WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN TEXAS-- FISCAL YEAR 1988

Compiled by Alicia A. Mitchell

U.S. GEOLOGICAL SURVEY
Open-File Report 89-73

Austin, Texas
1989

UNITED STATES DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

GEOLOGICAL SURVEY

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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 bases of court decrees, interstate compacts, international treaties, and water law.

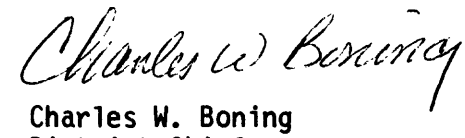
To accomplish its responsibility of providing hydrologic information, the Texas District of the Geological Survey, in cooperation with approximately 68 Federal, State, and local agencies, has established and operates a vast Statewide program for the collection and analysis of hydrologic, water-use, and 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 water-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 manmade, 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 YEAR 1988

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 to examine 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 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 year 1988 (October 1987 to September 1988).

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 at 8011 Cameron Road, Austin, Texas 78753. 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.

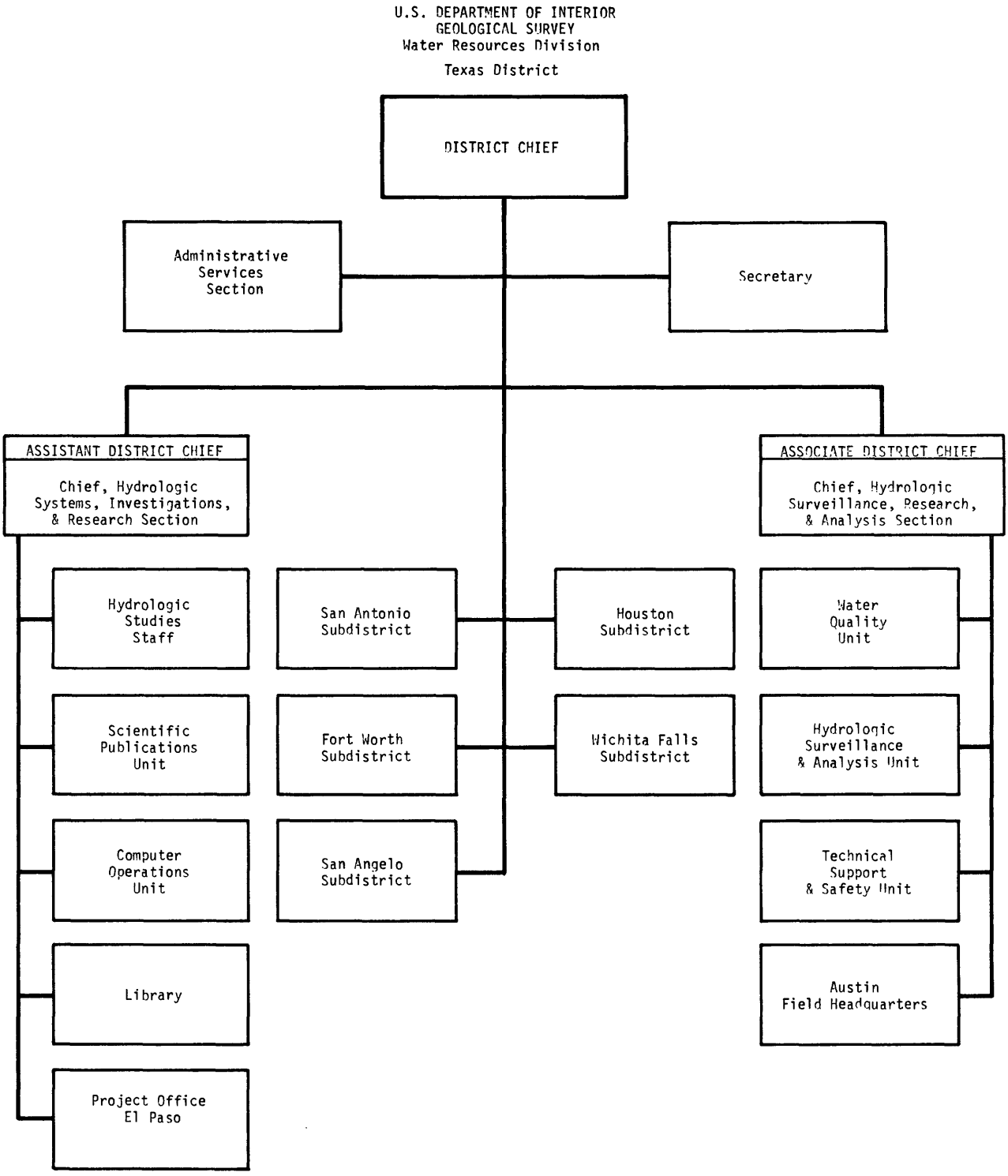


Figure 1.--Organizational chart of the Texas District.

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 Fort Worth, Houston, San Angelo, San Antonio, and Wichita Falls, and Field Headquarters in Austin and El Paso. Requests for information should be addressed as follows:

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Hydrologist
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El Paso, TX 79901
Telephone: (915) 534-6908

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 year 1988 are:

Federal

Federal Emergency Management Agency
International Boundary and Water Commission, United States and Mexico, U.S. Section
National Park Service
U.S. Air Force, Occupational and Environmental Health Laboratory
U.S. Air Force, Air Training Command
U.S. Air Force, Kelly Air Force Base
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
U.S. Army, Fort Hood, Texas
U.S. Bureau of Reclamation
U.S. Fish and Wildlife Service
U.S. Geological Survey

State

Texas Water Commission. Allen Beinke, Executive Director; Paul Hopkins, Chairman; Buck J. Wynn, III and John O. Houchins, Commissioners.

Texas Water Development Board. M. Regional Arnold II, Executive Administrator: Louie Welch, Chairman; Stuart S. Coleman, Vice Chairman; Wesley Pittman, Glen E. Roney, Thomas M. Dunning, and Charles W. Jenness, Members.

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. Chabert for Louisiana; and J.T. McMahon and Danny Choate for Texas.

Local

City of:

Abilene	Gainesville	Nacogdoches
Arlington	Garland	Runaway Bay
Austin	Georgetown	San Angelo
Carrollton	Graham	Wichita Falls
Corpus Christi	Houston	
Fort Stockton	Lubbock	

Bexar-Medina-Atascosa Counties Water Improvement District No. 1
Brazos River Authority
City Public Service Board of San Antonio
Coastal Industrial Water Authority
Colorado River Municipal Water District
Dallas Public Works Department
Dallas Water Utilities Department
Edwards Underground Water District
El Paso Public Service Board
Franklin County Water District

Galveston County
Greenbelt Municipal and Industrial Water Authority
Guadalupe-Blanco River Authority
Harris County Flood Control District
Harris-Galveston Coastal Subsidence District
Lavaca-Navidad River Authority
Lower Colorado River Authority
Lower Neches Valley Authority
North Central Texas Municipal Water Authority
Northeast Texas Municipal Water District
Orange County
Pecos River Commission
Red Bluff Water Power Control District
Sabine River Authority of Texas
Sabine River Compact
San Antonio City Water Board
San Antonio Department of Environmental Management
San Antonio Department of Public Service Board
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

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 1988 are given in table 1. All active (January 1988) 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 53 continuous-precipitation stations. Also, hydrologic data also are often collected for short periods of time in support of investigative studies. These data are published in interpretive 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, 1988

Station classification	Total
Surface-water stations	
Discharge:	
a. Continuous record	368
b. Partial record	96
Stage only--streams:	
a. Continuous record	38
b. Partial record	0
Stage only--lakes and reservoirs:	
a. Continuous record	77
b. Partial record	0
Quality:	
a. Continuous record	88
b. Scheduled, long-term operations	208
c. Short-term or project stations	11
Ground-water stations	
Water levels:	
a. Continuous record	34
b. Scheduled, long-term operations	1,035
c. Short-term or project stations	64
Quality:	
a. Scheduled long-term operations	239
b. Short-term or project stations	44

Table 1.--Hydrologic-data stations, 1988--Continued

Station classification	Total
Precipitation stations	
Quantity	53
Quality	2
Sediment stations	
Daily sampling	0
Periodic sampling:	
a. NASQAN	30
b. Other	34
c. Total sediment stations	64
Data-collection platforms (DCP)	
Operated by U.S. Geological Survey	193
Operated by others	4
Streams or reservoirs	187
Wells	6
Water quality	24
Precipitation	22

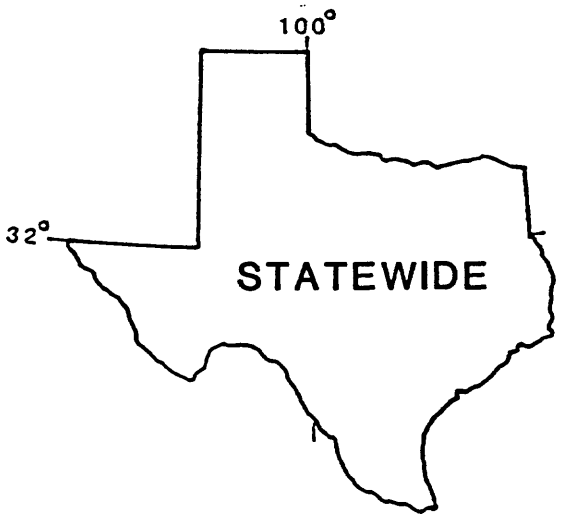
TX 00-001 SURFACE-WATER DATA PROGRAM

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

PROJECT CHIEF: 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. Surface-water records are computed on a continuing basis and the data are published annually.

Reports in preparation:

Gain, W.S., 1989, Time of travel of solutes in the Trinity River from Dallas to Trinidad, Texas, May and August 1987: U.S. Geological Survey Open-File Report.

Sladek, G.J., Water resources reports prepared by the U.S. Geological Survey, Texas District, 1973-88.

U.S. Geological Survey, 1989, Water resources data--Texas, water year 1988, Arkansas River, Red River, Sabine River, Neches River, and Trinity River basins and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 88-1.

------ 1989, Water resources data--Texas, water year 1988, San Jacinto River, Brazos River, and San Bernard River basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 88-2.

------ 1989, Water resources data--Texas, water year 1988, Colorado River, Lavaca River, Guadalupe River, Nueces River, and Rio Grande basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 88-3.

Veenhuis, J.E., and Slade, R.M., Jr., Relation between urbanization and the water-quality characteristics of streams in the Austin area, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports approved or published, 1988:

Andrews, F.L., Wells, F.C., Shelby, W.J., and McPherson, E.M., 1988 (in press), Water quality of Lake Austin and Town Lake, Austin, Texas: U.S. Geological Survey Water-Resources Investigations Report 88-4233.

Gordon, J.D., Pate, D.L., and Slagle, D.L., 1988, Hydrologic data for urban studies in the Austin metropolitan area, Texas, 1986: U.S. Geological Survey Open-File Report 87-768, 144 p.

Mitchell, A.A., 1988, Water-resources activities of the U.S. Geological Survey in Texas--Fiscal year 1987: U.S. Geological Survey Open-File Report 88-100, 92 p.

Rawson, Jack, Carrillo, E.R., and Buckner, H.D., 1988, Index of surface-water stations in Texas, January 1988: U.S. Geological Survey Open-File Report 88-483, 17 p.

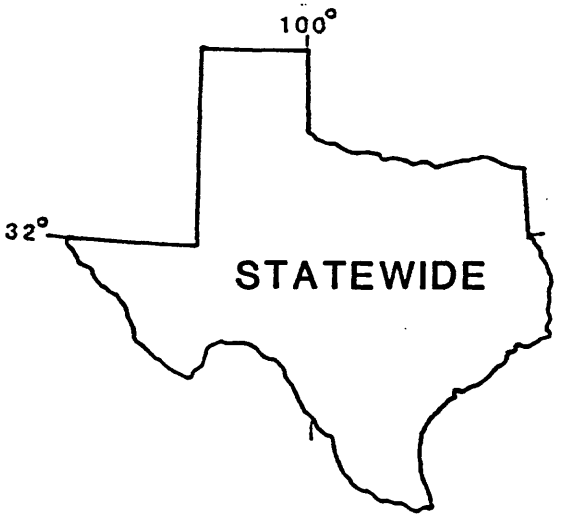
U.S. Geological Survey, 1988, Water resources data--Texas, water year 1987, Arkansas River, Red River, Sabine River, Neches River, and Trinity River basins and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 87-1, 443 p.

------ 1988, Water resources data--Texas, water year 1987, San Jacinto River, Brazos River, and San Bernard River basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 87-2, 419 p.

------ 1988, Water resources data--Texas, water year 1987, Colorado River, Lavaca River, Guadalupe River, Nueces River, and Rio Grande basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 87-3, 417 p.

TX 00-002 GROUND-WATER DATA PROGRAM

COOPERATING AGENCIES : City of Austin,
U.S. Air Force,
Air Training Command
U.S. Army,
Fort Bliss,
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: B.C. Massey,
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 00-00230 (El Paso ground water), TX 00 00250 (Houston ground water), TX 00-00251 (Subsidence, Texas Gulf Coast), TX 00-00252 (Orange County ground water), and TX 00-00272 (San Antonio ground water), are collected, compiled, and reported under project TX 00-002 ground-water data program (table 1). In addition to these subprojects, data-collection networks are operated in the Austin and Ft. Bliss areas. Technical assistance in evaluating the geohydrology at selected U.S. Air Force bases is being provided to the U.S. Air Force, Air Training Command. A Statewide ground-water monitoring program is operated by the Texas Water Development Board. These data are available from the Board.

Reports in preparation:

Land, L.F., and Dorsey, M.E., Summary of hydrologic data, San Gabriel River basin and Edwards aquifer, Georgetown area, Texas, 1988 water year: U.S. Geological Survey Open-File Report.

Ozuna, G.B., and Small, T.A., Hydrogeology of Lackland Air Force Base, San Antonio: U.S. Geological Survey Water-Resources Investigations Report.

Also see projects TX 00-00230, TX 00-00250, TX 00-00251, TX 00-00252, and TX 00-00272.

