the inflow and outflow sites each year. The reduction of peak flows will be determined by a comparison of discharge hydrographs at the inflow and outflow stations.

Project summary: During the three-year investigation, runoff from two types of urban development with two types of runoff controls were examined. The quantity and quality of runoff from (1) a large shopping center were sampled before and after flowing through a detention pond with a filtered drain and (2) a multi-family residential area with a grass-swale drain was sampled before and after flow over a small detention area with a coarse gravel bed. The outflow peak discharges for the shopping center were greatly reduced for all of the storms that did not exceed the capacity of the detention pond. Discharge-weighted densities, peak concentrations, and loads for constituents were reduced by flow through the filter and the average removal percentages were calculated for each constituant. Difficulties in drainage and gaging precluded calculating reductions in peak flow and removal efficiencies for the multifamily residential area although discharge-weighted densities and peak concentrations were not decreased by the grass swale and gravel.

Reports in preparation:

Welborn, C. T., and Veenhuis, J. E., 1986, Effects of runoff controls on the quantity and quality of urban runoff at two locations in Austin, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports published, 1985-86: None

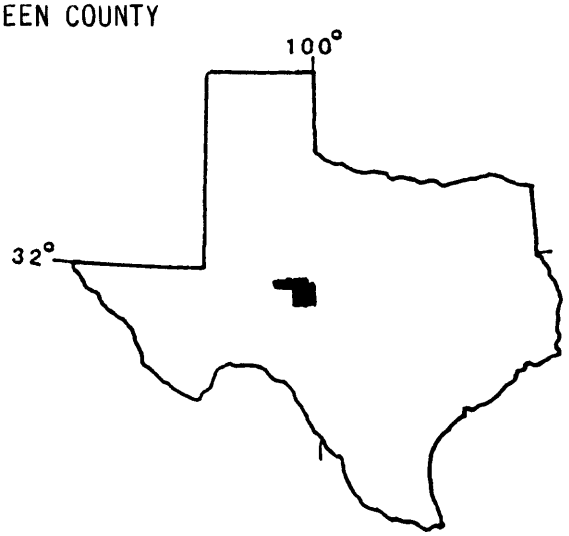
TX 82-078 RECONNAISSANCE OF SHALLOW GROUND-WATER SYSTEM IN TOM GREEN COUNTY

COOPERATING AGENCY : City of San Angelo
Tom Green County

PROJECT CHIEF: J. N. Lee,
Subdistrict Office,
San Angelo

PERIOD OF PROJECT : August 1982 to
July 1984

LOCATION : West central Texas



Problem: The protection of the limited fresh ground-water resources in Tom Green County has become a major concern. Recent reports have stated that the deterioration of water quality is caused by oil-field operations, septic tanks, and improperly constructed wells.

Objectives: (1) To define the current altitude of the water table and water quality of the ground-water system; (2) to determine the historic changes in water levels and water-quality characteristics; (3) to identify the causes of the change in the water levels and water-quality characteristics.

Approach: Following a literature and data review, a reconnaissance of water levels and specific conductance was made. Selected wells were established for periodic measurements during the year. The reconnaissance data were reviewed and detailed data were collected as needed. During the fieldwork, observations were made as to what may cause changes in water levels and quality. The analysis consisted of tabulating and mapping the current and historic water levels and water quality, and determining the changes and identifying causes for changes.

Project summary: An appraisal of the ground-water conditions in Tom Green County in 1984-85 indicates that water levels are relatively unchanged since 1941 and 1954. In most of the wells the changes were less than 10 feet. Hydrographs indicate that water levels fluctuate with rainfall and irrigation withdrawals. The dissolved solids concentrations of the shallow ground water usually range between 200 and 2,000 mg/L. Wells tapping the Cretaceous System and the Arroyo and Bullwagon aquifers did not show a significant change in quality since 1954. The dissolved concentrations generally increased 100 to 500 mg/L in the river valleys and Lipan Flat area. Local areas had increased between 500 and nearly 5,000 mg/L.

Reports in preparation:

Lee, J. N., 1986, Shallow ground-water conditions, Tom Green County, Texas: U.S. Geological Survey Water-Resources Investigations Report 86-4177, 72 p.

Reports published, 1985-86: None.

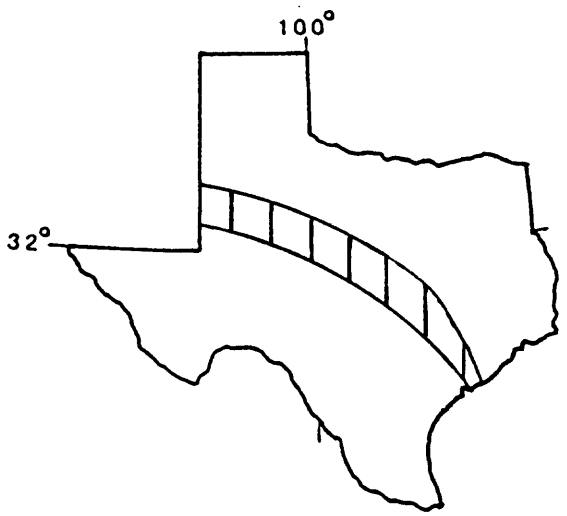
TX 83-079 STATISTICAL SUMMARY AND EVALUATION OF WATER QUALITY IN THE COLORADO RIVER

COOPERATING AGENCIES : Colorado River Municipal Water District, Lower Colorado River Authority

PROJECT CHIEF: Freeman L. Andrews, District Office, Austin

PERIOD OF PROJECT : October 1982 to September 1984

LOCATION : Central Texas



Problem: The Colorado River drains an area of about 40,000 square miles in Texas, or about 15 percent of the total area of the State. Surface-water resources in the basin are being used primarily for municipal and industrial supplies and irrigation. Muncipal growth throughout the basin is resulting in increased demands for surface water of good quality. Data analyses are needed to enhance conservation, development, and utilization of surface-water resources and to evaluate the adequacy of the data-collection network.

Objectives: Statistically analyze and interpret existing water-quality data from streams and reservoirs in the basin for the 1972-82 water years. Evaluate and document the quality of surface waters, define areal variations and delineate problem areas, and evaluate the adequacy of the water-quality data-collection network including the location of sites and frequency of sampling.

Approach: Computer programs of the Statistical Analysis System (SAS) were used for analysis of water-quality data collected during the 1973-82 water years for the network of daily and periodic stations. The mathematical relationship between the specific conductance and concentrations of selected constituents were developed by linear regression techniques. Upon the completion of the statistical analysis, the resulting summaries were compared in order to describe the water quality and to evaluate the adequacy of the current data-collection network.

Project summary: Significant upward trends in dissolved-solids concentrations were detected at three stations in the upper Colorado River basin during the study period. The increases exceeded 270 milligrams per liter per year at two stations and 165 milligrams per liter per year at the third station.

The composition of dissolved constituents in the Colorado River basin changes from predominantly sodium and chloride ions in the upper basin to predominantly calcium and bicarbonate ions in the lower basin. The U.S. Environmental Protection Agency (EPA) secondary maximum contaminant level of 500 milligrams per liter for total dissolved solids was exceeded 95 percent of

the time at each station on the mainstem Colorado River in the upper basin. In the middle Colorado River basin, the EPA secondary maximum contaminant level for total dissolved solids was exceeded approximately 95 percent of the time at most stations.

Nutrient concentrations in the Colorado River basin generally were low. Only one sample exceeded the level set for nitrate nitrogen, and no other nutrient species exceeded EPA levels. A general upward trend was detected in organic nitrogen and total nitrogen, but concentrations still remain low.

Reports published, 1985-86:

Andrews, Freeman L., and Schertz, Terry L., 1986, Statistical summary and evaluation of the water quality of surface water in the Colorado River basin, Texas, 1973-82 water years: U.S. Geological Survey Water Resources Investigations Report 85-4181, 97 p.

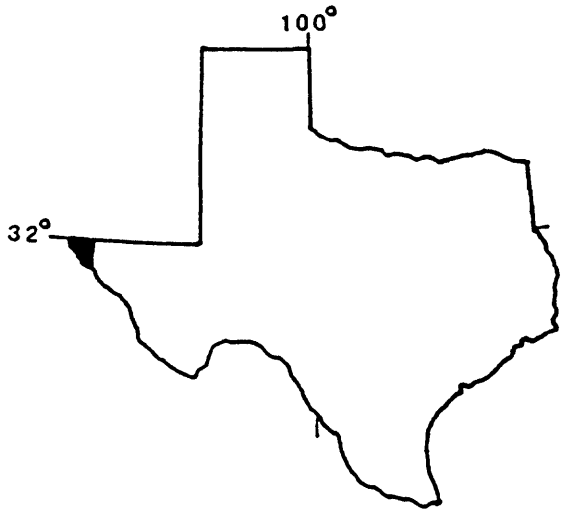
TX 83-080, 081 SOLUTE-TRANSPORT MODELING OF GROUND WATER IN THE HUECO BOLSON, EL PASO-FORT BLISS AREA

COOPERATING : El Paso Public Service Board, Texas Water Development Board, Department of the Army-Fort Bliss, Texas

PROJECT CHIEF: George Groschen, District Office, Austin

PERIOD OF PROJECT : October 1982 to September 1985

LOCATION : West Texas



Problem: Over 10 million acre-feet of fresh ground water in the Hueco bolson is being depleted. The quality of the freshwater is threatened by the intrusion of salinewater that almost surrounds the freshwater reservoir. Furthermore, there is interest in recharging the aquifer with treated wastewater. The potential for contamination due to continued and increased pumpage is unknown. The hydrologic relationship between the salinewater and the freshwater is poorly understood.

Objectives: The specific objectives of this study are: (1) to define and quantify the hydrologic effects of historic and projected pumping through the use of a solute-transport ground-water flow model; (2) to use this model to determine the movement of salinewater; and (3) to determine the model's reliability and parameter sensitivity and recommend procedures for improving its reliability and accuracy.

