TEXAS WATER COMMISSION

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BULLETIN 6302

# AVAILABILITY AND QUALITY OF GROUND WATER IN SMITH COUNTY, TEXAS

BY

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Prepared by the Texas Water Commission
in cooperation with the
Tyler Chamber of Commerce

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# PREFACE

Initiation of detailed ground-water investigations in Smith County was a part of the recognition by the Texas Water Commission that large quantities of fresh ground water are available in East Texas which are not now being fully utilized and about which more firm data must be made available before optimum development can be planned. Plans for this county-wide detailed study were included in the programming of statewide reconnaissance investigations which were begun by the Texas Water Commission as a part of its implementation of the Texas Water Planning Act of 1957. In carrying out the directives of the Planning Act, the Water Commission prepared and transmitted to the 56th Legislature a Progress Report which outlined two types of ground-water investigations: reconnaissance studies which were to be conducted on a statewide basis to determine the order of magnitude and the general chemical quality of ground-water supplies potentially available from the principal water-bearing formations throughout the State; and detailed investigations throughout the State in those areas where the intensity of ground-water information is not sufficient to obtain optimum benefit from the available supplies, and to determine the potential ground-water supplies for detailed water planning. In order to correlate information regarding ground-water supplies with availability of surface-water supplies, the ground--water reconnaissance studies were conducted on a river basin basis.

In September 1959, final stages of the statewide reconnaissance studies were underway. Four ground-water geologists of the Texas Water Commission were at work in the Trinity, Neches, and Sabine River Basins oE East Texas. With the knowledge that more detailed investigation would be required, not only in East Texas but over the entire State, and with the objectives of the detailed investigations set forth in the Progress Report to the 56th Legislature, it was decided by the Texas Water Commission to conduct a detailed study of Smith County concurrently with the reconnaissance investigation of this area.

In December 1961, a preliminary report draft and accompanying illustrations of the results of the detailed field study of Smith County were presented to the Tyler Chamber of Commerce, Tyler Industrial Foundation, and other interested parties in Smith County. Some expansion of the scope of the investigation and the results of the report were planned and agreed upon at this meeting. The Tyler Chamber of Commerce agreed to support financially the completion and publication of the final report. A contract was entered into by the Texas Water Commission and the Tyler Chamber of Commerce under the terms of which the Commission agreed to supplement and revise the data, maps, and manuscript of the Smith County report and to submit to the Chamber a copy of the manuscript and supporting illustrations by January 1963 for review. The manuscript was reviewed by the Chamber of Commerce and final approval was received by the Commission on January 30, 1963. The contract also provided that the final report would be published by the Commission after April 1963.

The investigation was made under the direction of Leslie G. McMillion, Director of the Ground Water Division, and John J. Vandertulip, Chief Engineer, of the Texas Water Commission. Editing and technical review of the manuscript was made by (Mrs.) Jean O. Williams, Ground Water Division, and John W. White, Reports Division, Texas Water Commission.

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# AVAILABILITY AND QUALITY OF GROUND WATER IN SMITH COUNTY, TEXAS

## ABSTRACT

Smith County, an area of economic growth in northeast Texas, has three aquifers, or water-bearing units, which can sustain large-scale increases in ground-water withdrawals. These aquifers, the Carrizo-Wilcox, Queen City, and Sparta, are comprised respectively of the Wilcox Group and Carrizo Formation, Queen City Formation, and Sparta Formation, all of Eocene age.

The Carrizo-Wilcox is the most important aquifer and is present throughout the County. In 1961 an estimated 1,490 million gallons (4,580 acre-feet) of water was withdrawn from the aquifer for municipal, industrial, and domestic supplies. Two estimates have been derived of the quantity of water that can be withdrawn continuously: (1) On the basis of a conjectured future water level 400 feet below land surface, 39 million gallons per day (43,560 acre-feet per year) of water will pass through and be available for withdrawal from the aquifer; (2) In three areas of best potential for well-field development, the Carrizo-Wilcox can yield a sustained 36 million gallons per day with pumping levels up to 650 feet below land surface. Quality of the water is very good, with the concentrations of dissolved solids generally ranging from less than 200 to 500 parts per million, but concentrations may reach 3,000 parts per million in the lowest part of the Wilcox.

From the Queen City aquifer, which is present in over 95 percent of the County, an estimated 490 million gallons (1,500 acre-feet) of water was pumped in 1961 for municipal, industrial, and domestic uses. A study of hypothetical well fields in three areas of best aquifer potential indicated that 3 million gallons per day (3,360 acre-feet per year) of water is available on a sustained basis plus an undetermined amount in the outcrop of the aquifer. The water from the Queen City is relatively low in mineral concentration except for iron. In 12 analyses the iron concentration ranges between 1.1 and 71 parts per million. The iron concentration may make the water from the Queen City less desirable for many uses than the water from the other aquifers, but with proper treatment the iron can be substantially removed.

The Sparta aquifer is limited in development potential by its small areal extent. In 1961 an estimated 163 million gallons (500 acre-feet) was withdrawn for municipal, industrial, and domestic uses. In the three areas in which the Sparta is suitable for additional development, it is estimated that 10 million gallons per day (11,200 acre-feet per year) of water could be withdrawn

continuously. Water from the Sparta aquifer is well suited for many industrial uses because of low concentration of dissolved solids and a temperature of 65° to 70° Fahrenheit.

Water of suitable quality for almost every use is available from these three aquifers in Smith County. It is estimated that they can yield collectively more than 50 million gallons of usable water per day on a sustained basis.

# AVAILABILITY AND QUALITY OF GROUND WATER IN SMITH COUNTY, TEXAS

## INTRODUCTION

### Purpose and Scope of Investigation

Continued economic development in East Texas makes it essential that sufficient data be available regarding ground-water supplies of good quality in order that industries considering location in the area may make a firm determination regarding the potential adequacy of water supplies. The immediate objective of the Smith County study was to determine and describe the occurrence, availability, and chemical quality of ground water in the County.

The scope of the study included the collection, compilation, and analysis of ground-water data for Smith County and the preparation of a report presenting the results of the study together with pertinent basic data and illustrations portraying ground-water conditions in the County. Principal emphasis was placed on those aquifers supplying water for municipal and industrial purposes, and on those aquifers from which it appears possible to develop additional supplies for municipal and industrial purposes.

The study was made chiefly to define ground-water conditions in Smith County; to determine changes in ground-water conditions resulting from development for those areas where earlier comparative data were available; to estimate the quantity of ground water available for development from the principal aquifers; and to provide recommendations for a continuing program of observations from which future changes in ground-water conditions and their causes can be determined.

Data available from work done in Smith County during 1959 and 1960 as a part of the statewide reconnaissance ground-water study were utilized in the course of the present study.

### Method of Investigation

In conducting the detailed ground-water investigation of Smith County the following items of work were performed:

1. Compilation and correlation of available electric logs of wells and the mapping of the subsurface geology.

2. Field checking of existing surface geologic data.

3. Inventory of municipal, industrial, irrigation, domestic, and livestock wells, and major springs.

4. Inventory of municipal, industrial, and irrigation pumpage.

5. Measurements of water levels in wells.

6. Determination of elevation of wells to provide control for maps, sections, and quantitative data.

7. Pumping tests were conducted to determine the hydraulic characteristics of the aquifers.

8. Collection of water samples from wells and springs for chemical analysis. Compilation of available chemical analyses of water from wells.

9. Compilation and analysis of data and preparation of illustrations to show the geologic and hydrologic conditions of the County.

10. The determination of quantity and chemical quality of water available from, adequacy of recharge to, and effects of future pumpage on each of the major aquifers of the County.

The outcrops of the geologic formations were studied for the purpose of providing a better understanding of the water-bearing characteristics of the formations; about 190 electric logs were studied to determine the attitude, depth, and thickness of the formations; 210 water wells were inventoried to determine the manner in which the wells were constructed and the aquifer in which the wells were completed; and water levels were measured in wells whenever possible to determine the direction of movement of water in the aquifer and the hydrostatic pressure on the water in the aquifer. Evaluation of 62 chemical analyses revealed the water-quality characteristics of the aquifers. The results of 20 aquifer (pumping) tests indicated the hydraulic characteristics of the aquifers.

## Previous Investigations

The present investigation is the first known effort to study in detail the ground-water resources of Smith County. Lyle (1937) presented an extensive tabulation of well records, water-level measurements, drillers' logs, and chemical analyses for water wells in Smith County. In 1944, W. L. Broadhurst conducted pumping tests on the city of Tyler water wells and presented the results in a memorandum report of the Texas Board of Water Engineers. The ground-water resources of Smith County are presented in the Neches and Sabine River Basin reconnaissance reports (in preparation) on a reconnaissance regional basis.

Previous geologic investigations include that portion of "The Geology of Texas" (Sellards and others, 1932) which concerned Smith County. Stenzel (1953) touched upon the geology of the southeastern part of the County in his report on Henrys Chapel Quadrangle in Cherokee County.

## Organization of Report

Organization of this report has been planned to facilitate its use. The report consists of a text and three appendices. A summary of ground-water conditions and recommendations for a continuing program of observations of these conditions in Smith County make up the text. Appendix A contains tables of wells, records which furnish pertinent data regarding the location and performance of water wells in the County; chemical analyses of water samples from selected wells; locations of oil tests of which electric logs were used as subsurface data control points in the report; and summary of data from pumping tests. Appendix B includes supplementary discussions of the geology of Smith County and general ground-water hydrology, and definitions of terms used in the report. The section on general ground-water hydrology contains material which has particular interest to the reader unfamiliar with the terminology of this field. While the major section of the text entitled "Results of Investigation" includes discussions of both the geology and ground-water hydrology of the County, Appendix B provides both additional detail and general explanatory material which may be helpful to a full understanding of special problems in Smith County. Appendix C contains the major illustrations with accompanying discussion.

## Geologic Nomenclature

Geologic nomenclature used in this report is that used by Sellards, Adkins, and Plummer in "The Geology of Texas" (1932) and H. B. Stenzel in "The Geology of Henrys Chapel Quadrangle, Northeastern Cherokee County, Texas" (1953). This is the most widely accepted nomenclature for this area.

## Well-Numbering System

The water wells, springs, oil wells, and test holes studied in this investigation have been numbered on the Texas Water Commission's statewide well-numbering system. The full description of this system is given in Appendix A.

## Acknowledgments

Grateful acknowledgment is given to Mr. Bruce W. Fox, District Geologist, Atlantic Refining Company for making available electric logs of wells in the County. Appreciation is expressed to the many geologists in Tyler who readily helped and gave advice on the geology of the area and to the municipal and industrial officials and landowners who gave access to their records and wells in order that ground-water information might be obtained. The writer is particularly indebted to Mr. Roy C. White, White Drilling Company, and Mr. R. G. Cousins and others of the Layne-Texas Company, for opening their records to the Commission and giving of their time so that complete water-well information could be obtained for this report.

Acknowledgment is given to Mervin L. Klug, formerly Assistant Director, Ground Water Division, Texas Water Commission, for his assistance in the determination of the available water.

# RESULTS OF INVESTIGATION

## Location

Smith County is located in northeast Texas, as shown on Figure 1. The area of the County is 939 square miles and its county seat is Tyler.

## Climate

The climate of Smith County is characterized by long mild summers with gradual seasonal transitions. January has an average temperature of 47° Fahrenheit, with the temperature rising gradually each month to July and August which have an average temperature of 83° Fahrenheit. The mean annual temperature of Smith County is 62°.

Precipitation, generally in the form of rain, is distributed rather evenly throughout the year and averages 44.4 inches annually. In April and May are recorded the highest average monthly precipitation, 5.1 and 5.9 inches respectively. July has the lowest average rainfall, with a recorded average of 2.5 inches. Figure 2 illustrates the mean monthly precipitation and temperature records from the Four Mile Northeast Tyler, Texas Station for the period of record, 1941-61.

## Topography and Drainage

Smith County is characterized by gently rolling topography although local areas are marked by rough terrain. The topography and well defined drainage system reflect the varying resistance to erosion of geologic formations which crop out in the County.

In the southeast part of Tyler the elevation reaches 671 feet above sea level which is the highest point in the County. Along the Sabine River in the northeast corner of the County the elevation drops to less than 270 feet. The average surface elevation in the County is 550 feet above mean sea level.

Most of the County is mantled by loose sandy soil although dense clay and rock mark the areas of rough terrain. Soils are of two types: upland and terrace. The upland soils are fine sandy loams and gravelly sandy loams and are a quartzose material. The terrace soils are clay and silty clay loam derived from material washed from the uplands.

A major drainage divide trends northwest-southeast across Smith County. This divide enters the county east of Van in Van Zandt County, passes just north of Tyler and leaves the county at Overton, in Smith and Rusk Counties. The drainage systems of the Sabine and Neches Rivers are separated by this divide. The Sabine River, which is the northern boundary of Smith County, receives the drainage north of the divide, and all drainage south of the divide enters the Neches River. Topography and drainage in the County are illustrated on Plate 1.

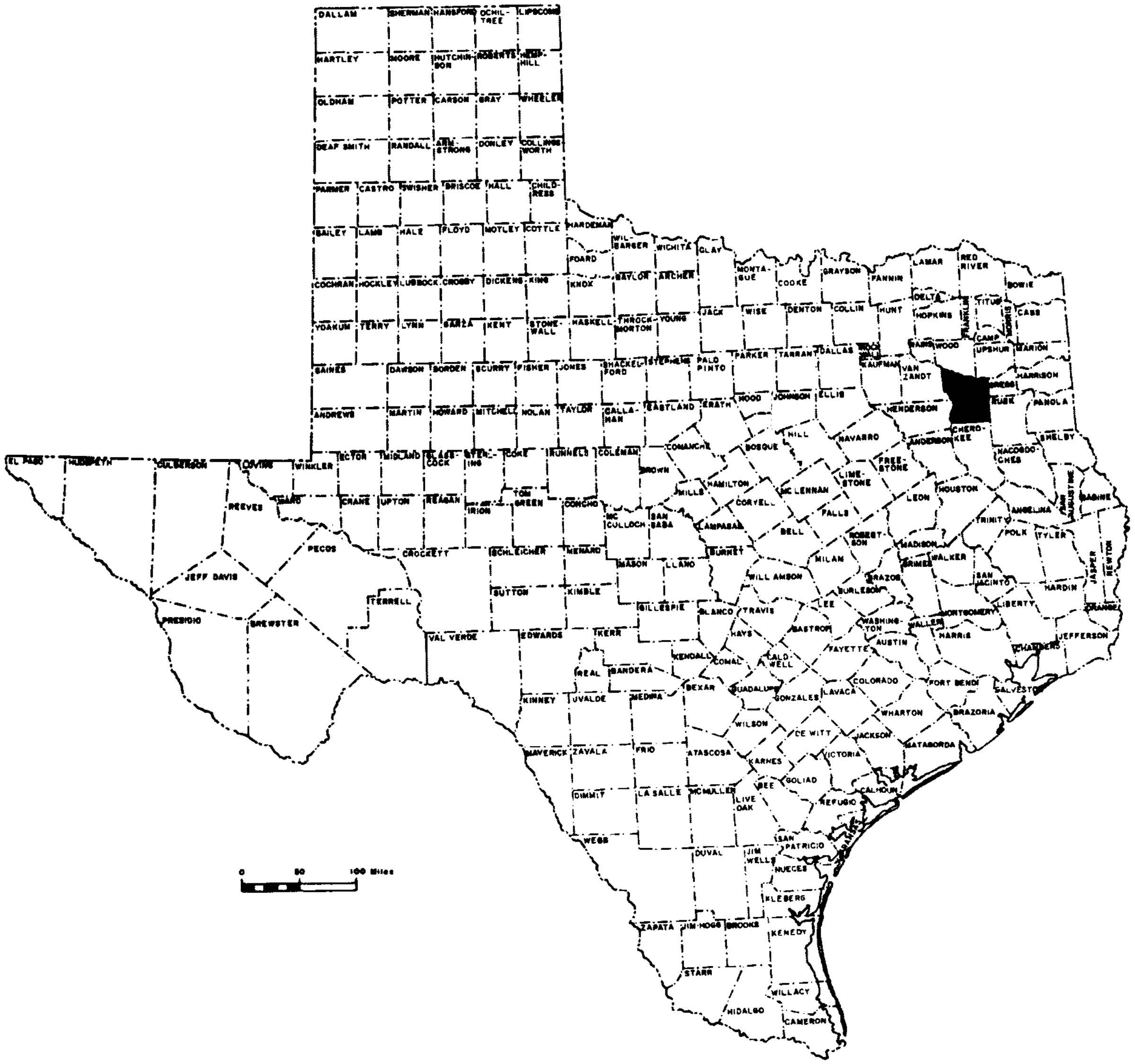
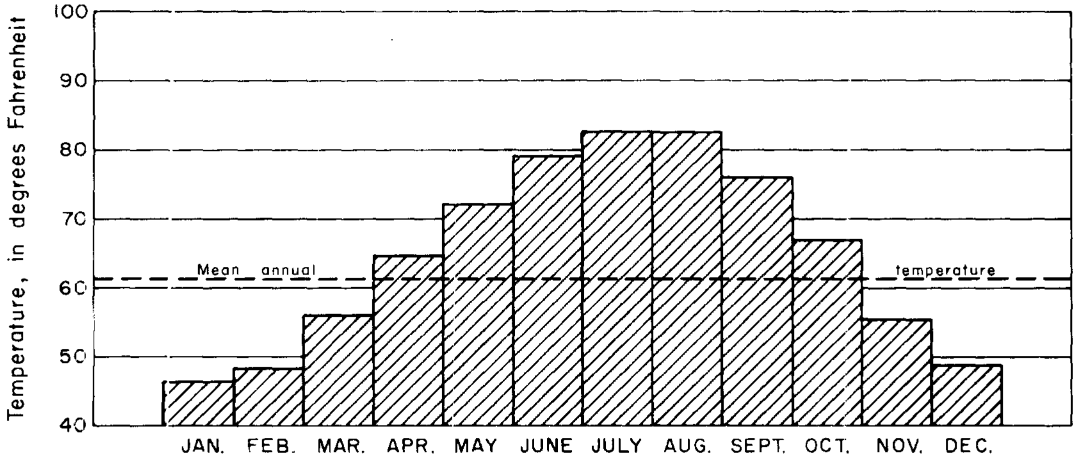


Figure 1

Map of Texas Showing the Location of Smith County

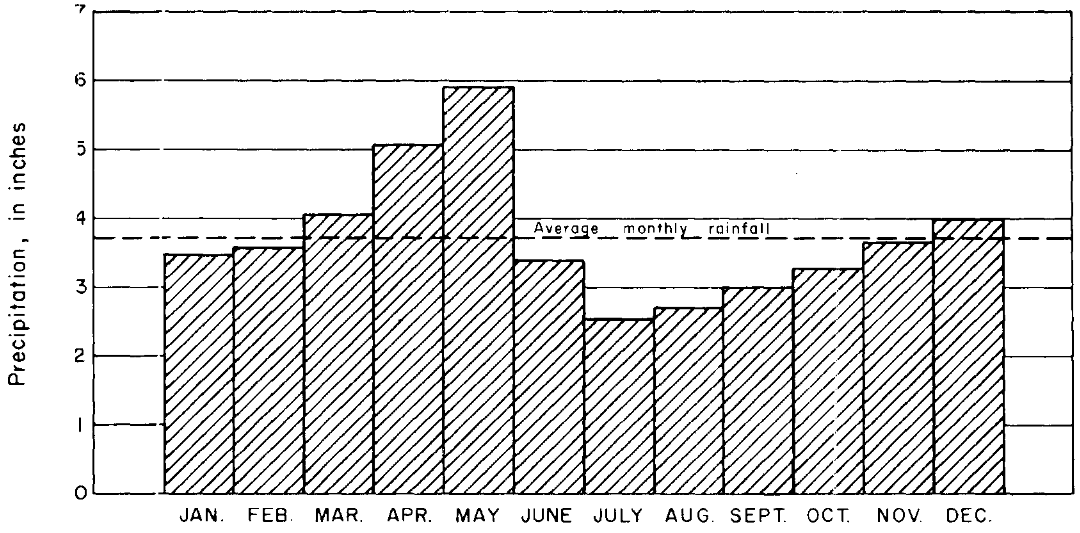
Texas Water Commission in cooperation with the

Tyler Chamber of Commerce



Mean monthly temperature

(Data from U.S. Weather Bureau)



Mean monthly precipitation

(Data from U.S. Weather Bureau)

**Figure 2**

**Mean Monthly Precipitation and Temperature at Tyler, 1941-61**

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## Population and Economy

The 1960 figures released by the U. S. Bureau of the Census showed Smith County to have a total population of 86,350. In Tyler, the county seat and the principal urban and industrial center, the population increase has reflected the continuing economic growth of the County. The 1960 population figures for principal towns and cities are shown below:

| | | | |
|---|---|---|---|
| Arp | 812 | Troup | 1,676 |
| Bullard | 364 | Tyler | 51,230 |
| Lindale | 1,285 | Whitehouse | 842 |

The economic stability and growth in Smith County has been the result of expansion in agriculture, oil production, and manufacturing. A large part of the County's agricultural income is derived from the growth and shipment of rose plants to all parts of the world. Representing an annual sales volume of 7.5 million dollars, 10 to 20 million plants are grown in the County. Other agricultural products include livestock, timber, vegetables, and fruit.

Oil production has been of major significance to the economy of the County since the development of the East Texas Oil Field beginning in 1931. More than 330 major and independent oil companies had principal offices in Tyler at the time of this study. This and other sources of income associated with oil and gas production contribute millions of dollars each year to the economy of the County.

Manufacturing represents the largest growth factor in the County's economic life during the past 15 years. In 1960 and 1961 two major industries located in Tyler, one manufacturing automobile tires and the other manufacturing plastic containers. Other industrial products include cast iron pipe, heaters, air conditioners, battery cases, ceramic products, oil tanks, and prefabricated homes. There were more than 125 manufacturing or processing plants in the County in 1962.

## Geologic Structure and Geologic History

Smith County is in the Tyler basin area of the East Texas embayment. This embayment is a principal geologic feature in East Texas lying approximately at right angles to the present shoreline of the Gulf of Mexico (Figure B1). It is separated from the Mississippi embayment to the east by the extensive Sabine uplift lying along the Sabine River on the Texas-Louisiana border. To the north and west it is bounded by the Mexia-Talco fault zone and the San Marcos arch.

The Tyler basin lies in the northern part of the East Texas embayment and is characterized by a number of piercement salt domes. Tyler, for which the basin was named, is approximately in its center. The Tyler basin is a synclinal structure opening to the south in Anderson and Cherokee Counties, and bounded on the south by the Mount Enterprise fault zone which extends from Shelby to Anderson County.

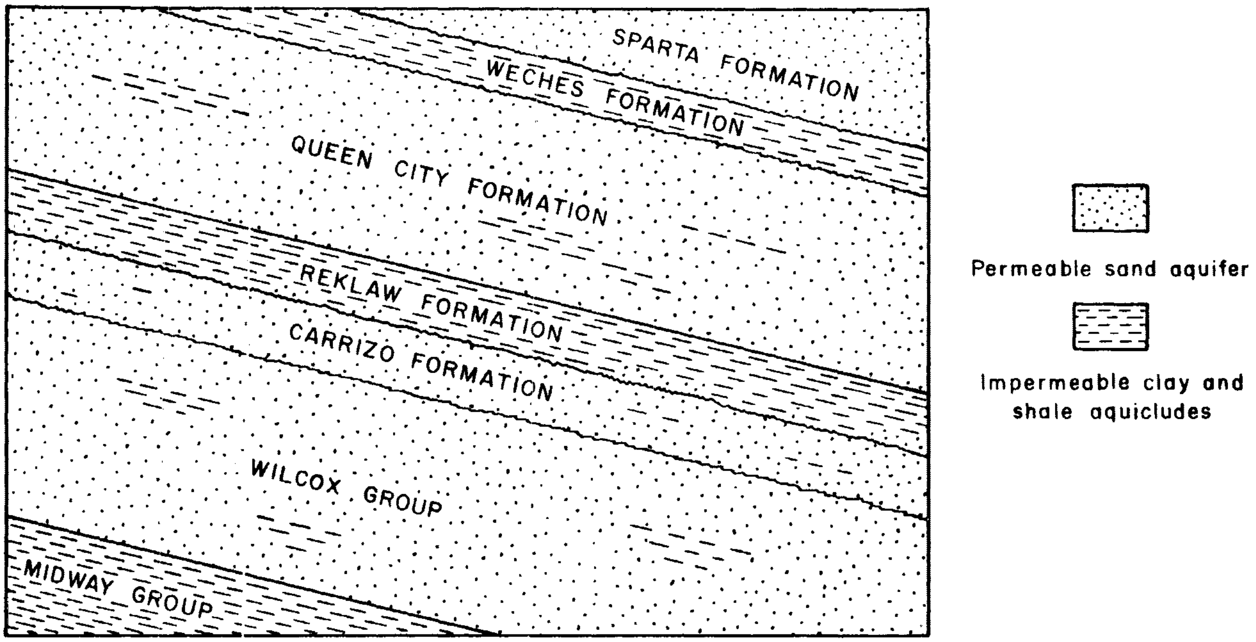
The depositional history and structural attitudes of the geologic formations in Smith County have been controlled largely by the Tyler basin and the piercement domes. Sediments were deposited in the Tyler basin as the seas of the geologic past moved repeatedly in and out from the area of the present Gulf of Mexico. When the seas invaded the basin, marine deposition occurred and when the seas retreated to the south, a continental environment prevailed.

During some period of the geologic past, probably in Jurassic time, the Tyler basin area was apparently cut off from the main body of sea and a massive evaporite deposit of salt was laid down. In its original stratigraphic position, this salt bed was about 10 to 15 thousand feet below the present land surface. However, rock salt under pressure deforms easily and flows from places of greater pressure to places of lesser pressure. Therefore, when the salt was subjected to the stresses of structural movement and the differential weight of overlying beds, the salt began to move and flow toward areas of lesser pressure where it was pushed upward, piercing and doming the rocks overlying the salt. In Smith County, the areas into which the salt moved became domes and elongated ridges.

The geologic structure and history of the Smith County area is included in Appendix B of this report to provide more detailed description of the environmental conditions which affected the water-bearing formations in the County.

## Occurrence of Ground Water

Large quantities of ground water are available in Smith County. The hydraulic characteristics of the geologic formations in which the ground water occurs were largely determined by the environments in which these formations were deposited and their stratigraphic relationships. In Smith County ground water of good quality is found in several geologic units of Eocene age that overlie the Midway Group. The stratigraphic sequence of these water-bearing formations and of the intervening aquicludes is shown on the following diagram.



Schematic Diagram of the Stratigraphic Sequence of Aquifers and Aquicludes in Smith County

Four of the geologic units above the Midway Group are important aquifers in the area: the Wilcox Group and the Carrizo, Queen City, and Sparta Formations. Ground water in the Carrizo Formation and the Wilcox Group is hydrologically connected and these formations will, therefore, be discussed in this report as one hydrologic unit, called the Carrizo-Wilcox aquifer. The stratigraphic relationships of these beds are shown also in Plate 3. Details of the development of ground water through wells in Smith County are summarized by aquifer in Table 1 of Appendix A.

Other geologic units above the Midway either are not known to yield water in Smith County or yield only small amounts of water. The Weches Formation and the Tyler greensand, which overlies the Sparta, are not known to yield water anywhere in the County. The Reklaw Formation yields small quantities of water to a few wells and springs but is not significant as an aquifer.

