DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

HYDROLOGIC INVESTIGATIONS
ATLAS HA–704

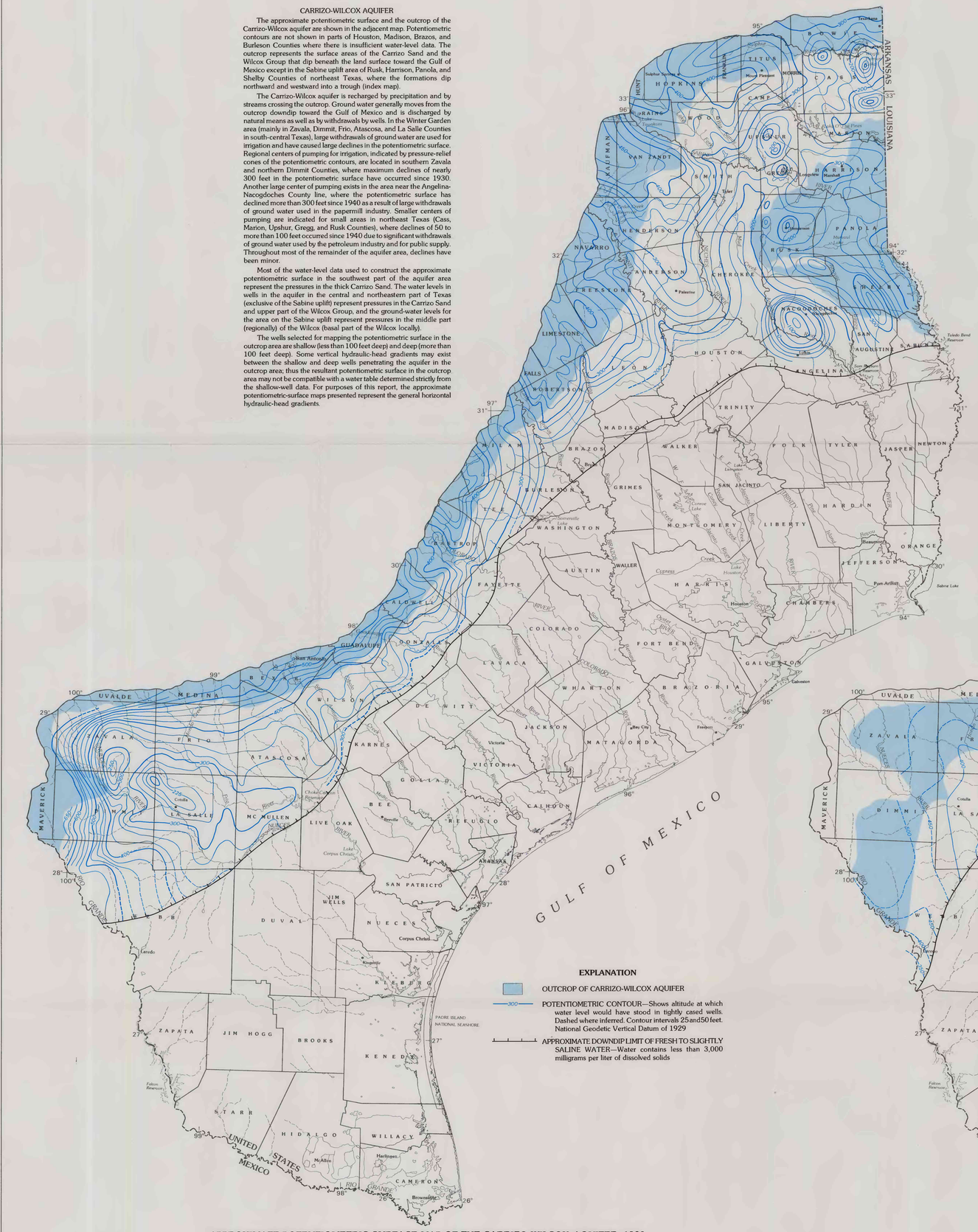
CARRIZO-WILCOX AQUIFER

The approximate potentiometric surface and the outcrop of the Carrizo-Wilcox aquifer are shown in the adjacent map. Potentiometric contours are not shown in parts of Houston, Madison, Brazos, and Burleson Counties where there is insufficient water-level data. The outcrop represents the surface areas of the Carrizo Sand and the Wilcox Group that dip beneath the land surface toward the Gulf of Mexico except in the Sabine uplift area of Rusk, Harrison, Panola, and Shelby Counties of northeast Texas, where the formations dip northward and westward into a trough (index map).