Approach: (1) Review of previous studies, especially Meyer (1976), to develop a conceptual model of the hydrologic system and to compile data; (2) set up the revised Geological Survey three-dimensional Heat and Solute Transport model; (3) calibrate and test the transport model for reliability and accuracy; and (4) use the model to simulate pumping stress to predict salinity and water levels for selected water-withdrawal plans.

Progress: The USGS three-dimensional ground-water flow (modular) code has been used to model the aquifer and to simulate the historical and projected pumping stress. The Heat and Solute Transport (HST) code has been partially calibrated for the historical period. The initial concept of the flow system assumed that the intense pumping from wells with screens of 300 to 800 feet long would eliminate any vertical gradient in the aquifer. Field data and modeling with the modular code with the MAW multi-aquifer well package indicates that the original upward gradient under the river is now reversed. The lack of vertical head data suggests the use of the multi-aquifer well package option. The results indicate that the wells create significant downward gradients but that many well screens act as short circuits to equalize the vertical heads

between model layers. This is due, in part, to the coarse vertical discretization used (4- to 300-foot layers), but most is due to the strong anisotropy of the aquifer sediments. Compared to the usual well option where per-layer production must be arbitrarily assigned, the package used shows that the drawdown deep in the aquifer is less because most water comes from water table decline. The results also indicate that well interference has a significant effect on the per-layer production. Using this information in the HST code shows that, contrary to conventional thought, the main source of contamination to the wells is from lateral migration, not upconing from below. It is also likely that the freshwater will be severely depleted due to the anisotropic nature of the sediments before large amounts of salinewater, other than from the river area, will be drawn into the freshwater wells.

Plans: Plans are to continue to investigate the discrepancy between results produced by the HST and the modular model. The cause may be a problem inherent in the HST code or a problem with the conceptual model as calibrated into the modular model. The report will be completed and final figures drafted pending the completion of the HST model calibration and test simulations.

Reports in preparation:

Groschen, G. E., Numerical simulation analysis of solute transport in ground water in the Hueco bolson, El Paso-Fort Bliss area, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports published, 1985-86: None.

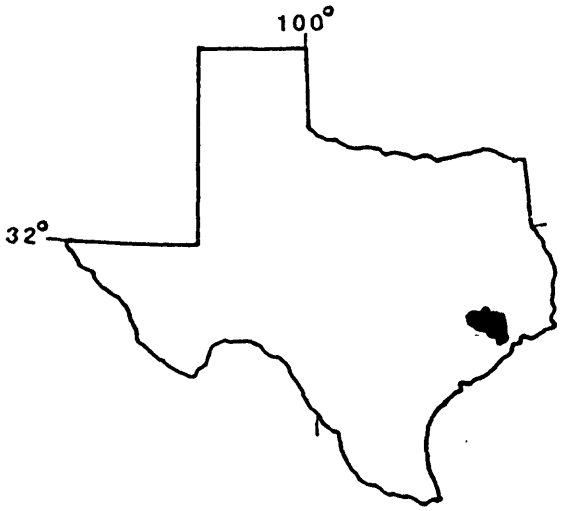
TX 83-082 NEAR REAL-TIME FLOOD ROUTING ALONG CYPRESS CREEK, HARRIS COUNTY

COOPERATING AGENCY : Harris County Flood Control District

PROJECT CHIEF: Fred Liscum, Subdistrict Office Houston

PERIOD OF PROJECT : January 1983 to September 1985

LOCATION : Texas Gulf Coast area



Problem: Some of the most intense urban growth in the Houston metropolitan area is occurring in northern Harris County. Cypress Creek, a 300-square-mile basin, flows through this urbanizing area before discharging into Lake Houston. Typical of southeast Texas, the area is relatively flat, and in urban areas, the channel has been rectified to improve conveyance. With a high degree of urbanization and its continued increase, flood warning methods are needed to aid local agencies in warning residents of impending flooding.

Objective: To develop a procedure for routing floods using near real-time hydrologic data in the lower reach of Cypress Creek.

Approach: The selected modeling approach includes the use of a distributed hydrologic-based watershed model and a hydraulic-based streamflow routing model. The storm rainfall driven watershed model will be applied independently in the upper and lower parts of the basin to generate inflow data needed by the routing model. The routing model will describe the magnitude and timing of the flood wave at selected points along the streams. Near-time storm-rainfall data will be used by the watershed model to generate inflow to the routing model.

Progress: A network of seven streamflow gages and four rain gages has been established in the Cypress Creek basin. Preliminary runs have been made of the computer programs which compose the two models, a distributed hydrologic-based watershed model and a hydraulic-based streamflow routing model. Data for calibration of these models have been obtained. Hydrologic data will be collected for the gage network throughout the length of the project.

Plans: Final model calibrations and preparation of a computer code to interface the real-time data-collection network of the cooperator with the models were prepared. Plans are to finalize the modeling system and prepare a detailed report documenting the model and procedures required to run the system.

Reports in preparation:

Liscum, Fred, Near-real time simulation of floods along Cypress Creek, Houston, Texas: U.S. Geological Survey Water Resources Investigations Report.

Reports published, 1985-86: None.

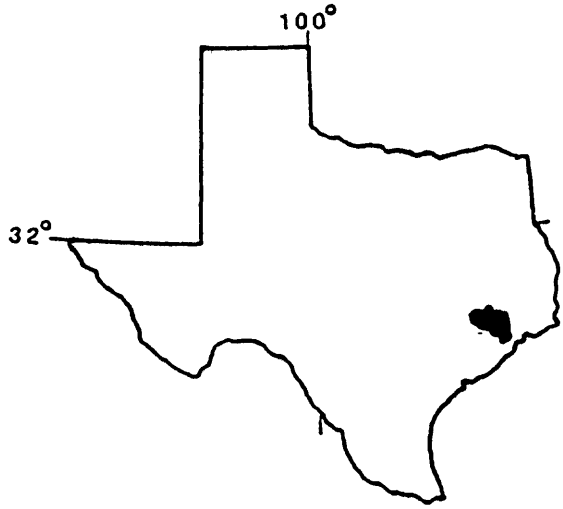
TX 83-083 POTENTIAL IMPACT OF THE TRINITY RIVER ON THE WATER QUALITY OF LAKE HOUSTON

COOPERATING AGENCY : City of Houston

PROJECT CHIEF: Fred Liscum, Subdistrict Office, Houston

PERIOD OF PROJECT : October 1983 to September 1989

LOCATION : Southeast Texas



Problem: Rapid growth in the Houston metropolitan area is resulting in increased demand for industrial and municipal water supplies. Because of the problems associated with ground-water development and the limit of these resources, additional surface water must be made available to insure an adequate supply. Current plans for providing additional water include diversions of surface water from the Trinity River through Luce Bayou into Lake Houston. Diversion of nutrient-laden water from the Trinity River may adversely affect the quality of water in Lake Houston.

Objectives: The objectives are: (1) To define the areal and temporal variations in water quality and stratification patterns in Lake Houston under current conditions; (2) to define the areal and temporal variations in water quality of inflows to Lake Houston from streams in the San Jacinto River basin; (3) to relate the water quality of inflows to the water quality in Lake Houston; (4) to define the temporal variations in the quality of water available for diversion from the lower Trinity River; and (5) to predict the potential impact of diversions from the Trinity River on the water quality of Lake Houston.

Approach: The study is designed to measure the quantity and quality of the natural inflow into Lake Houston from major streams, to collect comparable data on the Trinity River, near the planned point of diversion, and to determine the seasonal and areal variations of the chemical, physical, and biological characteristics of the water in Lake Houston. The periodic analysis and interpretation of the data will relate the response of the water quality in Lake Houston to its natural inflows using multiple regression techniques and the lake's predicted response to mixing natural inflows with diversion of Trinity River water using a dynamic lake model.

Progress: All gaging stations have been built and are operational. In addition, samples have been collected for six runoff events and four from low-flow conditions.

Plans: To continue the data collection program and to prepare a report summarizing data collected through June 1986. Long-term plans include the preparation of a report on the development, presentation, and evaluation of a procedure to predict the impact of the diversion water on the lake.

Reports in preparation:

Liscum, Fred, Goss, R. L., and Ploss, R. W., Assessment of the water-quality of Lake Houston and major tributaries, southeastern Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports published, 1985-86:

Flugrath, Marvin, W., Andrews, Freeman L., and McPherson, Emma M., 1986, Water quality of Lake Conroe on the West Fork San Jacinto River, southeastern Texas: U.S. Geological Survey Water-Resources Investigations Report 85-4301, 153 p.

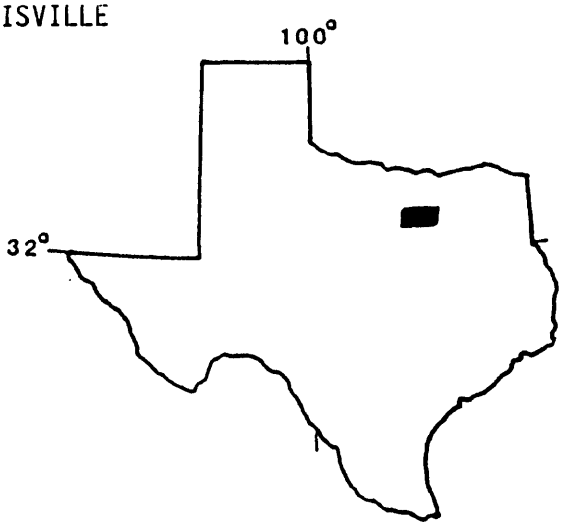
TX 84-084 SOURCES AND INFLOW OF NUTRIENTS INTO LAKE LEWISVILLE

COOPERATING AGENCY : Dallas Water Utilities Department

PROJECT CHIEF: W. Scott Gain, Subdistrict Office, Fort Worth

PERIOD OF PROJECT : October 1983 to September 1988

LOCATION : Northeast Texas



Problem: Lake Lewisville is located on the northern fringes of the rapidly growing Dallas-Fort Worth metropolitan area and is currently a major source of water for Dallas. During summers, algal blooms in the lake often result in taste and odor problems and consequently increase the cost of water treatment for the city. Before appropriate actions may be taken for the management of the lake's water quality, the source of nutrient loading must be identified and evaluated in terms of magnitude of input, effect on lake nutrient dynamics, and management feasibility.