Ground water occurs in Smith County under both water-table and artesian conditions. The structure of the Eocene rocks and the interbedding of sand and shale favor the occurrence of artesian conditions. Water-table conditions exist in the outcrops of the aquifers; however, artesian conditions occur downdip where the aquifers are saturated with water and overlain by relatively impermeable material.

Ground water in the fresh-water aquifers in Smith County moves steadily from areas of recharge to points of discharge under the influence of gravity. The natural rate of movement is very slow, and the time required for movement over a few hundred feet must be measured in years rather than hours or days. Recharge occurs chiefly by infiltration of precipitation on the outcrops. Sandy nature of the soils in the outcrops of the aquifers and the rather large amount of rainfall which is well distributed throughout the year contribute favorably to a high potential rate of recharge to the aquifers.

## Principal Aquifers

### Carrizo-Wilcox Aquifer

The Carrizo-Wilcox aquifer is defined as the hydrologic unit comprised of the Carrizo Formation and the Wilcox Group. Both the Carrizo Formation and Wilcox Group are separate and distinct geologic units, but they are hydrologically interrelated. Therefore, these two geologic units are designated as one aquifer. This aquifer exists throughout the County.

#### Geologic and Structural Description

The Wilcox Group conformably overlies the Midway Group, and its outcrop lies in the counties north, east, and west of Smith County. Available evidence indicates that sedimentation was continuous from the marine muds and silts of the underlying Midway into the littoral, deltaic, and nonmarine deposits of the Wilcox. These beds are composed of sand, sandy clay, cross-bedded river sand, lignite seams, and stratified silt. In general, the upper beds have higher proportions of sand and the lower beds higher proportions of clay and shale.

The total thickness of the Wilcox Group in Smith County ranges from about 750 feet to about 1,300 feet with a thickness of about 900 feet over most of the County. Sand layers 5 feet or more in thickness constitute an average of about 40 percent of the total section. The Wilcox Group has been affected to a greater extent lithologically and structurally by the formation of salt domes than the younger, shallower formations in the County. The greatest thickness of the Wilcox is found in the structural basins and generally is accompanied by an increase in net sand thickness.

Individual beds of sand in the Wilcox are not continuous, because of interfingering with, and lateral gradations into, shale and clay beds. As a result, these individual sands may behave as separate aquifers of limited areal extent in local areas. The thickness of the Wilcox section in Smith County is illustrated on Plate 8.

The Wilcox Group is unconformably overlain by the Carrizo Formation which outcrops in a very small part of Smith County. The contact of the Carrizo with the underlying Wilcox Group suggests an abrupt change in sedimentation pattern. For the most part, the Carrizo was laid down by streams building a broad alluvial deposit along a flat coastal plain. In its outcrop, which occurs mainly in the counties adjoining Smith County, the Carrizo forms a very loose deep sandy soil which is highly favorable for recharge.

The Carrizo ranges in thickness from 40 feet to 225 feet but averages and maintains for the most part a uniform thickness of about 100 feet. In most of the County 90 to 100 percent of this total thickness is sand. Structurally the Carrizo Formation conforms closely to the Wilcox Group although structural dips near the domes and basins are somewhat less than those at the base of the Wilcox. A study of electric logs in Smith County indicates an average net sand thickness of approximately 500 feet in the combined stratigraphic units of the Wilcox and the Carrizo.

Major exceptions to this average thickness are important in locating a ground-water supply in the County. Test drilling has indicated several areas in which the Carrizo is silty and very thin. Two test holes, numbers 34-45-605 and 606, shown on Plate 16, were drilled by the Tyler Industrial Foundation in 1961 for the purpose of evaluating ground-water conditions at a new plant site. Examination of electric and sample logs of these holes revealed that the Carrizo had thinned, but more important, had become extremely silty. Logs also indicate that the Carrizo is best developed on the south, southeast, and east flanks of the structural lows surrounding the domes and on the broad flat area in the eastern part of the County. Therefore, Carrizo wells which are drilled to produce large quantities of water should be located in these areas.

The depth to the top of the Carrizo ranges from 0 feet to more than 1,000 feet, and the depth to the base of the Wilcox ranges from 400 feet to 2,300 feet in the County.

## Source and Movement of Water

The principal source of water in the Carrizo-Wilcox aquifer is rainfall in its outcrop in Smith County and surrounding counties although some additional recharge is probably received from streams crossing the outcrop. Some recharge may reach the Carrizo-Wilcox from overlying formations but the amount probably is small. In the outcrop, water occurs in the Carrizo-Wilcox under water-table conditions, but the water enters areas of artesian conditions as it moves down the dip of the inclined beds to areas where it is confined by the overlying, less permeable Reklaw formation.

The direction and rate of movement of ground water through an aquifer is affected by the character of the reservoir rocks, the amount of recharge to the aquifer, and the amount of withdrawal from the aquifer. Principal movement of ground water in the Carrizo-Wilcox aquifer in Smith County is east and southeast from the western recharge area. Deviation from this regional direction of movement occurs near the recharge area in the southeast corner of Smith County, where the ground water locally moves northwest. Measurements of water levels indicate that the piezometric surface of the Carrizo-Wilcox aquifer is relatively flat across the County, although it steepens in isolated areas. The hydraulic gradient of this surface ranges from 2 to 25 feet per mile and averages approximately 5 feet per mile.

## Water Levels

Static water levels in the Carrizo-Wilcox range from 4 feet above to 323 feet below land surface, which in elevation is 418 feet to 243 feet and averages approximately 300 feet above sea level. There are no long-term records of water levels available to permit a detailed evaluation of water-level fluctuations in the aquifer during the years in which ground water has been developed in Smith County. However, the records which are available indicate that the Tyler and Winona areas have experienced substantial changes in water levels within the past 25 years. In both areas, a decline of water levels accompanied the period of extended drought that affected all of Texas in the early 1950's. However, in the Tyler area heavy pumpage preceeded the drought and also caused a decline in the water levels. Since the drought, water levels have shown a rapid rise in both areas.

Water levels in the vicinity of Tyler were lowered appreciably in the period between 1937 and the early 1950's during which the city of Tyler pumped ground water for municipal supplies. When the city increased its use of surface water and decreased its pumpage of ground water in 1952, water levels began to rise. Significant rises in water levels, ranging from 2 to 8 feet, were measured in the city wells between January 1960 and January 1962. The following table shows the significant changes in water levels in the Tyler area during the period of record.

| Well Number | Owner | Date of Measurement | Static water level below land surface (in feet) | Rise (+) or decline (-) of water level since preceding measurement (in feet) |
|---|---|---|---|---|
| 34-37-901 | Tyler Ind. School | 3- 9-57 | 145 | Date drilled |
| | | 3-23-62 | 98 | + 47 |
| 34-45-301 | City of Tyler<br>Pounds Field | 1-17-43 | 206 | Date drilled |
| | | 1-12-60 | 224 | - 18 |
| | | 3- 1-62 | 223 | + 1 |

(Continued on next page)

| Well Number | Owner | Date of Measurement | Static water level below land surface (in feet) | Rise (+) or decline (-) of water level since preceding measurement (in feet) |
|---|---|---|---|---|
| 34-46-101 | City of Tyler (Well 9) | 6-20-55 | 165 | Date drilled |
| | | 1-15-60 | 161 | + 4 |
| | | 3- 6-62 | 160 | + 1 |
| 34-46-105 | Kirkpatrick Utility | 8-20-56 | 209 | Date drilled |
| | | 3- 7-62 | 175 | + 34 |
| 34-46-109 | Willowbrook Country Club | 8- -34 | 152 | Date drilled |
| | | 12- -50 | 262 | -110 |
| | | 5- 9-54 | 190 | + 72 |
| | | 3- 5-62 | 203 | - 13 |
| 34-46-201 | City of Tyler (Well 5) | 3- 6-44 | 265 | Date drilled |
| | | 1- 9-50 | 291 | - 26 |
| | | 1-14-60 | 246 | + 45 |
| | | 3- 6-62 | 238 | + 8 |
| 34-46-202 | City of Tyler (Well 7) | 8-11-45 | 263 | Date drilled |
| | | 12-15-49 | 275 | - 12 |
| | | 1-14-60 | 225 | + 50 |
| | | 3- 6-62 | 223 | + 2 |
| 34-46-203 | City of Tyler (Well 2) | 4-11-37 | 258 | Date drilled |
| | | 9-21-44 | 340 | - 82 |
| | | 3-11-50 | 366 | - 26 |
| | | 3- 6-62 | 300 | + 66 |
| 34-46-301 | City of Tyler (Well 6) | 7-16-44 | 239 | Date drilled |
| | | 1-14-60 | 195 | + 44 |
| | | 3- 6-62 | 191 | + 4 |
| 34-46-401 | City of Tyler (Well 8) | 2-21-50 | 342 | -- |
| | | 1-14-60 | 287 | + 55 |
| | | 3- 6-62 | 284 | + 3 |
| 34-46-502 | City of Tyler (Well 4) | 7- 5-39 | 263 | Date drilled |
| | | 9- -44 | 281 | - 18 |
| | | 5-18-51 | 333 | - 52 |
| | | 3- 6-62 | 265 | + 68 |
| 34-46-503 | City of Tyler (Well 3) | 6- 9-38 | 219 | Date drilled |
| | | 9- -44 | 281 | - 62 |
| | | 1-21-50 | 316 | - 35 |
| | | 1-14-60 | 246 | + 70 |
| | | 3- 6-62 | 243 | + 3 |

The second area in which water levels have shown a significant change within the years of record is the Winona area, 10 miles northeast of Tyler. Water levels rose during the period 1957 through 1962, although pumpage was not decreased in this area during the period. This change in water levels is a result of the increased recharge that has occurred since the drought of the early 1950's. Records of water-level fluctuations in this area are shown in the following table.

| Well Number | Owner | Date of Measurement | Static water level below land surface (in feet) | Rise (+) or decline (-) of water level since preceding measurement (in feet) |
|---|---|---|---|---|
| 34-31-702 | Sylvestor Dayson | 6- 2-54 | 112 | Date drilled |
| | | 1-27-60 | 129 | - 17 |
| | | 3-27-62 | 121 | + 8 |
| 34-31-901 | Joe Zeppa (Well 4) | 1-21-60 | 54 | -- |
| | | 3-27-62 | 41 | + 13 |
| 34-31-902 | Joe Zeppa (Well 2) | 1-21-60 | 94 | -- |
| | | 3-27-62 | 80 | + 14 |
| 34-31-903 | Joe Zeppa (Well 1) | 1-21-60 | 123 | -- |
| | | 3-27-62 | 112 | + 11 |
| 34-39-501 | Smith Co. WCID #1 (Well 5) | 4-30-57 | 102 | -- |
| | | 3-13-62 | 81 | + 21 |
| 34-39-502 | Smith Co. WCID #1 (Well 4) | 4- -43 | 93 | Date drilled |
| | | 4-30-57 | 100 | - 7 |
| | | 3-13-62 | 84 | + 16 |
| 34-39-503 | Smith Co. WCID #1 (Well 3) | 4-30-57 | 97 | -- |
| | | 3-13-62 | 87 | + 10 |
| 34-39-504 | Smith Co. WCID #1 (Well 2) | 4-30-57 | 107 | -- |
| | | 3-13-62 | 96 | + 11 |
| 34-39-505 | B. G. Byars | 7- -56 | 85 | Date drilled |
| | | 3-27-62 | 70 | + 15 |
| 34-40-101 | Otis Kidd | 10-11-57 | 135 | Date drilled |
| | | 3-27-62 | 103 | + 32 |
| 34-40-401 | J. D. Walters | 2-16-60 | 111 | -- |
| | | 3-28-62 | 104 | + 7 |

Water levels in the vicinity of Troup and Arp declined 10 to 30 feet between 1960 and 1962. This decline resulted from increased ground-water pumpage and interference between wells. This decline is not a serious problem; such declines are to be expected in areas of increased pumpage. As soon as equilibrium has been reestablished this decline will cease.

## Water-Bearing Characteristics

Pumping tests were conducted on selected water wells in the County to determine the aquifer characteristics of the Carrizo-Wilcox. Tests conducted on wells completed in part of the Wilcox showed a range in the coefficients of transmissibility of 3,600 to 10,500 gallons per day per foot (gpd/ft.), with an average transmissibility of 5,000 gpd/ft. and a coefficient of permeability of 50 gpd/ft.$^2$ The Carrizo has a coefficient of transmissibility in the range of 20,000 gpd/ft. and a coefficient of permeability of 200 gpd/ft.$^2$ Wells completed in the Carrizo alone are not common, and few results of pumping tests are available for this formation.

Pumping tests on wells showed the Carrizo-Wilcox aquifer to have a transmissibility coefficient of 14,000 to 38,000 gpd/ft. with an average of 20,000 gpd/ft . The wells in which these tests were conducted screened only a small section of the Wilcox; therefore, most of the water is coming perhaps from the Carrizo. Coefficients of permeability range from 85 to 416 gpd/ft.$^2$ for the aquifer. The storage coefficient ranges from 1 x $10^{-4}$ to 2 x $10^{-4}$ (0.0001 to 0.0002). The average storage coefficient for the aquifer is 0.0001. On the basis of aquifer tests it is seen that the Wilcox Group contributes smaller quantities of water than the Carrizo for an equal amount of bed thickness, as its transmissibility is much lower. To illustrate, a 100-foot section of Wilcox will have an average transmissibility of 5,000 gpd/ft. as contrasted with an average transmissibility of 20,000 gpd/ft. for a 100-foot section of Carrizo. Table 4 summarizes the water-bearing characteristics of the aquifer.

## Chemical Quality of Water

Water in the Carrizo-Wilcox aquifer generally has a high content of sodium bicarbonate. In the Carrizo wells sampled, the dissolved solids ranged between 110 and 330 parts per million (ppm), and averaged between 175 and 200 ppm. Concentrations of dissolved solids in water from wells in the Wilcox Group generally ranged between 200 and 500, but may reach 3,000 ppm at its base. Water from the Carrizo has a pH value ranging between 6.2 and 8.3, and averaging 7.2 to 7.5, whereas the Wilcox Formation has a pH value above 8 and usually in the neighborhood of 8.5. Temperature of the water in the Carrizo-Wilcox ranges between 70 and 80 degrees Fahrenheit.

Water from the Carrizo Formation is characterized by moderate concentrations of iron. The iron probably was dissolved from the Reklaw Formation in the vicinity of the Carrizo-Reklaw contact. In the Carrizo, this constituent ranges from a trace to 5 ppm. A concentration of 0.3 ppm or more is common. A higher concentration of iron in the Carrizo usually is found when the top of the formation is less than 300 feet below land surface. At these shallow depths the iron probably has not had an opportunity to precipitate as the water moves downdip through the aquifer. It should be noted also that higher iron concentrations are generally found in the upper part of the Carrizo Formation regardless of depth. Iron bacteria have also been reported, particularly in the southeast part of the County.

Water from the Wilcox usually carries small amounts of iron, but this is not a serious problem in Smith County. In the Wilcox Group, however, the dissolved solids increase rapidly with depth. This gradient of dissolved solids ranges from approximately 200 ppm in the upper Wilcox to as much as 3,000 ppm at the base. The base of the Wilcox Group, shown on Plate 7, is also the base of fresh-water strata in Smith County.

Quality of the water in the Carrizo-Wilcox aquifer may be adversely affected by the salt domes in the County. City of Tyler Well No. 6, 34-46-301, has a higher concentration of dissolved solids than the other city wells which are completed in the same sand section. This well is on the west flank of the Tyler salt dome, and the high concentration of dissolved solids may result from contact of moving ground water with the salt. Table 2 contains the results of chemical analyses of water from the three principal aquifers in Smith County. The location of wells from which samples were taken for these analyses are shown on Plate 16.

## Utilization and Present Development

The Carrizo-Wilcox aquifer supplies water used for municipal, industrial, agricultural, and domestic purposes in Smith County. Pumpage from the aquifer is relatively small although it is the most widely developed aquifer in the County. In 1961, 967 million gallons or 2,969 acre-feet of water from the Carrizo-Wilcox was pumped for municipal use, 494.5 million gallons or 1,518 acre-feet of water from the Carrizo-Wilcox was pumped for industrial use, and domestic pumpage from the aquifer during the same period was estimated to be about 30 million gallons or 92 acre-feet. There was no agricultural pumpage from the aquifer during this period for all practical purposes.

This amount of pumpage, totaling 1,490 million gallons or 4,580 acre-feet per year, does not establish a steep hydraulic gradient and does not affect the regional movement of water across the County. The pumpage is spread evenly over much of the County and is not concentrated in any one area to the extent of creating major anomalies in the piezometric surface.

## Well Construction and Well Yields

Large-capacity wells completed in the Carrizo-Wilcox aquifer in Smith County have been developed to supply the needs of municipalities and industries, whereas smaller wells are found throughout the County which supply domestic needs. For whatever purpose the wells are used, the method of completion and development of water wells in Smith County is of major importance for satisfactory performance. Both the Carrizo and Wilcox contain fine-grained sand, and wells must be so constructed and completed that sand pumped during the life of the well is kept to a minimum. Figure 3 illustrates the common method of constructing both large-capacity, such as municipal and industrial, and small-capacity, such as domestic and farm, wells in Smith County.

Many large-capacity wells in the County are capable of producing more than 1,100 gallons per minute although most of the wells are pumped at a rate of about 600 gallons per minute. Tests conducted on wells in Smith County provided data on specific capacity, average discharge, and other factors affecting well yield. Data from these tests are summarized in Table 1.

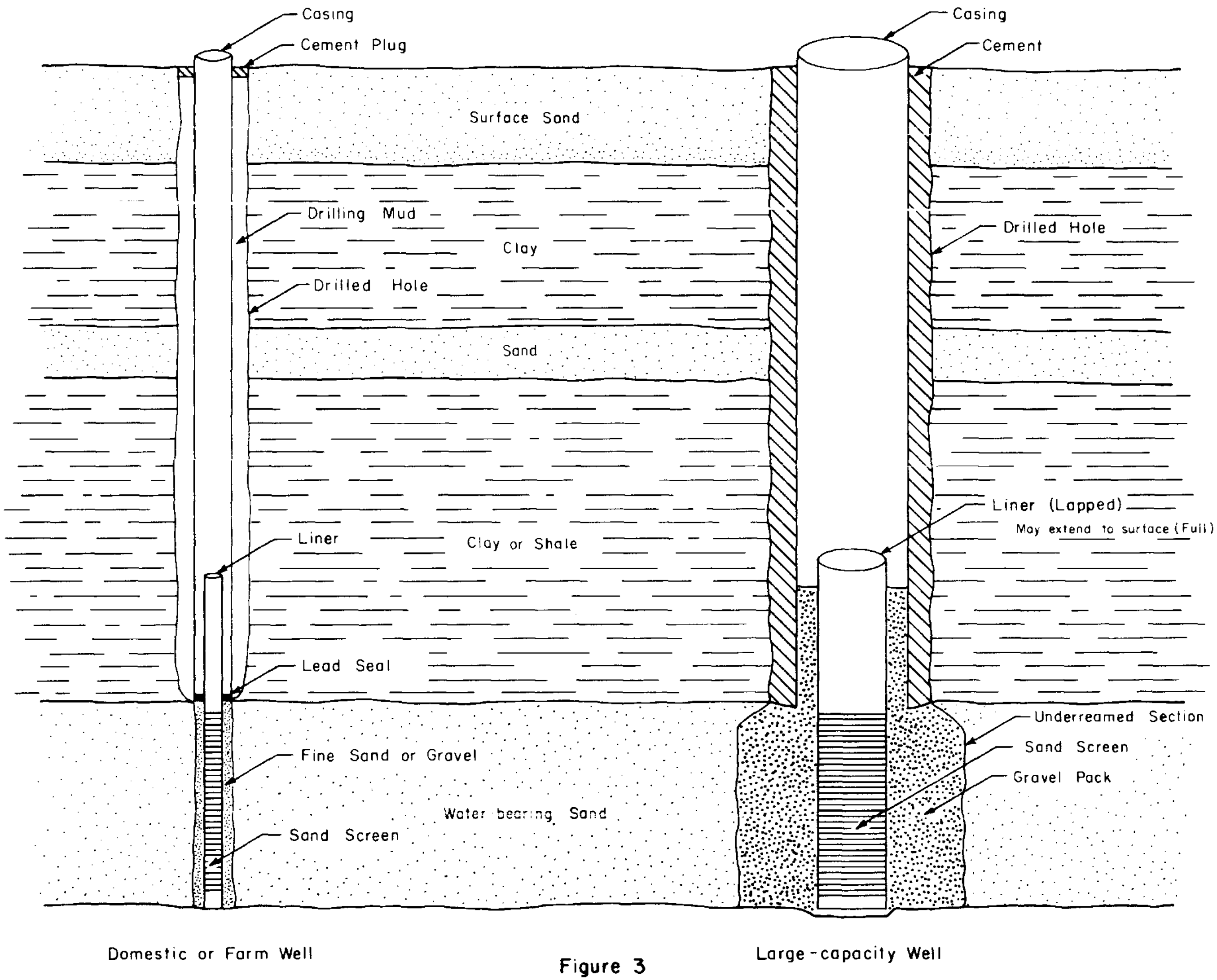


Figure 3

Diagram of Well Construction in Smith County

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## Ground Water Available for Development

Two methods have been used to determine the amount of water available for development on a sustained basis from the Carrizo-Wilcox aquifer in Smith County. First of the two methods is based on the calculation of amount of water passing through the aquifer, and the second is based on a quantitative evaluation of hypothetical well fields in the County.

The first method is based on Darcy's law which is expressed by the equation Q=TIL, where Q is gallons per day, T is the coefficient of transmissibility in gallons per day, and L is the length of a line in miles which is perpendicular to the direction of ground-water movement and is essentially parallel with the outcrop of the aquifer. For purposes of these calculations, L is assumed to intersect the points at which the top of the Carrizo is at a depth of 400 feet. This depth was chosen because under future conditions of pumpage if the water level were lowered to 400 feet below the surface the maximum safe yield from the aquifer could be obtained and yet pumping levels would still be at an economically feasible level.

On the basis of this method, and by using the average coefficients of transmissibility and the present hydraulic gradients in the County, it is estimated that on the order of 16 million gallons or 17,900 acre-feet per year of water per day is moving through the Carrizo-Wilcox aquifer, or 12 million gallons per day more than was pumped from the aquifer in 1961. However, by lowering the static water level to 400 feet below land surface, a steeper hydraulic gradient would be established, and under these postulated future conditions of pumping, it is estimated that approximately 39 million gallons of water per day or 43,650 acre-feet per year could be withdrawn from the Carrizo-Wilcox aquifer in Smith County on a sustained basis.

By increasing the pumpage from the Carrizo-Wilcox aquifer, ultimately lowering the water level to the 400 feet below land surface, additional water would be released from artesian storage. The quantity of water released in this manner is estimated at approximately 9 billion gallons or 27,000 acre-feet, which alone would meet the 1961 pumping requirements of Smith County for more than 6 years.

The second approach to the determination of the quantity of water available for development in Smith County was the quantitative evaluation of the development of hypothetical well fields in the County. This method gives a more practical value to the availability of ground water, and its results support the results of the first method. Three areas were selected for the hypothetical well fields on the basis of the presence of well-developed sand sections in the aquifer, submergence or available drawdowns, and suitability of location within the County. Each area has been given a name and is located on Plate 15. Also these areas correspond to the structural lows between the salt domes on Plate 9. The three areas or fields are Noonday, 10 miles southwest of Tyler; Swan, 9 miles northwest of Tyler; and Winona, 12 miles northeast of Tyler. On the basis of hypothetical values believed to represent realistic conditions of development, wells were designed to produce 600 gallons per minute. The average coefficients of transmissibility and storage for the Carrizo-Wilcox, 20,000 gpd/ft. and 0.0001, respectively, were used. On the basis of these calculations the following estimate of the order of magnitude of water which could be pumped from each of the three fields was made:

| Area | Quantity of water, in million gallons per day | Approximate pumping levels, in feet below land surface* |
|---|---|---|
| Noonday | 5 | 400 |
| | 8 | 540 |
| | 10 | 600 |
| Swan | 8 | 500 |
| | 10 | 550 |
| | 16 | 600 |
| Winona | 5 | 360 |
| | 8 | 550 |
| | 10 | 650 |
| Totals | 18 to 36 | -- |

* The approximate pumping levels reflect pumpage interference between each of the fields.

These are not the only areas of the County in which well fields can be developed, but because of the depth to the top of the Carrizo a greater available drawdown is possible in these areas. The city of Tyler has already developed a field in the structural low at Tyler. Other areas favorable for well-field development are those which are close to the aquifer outcrop, where the top of the aquifer is deep enough to allow sufficient drawdown, and in which the sand section of the aquifer is well developed. Kilgore has a field which meets these conditions located in the eastern edge of the County, well numbers 34-48-201, 202, 301, 501, 502, and 503 on Plate 16.

The Kilgore well field furnishes an excellent example of the accuracy of the well-field method for determining the quantity of water available for development. By using the original static water levels of the field, the average pumpage of 1.1 million gallons per day, and the coefficients of storage and transmissibility of the aquifer for the area, it was possible to calculate the pumping levels in the field in 1961 within 5 feet of the measured pumping levels.

Static water levels are not declining in this field now except in periods of heavy pumping, indicating that the field is in essential equilibrium. Figure 4 illustrates the relationship of rainfall on the outcrop and at the city of Kilgore, the pumpage from the field, and the static water level of the field for the period from 1953 through 1961.