The Carrizo-Wilcox aquifer is recharged by precipitation and by streams crossing the outcrop. Ground water generally moves from the outcrop downdip toward the Gulf of Mexico and is discharged by natural means as well as by withdrawals by wells. In the Winter Garden area (mainly in Zavala, Dimmit, Frio, Atascosa, and La Salle Counties in south-central Texas), large withdrawals of ground water are used for irrigation and have caused large declines in the potentiometric surface. Regional centers of pumping for irrigation, indicated by pressure-relief cones of the potentiometric contours, are located in southern Zavala and northern Dimmit Counties, where maximum declines of nearly 300 feet in the potentiometric surface have occurred since 1930. Another large center of pumping exists in the area near the Angelina-Nacogdoches County line, where the potentiometric surface has declined more than 300 feet since 1940 as a result of large withdrawals of ground water used in the papermill industry. Smaller centers of pumping are indicated for small areas in northeast Texas (Cass, Marion, Upshur, Gregg, and Rusk Counties), where declines of 50 to more than 100 feet occurred since 1940 due to significant withdrawals of ground water used by the petroleum industry and for public supply. Throughout most of the remainder of the aquifer area, declines have been minor.

Most of the water-level data used to construct the approximate potentiometric surface in the southwest part of the aquifer area represent the pressures in the thick Carrizo Sand. The water levels in wells in the aquifer in the central and northeastern part of Texas (exclusive of the Sabine uplift) represent pressures in the Carrizo Sand and upper part of the Wilcox Group, and the ground-water levels for the area on the Sabine uplift represent pressures in the middle part (regionally) of the Wilcox (basal part of the Wilcox locally).

The wells selected for mapping the potentiometric surface in the outcrop area are shallow (less than 100 feet deep) and deep (more than 100 feet deep). Some vertical hydraulic-head gradients may exist between the shallow and deep wells penetrating the aquifer in the outcrop area; thus the resultant potentiometric surface in the outcrop area may not be compatible with a water table determined strictly from the shallow-well data. For purposes of this report, the approximate potentiometric-surface maps presented represent the general horizontal hydraulic-head gradients.