Reports approved or published, 1988: See projects TX 00-00230, TX 00-00250, TX 00-00251, TX 00-00252, and TX 00-00270.

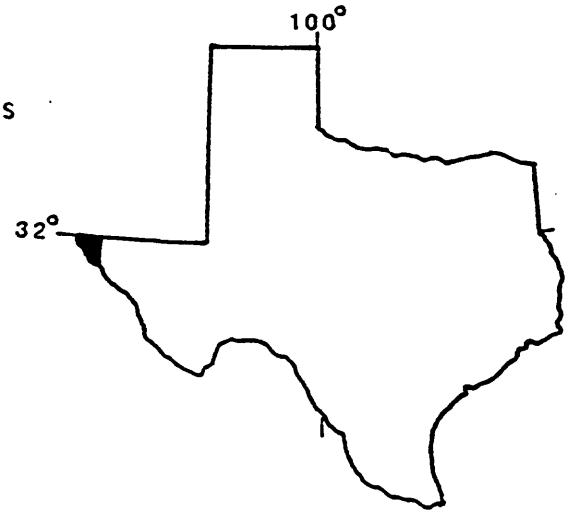
TX 00-00230 GROUND-WATER STUDIES IN THE EL PASO AREA

COOPERATING AGENCY : El Paso Public Service Board
U.S. Army, Fort Bliss

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 water supplies are obtained. The potential for saline-water 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; and prepare a data summary report.

Reports in preparation:

White, D.E., Hydrologic data summary of ground-water data in the El Paso area, Texas, 1976-85: U.S. Geological Survey Open-File Report.

Reports approved or published, 1988: None

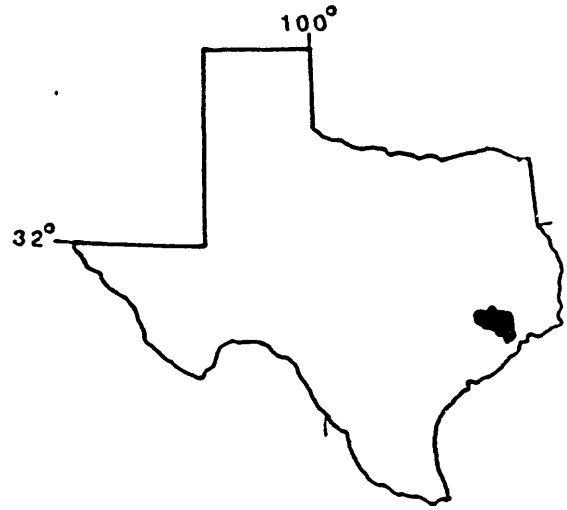
TX 00-00250 GROUND-WATER STUDIES IN THE GREATER HOUSTON AREA

COOPERATING AGENCY : City of Houston

PROJECT CHIEF: Dana L. Barbie, 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 planning.

Objective: To provide current up-to-date information on the status of fresh-water in the aquifers underlying the greater Houston area and to relate water levels and water-quality changes to increasing ground-water withdrawals in the area.

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

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 75 wells in areas near salt domes, chloride concentrations will be determined and specific conductance will be measured. The next 5-year update describing the effects of ground-water development will include 1985-89. Water-level and well-schedule data will be entered into GWSI (Ground-Water Level Site Inventory).

Reports in preperation: None.

Reports approved or published, 1988:

Gabrysch, R.K., Ranzau, C.E., Jr., and Coplin, L.S., 1988, Approximate altitude of water-levels in the Chicot and Evangeline aquifers in the Houston area, Texas, spring 1988: U.S. Geological Survey Open-File Report 88-334, 2 sheets.

------ 1988, Approximate water-level changes in wells completed in the Chicot and Evangeline aquifers, 1977-88 and 1987-88, and measured compaction, 1973-88, in the Houston-Galveston region, Texas: U.S. Geological Survey Open-File Report 88-168, 7 sheets.

Williams, J.F., III, Ranzau, C.E., Jr., Lind, W.B., and Coplin, L.S., 1987, Records of wells, drillers' logs, water-level measurements, and chemical analyses of ground water in Brazoria, Fort Bend, and Waller Counties, Texas, 1980-84: Texas Water Development Board Report 303, 53 p. (USGS OFR 86-068, 1986).

Williams, J.F., III, Coplin, L.S., Ranzau, C.E., Jr., and Lind, W.B., 1987, Records of wells, drillers' logs, water-level measurements, and chemical analyses of ground water in Chambers, Liberty, and Montgomery Counties, Texas, 1980-84, Texas Water Development Board 304, 39 p. (USGS OFR 86-057, 1986).

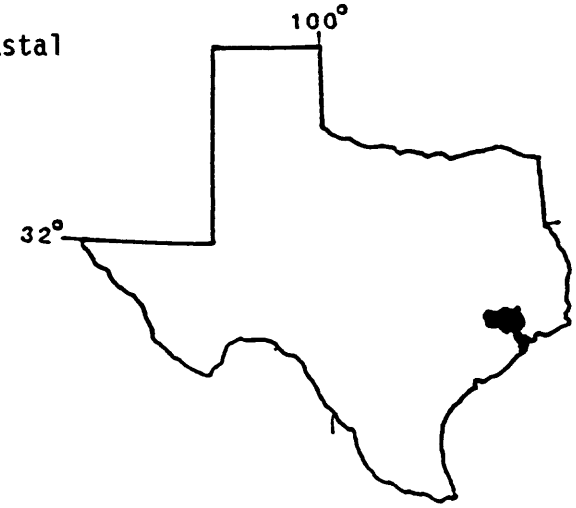
TX 00-00251 SUBSIDENCE STUDIES ALONG THE TEXAS GULF COAST

COOPERATING AGENCY : Harris-Galveston Coastal Subsidence District

PROJECT CHIEF: Dana L. Barbie, 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. An area of about 1,355 square miles in the northern part of the Gulf Coast has subsided 1 foot or more since 1943. The area of maximum subsidence is near Pasadena where there was 9 feet of subsidence 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 caused by the withdrawals of ground water and to determine the possible relation between faulting, land-surface subsidence, and drainage changes at elevations not subject to flooding by tidal waters.

Approach: Continue the data-collection and research including the following: Collecting land-surface altitudes at the network of extensometers; updating specific unit-compaction values, investigating the relation between aquifer conditions and ground-water withdrawals; and determining changes in drainage patterns.

Progress: Data have been collected at a network of sites to measure compaction, horizontal strain, and changes in stress. A comprehensive report has been prepared describing subsidence through 1987.

Plans: Hydrologic and extensometer data collection will be continued to better define the relation between ground-water withdrawal and land-surface subsidence. Analysis of the effects of localized subsidence on drainage is planned. A report of subsidence and water-level changes during 1988 will be prepared for the annual hearing of the Harris-Galveston Coastal Subsidence District in March 1989.

Reports in preparation:

Gabrysch, R.K., and Coplin, L.C., Land-surface subsidence resulting from ground-water withdrawals in the Houston-Galveston region, Texas through 1987: Harris-Galveston Coastal Subsidence District report.

Reports approved or published, 1988: None.

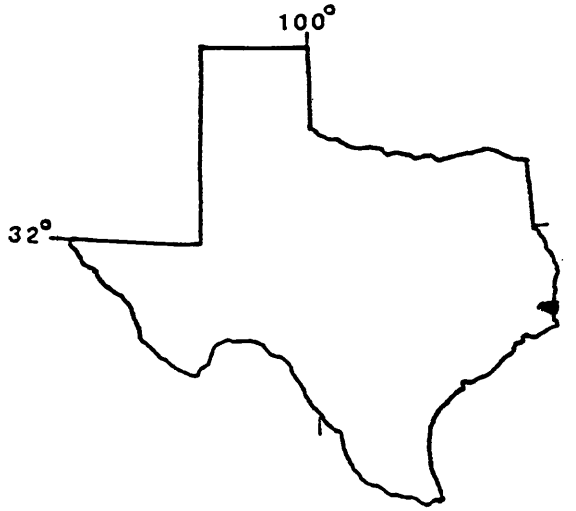
TX 00-00252 GROUND-WATER STUDIES IN ORANGE COUNTY AND ADJACENT AREAS

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; compile annual ground-water pumpage for municipal and industrial uses; and 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. Water levels were measured in the spring and in the fall to record the effects of ground-water withdrawals in the summer. 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: None.

Reports approved or published, 1988:

Bonnet, C.W., and Williams, James F., III, 1987, Development of ground-water resources in the Orange County area, Texas and Louisiana, 1980-spring of 1985: U.S. Geological Survey Water-Resources Investigations Report 87-4158, 50 p.

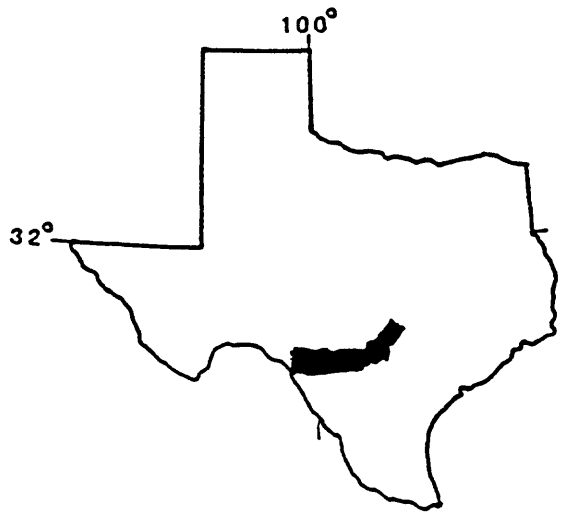
TX 00-00270, 00271, GROUND-WATER STUDIES OF THE SAN ANTONIO AREA AND BALCONES FAULT ZONE

COOPERATING AGENCIES : Edwards Underground Water District

PROJECT LEADERS : Paul L. Rettman, sampling network; and Gregory M. Nalley, annual report, 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 flow ceases. 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; compiling municipal, industrial, military, and irrigation pumpage and spring discharge data; determining recharge to the Edwards aquifer; and collecting water samples for chemical analyses, including but not limited to, inorganic, biologic, pesticide, and minor element determinations.

Progress: Hydrologic data were collected and compiled from a network of stream-gaging stations and wells as scheduled. Monitoring to date indicates little 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 freshwater/saline water interface in order to detect changes in water quality as the potentiometric head in the aquifer changes.

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

Reports in preparation:

Nalley, G.M., and Rettman, P.L., Hydrologic data of the Edwards aquifer, San Antonio area, Texas, 1987: U.S. Geological Survey Open-File Report.

Reports approved or published, 1988:

Nalley, G.M., and Rettman, P.L., 1988, Compilation of hydrologic data for the Edwards aquifer, San Antonio area, Texas, 1987, with 1934-87 summary: Edwards Underground Water District Bulletin 47, 154 p., 6 plates.

Ozuna, G.B., Nalley, G.M., and Stein, W.G., 1988, Compilation of hydrologic data for the Edwards aquifer, San Antonio area, Texas, 1986, with 1934-86 summary: Edwards Underground Water District Bulletin 46, 147 p., 5 plates.

Roddy, W.R., 1988 (in press), Water quality of the Edwards aquifer and streams recharging the aquifer in the San Antonio region, Texas: U.S. Geological Survey Hydrologic Investigations Atlas.

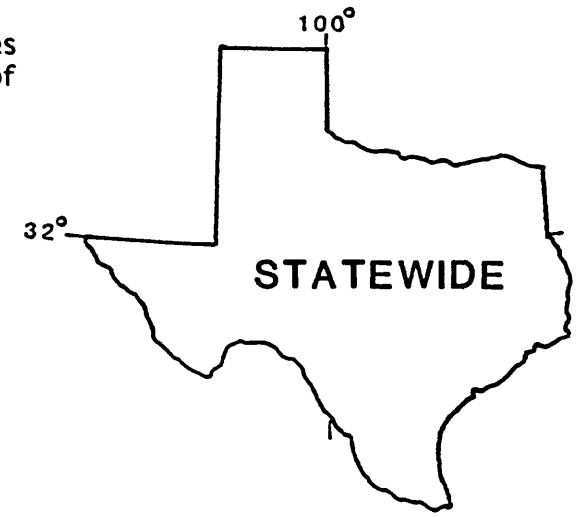
TX 00-003 QUALITY OF WATER DATA PROGRAM

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 caused by 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. Twenty-seven 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.

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:

U.S. Geological Survey, 1989, Water resources data--Texas, water year 1988, Arkansas River, Red River, Sabine River, Neches River, and Trinity River basins and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 88-1.

------- 1989, Water resources data--Texas, water year 1988, San Jacinto River, Brazos River, and San Bernard River basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 88-2.

------- 1989, Water resources data--Texas, water year 1988, Colorado River, Lavaca River, Guadalupe River, Nueces River, and Rio Grande basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 88-3.

Reports approved or published, 1988:

Rawson, Jack, Carrillo, E.R., and Buckner, H.D., 1988, Index of surface-water stations in Texas, January 1988: U.S. Geological Survey Open-File Report 88-483, 17 p.

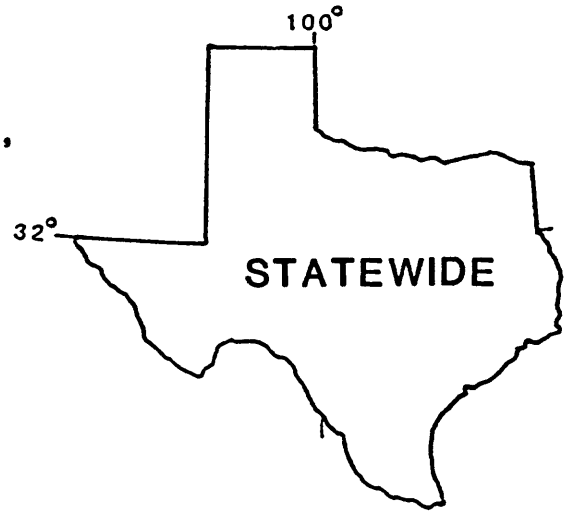
TX 00-004 SEDIMENT DATA PROGRAM

COOPERATING AGENCIES : U.S. Army Corps of Engineers

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

PERIOD OF PROJECT : Continuous

LOCATION : Statewide



Program: Data collected in the sediment data continuing program 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 64 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, 1989, Water resources data--Texas, water year 1988, Arkansas River, Red River, Sabine River, Neches River, and Trinity River basins and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 88-1.