The available water depends on recharge to the aquifer. Both methods of determining the quantity of water which is available for development in Smith County, and their results, which indicate that 39 million gallons per day over the entire County or 36 million gallons per day from three well fields can be obtained, are based on the assumption that recharge will supply this amount of water to the aquifer and that this amount will not be drawn from storage. If 5 percent of the annual rainfall enters the outcrop as recharge, approximately 70 million gallons per day or 80,600 acre-feet per year would be available to supply the aquifer in Smith County. The 5 percent appears to be reasonable because the soils of the outcrop are loose and sandy and the rainfall is evenly

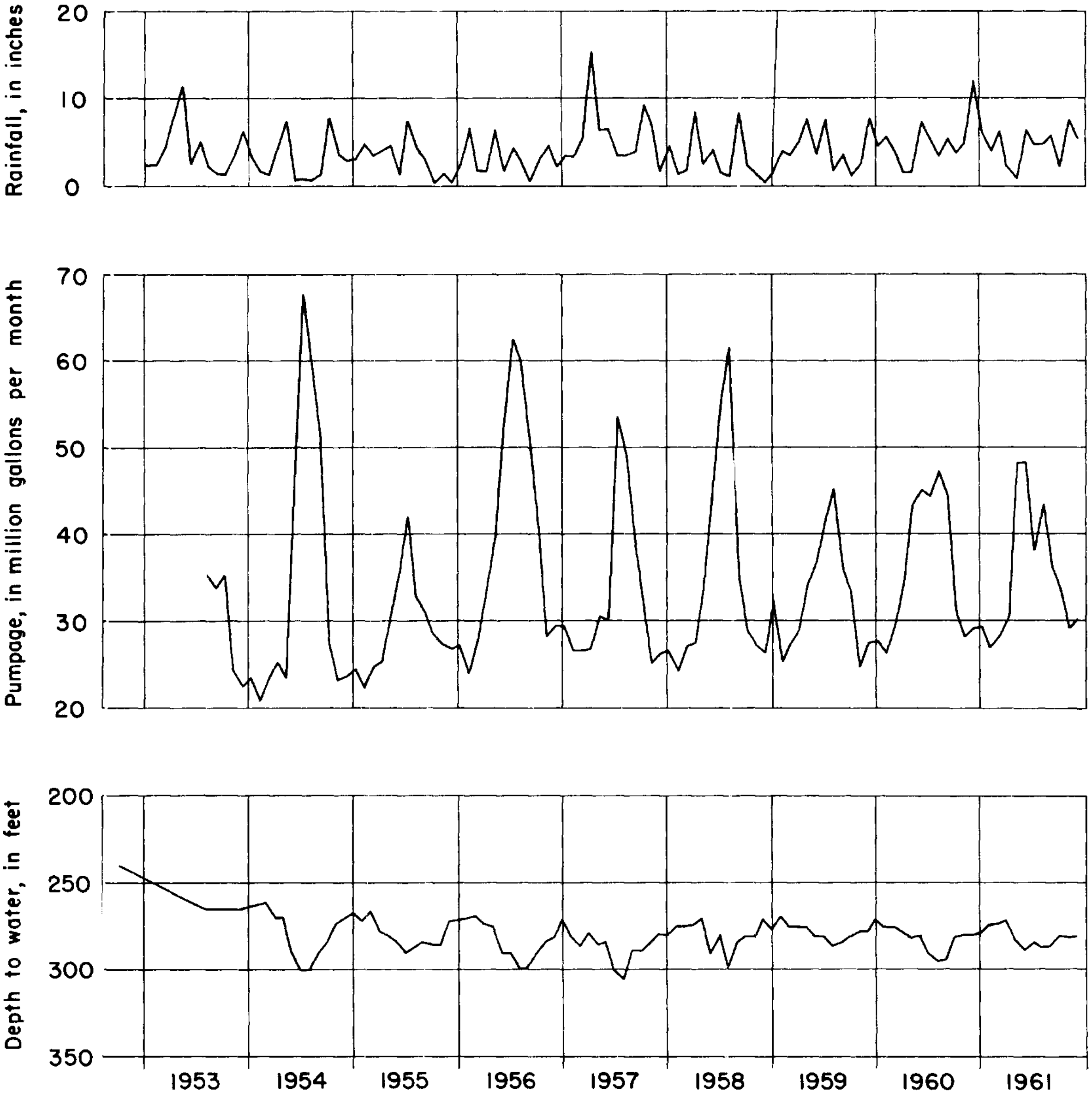

Figure 4

Graph of Water Levels, Pumpage, and Precipitation, City of Kilgore Well Field

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distributed throughout the year. Therefore, this amount of available recharge would be more than sufficient to sustain pumpage on the order of 30 to 40 million gallons per day in Smith County.

### Physical Factors Affecting Future Development

In developing a water supply the interference of a pumping well, or the cone of depression created by a pumping well which lowers water levels in neighboring wells, must be taken into consideration. Figure 5 shows the effect that a well completed in the Carrizo-Wilcox aquifer, pumping 600 gallons per minute would have on water levels at various times and distances from the pumped well. Average coefficients of transmissibility and storage for the Carrizo-Wilcox aquifer were used, and the well could be in either of the three hypothetical well fields outlined or at any other point in the County which is 25 miles from the outcrop of the aquifer. This graph illustrates the need for proper spacing of wells with respect to each other, and of well fields with respect to other well fields.

Additional factors affecting development of the Carrizo-Wilcox aquifer are the salt domes and the fault system west of Lindale. Wells should not be drilled on the domes because of problems of water quality, and because of erratic hydrologic conditions. The fault system west of Lindale probably deters the movement of the water and forms a partial barrier to the movement of water from the outcrop to the Swan area. Therefore, well fields in this area must be designed and operated in a manner which will compensate for these conditions. In making calculations regarding the hypothetical well field at Swan, this fault condition was taken into consideration.

## Queen City Aquifer

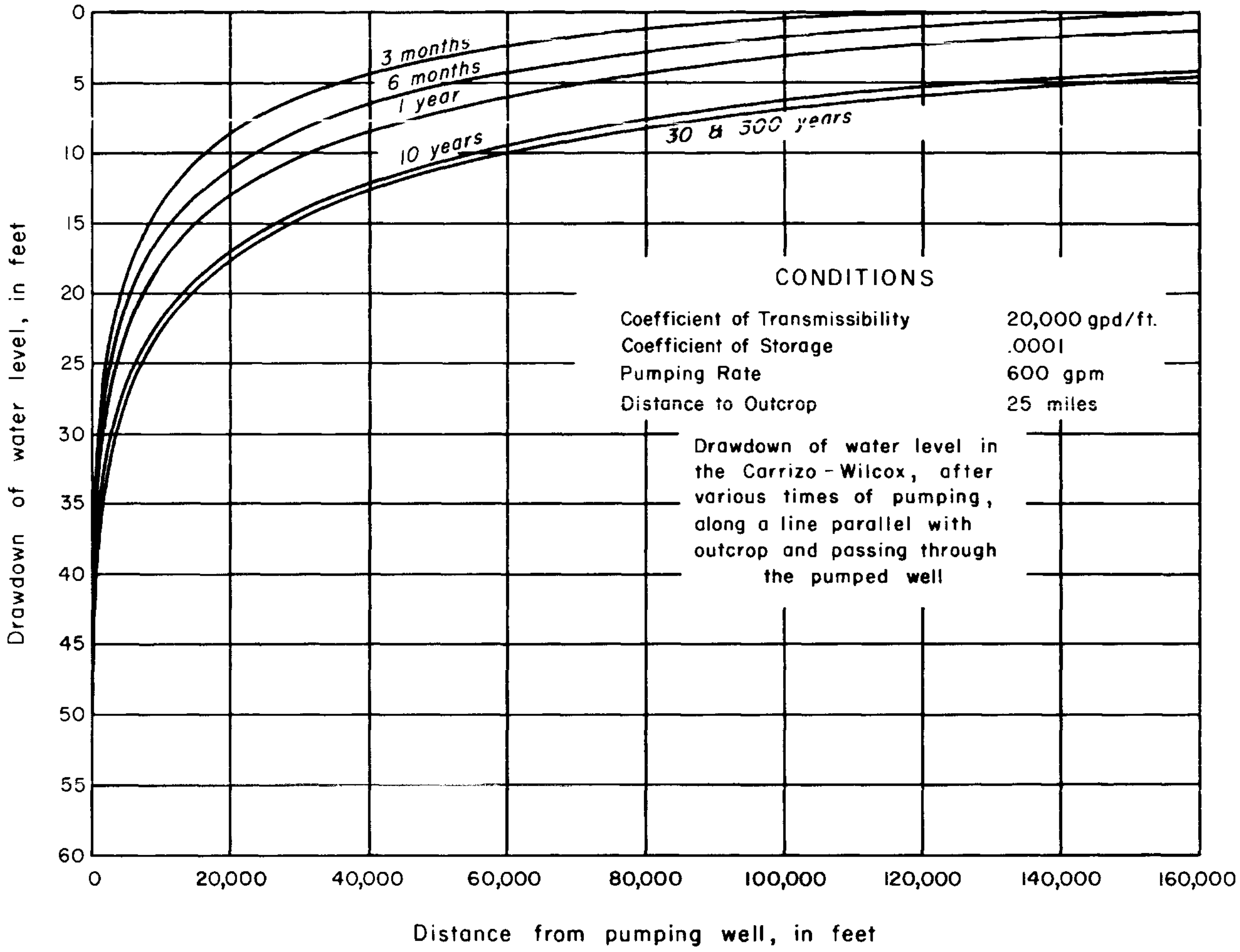
The Queen City Formation as described in this report is designated the Queen City aquifer. This aquifer exists throughout the County except in the northwest and southeast corners.

### Geologic and Structural Description

The Queen City Formation is composed of interfingering beds of sand, silt, shale, and lignite. The formation ranges in thickness from 0 to more than 700 feet, approximately 55 percent of which is sand thickness. Plate 12 illustrates the thickness and percentage of sand in the Queen City. The outcrop of the Queen City, which covers more than 75 percent of the County, is characterized for the most part by loose sandy soils which support rather heavy growths of grass. Depth to the top of the aquifer ranges from 0 feet to more than 300 feet in the County.

### Source and Movement of Water

The gentle topography, sandy soil, and vegetation of the Queen City outcrop create conditions for a high rate of recharge to the aquifer. It is



CONDITIONS

| | |
|---|---|
| Coefficient of Transmissibility | 20,000 gpd/ft. |
| Coefficient of Storage | .0001 |
| Pumping Rate | 600 gpm |
| Distance to Outcrop | 25 miles |

Drawdown of water level in the Carrizo-Wilcox, after various times of pumping, along a line parallel with outcrop and passing through the pumped well

**Figure 5**

**Distance-Drawdown Curves, Carrizo-Wilcox Aquifer, Smith County**

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estimated that at least 5 percent of the annual rainfall enters the aquifer at the outcrop and percolates downdip as recharge.

In the outcrop, shown in Plate 2, the water is under water-table conditions, although individual sand sections may locally be confined both above and below by impermeable beds of shale or clay. The formation dips into the center of the Tyler basin (toward Tyler) from the west and the east. Downdip, the formation is overlain by the relatively impermeable Weches Formation, and the water is under artesian conditions.

Ground water in the Queen City aquifer moves in two directions. A ground-water divide corresponding to the topographic divide between the Sabine and Neches River Basins controls the movement of ground water in the formation. The water in the Queen City north of the divide moves north toward the Sabine River and has an average hydraulic gradient of 10 feet per mile. South of the divide water in the Queen City moves south toward the Neches River with a gradient of approximately 10 feet per mile. Numerous springs in the outcrop feed many creeks in the County, and ground-water underflow into the Neches and Sabine Rivers is apparently large.

## Water Levels

Water levels in the Queen City range from 7 to 197 feet below the land surface, or 550 to 315 feet above sea level. Water levels in the formation have risen since the drought of the 1950's, and respond quickly to rainfall fluctuations. The effects of rainfall can be seen immediately in local areas. There are no long-term water-level records from wells completed in this formation in Smith County.

## Water-Bearing Characteristics

Data from pumping tests conducted on two Queen City wells in the County, wells 34-29-901 and 34-46-302, indicate that the aquifer has an average coefficient of transmissibility of 3,200 gpd/ft. These data are not sufficient to fully evaluate the characteristics of the aquifer, but the number of tests conducted were limited to the number of wells which were suitable for a pumping test. Observation wells located near the wells on which pumping tests were conducted are necessary for a determination of the storage coefficient of the aquifer. Such wells were not available, and a storage coefficient of 0.0001 was therefore assumed for the aquifer. The coefficient of permeability ranges from 10 to 30 gpd/ft.$^2$ Almost the entire aquifer has been screened in well 34-29-901, city of Lindale Well No. 3. The coefficient of transmissibility, 3,200 gpd/ft., and permeability, 10 gpd/ft.$^2$, determined in the test on this well are believed to be representative of the aquifer in Smith County.

## Chemical Quality of Water

Ground water in the Queen City Formation is acidic and has high iron concentrations, generally over 0.3 ppm. Results of chemical analyses of water from 12 Queen City wells are included in Table 2. The range in iron concentrations in the samples from the 12 wells is 1.1 to 71 ppm. Other prominent characteristics are the presence of dissolved gas, such as carbon dioxide or methane, and a low pH value. The range of pH values for water from the 12 Queen City wells is 3.0 to 6.9 with an average pH of 5.5. With these three exceptions--iron, low pH, and dissolved gas--Queen City water is of excellent quality. It has low concentrations of dissolved solids, ranging from 53 to 308 ppm in the 12 wells sampled. Calcium, sodium, and sulfate are the most abundant ions.

Untreated water from the Queen City is objectionable in odor and taste, and domestic users of Queen City water commonly obtain water for cooking and drinking purposes from other sources. As a result of the low pH and the high iron concentration, Queen City water is corrosive and will stain objects with which it comes in contact.

Irrigators, such as nurserymen, may find use of untreated water from the Queen City Formation beneficial to certain types of crops requiring plant food of an acidic nature. The iron in the water frequently stains the foliage of the crops raised but the plants are not harmed.

Because the water from this aquifer is generally high in iron concentration and may be considered of inferior quality, this aquifer should be cased and cemented off in wells drilled to the deeper Carrizo-Wilcox aquifer in order to protect the quality of this deeper water.

Treatment of the water from the Queen City is best accomplished by aeration and filtration. Aeration removes the dissolved gas and this in turn raises the pH. When this has been accomplished the iron will precipitate and can be removed by filtration.

## Utilization and Present Development

The Queen City aquifer supplies water to one municipality, one industrial user, several schools, and several small irrigators in Smith County. In the outcrop area it supplies water that is used for domestic purposes because of its availability at low cost.

Present pumpage from the Queen City aquifer is small. In 1961, 25 million gallons or 77 acre-feet of ground water from the aquifer was pumped for municipal use and 365 million gallons or 1,120 acre-feet for industrial use. An estimated 100 million gallons or 306 acre-feet was pumped for domestic and irrigation use. The total pumpage of approximately 490 million gallons (1,500 acre-feet) is probably less than the amount discharged naturally by springs and seeps in the County.

## Well Construction and Well Yields

Large-capacity wells completed in the Queen City Formation are gravel packed and constructed in a manner similar to wells completed in the Carrizo-Wilcox aquifer. The yields of these wells are small, the maximum yield being approximately 400 gallons per minute in Smith County. Yield is dependent not only on well construction but also on the transmissibility of the Queen City Formation. The specific capacity of the Queen City wells tested ranged between 1 and 2 gallons per minute per foot of drawdown (gpf). Most wells completed in the aquifer performed better at a pumping rate of approximately 250 to 300 gallons per minute than at higher pumping rates, thus avoiding excessive drawdown. Deep well turbine pumps equipped with electric or gasoline motors are used on these large wells.

Domestic, small irrigation, and school wells are generally completed with 4- to 2-inch casing. These wells are equipped with small-horsepower submersible or jet type pumps and are capable of yielding 10 to 25 gallons per minute.

Performance of Queen City wells is sharply limited by the quality of the water. Corrosion of pumps, casing, and sand screen shortens the life of these wells. Sand screens must be acidized to remove precipitated iron so that water can move into the well. Specially designed pumps of various alloys are used in order to prolong the life of the pumping equipment.

## Ground Water Available for Development

Because the water in the Queen City aquifer occurs under artesian conditions where the aquifer is confined above by the younger Weches Formation, and under water-table conditions in the outcrop, two approaches are used in determining the available water from this aquifer.

Three Queen City well-field areas, Noonday, Swan, and Tyler, are promising as sites for future development in the County. In each of these areas the water is under artesian conditions. The depth to the top of the aquifer averages 250 to 300 feet, thus allowing approximately 200 feet of available drawdown to the top of the aquifer. Each of the three areas could produce 1 million gallons of water per day, for a total of 3 million gallons per day or 3,360 acre-feet per year, and still maintain a pumping level just above or at the top of the aquifer. A field of 3 or 4 wells may be expensive for only 1 million gallons of water per day; however, in the future the economics of water production may change so that this will not be unreasonable. In producing the 3 million gallons per day in these areas, approximately 20 million gallons (62 acre-feet) of water is going to be released from artesian storage and be available to pumpage.

The greatest amount of water from the Queen City aquifer is available in the outcrop of the aquifer. This outcrop covers approximately 75 percent of the County. The average thickness of the formation in the outcrop is 200 feet, 110 feet of which is sand. Based on a water table storage coefficient or specific yield of 15 percent, there is approximately 7 million acre-feet of water available for development in the outcrop. However, only approximately 50 percent of this amount will be recoverable; therefore, 3.5 million acre-feet or 1.1 trillion gallons of water could be pumped from the outcrop area. Production of water from the outcrop would be relatively inexpensive because the wells would be shallow and the water levels are near the surface. This area could be used as a source of water supply during periods of drought by agricultural, municipal, and industrial users.

Development of the Queen City, in the areas of both artesian and water-table conditions, will require that more wells be drilled and the wells pumped at lower rates that might be desired, because of the low transmissibility of the aquifer.

Recharge to the aquifer in Smith County appears to be large and is estimated to be on the order of 50,000 to 100,000 acre-feet per year, which is equivalent to 45 to 90 million gallons per day.

### Physical Factors Affecting Future Development

In developing a well field in the Queen City aquifer, the interference between wells and fields should be considered so that the spacing of the wells will be satisfactory and the interference between the wells will not cause a loss of efficiency. Figure 6 illustrates the relationship of time, distance, and drawdown of a pumping Queen City well. The area of influence of a pumping well can be readily seen in this illustration.

## Sparta Aquifer

The Sparta aquifer, as used in this report, is equivalent to the Sparta Formation. This aquifer exists in the mid-third of the County.

### Geologic and Structural Description

The Sparta aquifer is a coarse to fine-grained sand with interfingering layers of blue and gray shale and clay. An average of 70 percent of the formation thickness is estimated to be sand. The Sparta Formation ranges in thickness in Smith County from 0 to 280 feet and crops out over approximately 20 percent of the County as illustrated in Plate 14. In the outcrop the Sparta weathers to a deep, loose sandy soil that supports vegetation well.

### Source and Movement of Water

The topography, sandy soil, and vegetation cover provide favorable conditions for recharge to the Sparta aquifer. The rate of recharge to the aquifer probably is high, and it is estimated that at least 5 percent of the annual rainfall in the outcrop enters the aquifer. Water in the aquifer occurs under both water-table and artesian conditions. Where the sand beds are confined by impermeable clay layers, or where the aquifer is overlain by the impermeable Tyler greensand, the water is under artesian conditions. Water-table conditions exist over most of the outcrop.

Movement of ground water in the Sparta aquifer is essentially down the dip of the formation, to the southeast toward Tyler, although locally the direction of movement is influenced by places of natural discharge where streams of the County have cut into the aquifer to the water table. In these areas the hydraulic gradient has been altered so that water in the aquifer moves toward these streams. The water table in the Sparta aquifer conforms generally to the attitude of the surface topography. The hydraulic gradient is variable, ranging from 5 to more than 30 feet per mile depending on the topographic gradient.

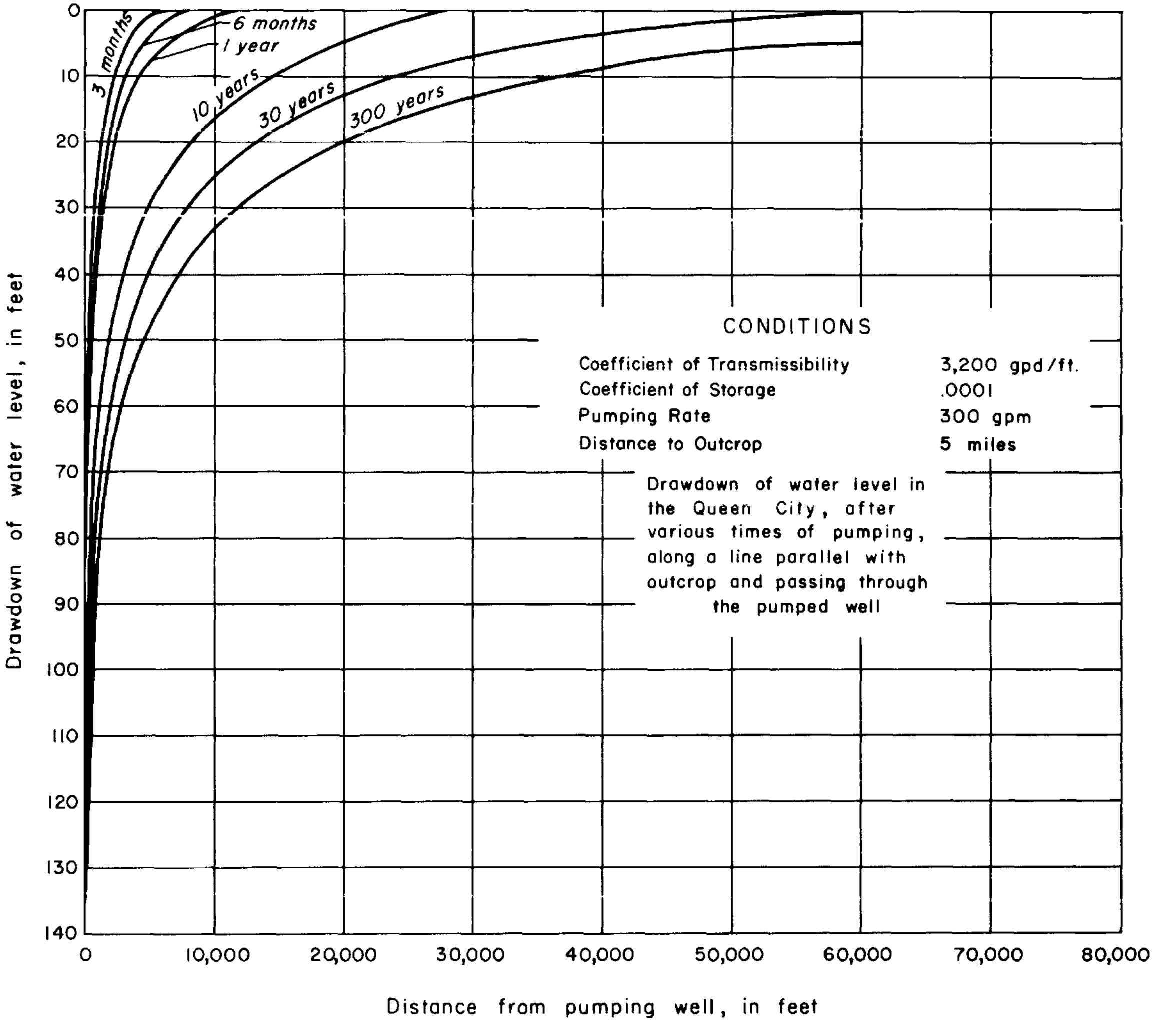

Figure 6

Distance-Drawdown Curves, Queen City Aquifer, Smith County

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## Water Levels

Water levels in the Sparta aquifer range from 430 to 520 feet above sea level, or from 4 to 150 feet below the land surface. Water levels in the aquifer are affected immediately by periods of heavy precipitation. The aquifer is never full, as is indicated by the water levels measured in the County. In the test drilling program by the Tyler Industrial Foundation to obtain water for a new industry near the western edge of Tyler, a small rig used for the test drilling lost circulation in an extremely dry, unsaturated zone which extended through the top 80 feet of the Sparta.

## Water-Bearing Characteristics

In Smith County, only two wells in the Sparta aquifer are suitable for pumping tests (wells 34-46-204 and 205). Tests conducted on these wells indicated an average coefficient of transmissibility of 12,400 gpd/ft. and a coefficient of storage of 0.00017. Water encountered by these two wells was under artesian conditions. Two wells and one pumping test do not provide sufficient data to evaluate the characteristics of an aquifer, but the wells available for testing are extremely few in the County.

## Chemical Quality of Water

The chemical quality of water from the Sparta Formation is good. Results of 12 chemical analyses of samples from wells in the County are listed in Table 2. These analyses show a range in dissolved solids from 28 to 205 ppm. In shallow drilled and dug wells, nitrate concentrations commonly are high, but this is due to entry of water into the well from the surface.

High iron concentrations and acidity are problems in the water of some wells completed in the Sparta aquifer, and a dissolved gas such as methane is frequently present. The concentrations of iron in the 12 analyses range from 0.1 to 65.0 ppm. The pH values of the water from the Sparta aquifer range from 3.7 to 6.6. Iron can be brought into the Sparta aquifer in three ways: by surface runoff which crosses the outcrop of the Weches Formation, by percolation of water down through the Tyler greensand, and by water moving along the Weches-Sparta contact in the subsurface. Those wells completed within the Sparta section which do not reach the base of the aquifer are relatively free of iron and have a pH of 5.5 to 6.6, whereas wells drilled and screened to the base of the Sparta, or which penetrate into the Weches Formation, have a high iron concentration and a low pH.

Water from the Sparta aquifer which is relatively free of iron is desirable for municipal and industrial uses. The temperature of the water ranges from 65° to 70° Fahrenheit, and is well suited for industrial cooling purposes. As more industry is located in the County, the Sparta aquifer will be further developed because of this low and constant temperature. Plant nurserymen have found that the acidic and iron-rich water from the Sparta is good for irrigation and sprinkling of certain types of plants.

## Utilization and Present Development

In 1962 only one industry and one municipality were using water from the Sparta aquifer. Many domestic wells have been drilled to the aquifer in suburban areas around the city of Tyler. Pumpage from the Sparta Formation in 1961 reached an approximate total of 163 million gallons or 500 acre-feet. Of this total, the city of Bullard used 13 million gallons or 40 acre-feet of water from a large Sparta spring. Industrial use in the same period was 50 million gallons or 153 acre-feet. An estimated 100 million gallons or 307 acre-feet was pumped for domestic use. An unknown amount of water is discharged annually into streams by the many springs from the Sparta aquifer.

## Well Construction and Well Yields

Industrial wells in the Sparta aquifer are constructed with 16-inch casing and 10-inch liners to the surface. Gravel is packed opposite the sand screen and liner in the productive zone. Deep well turbine pumps with 20-horsepower electric motors are used for lifting water from the aquifer. Yields of these wells average 250 gallons per minute and the wells have a specific capacity of 4.5 to 10 gpm per foot of drawdown. Some corrosion of the pump casing and sand screen has been experienced in Sparta wells. Domestic wells are usually constructed with 4-inch casing and sand screens and are equipped with submersible or jet pumps. In these small wells corrosion of equipment is common. Iron bacteria have been reported growing on screens on some wells in the County completed in the Sparta aquifer in which the iron content of the water is high. The bacteria and corrosion are removed by use of a muriatic acid solution.

## Ground Water Available for Development

The estimate of the available water in the Sparta aquifer is necessarily based on a series of assumptions, because information is not available regarding past water levels, the effect of pumpage, and other vital data. Calculations indicate that by volume the aquifer is capable of storing between 1 and 2 trillion gallons of water (3.3 to 4.8 million acre-feet), but this amount of water is not recoverable by known pumping methods. If 10 percent or 100,000 to 200,000 million gallons of this amount could be recovered it would supply the city of Tyler for 50 years at present water-use rate. Recharge to the aquifer is on the order of 21,000 acre-feet or 7,000 million gallons per year. These two figures represent an abundance of water but do not indicate the amount of water that is feasible for production. An approach to this problem is based on calculations with the equation Q=TIL, which was utilized in the quantitative discusion of the Carrizo-Wilcox aquifer on page 20. It must be noted that such calculations provide only an estimate and that future development will be required for refinement of the estimate.