APPROXIMATE POTENTIOMETRIC-SURFACE MAP OF THE CARRIZO-WILCOX AQUIFER, 1980

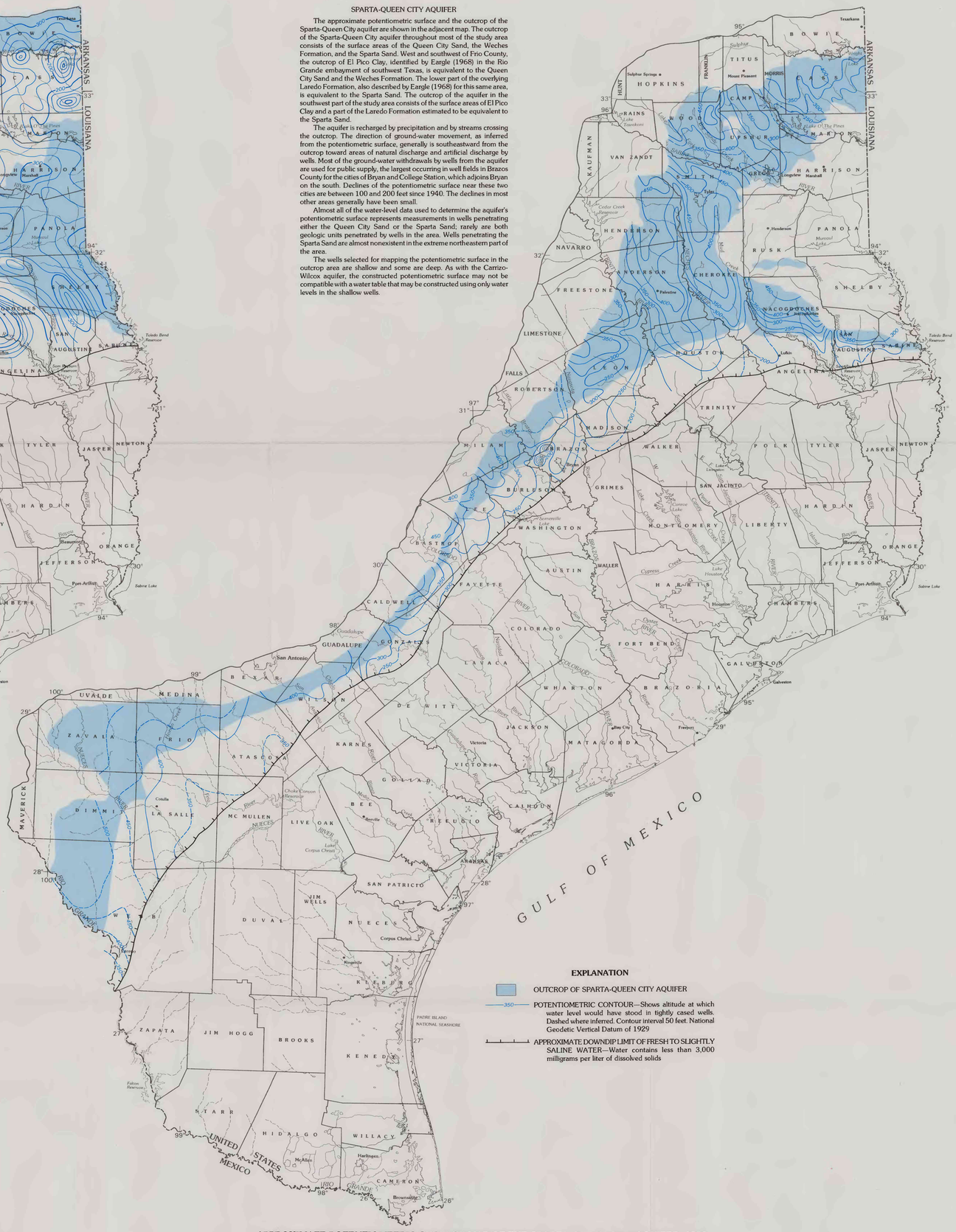
SPARTA-QUEEN CITY AQUIFER

The approximate potentiometric surface and the outcrop of the Sparta-Queen City aquifer are shown in the adjacent map. The outcrop of the Sparta-Queen City aquifer throughout most of the study area consists of the surface areas of the Queen City Sand, the Weches Formation, and the Sparta Sand, West and southwest of Frio County, the outcrop of El Pico Clay, identified by Eargle (1968) in the Rio Grande embayment of southwest Texas, is equivalent to the Queen City Sand and the Weches Formation. The lower part of the overlying Laredo Formation, also described by Eargle (1968) for this same area, is equivalent to the Sparta Sand. The outcrop of the aquifer in the southwest part of the study area consists of the surface areas of El Pico Clay and a part of the Laredo Formation estimated to be equivalent to the Sparta Sand.

The aquifer is recharged by precipitation and by streams crossing the outcrop. The direction of ground-water movement, as inferred from the potentiometric surface, generally is southeastward from the outcrop toward areas of natural discharge and artificial discharge by wells. Most of the ground-water withdrawals by wells from the aquifer are used for public supply, the largest occurring in well fields in Brazos County for the cities of Bryan and College Station, which adjoins Bryan on the south. Declines of the potentiometric surface near these two cities are between 100 and 200 feet since 1940. The declines in most other areas generally have been small.

Almost all of the water-level data used to determine the aquifer's potentiometric surface represents measurements in wells penetrating either the Queen City Sand or the Sparta Sand; rarely are both geologic units penetrated by wells in the area. Wells penetrating the Sparta Sand are almost nonexistent in the extreme northeastern part of the area.

The wells selected for mapping the potentiometric surface in the outcrop area are shallow and some are deep. As with the Carrizo-Wilcox aquifer, the constructed potentiometric surface may not be compatible with a water table that may be constructed using only water levels in the shallow wells.