------- 1989, Water resources data--Texas, water year 1988, San Jacinto River, Brazos River, and San Bernard River basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 88-2.

------- 1989, Water resources data--Texas, water year 1988, Colorado River, Lavaca River, Guadalupe River, Nueces River, and Rio Grande basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 88-3.

Reports approved or published, 1988:

Andrews, F.L., 1988 (in press), Monthly and annual suspended sediment loads in the Brazos River at Richmond, Texas, 1966-86 water years: U.S. Geological Survey Water-Resources Investigations Report 88-4216.

U.S. Geological Survey, 1988, Water resources data--Texas, water year 1987, Arkansas River, Red River, Sabine River, Neches River, and Trinity River basins and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 87-1, 443 p.

------ 1988, Water resources data--Texas, water year 1987, San Jacinto River, Brazos River, and San Bernard River basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 87-2, 419 p.

------ 1988, Water resources data--Texas, water year 1987, Colorado River, Lavaca River, Guadalupe River, Nueces River, and Rio Grande basins, and intervening coastal basins: U.S. Geological Survey Water-Data Report TX 87-3, 417 p.

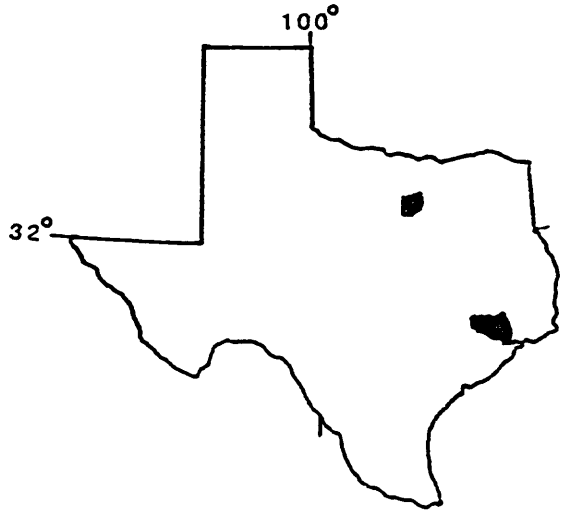
TX 00-005 NATIONAL TRENDS NETWORK STATIONS

COOPERATING AGENCY : U.S. Geological Survey

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

PERIOD OF PROJECT : Continuous since 1983

LOCATION : Northeast-central and southeast-central Texas



Program: Because there is a potential for damage to the environment from acid rain, more knowledge of precipitation chemistry and resulting effects on the environment in the Nation are necessary to help avert future problems. Work on this project includes determining variations in atmospheric deposition that occur on a week-to-week basis, and collecting wet and dry deposition products for analysis of elements and compounds that can contribute to the chemical composition of surface waters.

Monitoring stations were established as part of the National Trends Network. Personnel maintain stations, make onsite measurements, process samples, and submit samples to an analytical laboratory. Two monitoring stations have been established in the Fort Worth Subdistrict and in the Houston Subdistrict. The data are collected on a weekly basis.

Data retrievals are verified and reports on the results are prepared. Reports will be prepared at the regional and national levels.

Reports in preparation: None.

Reports approved or published, 1988: None.

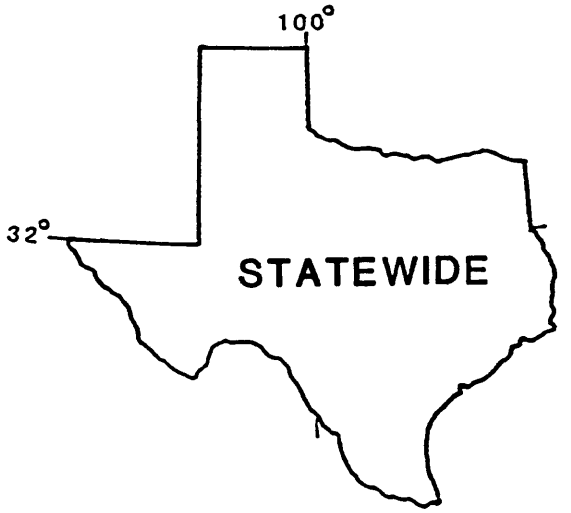
TX 00-006 FLOOD INVESTIGATIONS

COOPERATING AGENCY : Federal Emergency Management Agency

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

PERIOD OF PROJECT : Continuing

LOCATION : Statewide



Program: 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.

Work on the program includes conducting the necessary hydrologic and hydraulic evaluations and studies of areas assigned by FEMA by making surveys by ground or photogrammetric methods and applying appropriate engineering techniques. Also, determining flood-discharge frequency relations using historical information and determining water-surface profiles using step-backwater streamflow models or by other acceptable methods. The results are submitted to FEMA.

The Limited Detail Federal Insurance Study for Del Rio, Poteet, and Alpine were completed and submitted to FEMA during the 1988 fiscal year. Limited Detail flood insurance studies are now in progress for Kaufman and Hunt Counties. Field data collection for these studies is about 95-percent complete and computer data files are now being prepared for the hydraulics computations. The completion dates for these studies are March 1989 for the Hunt County study, and June 1989 for the Kaufman County study.

Reports in progress: None.

Reports approved or published, 1988: None.

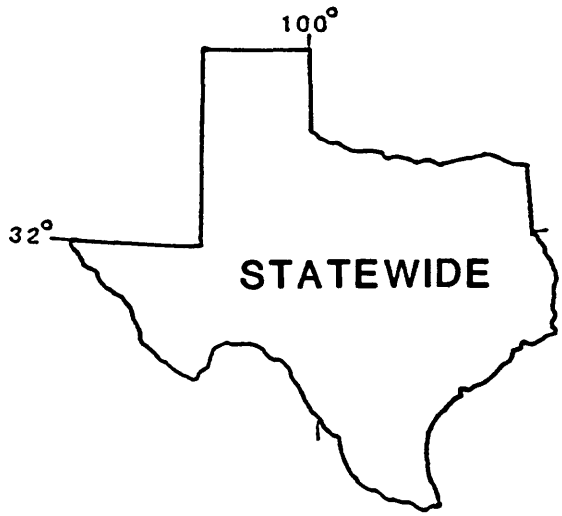
TX 78-007 WATER-USE DATA PROGRAM

COOPERATING AGENCIES : Texas Water Development Board,
City of Houston,
Federal,
Edwards Underground Water District,
El Paso Public Service Board,
Harris-Galveston Coastal Subsidence District,

PROJECT CHIEF: Dee L. Lurry,
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 data 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.

The primary objective of this program is to transfer water-use data from the Texas Water Development Board computerized data base to the USGS Aggregated Water-Use Data System (AWUDS). A secondary objective is to continue a program at the State level that includes collecting and compiling water-use data and developing and operating a State-level computer data-handling system to disseminate data to local users. A third objective is to estimate annual water use for 12 categories for inclusion in reports on water use in Texas and use by Geological Survey project personnel.

The project responsibilities are divided between the Survey and Texas Water Development Board. Direction, management, and standards development to meet the national needs will be the responsibility of the Survey while the State needs will be the responsibility of the Board. The major operational responsibilities of the Survey include developing computer software for reformatting and recoding the water-use data from the Board's computer tapes for loading to AWUDS and loading the data set to AWUDS for a recent and complete year. The major operational responsibility of the Board is to copy selected water-use data to computer tapes from existing Board data files.

The Board 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 latest year for

estimation. Annually, the Board has prepared a computerized data tape for use by the Survey. Water use for 1985 for 12 categories was assimilated by Survey personnel and submitted to Headquarters for inclusion in the National water use report entitled "Estimated use of water in the United States, 1985."

The Board is continuing to collect water-use data by identified categories. The Survey will also prepare an atlas for publication which will present the latest available State water-use data.

Reports in preparation:

Lurry, D.L., and Barber, Nancy L., Withdrawals of freshwater in Texas, 1985: U.S. Geological Survey Water-Resources Investigations Report.

Reports approved or published, 1988: 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. The summaries include currently funded projects as well as other projects that have reports in preparation or published in 1988.

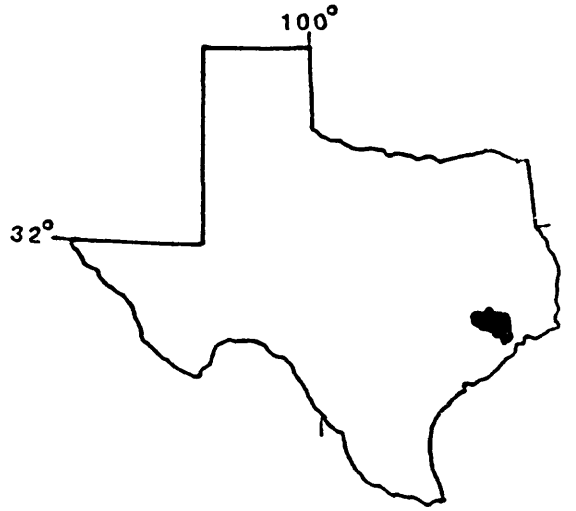
TX 65-028 URBAN HYDROLOGY STUDY IN THE HOUSTON METROPOLITAN AREA

COOPERATING AGENCIES : City of Houston

PROJECT CHIEF: Fred Liscum, Subdistrict Office, Houston

PERIOD OF PROJECT : July 1964 to September 1988

LOCATION : Southeast Texas



Problem: The city of Houston experiences severe flood problems associated with storm 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: 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; to delineate actual floods to determine flood hazard areas; 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; to establish techniques for predicting flood frequencies in an urbanized area; and to determine the effects of various land uses on the water quality of storm runoff.

Approach: Drainage basins with different hydrologic characteristics were instrumented to collect simultaneous rainfall-runoff data. Field surveys were conducted to determine areas affected by unusual floods. Water-quality samples were 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 urbanized area.

Plans: The hydrologic data-collection program ended in fiscal year 1988. Reports presenting (1) the effects of urbanization on the surface-water hydrologic response of the area, (2) statistical summary and review of the hydrologic data, and (3) predicting contributions to receiving channel water quality from single land-use nonpoint sources will be prepared.

Reports in preparation:

Liscum, Fred, Effects of urbanization on flood peaks and volumes in the Houston area, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Liscum, Fred, Kasmarek, M.C., and Brown, D.W., Statistical summary of hydrologic data for urban studies in the Houston, metropolitan area, Texas, 1965-86: U.S. Geological Survey Open-File Report.

Reports approved or published, 1988: None.

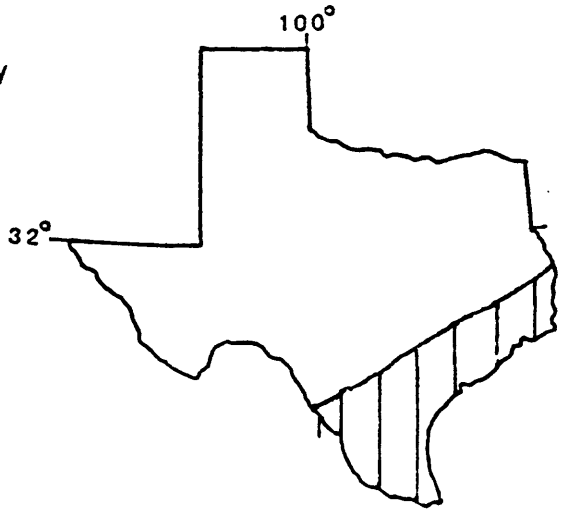
TX 82-075 WEST GULF COAST REGIONAL AQUIFER-SYSTEM ANALYSIS (RASA)--TEXAS AQUIFER SYSTEM

COOPERATING AGENCY : U.S. Geological Survey

PROJECT CHIEF: Paul Ryder, District Office, Austin

PERIOD OF PROJECT : March 1982 to September 1989

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, land subsidence, and saltwater intrusion. Other areas within the Texas part have significant potential for additional development of ground water, but the effects of large increases in possible developments are not known.

Objective: To support 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, to participate in the development of a computerized data base, to correlate the continuity of aquifers with adjacent states, to develop and calibrate ground-water-flow models, and to estimate future water needs to estimate the response of the aquifer to future withdrawals.

Approach: Identification and delineation of aquifers and confining beds shall be accomplished by development of hydrologic sections, review of published information, and 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: A report entitled "Hydrogeology and predevelopment flow in the Texas Gulf Coast Aquifer Systems" was approved as WRIR 87-4248. The report describes the hydrogeologic framework and the simulated flow system prior to development.

Calibration of a transient model that includes a land-surface subsidence code was completed. Preparation of the Professional Paper, titled "Hydrology of the Texas Gulf Coast aquifer system", continued.

Plans: The Professional Paper will be completed and submitted for review and approval. Hydrostratigraphic dip (four) and strike (two) sections will be completed and a report submitted for review and approval.

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.

Ryder, P.D., and Ardis, A.F., Hydrology of the Texas Gulf Coast aquifer systems: U.S. Geological Survey Professional Paper 1416.

Reports approved or published, 1988:

Ryder, Paul D., 1988, Hydrogeology and predevelopment flow in the Texas Gulf Coast aquifer systems: U.S. Geological Survey Water-Resources Investigations Report 87-4248, 109 p.