Three areas of the County are favorable for future development in the areas where the Sparta aquifer reaches maximum thickness; Noonday, Tyler, and Swan. As a part of this investigation a quantitative calculation was made on the basis of the present hydraulic gradient and of a future gradient established by lowering the water level to a depth 100 feet above the base of the aquifer in these three areas. The future gradient was determined by selecting a static water level which would provide 100 feet of saturated material in the wells. This future static water level is 350 to 375 feet above sea level. The imaginary line of pumpage was placed in the center of the structural lows on Plate 13 and parallel with the aquifer outcrop, which would allow water to move in two directions toward the line. The results of these calculations by the equation Q=TIL provide the quantities of water passing through the aquifer in these areas:

| Area | Quantity at present gradient (Mgd) | Quantity at future gradient (Mgd) |
|---|---|---|
| Noonday | 0.5 | 5 |
| Tyler | 0.5 | 2 |
| Swan | 0.3 | 2.5 |
| Total | 1.3 | 9.5 |

These figures indicate that a total of 1.3 million gallons per day (mgd) or 1,450 acre-feet per year is passing through the aquifer and is available for development in these three areas under present hydraulic conditions. Under future hydraulic conditions 9 to 10 mgd or 10,000 to 11,200 acre-feet per year could be withdrawn, although this would dewater that part of the aquifer in which the base is higher than 350 to 375 feet above sea level. This would leave much of the aquifer dry, but in the process of lowering the water levels to this point, approximately 300 million gallons or 920 acre-feet of water would be released from artesian storage. Therefore, if the need arises to develop this aquifer extensively, as much as 9 to 10 mgd plus the amount of water released from storage could be developed. With proper well-field design and pumping practices, this aquifer could be of great importance to the County. Large-scale development of the aquifer will be limited to the three areas outlined, Noonday, Tyler, and Swan, because it is only in these areas that the aquifer is thick enough to permit large-scale development.

## CONCLUSIONS

Three principal aquifers in Smith County supply water that is of suitable quality for municipal, agricultural, and most industrial uses. These three aquifers are the Carrizo-Wilcox, Queen City, and Sparta. The amount of water available from the Carrizo-Wilcox aquifer throughout the County on a sustained basis is 39 million gallons per day. Well fields in the four areas of best potential for development could produce a total amount of water from the three aquifers, on a sustained basis, as follows:

| | |
|---|---|
| Carrizo-Wilcox | 36 million gallons per day |
| Queen City | 3 million gallons per day |
| Sparta | 10 million gallons per day |
| Total | 49 million gallons per day |

In the process of developing the outlined quantity of water from each of the aquifers on a sustained basis, a certain amount of water will have been released from artesian storage due to a lowering of the static water levels. This amount of water is:

| | |
|---|---|
| Carrizo-Wilcox | 9,000 million gallons |
| Queen City | 20 million gallons |
| Sparta | 300 million gallons |
| Total | 9,320 million gallons |

In addition to this 9,320 million gallons, approximately 1.1 trillion gallons is available in the outcrop of the Queen City aquifer.

Water from the three aquifers is of fair to very good quality. The Carrizo-Wilcox aquifer has water of very good quality, the Queen City aquifer has water of fair to good quality but with high iron concentration, and the Sparta has water of very good quality except where iron is present.

## RECOMMENDATIONS

On the basis of the findings of this investigation the following recommendations are made:

1. Careful planning for the development of large ground-water supplies by large-yield wells. Large-yield wells should not be located on the structural highs such as the salt domes and elongated ridges. Such wells should not be placed closer to the major fault systems than necessary, and if possible the wells should be drilled in areas where the aquifer is thickest.

2. In developing the ground-water supply of the County, precaution should be taken in the proper spacing and construction of wells and well fields. Proper well construction should be of primary importance to developers in order to insure efficient operation and safeguard against contamination.

3. Establishment of a network of observation wells for the purpose of monitoring water levels in the three aquifers. As part of the Texas Water Commission's statewide Water Level Observation Program, water levels in selected water wells will be measured at least one time a year. However, as development takes place in the County small-diameter observation wells should be drilled at strategic points in order to observe the change in water levels. The drilling of such wells is the responsibility of the local municipal and industrial leaders. Only by a comprehensive program of water-level measurements and analysis of these data will it be possible to know when ground-water development in the County has reached its limit as far as safe withdrawals are concerned.

4. Creation of a continuing program of water-quality observation. As development takes place any change in water quality should be recognized early enough so that corrective measures can be undertaken. A change in water quality may develop from several sources: (1)An upward gradient established by excessive pumpage in the Carrizo-Wilcox aquifer will cause the poorer quality water in the base of the aquifer to move upward toward the zones of better quality water; (2)Heavy pumpage may cause water to move in the vicinity of the salt domes in such a manner as to locally increase the dissolved-solids content of the water by the dissolving of the salt; (3)Contaminants and pollutants disposed both onto the surface and into the subsurface may reach the aquifers producing in Smith County.

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* Name of agency changed to Texas Water Commission January 30, 1962.

# APPENDIX A

# TABLES OF BASIC DATA

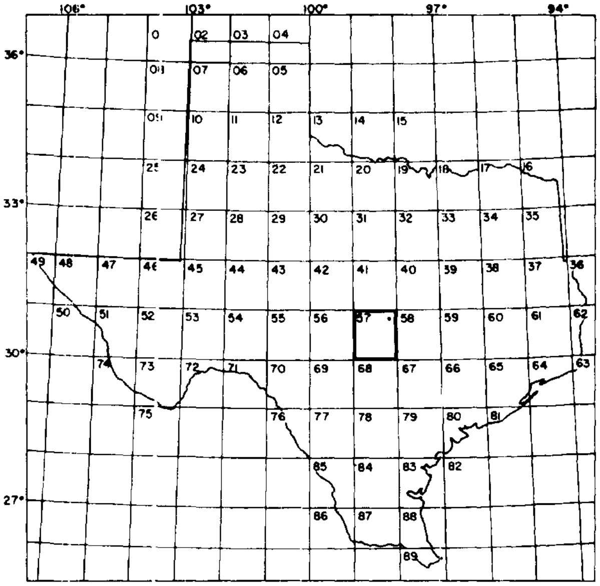
Well-Numbering System
1. Records of selected wells and springs
2. Chemical analyses of water from selected wells and springs
3. Location of oil tests selected as data-control points
4. Summary of pumping tests on selected wells

## Well-Numbering System

The Texas Water Commission has adopted a statewide well-numbering system which is based on the repeated division and numbering of quadrangles defined by lines of latitude and longitude. This system is illustrated on the following page.

The State has been divided into a grid of 1-degree quadrangles numbered 01 through 89. Smith County is in the 1-degree quadrangles numbered 34 and 35. Each 1-degree quadrangle is subdivided into 7-1/2 minute quadrangles numbered through 64, and each 7-1/2 minute quadrangle is subdivided further into 2-1/2 minute quadrangles numbered 1 through 9. The wells in each 2-1/2 minute quadrangle are numbered consecutively beginning with 01. The city of Tyler well 9 is 34-46-101. This indicates that it is well 01 in the 2-1/2 minute quadrangle 1, of the 7-1/2 minute quadrangle 46, of the 1-degree quadrangle 34.

In the tables the 1-degree quadrangle number and the 7-1/2 minute quadrangle number have not been repeated on each well, but only at the beginning of a page or where the number changes. It will be noted that the 2-1/2 minute grid lines have been omitted on the plates for the purpose of clarity. On the plates the well number consists of three digits; the first digit is the 2-1/2 minute quadrangle number and the last two designate the order in which the well was inventoried within the 2-1/2 minute quadrangle.



I-degree Quadrangles

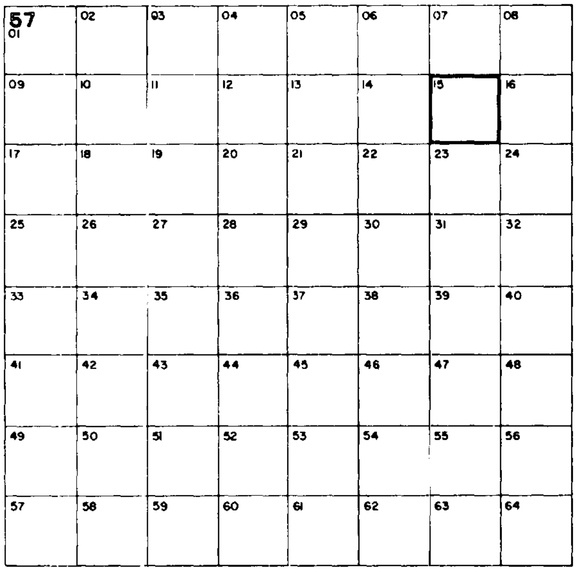
## Location of Well 57-15-701

**57** I-degree quadrangle

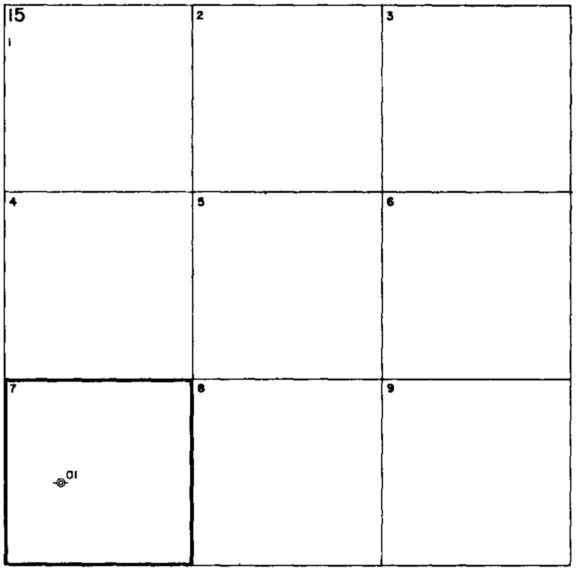
15 7 1/2 minute quadrangle

7 2 1/2 minute quadrangle

01 Well number within 2 1/2 minute quadrangle



7 1/2-minute Quadrangles



2 1/2-minute Quadrangles

## Table 1.--Records of selected wells and springs

The wells listed in this table are of the drilled type except those which are shallow in depth and have large casing. These latter types of wells are either hand dug or bored. The column headed "screened depth interval" is the depth setting in the well of either the sand screen, perforated or slotted pipe, or open hole through which water enters the well. In the shallow dug wells no interval is given because the water enters the well from the bottom of the hole.

Altitude of the land surface is given to the nearest foot. Where the altitude is followed by a plus and minus symbol (±), this indicates that the altitude was derived from topographic maps and is accurate to within 10 feet.

Water levels are given to the nearest foot and tenths of a foot. Date of measurement is by month and year or by month, day, and year. Where the water level is given to tenths of a foot and the day of measurement is indicated, the water level was measured with a steel tape. Where the water level is given to the nearest foot and the day of measurement is indicated, the level was measured by airline, electric line, or wire-line methods. Where the water level is given to the nearest foot and the date is given by month and year only, the level was reported to the author by others and the method of accuracy of measurement is not known. Where a water level is not given or is a reported measurement, the water level could not be measured because the pump or other physical features prohibited the measurement being made.

## Table 1.--Records of selected wells and springs

Method of lift and type of power: A, airlift; B, bucket; E, electric; G, gasoline, diesel, or butane; H, hand; J, jet; N, none; S, submersible; T, turbine. Number indicates horsepower.
Use of water : D, domestic; Ind, industrial; Irr, irrigation; N, none; P, public supply; S, stock.