Objectives: The objectives are: (1) To evaluate potential nitrogen, phosphorus, and organic carbon loading by streams tributary to Lake Lewisville; (2) to identify the streams having the most nutrients; (3) to determine annual loads of nitrogen and phosphorus from three of those streams; and (4) to evaluate the relative importance of point and nonpoint sources to loads of nitrogen and phosphorus contributed to the lake.

Approach: The study includes the collection of two unique data sets. The first set included the results of field and lab analyses on samples collected in each of two synoptic surveys--one survey at low flow and one at high flow. During synoptic surveys, samples were collected and discharges were measured at each of 30 sites on streams within the drainage basin of Lake Lewisville. The synoptic sampling data, along with other data previously published for major streams in the basin were intended to meet the study's first two objectives.

The second data set collected includes the results of more comprehensive sampling at three sites identified in the synoptic surveys as having potentially a great effect on the quality of water in the lake. Runoff from four storms in each of three years at each of these sites will be used to calculate annual loads to the lake. These data, in addition to reported loads by waste-water treatment plants discharging into Lake Lewisville, will be used to meet the third and fourth study objectives.

Progress: The low-flow synoptic sampling was completed in March of 1984 and the high-flow sampling in March of 1985. The three sites for storm runoff sampling were selected and sampling began in April of 1985. Automatic samplers were installed at these sites during the summer of 1985. Vandalism at two sites rendered the samplers inoperable and they were reinstalled in protective concrete conduit in April 1986.

Plans: Sampling at these sites is currently planned to continue through September 1987. A data report is planned to present the data collected during the two synoptic surveys. A final interpretative report is planned for fiscal year 1988.

Reports in preparation:

Gain, W. Scott, Water quality and flow data in the Upper Trinity River basin, Texas, 1985-87: U.S. Geological Survey Open-File Report.

------ Water quality characteristics in and inflow to Lake Lewisville, Dallas, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports published, 1985-86: None

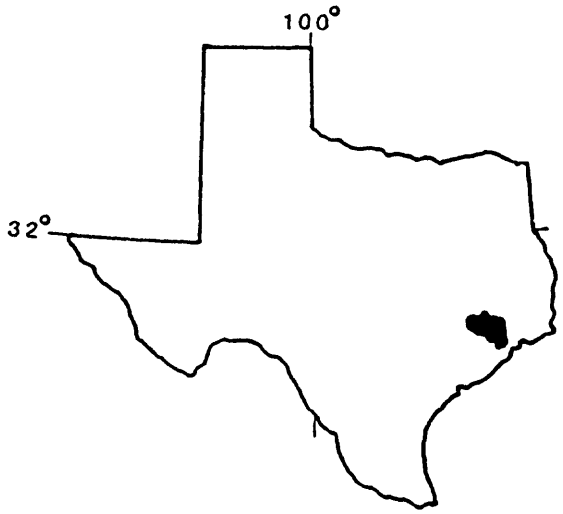
TX 84-085 ASSESSMENT OF WATER QUALITY AND CONTAMINANT PROBLEMS WITHIN THE GULF COAST AQUIFERS

COOPERATING AGENCY : U.S. Geological Survey

PROJECT CHIEF: Jeffrey L. Strause, Subdistrict Office, Houston

PERIOD OF PROJECT : January 1984 to September 1985

LOCATION : Southeast Texas



Problem: In an attempt to improve knowledge about the problem of contamination to the Nation's ground water and the trends and influence of man's activities, the Geological Survey has undertaken a national program that will closely study 14 areas. The Gulf Coast aquifer in the Houston area was selected as one of the study areas. In this area, about 500 million gallons of water per day are pumped from lenticular deposits of sand and clay. During preliminary investigations, contaminants have been found at shallow depths, but not in the major aquifers.

Approach: Ambient water quality was described from existing data and data collected in a reconnaissance sampling program. Data were from the U.S. Geological Survey, the Texas Department of Water Resources, and the Texas Health Department. The chemical quality data, relevant well data, and associated geophysical and hydraulic data were entered into computerized data bases. A reconnaissance sampling was performed to determine major inorganic-ion concentrations, selected nutrients, minor elements, and to identify the presence of selected organic constituents. These data were hydrologically and statistically analyzed to determine areal and vertical distribution of constituents.

Progress: The study area is located in the recharge area to the Chicot aquifer, one of two major producing aquifers in the Houston area. Land uses in this area include irrigated agricultural, highly developed residential, commercial and light industrial, and rural areas.

Data for about 600 chemical analyses from 400 wells were compiled. Statistical and graphical analyses were performed, and a report was prepared detailing the change in hydrochemical facies between the Chicot and Evangeline aquifers in the study area. Minor elements and organic substances were found to be mostly at concentrations of less than 10 micrograms per liter. Gross alpha radioactivities of greater than 20 piocuries per liter were found in a small part of north central Harris County, mostly in wells screened to depths

of about 900 to 1,100 feet. The final report has been prepared and is in review.

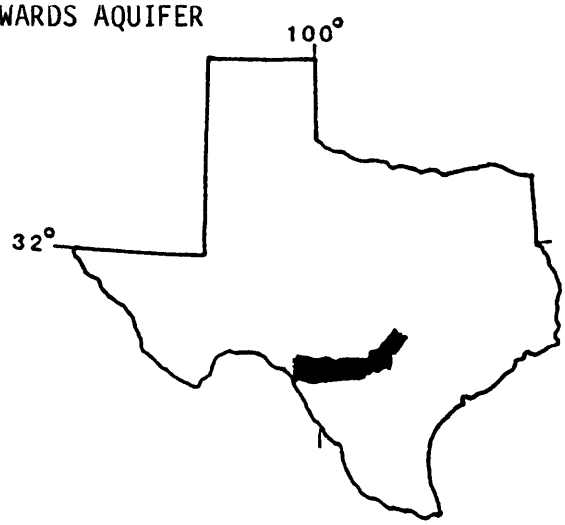
Plans: Complete review and obtain approval of the first report.

Reports in preparation:

Strause, J. L., Ground-water quality in the recharge area to the Chicot aquifer near Houston, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports published, 1985-86: None.

TX 84-086 ASSESSMENT OF WATER QUALITY AND CONTAMINATION PROBLEMS WITHIN THE EDWARDS AQUIFER



COOPERATING AGENCY : U.S. Geological Survey

PROJECT CHIEF: Paul Buszka, Subdistrict Office, San Antonio

PERIOD OF PROJECT : January 1984 to September 1986

Location : Southwest-central Texas

Problem: The extent of contamination of the Nation's ground water is largely undefined. Furthermore, the trends and influence of man's activities on ground water are poorly understood. In an attempt to gain this knowledge, the Geological Survey has undertaken a national program to study the relation of hydrogeology and land use to ground-water quality in 14 regions typical of a variety of hydrogeologic settings. The Edwards aquifer, San Antonio area, was selected as one of the sites for intensive study. The Edwards aquifer is the sole source of drinking water for the city of San Antonio and is a major source of supply for six rural counties. The quality of water in the aquifer historically has been suitabale for most all uses. The detection of manmade chlorinated hydrocarbons in ground water from several wells near San Antonio and Uvalde, and the presence of coliform bacteria in other wells in the area indicate that the aquifer is vulnerable to contamination. Carbonate aquifers such as the Edwards are highly susceptible to ground-water contamination where pollutant inputs coincide with open and connected conduits.

Objectives: The purpose of this study is to assess the quality of water within the Edwards aquifer in the San Antonio area with respect to selected inorganic and organic elements and compounds, bacteria, and properties that may indicate present or potential contamination. This includes: (1) The hydrogeologic characteristics and land-use practices that can effect ground-water chemistry; (2) the general inorganic and organic chemical character of ground water with particular attention to trace elements, pesticides, and volatile organic compounds; (3) the relation between ground-water flow, land use, and water quality; and (4) a brief description of the areas where ground-water contamination has occurred or may occur.

Approach: Water-quality data consisting of laboratory analyses of ground-water samples were compiled from the existing USGS-WATSTORE database and supplemented by analyses from 54 additional wells sampled during 1984 and 1985. An aquifer zone in the vicinity of each well was classified using tritium data from Pearson and Rettman (1976), hydrochemical facies data from Maclay and others (1980), and hydrogeologic data from Maclay and Small (1984). Land-use data derived from a 1978 Texas Department of Water Resources study, and field visits by

USGS personnel were used to classify the major land use associated with each well. Nonparametric-statistical procedures were used to test whether land use and aquifer zone were correlated with the distribution of selected chemical constituents.

Project summary: In general, ground water in the Edwards aquifer has not been significantly degraded by land-use activities. Greatest nitrate plus nitrite concentrations were spatially associated with ground water that contains relatively high tritium concentrations and in the cultivated agricultural area of central Uvalde County and in northern Bexar County. Detections of total coliform bacteria in ground water were mainly associated with wells in the unconfined zone. Most of the occurrences in ground water of tetrachlorethylene, 1, 2-(trans)-dichloroethylene and trichlorofluoromethane were associated with two sources, a landfill in north-central San Antonio and a small area east of Uvalde. Occurrences of concentrations of lead greater than 5 micrograms per liter and zinc concentrations greater than 100 micrograms per liter in ground water from the unconfined zone of the aquifer were associated with small volumes of presampling pumpage.

Reports in preparation:

Buszka, P. M., Water quality in the Edwards aquifer, San Antonio area, Texas, and its relation to hydrogeology and land use: U.S. Geological Survey Water-Resources Investigations Report.

Reports published, 1985-86: None.