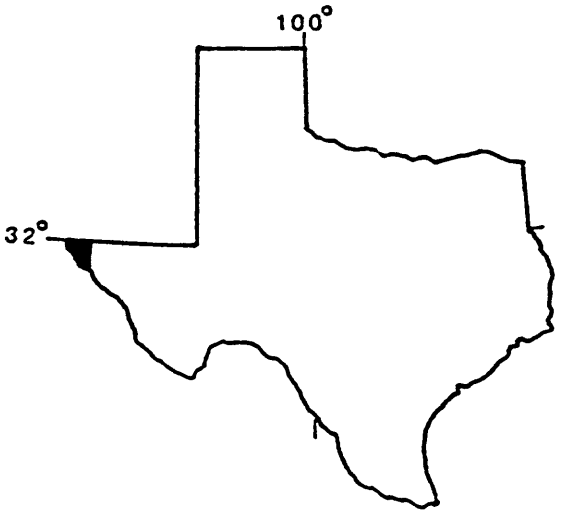
TX 83-080, 081 SOLUTE-TRANSPORT MODELING OF GROUND WATER IN THE HUECO BOLSON, EL PASO-FORT BLISS AREA

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

PROJECT CHIEF: George Groschen, Subdistrict Office, San Antonio

PERIOD OF PROJECT : October 1982 to September 1985

LOCATION : West Texas



Problem: More than 10 million acre-feet of fresh ground water in the Hueco bolson are being depleted. The quality of the freshwater is threatened by the intrusion of saline water 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 relation between the saline water and the freshwater is poorly understood.

Objectives: To define and quantify the hydrologic effects of historic and projected pumping through the use of a solute-transport ground-water flow model; to use this model to determine the movement of saline water; and to determine the model's reliability and parameter sensitivity and recommend procedures for improving its reliability and accuracy.

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

Summary: The simulations of the movement of saline water in the Hueco bolson aquifer indicate that the historical movement of saline water has been confined to the zone near and underneath the Rio Grande. The sediments of the Rio Grande contain slightly saline to saline water over most of the study area. The primary cause for movement of the saline water is the large quantities of water withdrawn from the freshwater zone of the aquifer. The data available for calibrating the simulated movement of saline water is inadequate to accurately assess the small amount of simulated historical movement. Simulations of pumping stresses expected to 2000, indicate that the saline-water movement will continue primarily near the Rio Grande. Water levels in the aquifer will decline more than 200 to 250 feet below the estimated predevelopment conditions. This fact created a limitation on the length of time that could be simulated using projections of pumping into the future.

Test simulations of pumping around one and two wells showed that even under various poorly defined aquifer conditions, upconing of saline water probably will not occur. The length of most municipal well screens in the aquifer prevent obtaining accurate information on the actual source of increased salinity to some wells. The test simulations and field information indicate that lateral transport along or near the water table is the most likely route of saline water to wells. The report will be submitted for approval in 1989.

Plans: The report is expected to be approved and published in 1989.

Reports in preparation:

Groschen, G.E., Numerical-simulation analysis of the movement of saline water in the Hueco bolson, El Paso-Fort Bliss area, Texas: U.S. Geological Survey Water-Supply Paper.

Reports approved or published, 1988: None.

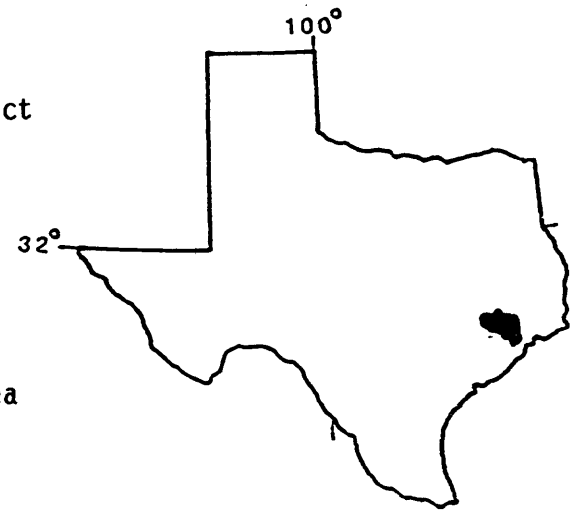
TX 83-082 NEAR-REAL-TIME FLOOD ROUTING ALONG CYPRESS CREEK, HARRIS COUNTY

COOPERATING AGENCY : Harris County Flood Control District

PROJECT CHIEF: Fred Liscum, Subdistrict Office, Houston

PERIOD OF PROJECT : January 1983 to September 1987

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 urbanized 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 large amount 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. A modeling system has been developed which links a hydrologic-based watershed model and a hydraulic-based streamflow routing model. Each model is supported by a preprocesor, which prepares data entry for each. Each model includes routines for producing graphical output or storing results on computer storage media.

Plans: A report documenting the modeling system developed to link the two models and procedures required to run the system will be prepared.

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 approved or published, 1988: None.

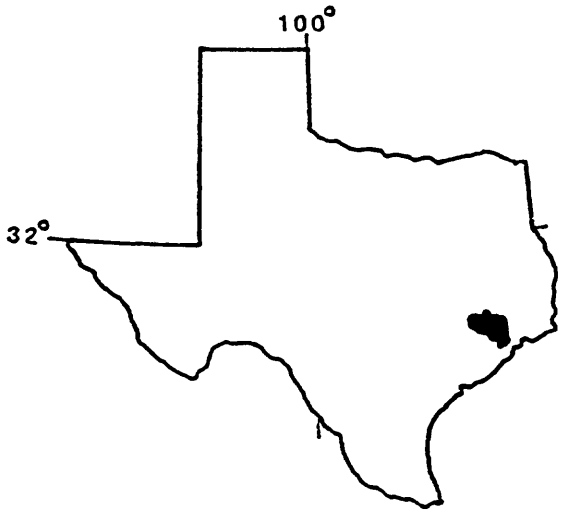
TX 84-083 POTENTIAL IMPACT OF THE TRINITY RIVER ON THE WATER QUALITY OF LAKE HOUSTON

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: To define the areal and temporal variations in water quality and stratification patterns in Lake Houston under current conditions; to define the areal and temporal variations in quality of inflows to Lake Houston from streams in the San Jacinto River basin; to relate the quality of inflows to the water quality in Lake Houston; to define the temporal variations in the quality of water available for diversion from the lower Trinity River; and 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. A dynamic lake model has been selected and is being adapted

to the PRIME[1/] computer. The model selected is a two-dimensional laterally averaged model developed by the U.S. Army Corps of Engineers, CE-QUAL-W2. An interim report summarizing data collected through March 1987 has been prepared.

Plans: PLans are to continue the data collection program and to prepare a data report summarizing data collected during an intense sampling started in May 1987 and to calibrate the selected dynamic model, CE-QUAL-W2. 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:

Goss, R.L., Preliminary analysis of water-quality data in and upstream from Lake Houston: U.S. Geological Survey Water-Resources Investigations report.

Goss, R.L., and Liscum, Fred, Potential impact of transferring water from the Trinity River into Lake Houston, southeastern Texas....an interim report: U.S. Geological Survey Water-Resources Investigations Report.

Reports approved or published, 1988: None.

[1/] Use of trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

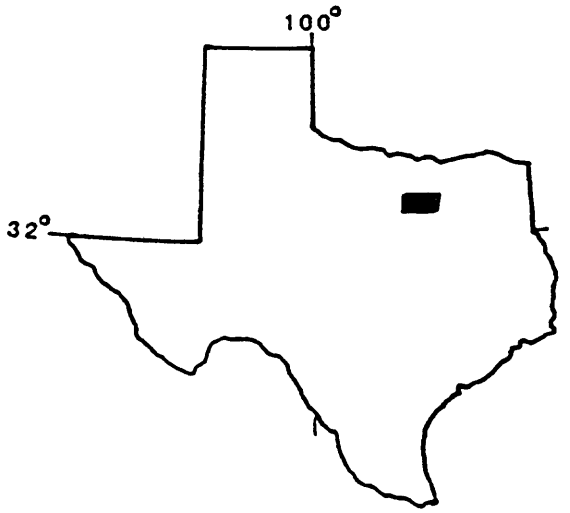
TX 84-084 SOURCES AND INFLOW OF NUTRIENTS INTO LAKE LEWISVILLE

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 can 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: To evaluate potential nitrogen, phosphorus, and organic carbon loading by streams tributary to Lake Lewisville; to identify the streams having the most nutrients; to determine annual loads of nitrogen and phosphorus from three of those streams; and 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 is 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 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. Samples from storms over a three-year period at these sites will be used to define the nutrient/flow transport relations and total nutrient loads to the lake. A comparison to known and estimated point source loads to the lake will provide insight about the relative importance of point and nonpoint sources.

Progress: The low-flow synoptic survey was completed in March 1984 and the high-flow survey in March 1985. The three sites for storm runoff sampling

were selected and sampling began in April 1985. Automatic samplers were installed at these sites during the summer of 1985 and sampling continued through January 1988.

Plans: A data report has been prepared for the data collected during the two synoptic samplings. Preparation of a final interpretive report of all data collected has begun and this report should be completed by the first part of fiscal year 1989.

Reports in preparation:

Gain, W. Scott, Physical and nutrient data from two water-quality surveys of the Lake Lewisville watershed, north-central Texas, 1984-85: U.S. Geological Survey Open-File Report.

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

Reports approved or published, 1988: None

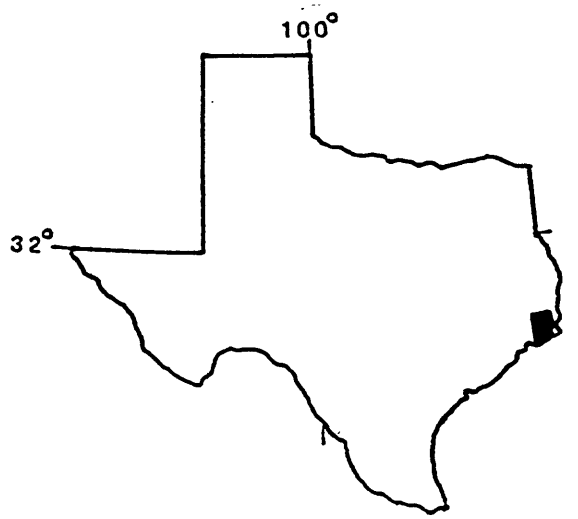
TX 84-088 SURFACE-WATER HYDROLOGY OF THE SALT BAYOU IN SOUTHEAST TEXAS

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 McFadden 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 McFadden National Wildlife Refuge. In order to correct the problem, the construction of control 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 relations, is needed to aid in the assessment and possible future enhancement of the basin's shellfish community.

Objectives: To define flow patterns and magnitudes at the major outlet to the Intracoastal Waterway, to define the water budget of the basin; to determine velocity profiles for the inflows over several complete tide cycles; and to 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 bihourly 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 were compiled from Sea Rim State Park records.

Summary: Hydrologic data were collected for an 18-month period for October 1984 through March 1986 on the Salt Bayou estuary just west of Sabine Pass, Texas. Sea Rim State Park and the McFadden National Wildlife Refuge are located within the The salt Estuary. The hydrologic data obtained by the USGS will be used in conjunction with biological data collected by the Louisiana Cooperative Fish and Wildlife Research Unit, Louisiana State University to design and implement water control structures or improved water management practices.

It is believed that the salt content of this estuary is higher than it was prior to construction of the Gulf Intracoastal Waterway because of reduced freshwater inflow from the upper reaches of Salt Bayou. It is also believed that the increased salt levels have had a detrimental effect on wildlife. The Salt Bayou estuary is an important nursery area for marine fish and shrimp and is also an important waterfowl area.

Reports approved or published, 1988:

Fisher, J.C., 1988 (in press), Hydrologic data for the Salt Bayou estuary near Sabine Pass, Texas, October 1984 to March 1985: U.S. Geological Survey Open-File Report 88-499.

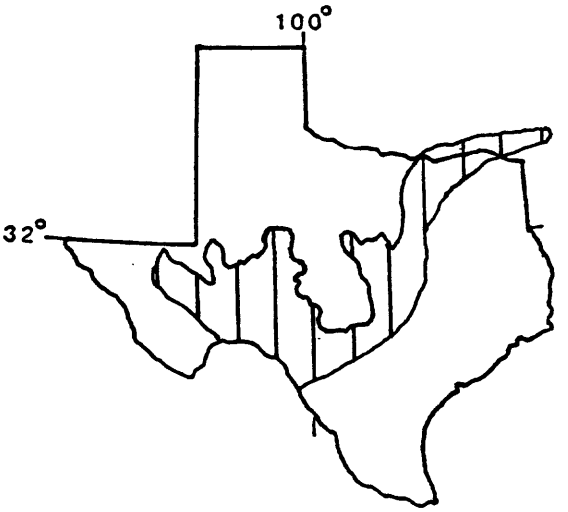
TX 85-090 EDWARDS-TRINITY REGIONAL AQUIFER-SYSTEM ANALYSIS (RASA)

COOPERATING AGENCY : U.S. Geological Survey

PROJECT CHIEF: Peter Bush, District Office, Austin

PERIOD OF PROJECT : October 1985 to October 1993

LOCATION : Central Texas, southeast Oklahoma, southwest Arkansas



Problem: Continued use of water from the Edwards-Trinity regional aquifer system 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: To provide a better understanding of the water-yielding potential of the Edwards-Trinity regional aquifer system. The specific objectives are to describe the aquifer system by determining the hydrologic framework on a regional scale, describe the regional water chemistry and use the water chemistry to identify and understand the patterns of ground-water flow, and describe the regional flow system based on simulation.

Approach: A multidisciplinary approach will be used. Geologists will construct a regional hydrogeologic framework that divides the aquifer system into mappable permeability units. Hydrologists 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: The project area was divided into a southern area and a northern area. The southern project area, designated the Edwards-Trinity aquifer system, west-central Texas, is being studied first. Seven stratigraphic sections spanning the southern project area based on formation picks from electric logs have been completed. Regional hydrogeologic units (aquifers and confining units) have been identified and work is proceeding on mapping the tops, bottoms, and distribution of transmissivity of the major aquifers. Appreciable time has been spent preparing hydrologic input data and designing a mesh for a regional finite-element model of the system in west-central

Texas. System boundary conditions have been identified and work is progressing on locating boundaries that are not precisely known. A major work item, a regional water budget that will lead to areal distributions of recharge for simulation, is nearly complete. A preliminary potentiometric surface map of major aquifers during winter 1974-75, the start of the 28-month model calibration period, has been prepared. A detailed data base of ground-water withdrawals during the calibration period has been completed. Use of the geographic information system ARC/INFO has been made an integral part of the project activities, particularly in the preparation of model input data.