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| | | | | | | | | | | | | | |
| **Carrizo-Wilcox aquifer** | | | | | | | | | | | | | |
| 34-20-701 | S. B. Bruner | Pete Rowan | 1956 | 225 | 4 | 225 | -- | 400± | 37 | 9- -59 | J,E, 1 | D | Screened in Wilcox only. |
| * 28-101 | C. M. Crawford | Nations & Rowan | 1958 | 480 | 4 | 480 | 420-480 | 410± | 36.5<br>36.9 | 9-22-59<br>3-26-62 | J,E, 1 | D | Do. |
| 402 | Hersch Smith | H. Smith | 1953 | 16 | 36 | 16 | -- | 420± | 10.5 | 9-28-59 | J,E | D | |
| 403 | L. J. Anderson | Nations & Rowan | 1957 | 285 | 4 | 160 | -- | 400± | 40 | 7- -59 | J,E, 1-1/2 | D | |
| 404 | J. A. Baker | J. A. Baker | 1956 | 14 | 30 | 14 | -- | 405± | 9.5 | 9-28-59 | J,E, 1-1/2 | D | Screened in Carrizo only. Not used for drinking. |
| 701 | T. A. Martin | -- | 1935 | 75 | 30 | 75 | -- | 460± | 43.5 | 9-28-59 | J,E, 1/3 | D | Screened in Carrizo only. |
| 801 | L. S. Toone | Pete Rowan | 1956 | 415 | 4 | 415 | 400-415 | 550± | 92.8<br>144.6 | 9-28-59<br>3-26-62 | J,E, 1-1/2 | D | |
| 29-101 | Paul D. Smith | Roy White | 1952 | 525 | 4 | 360 | 360-525 | 340 | +3<br>+3 | 10- 7-59<br>3-26-62 | Flows | D | |
| 102 | do | -- | 1930's | 450± | 4 | -- | -- | 340 | +1<br>+1 | 10- 7-59<br>3-26-62 | Flows | D | |
| 201 | Joe Zeppa Oakhurst Farm | Delta Drlg. Co. | 1954 | 774 | 13<br>8 | 610<br>768 | 610-640,<br>720-770 | 390 | 43.8<br>38.9 | 1-21-60<br>3-26-62 | T,G, 100 | Irr | Pump set at 300 ft. |
| 501 | Colonial Nursery | Roy C. White | 1959 | 800 | 4<br>2 | 717<br>800 | 770-800 | -- | 150 | 10- -59 | J,E, 2 | Ind, Irr | Reported yield 25 gpm. Pump set at 275 ft. |
| 902 | City of Lindale well 2 | Layne-Texas Co. | 1947 | 700 | 16<br>8 | 580<br>700 | 580-610,<br>634-654,<br>677-698 | 550 | 243.2 | 3-28-62 | T,E, 30 | P | Drawdown 125 ft. after pumping 30 hrs. at 94 gpm. Specific capacity 0.75 gpf. Pump set at 380 ft.[1] |
| 903 | City of Lindale well 1 | do | 1939 | 750 | 10<br>8 | 700<br>750 | 700±-750 | 558 | 265.3<br>269.0 | 2- 8-60<br>3-26-62 | T,E, 25 | P | Yields 80 gpm. Pump set at 369 ft. |
| * 31-702 | Sylvester Dayson | do | 1954 | 792 | 8<br>4 | 719<br>792 | 719-771 | 430 | 128.9<br>121.8 | 1-27-60<br>3-27-62 | T,E, 40 | Irr, D,S | Drawdown 16 ft. after pumping 24 hrs. at 154 gpm. Specific capacity 9.6 gpf. Pump set at 220 ft. |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| 34-31-802 | H. L. Hunt | H. L. Hunt | 1955 | 885 | 16<br>10 | 685<br>885 | 690-740,<br>800-885 | 392 | 98.1 | 3-27-62 | S,E,<br>150 | Irr | Drawdown 51 ft. when pumping at 450 gpm. Specific capacity 9 gpf.[1] |
| 803 | do | do | 1955 | 950 | 16<br>10 | 700<br>950 | 700-900 | 425 | -- | -- | S,E,<br>150 | Irr | [1] |
| 901 | Joe Zeppa Pinehurst Farm well 4 | Delta Drlg. Co. | 1955 | 802 | 13<br>8 | 692<br>801 | 708-801 | 335 | 54.1<br>41.7 | 1-21-60<br>3-27-62 | T,E,<br>100 | Irr | Pump set at 290 ft. |
| 902 | Joe Zeppa Pinehurst Farm well 2 | do | 1954 | 763 | 13<br>8 | 680<br>763 | 683-763 | 375 | 93.9<br>79.8 | 1-21-60<br>3-27-62 | T,G,<br>100 | Irr | Drawdown 50 ft. when pumping at 730 gpm. Specific capacity 14.6 gpf. Pump set at 330 ft. |
| 903 | Joe Zeppa Pinehurst Farm well 1 | do | 1950 | 714 | 9<br>7 | 655<br>714 | 664-714 | 397 | 123.5<br>111.6 | 1-21-60<br>3-27-62 | T,E,<br>15 | D | Pump set at 340 ft. |
| 904 | Joe Zeppa Pinehurst Farm well 3 | do | 1954 | 780 | 13<br>8 | 685<br>780 | 690-780 | 426 | 136.3 | 3-27-62 | T,E,<br>60 | Irr | Pump set at 300 ft.[1] |
| 36-201 | C. E. Bogue | Sohio & Rowan | 1953 | 70 | 3 | 70 | 60- 70 | 487 | +1<br>+1 | 10- 1-59<br>3-26-62 | Flows | D | Screened in Carrizo only. |
| * 37-101 | Butane Gas & Electric Co. | Roy C. White | 1960 | 800 | 4<br>2 | 655<br>800 | 720-730,<br>758-798 | 540± | 190.6 | 3-23-62 | S,E,<br>5 | P | Pump set at 294 ft. |
| * 303 | City of Lindale well 4 | Layne-Texas Co. | 1962 | 990 | 16<br>10 | 860<br>990 | 865-926,<br>931-980 | 477 | 182.0 | 5-16-62 | T,E,<br>60 | P | Drawdown 109 ft. after pumping 24 hrs. at 608 gpm. Specific capacity 5.6 gpf. Pump set at 340 ft.[1] [2] |
| * 901 | Tyler Ind. School Dist., Dixie Colored School | Roy C. White | 1957 | 747 | 4<br>2 | 577<br>747 | 726-746 | 450± | 145<br>98.5 | 3- -57<br>3-23-62 | S,E,<br>1 | P | |
| 38-302 | Skelly Oil Co. | Barnwell Drlg. Co. | 1960 | 1,269 | 10<br>6 | 1,160<br>1,265 | 1,160-1,265 | 440 | 113.0 | 8- 8-60 | T,E,<br>40 | Ind | Drawdown 53 ft. when pumping at 315 gpm. Specific capacity 6 gpf.[2] |
| * 401 | Tyler Pipe & Foundry | Layne-Texas Co. | 1955 | 1,019 | 18<br>12 | 854<br>1,019 | 860-925,<br>940-991 | 610 | 309<br>310<br>323 | 4-29-55<br>1-21-60<br>3-12-62 | T,E,<br>100 | Ind | Drawdown 52 ft. after pumping 24 hrs. at 800 gpm. Specific capacity 15.4 gpf. |
| * 39-201 | Butane Gas & Electric | Roy C. White | 1956 | 760 | 4<br>2 | 715<br>759 | 729-759 | 390± | 135 | 2- -56 | T,E,<br>5 | P | |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| *34-39-501 | Smith Co. WCID No. 1, well 5 | Layne-Texas Co. | 1943 | 983 | 16<br>8 | 570<br>983 | 578-648,<br>677-699,<br>742-782,<br>814-846,<br>866-886,<br>932-960 | 374 | 102<br>81.2 | 4-30-57<br>3-13-62 | T,E, 75 | Ind | Drawdown 33 ft. when pumping at 555 gpm. Specific capacity 16.8 gpf. Pump set at 220 ft. 2/ |
| * 502 | Smith Co. WCID No. 1, well 4 | do | 1943 | 977 | 16<br>8 | 535<br>977 | 545-620,<br>714-750,<br>810-886,<br>896-920 | 376 | 100<br>84.3 | 4-30-57<br>3-13-62 | T,E, 75 | Ind | Drawdown 24 ft. when pumping at 520 gpm. Specific capacity 21.5 gpf. Pump set at 220 ft.1/ 2/ |
| * 503 | Smith Co. WCID No. 1, well 3 | do | 1943 | 970 | 16<br>8 | 540<br>970 | 550-620,<br>780-830,<br>876-946 | 377 | 97<br>87.5 | 4-30-57<br>3-13-62 | T,E, 75 | Ind | Drawdown 16 ft. when pumping at 420 gpm. Specific capacity 23.8 gpf. Pump set at 160 ft.2/ |
| * 504 | Smith Co. WCID No. 1, well 2 | do | 1943 | 668 | 16<br>8 | 560<br>668 | 569-619,<br>635-655 | 381 | 107<br>95.4 | 4-30-57<br>3-13-62 | T,E, 75 | Ind | Drawdown 47 ft. when pumping at 600 gpm. Specific capacity 12.8 gpf. Pump set at 240 ft.2/ |
| 505 | B. G. Byars Royal Oak Farm | Roy C. White | 1956 | 584 | 4<br>2 | 514<br>584 | 563-583 | 360± | 70.2 | 3-27-62 | S,E, 1 | D | |
| 601 | Knox Lee | do | 1954 | 450 | 4<br>2 | 387<br>450 | 427-447 | 430± | 160 | 3- -54 | S,E, 1-1/2 | D | |
| * 40-101 | Otis Kid | do | 1957 | 420 | 4<br>2 | 358<br>420 | 398-418 | 400± | 102.8 | 3-27-62 | S,E, 1 | D | |
| 102 | E. C. Wells | do | 1956 | 420 | 4<br>2 | 342<br>420 | 399-419 | 390± | 104.5 | 3-27-62 | S,E, 1 | D | |
| 201 | J. A. Rowley | do | 1954 | 390 | 4<br>2 | 316<br>390 | 324-338 | 460± | -- | -- | S,E, 1 | D | |
| 202 | W. A. Eason | do | 1960 | 248 | 4<br>2 | 230<br>248 | 232-247 | 440± | 120 | 6- -60 | S,E, 3/4 | D | |
| 401 | J. D. Walters | do | 1952 | 308 | 4<br>2 | 258<br>308 | 291-306 | 400± | 111.1<br>103.8 | 2-16-60<br>3-28-62 | S,E, 3/4 | D | |
| 501 | J. F. McComb | do | 1957 | 328 | 5<br>3 | 275<br>328 | 292-312 | 390± | 125.3 | 3-28-62 | J,E, 1-1/2 | D | |
| * 701 | Lone Star Gas Co. | Layne-Texas Co. | 1946 | 372 | 16<br>10 | 268<br>372 | 275-370 | 430± | 160<br>158 | 2-16-60<br>3-28-62 | T,G, 38 | Ind | Drawdown 18 ft. when pumping at 325 gpm. Specific capacity 18 gpf. Pump set at 200 ft. Air-line 218 ft.1/ |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing: Diameter (in.) | Casing: Depth of base (ft.) | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level: Below or above (+) land-surface datum (ft.) | Water level: Date of measurement | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34-40-702 | East Texas Producers Gas Association | Delta Drlg. Co. | 1952 | 376 | 10<br>7 | 336<br>376 | 336-376 | 450 | 181.4<br>179.1 | 2-16-60<br>3-28-62 | T,G | Ind | Reported yield 100 gpm. Another identical well 100 feet west. |
| 703 | M. L. Brooks | Roy C. White | 1956 | 380 | 4<br>2 | 290<br>380 | 360-380 | 470± | 155 | 5- -56 | S,E, 1 | D | |
| * 45-301 | City of Tyler Pounds Field | Layne-Texas Co. | 1943 | 880 | 10<br>6 | 700<br>880 | 710-875 | 537 | 223.8<br>223.6 | 1-12-60<br>3- 1-62 | T,E, 20 | P | Drawdown 49 ft. when pumping at 200 gpm. Specific capacity 4 gpf. Pump set at 300 ft.1/ |
| 501 | R. G. Werner | Roy C. White | 1955 | 549 | 4<br>2 | 444<br>549 | 474-484,<br>520-540 | 400± | 87 | 1- -55 | S,E, 1 | D | |
| 601 | Judge Lindsey | do | 1960 | 749 | 4<br>2 | 680<br>749 | 718-748 | 440 | 125.0<br>125.6 | 2- 2-60<br>3- 1-62 | S,E, 3 | D | |
| 603 | Texas Game & Fish Comm., Tyler Fish Hatchery | do | 1959 | 750 | 4<br>2 | 685<br>750 | 705-735 | 430± | 121.8 | 3- 1-62 | S,E, 1-1/2 | D | 1/ |
| * 605 | Tyler Ind. Foundation | Layne-Texas Co. | 1961 | 940 | None | -- | -- | 462 | -- | -- | -- | -- | Test hole. Temperature-survey, electric, and sample logs and pumping-test data are available for this well, which may be compared with available electric log of test hole 34-45-606 located 1,500 ft. to the east. |
| * 46-101 | City of Tyler well 9 | do | 1955 | 980 | 16<br>8 | 695<br>980 | 699-779,<br>794-804,<br>849-869,<br>879-889,<br>930-970 | 472 | 161.0<br>160.3 | 1-15-60<br>3- 6-62 | T,E, 100 | P | Drawndown 71 ft. when pumping at 815 gpm. Specific capacity 11.5 gpf. Pump set at 360 ft.1/ |
| * 105 | Kirkpatrick Utility Co. | do | 1956 | 800 | 8<br>4 | 718<br>800 | 723-752,<br>762-778 | 495 | 174.8 | 3- 7-62 | T,E, 10 | P | Drawdown 26 ft. when pumping at 110 gpm. Specific capacity 4.2 gpf. |
| 109 | Willowbrook Country Club | do | 1934 | 827 | 10<br>5 | 686<br>827 | 743-825 | 511 | 203.3 | 3- 5-62 | T,E, 40 | Irr | Estimated yield 200 gpm. Pump set at 300 ft. |
| * 201 | City of Tyler well 5 | do | 1944 | 1,045 | 16<br>8 | 930<br>1,045 | 935-1,035 | 550 | 246.3<br>237.5 | 1-14-60<br>3- 6-62 | T,E, 100 | P | Drawdown 101 ft. when pumping at 400 gpm. Specific capacity 4 gpf. Pump set at 520 ft.1/ 2/ |
| * 202 | City of Tyler well 7 | do | 1945 | 1,074 | 16<br>8 | 753<br>1,074 | 766-916<br>961-1,052 | 545 | 225.4<br>223.0 | 1-14-60<br>3- 6-62 | T,E, 150 | P | Drawdown 68 ft. when pumping at 725 gpm. Specific capacity 10.6 gpf. Pump set at 460 ft.1/ |
| * 203 | City of Tyler well 2 | do | 1937 | 1,086 | 16<br>8 | 910<br>1,086 | 928-1,066 | 611 | -- | -- | T,E, 100 | P | Drawdown 91 ft. when pumping at 455 gpm. Specific capacity 5 gpf. Pump set at 600 ft.1/ 2/ |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| *34-46-301 | City of Tyler well 6 | Layne-Texas Co. | 1944 | 1,056 | 18<br>8 | 910<br>1,056 | 898-1,032 | 505 | 194.7<br>191.0 | 1-14-60<br>3- 6-62 | T,E, 100 | P | Reported yield 600 gpm. Drawdown 53 ft. when pumping at 400 gpm. Specific capacity 7.5 gpf. Pump set at 460 ft.1/ 2/ |
| 402 | Briarwood Country Club | Roy C. White | 1959 | 760 | 6<br>4 | 665<br>760 | 695-760 | 500± | 182.1 | 3- 5-62 | S,E, 10 | D | Estimated yield 150 gpm. |
| * 501 | City of Tyler well 8 | Layne-Texas Co. | 1947 | 1,144 | 16<br>8 | 796<br>1,144 | 810-933,<br>1,038-1,120 | 600 | 286.9<br>284.3 | 1-14-60<br>3- 6-62 | T,E, 100 | P | Drawdown 60 ft. when pumping at 572 gpm. Specific capacity 9.5 gpf. Pump set at 520 ft.1/ |
| * 502 | City of Tyler well 4 | do | 1939 | 1,042 | 13<br>6 | 830<br>1,042 | 848-868,<br>893-1,030 | 592 | 265.4 | 3- 6-62 | T,E, 100 | P | Reported yield 743 gpm. Drawdown 75 ft. when pumping at 500 gpm. Specific capacity 6.7 gpf. Pump set at 520 ft.1/ 2/ |
| * 503 | City of Tyler well 3 | do | 1938 | 973 | 13<br>6 | 780<br>973 | 785-820,<br>835-882,<br>897-950 | 565 | 246.2<br>242.9 | 1- 4-60<br>3- 6-62 | T,E, 100 | P | Drawdown 140 ft. when pumping at 400 gpm. Specific capacity 2.8 gpf. Pump set at 520 ft.1/ 2/ |
| * 701 | Otis Mingus | Roy C. White | 1962 | 913 | 4<br>2 | 829<br>913 | 882-912 | 510 | 224.0 | 2-19-62 | S,E, 2 | D | |
| * 801 | City of Tyler Sewage Treatment Plant | Texas Water Wells | 1954 | 718 | 8 | 718 | 590-610,<br>620-645,<br>700-715 | 424 | -- | -- | T,E, 55 | D | Reported yield 65 gpm.1/ |
| 802 | Dr. Paul Goldsmith & Hugh Denson | Roy C. White | 1961 | 870 | 7<br>4 | 792<br>870 | 828-868 | 495± | 210.6 | 3- 7-62 | S,E, 3 | D | |
| 47-202 | Homer Ward, Jr. | do | 1959 | 720 | 4<br>2 | 662<br>720 | 670-720 | 440± | 180 | 5- -59 | S,E, 2 | D | |
| * 401 | Texas Game & Fish Comm. Quail Farm | J. L. Myers' Sons | 1955 | 673 | 8<br>4 | 550<br>673 | 595-665 | 560 | 246<br>257 | 2- 9-60<br>3-15-62 | T,E, 7-1/2 | Ind, Irr | Drawdown 51 ft. when pumping at 50 gpm. Specific capacity 1 gpf. Pump set at 390 ft. |
| 501 | Bethel Baptist Church | Roy C. White | 1960 | 600 | 4<br>2 | 535<br>600 | 570-590 | 490± | 165 | 2- -60 | S,E, 22 | D | |
| * 48-201 | City of Kilgore well 4 | Texas Water Wells | 1952 | 738 | 14<br>10 | 300<br>738 | 323-418,<br>428-448,<br>598-628,<br>643-658,<br>688-728 | 520 | 241<br>238 | 2- 8-60<br>3-22-62 | T,E, 100 | P | Drawdown 32 ft. when pumping at 538 gpm. Specific capacity 16.8 gpf. Pump set at 290 ft.2/ |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| *34-48-202 | City of Kilgore well 3 | Texas Water Wells | 1952 | 534 | 14<br>12 | 313<br>534 | 313-413,<br>428-443,<br>493-523 | 514 | 224<br>221 | 2- 8-60<br>3-22-62 | T,E,<br>125 | P | Drawdown 26 ft. when pumping at 671 gpm. Specific capacity 25.8 gpf. Pump set at 285 ft.[2] |
| * 301 | City of Kilgore well 1 | do | 1952 | 760 | 14<br>10 | 350<br>760 | 350-475,<br>522-542,<br>680-750 | 549 | 266<br>261.9 | 2- 8-60<br>3-22-62 | T,E,<br>150 | P | Drawdown 19 ft. when pumping at 710 gpm. Specific capacity 37.3 gpf. Pump set at 320 ft.[1] [2] |
| 501 | City of Kilgore well 2 | do | 1952 | 508 | 14<br>12 | 370<br>508 | 374-499, | 560 | 275<br>275 | 2- 8-60<br>3-22-62 | T,E,<br>75 | P | Drawdown 25 ft. when pumping at 371 gpm. Specific capacity 14.8 gpf. Pump set at 357 ft.[2] |
| 502 | City of Kilgore well 5 | Montgomery Drlg. Co. | 1957 | 476 | 24<br>12 | 340<br>470 | 340-470 | 563 | 254<br>252 | 2- 8-60<br>3-23-62 | T,E,<br>100 | P | Drawdown 20 ft. when pumping at 468 gpm. Specific capacity 23.4 gpf. Pump set at 322 ft.[2] |
| 503 | City of Kilgore well 6 | Texas Water Wells | 1957 | 470 | 16<br>8 | 330<br>470 | 340-460 | 545 | 235<br>235 | 2- 8-60<br>3-23-62 | T,E,<br>60 | P | Drawdown 30 ft. when pumping at 330 gpm. Specific capacity 11 gpf. Pump set at 310 ft.[2] |
| * 53-201 | Bert Pfaff | Roy C. White | 1959 | 992 | 5<br>3 | 870<br>992 | 887-902,<br>954-964,<br>972-992 | 460± | 146.8 | 3-22-62 | S,E,<br>5 | D | Estimated yield 50 gpm. |
| 202 | D. E. McMillan | do | 1959 | 817 | 5<br>3 | 686<br>817 | 707-747 | 420± | 90 | 8- -59 | S,E,<br>5 | D | Estimated yield 100 gpm. |
| * 54-201 | Roy C. White | do | 1960 | 990 | 4<br>2 | 912<br>990 | 955-990 | 525± | 213<br>213 | 1- 4-60<br>3-19-62 | S,E,<br>1/2 | D | |
| 302 | Roy Carpenter | do | 1961 | 600 | 4<br>2 | 556<br>600 | 577-597 | 530± | 217.6 | 3-19-62 | S,E,<br>1 | D | |
| * 55-101 | City of Whitehouse | Layne-Texas Co. | 1955 | 610 | 10<br>6 | 567<br>610 | 570-600 | 485± | 220.3<br>221.0 | 1-27-60<br>3-19-62 | T,E,<br>40 | P | Drawdown 181 ft. when pumping at 155 gpm. Specific capacity 0.9 gpf. Pump set at 400 ft.[1] |
| 201 | Andrews & Daughtry | Roy C. White | 1955 | 685 | 4<br>2 | 635<br>689 | 645-685 | 420± | 133.3 | 3-19-62 | N | N | |
| 601 | W. E. Ashcraft | do | 1955 | 240 | 4<br>2 | 179<br>224 | 224-239 | 390± | 52.1 | 3-29-62 | J,E,<br>1 | D | |
| 801 | Joe W. Bailey | do | 1954 | 230 | 4 | 190 | 190-230 | 320± | +1<br>+1 | 3- 2-60<br>3-16-62 | Flows | D | Estimated yield 30 gpm. |
| * 802 | Earl Towns | do | 1957 | 200 | 4<br>2 | 167<br>200 | 183-198 | 325± | +4 | 3-16-62 | Flows | D | |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| 34-55-901 | Pinecrest, Inc. | Roy C. White | 1958 | 322 | 6<br>4 | 253<br>322 | 290-320 | 460± | 140<br>124.0 | 3- -58<br>3-16-62 | S,E, 5 | Irr | Estimated yield 75 gpm. |
| 902 | City of Troup well 4 | Layne-Texas Co. | 1940 | 345 | 16<br>8 | 261<br>342 | 267-288,<br>306-327 | 450± | 94.4<br>93.3 | 1-20-60<br>3-16-62 | T,E, 15 | P | Reported yield 75 gpm. Pump set at 220 ft. |
| *903 | City of Troup well 7 | do | 1957 | 1,080 | 16<br>8 | 700<br>1,080 | 724-739,<br>747-762,<br>774-824,<br>967-997,<br>1,007-1,062 | 450± | 154<br>171 | 1-21-60<br>3-21-62 | T,E, 75 | P | Yield 500 gpm. Pump set at 300 ft.[1] |
| 56-101 | C. G. Proutys | Roy C. White | 1952 | 210 | 4 | 210 | 200-210 | 415± | 73 | 10- -52 | J,E, 1 | D | |
| *201 | City of Arp | Layne-Texas Co. | 1944 | 1,014 | 10<br>5 | 613<br>1,014 | 880-922,<br>925-1,013 | 500± | 220<br>257 | 1-20-60<br>3-21-62 | T,E, 30 | P | Drawdown 43 ft. when pumping at 265 gpm. Specific capacity 6.1 gpf. Pump set at 340 ft.[1] |
| *202 | do | Cooper-Herring | 1947 | 1,240 | 10<br>5 | 885<br>1,240 | 900-980 | 500± | 212<br>222.0 | 1-20-60<br>3-21-62 | T,E, 40 | P | Drawdown 47 ft. when pumping at 216 gpm. Specific capacity 4.6 gpf. |
| 301 | Arp Ind. School Dist. | Roy C. White | 1958 | 510 | 4<br>2 | 439<br>510 | 480-500 | 570± | 270 | 8- -58 | S,E, 1-1/2 | P | |
| 302 | E. E. Davis | do | 1956 | 509 | 4<br>2 | 430<br>509 | 488-508 | 530± | 250 | 1- -56 | J,E, 2 | D | |
| *401 | American Petrofina | Layne-Texas Co. | 1960 | 1,035 | 10<br>6 | 895<br>1,035 | 895-1,015 | 435 | 175 | 6-17-60 | T,G | Ind | Drawdown 97 ft. when pumping at 415 gpm. Specific capacity 4.3 gpf. Pump set at 300 ft.[1] [2] |
| 402 | C. C. Ellis | Roy C. White | 1954 | 240 | 4<br>2 | 196<br>240 | 224-239 | 440± | 107.0 | 3-21-62 | N | N | |
| 403 | J. D. Flewellan | do | 1956 | 275 | 4<br>2 | 213<br>275 | 254-275 | 395± | 110 | 5- -56 | S,E, 1 | D | |
| 501 | Sinclair Pipeline Co. | Layne-Texas Co. | 1930's | 368 | 6 | 368 | 338-368 | 440± | 142.8 | 3-22-60 | T,E, 5 | Ind | |
| 502 | Carl Wright | Roy C. White | 1956 | 390 | 4<br>2 | 309<br>390 | 325-335,<br>375-385 | 480± | 190.2 | 3-21-62 | S,E, 1 | D | |
| *35-41-701 | City of Overton | R. L. Clifford & Layne-Texas Co. | 1956 | 290 | 16<br>10 | 190<br>290 | 200-280 | 420± | 120.6<br>126 | 1-13-60<br>3-21-62 | T,E, 30 | P | Drawdown 51 ft. when pumping at 350 gpm. Specific capacity 7 gpf. Pump set at 240 ft.[2] |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date com-pleted | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| | | | | | | | Queen City aquifer | | | | | | |
| 34-20-501 | H. B. Pagdett | -- | 1941 | 31 | 26 | 30 | -- | 370± | 28.1 | 9-22-59 | B,H | D | |
| 801 | F. E. Carter | -- | -- | 24 | 36 | 24 | -- | 390± | 19.6 | 9-22-59 | J,E, 1/2 | D | |
| 802 | C. E. Hamman | -- | 1925 | 23 | 26 | 23 | -- | 400± | 15.0 | 9-22-59 | J,E | D | |
| 28-201 | A. M. Stevens | -- | -- | 30 | 36 | 30 | -- | 400± | 26.1 | 9-22-59 | J,E | D | |
| 301 | C. D. Taylor | -- | 1935 | 12 | 30 | 12 | -- | 400± | 8.1 | 10- 1-59 | J,E, 1/3 | D | |
| 401 | D. E. Null | -- | -- | 16 | 36 | 16 | -- | 410± | 11.4 | 9-28-59 | J,E, 1/2 | D | |
| 501 | Mrs. L. K. Kindle | -- | -- | 26 | 36 | 26 | -- | 410± | 19.4 | 9-28-59 | J,E, 1/4 | D | Reklaw Formation? Reported high iron concentration. |
| 502 | M. G. Humphrey | -- | -- | -- | -- | -- | -- | 395± | Flows | 9-28-59 | N | D | Spring |
| 601 | J. C. Barnett | -- | 1900 | 33 | 30 | 33 | -- | 400± | 27.2 | 10- 1-59 | J,E, | D | Reported high iron concentration. |
| 702 | C. C. Gilley | -- | 1940 | 19 | 30 | 19 | -- | 505± | 16.1 | 9-28-59 | B,H | D | |
| 703 | T. E. Calhoun | -- | 1957 | 25 | 28 | 24 | -- | 500± | 8.6 | 9-28-59 | J,E, 1/2 | D | |
| 901 | Les Lucas | Les Lucas | 1950 | 43 | 30 | 43 | -- | 575± | 21.9 | 10- 1-59 | B,H | D | |
| 902 | C. H. Hamman | C. H. Hamman | 1929 | 53 | None | -- | -- | 500± | 48.7 | 10- 1-59 | J,E, 1/4 | D | |
| 29-401 | H. C. Sloan | Coleman | -- | 16 | 30 | 16 | -- | 415± | 7.4 | 10- 7-59 | J,E, 3/4 | D | |
| 601 | T. M. Goolesby | -- | 1936 | 32 | 30 | 31 | -- | 475± | 18.7 | 10-15-59 | B,H | D | |
| * 701 | W. S. Ashcraft | -- | 1923 | 26 | 32 | 25 | -- | 440± | 16.0 | 10-13-59 | J,E, 1/2 | D | |
| * 901 | City of Lindale well 3 | Layne-Texas Co. | 1951 | 635 | 16<br>10<br>8 | 265<br>438<br>635 | 275-290,<br>320-330,<br>375-435,<br>458-468,<br>480-490,<br>500-515,<br>565-590,<br>610-630 | 565 | 163.2<br>162.4 | 2- 8-60<br>3-26-62 | T,E, 40 | P | Drawdown 103 ft. when pumping at 250 gpm. Specific capacity 2.5 gpf. Pump set at 370 ft.[1] [2] |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| 34-30-401 | Fred Taylor | -- | 1954 | 20 | 36 | 20 | -- | 410± | 10.7 | 10-15-59 | J,E, 1/3 | D | |
| 402 | Grady Lyons | -- | 1945 | 29 | 30 | 28 | -- | 500± | 23.0 | 10-15-59 | J,E, 1/3 | D | |
| 501 | J. D. Goodman | J. D. Goodman | 1934 | 17 | 30 | 16 | -- | 400± | 12.0 | 10-15-59 | J,E, 1/3 | D | |
| 601 | J. A. Bergfeld | -- | -- | 31 | 30 | 30 | -- | 350± | 24.4 | 10-15-59 | J,E, 1/2 | D | |
| 801 | G. M. Stripling | -- | 1934 | 34 | 30 | 34 | -- | 395± | 14.7 | 10-16-59 | J,E, 1/2 | D | |
| 901 | C. J. Coulter | -- | 1950 | 50 | 30 | 50 | -- | 450± | 34.1 | 10-16-59 | J,E, 1/3 | D | |
| 31-701 | S. M. McCauley | -- | 1902 | 40 | 36 | 40 | -- | 420 | 31.3 | 10-15-59 | J,E, 1/3 | D | |
| * 905 | H. L. Hunt | Roy C. White | 1961 | 277 | 4<br>2 | 219<br>277 | 246-276 | 430 | 108 | 6- 7-61 | S,E, 3 | D | Reported yield 30 gpm. |
| 906 | do | do | 1953 | 282 | 7<br>4 | 267<br>282 | 267-282 | 335 | 18<br>19.9 | 11- -53<br>3-27-62 | S,E, 2 | S | |
| 36-202 | H. M. Armstrong | -- | -- | 23 | 27 | 23 | -- | 420± | 19.7 | 10- 6-59 | B,H | D | |
| 301 | C. J. Ellison | -- | 1880 | 93 | 48 | 93 | -- | 580 | 63.5 | 10- 1-59 | J,E, 1 | D | |
| 302 | G. B. Dennis | -- | 1880 | 28 | 30 | 28 | -- | 535 | 21.0 | 10- 6-59 | J,E, 1/4 | D | |
| 601 | J. R. Dowell | -- | 1900's | 33 | 36 | 33 | -- | 450± | 26.4 | 10- 6-59 | J,E, 1/2 | D | |
| * 37-102 | Dr. S. W. Bradford | Roy C. White | 1959 | 340 | 6<br>4 | 280<br>340 | 288-338 | 610± | 197 | 12-19-59 | S,E, 5 | D,S | |
| 401 | B. T. Patrick | -- | 1950 | 30 | 36 | 30 | -- | 540± | 4.0 | 3- 7-60 | J,E, 1/4 | D | |
| 701 | T. A. Barron | -- | 1930 | 35 | 36 | 35 | -- | 505± | 32.3 | 3- 7-60 | B,H | D | |
| 702 | Rufus McGee | Roy C. White | 1960 | 128 | 4 | 128 | 118-128 | 510± | 90 | 6- -60 | J,E, 3/4 | D | |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| 34-38-402 | Leon Miller | Roy C. White | 1955 | 300 | 4<br>2 | 268<br>300 | 279-299 | 495± | 100 | 10- -55 | J,E, 1-1/2 | D | |
| 701 | A. W. Wilson | do | 1957 | 242 | 4<br>2 | 196<br>242 | 221-241 | 480± | 79.3 | 3-12-62 | S,E, 1 | D | |
| 905 | Frank Ragsdale | do | 1956 | 167 | 4 | 167 | 147-167 | 500± | 78.8 | 3- 9-62 | S,E, 1/3 | D | |
| * 907 | Pine Springs School | do | 1954 | 225 | 4<br>2 | 188<br>225 | 202-222 | 495± | 35 | 6- -54 | S,E | P | |
| 39-301 | Myra York | -- | 1952 | 49 | 30 | 49 | -- | 460± | 34.0 | 3- 8-60 | J,E, 1/4 | D | |
| 40-301 | E. W. Buckaloo | -- | 1930 | 23 | 36 | 3 | 3- 23 | 395± | 7.6 | 3- 8-60 | J,E, 1/4 | D | |
| 601 | -- Hicks | -- | 1900's | 28 | None | -- | -- | 400± | 21.7 | 3- 8-60 | N | N | |
| * 45-502 | George Tidmore | Roy C. White | 1957 | 200 | 4<br>2 | 150<br>200 | 184-199 | 450± | 66.4 | 3- 1-62 | S,E, 1/2 | D | |
| 602 | Dean Baptist Church | do | 1954 | 275 | 4<br>2 | 228<br>275 | 259-274 | 460± | 80.9 | 3- 1-62 | J,E, 1/2 | D | |
| 801 | Galilee Church | -- | -- | 60 | 36 | 60 | -- | 430± | 12.1 | 1-29-60 | J,E, 1/4 | D | |
| * 46-106 | Breedlove Nurseries | Roy C. White | 1956 | 207 | 4 | 207 | 177-207 | 520± | 70.0 | 3- 2-62 | S,E, 2 | Irr | |
| * 302 | Texas Eastman Co. | Layne-Texas Co. | 1960 | 633 | 10 | 633 | 300-350,<br>530-550,<br>565-585 | 500± | 26.0 | 1-22-60 | T,E, 50 | Ind | Drawdown 300 ft. when pumping at 400 gpm. Specific capacity 1.3 gpf.[2] |
| 304 | Testco Co. | Roy C. White | 1957 | 176 | 4 | 176 | 166-176 | 540± | 85 | 1- -57 | S,E, 1 | D | |
| 505 | H. L. Roberts | do | 1958 | 275 | 4<br>2 | 240<br>275 | 254-274 | 495± | 102.0 | 3- 2-62 | S,E, 1 | D | |
| 703 | M. J. English | do | 1958 | 320 | 4<br>2 | 202<br>320 | 299-319 | 540± | 90.6 | 3- 7-62 | S,E, 1 | D | |
| 803 | H. B. Sampson | do | 1958 | 290 | 4<br>2 | 233<br>290 | 258-288 | 460± | 85 | 4- -58 | S,E, 1 | D | |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| *34-46-804 | G. R. Rieck | Roy C. White | 1953 | 440 | 4<br>2 | 193<br>440 | 420-440 | 480± | 77.5 | 3- 7-62 | S,E, 1 | D | |
| 47-101 | Bill Johnson | do | 1959 | 190 | 4 | 190 | 180-190 | 570± | 89.2 | 3-15-62 | S,E, 3/4 | D | |
| 102 | Gloria Bradford | do | 1957 | 118 | 4 | 118 | 108-118 | 460± | 23.6 | 3-21-62 | J,E, 1/2 | D | |
| 201 | Frank Holmes | -- | 1946 | 23 | 30 | 23 | -- | 430± | 13.8 | 3-10-60 | B,H | D | |
| 203 | T. S. Farrel | Roy C. White | 1952 | 129 | 4 | 129 | 115-125 | 460± | 63.2 | 3-15-62 | S,E, 1 | D | |
| * 301 | Jackson School Chapel Hill School Dist. | V. E. West | 1952 | 145 | 6 | 145 | 90-120 | 480± | 30 | 2- -62 | T,E, 3 | P | Estimated yield 50 gpm. |
| 402 | Tom Clark | Roy C. White | 1955 | 353 | 4<br>2 | 305<br>353 | 331-351 | 600± | 175 | 12- -55 | S,E, 1 | D | |
| * 502 | Chapel Hill Ind. School Dist. | V. E. West | 1948 | 245 | 6 | 245 | 225-245 | 440± | 30 | 10- -60 | T,E, 3 | P | |
| 701 | J. W. Roberts | Roy C. White | 1956 | 170 | 4<br>2 | 158<br>170 | 158-168 | 500± | 97.0 | 3-15-62 | J,E, 1 | D | |
| 702 | Roy Dickson | do | 1956 | 255 | 4<br>2 | 214<br>255 | 238-253 | 570± | 165 | 12- -56 | S,E, 1 | D | |
| 48-401 | -- Church | -- | -- | 24 | None | -- | -- | 410± | 18.2 | 3-10-60 | B,H | D | |
| 701 | Swinney Town Church of God | -- | -- | 24 | 40 | 4 | 4- 24 | 440± | 7.9 | 3-11-60 | J,E, 1/2 | D | |
| 53-801 | Roy Baker | -- | 1953 | 35 | 30 | 34 | -- | 390± | 17.0 | 1-29-60 | N | S | |
| 901 | -- Junell | -- | 1900's | 17 | 36 | 17 | -- | 425± | 4.4 | 1-29-60 | J,E, 1/4 | D | |
| 54-101 | F. A. Kellman | Roy C. White | 1955 | 180 | 4<br>2 | 140<br>180 | 165-180 | 470± | 88.2 | 3-20-62 | S,E, 3/4 | D | |
| 301 | H. C. Staples | do | 1956 | 213 | 4<br>2 | 180<br>213 | 192-212 | 550± | 145 | 6- -56 | S,E, 1 | D | |
| 303 | Melvin Cates | do | 1953 | 300 | 4<br>2 | 267<br>300 | 282-297 | 540± | 135 | 6- -53 | S,E, 1 | D | |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing: Diameter (in.) | Casing: Depth of base (ft.) | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level: Below or above (+) land-surface datum (ft.) | Water level: Date of measurement | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34-54-402 | Milton Vanderpool | Roy C. White | 1953 | 310 | 4<br>2 | 245<br>294 | 294-309 | 440± | 85 | 9- -53 | S,E, 1/2 | D | |
| * 501 | Stanton School Whitehouse School Dist. | do | 1954 | 300 | 4<br>2 | 247<br>300 | 280-300 | 430± | 43.9 | 3-19-62 | S,E, 1 | P | |
| 502 | G. B. White | do | 1957 | 520 | 4<br>2 | 494<br>520 | 499-519 | 420± | 29.4 | 3-20-62 | S,E, 1 | D | |
| 601 | W. E. Davis | do | 1958 | 279 | 4<br>2 | 221<br>279 | 258-278 | 510± | 126.5 | 3-19-62 | S,E, 1/2 | D | |
| 901 | C. C. Teasdale | do | 1952 | 159 | 4<br>2 | 139<br>159 | 139-154 | -- | 95 | 6- -52 | -- | D | |
| 55-301 | Arp Nursery | do | 1957 | 115 | 6<br>4 | 69<br>115 | 69- 89 | 425± | 34.6 | 3-23-62 | J,G, 4 | Irr | |
| 401 | A. L. Portwood | -- | 1956 | 50 | 30 | 50 | -- | 500± | 36.2 | 2- 2-60 | J,E, 1/4 | D | |
| 402 | Bill Coates | Roy C. White | 1954 | 204 | 7 | 204 | 82- 95,<br>100-115,<br>120-148,<br>155-180,<br>200-204 | 480± | 38.6 | 3-15-62 | J,G, 10 | Irr | |
| 403 | C. H. Carr | do | 1957 | 280 | 4 | 280 | 265-280 | 440± | 83 | 5- -57 | S,E, 1 | D | |
| 501 | Unknown | -- | -- | 13 | 36 | 13 | -- | 400± | 5.4 | 3-10-60 | B,H | N | |
| 56-203 | Carl Newman | Roy C. White | 1952 | 81 | 4 | 81 | 71- 81 | 540± | 34 | 10- -60 | J,E, 1/2 | D | |

Sparta aquifer

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing: Diameter (in.) | Casing: Depth of base (ft.) | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level: Below or above (+) land-surface datum (ft.) | Water level: Date of measurement | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34-30-701 | D. D. Stringer | -- | 1954 | 25 | 30 | 25 | -- | 500± | 8.3 | 10-15-59 | J,E, 1/3 | D | |
| 31-401 | Shuford Walker | -- | 1900's | 21 | 30 | 20 | -- | 330± | 15.8 | 10-16-59 | B,H | D | |
| 801 | Winona Industrial School | -- | -- | 22 | 36 | 22 | -- | 390± | 7.8 | 10-16-59 | J,E, 3/4 | P | |
| 36-303 | A. D. Clark | -- | -- | -- | -- | -- | -- | 500± | + | 10- 6-59 | Flows | D | Spring |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| *34-37-301 | Prairie Creek Baptist Church | Roy C. White | 1957 | 70 | 4 | 70 | 37- 47 | 505± | 19.2 | 3-23-62 | J,E, 1 | D | |
| 501 | Ina Watton | -- | 1956 | 23 | 30 | 23 | -- | 455± | 1.9 | 3- 7-60 | B,H | D | |
| * 38-101 | Texas A & M Experiment Sta. | -- | 1920's | 43 | 36 | 43 | -- | 540± | 21.3 | 3- 7-60 | C,E, 1-1/2 | D,S | |
| 301 | J. N. Hawkins | -- | 1954 | 31 | 36 | 31 | -- | 610± | 19.7 | 3- 7-60 | J,E, 1/4 | D | |
| * 501 | D. L. Baxter | Roy C. White | 1957 | 120 | 4 | 120 | 90-100 | 500± | 51.8 | 3- 7-62 | S,E, 1 | D | |
| 601 | Dan Whiteside | do | 1957 | 200 | 4 | 200 | 190-200 | 600± | 158.2 | 3-12-62 | S,E, 3/4 | D | |
| 602 | Alfonsa Black | do | 1958 | 81 | 4 | 81 | 71- 81 | 505± | 28.9 | 3-14-62 | J,E, 1/2 | D | |
| 801 | Jack Nichols | do | 1957 | 130 | 4 | 130 | 120-130 | 540± | 50 | 3- -62 | J,E, 1 | D | |
| 901 | H. S. Holland | do | 1955 | 100 | 4<br>2 | 90<br>100 | 90-100 | 536 | 40 | 3- -60 | J,E, 1/2 | D | |
| 902 | Byran Hardy | do | 1952 | 120 | 4 | 120 | 110-120 | 540± | 66.2 | 3- 7-62 | J,E, 1 | D | |
| 903 | Morgan Harris | do | 1956 | 100 | 4 | 100 | 90-100 | 500± | 7.9 | 3- 7-62 | J,E, 1/2 | D | |
| * 904 | J. R. Bratton | do | 1952 | 99 | 4 | 99 | 89- 99 | 530± | 44.9 | 3-29-62 | J,E, 1/2 | D | |
| 906 | Fred Moore | do | 1962 | 114 | 4 | 114 | 104-114 | 500± | 28.7 | 3- 9-62 | S,E, 1/2 | D | |
| * 908 | Larison Nursery | do | 1955 | 108 | 4 | 108 | 93-108 | 540± | 36.5 | 3-12-62 | T,E, 2 | Irr | |
| * 909 | Fred's Nursery | do | 1960 | 112 | 4 | 112 | 101-111 | 540± | 40.3 | 3-12-62 | S,E, 2 | Irr | |
| 910 | Jim Negam | do | 1953 | 120 | 4 | 120 | 110-120 | 510± | 26.6 | 3-29-62 | S,E, 1/2 | D | |
| 911 | W. F. Schneider | do | 1954 | 130 | 4 | 130 | 99-109 | 520± | 44.5 | 3-12-62 | J,E, 3/4 | D | |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| 34-45-302 | C. A. Morrow | Roy C. White | 1953 | 81 | 4 | 81 | 71- 81 | 515± | 35 | 1- -53 | T,E, 1 | D | |
| * 901 | James Lockhart | do | 1957 | 82 | 4 | 80 | 70- 80 | 510± | 33.1 | 3- 1-62 | J,E, 1-1/2 | D | |
| * 46-102 | Mrs. W. M. Gaar | do | 1952 | 75 | 4 | 75 | 65- 75 | 490± | 18 | 3- -62 | J,E, 1/2 | D | |
| 103 | G. B. Pledger | do | 1952 | 70 | 4<br>2 | 50<br>70 | 54- 64 | 520± | 24.8 | 3- 2-62 | J,E, 1/2 | D | |
| 104 | Tyler Memorial Park | do | 1952 | 93 | 4 | 93 | 76- 91 | 505± | 30.2 | 3- 2-62 | S,E, 3/4 | Irr | |
| 108 | Ralph Cates | do | 1953 | 73 | 4 | 73 | 63- 73 | 445± | 5.9 | 3- 2-62 | J,E, 1/2 | D | |
| 110 | Bellwood Golf Club | do | 1960 | 110 | 4 | 110 | 100-110 | 460± | 30 | 6- -60 | S,E, 1 | D | Estimated yield 75 gpm. |
| 204 | Richardson Co. well 2 | Layne-Texas Co. | 1945 | 193 | 16<br>10 | 106<br>197 | 108-118,<br>140-181 | 554 | 89.5 | 3- 6-62 | T,E, 20 | Ind | Drawdown 30 ft. when pumping at 351 gpm. Specific capacity 11.7 gpf. Pump set at 160 ft.[1] [2] |
| * 205 | Richardson Co. well 1 | do | 1945 | 220 | 16<br>10 | 102<br>220 | 146-177,<br>200-220 | 551 | 82<br>76 | 3-23-60<br>3- 6-62 | T,E, 20 | Ind | Drawdown 57 ft. when pumping at 278 gpm. Specific capacity 5 gpf. Pump set at 160 ft.[1] [2] |
| 303 | Stewart Oil Co. | Roy C. White | 1958 | 120 | 4 | 120 | 110-120 | 550± | 68 | 1- -58 | S,E | D | |
| * 401 | Morris Dorbant | do | 1961 | 92 | 4 | 92 | 82- 92 | 584± | 65.5 | 3- 2-62 | J,E, 1 | D | |
| 504 | Ami Goss | do | 1952 | 98 | 4 | 98 | 65- 75 | 571± | 55.9 | 3- 7-62 | J,E, 1/2 | D | |
| 506 | Ruth McElory | do | 1957 | 99 | 4 | 99 | 89- 99 | 575± | 57.8 | 3- 7-62 | J,E, 1/2 | D | |
| 702 | J. L. Riddle, Jr. | do | 1962 | 88 | 4 | 88 | 78- 88 | 540± | 48 | 2-10-62 | S,E, 1/2 | D | |
| 53-203 | Texas Highway Dept. | -- | 1900± | 37 | None | -- | -- | 460± | 30.5 | 3-10-60 | B,H | D | |
| * 301 | W. G. McKay | Roy C. White | 1955 | 279 | 4<br>2 | 216<br>278 | 258-278 | 450± | 11.5<br>9.3 | 3-10-60<br>3-22-62 | J,E, 1 | D | |

See footnotes at end of table.