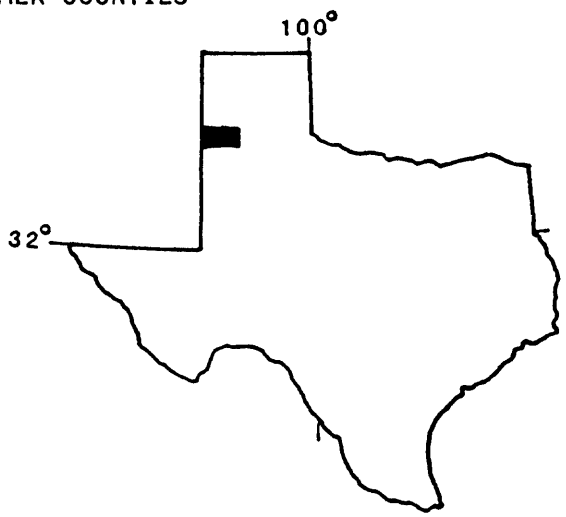
TX 84-087 INVESTIGATION OF RETURN FLOW FROM IRRIGATION IN CASTRO AND PARMER COUNTIES

COOPERATING AGENCY : U.S. Geological Survey

PROJECT CHIEF: Gary W. Mackey, District Office, Austin

PERIOD OF PROJECT : October 1983 to September 1985

LOCATION : Northwest Texas



Problem: The amount of water returning to the aquifer from that which was pumped for irrigation needs to be determined to improve our understanding of the long-term availability of ground water.

Objectives: To establish, test, and apply procedures to determine the amount of return flow from applied irrigation water.

Approach: Pumpage, rate of application, crop types, and irrigated acreage from 1983 to 1984 will be measured from about 110 randomly selected wells. The major steps are: (1) Devise procedure for estimating irrigation application for 1975-83; (2) construct water-level change maps for 5- and 10-year periods; (3) statistically evaluate differences in the maps; (4) prepare specific-yield maps and compute change in ground-water storage from specific-yield data and water-level change maps; and (5) estimate irrigation return flow for January 1975 to January 1984 from the difference between pumpage and change in ground-water storage.

Project summary: Because historical irrigation pumpage data in the High Plains of Texas were unavailable, an approach based upon crop consumptive-use patterns was employed to estimate pumpage from 1974 through 1983 for two counties located in the Texas High Plains. Due to the unreliability of irrigated acreage data, two different sources were used to obtain estimates for total irrigated acreage and individual irrigated crop acreage. Reported sources of irrigated acreage consistently provided larger values than data obtained from interpreted LANDSTAT imagery. Total estimated pumpage for the 9-year period was 11,269,000 acre-feet and 8,914,000 acre-feet based upon reported crop acreage data and LANDSAT acreage data, respectively. Change-in-storage was found to total 5,168,000 acre-feet for 9 years. The difference between irrigation pumpage and change-in-storage approximates irrigation return flow. Return flow for the 9 years was approximately 6 million acre-feet and 4 million acre-feet based upon reported crop acreage data and LANDSAT acreage data, respectively. This volume is 54 percent estimated reported pumpage and 42 percent pumpage estimated from LANDSAT data.

Reports in preparation:

Mackey, Gary W., Comparison of irrigation pumpage and change in ground-water storage in the High Plains, Castro and Parmer Counties, Texas, 1975-83: U.S. Geological Survey Water-Resources Investigations Report.

Reports published, 1985-86:

Rettman, P. L., and McAdoo, G. D., 1986, Irrigation data from Castro and Parmer Counties, Texas, 1983-84: U.S. Geological Survey Open-File Report 85-699, 36 p.

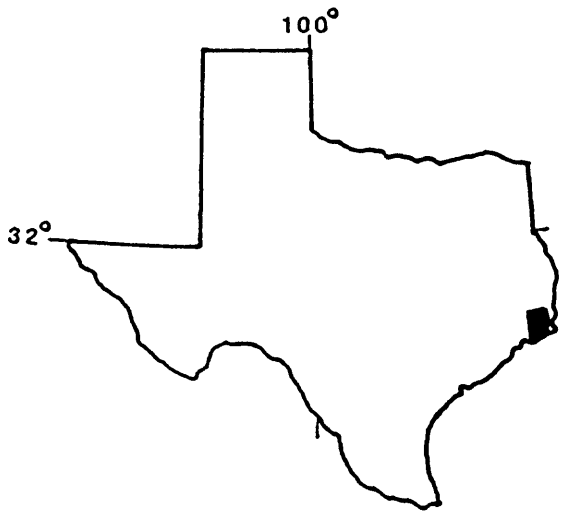
TX 84-088 SURFACE-WATER HYDROLOGY OF THE SALT BAYOU IN SOUTHEAST TEXAS

COOPERATING AGENCY : Texas Parks and Wildlife

PROJECT CHIEF: J. C. Fisher, Subdistrict Office, Houston

PERIOD OF PROJECT : January 1984 to September 1986

LOCATION : Southeast Texas



Problem: The Salt Bayou basin in southeast Texas is a complex marshland ecosystem. Much of the basin has been reserved by the State to maintain this ecosystem. The basin contains both the McFaddin National Wildlife Refuge and the Sea Rim State Park. The refuge, maintained by the U.S. Fish and Wildlife Service, serves as a primary breeding ground for shellfish.

The construction of the Gulf Intracoastal Waterway and the Port Arthur Canal has interrupted the historical saltwater-freshwater exchange pattern for the basin ecosystem. The increased salinity of the marsh has caused concern that shellfish productivity will be adversely affected in the McFaddin National Wildlife Refuge. In order to correct the problem, the construction of controlled structures has been proposed at the three inflows to the area, Keith Lake, Shell Lake, and Star Lake. These structures are intended to help control the saltwater-freshwater exchange by reducing saltwater inflow into the area.

Improved knowledge of the hydrology of the basin, particularly the saltwater-freshwater relationships, is needed to aid in the assessment and possible future enhancement of the basins' shellfish community.

Objectives: The major objective is to define the water budget and flow patterns and magnitudes at the major outlet to the Intracoastal Waterway. Specific goals of the study are to: (1) Define the water budget for the basin; (2) determine velocity profiles for the inflows over several complete tide cycles; and (3) define salinity profiles for the main channel in the refuge.

Approach: One stage, two stage-discharge, and one stage-velocity gages were installed. Salinity profiles were determined, and six 24-hour surveys at selected points were obtained to collect bi-hourly discharge, velocity, specific conductance, and temperature. The Fish and Wildlife Service collected biological data over a tidal cycle. Salinity-profile data were obtained by traversing the main channels. Additional water-budget data are available from Sea Rim State Park.

Progress: Twenty-four hour surveys were run in Oct. and Nov. 1984, and Jan., April, June, and Aug. 1985. During these surveys, temperature and conductance observation were obtained at 41 sites. A series of discharge measurements were made at the major inflow channels entering the marsh during the surveys.

Instrumentation was removed on April 1, 1986. The gage shelter and velocity transponder towers were left in place at the Keith Lake site and will be removed at a later date. Review and processing of stage velocity, temperature and conductivity and discharge data of stage, velocity, temperature, and conductivity data are complete. National Weather Service data from Port Arthur has been obtained through Nov. 1985. Winnie and additional Port Arthur Weather data may be required for precipitation definition.

Plans: Prepare data and interpretive reports.

Reports in preparation:

Fisher, J. C., Hydrologic data of MacFaddin National Wildlife Refuge and Sea Rim State Park, Oct. 1985 to March 1986: U.S. Geological Survey Open-File Report.

Reports published, 1985-86: None.

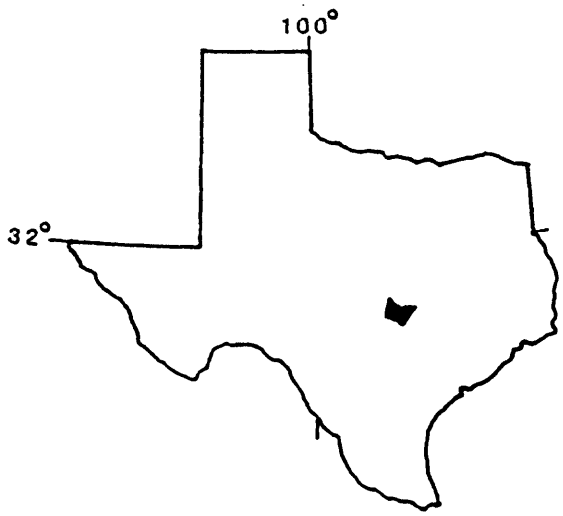
TX 84-089 LOCATION OF RECHARGE ZONE--EDWARDS AQUIFER, AUSTIN

COOPERATING AGENCY : City of Austin

PROJECT CHIEF: Raymond M. Slade, Jr., District Office, Austin

PERIOD OF PROJECT : March 1984 to September 1985

LOCATION : Central Texas



Problem: Barton Springs is located in Zilker Park near the center of Austin and is a major recreational area for the city. Discharge from Barton Springs maintains flow in the lowest reaches of Barton Creek and enters into Town Lake, which is a source of water for Austin. The Edwards aquifer supplies water to Barton Springs. The aquifer encompasses about 155 square miles, of which about 90 square miles is within the recharge zone.

Much of the land in the recharge area is being rapidly developed. The quality of runoff from the developed areas in the watersheds crossing the recharge area may cause a degradation of the quality of water in the Edwards aquifer. In an attempt to prevent adverse impacts, the city government has enacted development ordinances and is considering imposing stricter ordinances within the recharge area. A detailed map delineating the areal extent of the recharge area is needed. This map will assist land owners and city officials in identifying environmentally sensitive areas and can serve as the basis for delineating areas where development controls are needed.

Objective: This study will delineate the areal extent of the outcrop area and the recharge area for the Edwards aquifer that has been determined to be in hydrologic circulation with Barton Springs.

Approach: A combination of field inspections and interpretation of aerial photographs were used to identify the extent of the Edwards aquifer outcrop. Mapping along creeks located faults and fractures. Aerial photographs, soils maps, and other maps were used to relate the aquifer outcrop boundaries to characteristics or features that can be identified on the photos/maps. The extent of the outcrop of the Edwards aquifer is shown, along with the downstream extent of the outcrop along creek beds. The western boundary of the recharge zone is defined as the westernmost extent of the Edwards aquifer outcrop. The downstream (eastern) boundary of the recharge zone is defined as the easternmost boundary of either the eastern extent of the outcrop of the Edwards aquifer outcrop, or the delineation of the drainage area that contributes runoff to the downstream end of the recharge zone for each creek.