A very large geochemical data base compiled from several sources has been screened and systematically reduced to a set of "best available" analyses for the purpose of constructing maps of the distributions of dissolved constituents of major aquifers. A plan is being devised to collect and analyze water and mineral samples along major flow paths of the system in west-central Texas in order to describe and relate to ground-water flow the rock-water interactions and time-of-travel.

Plans: Complete the mapping of aquifer-system geometry and finalize a map of transmissivity of the major aquifers. Prepare a predevelopment potentiometric-surface map of major aquifers of the system in west-central Texas. Complete areal distribution maps of total dissolved solids, chloride concentration, sulfate concentration, and hardness the major aquifers. Collect and analyze approximately 40 water samples and 20 mineral samples along major flow paths of the system. Begin interpretation of the results with emphasis on relating rock-water interactions to ground-water flow. Complete hydrologic data input preparation and calibrate the regional flow model over the 28-month calibration period. Complete first drafts of a series of interim map reports documenting the results of the study in the southern project area.

Reports in preparation:

Barker, R.A., Altitude of the top and predevelopment saturated thickness of the Edwards-Trinity aquifer system, west-central Texas: U.S. Geological Survey Water-Resources Investigations Report.

Barker, R.A., and Ardis, A.F., Geology and configuration of the base of the Edwards-Trinity aquifer system, west-central Texas: U.S. Geological Survey Water-Resources Investigations Report.

Bush, P.W., Predevelopment potentiometric surface of the major aquifers of the Edwards-Trinity aquifer system, west-central Texas: U.S. Geological Survey Water-Resources Investigations Report.

Kuniansky, E.L., Potentiometric surface of the major aquifers of the Edwards-Trinity aquifer system, west-central Texas, winter 1974: U.S. Geological Survey Water-Resources Investigations Report.

------ Simulation of the Edwards-Trinity aquifer system, west-central Texas: Modeling strategy, boundary conditions, and preliminary results, west-central Texas: U.S. Geological Survey Water-Resources Investigations Report.

Lurry, D.L., and Pavlicek, Dianne, Withdrawals from the Edwards-Trinity aquifer system, west-central Texas: U.S. Geological Survey Water-Resources Investigations Report.

Rittmaster, R.L., and Busby, J.F., Chloride concentration in water from the major aquifers of the Edwards-Trinity aquifer system, west-central Texas: U.S. Geological Survey Water-Resources Investigations Report.
------ Dissolved-solids concentration in water from the major aquifers of the Edwards-Trinity aquifer system, west-central Texas: U.S. Geological Survey Water-Resources Investigations Report.
------ Sulfate concentration in water from the major aquifers of the Edwards-Trinity aquifer system, west-central Texas: U.S. Geological Survey Water-Resources Investigations Report.
------ Total hardness in water from the major aquifers of the Edwards-Trinity aquifer system, west-central Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports approved or published, 1988:

Kuniansky, E.L., 1988, Precipitation, streamflow, and base flow in west-central Texas, December 1974 through March 1977: U.S. Geological Survey Water Resources Investigations Report 88-4218, 2 sheets.

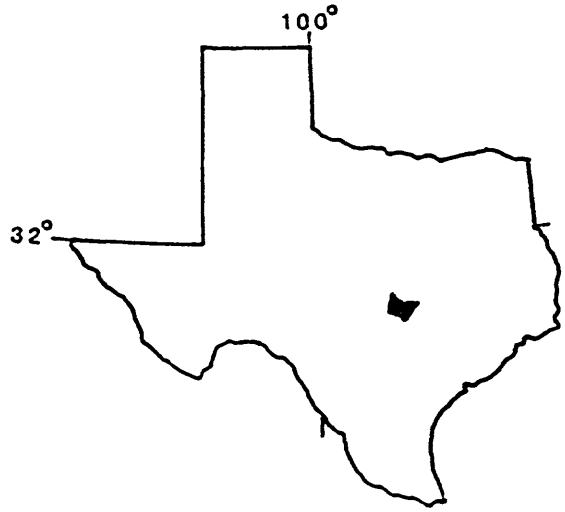
TX 85-093 ATTENTUATION OF SELECTED POLLUTANTS IN THE UNSATURATED ZONE OF THE EDWARDS AQUIFER, AUSTIN AREA

COOPERATING AGENCY : City of Austin

PROJECT CHIEF: Paul M. Buszka, District Office, Austin

PERIOD OF PROJECT : March 1985 to September 1988

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: 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 collect field and laboratory data and define the quality of water in the vertical profile in the unsaturated zone, and to 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: Study, development, statement, and testing of hypotheses; laboratory (batch or column) experiments; and field experiments using a suite of wells open to bedding planes and solution openings that are believed to be temporarily saturated after storms.

Progress: The operation of continuous monitoring equipment for water level, electrical conductance, and temperature continued in five wells at a site on Williamson Creek. Because of dry conditions during the year and transducer-related malfunctions, only one short recharge event was monitored in the creek this year. Trace concentrations of toluene, xylene, and two tentatively identified cycloalkane organic compounds were observed in samples collected during early December from the two saturated-zone wells at the site but not in previous or subsequent samples. The detection coincides with a gasoline spill during late November upstream from the site. An analysis of surfaces from fractures and dissolution-modified permeability in cored limestone from the unsaturated zone did not reveal any presence of trace elements such as lead and zinc that are characteristic of urban street runoff.

Other progress on establishing a conceptual framework for unsaturated-zone flow in carbonate rock has been made through a search of existing literature. Ground-water chemistry data from several storm-related samplings of wells in the unconfined zone have been entered into a computer data file. This file will be used for analysis of regional impacts of recharge chemistry on ground water.

Plans: A report which summarizes and interprets the data collected by this study will be completed. Future plans for studies of other sites in the Austin area are on hold pending findings and approval of additional cooperator funding.

Reports in preparation:

Buszka, P.M., Water movement and changes in water quality in the unsaturated zone of the Edwards aquifer, Austin, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports approved or published, 1988: None.

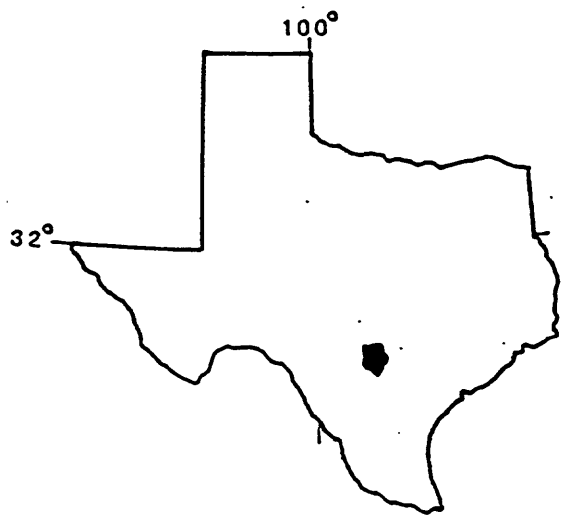
TX 85-094 HYDROLOGIC CONTROLS AFFECTING GROUND-WATER MOVEMENT IN THE VICINITY OF THE "BAD-WATER" LINE IN THE EDWARDS AQUIFER, SAN ANTONIO AREA

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

PROJECT CHIEF: George Groschen
Subdistrict Office, San Antonio

PERIOD OF PROJECT : October 1984 to September 1986

LOCATION : South-central Texas



Problem: Saline water intrusion from the downdip boundary of the Edwards aquifer into the freshwater is hydraulically possible. Significant movement of the saline water 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 saline water is most likely to occur.

Objectives: To delineate the three-dimensional shape of the transition zone between the freshwater and saline water, to obtain data on the vertical and horizontal circulation in the transition zone, and to establish permanent monitoring wells to determine transient changes in water quality.

Approach: A test drilling program was designed whereby three different clusters of wells were drilled. A well cluster is located in the freshwater 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: Geologic, geophysical, hydrologic, and water-quality data were collected during the drilling phase. Eighteen months of monitor data have been collected from the seven wells completed at this site. A data report presenting the data collected from the drilling phase and from the monitoring phase of the artesia test site along with various aspects of the interface or saline-water zone, or with the water chemistry within the saline-water zone has been published.

Previous investigators stated that the freshwater zone evolved through reactions called dedolomitization. The dolomitic rock was converted to relatively pure calcium carbonate with an extremely large secondary porosity. The flow that developed is relatively restricted vertically and regionally parallel to barrier faults and toward major springs. Little is known about the location and discharge of saline water but is believed to move move very slowly and discharges little water compared to the freshwater zone that developed in the Edwards Group.

The data collected from the test drilling and the monitor wells supports this concept of the aquifer. Although the actual flowpaths leading to each of the monitor wells is not well-defined, simulated reaction paths produce similar water chemistries to those of the monitor well samples.

Plans: Plans are to have the report approved and published.

Reports in preparation:

Groschen, G.E., Evaluation of theories on the occurrence of the freshwater/saline-water interface in the Edwards aquifer, San Antonio region, Texas--with results from the 1985-88 test-drilling and monitoring study: U.S. Geological Survey Water-Supply Paper.

Reports approved or published, 1988: None.

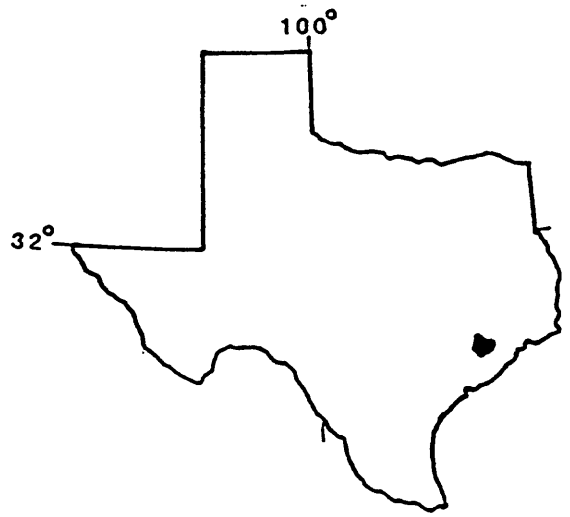
TX 86-095 EFFECTS OF GROUND-WATER DEVELOPMENT ON FORT BEND COUNTY

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. Investigation of the ground-water resources of Fort Bend County was conducted. Since the 1960's, the development in Fort Bend County and the city of Houston has required an increase in the 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. Information on the current and potential impact of continued ground-water withdrawals is needed for planning purposes.

Objectives: To update information collected in 1968-69, to determine the impact of ground-water development on water levels and water quality, and to delineate 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. Maps of water-level altitudes and changes since the county report (1969) will be made. Available data on land-surface subsidence will be compiled. 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).

Summary: Since 1969, 99 large-capacity wells have been drilled, of which 61 were public supply wells, 27 were irrigation wells, and 11 were industrial wells. The withdrawal of ground water increased from 56 million gallons per day (Mgal/d) in 1969 to 72 Mgal/d in 1982 and then decreased to 53 Mgal/d in 1986. The net decline in the potentiometric surface of the lower unit of the Chicot aquifer during 1968-69 to 1987, ranged from 90 feet in the northeast to less than 10 feet in the western part of the county. The net decline in the potentiometric surface of the Evangeline aquifer for the same period ranged from 125 feet in the northeast to less than 25 feet in the northwest part of the county.

The total thickness of clay in the Chicot aquifer increases from less than 150 feet in the northwest to about 350 feet along the eastern part of the county. The total thickness of clay in the Evangeline aquifer increases from 700 feet to about 1,200 feet in the same direction. The northeast part of the county is most susceptible to future subsidence, because it is the area of largest water-level declines and is underlain by the greatest thickness of the most compressible clays in the county.

Fifty-one wells located around the county had been sampled at least twice between 1969 and 1987. The comparison of these samples indicates that there has been no significant change in the chemical composition of the water since at least 1969. This includes water from wells in areas adjacent to the shallow salt domes and areas of large water-level decline.

Plans: Plans are to have the report approved and published.

Reports in preparation:

Locke, G.L., Effects of ground-water withdrawals on water levels, land-surface subsidence, and water quality, Fort Bend County, Texas, 1969-87: U.S. Geological Survey Water-Resources Investigations Report.

Reports approved or published, 1988: None.

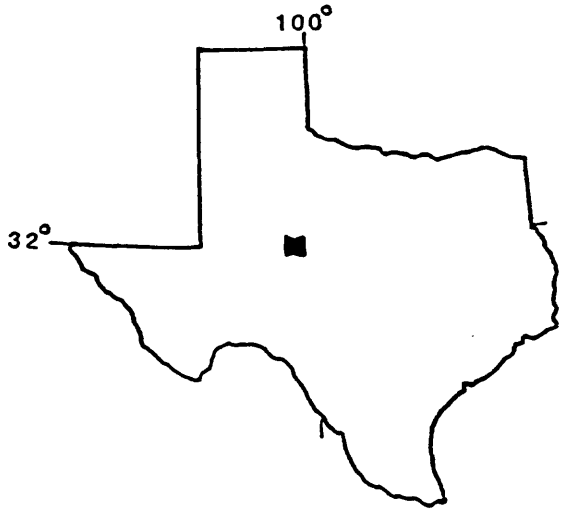
TX 86-096 GROUND-WATER CONTRIBUTION OF SALINITY IN THE UPPER COLORADO RIVER

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 basin-wide 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 milligrams per liter (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: To delineate the source areas of saline ground-water inflow and quantify the quality and quantity of ground water to the study reaches, to identify and describe the fresh and saline aquifers that may contribute water to the streams, to determine the historical ground-water conditions in the aquifers, to determine the current ground-water conditions, to locate and describe oil-field activities, and to investigate the feasibility of using indirect techniques to identify specific sites of saline-water discharge. The study area consists generally of the contributing basins to the confluence of the Colorado River and the Concho River.