Table 1.--Records of selected wells and springs--Continued

| Well | Owner | Driller | Date completed | Depth of well (ft.) | Casing | | Screened depth interval (ft.) | Altitude of land surface (ft.) | Water level | | Method of lift | Use of water | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (in.) | Depth of base (ft.) | | | Below or above (+) land-surface datum (ft.) | Date of measurement | | | |
| 34-54-401 | G. M. Smith | -- | 1920's | 33 | 36 | 33 | -- | 525± | 22.9 | 3-10-60 | J,E, 1/4 | D | |
| * 701 | City of Bullard | -- | -- | -- | -- | -- | -- | 495± | + | -- | Flows | P | Spring |

* See Table 2 for chemical analysis of the water

1/ Driller's log or electric log in files of Texas Water Commission.

2/ See Table 4 for pumping test.

## Table 2.--Chemical analyses of water from selected wells and springs

(In parts per million except specific conductance, pH, and percent sodium)

| Well | Owner | Depth of well (ft.) | Date of collection | Analyst[1] | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium and potassium (Na + K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Dissolved solids | Total hardness as $CaCO_3$ | Percent sodium | Specific conductance (micromhos at 25°C) | pH | Temperature (°F) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <u>Carrizo-Wilcox aquifer</u> | | | | | | | | | | | | | | | | | | | | |
| 34-28-801 | L. S. Toone | 415 | 3-16-60 | USGS | 32 | 18.0 | 28 | 10 | 38 | 108 | 65 | 26 | 0.0 | 0.0 | 252 | 111 | 42 | 383 | 6.7 | -- |
| 31-702 | S. Dayson | 792 | 6-22-54 | CL | 10 | .2 | 4 | 2 | 75 | 139 | 36 | 14 | -- | -- | 286 | -- | -- | -- | 8.0 | -- |
| 902 | Joe Zeppa | 763 | 6- -54 | CL | 14 | .1 | 4 | 2 | 65 | 146 | 21 | 12 | -- | -- | 264 | -- | -- | -- | 7.3 | -- |
| 37-101 | Butane Gas & Electric | 800 | 4- 5-62 | USGS | 17 | .04 | 9.5 | 1.8 | 93 | 221 | 28 | 16 | .1 | .0 | 280 | 31 | 87 | 447 | 7.4 | 72 |
| 303 | City of Lindale well 4 | 990 | 5-16-62 | CL | 7 | .1 | 4.1 | .5 | 103 | 238 | 21 | 13 | -- | -- | 285 | 12 | -- | 403 | 8.1 | -- |
| 901 | Tyler Ind. School Dist. | 747 | 4- 9-62 | USGS | 12 | 2.2 | 12 | 3.8 | 24 | 99 | 9.6 | 4 | .1 | .2 | 115 | 46 | 53 | 196 | 6.9 | -- |
| 38-401 | Tyler Pipe & Foundry | 1,019 | 4-20-55 | CL | 8 | .1 | 8 | 2 | 42 | 110 | 17 | 8 | -- | -- | 200 | 28 | -- | -- | 7.4 | 74 |
| 39-201 | Butane Gas & Electric | 760 | 4- 6-62 | USGS | 11 | .5 | 2 | .6 | 93 | 164 | 55 | 12 | .1 | .0 | 256 | 7 | 96 | 411 | 7.7 | -- |
| 501 | Smith Co. WCID No. 1, well 5 | 983 | 6- 5-43 | CL | -- | .3 | 3 | .6 | 102 | 220 | 27 | 16 | -- | -- | 420 | 9.7 | -- | -- | 7.6 | -- |
| 502 | Smith Co. WCID No. 1, well 4 | 977 | 6- 5-43 | CL | 14 | .4 | 2.4 | .5 | 106 | 212 | 9.7 | 16 | -- | -- | 426 | 8.1 | -- | -- | 8.2 | 73 |
| 503 | Smith Co. WCID No. 1, well 3 | 970 | 6- 5-43 | CL | -- | .3 | 2.3 | .8 | 150 | 329 | 14 | 19 | -- | -- | 572 | 11.4 | -- | -- | 8.5 | 73 |
| 504 | Smith Co. WCID No. 1, well 2 | 668 | 6- 5-43 | CL | -- | .1 | 2.3 | .4 | 71 | 151 | 11 | 11 | -- | -- | 333 | 7.4 | -- | -- | 7.6 | 72 |
| 40-101 | Otis Kidd | 420 | 4- 5-62 | USGS | 11 | .06 | 4.2 | 1.8 | 65 | 146 | 23 | 10 | .1 | .8 | 189 | 18 | 89 | 309 | 7.3 | -- |
| 701 | Lone Star Gas | 372 | 8- 4-46 | CL | 16 | | 13 | 7.6 | 42 | 131 | 16 | 21 | -- | -- | 212 | 28 | -- | -- | 7.1 | -- |
| 45-301 | City of Tyler Pounds Field | 880 | 8-26-54 | TSDH | 4 | .5 | 6 | 2 | 60 | 122 | 8 | 18 | .4 | .4 | 175 | 23 | -- | -- | -- | -- |
| 605 | Tyler Ind. Foundation | 940 | 2-22-61 | CL | 15 | .2 | 2.1 | .5 | 148 | 323 | 25 | 25 | -- | -- | 398 | 5 | -- | 590 | 8.3 | -- |
| 46-101 | City of Tyler well 9 | 980 | 5-31-55 | CL | 11 | 1.2 | 11 | 3 | 39 | 128 | 8 | 8 | -- | -- | 209 | 40 | -- | -- | 7.5 | 70 |
| 105 | Kirkpatrick Utility | 800 | 8-20-56 | CL | 8 | .2 | 11 | 2.2 | 37 | 116 | 12 | 6 | -- | -- | 149 | -- | -- | -- | 8.2 | -- |
| 201 | City of Tyler well 5 | 1,045 | 9- 1-54 | TSDH | 11 | .5 | 6.9 | 4.0 | 36 | 98 | 10 | 14 | .2 | .4 | 120 | 34 | -- | -- | 7.9 | -- |
| 202 | City of Tyler well 7 | 1,126 | 8-27-54 | TSDH | 11 | .1 | 4.0 | 3.0 | 51 | 128 | 11 | 14 | .1 | .4 | 150 | 23 | -- | -- | 7.7 | -- |

See footnote at end of table.

Table 2.--Chemical analyses of water from selected wells and springs--Continued

| Well | Owner | Depth of well (ft.) | Date of collection | Analyst[1] | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium and potassium (Na + K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Dissolved solids | Total hardness as $CaCO_3$ | Percent sodium | Specific conductance (micromhos at 25°C) | pH | Temperature (°F) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34-46-203 | City of Tyler well 2 | 1,086 | 8-26-54 | TSDH | 8 | 0.3 | 6.0 | 3.0 | 41 | 116 | 9 | 7 | 0.2 | 0.4 | 129 | 28 | -- | -- | -- | -- |
| 301 | City of Tyler well 6 | 1,078 | 8- 6-54 | TSDH | 13 | .2 | 83 | 6.0 | 145 | 122 | 202 | 167 | .2 | .4 | 700 | 232 | -- | -- | 7.2 | -- |
| 501 | City of Tyler well 8 | 1,144 | 8-26-54 | TSDH | 15 | .2 | 4.0 | 3.0 | 92 | 220 | 10 | 18 | .1 | .4 | 240 | 23 | -- | -- | -- | -- |
| 502 | City of Tyler well 4 | 1,042 | 8-26-54 | TSDH | 16 | 2.6 | 23 | 8.0 | 44 | 92 | 48 | 43 | .2 | .4 | 225 | 91 | -- | -- | 7.5 | -- |
| 503 | City of Tyler well 3 | 1,057 | 8-26-54 | TSDH | 15 | .2 | 17 | 6.0 | 25 | 110 | 10 | 14 | .2 | .4 | 150 | 67 | -- | -- | 8.2 | -- |
| 701 | Otis Mingus | 913 | 4- 9-62 | USGS | 9 | .1 | 8 | 2.6 | 30 | 99 | 8 | 4 | .1 | .0 | 110 | 31 | 68 | 186 | 7.2 | -- |
| 801 | City of Tyler Sewage Plant | 715 | 10- 5-60 | TSDH | -- | .3 | 8 | 2 | 62 | 137 | 17 | 15 | .1 | -- | 195 | 30 | -- | 325 | 8.3 | -- |
| 47-401 | Texas Game & Fish Comm. | 864 | 3-16-60 | USGS | 12 | .3 | 3.1 | 1.3 | 58 | 151 | 11 | 3 | .0 | .0 | 163 | 13 | 91 | 256 | 7.9 | -- |
| 48-201 | City of Kilgore well 4 | 738 | 10- 7-52 | CL | 11 | .2 | 4.7 | 1.4 | 100 | 234 | 19 | 10 | -- | -- | 387 | 18 | -- | -- | 8.4 | -- |
| 202 | City of Kilgore well 3 | 534 | 9-25-52 | CL | 11 | 5.0 | 5.7 | 1.9 | 49 | 101 | 27 | 12 | -- | -- | 212 | 11 | -- | -- | 7.6 | -- |
| 301 | City of Kilgore well 1 | 760 | 9-25-52 | CL | 15 | .1 | 5.4 | 2.4 | 47 | 98 | 29 | 10 | -- | -- | 207 | 11 | -- | -- | -- | -- |
| 53-201 | Bert Pfaff | 992 | 4- 9-62 | USGS | 10 | .6 | 7.5 | 2.5 | 60 | 159 | 16 | 8 | .2 | .0 | 207 | 29 | 82 | 305 | 7.5 | -- |
| 54-201 | Roy White | 990 | 3-16-60 | USGS | 10 | .2 | 4.1 | 2.1 | 59 | 156 | 11 | 6 | .0 | .0 | 169 | 19 | 87 | 278 | 8.2 | -- |
| 55-101 | City of Whitehouse | 610 | 9-10-55 | CL | 20 | .1 | 2.9 | 1.0 | 85 | 207 | 12 | 9 | -- | -- | 337 | 12 | -- | -- | 8.3 | -- |
| 802 | Earl Towns | 200 | 4- 9-62 | USGS | 9 | .01 | .8 | .7 | 99 | 175 | 61 | 10 | .3 | .0 | 288 | 5 | 98 | 438 | 7.8 | -- |
| 903 | City of Troup | 1,100 | 10- -57 | CL | 14 | .4 | 12.1 | .3 | 374 | 747 | 30 | 130 | -- | -- | 1,307 | -- | -- | 1,535 | 8.5 | -- |
| 56-201 | City of Arp | 1,014 | 2- -50 | TSDH | -- | .3 | 3.0 | 2.0 | 131 | 256 | 65 | 11 | .7 | .9 | 338 | -- | -- | -- | 8.6 | -- |
| 202 | do | 1,240 | 9-26-60 | USGS | -- | .2 | 2 | -- | 264 | 498 | 15 | 78 | .2 | -- | 696 | 5 | -- | 1,160 | 8.5 | -- |
| 401 | American Petrofina | 1,035 | 6- 2-60 | CL | 22 | .7 | 4.1 | 1.1 | 771 | 586 | 52 | 820 | -- | -- | 1,997 | 15 | -- | 3,580 | 8.3 | 80 |
| 35-41-701 | City of Overton | 290 | 10- -59 | TSDH | -- | 2.7 | 6 | 3 | 28 | -- | 48 | 19 | .1 | .4 | 150 | 29 | -- | 250 | 6.2 | -- |
| Queen City aquifer | | | | | | | | | | | | | | | | | | | | |
| 34-29-701 | W. S. Ashcraft | 26 | 3-18-60 | USGS | 74 | 0.5 | 2.8 | 4.4 | 17 | 0 | 15 | 34 | 0.1 | 25 | 174 | 25 | 44 | 245 | 4.1 | -- |
| 901 | City of Lindale well 3 | 635 | 3-21-52 | CL | 9.3 | 2.7 | 15.6 | 4.5 | 21 | 91 | 20 | 6 | -- | -- | 172 | 58 | -- | -- | -- | -- |

See footnote at end of table.

Table 2.--Chemical analyses of water from selected wells and springs--Continued

| Well | Owner | Depth of well (ft.) | Date of collection | Analyst[1] | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium and potassium (Na + K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Dissolved solids | Total hardness as $CaCO_3$ | Percent sodium | Specific conductance (micromhos at 25°C) | pH | Temperature (°F) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34-31-905 | H. L. Hunt | 277 | 4- 6-62 | USGS | 30 | 6.7 | 14 | 6.6 | 18 | 64 | 31 | 12 | 0.1 | .0 | 143 | 62 | 39 | 208 | 6.2 | -- |
| 37-102 | S. W. Bradford | 340 | 4- 5-62 | USGS | 26 | 23 | 4 | 2.2 | 11 | 23 | 11 | 10 | .0 | .0 | 75 | 19 | 39 | 102 | 5.6 | -- |
| 38-907 | Pine Springs School | 225 | 4- 6-62 | USGS | 22 | 2.6 | 2.8 | 1.6 | 8 | 16 | 6.4 | 4.5 | .1 | .0 | 53 | 14 | 22 | 68 | 5.2 | -- |
| 45-502 | George Tidmore | 200 | 4- 6-62 | USGS | 37 | 3.2 | 8.8 | 2.1 | 14 | 58 | 6.2 | 5.0 | .1 | .0 | 102 | 31 | 50 | 124 | 6.1 | -- |
| 46-106 | Breedlove Nurseries | 207 | 4- 6-62 | USGS | 19 | 3.1 | 3.2 | 1.6 | 8 | 9 | 4.2 | 13 | .0 | .0 | 53 | -- | 15 | 72 | 4.9 | 68 |
| 302 | Texas Eastman | 633 | 1-24-60 | CL | 27 | 5.5 | 8.2 | 3.5 | 18 | 49 | .4 | 24 | -- | -- | 139 | -- | -- | 163 | 5.7 | 79 |
| 804 | G. R. Rieck | 440 | 4- 6-62 | USGS | 13 | 1.1 | 18 | 5.9 | 21 | 104 | 20 | 6.2 | .1 | .8 | 136 | 69 | 40 | 219 | 6.9 | -- |
| 47-301 | Jackson School Chapel Hill Dist. | 145 | 4- 6-62 | USGS | 30 | 71 | 23 | 20 | 26 | 0 | 154 | 52 | .0 | .8 | 308 | 140 | 20 | 660 | 3.0 | -- |
| 502 | Chapel Hill School | 245 | 4- 9-62 | USGS | 48 | 8.4 | 5.5 | 5.3 | 15 | 4 | 36 | 19 | .1 | .0 | 131 | 36 | 48 | 163 | 4.6 | -- |
| 54-501 | Stanton School Whitehouse Dist. | 300 | 4- 6-62 | USGS | 30 | 2.5 | 20 | 9.6 | 19 | 35 | 75 | 17 | .1 | .0 | 191 | 89 | 32 | 278 | 5.7 | -- |
| | | | | | | | | | **Sparta aquifer** | | | | | | | | | | | |
| 34-37-301 | Prairie Creek Baptist Church | 70 | 4- 4-62 | USGS | 10 | 3.0 | 4.8 | 3.5 | 8.4 | 4 | 14 | 17 | 0.0 | 1.2 | 61 | 26 | 34 | 106 | 5.0 | -- |
| 38-101 | Texas A & M Experiment Sta. | 43 | 3-16-60 | USGS | 45 | .4 | 1.0 | 1.9 | 7.1 | 0 | 15 | 5.5 | .1 | 4.3 | 81 | 10 | 34 | 84 | 3.7 | -- |
| 501 | D. L. Baxter | 120 | 4- 6-62 | USGS | 17 | .5 | 2.5 | 1.0 | 4.9 | 6 | .4 | 3.8 | .0 | 16 | 49 | 10 | 39 | 54 | 5.0 | -- |
| 904 | J. R. Bratton | 99 | 4- 6-62 | USGS | 12 | .3 | 1.8 | .6 | 3.1 | 8 | .6 | 2.2 | .0 | 3.5 | 28 | 7 | 39 | 32 | 5.2 | -- |
| 908 | Larison Nurseries | 108 | 4- 6-62 | USGS | 28 | 6.5 | 3.0 | 2.3 | 7.6 | 2 | .8 | 5.8 | .0 | 27 | 76 | 17 | 44 | 87 | 4.8 | -- |
| 909 | Fred's Nursery | 112 | 4- 6-62 | USGS | 11 | .3 | 12.0 | 1.1 | 4.0 | 41 | 4.8 | 3.0 | .0 | 7.6 | 64 | 34 | 11 | 105 | 6.1 | -- |
| 45-901 | James Lockhart | 82 | 4- 4-62 | USGS | 31 | 1.0 | 34 | .9 | 9.5 | 109 | 5.2 | 5.5 | .0 | 4.8 | 145 | 89 | 16 | 218 | 6.1 | -- |
| 46-102 | Mrs. W. M. Gaar | 75 | 4- 4-62 | USGS | 18 | 10 | 2.8 | 1.3 | 6.2 | 14 | 5.0 | 6.5 | .0 | .0 | 47 | 12 | 45 | 65 | 5.2 | -- |
| 205 | Richardson Co. | 220 | 3-25-45 | CL | 11 | .5 | 4.0 | 2.4 | 21.2 | 18 | 6.7 | 28 | -- | -- | 94 | 20 | -- | -- | 6.1 | 68 |
| 401 | Morris Dorbant | 92 | 4- 6-62 | USGS | 16 | .1 | 28 | 1.7 | 23 | 83 | 36 | 7.0 | .0 | 15 | 168 | 77 | 40 | 200 | 6.6 | -- |
| 53-301 | W. G. McKay | 279 | 4-16-60 | USGS | 24 | 65 | 17.0 | 12.0 | 20 | 0 | 111.0 | 20 | .0 | .0 | 205 | 92 | 30 | 345 | 3.8 | -- |
| 54-701 | City of Bullard | Spring | 5- -49 | TSDH | -- | .3 | 10.0 | 2.0 | 10 | -- | 6 | 18 | .1 | 9.0 | 86 | 33 | -- | -- | 6.5 | -- |

[1] Analyst: CL, Curtis Laboratories; TSDH, Texas State Department of Health; USGS, Unites States Geological Survey.

Table 3.--Location of oil tests selected as data-control points

| Well | Operator | Lease and well | Survey | Date of electric log |
|---|---|---|---|---|
| 34-20-702 | W. J. Weaver | Landers #1 | A. Dickinson | 1-56 |
| 901 | L. A. Grelling | Pirtle #1 | W. Benson | -- |
| 28-503 | Meers & Thompson | Bartlett #1 | R. G. Stewart | 3-39 |
| 504 | J. N. Williams | Driver #1 | Peter Woods | 8-53 |
| 802 | Calto | Genecov #1 | Richard Howell | 11-51 |
| 803 | (Confidential) | -- | -- | -- |
| 29-402 | Ranchero Oil Co. | Perry #1 | M. V. Lout | 7-53 |
| 602 | J. E. Fleming | Lyons #1 | Middletown | 8-51 |
| 603 | Peyton McKnight | Balfour #1 | Wm. Gatlin | 1-58 |
| * 801 | Magnolia Pet. Co. | King #1 | J. H. Sanders | 1-52 |
| 802 | J. E. Fleming | Yarbrough #1 | Thos. Burbridge | 9-53 |
| 803 | Trans-Texas Oil Co. | Gaston #1 | J. Splawn | 6-52 |
| 30-201 | Ryan Consolidated | Wright #1 | Jose Garcia | 1-42 |
| 403 | Ryan Consolidated | Wright #2 | Jose Garcia | 2-51 |
| 404 | Trant Drilling Co. | Crews #1 | J. Sims | -- |
| 405 | Georesearch | Leach #1 | Jos. Burgun | 9-56 |
| 502 | Sohio Oil Co. | Wright #1 | Jose Garcia | 12-43 |
| 503 | John G. Voight | Wright #1 | Jose Garcia | 9-58 |
| 702 | Clark Exploration | Mims #1 | W. Moore | 12-58 |
| 802 | W. F. Nenney | Braziel #1 | Thos. Rives | 4-48 |
| * 902 | Humble Oil & Rfg. Co. | E. Winters #1 | Wm. Price | 5-48 |
| 903 | E. A. Ellison | Mullins #1 | Maria Estrada | 4-59 |
| 904 | Humble Oil & Rfg. Co. | Coulter #1 | M. G. Estrada | 2-51 |
| 905 | Humble Oil & Rfg. Co. | Red Springs Gas #3 | S. M. Grace | 7-50 |
| 906 | Humble Oil & Rfg. Co. | Forston #1 | Wm. Price | 8-49 |
| * 31-501 | F. R. Jackson | Henry, et al #1 | -- | -- |
| 703 | Humble Oil & Rfg. Co. | Chambers #2 | G. W. Welsh | -- |
| 704 | Delta Drlg. Co. | Baker #1 | M. Draper | 7-53 |
| 32-801 | Phillips | Starnes #1 | Samuel Epps | 1-43 |
| * 901 | Coats Drlg. Co. | Berryhill #1 | Samuel Epps | 7-55 |
| 36-304 | Fair Oil Co. | Clark #1 | Jacob Lewis | 3-39 |
| 602 | Humble Oil & Rfg. Co. | Beasley #1 | L. Watson | 1-48 |
| 603 | Humble Oil & Rfg. Co. | Williams #1 | Marshall Univ. | 7-47 |
| 37-103 | E. L. Howard | Waters #1 | J. Splawn | 12-52 |
| 302 | Gulf Oil Co. | Moore #1 | J. H. Saunder | 8-56 |
| 402 | McMurrey Rfg. | Becker #1 | M. Culberson | 6-41 |
| 403 | Humble Oil & Rfg. Co. | Gory #1 | J. J. Smith | 4-47 |
| * 404 | A. M. Rowan | Staples #1 | K. H. Latham | 8-59 |
| 801 | Happy Gist | Smith #1 | L. Jones | 7-57 |
| 38-303 | Humble Oil & Rfg. Co. | Matthews #1 | M. G. Estrada | 4-52 |
| 304 | Humble Oil & Rfg. Co. | Goyen #1 | S. Leeper | 2-46 |
| 305 | Humble Oil & Rfg. Co. | Dugger #1 | M. G. Estrada | -- |
| 306 | Humble Oil & Rfg. Co. | Griffen #1 | S. Smith | 10-45 |
| 307 | Humble Oil & Rfg. Co. | Kidd #1 | J. L. Underwood | 10-47 |
| 308 | Pure Oil Co. | Christian #1 | Wm. Keys | 12-46 |
| 309 | Humble Oil & Rfg. Co. | Harris #1 | Felix Flores | 7-46 |
| 310 | Skelly Oil Co. | Chisum #26 | D. Minor | 11-57 |
| 502 | Sun Oil Co. | Pierce #1 | John Kirkley | 6-55 |
| * 503 | Sun Oil Co. | River #1 | John Kirkley | 9-55 |
| 504 | Atlantic Rfg. Co. | Burger #1 | A. J. Leverly | 8-56 |

See footnote at end of table.