Project summary: Two reports present the results of the study. The first report describes the surface boundaries of the outcrop of the Edwards aquifer. The second report describes the recharge area for the Edwards aquifer study area. The recharge area is the combination of the outcrop area and those parts of the drainage areas of the creeks which overlie the aquifer but contribute runoff to the outcrop area.

Reports in preparation: None

Reports published, 1985-86:

Ardis, A. F., Slagle, D. L., and Snyder, F. R., 1985, Delineation of the outcrop of the Edwards aquifer hydrologically associated with Barton Springs in the Austin area, Texas: U.S. Geological Survey Open-File Report 85-643, 1 sheet, scale 1:24,000.

Slagle, D. L., Ardis, A. F., and Slade, R. M., Jr., 1986, Recharge zone of the Edwards aquifer hydrologically associated with Barton Springs in the Austin area, Texas: U.S. Geological Survey Water Resources Investigations Report 86-4062, 1 sheet, scale 1:24,000.

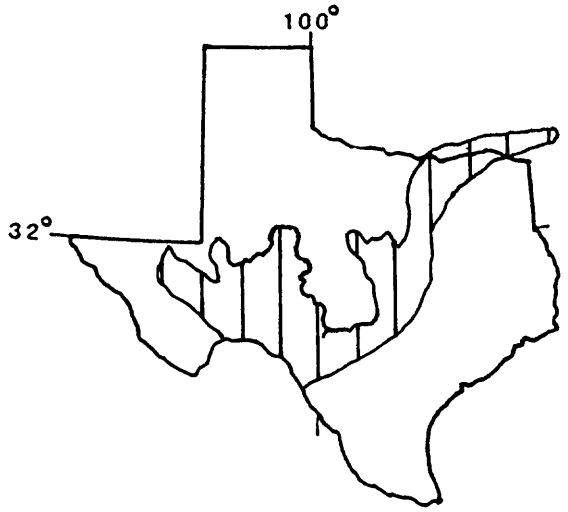
TX 85-090 EDWARDS-TRINITY REGIONAL AQUIFER-SYSTEM ANALYSIS (RASA)

COOPERATING AGENCY : Federal

PROJECT CHIEF: Peter Bush, District Office, Austin

PERIOD OF PROJECT : October 1985 to September 1991

LOCATION : Central Texas, southeast Oklahoma, southwest Arkansas



Problem: Continued use of water from the Cretaceous aquifers in the study area will lower water levels, reduce streamflows, and possibly cause deterioration of water quality in the aquifers. Lower water levels in aquifers will reduce springflow and discharge to streams in discharge areas and may increase aquifer recharge from streams in recharge areas. In some areas, poor-quality water occurs in aquifers or zones of aquifers adjacent to pumping centers and continued pumping may cause movement of poor-quality water toward water supplies.

Objectives: The ultimate objective is to better understand the long-term water-bearing potential of the Cretaceous aquifers that comprise the Edwards-Trinity regional aquifer system. The study will provide a regional description of the original flow system, the changes that have occurred in response to ground-water development, and to the extent possible, the changes that might occur as a result of future development.

Approach: A multidisciplinary approach will be used. Geologists will construct a regional hydrogeologic framework that divides the aquifer system into mappable permeability units. Ground-water modelers will use the hydrogeologic framework to construct digital flow models on regional and subregional scales. Geochemists will describe the water chemistry and interpret the flow system based on the water chemistry. Different interpretations or hypotheses of the structure of the aquifer system and patterns of flow suggested by geologic, hydrologic, and geochemical studies will be tested with the digital models.

Progress: Five of the six staff members have begun reviewing the literature and preparing study plans. The remaining staff member is expected to join the project in early 1987.

Reports in preparation:

Bush, P. W., Plan of study for the Edwards-Trinity regional aquifer-system analysis, central Texas, southeast Oklahoma, and southwest Arkansas: U.S. Geological Survey Water Resources Investigations Report.

Reports published, 1985-86: None

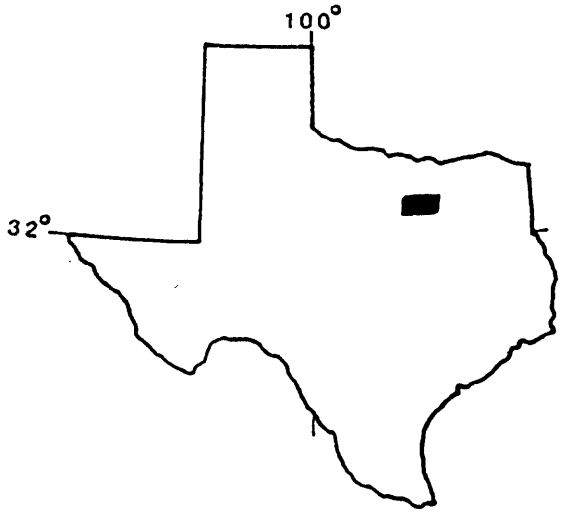
TX 85-091 WATER QUALITY OF CEDAR CREEK RESERVOIR, NORTH-CENTRAL TEXAS

COOPERATING AGENCY : Tarrant County Water Control and Improvement District No. 1

PROJECT CHIEF: Norman Leibbrand
District Office, Austin

PERIOD OF PROJECT : October 1984 to September 1986

LOCATION : North-central Texas



Problem: Projections by the Texas Water Development Board indicate that by the year 2000, water use in Dallas and Tarrant Counties will be nearly 1 million acre-feet per year, up about 50 percent from 1980. Ninety-five percent of the water used in 1980 was obtained from surface-water supplies. Lake Worth, Lake Arlington, and Benbrook Lake currently serve as the principal source of municipal and industrial water for the Fort Worth metropolitan area. Increased demands on this water supply have caused water managers in the Fort Worth and Arlington areas to supplement the supplies from Cedar Creek Reservoir, approximately 80 miles southeast.

Objectives: This study will summarize and explain the variations of selected chemical constituents and characteristics of water in Cedar Creek Reservoir. It is designed to fulfill the following specific objectives: (1) Provide a brief description of Cedar Creek Reservoir and surrounding environment; (2) define the amount of water withdrawn from the reservoir; (3) define seasonal and areal variations in concentrations of dissolved solids, chloride, sulfate, hardness, iron, manganese, and selected nutrients during the 1977-84 water year.

Approach: Comprehensive water-quality data have been collected during winter, spring, and summer since January 1977. Data have been collected at appoximately 10-foot depth intervals at approximately 10 sampling locations at the lake to define variations in water quality throughout the reservoir.

Analysis of these data was done using the SAS (Statistical Analysis System) which is interfaced with the USGS WATSTORE computer files. SAS programs have been developed by District personnel to compute seasonal average concentrations of constituents at varying depths, and to compute volume-weighted average concentrations of constituents.

Project summary: Thermal stratification in Cedar Creek Reservoir usually begins in late winter or early spring and persists until late fall. Thermal stratification or summer stagnation causes significant seasonal and areal variations in concentrations of dissolved oxygen and in other dissolved and suspended

constituents. Oxygen used in the decay of organic matter is not replenished during summer stagnation, and water below depths of 30 feet usually contains less than 2 milligrams per liter of dissolved oxygen.

The volume-weighted average concentrations of dissolved solids, dissolved sulfate, and dissolved chloride were less than 140 milligrams per liter, 30 milligrams per liter, and 25 milligrams per liter respectively. The water was soft to moderately hard ranging between 55 and 75 milligrams per liter as calcium carbonate.

Barium and arsenic were the most commonly found elements in detectable concentrations in 10 trace elements studied. Of 22 water samples collected for trace elements analysis, 15 contained barium in concentrations ranging from 40 to 300 micrograms per liter, and 19 contained arsenic in concentrations ranging from 1 to 26 micrograms per liter.

Report in preparation:

Leibbrand, Norman F., and Gibbons, W. J., Water quality of Cedar Creek Reservoir in north central Texas, U.S. Geological Survjey Water-Resources Investigations Report.

Reports published, 1985-86: None

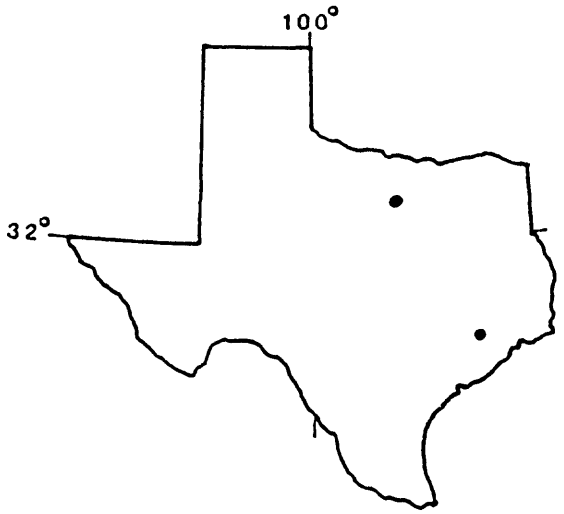
TX 85-092 TRENDS ANALYSIS OF ACID RAIN DATA FROM THE NATIONAL TRENDS NETWORK (NTN)

COOPERATING AGENCY : Federal

PROJECT CHIEF: Terry L. Schertz
District Office,
Austin

PERIOD OF PROJECT : October 1984 to September 1986

LOCATION : Nationwide



Problem: The occurrence of acid rain has caused considerable environmental damage to streams and reservoirs as well as damage to property. Recognizing this problem, several major actions have been implemented that are designed to reduce the emissions of acid-rain causing substances into the atmosphere. In the meantime the National Trends Network (NTN) was established to provide long-term record for the detection of temporal and spatial trends in the chemical composition of atmospheric deposition. The NTN data base includes 19 stations that now have a full 5-year period of record. However, a study of the data as to the changes in acid rain concentrations, patterns, and trends has not been undertaken.

Objectives: Objectives of the nationwide study are to: (1) Test various methods and models for trend analysis of deposition data to determine the best approach to analysis of the data; (2) perform trend analysis on selected precipitation data at the 19 stations having 5 or more years of record; (3) determine if trends are local or regional in nature in areas where several stations are close to each other.