APPROXIMATE POTENTIOMETRIC-SURFACE MAP OF THE SPARTA-QUEEN CITY AQUIFER, 1980

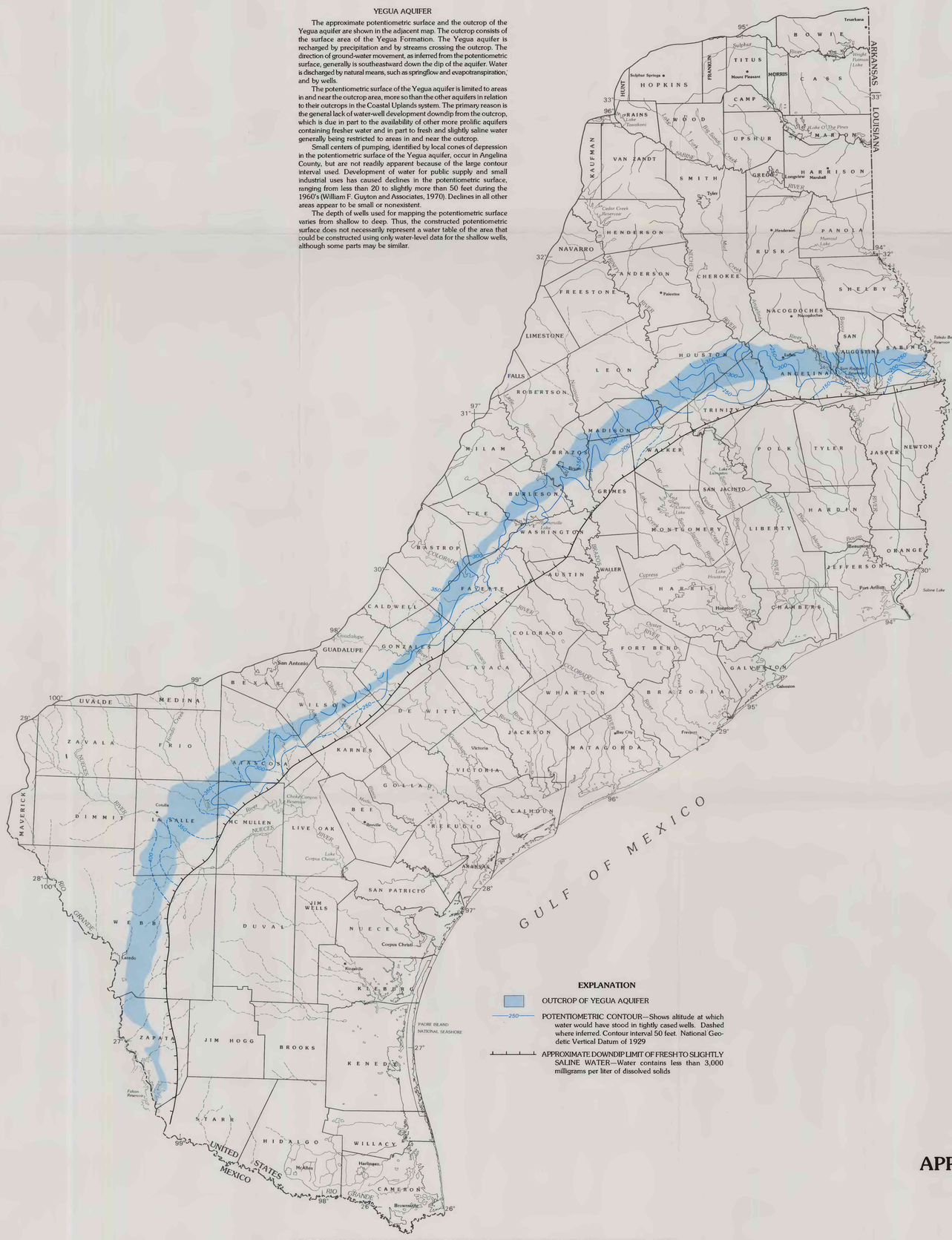
YEGUA AQUIFER

The approximate potentiometric surface and the outcrop of the Yegua aquifer are shown in the adjacent map. The outcrop consists of the surface area of the Yegua Formation. The Yegua aquifer is recharged by precipitation and by streams crossing the outcrop. The direction of ground-water movement, as inferred from the potentiometric surface, generally is southeastward down the dip of the aquifer. Water is discharged by natural means, such as springflow and evapotranspiration, and by wells.

The potentiometric surface of the Yegua aquifer is limited to areas in and near the outcrop area, more so than the other aquifers in relation to their outcrops in the Coastal Uplands system. The primary reason is the general lack of water-well development downdip from the outcrop, which is due in part to the availability of other more prolific aquifers containing fresher water and in part to fresh and slightly saline water generally being restricted to areas in and near the outcrop.