Table 3.--Location of oil tests selected as data-control points--Continued

| Well | Operator | Lease and well | Survey | Date of electric log |
|---|---|---|---|---|
| 34-38-505 | Sun Oil Co. | Vanhavengerg #1 | J. Burt | 6-56 |
| 506 | Lyons & Logan | Frazier #1 | John Lane | 11-57 |
| * 507 | Iowa-Payne | Spring Lake Club #1 | John Lane | 6-41 |
| 508 | Carco Drlg. Co. | McClung #1 | I. Strong | -- |
| 509 | Drilling & Explor. | Lemon #3 | G. S. Null | -- |
| 603 | (Unknown) | -- | -- | -- |
| 604 | Humble Oil & Rfg. Co. | Shamburger #1 | T. Hawkins | 3-44 |
| * 605 | Lyons & Logan | Holloway #1 | M. H. White | 7-57 |
| 702 | Wm. Hamm | House #1 | H. George | 12-49 |
| 802 | Mitchell & Jackson | Harrell #1 | Thos. Burbridge | 11-58 |
| 803 | Vernon Whiteley | Hefler #1 | H. George | 4-53 |
| 804 | Delta Drlg. Co. | Duffield #1 | F. Bodenhammer | 1-58 |
| 39-101 | Roosth & Genecov | Handy #1 | T. F. Burnett | 2-59 |
| * 202 | H. M. Ogg, et al | McClung #1 | Nancy Sumpter | 3-42 |
| 401 | L. A. Grelling | Kirby #1 | W. Oliphant | 12-57 |
| 402 | Humble Oil & Rfg. Co. | Atwood #1 | J. W. Parchman | 1-54 |
| 403 | L. A. Grelling | Atwood #1 | J. W. Parchman | 2-55 |
| 701 | Warren Pet. Co. | Warren #1 | C. C. Alexander | 1-53 |
| * 40-602 | Humble Oil & Rfg. Co. | Timms #1 | G. W. Slaughter | 6-53 |
| 704 | (Confidential) | -- | -- | -- |
| 705 | Coulston Drlg. Co. | Butler #1-A | W. W. Hanks | 7-52 |
| 706 | (Confidential) | -- | -- | -- |
| * 707 | Coulston Drlg. Co. | Thompson #1 | W. W. Hanks | 9-57 |
| 708 | Sun Oil & Shell Oil | Moseley #1 | Levi Hinds | 9-40 |
| * 901 | Humble Oil & Rfg. Co. | Merritt #1 | G. W. Slaughter | 5-54 |
| 45-201 | D. A. Feldman | Verner #A-1 | B. Kuykendall | 11-54 |
| 202 | Grelling & Byars | Verner #1 | B. Kuykendall | 6-53 |
| 203 | Carter-Jones | Hanjeain #1 | John Dean | 1-55 |
| 303 | Wisconsin Iron | Vaughn #1 | Geo. Myers | 1-52 |
| * 503 | Humble Oil & Rfg. Co. | Humble #1 | Geo. Pettigrew | 12-55 |
| 504 | Delta Drlg. Co. | Boren #1 | N. M. Newsome | 2-50 |
| 505 | Halbert & Casey | Venable #1 | E. D. Holland | 11-58 |
| 604 | Carter & Kaemmerer | Morris #1 | Marg. Brown | 12-57 |
| * 802 | Iowa-Payne | Murray #1 | T. Quevado | 1-43 |
| 46-305 | M. Herring | Florence #1 | P. Chiring | 12-58 |
| 507 | Humble Oil & Rfg. Co. | Tyler Oil Unit #2 Well #1 | O. Anderson | 1-53 |
| 508 | Phillips Pet. Co. | Goss #1 | O. Anderson | 12-52 |
| 509 | Humble Oil & Rfg. Co. | Sherlock #2 | O. Anderson | -- |
| 510 | Bobby Manziel | Owens #1 | R. Fletcher | 3-51 |
| 601 | Delta Drlg. Co. | Ramey #1 | R. Fletcher | 6-50 |
| 704 | Phillips Pet. Co. | Grelling #1 | T. Price | 3-45 |
| 805 | Delta Drlg. Co. | Walker #1 | R. Fletcher | 7-50 |
| 806 | Phillips Pet. Co. | Harriston #1 | John Hope | 3-45 |
| 807 | Phillips Pet. Co. | Vannie #1 | M. M. Long | 4-46 |
| 47-204 | Grier & Jackson | Dala #1 | I. Rainflow | -- |
| * 503 | Georesearch, Inc. | Moore #1 | J. M. Hall | 11-56 |
| 703 | Zepher Oil Co. | Bergfeld #1 | R. McGill | 6-52 |
| 801 | Atlantic Rfg. Co. | Baley #1 | Wade Love | 5-54 |
| 802 | J. E. Fleming | Neill #1 | David Love | 1-58 |

See footnote at end of table.

Table 3.--Location of oil tests selected as data-control points--Continued

| Well | Operator | Lease and well | Survey | Date of electric log |
|---|---|---|---|---|
| 34-47-901 | Sinclair Oil Co. | Connally #2 | J. Herrin | 12-55 |
| 48-101 | Sun Oil Co. | Everhart #1 | P. Lively | 6-40 |
| 102 | Hunt Oil Co. | Bradley #1 | T. P. Payne | 5-38 |
| 302 | Evans Prod. Corp. | Knowles #1 | A. J. Stevens | 5-56 |
| 402 | Sinclair Oil Co. | Shofner #1 | W. Dickerson | 12-44 |
| 403 | Sun Oil Co. | Huddle #1 | W. Dickerson | 3-40 |
| 404 | Farrar & Wilson | Rayford #1 | L. H. Dillard | 6-57 |
| 504 | Phillips Pet. Co. | Bean #1 | J. E. Bean | -- |
| 601 | Watburn Oil Co. | Scape #1 | H. C. Cook | 2-57 |
| 602 | Gibson Drlg. Co. | Wilson #1 | B. Brown | 2-58 |
| * 603 | Continental Oil Co. | Mayfield Co. #1 | S. L. B. Jasper | 7-54 |
| 801 | Evans Prod. Corp. | Mills #1 | John Pate | 2-56 |
| 901 | Grelling & Oldham | Pope #1 | T. Woozie | 9-55 |
| 902 | Grelling Est. | Bell #1 | S. McAnulty | 2-58 |
| * 903 | K. Hughes | Chambers #1 | John Mason | 8-59 |
| 53-101 | R. L. Peveto | Friedlander #1 | J. Smith | 10-55 |
| * 501 | Voight & McKnight | Hudnall #1 | W. Ferguson | 1-59 |
| 601 | Gist & Johnson | Watson #1 | E. J. DeBard | 8-57 |
| 602 | Johnson Drlg. Co. | Gayle #1 | P. E. Bean | 2-58 |
| * 603 | Purnell & Coleman | Neeley #1 | E. J. DeBard | 12-59 |
| 701 | Humble Oil & Rfg. Co. | Wendlant #1 | J. M. Acosta | 2-59 |
| * 802 | John G. Voight | Alexander #1 | P. E. Bean | 6-60 |
| 902 | Gist & Johnson | Vaughn #1 | D. Page | 1-58 |
| 54-102 | Phillips Pet. Co. | England #1 | D. T. Queveda | 12-45 |
| 103 | M. Herring | Morgan #1 | V. Tejeda | 7-58 |
| 202 | Talbert & Gulley | Simpson #1 | J. Kennedy | 5-57 |
| 203 | J. G. Voight | Burns #1 | F. Williams | 11-58 |
| 204 | J. G. Voight | Burns #2 | F. Williams | 1-59 |
| 205 | Herring Drlg. Co. | Beddingfield #1 | V. Tejeda | 2-56 |
| * 304 | Halbert & Casey | Skidmore #1 | D. Smith | 3-58 |
| 403 | Humble Oil & Rfg. Co. | Sackett #1 | V. Tejeda | 8-48 |
| 404 | Purnell & Coleman | Epsy #1 | D. Page | 9-58 |
| 902 | Halbert & Casey | Ray #1 | J. Mast | 9-58 |
| 903 | Pruett & Pope | Cawthorn #1 | J. Mast | 6-41 |
| 55-102 | Whiteley Drlg. Co. | Edwards #1 | E. Brown | 5-55 |
| 202 | Whiteley Drlg. Co. | City of Tyler #1 | M. Maise | 6-54 |
| 302 | L. A. Grelling | Bullock #1 | W. Miller | -- |
| 404 | W. C. Perryman | Chesley #1 | W. Saunders | 2-59 |
| 405 | U. S. Smelting | Johnson #1 | E. Gandy | 9-55 |
| 406 | Jerry McCutchin | Agnew #1 | E. Gandy | 1-57 |
| 502 | L. A. Grelling | Starr #1 | W. L. McKinley | 5-52 |
| 503 | L. A. Grelling | Hammonds #1 | S. Brimberry | 6-52 |
| 602 | Grelling & Am. Liberty | Bledsoe #1 | W. Miller | 2-54 |
| 803 | T. M. Evans | Towns #1 | Jacob Lewis | 12-55 |
| 804 | Watburn Oil Co. | Towns Est. #1 | Jacob Lewis | 6-55 |
| 805 | D. E. Proctor | Warren #1 | Jacob Lewis | 1-56 |
| 904 | L. A. Grelling | Moore #1 | W. Miller | 11-54 |
| 905 | Sam Sklar | Wilson #1 | W. Miller | 1-58 |
| 906 | Dorfman Prod. Co. | McRae #1 | W. George | 4-59 |
| 907 | D. E. Proctor | Stovall #1 | W. George | 8-55 |

See footnote at end of table.

Table 3.--Location of oil tests selected as data-control points--Continued

| Well | Operator | Lease and well | Survey | Date of electric log |
|---|---|---|---|---|
| 34-55-908 | D. E. Proctor | Martin #1 | W. George | 10-55 |
| 909 | L. A. Grelling | Hitt #1 | W. Miller | 1-55 |
| 910 | W. H. Bryant | Larson #1 | J. Miller | 7-57 |
| 56-102 | E. E. Stephens | Cook #1 | J. A. Caro | 2-56 |
| 103 | Grelling & Am. Liberty | Wilson #1 | W. A. Parmer | 8-55 |
| 104 | Johnson & Graham | Wilson #1 | B. Lafferty | 5-56 |
| 105 | Lewis | Frazier #1 | S. L. Dupree | 10-50 |
| 204 | H. R. Stroube | P. M. Wilson #1 | J. Jordan | 10-56 |
| 205 | P & A Oil Co. | Hodges #1 | J. Jordan | 9-56 |
| 206 | Grelling & Am. Liberty | Wolf #2 | M. G. Henriquez | -- |
| * 303 | Gulf Oil Corp. | Trimble #2 | W. G. Belcher | 4-44 |
| 404 | Trant Drlg. Co. | Arnold #2 | B. Lafferty | 10-55 |
| 405 | L. A. Grelling | Forks #1 | B. Lafferty | 11-53 |
| 406 | L. A. Grelling | Pinkston #1 | B. Lafferty | 11-52 |
| 407 | W. H. Bryant | Moore #1 | J. Miller | 10-58 |
| 408 | Wilson Exploration | Douglas #1 | J. Miller | 7-54 |
| 503 | Woolf & McGee | Arnold #1 | M. G. Henriquez | 11-56 |
| 601 | Fair & Proctor | Ray #1 | M. G. Henriquez | 3-55 |
| 602 | Sun Oil Co. | Pace #39-B | Juan Vargas | 1-54 |
| 701 | W. H. Byrant | Peyton #1 | J. Miller | 10-58 |
| 35-33-401 | Humble Oil & Rfg. Co. | Gary #1 | G. W. Slaughter | 11-53 |

*Log in files of Texas Water Commission.

## Table 4.--Summary of pumping tests on selected wells

All tests were conducted by or evaluated by the Texas Water Commission unless otherwise noted.

| Well | Coefficient of transmissibility (gpd/ft.) | Average coefficient of storage | Remarks |
|---|---|---|---|
| | **Carrizo-Wilcox aquifer** | | |
| 34-37-303 | 10,900 | -- | Screened in Wilcox only. |
| 38-302 | 5,070 | -- | Screened in Wilcox only. |
| 39-501 thru 505 | 16,500 | -- | Tests by USGS. |
| 45-605 | 9,630 | -- | Screened in Wilcox only. |
| 46-101 | 22,675 | -- | -- |
| 201 | 16,240 | 1.06X10$^{-4}$ | Tests by W. L. Broadhurst, USGS, 1944. |
| 203 | 17,950 | | |
| 301 | 19,350 | | |
| 502 | 15,880 | | |
| 503 | 15,750 | | |
| 48-201, 202, 301, and 501 thru 503 | 19,000 to 38,000 | 2.1X10$^{-4}$ | Tests by W. F. Guyton & Associates, Austin. |
| 56-401 | 6,100 | -- | Screened in Wilcox only. |
| 35-41-701 | 19,700 | -- | -- |
| | **Queen City aquifer** | | |
| 34-29-901 | 3,260 | -- | -- |
| 46-302 | 3,020 | -- | -- |
| | **Sparta aquifer** | | |
| 34-46-204 | 12,900 | 1.60X10$^{-4}$ | -- |

# APPENDIX B

# SUPPLEMENTARY DISCUSSIONS OF GEOLOGY AND HYDROLOGY

Geology of Smith County
General Ground-Water Hydrology
Definitions

# GEOLOGY OF SMITH COUNTY

## Geologic History

The oldest geologic formation which has been penetrated by wells in Smith County is of Jurassic age, the middle period of the Mesozoic Era. Formations of the Jurassic Period are composed of sand, shale, limestone, and salt deposited under marine conditions. As the Jurassic Period came to a close the sea retreated and left a land mass subject to erosion. The sea then began advancing northward and brought about the beginning of the Cretaceous period, the last period of the Mesozoic. This period was characterized by the deposition of typical near-shore sand, marine shale, limestone, and anhydrite. More than 8,000 feet of sediment was deposited in the Smith County area during this period, after which the sea once again retreated. Then, following a period of uplift and erosion, the sea advanced northward and ushered in the Cenozoic Era. This era was characterized by fluctuations of the shoreline, and by alternation in East Texas between deposition by the sea and by heavily loaded streams emptying into it. The first period of deposition during the Cenozoic known in Texas, the Eocene Epoch, is of primary importance in Smith County. Deposition in Eocene time took place during alternating marine and continental environments as a result of repeated transgression and regression of the sea. Marine sediments consisting mainly of clay, shale, and minor amounts of sand were laid down at this time, alternating with continental and near-shore deposits consisting of sand and lesser amounts of clay, shale, and lignite.

## Stratigraphy

This report is concerned with the ground water of Smith County, and the detailed geologic discussion will be limited to those geologic formations which bear or transmit fresh water in the County and to those adjacent relatively impermeable formations which influence the occurrence of ground water. No fresh water is known to occur below the Eocene formations in Smith County; therefore, this discussion will begin with the oldest Eocene rocks, the Midway Group, and work progressively upward to the youngest Eocene bed in the County. Plate 3 shows the typical electrical features, lithology, and thickness of each of these rock units.

### Midway Group

The Midway Group is composed of marine-deposited shale, clay, and silt and unconformably overlies the Cretaceous beds. This group is relatively impermeable and does not contain or transmit usable amounts of fresh water.

## Wilcox Group

The Wilcox Group crops out in the counties adjoining Smith County to the east and west. In lithology, the Wilcox is variable but for the most part is a white to gray, medium to fine grained, loose to poorly cemented quartz sand. Interfingering with the sand are lenses of gray to brown, silty shale and clay. Lignite in stringers ranging in thickness from less than one foot to 10 feet is common, particularly in the upper part of the formation. Interfingering of sand, shale, and lignite makes tracing or correlating a sand section over any appreciable distance very difficult. The Wilcox ranges in thickness in the County from 755 feet to more than 1,320 feet. Of this total thickness, approximately 42 percent is sand. Plate 8 illustrates the thickness of the Wilcox and the percentage of sand at various points in the County.

Lying conformably over the Midway shale, the Wilcox is predominantly a continental near-shore deposit. The lignite and shale indicate swampy and lagoonal conditions of deposition.

## Carrizo Formation

Unconformably overlying the Wilcox Group, the Carrizo Formation is the oldest outcropping formation in the County except for two Cretaceous blocks that have been thrust to the surface by salt movement. Plate 2 shows the extent of formations that outcrop in Smith County. The Carrizo is found at the surface as thin narrow bands in the northwestern and southeastern parts of the County where it forms a very loose, deep, sandy soil. This sandy soil does not support a dense vegetation but is suitable for roses and coastal bermuda. Lithologitally, the Carrizo is a uniform white to gray, fine to medium grained, clean, very porous, loose quartz sand that grades upward to a more silty sand at the top. Ranging in thickness from 40 feet to 225 feet, the Carrizo averages and maintains for the most part a uniform thickness of about 100 feet in Smith County. Plate 10 illustrates the thickness of the formation and the percentage of sand. On an average, 95 percent of the Carrizo is sand, although Plate 10 illustrates that this percentage decreases locally indicating the occurrence of silt and shale in the formation.

DepositionaL environment of the Carrizo Formation was continental. The relatively homogenous sediments of the Carrizo probably were deposited by heavily loaded streams in near-shore areas.

## Reklaw Formation

The Reklaw Formation unconformably overlies the Carrizo and crops out in the northwestern and southeastern parts of the County. On weathering in the outcrop, the glauconitic sands of the Reklaw become hard indurated sandstones which form small prominent bluffs, since they are more resistant to erosion than adjacent rocks. However, for the most part a rich fertile soil is derived from the formation and it supports a dense growth of timber and grass. The Reklaw has two members, the lower, Newby Sand Member and the upper, Marquez Shale Member. The Newby Sand Member is a coherent, gray to green, poorly bedded, fine to very fine-grained, glauconitic sandstone ranging in thickness from 5 to 40 feet, and is an important marker bed in the drilling of water wells in the area.

The Marquez shale Member is a soft, black to chocolate-brown, silty, carbonaceous shale with a thickness of 50 to 80 feet. Total thickness of the Reklaw ranges from 55 to 100 feet but averages 70 feet in the County. In the southern part of the County small fragments of mollusk shells may be found in drill cuttings of the Reklaw and in the outcrop of the formation.

After deposition of the Carrizo came to a close, the sea advanced northward from the Gulf. The Carrizo, which had been exposed to erosion for a period of time, was covered by the sea which advanced over the Smith County area. The Reklaw was deposited in a shallow-water, brackish, marine environment produced by this transgression of the sea, Later the sea again retreated and the Queen City Formation was deposited conformably over the Reklaw.

## Queen City Formation

The Queen City Formation crops out in more than 75 percent of the County. Loose, sandy soils with hilly topography are typical of the outcrop of the formation except where the shale beds of the formation crop out; the latter areas are covered with fairly fertile and level soils.

In Smith County, the Queen City Formation is subdivided into the basal Arp Member, middle Omen Member, and an upper unnamed member. It is not always possible to distinguish these members from one another, especially in drill cuttings and electric logs. The basal Arp Member of the Queen City Formation is a loose, gray to brown, porous, medium to fine-grained, silty to shaly, quartz sand with an average thickness of 40 feet. Overlying this section is the Omen Member which is a soft, coherent, dark, olive-green, glauconitic sandstone averaging 30 feet in thickness. The upper unnamed member is predominantly a soft, massive, cross-bedded, fine-grained, muscovitic quartz sand with interfingering beds of soft, dark brown, sandy shale; hard, concretionary, ferruginous sandstone layers; and brown to black lignite stringers. The members of the Queen City can best be seen in the southeastern corner of the County; however, they are difficult to distinguish as separate units farther north in the County. The thickness of the Queen City ranges from 0 to more than 700 feet, of which an average 55 percent is sand (Plate 12). The thickness varies considerably in the outcrop because of variations in topography.

A near-shore continental environment, such as lagoons and swamps, controlled deposition of the Queen City Formation. At one time the sea may have advanced into the area, resulting in the marine, brackish-water deposition of the Omen Member. However, the sea quickly retreated. The upper section of the Queen City was exposed to erosion before the sea once again advanced. Thus the Weches Formation overlies the Queen City unconformably.

## Weches Formation

The Weches Formation crops out as a thin belt and as outliers in the County. Highly resistant to erosion, the formation forms small cuestas or escarpments that can be easily seen. Weathering of the formation results in a rich, fertile but rocky soil which supports heavy growths of grass and pine trees. The Weches Formation varies in lithology in short distances but consists predominantly of black to brown massive shale in the lower parts and has a layer of green to brown, hard, glauconitic sandstone at the top. The top glauconitic layer may range in thickness from a few feet to 10 feet. Average thickness for the Weches Formation in the County is 70 feet.

This formation was deposited in a brackish marine environment, following which the sea once again retreated and the Sparta Formation was deposited unconformably over the Weches.

### Sparta Formation

The Sparta Formation crops out in more than 20 percent of the County, forming a very loose, deep, white sandy soil. Lithologically, the Sparta Formation is a mottled reddish-gray to white, loose, coarse to fine-grained quartz sand with interfingering layers of blue and gray shale. It ranges in thickness from 0 at its basal outcrop to 280 feet at Tyler where a complete section is believed to be present. Plate 14 illustrates the approximate thickness of the Sparta and its percentages of sand, which averages 70 percent.

The Sparta was deposited under continental, near-shore conditions which resulted in a relatively continuous sand section.

### Tyler Greensand

The Tyler greensand crops out in the city of Tyler and reportedly in the Noonday area of the southwest part of the County. This unit has been mapped by Wright and others (A. C. Wright, personal communication, 1960) but not for publication, and it does not, therefore, appear on the geologic map, Plate 2, or on the typical log, Plate 3. Lithologically the Tyler greensand is a highly glauconitic sandstone which oxidizes to a reddish brown or rusty color. Its maximum thickness is believed to be 60 feet. The Tyler greensand has been correlated with the Cook Mountain Formation found in Houston County and surrounding counties. There is a possible unconformity between the Tyler greensand, deposited in a brackish marine environment, and the underlying Sparta Formation.

## Structure

Regional structural features affecting deposition of sediments are significant in the study of the occurrence of ground water in the Smith County area. These regional features shown on Figure B1 largely determine the areas of recharge and direction of ground-water movement and affect the quality of ground water found in different parts of the County.

Smith County lies in the Gulf of Mexico basin which is the structural and depositional province that borders the continent on the south. The Coastal Plain is that part of this basin which is exposed on the surface and is not covered by the waters of the Gulf. The outcrop of the Cretaceous formations, usually in thin or narrow belts parallel with the present shoreline, form the inland boundary of the Coastal Plain.

The emerged portion of the basin is marked by two sets of structural and depositional features. One set is perpendicular to the present coast line and

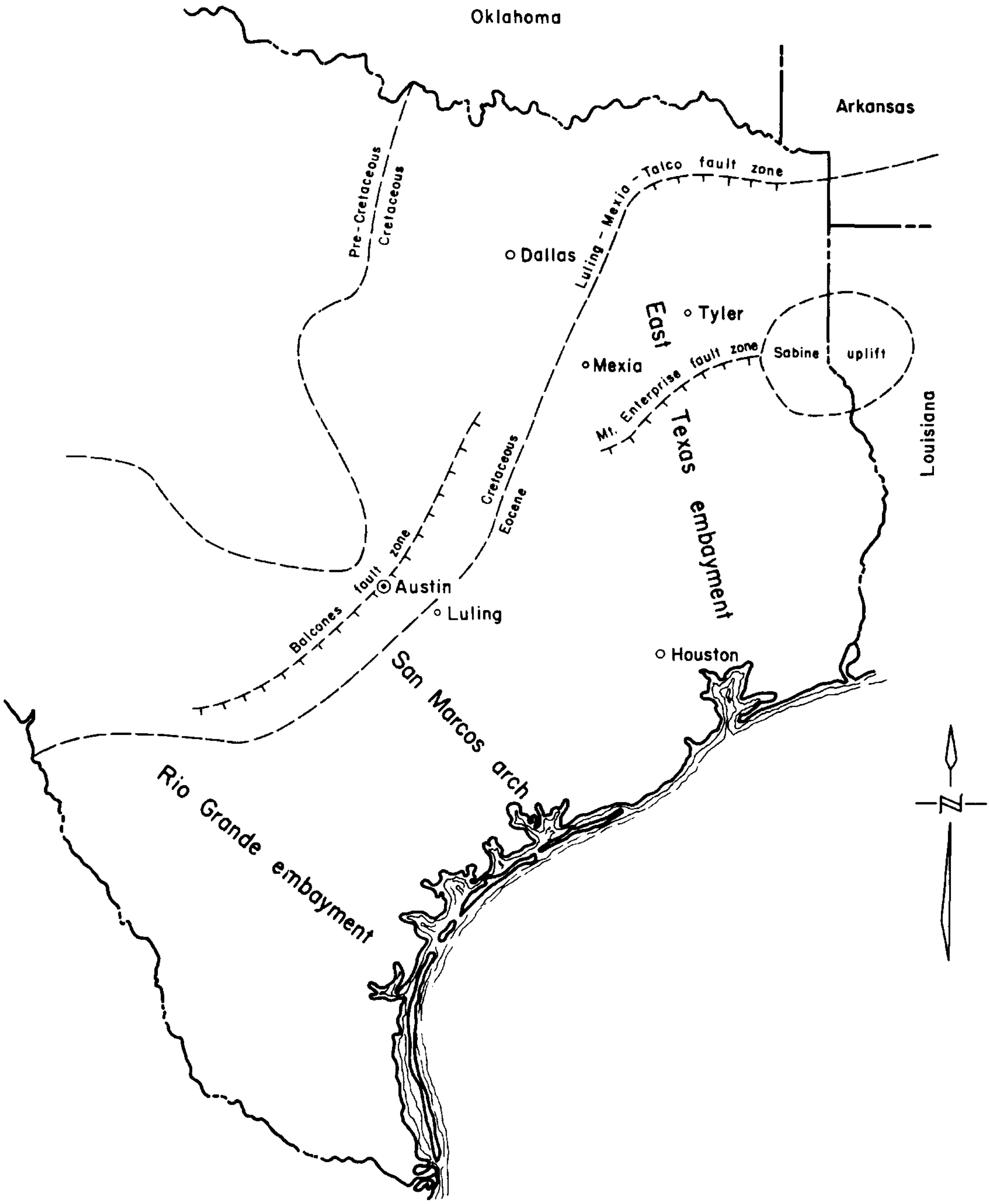


Figure B1

Regional Geologic Structure of Eastern Texas

Texas Water Commission in cooperation with the
Tyler Chamber of Commerce

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the other parallel. Figure B1 illustrates these features on the Coastal Plain. Three embayments, the Rio Grande, East Texas, and larger Mississippi, are perpendicular to the coast. Separating the Rio Grande and East Texas embayment is the San Marcos arch, and separating the East Texas and Mississippi embayment is the Sabine uplift. The major fault systems are parallel with the present coastline. One fault system, a combination of the Luling-Mexia-Talco fault zone and the Balcones fault zone, essentially tracks the Eocene-Cretaceous contact and forms the inland boundary of the Coastal Plain. A second fault system, the Mt. Enterprise, divides the inner and shoreward areas of the Coastal Plain. This fault system extends through Rusk, Cherokee, Anderson, and Leon Counties.

The East Texas embayment has distinct northern and southern subdivisions. That part to the north between the Talco fault system and the Mt. Enterprise fault system is known as the Tyler basin. South of the Mt. Enterprise fault system to the coast is the Coastal basin of the East Texas embayment. The Tyler basin, in the center of which lie the city of Tyler and Smith County, is bounded on the west and north by the Eocene-Cretaceous contact and Mexia-Talco fault zone, in the east by the Sabine uplift, and in the south by the Mt. Enterprise fault system. Regionally in the Gulf of Mexico basin, Cretaceous and Tertiary beds dip south and southeast toward the Gulf. This regional dip has been altered by local structure in the Tyler basin.