Approach: Data analysis will be done with the SAS. Because of the limited amount of data analysis on acid deposition, many of the methods for detection of trends will be experimental. Chemical and physical parameters to be considered will be pH, specific conductance, dissolved sulfate, nitrate, chloride, ammonia, sodium, potassium, calcium, and magnesium.

Project summary: Forty-nine percent of the trends detected in concentrations of dissolved constituents, pH, and specific conductance were downtrends, 7 percent showed uptrends, and 44 percent showed no detectable trends at a significance level of 0.2. The two constituents of greatest interest in terms of human generated emissions and environmental effects, sulfate, and nitrate showed only downtrends, and sulfate showed the largest decreases in concentration per year of all the ions tested.

Reports in preparation:

Lins, Harry F., Schertz T. L., and Lanfear, K. J., 1986, Recent areal reductions in constant precipitation acidity surfaces: U.S. Geological Survey selected papers in hydrologic Sciences.

Reports published, 1985-86:

Schertz, Terry L., and Hirsch, Robert M., 1986, Trend analysis of weekly acid rain data--1978-83: U.S. Geological Survey Water-Resources Investigations Report 85-4211, 64 p.

Schertz, Terry L., Lins, Harry F., and Hirsch, Robert M., 1985, Evidence for a downtrend in precipitation acidity in the eastern United States in National Atmospheric Deposition Program, 1985, NADP Technical committee meeting abstracts of papers, October 8-11: Natural Resources Ecology Laboratory, Colorado State University, Fort Collins, Colorado, p. 31.

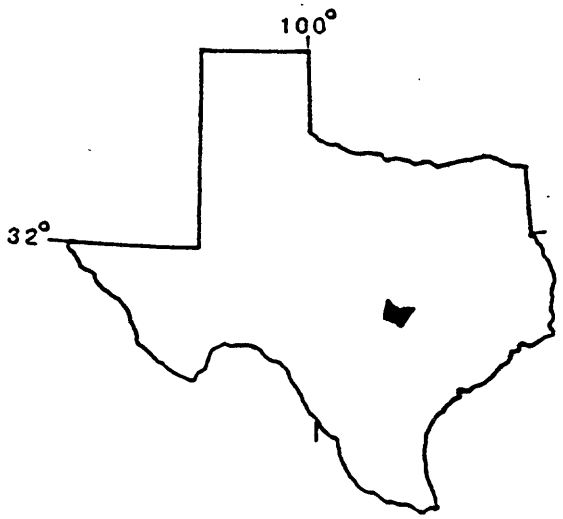
TX 85-093 ATTENTUATION OF SELECTED POLLUTANTS IN THE UNSATURATED ZONE OF THE EDWARDS AQUIFER, AUSTIN, TEXAS AREA

COOPERATING AGENCY : City of Austin

PROJECT CHIEF: Paul M. Buszka
District Office,
Austin

PERIOD OF PROJECT : March 1985 to September 1992

LOCATION : Central Texas



Problem: The Edwards aquifer of central Texas is a major freshwater resource that supplies much or all the water needs of many municipalities, industries, businesses, farms, and recreation centers. Because of the rapid population growth in the area overlying the aquifer and more recently in the recharge zone, concern is being expressed about the pollution potential from storm-water runoff that enters the aquifer. The potential for contamination of the Edwards aquifer through the storm-water runoff and aquifer recharge process, and the attenuation of pollutants in the subsurface are poorly understood. To prevent long-term implications of ground-water pollution, knowledge of the movement of selected pollutants, and the capacity of the subsurface material to attenuate the concentrations of pollutants is needed. The Edwards aquifer, predominantly composed of limestone that is locally fractured, faulted, and solution-riddled appears to be highly vulnerable to contamination.

Objective: The major objective is to develop an understanding of the process affecting the quality of water as water migrates from the streambed to the saturated zone. The water-quality characteristics of major interest are nonconservative pollutants including organics, nitrogen and phosphorus, trace metals, and fecal bacteria. Supporting objectives are to (1) collect field and laboratory data and define the quality of water in the vertical profile in the unsaturated zone, and (2) develop a means of estimating the attenuation of pollutants in untested areas. Several types of water will be tested; each typical of storm-water runoff from a given land use.

Approach: The scope of the investigation will be limited to areas along streams following storm-runoff, when most of the recharge occurs. This investigation is research in nature and, consequently, the stated objective is not assured. The project will be conducted in phases and advancement to the next phase will require the satisfactory completion of the current phase. The project consists of three supporting elements. All of the elements will be investigated concurrently and include: (1) Study, development, statement, and testing of hypotheses; (2) laboratory (batch or column), experiments; and (3) field experiments using a suite of wells open to bedding planes and solution openings that are believed to be temporarily saturated after storms.

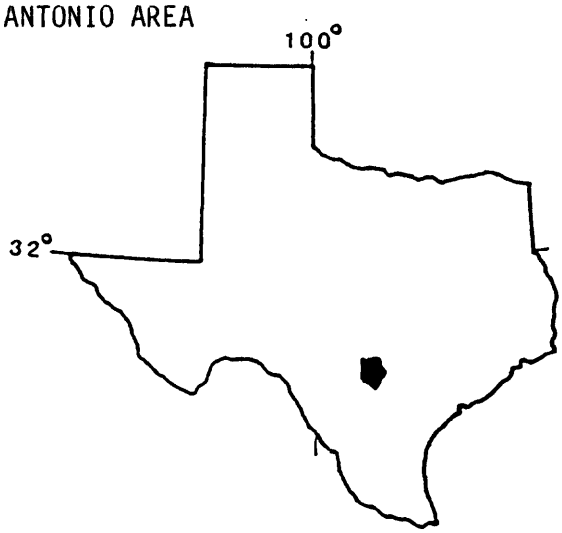
Progress: Plans for the project are being formulated. Considerable effort has been spent on literature review. The first test site is on Williamson Creek near the middle of the recharge zone. Installation of the suite of seven wells is complete. Instrumentation has been planned and is on order.

Plans: Plans for the coming year include installing the instruments, collecting water sampling after floods, and designing and setting up laboratory experiments.

Reports in preparation: None.

Reports published, 1985-86: None.

TX 05-094 HYDROLOGIC CONTROLS AFFECTING GROUND-WATER MOVEMENT IN THE VICINITY OF THE "BAD-WATER" LINE IN THE EDWARDS AQUIFER, SAN ANTONIO AREA



COOPERATING AGENCIES : San Antonio City Water Board, Edwards Underground Water District, and Texas Water Development Board

PROJECT CHIEF: Robert W. Maclay, Subdistrict Office, San Antonio

PERIOD OF PROJECT : October 1984 to September 1986

LOCATION : South-central Texas

Problem: Salinewater intrusion from the downdip boundary of the Edwards aquifer into the freshwater is hydraulically possible. Significant movement of the salinewater would be more likely to occur during periods of low water levels when gradients across the transition zone could increase. A drought condition creates a situation where larger-than-normal amounts of water will be withdrawn from the aquifer causing additional lowering of water levels and possible reversal of the present gradient toward Comal Springs. The increase in water withdrawal, lower recharge, and resulting low-water levels will create a condition where the encroachment of the salinewater is most likely to occur.

The extended dry condition that has existed in south Texas during the winter, spring, and early summer of 1984 has resulted in a condition that could establish a historical water-level low within the aquifer. Water levels at the beginning of May were within 20 feet of the record low that occurred in 1956 in San Antonio. Water levels declined an additional 8 feet before the end of June 1984. The increase in population and the consequent increase in water demand could cause the water level in the aquifer to fall below the record low if the present dry condition continues through the summer of 1984. Because the Edwards aquifer is the designated sole-source water supply for more than 1 million people, it is critical to know if the salinewater will move into the freshwater zone and, if it does, it is critical to know how rapidly and in what quantity the salinewater will move. Should intrusion occur, the highly leached freshwater part of the aquifer may allow rapid mixing of the salinewater and possible contamination of the most highly productive part of the aquifer in the vicinity of San Antonio and northeastward toward the major springs.

Objectives: The major objectives are to (1) delineate in the three-dimensional shape of an interface between the freshwater and salinewater, (2) obtain data on the vertical and horizontal circulation near the "bad-water line," and (3) establish permanent monitoring wells to determine transient changes in water quality.

Approach: A test drilling program is designed whereby three different clusters of wells are drilled in the aquifer. A well cluster is located in the fresh-water zone, in the transient zone between the fresh and saline zones, and another in the saline zone. Extensive testing of formation was conducted at each cluster. Tests include vertical flow tests and aquifer yield tests. Geophysical logging provided porosity, lithology, and water-quality information to determine vertical and lateral variations.

Progress: Drilling, testing, and well installation have been completed. Data show that the test well fully penetrating the aquifer flowed under natural artesian head at almost 60 gallons per minute of salinewater having a total dissolved solids concentration of about 2,500 mg/L. The flow rate was about evenly distributed between the permeable beds above and below the regional dense bed that occurs within the aquifer. The greatest salinity (up to 4,000 mg/L of dissolved solids) occurred in the deep zone. The full depth well flowed about 1,000 gallons per minute, but mostly from the upper zone. This water was fresh but water below the regional dense bed was slightly saline. A second well at this site flowed only about 150 gallons per minute from the permeable bed above the regional dense bed and the water was slightly saline.

Plans: Plans for the coming year include completing the data report, analyzing the data, and preparing an interpretative report.

Reports in preparation:

Pavlicek, Diane J., Small, Ted A., Rettman, Paul L., and Groschen, George E., Hydrologic and geologic data for aquifer tests along the "bad-water" line: U.S. Geological Survey Open-File Report.