Small centers of pumping, identified by local cones of depression in the potentiometric surface of the Yegua aquifer, occur in Angelina County, but are not readily apparent because of the large contour interval used. Development of water for public supply and small industrial uses has caused declines in the potentiometric surface, ranging from less than 20 to slightly more than 50 feet during the 1960's (William F. Guyton and Associates, 1970). Declines in all other areas appear to be small or nonexistent.

The depth of wells used for mapping the potentiometric surface varies from shallow to deep. Thus, the constructed potentiometric surface does not necessarily represent a water table of the area that could be constructed using only water-level data for the shallow wells, although some parts may be similar.



APPROXIMATE POTENTIOMETRIC-SURFACE MAP OF THE YEGUA AQUIFER, 1980

INTRODUCTION

The National Water Commission recommended that the U.S. Geological Survey conduct intensive studies of the important regional aquifer systems in the United States, particularly those with declining water levels and deteriorating water quality. The result has been a series of Regional Aquifer-System Analysis (RASA) studies, one of which is the West Gulf Coast RASA study (Grubb, 1984). The West Gulf Coast RASA study, which began in 1982, is investigating several major regional aquifers mainly in parts of Texas, Louisiana, Arkansas, and Mississippi, but also in parts of Missouri, Kentucky, and Tennessee.

The Texas part of the West Gulf Coast RASA study area includes two large systems of regional aquifers and confining layers that crop out approximately parallel to the Texas Gulf Coast—the Coastal Uplands and Coastal Lowlands systems (index map). The Texas Coastal Uplands system consists of three aquifers, each of which is separated by a confining bed. The aquifers, from oldest to youngest, are the Carrizo-Wilcox, Sparta-Queen City, and Yegua; the confining beds, from oldest to youngest, are the Reklaw Formation and Cook Mountain Formation. The aquifers dip toward the Gulf of Mexico, except for some reversals in dip near the Sabine uplift in northeast Texas. Unconfined conditions generally exist in the outcrop area of each aquifer and confined conditions generally exist downdip. The Jackson Group, a confining layer that overlies the Yegua aquifer, separates the two coastal systems at the land surface and, together with the Vicksburg Group, separates the two systems in most of the subsurface.

The West Gulf Coast RASA study requires quantitative evaluation of hydrogeologic and chemical-quality data as well as the identification of hydrogeologic boundaries affecting the potential for ground-water use and development. An important part of this study is the definition of the potentiometric surface for each regional aquifer. Each of these surfaces represents the response of the aquifer to natural and man-made stresses and is an important aid in the quantitative determinations of the characteristics of the aquifer for flow-simulation models. The quantitative determinations are an important part of the analyses needed for the long-term management of the area's ground-water resources.

This report presents the 1980 approximate potentiometric surfaces for each of the three aquifers within the Texas Coastal Uplands system based on water levels in wells developed in those aquifers. The year 1980 was selected by the West Coast RASA staff for representing the approximate potentiometric surfaces for all aquifers included in their study.

Water levels measured during 1980 in more than 900 wells were used in preparing the potentiometric-surface maps; most of these data were obtained from the observation-well computer files of the Texas Department of Water Resources. Additional data that were used consisted of estimates of 1980 water levels for about 250 wells. The estimates were based on historical water-level measurements and the extension of water-level hydrographs for many of these wells. The historical records generally were obtained from reports describing ground-water resources in various counties published by the Texas Department of Water Resources or its forenamed agencies: The Texas Water Development Board, the Texas Water Commission, or the Texas Board of Water Engineers. (See references.)

The approximate potentiometric surfaces were determined from data that largely represent stable and generally undisturbed water-level conditions during winter months. Water levels fluctuate primarily in response to pumping stresses, and to a lesser extent to recharging conditions during rainy periods. Pumping during the winter generally is minimal; rainfall is variable throughout the year. The potentiometric-surface maps of the three aquifers in the Texas Coastal Uplands system are restricted to those parts of the aquifers containing fresh to slightly saline water (dissolved-solids concentration less than 3,000 milligrams per liter). Water-well data generally are not available for the downdip parts of the aquifers that contain more saline water.