Approach: The general approach follows: Conduct two base-flow reconnaissance studies of the quantity and quality of streamflow in the area; 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 saline water); obtain water-level, water-quality, and related data in the study area, and tabulate and analyze the data to detect any significant changes or trends; locate and inventory selected

water wells and springs, including public supply, industrial, irrigation, and rural-domestic or stock wells; collect about 50 water samples from wells contaminated with saline water and analyze the water for constituents that may indicate the source of salinity; identify oil-field activities that may be associated with occurrences of salinity to streams and shallow aquifers; tabulate the quantity of saline-water-enhanced recovery operations; and test indirect methods of locating saline water in the shallow subsurface by first locating a known source of saline-water discharge at the land surface.

Progress: All of the data collection and items identified in the "Approach" section have been completed.

Plans: Reports containing data, findings, and conclusions from the study are to be prepared.

Reports in preparation:

Slade, R.M., Jr., and Buszka, P.M., Relation between salinity in streams and aquifers and sources of saline water in the upper Colorado River basin, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Slade, R.M., Jr., and Shotwell, J.D., Potentiometric surface, altitude of top, thickness, and dissolved-solids concentrations for deep saline aquifers in the upper Colorado River basin, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports approved or published, 1988: None

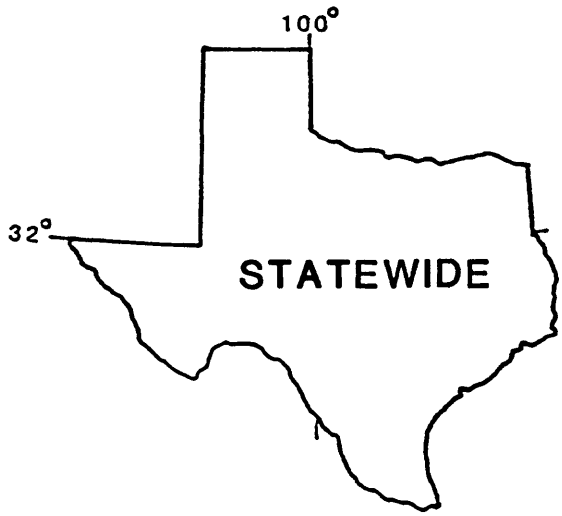
TX 86-097 NATIONAL LAKE SUMMARY

COOPERATING AGENCY : U.S. Geological Survey

PROJECT CHIEF: Walter R. Rast, Jr., District Office, Austin

PERIOD OF PROJECT : October 1985 to September 1990

LOCATION : Statewide



Problem: Deterioration of water quality in receiving waters (lakes and reservoirs) is an inevitable consequence of man's settlement in a drainage basin. Furthermore, problems of surface-water-quality deterioration will increase in importance in the United States as the extent of ground-water-quality deterioration becomes more widespread and as finite water resources are stressed further with future population and economic growth. In order for scientifically-sound management of such resources to be achieved, it is necessary to provide accurate lake and reservoir information and data for officials and agencies responsible for policy formulation and management of the Nation's water resources. Such overview information is currently lacking.

Objective: To identify and compile relavent water-related information and data bases descriptive of the overall water qualtiy of the Nation's lakes and reservoirs; and to use the compiled data bases to prepare an overview summary and description of the water quality of the Nation's lakes and reserviors, especially conditions descriptive of the deterioration of water quality.

Approach: Identify and compile water-quality data from existing data bases and written reports of relevant Federal, State, and local studies. Assess the adequacy of such information for providing an overview assessment of the water quality of the Nation's lakes and reservoirs. Using appropriate statistical and graphic techniques, prepare an assessment of the overall water quality of lakes and reservoirs.

Progress: The compilation of the data base to be used in the water-quality assessment of lakes and reservoirs in the United States was completed. The data base was documented, including the rationale for the water-quality parameters selected, and the procedures used to identify, access, and acquire the water-quality data base. A data-documentation report on these activities will be completed.

Plans: The major planned activity is the statistical analysis of the screened data base, and initiation of the final report on this project. The planned statistical analyses include frequency diagrams, calculation of medians, means, statistical deviations and other statistical characteristics of the data set, correlations and regressions of relevant limnological parameters, and assessment of changes in water quality over time in selected water bodies. The data will be presented in tabular and graphic form on a State-by-State basis. A regional and national overview also will be prepared.

Reports in preparation:

Rast, Walter R., Assessment of water quality of lakes and reservoirs in the United States: U.S. Geological Survey Water-Resources Investigations Report.

------ Overview of water quality of United States lakes and reservoirs: U.S. Geological Survey Water-Resources Investigations Report.

Reports approved or published, 1988: None

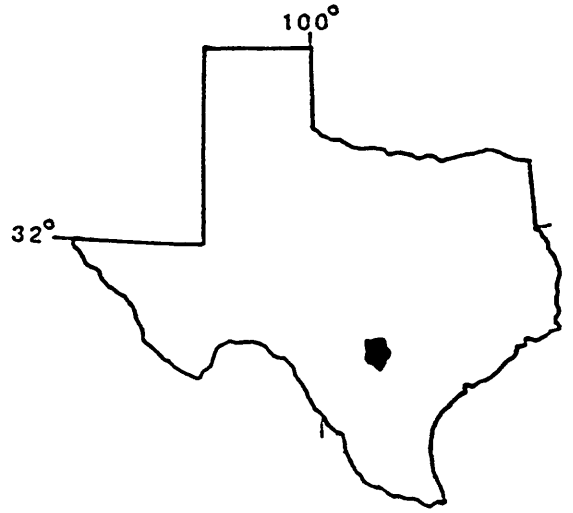
TX 86-098 LIMESTONE HYDROLOGY WATER-SUPPLY PAPERS, THE EDWARDS AQUIFER, SAN ANTONIO AREA

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.

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: To prepare a single document on the geology and hydrology of the Edwards aquifer in the San Antonio area that integrates current knowledge and scientific intuition concerning the flow and storage within 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 Water-Supply 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 draft of the report has been prepared and is in review.

Plans: Complete the review and approval of the report.

Reports in preparation:

Maclay, R.W., Geology and hydrology of the Edwards-Trinity aquifer system, San Antonio region, Texas: U.S. Geological Survey Water-Supply Paper.

Reports approved or published, 1988: None.

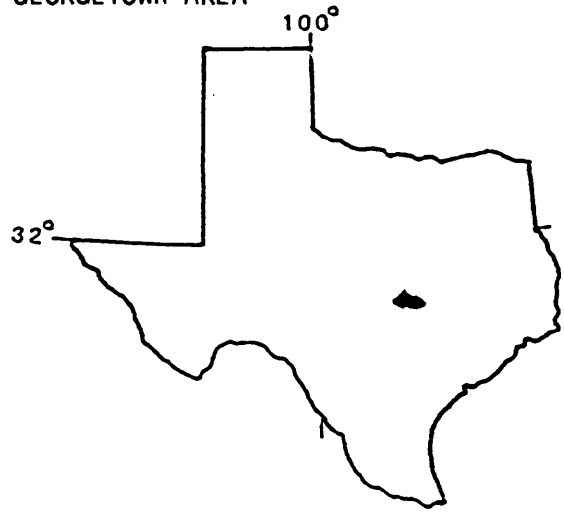
TX 86-099 RECHARGE CHARTERISTICS OF THE GEORGETOWN FORMATION IN THE GEORGETOWN AREA

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 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 Board agreed to an additional study of the Edwards (Balcones fault zone) aquifer at and in the immediate vicinity of the city of Georgetown.

Objective: 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 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.

Summary: A reassessment of the uppermost geologic unit of the Edwards aquifer, the Georgetown Limestone, to determine if it should continue to be classified as a unit of the Edwards aquifer, was conducted in the Georgetown area using data from six surveys of streamflow gains and losses and ground-water levels, aquifer tests at three clusters of test wells, and variation in water-quality characteristics to indicate ground-water circulation. The surveys did not show a pattern of corresponding streamflow gains and losses with positive (upward) and negative (downward) head differentials, respectively, between the main water-bearing zone of the Edwards aquifer and the streams. A consistent and corresponding pattern was shown only for the subreach containing Berry Springs. The aquifer tests consisted of "slug" test analyses to determine the transmissive characteristics of the Georgetown Limestone and produced hydraulic conductivity values ranging from 1.4×10^{-8} to 2.8×10^{-9} centimeters/second at four of the six test wells. The other two test wells did not produce data suitable for conventional aquifer-test analysis. An analysis of the water-quality characteristics indicates that the Edwards Limestone and the streams have a significant hydraulic connection but the ground-water circulation between the Edwards Limestone and the Georgetown Limestone is very limited. The only area where a high degree of hydraulic connection between the main water-bearing zone of the Edwards aquifer and the streams was found is near the updip limits of the Georgetown Limestone where a nearby major fault occurs and where major springs have developed. These findings indicate that the Georgetown Limestone does not function as a unit of the Edwards aquifer but as a regional confining bed with localized avenues that allow flow to and from the underlying Edwards aquifer.

Reports approved or published, 1988:

Land, L.F., and Dorsey, M.E., 1988, Reassessment of the Georgetown Limestone as a hydrogeologic unit of the Edwards aquifer, Georgetown area, Texas: U.S. Geological Survey Water-Resources Investigation Report 88-4190, 49 p.

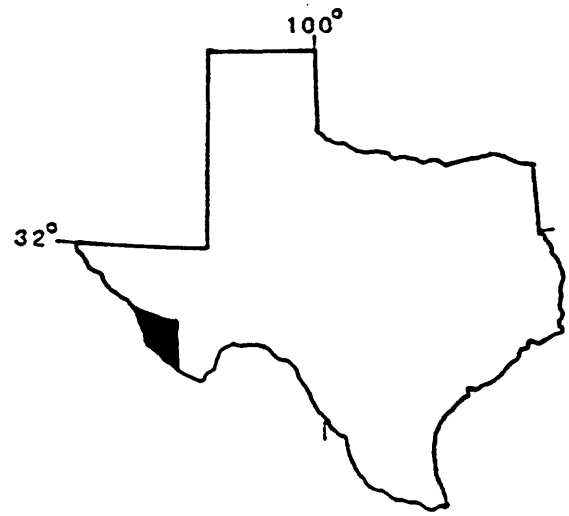
TX 86-101 GEOHYDROLOGY OF THE WATER RESOURCES OF OAK SPRING, BIG BEND NATIONAL PARK

COOPERATING AGENCY : National Park Service

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

PERIOD OF PROJECT : June 1986 to September 1989

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 Spring 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.

Objectives: To describe the hydrology of the aquifer supplying Oak Spring, to determine the source of water supplying the spring and determine if the source includes the sewage lagoons, to determine the quality of water in the aquifer, to determine the direction and rate of ground-water movement, to determine the changes in water quality in the aquifer between the lagoons and the spring, and to determine the factors that influence the quantity and quality of water from the spring.

Approach: The approach includes mapping the surface geology related to Oak Spring and studying the subsurface geologic features controlling water movement using test drilling and geophysical surveys (borehole and surface). Test holes will be drilled to define hydraulic properties of the aquifer and wells constructed to monitor water quality. Water samples will be collected from springs, test wells, lagoons, and other sources, and analyzed for a wide range of constituents and properties so that areal variations and changes with time can be defined. Recorders will be installed in Oak Spring and in observation wells to aid in estimating the water budget of the aquifer supplying the spring.

Progress: Test drilling was conducted in the basin area along Oak Creek to determine if the basin fill is an aquifer, and if it is, to monitor, by means of observation wells, the effects of the sewage lagoons on the aquifer. The basin fill was believed to be a possible source of water to Oak Spring, which could be affected by possible pollutants from the lagoons or by the heavy use of the basin by park visitors. Test drilling showed that the basin fill is not saturated in the area where the lagoons are located. Seismic investigations, which were conducted in the basin substantiated the test drilling.

Seismic work was also conducted at Oak Spring and this revealed the depths to the water table and bedrock. Water samples were collected from Oak Spring and other important sites for very detailed analysis in an effort to trace the source of the water at Oak Spring and to detect any changes in the water quality. A continuous spring-flow recorder was installed at Oak Spring and continuous fluctuations in flow are being recorded. Sixteen additional seismic surveys and geologic mappings were conducted in the Oak Spring area to delineate the aquifer. Viral and bacterial samples were collected at several water sources with the objective of testing the feasibility of using possible viruses as tracers. A sediment sample was taken at Oak Spring for analysis of pesticides. The results indicate that no pesticides were present.

Plans: Test drilling is planned for the Oak Spring area to assist in identifying the aquifer supplying the spring. Data on the wells should help establish the direction and rate of ground-water movement. Tracers may be used in the wells to help define flow paths and water velocities. Additional water sampling will be conducted in wells and other significant sites. All of the data collected will be interpreted and included in a final report.

Reports in Preparation:

Baker, E.T., Jr., Buszka, P.M., and Woodward, D.G., Hydrogeology and geochemistry of water of the basin and Oak Spring areas of the Chisos Mountains, Big Bend National Park, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports approved or published, 1988: None.

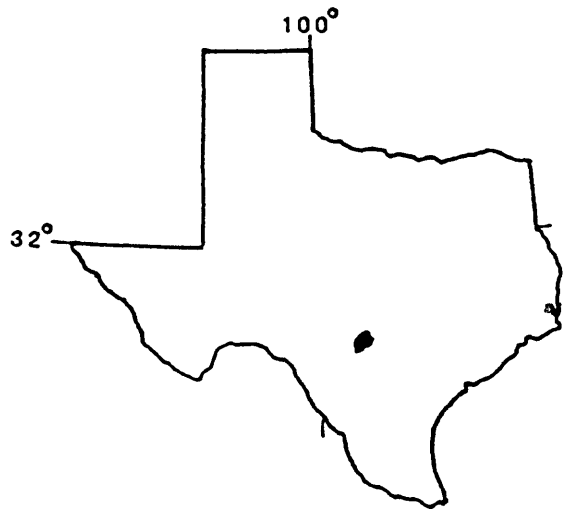
TX 87-102 KELLY AIR FORCE BASE INSTALLATION RESTORATION PROGRAM, PHASE II, STAGE 3

COOPERATING AGENCY : U.S. Air Force, Occupational and Environmental Health Laboratory

PROJECT CHIEF: George B. Ozuna, Subdistrict Office, San Antonio

PERIOD OF PROJECT : October 1986 to September 1988

LOCATION : Southwest Texas



Problem: The Installation Restoration Program of the Department of Defense (DOD) is a comprehensive program that identifies hazardous waste sites and evaluates the risks they pose to public health and the environment on active, inactive, or formerly used DOD property.