Reports published, 1985-86: None

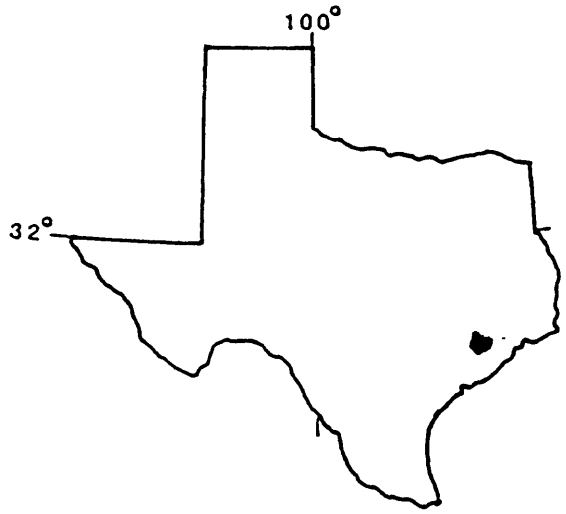
TX 86-095 EFFECTS OF GROUND-WATER DEVELOPMENT ON FORT BEND COUNTY

COOPERATING AGENCY : Fort Bend County

PROJECT CHIEF: Glenn Locke, Subdistrict Office, Houston

PERIOD OF PROJECT : October 1985 to September 1987

LOCATION : East-central Texas



Problem: Fort Bend County is one of the fastest growing counties in the United States and is dependent entirely on ground water for supply. An investigation of the ground-water resources of Fort Bend County was conducted by the U.S. Geological Survey in 1968-69. Since 1969, the increased development in Fort Bend County and the growth of Houston has required increased production of ground water. Fort Bend County has been impacted by declines of water levels, land-surface subsidence, and possibly, encroachment of saltwater from salt domes and by updip migration. Although the city of Houston has only one water well in Fort Bend County, declines in water levels in Fort Bend County due to pumpage in adjacent Harris County have been significant. Two large (25 to 30 Mgal/d) well fields in Fort Bend County, which have been planned by Houston, cause concern to Fort Bend County officials. Information on the current and potential impact of development is needed for planning purposes, which may include the creation of a subsidence control district.

Objectives: The objectives of the study are to update information collected in 1968-69, determine the impact of recent developmnt of ground water in Fort Bend County and the western part of Harris County, and delineate the areas most susceptible to land-surface subsidence.

Approach: Well inventory, pumpage inventory, and water-level measurement networks will be updated and expanded as necessary to provide adequate control in critical areas. A limited program of sampling wells in areas near salt domes, particularly the Blue Ridge Dome, will be instituted to monitor any salinity changes. Maps of water-level altitudes and changes since the county report (1969) will be made. Available data on land-surface subsidence will be collected. Areas most susceptible to land-surface subsidence will be described based on clay thickness (determined in this study) and compressibility (from studies in adjacent areas).

Progress: Study plans have been formulated, and compilation, and collection of water level, water samples, and well inventory data have been completed.

Plans: Plans are to analyze the data and prepare the final report.

Reports in preparation:

Locke, G. L., Ground-water development and conditions in Fort Bend County, Texas, 1986: U.S. Geological Survey Water Resources Investigations Report.

Reports published, 1985-86: None.

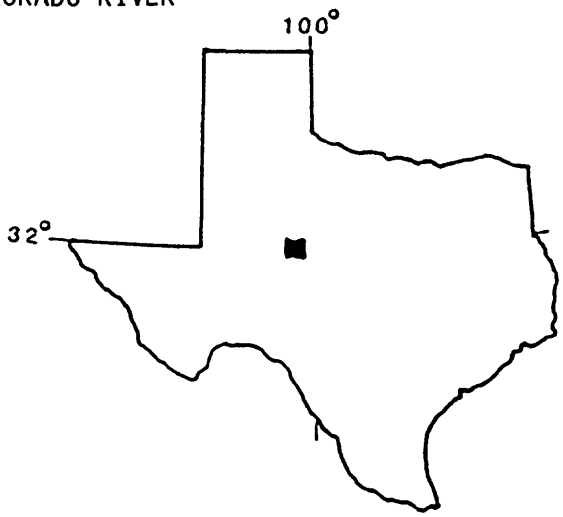
TX 86-096 GROUND-WATER CONTRIBUTION OF SALINITY IN THE UPPER COLORADO RIVER

COOPERATING AGENCY : Colorado River Municipal Water District

PROJECT CHIEF: Raymond M. Slade, Jr. District Office, Austin

PERIOD OF PROJECT : October 1985 to September 1988

LOCATION : Central Texas



Problem: A basinwide study of the quality of surface water by the U.S. Geological Survey indicated that significant increasing trends in the concentration of dissolved solids are occurring in a 40-mile reach of the Colorado River upstream from E. V. Spence Reservoir. From October 1972 to September 1982 the flow-adjusted concentration of dissolved solids in the Colorado River at Colorado City increased at an average rate of more than 270 mg/L per year. Similarly, the flow-adjusted concentration of dissolved solids in Beals Creek near Westbrook increased at an average rate of more than 270 mg/L per year. Several studies indicate that discharge of ground water contributes significantly to the salinity of the Colorado River upstream from E. V. Spence Reservoir. However, the large increasing trends of salinity in surface waters after 1972 is strong presumptive evidence that the inflow of saline ground water between Colorado City and the E. V. Spence Reservoir has resulted from causes other than the natural discharge of shallow ground water.

Objectives: The major objectives are to: (1) Delineate the source areas of saline ground-water inflow and quantify the quality and quantitiy of ground water to the study reaches; (2) identify and describe the aquifer(s) that may contribute water to the streams; (3) determine the historical ground-water conditions in the aquifer; (4) determine the current ground-water conditions; (5) locate and describe oil field activities; and (6) investigate the feasibility of using indirect techniques to identify specific sites of salinewater discharge.

Approach: The general approach follows: (1) Conduct several base-flow reconnaissance of the quantity and quality of streamflow in the reaches; (2) map the aquifers that crop out or underlie the study area as to areal extent, thickness, and depth, utilizing geologic maps, drillers' logs, geophysical logs, field observations, and existing technical literature. Emphasis will be on those aquifers that may discharge salinewater; (3) conduct a literature search; retrieve from computer storage water-level, water-quality, and related data in the study area, and tabulate and analyze such data to detect any significant changes or trends; (4) locate and inventory selected water wells and springs, including public supply, industrial, irrigation, and rural-domestic or stock

wells; (5) collect about 50 water samples from the inventoried wells and analyze the water for major inorganic chemical constituents; (6) locate and plot on maps all wells drilled in the search for oil and gas in the area; (7) tabulate the quantity of saltwater disposed, and indicate the methods of disposal; (8) tabulate data on secondary or enhanced recovery operations; and (9) test indirect methods of locating salinewater in the shallow subsurface by first locating a known source of salinewater discharge at the land surface.

Progress: Streamflow and water-quality data that relate to the area have been compiled. One gain-loss study has been conducted. Well inventories are nearly complete.

Plans: For the second year of the study, plans are to compile data on historical oil-field activities, conduct two gain-loss studies in the main streams, collect water samples from the wells and streams, describe the shallow aquifer systems that are in hydraulic connection with the streams, and begin analysis of the data as to the causes of increasing salinity.

Reports in preparation:

Slade, R. M., Jr., Hydrologic data for streams and aquifers in the upper Colorado River basin, Texas, 1986-87: U.S. Geological Survey Open-File Report.

Reports published, 1985-86: None

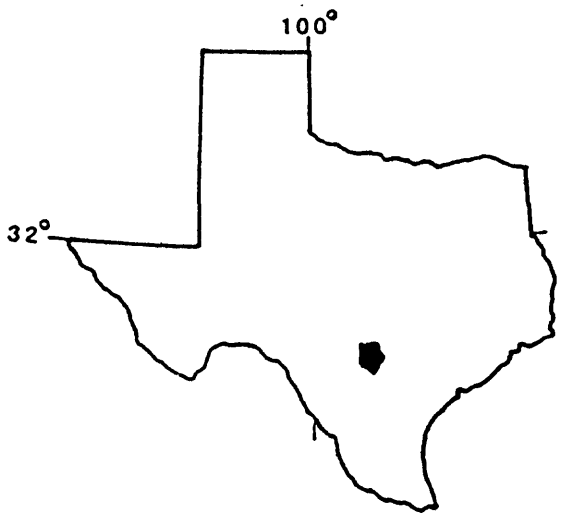
TX 86-098 LIMESTONE HYDROLOGY PROFESSIONAL PAPERS, THE EDWARDS AQUIFER, SAN ANTONIO AREA

COOPERATING AGENCY : San Antonio City Water Board

PROJECT CHIEF: Robert W. Maclay, Subdistrict Office, San Antonio

PERIOD OF PROJECT : October 1985 to September 1986

LOCATION : Central Texas



Problem: The Edwards aquifer is one of the most important limestone aquifers in the United States. It is a highly permeable and productive aquifer that has been designated the sole source of water supply for San Antonio and other towns in south-central Texas. The area needs for water are increasing rapidly, and this growth is projected to accelerate dramatically as the corridor between San Antonio and Austin undergoes expected population, agricultural, and industrial expansion.

For the past 80 years, the Geological Survey has collected, analyzed, and published a great deal of information concerning the Edwards aquifer and the streams which recharge the aquifer.

A consolidation of previously published reports in an integrated publication by the Survey needs to be prepared in order to allow the work of the Survey to be available to a large and diverse audience concerned about understanding the Edwards aquifer.

Objectives: The objective of this project is to prepare a single document on the hydrology of the Edwards aquifer in the San Antonio area that integrates current knowledge and scientific intuition concerning the hydrology of the aquifer. The intended audience of the report primarily will be the practitioner in the field of water resources and the technical reader. The report will be prepared as a Professional Paper, and will serve as a source and guide of the current understanding of and information about the hydrology of the Edwards aquifer.

Approach: All previously published reports and data and the current understanding of the hydrogeologic characteristics of the Edwards aquifer will be used in this project.

Progress: The outline has been reviewed and accepted and the initial draft of the report will be completed in the spring of 1987.

Plans: The work plans are to schedule a draft of the report by April 1987.

Reports in preparation:

Maclay, R. W., Hydrologic evolution of the Edwards aquifer in the San Antonio area, Texas: U.S. Geological Survey Professional Paper.

Reports published, 1985-86: None.