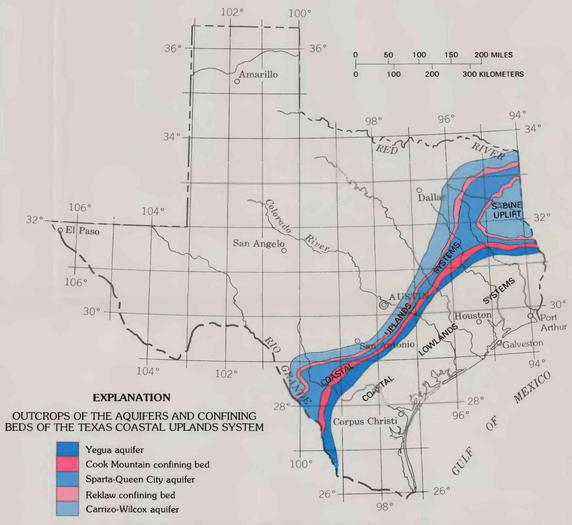
GEOLOGIC UNITS OF TEXAS COASTAL UPLANDS SYSTEM

The Texas Coastal Uplands system consists of geologic units in the Wilcox and Claiborne Groups of Eocene age. In most of the water-resources reports of areas in Texas, the Wilcox Group is not differentiated into specific geologic units. The geologic units identified in the Claiborne Group are, from oldest to youngest: the Carrizo Sand, Reklaw Formation, Queen City Sand, Weches Formation, Sparta Sand, Cook Mountain Formation, and Yegua Formation. Detailed description of these units and their water-bearing properties may be found for the various counties in the reports published by the Texas Department of Water Resources or its forenamed agencies.

The Carrizo-Wilcox aquifer consists of hydraulically connected beds of sand and sandstone of the Wilcox Group and the Carrizo Sand. The Wilcox Group is a series of interbedded sand, sandstone, clay, shale and lignite. Massive sand beds occur in places. The Carrizo Sand is a medium- to fine-grained sand, which generally is massive. The Carrizo-Wilcox aquifer commonly yields 300–800 gallons per minute to wells and is capable of yielding water in excess of 3,000 gallons per minute (Baker, 1985, p. 398). The aquifer, with a maximum thickness of more than 3,000 feet, is considered a major aquifer in Texas and is the principal source of ground water for more than 30 counties in and downdip from the aquifer outcrop.

The Sparta-Queen City aquifer includes the hydraulically connected beds of sand and sandstone of the Queen City Sand, the Weches Formation, and the Sparta Sand. The Queen City Sand consists of as much as 500 feet of medium- to fine-grained sand and sandstone, which can be massive or thin-bedded, and silty, lignitic shale; it may yield in excess of 400 gallons per minute of fresh to slightly saline water to wells (Baker and Wall, 1976, p. F-7). The Weches Formation generally is a thin layer of clay with glauconite and very thin beds of sand. The Sparta Sand, which generally is 100–300 feet thick, is composed mainly of sand and interbedded clay; large-capacity wells generally yield about 500 gallons per minute of fresh to slightly saline water, although the yields of some wells exceed 1,000 gallons per minute (Baker and Wall, 1976, p. F-7). Except for relatively heavy localized development, the Sparta-Queen City aquifer is only slightly developed throughout most of its extent.

The Yegua aquifer consists of the hydraulically connected sand and sandstone in the Yegua Formation, which generally is composed of interbedded sands, sandstones, and clays with some lignite. The maximum thickness of the Yegua Formation in and near its outcrop is about 1,500 feet. The aquifer generally yields less than 50 gallons per minute of fresh to moderately saline water to wells but is capable of yielding more than 500 gallons per minute to large-capacity wells in some areas (Baker and others, 1974, p. 44). However, the aquifer is only slightly developed by wells throughout its extent.



INDEX MAP SHOWING GENERALIZED OUTCROP OF THE TEXAS COASTAL UPLANDS SYSTEM AND THE TEXAS COASTAL LOWLANDS SYSTEM

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CONVERSION FACTORS FOR METRIC EQUIVALENTS

To convert ENGLISH UNIT	Multiply by	To obtain METRIC UNIT
Mile	1.609	Kilometer
Foot	0.3048	Meter
gallon/minute	0.06308	liter/second

SCALE 1:1 500 000

0 50 100 150 MILES

0 50 100 150 KILOMETERS

APPROXIMATE POTENTIOMETRIC SURFACES FOR THE AQUIFERS OF THE TEXAS COASTAL UPLANDS SYSTEM, 1980

By

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1987

Base from U.S. Geological Survey, 1986

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