Objectives: To confirm the presence or absence of contamination within two specific sites of investigation; to determine the extent and degree of contamination and the potential for migration of those contaminants, if possible; and to delineate additional investigations that might be required.

Approach: Wells for monitoring water levels and for collecting water samples were drilled and installed at each of the study sites. Soil borings were drilled and sampled to determine soil contamination, and then plugged. Aquifer tests were performed on all monitoring wells to determine the hydrogeologic characteristics of the local aquifer. Finally, a synoptic survey of water-level measurements in the monitoring wells was conducted to determine the configuration of the potentiometric surface of the ground water in the shallow aquifer.

Water quality, soil quality, and hydrogeologic data will be analyzed and interpreted to make estimates of the magnitude, extent, and direction of the detected contaminants. The data will also be used to identify potential environmental consequences of discovered contamination, based upon State and Federal standards.

Summary: This investigation defined the hydrogeologic setting and confirmed the presence of contamination of both soil and ground water within two sites at Kelly Air Force Base.

The geologic setting at the Security Hill site contained no fluvial material deposits. Except for manmade fill in local areas, the site is underlain by the upper beds of the Navarro Group, consisting of a tan silty clay grading to blue clay. A water-level map of this site indicated that ground-water movement is northeast toward Leon Creek. Soil and ground-water

sampling revealed the existence of organic and inorganic contaminants in ground water at several locations in the landfill and downgradient in the low-permeability silty clay of the Navarro Group. One of three polychlorinated biphenyl (PCB's) mixtures were detected in ground water downgradient from the landfill.

Fluvial material containing silts and gravels, underlain by a confining bed of blue clay belonging to the Navarro Group, comprised the geologic setting at the Jet Engine Test Cell site. A water-level map of this site indicated that ground-water movement is toward Leon Creek. Detectable concentrations of aromatic organic compounds sorbed onto soil and the large concentrations of aromatic organic compounds in water were associated with an aqui-fuels system, a former waste-disposal lagoon, and a sludge-spreading field at this site. Contaminants at this site included meta-xylene, toluene, and napthalene.

Reports in preparation:

Ozuna, G.B., Ground-water contamination at two sites at Kelly Air Force Base, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Ozuna, G.B., and Buszka, P.M., Installation Restoration Program, Phase II--confirmation/quantification stage 3: U.S. Geological Water-Resources Investigations Report.

Reports approved or published, 1988: None.

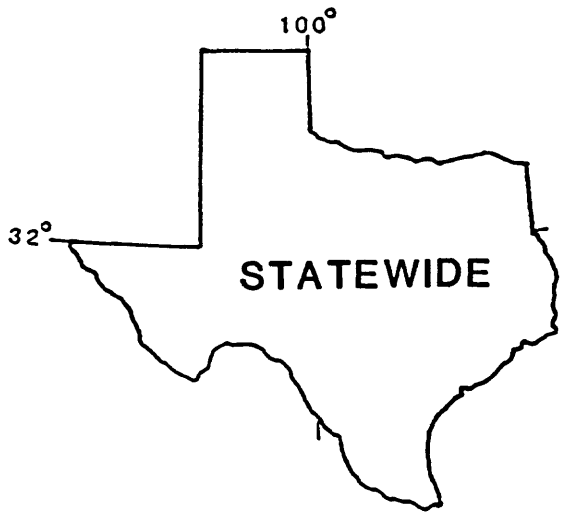
TX 87-103 TRENDS IN WATER-QUALITY DATA

COOPERATING AGENCY : U.S. Geological Survey

PROJECT CHIEF: Terry L. Schertz, District Ofice, Austin

PERIOD OF PROJECT : October 1986 to September 1989

LOCATION : Statewide



Problem: A network of water-quality stations on streams in Texas has been operated by the U.S. Geological Survey in cooperation with the Texas Water Development Board and other State, Federal, and local agencies. Over 500 stations were included in the network for at least 5 years during 1968-86, with about 75 stations included for the entire period. The data have been collected at periodic intervals, but the frequency of data collection has varied over the years from weekly, to monthly, to bimonthly, and quarterly due to changes in the network design and funding. Examination of this extensive data base for the occurrence of spatial and temporal trends in water-quality parameters is needed to determine what impact such factors as oil-field activity and population growth have had on the quality of water in Texas.

Objectives: To select sites from the Texas water-quality data base that have the appropriate characteristics necessary for trend detection, to develop the methods needed to process extensive data sets with complicated patterns of variability and produce temporal trend results, and to examine temporal trend results for evidence of regional patterns. A second phase to the project will incorporate sources of ancillary information and more detailed analysis of the flow and concentration data to establish possible causes of the trends detected in the first phase. The procedures developed and tested in this project are intended to serve as a prototype for future studies of large water-quality networks.

Approach: Data analysis will be done for the selected sites using a combination of subjective decisions and automated procedures designed to handle trend detection in large, complex data sets. The chemical parameters to be examined for detectable trends will include inorganic, trace metal, and nutrient and pesticide constituents. Physical parameters such as water temperature, pH, dissolved oxygen, specific conductance, and biological oxygen demand will also be examined. The regional patterns of detectable trends in each constituent will be examined in more detail in the second phase to look for possible sources. Correlation between the trends and related ancillary data will be used to determine the most probable causes of the trends.

Progress: The trend detection phase of the project is complete. A draft of report "Trends in water-quality data in Texas" contains the results of the first phase and is in review. The software package that incorporates the methods used for data manipulation, screening, and analysis has been revised and is being tested for release to two newly funded projects.

Plans: The final testing of the revised code will be completed by November 1988. A rough draft of the report "Methods of trend detection in long-term, variable water-quality data" will be ready for review in 1988. The second phase of the project will begin in December 1988 and a draft of the report "Analysis and interpretation of trends in water-quality data in Texas," containing the results of the second phase will be ready for review by the end of September 1989.

Reports in preparation:

Schertz, T.L., Trends in water-quality data in Texas: U.S. Geological Survey Water-Resources Investigations Report.

------, Analysis and interpretation of trends in water-quality data in Texas: U.S. Geological Survey Water-Resources Investigations Report.

Schertz, T.L., Alexander, R.B., and Ohe, Dane J., Methods of trend detection in long-term, variable water-quality data: U.S. Geological Survey Water-Resources Investigations Report.

Reports approved or published, 1988: None.

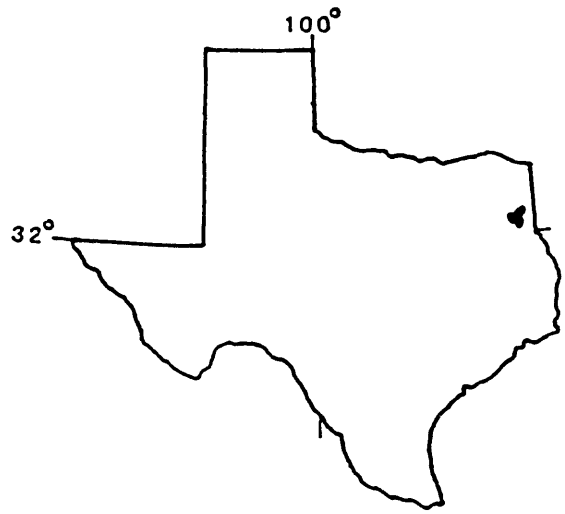
TX 87-104 WATER SURFACE AND FLOW PATTERN OF A MAJOR FLOOD AT THE TEXAS HIGHWAY 43 CROSSING OF THE SABINE RIVER

COOPERATING AGENCY : Texas Department of Highways and Public Transportation

PROJECT CHIEF: Dennis R. Myers, Subdistrict Office, Fort Worth

PERIOD OF PROJECT : January 1987 to September 1988

LOCATION : Northeast Texas



Problem: Texas Highway 43 is overtopped by 10-year recurrence-interval floods on the Sabine River. The Texas Department of Highways and Public Transportation (TDH&PT) plans to raise the elevation of the highway and to reconstruct the bridges to safely withstand floods having a 50-year recurrence interval. The new bridge and embankment designs have been prepared and approved, but construction has been delayed pending environmental and historical assessments. An opportunity exists to evaluate the designs by utilizing a mathematical simulation of the flood flows to determine if the cost of the construction can be reduced.

Objectives: To assess the proposed bridge and embankment designs in conveying runoff from floods having a 50-year recurrence interval, to explore a more efficient design with respect to the placement and height of the bridges and embankments, and to compare the designs to a no-highway alternative.

Approach: The study will involve the use of a two-dimensional finite-element surface-water-flow model (FESWMS). Given the inflow and outflow at the limits of the reach, topography and roughness of the flood plain, and geometry of the bridges and embankments, the model can compute the depth and velocity in two dimensions at each node in a network of elements. The network of elements can be sufficiently detailed to adequately represent the opening of the bridges, the location of the embankment, and the location of the main channel. The results from the model can be used to map the water surface, flow distribution, and the velocity patterns in the flood plain and in and around the bridge openings. The model simulation will assume steady-state conditions.

Summary: The hydraulic effects of the proposed Texas Highway 43 crossing of the Sabine River were determined using FESWMS. In the planning of the crossing by the TDH&PT, accurate approximations of apportionment of flow among the openings and velocities within the openings were of concern. The model was used to simulate flow in the river flood-plain system for conditions of the proposed crossing design, an alternate crossing design configuration, and for the natural condition. The proposed opening consisted of a 320-foot main

natural condition. The proposed opening consisted of a 320-foot main channel opening, four left-overflow bridges with widths of 120, 320, 320, and 280 feet, and one right-overflow opening with a width of 440 feet. The alternate configuration consists of a 950-foot main channel opening, three left-overflow openings with widths of 320 320, and 280 feet, and one right-overflow opening with a width of 200 feet. The alternate design more closely represents the existing bridge widths. The simulations show that, among other things, a proposed lengthening of the right-overflow bridge is not beneficial. The alternate design simulated is one that does not include the proposed lengthening of the right-overflow bridge or the proposed construction of a new embankment at the existing main channel opening.

The results of the two-dimensional simulation of the proposed design indicate some differences in the apportionment of flow among the openings when compared to the traditional computational methods. Simulations of the alternate design computed water-surface altitudes which are slightly lower than the proposed design. The alternate design would require less modification to the existing embankment. Velocities computed at the bridge abutments using the two-dimensional model were within the design specifications of the TDH&PT.

Report in preparation: None.

Reports approved or published, 1988:

Gilbert, J.J., and Myers, D.R., 1988 (in press), Analysis of water surface and flow distribution for the design flood at a proposed highway crossing of the Sabine River near Tatum, Texas: U.S. Geological Survey Water-Resources Investigations Report 88-4231.

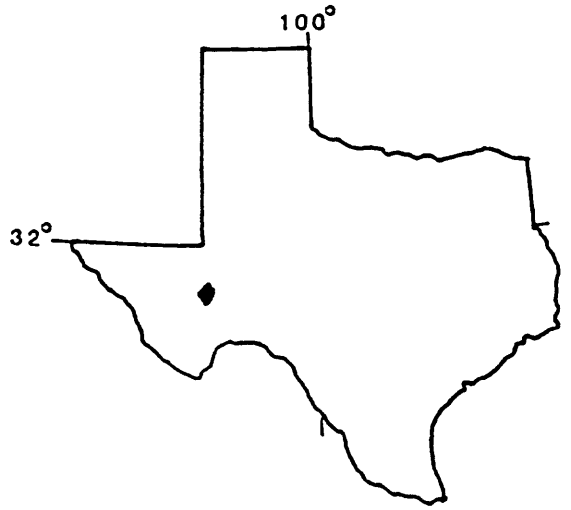
TX 87-105 CURRENT AND HISTORIC HYDROLOGIC CONDITIONS OF THE EDWARDS-TRINITY AQUIFER, PECOS COUNTY

COOPERATING AGENCY : City of Fort Stockton

PROJECT CHIEF: Ted A. Small, Subdistrict Office, San Antonio

PERIOD OF PROJECT : January 1987 to January 1989

LOCATION : West Texas



Problem: The city of Fort Stockton and many farmers depend on water from the Edwards-Trinity aquifer as an important source of water supply. However, the ground-water resources in Pecos County are limited to the extent that water levels at times have been extremely low and flow from Comanche Springs has ceased. Hydrologic information and understanding are needed to properly manage the limited ground-water resources of Pecos County.

Objectives: To describe the current water-level and water-quality characteristics of the aquifer; to determine the historical changes in water levels and water quality; and to determine the pumping rates and water-level declines at which flow from Comanche Springs ceases.

Approach: Following a data review and literature search, water levels were measured in a number of wells and water samples for chemical analyses were collected from about 35 wells.

Progress: All maps planned for the project have been completed. These include current (1987) water levels, historic (1940-49) water levels, and difference between historic and current water levels; water-quality maps showing dissolved solids, chlorides and sulfates, specific conditions, and difference in dissolved solids based on conductances in 1987 and historic dissolved solids from 1940-49; and hydrographs comparing water levels in selected wells with flow of Comanche Springs and precipitation at Ft. Stockton.

Plans: Complete preparation of the report.

Reports in preparation:

Small, T.A., and Ozuna, G.B., Conditions of ground-water resources in Pecos County, Texas: U.S. Geological Survey Water-Resources Investigations Report.

Reports approved or published, 1988: None.