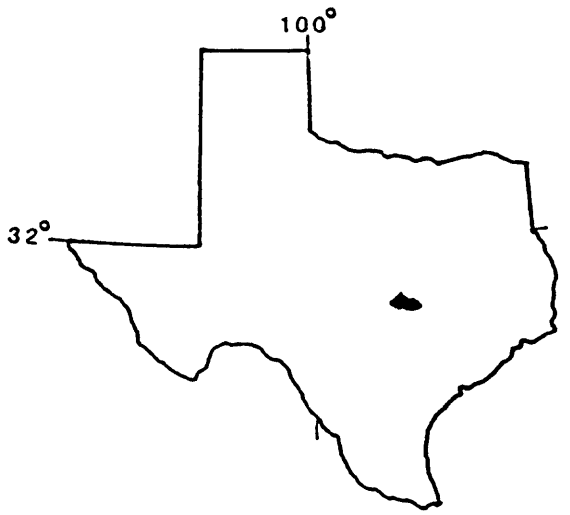
TX 86-099 RECHARGE CHARTERISTICS IN THE GEORGETOWN FORMATION IN THE GEORGETOWN AREA

COOPERATING AGENCY : Texas Water Development Board

PROJECT CHIEF: Larry F. Land, District Office, Austin

PERIOD OF PROJECT : March 1986 to September 1988

LOCATION : Central Texas



Problem: The Texas Water Development Board (TWDB) adopted rules for regulating activities that have the potential for causing pollution of the Edwards aquifer in Williamson County. During public hearings prior to the adoption of the Williamson County rules, several questions were raised about the hydrology of the Edwards aquifer and the extent of the "recharge zone." Most of these questions were related to recharge, specifically the possible flow of water through the Georgetown Formation, which directly overlies the Edwards aquifer. In order to address the issue of possible recharge to the Edwards through the Georgetown Formation, the TWDB agreed to an additional study of the Edwards (Balcones fault zone) aquifer at and in the immediate vicinity of the city of Georgetown.

Objective: The major objective of the investigation is to determine if the Edwards aquifer is recharged by infiltration of rain and streamflow through the Georgetown and Kiamichi Formations in the vicinity of Georgetown. If infiltration does occur, a secondary objective is to determine how readily water migrates vertically through these formations and what are the geologic features that convey the water from the surface to the main producing zone of the aquifer.

Approach: The primary approach is to install three clusters of three observation wells each. Each well will be open to a different stratum. Sites are to be located near the downdip limit of the exposure of the Georgetown Formation. Water-level maps will be prepared from data collected from a network of wells that are to be inventoried and selected for this purpose. The network will emphasize wells near streams. A network of sites along the major streams and tributaries will be selected to determine where streamflow gains and losses occur. Emphasis will be placed on finding sites at or near contacts between geologic formations. These streamflow surveys (three per year for the first two years) will coincide with the ground-water level mapping. Water samples will be collected and chemically analyzed for the standard inorganic constituents from each of the newly drilled observation wells and from 5 to 10 other wells and stream sites. Finally, detailed maps for each of the surface- and

ground-water surveys, hydrographs at observation wells, water chemistry geologic and hydraulic data, and geologic maps will be used to make the analyses and interpretations.

Progress: The network of observation wells and stream gaging sites have been selected and field-checked. The second of six synoptic surveys of streamflow gains and losses, and ground-water levels have been conducted. The sites for the three well clusters have been selected.

Plans: Continue to conduct synoptic surveys at approximately two-month intervals. Drill and install the clusters of observation wells. Install and operate water-level recorders at these wells. Water samples will be collected from each well in the cluster and from selected wells and stream sites in the network.

Reports in preparation: None.

Reports published, 1985-86: None.

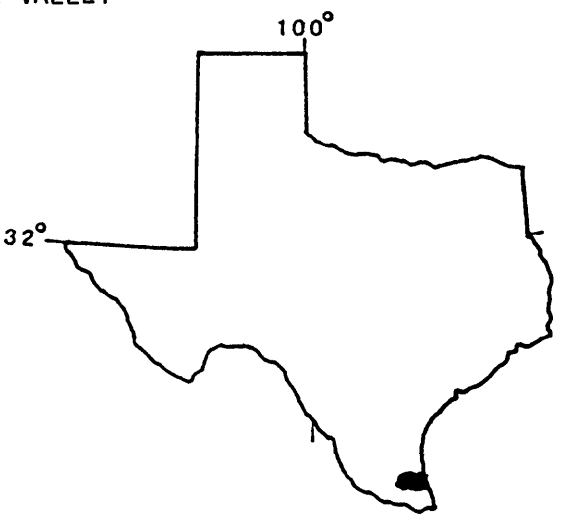
TX 86-100 IRRIGATION DRAINAGE QUALITY OF THE LOWER GRANDE VALLEY

COOPERATING AGENCY : Department of the Interior

PROJECT CHIEF: Frank C. Wells, District Office, Austin

PERIOD OF PROJECT : February 1986 to October 1987

LOCATION : South Texas



Problem: During the last several years, there has been increasing concern about the quality of irrigation drainage waters and its potential effects on human health, fish, and wildlife. To address the irrigation drainage quality issues, the Department of Interior will conduct studies to determine the extent of contamination in (1) project irrigation or drainage facilities constructed or managed by the Department, (2) National Wildlife Refuge areas managed by the Department, and (3) other migratory species management areas that receive water from Department-funded projects.

Objectives: The objectives are to: (1) Determine from existing information and field screening studies whether irrigation drainage waters have caused or have the potential to cause harmful effects on human health, fish, wildlife, or other water users; (2) conduct more detailed investigations if information indicates an existing or a high potential for harmful effects; (3) a planning process will be initiated to identify a cost-effective solution if study and evaluation indicate corrective action is justified; and (4) the Department will implement corrective action if necessary.

Approach: Collect existing data from State, local, and other Federal agencies and design a field screening study to evaluate the extent of contamination in irrigation drainage waters. The field screening study is designed to do extensive sampling at 15 locations in the lower Rio Grande Valley and the Laguna Atascosa National Wildlife Refuge for selected metals and pesticides in water and bed sediments. At four locations, water samples will be collected for GC-MS analysis to identify toxic organics associated with the agri-chemical industry. In addition, three of the fifteen stations will be selected for sampling of pesticides during a storm.

Progress: A field-screening study has been designed by an interagency task group, and sampling began in June 1986.

Plans: Data will be reviewed, compiled and reported during the 1987 fiscal year.

Reports in preparation: None.

Reports published, 1986-87: None.

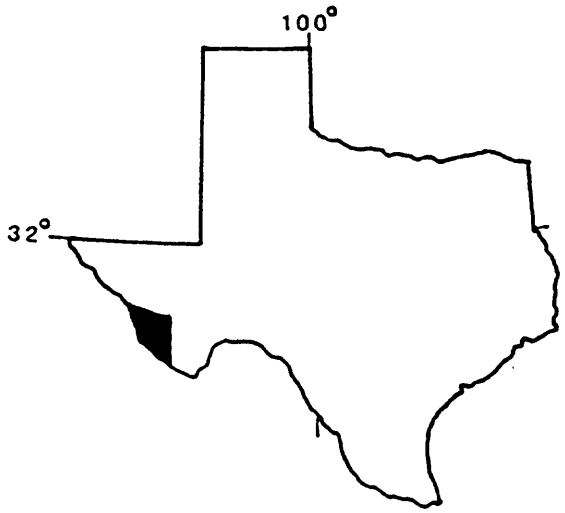
TX 86-101 GEOHYDROLOGY OF THE WATER RESOURCES OF OAK SPRING, BIG BEND NATIONAL PARK

COOPERATING AGENCY : National Park Service

PROJECT CHIEF: Ernest T. Baker, Jr., District Office, Austin

PERIOD OF PROJECT : June 1986 to September 1988

LOCATION : West Texas



Problem: Oak Spring is the sole source of water for a major developed area in Big Bend National Park. There is concern that water may migrate from sewage lagoons to the aquifer that supplies Oak Springs and thus, could contaminate this important spring. There is also concern regarding the ability of Oak Spring to continue to provide sufficient quantities of water for the developed area.

Objective: The objectives are to: (1) Describe the hydrology of the aquifer supplying Oak Spring; (2) determine the source of water supplying the spring and determine if the source includes the sewage lagoons; (3) determine the quality of water in the aquifer; (4) determine the direction and rate of groundwater movement; (5) determine the changes in water quality in the aquifer between the lagoons and the spring; (6) determine the factors that influence the quantity and quality of water from the spring.

Approach: The approach includes the following: (1) Map the surface geology related to Oak Spring; (2) study the subsurface geologic features controlling water movement using test drilling and geophysical surveys (borehole and surface). Test holes will define hydraulic properties of the aquifer and serve to monitor water quality; (3) collect water samples from springs, test wells, lagoons, and other sources, and analyze samples for a wide range of constituents and properties and compare the results with historical data; (4) estimate the water budget of the aquifer supplying the spring. Recorders will be installed in Oak Spring and observation wells.

Progress: The Oak Spring area has been investigated on a reconnaissance basis. Water-quality samples were collected and the spring water was age-dated. Color aerial photographs of the study area were obtained.

Plans: Plans are to map the surface geology and study the subsurface geology with respect to infiltration losses and water movement. Also to investigate the subsurface area using test drilling and seismic surveys in the basin and in the vicinity of Oak Spring, and collecting and analyzing water-quality samples

from wells, Oak and Window Springs, and the sewage lagoons. Interpretations of the data resulting from these activities are expected to identify the source of water for Oak Spring and to meet other objectives of the study.

Reports in Preparation:

Baker, E. T., Jr., and others, Geohydrology of the water resources and the potential for contamination of the Oak Springs, Big Bend National Park, Texas: U.S. Geological Survey Water Resources Investigations Report.

Reports Published, 1986-87: None.

REPORTS PUBLISHED OR APPROVED FOR PUBLICATION IN FISCAL YEARS 1985-86

Andrews, Freeman L., and Schertz, Terry L., 1986, Statistical summary and evaluation of the water quality of surface water in the Colorado River basin, Texas, 1973-82 water years: U.S. Geological Survey Water-Resources Investigations Report 85-4181, 97 p.

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