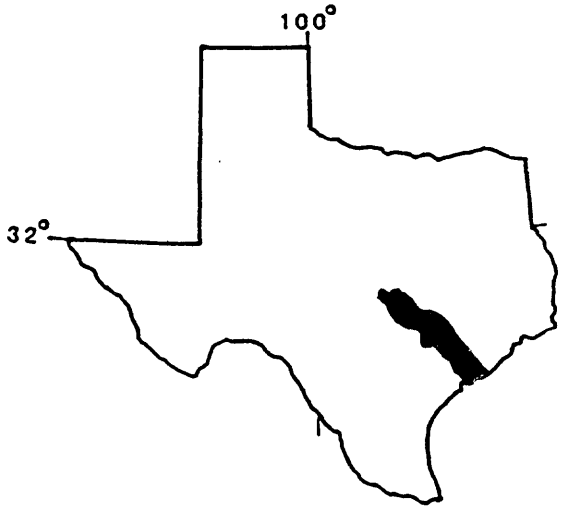
TX 87-106 FLOW RELATIONS BETWEEN THE LOWER COLORADO RIVER AND REGIONAL AQUIFERS

COOPERATING AGENCY : Lower Colorado River Authority

PROJECT CHIEF: Dennis G. Woodward, District Office, Austin

PERIOD OF PROJECT : July 1987 to September 1988

LOCATION : Southeastern Texas



Problem: Water in the Colorado River travels about 560 miles from where it enters San Saba County to where it discharges into the Gulf of Mexico. Along this reach, the river flows either directly on or over several regional aquifers. Along certain subreaches of the river, ground water from the regional aquifers flows into the river valley and provides recharge to the Colorado River; along other subreaches, water in the river may seep downward through the river valley and provide recharge to the aquifer(s). The exchange of water between the river and the aquifers will become increasingly important when the Lower Colorado River Authority will have to operate under a River Master Plan, which is scheduled to begin in 1991.

Objectives: To identify those subreaches of the lower Colorado River through which water can flow at a significant rate between the river and the underlying regional aquifers, and to determine the present pattern (or flow direction) of water between the river and the regional aquifers. The scope of the study does not include quantifying the flow rates.

Approach: The study consists of two components: (1) Define and delineate the regional aquifers in the study area; existing geologic and hydrogeologic data are expected to provide the necessary information; and (2) compile and analyze data for determination of river subreaches that have substantial ground-water gains and losses; this includes mapping the local potentiometric surface of each regional aquifer in and near the river valley, analyzing the ground-water flow directions of each regional aquifer near the river valley, and determining the lateral extent of those subreaches gaining ground water and losing surface water. Existing water-level data from the files of the U.S. Geological Survey and the Texas Water Development Board will be used to prepare the potentiometric maps.

Summary: The lower Colorado River discussed in this report consists of the 318-mile reach from Mansfield Dam near Austin to the Gulf of Mexico. The river is underlain directly or indirectly by six regional aquifers--the Trinity Group, Edwards, Carrizo-Wilcox, Queen City, Sparta, and Gulf Coast; the Trinity Group aquifer is further subdivided into the lower Trinity, middle

Trinity, and upper Trinity aquifers. Generalized potentiometric-surface maps of each regional aquifer show the ground-water-flow pattern near the river valley. Each regional aquifer discharges water to the lower Colorado River valley, particularly in the outcrop area of each aquifer. Only the Gulf Coast aquifer in central Wharton County appears to be recharged by water in the river valley. A summary map shows those subreaches of the lower Colorado River which gain water from the aquifers and those subreaches which lose water to the aquifers.

Reports in preparation: None.

Reports approved or published, 1988:

Woodward, D.G., 1988 (in press), Flow patterns in regional aquifers and flow relations between the lower Colorado River valley and regional aquifers in six counties of southeastern Texas: U.S. Geological Survey, Water-Resources Investigations Report 88-4154.

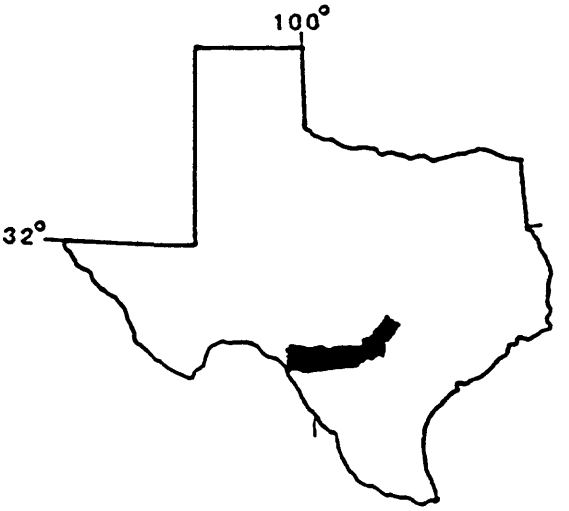
TX 88-107 ANALYSIS OF SPECIFIC FLOW PATHS IN THE EDWARDS AQUIFER, SAN ANTONIO REGION, TEXAS

COOPERATING AGENCY : San Antonio City Water Board

PROJECT CHIEF: George E. Groschen, Subdistrict Office, San Antonio

PERIOD OF PROJECT : October 1987 to September 1990

LOCATION : South-central Texas



Problem: Defining flowpaths and residence times for water in the Edwards aquifer is made difficult and uncertain because of great anisotropy created by fault barriers. The delineation of flow cannot be made on the basis of the gradients determined by water-level measurements because the steepest gradients are apparently across the faults. Thus, the location and extent of the faults is important in controlling the direction of flow of the water that enters the aquifer. These regional flow paths and the local complexities help determine the residence time of water in the aquifer and the potential for contamination to supply wells.

Objectives: To better understand the various structural and stratigraphic characteristics and the control they have on the flow of water; To integrate as much of the available information on the structure and geometry of the aquifer to infer the major directions of flow down fault blocks and the change in direction of the flow; and to delineate the major paths that a parcel of recharge water would take from the point of recharge until it is discharged near San Antonio or one of the major springs.

Approach: Specific techniques that will be combined in the approach to this problem are: literature review; study the record of the recharge to each subbasin; digitize the geologic information; determine flow paths of water that is recharged in Bexar County; assemble cross sections along the major flow path leading to San Antonio; fill in details and gaps in the cross sections using other recently collected data; plot chemical and head data along the flow paths; plot all available tritium data; investigate and apply new tracers or reapply old tracers; sensitive leveling of specifically selected wells; review drillers' logs and geophysical logs; study the historical range of water levels to determine low water levels in northern Bexar County.

Progress: During the first year of the project, the pertinent literature was reviewed to help define potential flow paths for further study. The period of recharge (1982-87) was studied to help define the spatial and temporal characteristics of recharge to the aquifer. This helps define flow paths and

indicates potential areas for tracing flow in the aquifer. A major finding is that most recharge apparently enters the aquifer in the outcrop area between stream channels during normal to wet years. This contradicts the prior assumptions.

The geologic and water-level data have been digitized and put into files to generate contour maps and cross sections of the aquifer. The major flow path in northern Bexar County was defined by R.W. Maclay (U.S. Geological Survey, written commun., 1988). Maclay also defines the area where temporary divides may strongly affect flow directions. The major flow path from the west will be delineated when the final cross sections are prepared. Data from various sources have been collected and entered into the geologic and hydrologic data base, except for locations of caves and other karst features in the outcrop area. Also, the tritium data have been put into a computerized data base and are ready for mapping. Sampling for stable isotopes for potential tracers was completed.

Plans: The work with stable isotopes and other constituents to find a naturally occurring tracer will continue. Field work to map the outcrop in northern Bexar County will be done after a compilation of karst features and caves is received. Final work on the geologic mapping and cross-section development will be completed. The flow path to be analyzed in the western area will be delinated and specific wells for study of this path will be selected for leveling and intensive sampling. The water level and tritium and some of the maps of major ions will be drafted by computer.

Reports in preparation: None.

Reports approved or published, 1988: None.

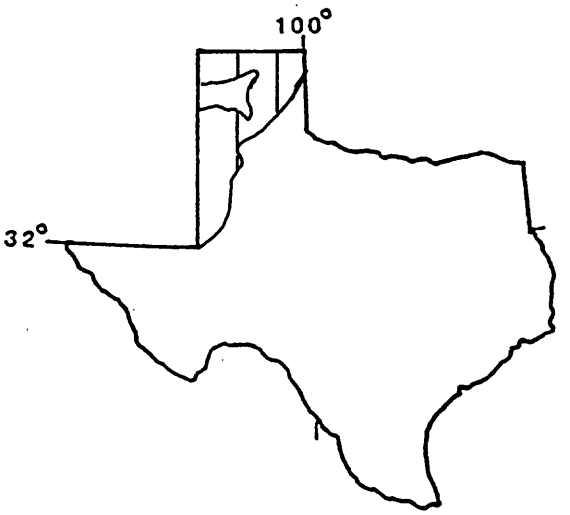
TX 88-108 MONITORING GROUND-WATER LEVELS IN THE HIGH PLAINS OF TEXAS

COOPERATING AGENCY : Texas Water Development Water Board

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

PERIOD OF PROJECT : March 1988 to September 1993

LOCATION : Northwest Texas



Problem: Because of the continued decline of ground-water levels in much of the High Plains aquifer and the potential long-term impact on the Nation's economy, the U.S. Congress requested the Geological Survey to meaure the variations of the aquifer's water levels to determine the causes for the variations and to periodically report the findings to them. These findings are needed to develop water-management plans.

Objectives: To support a program for monitoring the water levels in the High Plains aquifer and to explain the causes for the water-level changes. This project is limited to Texas and is to be coordinated with similar projects in the other High Plains states.

Approach: The project will be jointly executed by the Geological Survey and the Texas Water Development Board. The network of wells for the project will come from the current network operated by the Board concept for several wells with recorders. Thus, historic data are available. About 12 wells will have recorders. Several hundred other wells will be measured manually once a year. The data will be entered in the Geological Survey Ground-Water Site Inventory (GWSI) data base.

Progress: The network of data-collection stations has been designed and the instrumentation installed. Maps of the water levels and the changes in water levels have been designed and the instrumentation installed. Maps of the water levels and the changes in water levels have been prepared by the regional project office.

Plans: Plans are to continue the data-collection program and prepare a water-level map and an annual change-in-water-level map for the winter of 1989.

Reports in preparation: None.

Reports approved or published, 1988: None.

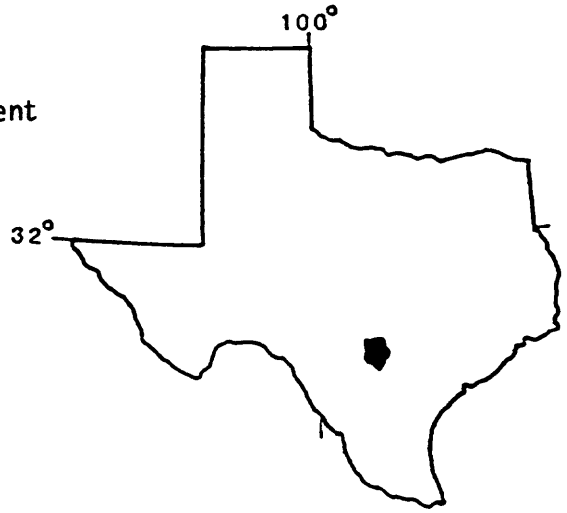
TX 88-112 COMMUNITY STRUCTURE OF AQUATIC ORGANISMS IN THE SAN ANTONIO RIVER, TEXAS

COOPERATING AGENCY : City of San Antonio Environmental Management

PROJECT CHIEF: Rodger F. Ferreira, Subdistrict Office, San Antonio

PERIOD OF PROJECT : October 1988 to September 1995

LOCATION : Southwest Texas



Problem: The city of San Antonio Environmental Management is scheduled to construct a wastewater treatment plant north of the San Antonio International Airport. The city has plans to reuse wastewater from this treatment plant as part of a regional water-supply system for San Antonio. A major use of this water would be to irrigate city-owned properties in and around Olmos Basin Park and Brackenridge Park. Return flow from these irrigated areas will enter Olmos Creek and the San Antonio River.

The city of San Antonio wants to be in compliance with water-quality standards established by the Clean Water Act of 1972. However, national water-quality criteria established by the U.S. Environmental Protection Agency (1986) might not accurately address the bioavailability or toxicity of certain effluents relative to water-quality characteristics of the San Antonio River. Study of the aquatic ecosystem of the San Antonio River could provide a direct indication of water-quality degradation and resultant negative impacts on aquatic biota.

Objective: Provide baseline physical, chemical, and biological data for Olmos Creek and the San Antonio River in Olmos Basin Park and Brackenridge Park; to determine the effects of wastewater effluent on the aquatic ecosystem in a 2.6-mile reach of Olmos Creek and the San Antonio River downstream from Olmos Park and through Brackenridge Park; and to define casual relations between changes in physical and chemical data and observed changes in the aquatic community.

Approach: Data collection for the project will continue for 6 years; 3 years preceding and three years following completed construction of the waste-water treatment plant near the airport. One sampling site will coincide with a site previously sampled by the San Antonio River Authority during their 1-year ecological assessment of the upper San Antonio River.

The major sampling effort will be conducted five times each year; twice during low flow in early spring, and three times during low flow in the summer. Physical, chemical, and biological sampling will be conducted at

three sites. One site will be in Olmos Creek just below Olmos Dam. Olmos Dam only operates during floods to lessen the impact of high flows on the city of San Antonio. Two sites will be in the San Antonio River; one upstream from Brackenridge Park and one downstream near the southern boundary of Brackenridge Park. A continuous streamflow station will be established at each of these sites.

Trend analysis will be used to indicate changes in water quality after the wastewater treatment plant is on line. Any changes in water quality will be correlated, if possible, with changes in the biotic community as indicated by various biotic or diversity indices. Evaluations of the biotic community will be based not only on numbers of organism types, but also on number of organisms in groups with similar functions in the environment. Correlations between various water-quality constituents and specific types of organisms and organisms with specific functional relation in the community, will be examined to define cause and effect relations for observed community changes.

Progress: A review of commercial portable equipment for continuous measurements of selected water-quality characteristics and selection of equipment for sampling aquatic invertebrates is in progress.

Plans: Collect physical, chemical, and biological water-quality information as outlined in the approach and prepare a data report for the first year.

Reports in preparation: None.

Reports approved or published, 1988: None

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