During Jurassic time massive salt layers were deposited, which if in their original position today would be at a depth of approximately 15,000 feet or more. However, rock salt under pressure deforms easily and flows from the places of greater pressure to places of lesser pressure. Hence as time passed this salt began to flow in response to differential pressures resulting in part from weight of overlying sediments. In some of these areas the salt began to move upward, pushing, piercing, and doming the rocks overlying the salt. Areas from which the salt moved became structural lows, and areas to which the salt moved became domes and elongated ridges. This movement was not confined to any particular time or geologic period, but began in Jurassic time when the salt was deposited and is probably continuing today. This movement of salt and the formation of structural lows, domes, and ridges has been a controlling factor for the geologic structure and deposition in Smith County throughout Cretaceous and Tertiary times. Structural contour maps drawn on Cretaceous formations and on Eocene formations reflect the same structural pattern in Smith County, although the reflection of this pattern on Eocene sediments is generally less pronounced. Plate 7, "Contour Map on the Base of the Wilcox Group, Smith County," shows the structural features of the County.

Plate 7 illustrates a pattern of circular and elongate structural highs and adjoining structural lows. These circular highs are salt domes, the controlling factor for the geologic structure of the County. There are six known salt domes in Smith County falling in a series of lines trending northeast-southwest. Beginning in the north part of the County east of Lindale is the Steen dome; southwest of the Steen dome on the Neches River is the Mt. Sylvan dome; at Tyler is the Tyler dome; in the southwest corner of the County is the Brooks dome; west of Whitehouse in the south part of the County is the Whitehouse dome; and south of the Whitehouse dome and northeast of Bullard is the Bullard dome.

The domes were created by flowing of salt to places of lesser pressure. Much of the salt which did not move into domes formed elongated ridges between the three series of domes, and the areas from which the salt moved became structural lows between the surrounding domes and ridges. The domes, ridges, and lows play an important part in ground-water occurrence and development in Smith County.

Structurally, the Wilcox Group has been affected by the salt domes more than the other Eocene units. The depth to the base of the Wilcox ranges from approximately 400 feet on top of the Steen dome to 2,300 feet in the structural low area north of the Brooks dome. Thickness of the Wilcox tends to increase in the structural lows because sediments collected preferentially in low areas during deposition (See Plate 8, "Isopach Map of the Wilcox Group, Smith County"). A slight increase in percentage of sand in the section is also noted in the lows.

The eastern part of the County is characterized by a gentle dip of the beds to the west with a few localized structures. This is the eastern flank of the Tyler basin as it extends upward toward the Sabine uplift to the east.

Three faults are shown on Plate 7. Many faults have resulted from the movement of the salt, but because of lack of subsurface data the traces of many of these faults could not be determined for the structure contour maps. The three faults shown on Plate 7 are believed to be the major ones in the County and those that would most affect the movement of ground water. These faults are post-Eocene in age, as they extend to the surface. Many other faults in the County are pre-Eocene and can be located only by subsurface methods. The faults probably are due to the forces exerted and the stresses that resulted from the upward movement of the domes.

Except for the eastern part of the County it is difficult to generalize the direction and rate of dip for the Wilcox beds. Around the domal structures as shown on Plate 7, the direction and rate of dip change rapidly. However, for the most part the rate of dip averages 100 feet per mile into the structural lows. In areas to the east the beds dip west at an average rate of 100 feet per mile.

The structural features of the Carrizo Formation are shown on Plate 9. It can be noted that the structure of the Carrizo Formation is similar to that of the Wilcox Group (Plates 7 and 9). In the eastern third of the County the structure of the formation is characterized by a large flat area. From this flat area, the Carrizo dips westward into the Tyler basin at a rate of about 100 feet per mile. In the northwest part of the County the Carrizo crops out on the western flank of the Tyler basin. Depth to the Carrizo ranges from 0 feet to 1,000 feet below the surface. Thickness of the Carrizo, shown on Plate 10, has been affected by structural conditions at the time of deposition. The thickness tends to increase in the structural lows surrounding the domes because the sediments collected preferentially in these lows during deposition. Increase in thickness and percentage of sand appear to be greater on the southeastern flanks of these lows. Also, thickness and sand percentages are generally greater on the broad flat area with its localized depressions in the eastern part of the County. It has been found that the Carrizo is thin, silty, and poorly developed on the ridges separating the structural lows, as well as on the domal areas. The thickness is also affected by the presence of two unconformities or buried surfaces of erosion. One of these unconformities underlies the Carrizo and is an irregular surface, having depressions and hills formed by erosion by wind and water over which the Carrizo was deposited. The other unconformity, also an irregularly shaped erosion surface, is at the top of the Carrizo and beneath the overlying Reklaw Formation. Although the deposition of the Carrizo was affected by structural and deposition events, the formation has a moderately uniform thickness throughout the County.

In computing the combined thickness for the Wilcox Group and the Carrizo Formation, which amounts to a single fresh-water section, it should be noted that, at any one location, the value obtained by adding the thicknesses shown on Plate 8 and 10 may be slightly more or less than the value obtained by subtracting the altitudes of the formation contacts shown on Plates 7 and 9. The unconformities and sharp changes in structure make it difficult to construct a map showing thickness of the Carrizo and the Wilcox which will correspond absolutely to an interpretation of their structure. The thickness maps are intended as a guide, and the structural maps (Plates 7 and 9) should be used for more accurate determinations of total thickness.

The Reklaw Formation, overlying the Carrizo, is marked by the same structural features as the Carrizo Formation. Overlying the Reklaw is the Queen City Formation. Plate 11 is a map showing contours on the top of the Queen City. Very little subsurface data was available for preparation of this map. The reader is, therefore, requested to use the map with this condition in mind and with the view that the map will be refined as more subsurface information becomes available. As indicated on Plate 11, the Queen City is structurally affected by the domes and surrounding lows, although to a less pronounced extent than the older or deeper formations. Depth to the top of the Queen City ranges from 0 feet at its upper outcrop to 300 feet in the structural low in the southwestern part of the County. The thickness ranges from 0 feet at the basal outcrop to more than 700 feet. The thickness of this formation in the outcrop is controlled largely by topography; however, where the section is complete the thickness is controlled by structure and depositional history. More deposition of the Queen City occurred in the structural lows than elsewhere (Plate 12). Also the percentage of sand is greater in these lows. An unconformity at the top of the formation shows that the thickness of the Queen City was also affected by erosion which stripped away some of this unit before the overlying Weches Formation was deposited. The Queen City has an average dip of 100 feet per mile into the structural lows. The Weches, which unconformably underlies the Sparta Formation, has the same attitude as the Queen City.

Plate 13 shows the approximate attitude and altitude of the base of the Sparta and top of the Weches. Subsurface data control points used in constructing this map were very limited, and therefore the map should be used with some caution. However, the map reveals that the Sparta Formation follows generally the structural pattern of the older beds.

As shown on Plate 14, the thickness of the Sparta ranges from 0 feet at the basal outcrop to 280 feet. This thickness includes the Tyler greensand where it is present, but this does not change the thickness more than a maximum of 60 feet. Thickness of the Sparta is controlled by topography, structure, depositional history, and an unconformity. Rapid changes in land surface elevation of 50, 100, or more feet cause corresponding changes in thickness in the areas of outcrop. This change in surface elevation is not uncommon around Tyler, and is an important factor in developing ground water from the Sparta Formation. For this reason, even an approximation of the altitude of the base of the Sparta is important in evaluating the unit as a source of ground water. Erosion of the underlying Weches resulted in the Sparta being deposited on an irregular erosional surface, thus somewhat affecting the thickness of the formation. The Sparta dips into the structural lows at approximately 100 feet per mile.

The structural and depositional features just outlined are illustrated in the geologic sections, A-A', B-B', and C-C' (Plates 4, 5, and 6). Two types of geologic sections are commonly made, one in which well-to-well control is used, and another in which the structure is interpreted more generally along a given line. The second type was chosen for this report because many more control points than are available would be required to make a geologic section through Smith County which would adequately show the complex structure.

Section A-A', northwest-southeast, illustrates the formations dipping from the outcrops into the Tyler basin, both from the west and east. The section also shows that the position of the formations is greatly modified by the fault displacements, by piercement and doming by the Tyler salt dome, and by structural lows and ridges.

## GENERAL GROUND-WATER HYDROLOGY

### Hydrologic Cycle

The hydrologic cycle can be described as the earth's circulatory system, a process by which water moves from the sea and returns to the sea. Figure B2 illustrates this cycle and the numerous paths the water takes in its journey.

### Occurrence and General Hydraulics

Ground water is contained in the interstices or voids of pervious strata. Two rock characteristics of fundamental importance in the occurrence of ground water are porosity, the amount of open space contained in the rock, and permeability, which is the ability of the porous material to transmit water. Fine-grained sediments, such as clay and silt, commonly have high porosity, but owing to the small size of the voids, they do not readily yield or transmit water. An aquifer is defined in this report as a stratum, formation, or group of formations which is porous, permeable, and water-bearing and has hydraulic continuity.

Water which falls on the outcrop of an aquifer may take one of many courses in completing the hydrologic cycle. The greater percentage of the water is (1) evaporated directly back into the atmosphere, or (2) transpired into the atmosphere by vegetation, or (3) returned to the sea as surface runoff by the rivers and streams. A smaller percentage of the water seeps downward below the surface of the earth. Water percolating downward under the force of gravity enters a zone in which the voids of the rocks are filled with air and water, the zone of aeration, and may continue downward to a zone in which all the voids are filled with water, the zone of saturation. The upper surface of the zone of saturation is known as the water table. On its trip downward toward the zone of saturation, water may be trapped above an impermeable barrier, forming a perched water-table condition. A perched water table is generally of small areal extent. The water continues movement downward or laterally until an impermeable formation such as a clay or shale is reached; this is the base of the saturation zone. Water that is contained in the zone of saturation under the water-table

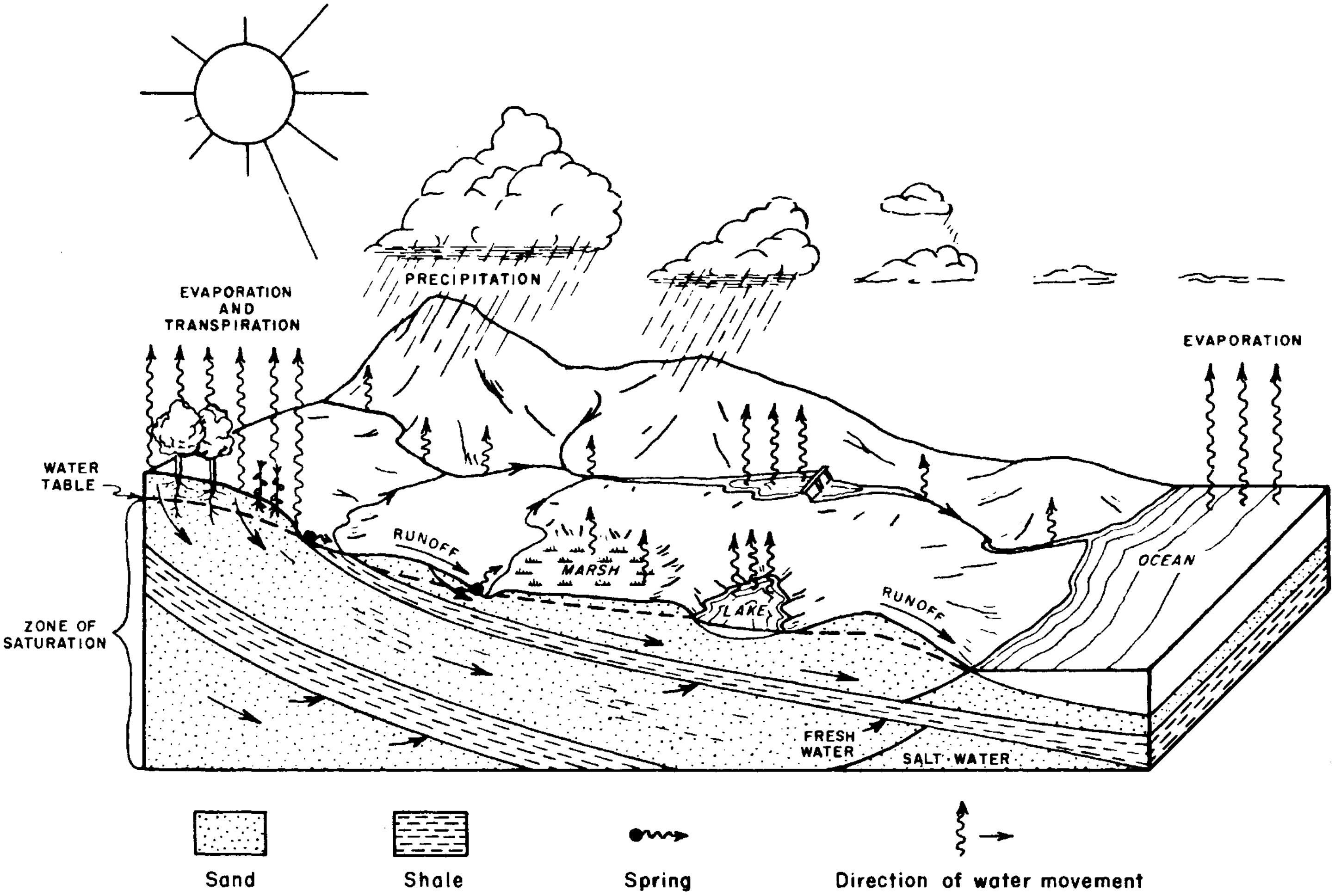

Figure B2

Hydrologic Cycle

Texas Water Commission in cooperation with the
Tyler Chamber of Commerce

conditions is said to be unconfined and is at atmospheric pressure. This condition occurs in the outcrop of an aquifer. However, if this aquifer dips below the ground surface so that the water is confined by relatively impermeable beds both above and below, the water is then under artesian conditions. That is, the hydrostatic pressure will cause the water to rise in wells to a level above the depth at which the aquifer is first encountered. Therefore, ground water may be under two major conditions, water table (unconfined) and artesian (confined).

Water-table conditions, as stated above, occur in the aquifer outcrop where the surface of the water corresponds to the top of the zone of saturation; the water as a rule will not rise, unless it is pumped, above the point in which it is first encountered in wells. The water table is variable in form and shape depending upon areas of recharge and discharge and commonly also on the topography or the shape of the land surface. If the depth to the water is measured in wells and converted to elevations, contour maps and profiles of the water table can be prepared and from these contour maps the hydraulic gradient and direction of movement of the water can be determined. The hydraulic gradient is the slope or rate of vertical change of the water-table.

The artesian part of an aquifer is simply a conduit for water and one in which the water will rise above the upper confining beds when the aquifer is tapped. The water level as measured in a well penetrating a confined aquifer fines the elevation of the piezometric surface at that point. The piezometric surface is an imaginary surface coinciding with the hydrostatic pressure level of the aquifer. A well will flow if the piezometric surface is above the land surface. Contour maps and profiles of the piezometric surface can be made in areas of artesian conditions, corresponding to the maps and profiles of the water table in areas of water-table conditions, and from these maps also the hydraulic gradient and direction of water movement can be determined.

To be of value, an aquifer must be able readily to store and transmit water. Since water is contained in all the voids of an aquifer below the water surface, porosity can be used to determine the amount of water stored in an aquifer. However, not all of the water may be removed from storage because of surface tension and molecular forces between the water and the rock particles. The coefficient of storage is the means by which the storage capability of an aquifer is defined and is equal to the amount of water in cubic feet that will be released from or taken into storage by a vertical column of the aquifer having a base one foot square when the water level or piezometric surface is lowered or raised one foot. In an aquifer under water-table conditions, the coefficient of storage is equal to the specific yield, which is the ratio of the volume of water that a saturated material will yield under the force of gravity to the total volume of material drained.

The coefficient of storage does not necessarily reflect the quantity of water that can be produced from the aquifer, since the ability of the aquifer to transmit and give up water is also very important in determining the quantity of water which may be withdrawn from it. An index to this ability is the coefficient of transmissibility which is defined as the amount of water in gallons per day which will pass through a vertical strip of the aquifer one foot wide under a hydraulic gradient of one foot per foot. The amount of water which will pass through an aquifer can be calculated using the coefficient of transmissibility and hydraulic gradient of the aquifer. By dividing the coefficient of transmissibility by the saturated thickness of the aquifer in feet, another important hydraulic characteristic of the aquifer can be determined. This is the coefficient of permeability, which is defined as the quantity of water in gallons per day that will pass through a section of the aquifer one foot square under a hydraulic gradient of one foot per one foot.

In an investigation to determine the quantity of water available from an aquifer, the hydraulic characteristics, coefficients of storage and transmissibility, of the aquifer must be learned. This information is gained by conducting a pumping test on a well or wells completed in the aquifer. A pumping test consists of pumping a well at a constant rate for a period of time and making periodic water-level measurements in the pumped well and, if possible, in one or more observation wells nearby. After pumping stops, the recovery of the water level is also measured. From the data obtained during the test the coefficient of transmissibility can be calculated by means of various formulas, but only if an observation well is used in the test can the coefficient of storage be calculated.

The coefficients of storage and transmissibility are vital not only in determining the quantity of water available from an aquifer, but also in determining proper well spacing, the interference or effect that one well may have on another, and the predicted future water levels of an area.

A general indication of the hydraulic characteristics of an aquifer can also be provided by the specific capacities of wells. The specific capacity is defined as the number of gallons per minute that a well produces for each foot of drawdown of the water level, during a period in which the well is pumped at a constant rate. For best results the period of pumping should be long enough for the water level in the well to stabilize. The type of well construction and thoroughness of well development strongly affect a well's specific capacity.

## Recharge, Discharge, and Movement

Recharge is the process by which water is added to an aquifer, either by natural processes or by artificial means. Precipitation in the outcrop of an aquifer is by far the most significant source of recharge, but recharge also occurs when surface streams and lakes cross an aquifer outcrop. Interformational leakage adds water to an aquifer under some subsurface conditions. Recharge is a limiting factor for the amount of water that can be developed from an aquifer, as recharge must balance discharge over a long period of time or the water in storage in the aquifer will be depleted. Factors which limit the amount of recharge received by an aquifer are the amount and frequency of precipitation, the areal extent of the aquifer outcrop, the topography, the type and amount of vegetation, the condition of the soil in the outcrop, and the ability of the aquifer to accept recharge and transmit it to areas of discharge. Methods of artificial recharge include injecting water into the aquifer through wells, and spreading surface water over the outcrop in ditches, basins, and lakes.

Discharge is the process by which water is removed from the aquifer, whether by natural or artificial means. Natural discharge occurs by springs, effluent seepage, evapo-transpiration, and interformational leakage. Examples of artificial discharge are flowing and pumped wells, and drainage ditches and other types of excavation that intersect the water table or the piezometric surface.

Water entering the interstices of a formation begins a slow process of movement from the area of recharge to an area of discharge. Discharge from an aquifer causes dewatering in areas of water-table conditions, and lowering of the hydrostatic head in areas of artesian conditions. In both cases the water moves to the discharge area under the force of gravity, tending to maintain hydrostatic equilibrium in the aquifer. Under artesian conditions, movement of water generally is down the dip of the strata; and under water-table conditions, the slope of the water table is closely related to the slope of the land surface. However, under both the artesian and water-table conditions the direction of movement and the hydraulic gradient can be altered by artificial discharge. The rate of movement of water through an aquifer is very slow because of the circuitous path it must follow between the rock particles and the surface tension between the water and the solid material of the aquifer. In Smith County this rate of movement generally ranges from a few feet to a few hundred feet per year.

## Water Levels in Wells

Measurements of the depth to water in wells indicate the depth of the water table in an unconfined aquifer and of the piezometric surface in an artesian aquifer. Two types of water-level measurements are made, static and pumping. A static water level is one which represents the position of the water-table or piezometric surface not under the influence of artificial discharge, whereas the pumping level is that position of the water table or piezometric surface in a discharging well. Changes in water levels are due to many causes and are important in the evaluation of an aquifer. These changes can be regional or local, and of short or long duration. One of the most significant causes of water-level changes or fluctuations is the change in the balance of recharge and discharge of the aquifer. During a drought, when recharge is reduced, water discharged from the aquifer must be withdrawn from storage and the water levels decline. When the drought ends and precipitation increases, water withdrawn from storage is replaced and the water levels rise.

Another significant cause for the change in water levels is concentrated artificial discharge. The water table or piezometric surface in the vicinity of a pumped well is drawn down into the shape of an inverted cone with the apex at the pumped well. The development of this cone is dependent upon the aquifer's coefficients of storage and transmissibility and the pumping rate of the well. As pumping continues, this cone of depression expands until it intercepts a source of replenishment capable of supplying sufficient water to satisfy the pumping demand. If the quantity of water received from these sources is sufficient to compensate for the water pumped, the growth of the cone will cease. In areas where recharge is less than the amount of water being pumped from wells, water is removed from storage in the aquifer and the water levels will continue to decline. In areas of extensive ground-water development each well superimposes its cone of depression onto that of adjacent wells. This creates a regional cone of depression, lowering the water levels over a large regional area. As each well is pumping and extending its cone of depression, it adversely affects water levels and discharge rates of neighboring wells. Factors such as aquifer characteristics, well spacing and rate and duration of pumping of each well determine the degree of interference between wells. These factors must be considered in planning efficient and economical development of ground-water supplies.

Other causes of water-level fluctuations, especially in artesian aquifers, are barometric pressure changes, tidal forces, and earthquakes. The changes from these causes are expected to be small and relatively insignificant in Smith County.

## Chemical Quality

All ground water contains dissolved minerals carried in solution, the kinds and concentrations of these depending on the environmental history, movement, and source of the ground water. Water derived from precipitation is relatively free of mineral matter until it comes into contact with the soils and rocks of the earth's crust. Rocks and the soils which are formed from them are composed of minerals in varying types and amounts. As the water, which has some solvent power, comes into contact with the rock it begins to dissolve the minerals and carry them in solution. The length of time the water is in contact with the rock, the solubility of the minerals, and the amount of free carbon dioxide in the water control the amount of minerals dissolved. Percolating downward into the aquifer and then moving through it, the water increases its content of dissolved minerals. The concentration of dissolved solids generally increases with depth in an aquifer and is greater where the movement of the water is restricted. Many aquifers were deposited under marine conditions. If, in these aquifers, the flushing action by fresh water has not been complete, brackish or highly mineralized water will be encountered by wells. This typically occurs in downdip parts of an aquifer but may also occur in some local updip areas.

The chemical quality of ground water is affected in some areas by artificial or man-made conditions as well as by natural conditions. Highly mineralized water, generally encountered in oil wells and commonly produced with oil, can enter a fresh-water aquifer by seepage from waste-disposal pits or from improperly plugged or improperly completed test holes or those with severe corrosion of the well casing. Disposal of sewage waste into the ground or into surface streams which may provide recharge to ground-water aquifers may also cause pollution to the fresh water.

Uncontaminated ground water, unlike surface water, maintains a relatively constant quality at all times. This constant quality, in addition to its constant year-round temperature, makes ground water highly desirable for many uses, particularly industrial uses. Ground water will have a constant temperature that is approximately 1.8°F above the mean annual surface temperature per 100 feet of depth at which it is encountered.

## Chemical Quality Criteria

The principal chemical constituents found in ground water are calcium, magnesium, sodium, potassium, iron, silica, bicarbonate, carbonate, sulfate, chloride, and minor amounts of manganese, nitrate, fluoride, and boron. Concentrations of these ions or chemical constituents are commonly reported by weight in parts per million (ppm). One ppm defines one part by weight of the ion to a million parts by weight of water.

Certain quality standards have been established or suggested for public, industrial, and irrigation supplies. Water used for public supplies should be colorless, odorless, palatable, and if possible within the mineral concentration limits set forth by the U. S. Public Health Service (1962) for drinking water used on interstate carriers. Some of these standards, in parts per million, are as follows:

Chloride (Cl)---------------250
Iron (F)-------------------- 0.3
Manganese (Mn)-------------- 0.05
Nitrate ($NO_3$)---------------- 45
Sulfate ($SO_4$)----------------250
Total dissolved solids------500

In many areas of Texas, municipal water supplies complying with these standards cannot be obtained. However, supplies that fail to meet these standards have been used for long periods without apparent ill effects to the user. The Texas State Department of Health reports that some authorities recommend that drinking water should not contain in excess of 20 ppm of nitrate. Hardness of water is also important in consideration of water supplies. It is expressed in parts per million as calcium carbonate. Water having a hardness of 60 ppm is rated soft, 61 to 120 ppm is moderately hard, and 121 to 200 ppm is hard. More than 200 ppm is very hard.

Standards for industrial supplies are varied depending upon the type of industry. A major concern to industries is the development of a water supply which does not contain corrosive or scale-forming constituents. Calcium and magnesium, which directly affect the hardness, are a limiting factor in the suitability of water for boiler use. Iron and silica in excessive amounts also cause scale deposits which clog lines and reduce the efficiency of other industrial processes. Each industry interested in developing a water supply will have its own quality requirements.

Whether water is suitable for irrigation depends not only the quality of the water but also on the type of soil to which it is applied, adequacy of drainage, type of crops, and climatic conditions. The U. S. Salinity Laboratory Staff (1954) outlined the characteristics which are important in determining the suitability of water for irrigation. These characteristics are: (1) total concentration of soluble salts, (2) percentage of sodium in relation to the other cations, (3) residual sodium carbonate, and (4) concentration of boron and other toxic elements.

## Treatment of Water

Water that does not meet the requirements of a municipal or industrial user commonly can be treated by various methods so that it will become usable. Treatment methods include softening, aeration, filtration, cooling, dilution or blending of poor and good quality waters, and addition of chemicals. The limiting factor in treatment is economy. Each water may require different treatment practices and the treatment should be designed for that particular water. However, once a treatment is established it probably will not have to be changed as the chemical characteristics of uncontaminated ground water remain fairly constant.

# DEFINITIONS

*Acre-foot*. The amount of water required to cover one acre to a depth of one foot. Equivalent to 325,850 gallons.

*Aquiclude*. A stratum, formation, or group of formations which is relatively impermeable and does not transmit water.

*Aquifer*. A stratum, formation, or group of formations, which is porous, permeable, and water-bearing and has hydraulic continuity.

*Artesian aquifer*. An aquifer that is confined both above and below by an impermeable layer, so that the water is under hydrostatic pressure and the water will rise above the point at which it is first encountered in a well.

*Contour*. An imaginary line on the surface of the ground or geologic horizon on which every point is at the same altitude.

*Fault*. A fracture or fractured zone along which there has been displacement of the two sides relative to one another.

*Formation*. A body of rock that is characterized by lithologic homogeneity and that can be mapped.

*Glauconite*. A green mineral, essentially a hydrous potassium iron silicate.

*Ground water*. That part of subsurface water which is in the zone of saturation.

*Group*. A rock stratigraphic unit consisting of two or more associated formations.

*Hydraulic gradient*. The slope or rate of vertical change of the water table or piezometric surface.

*Isopach*. A line, on a map, drawn through points of equal thickness of a designated unit.

*Lithology*. The composition and texture of rocks. The study of rocks.

*Littoral*. The environment of the ocean between the limits of high and low tide.

*Outcrop*. That part of a geologic stratum which appears at the surface of the ground.

*Permeable*. Having a texture that permits water to move through it perceptibly under the head differences ordinarily found in subsurface water. A permeable rock has communicating interstices, generally of capillary or subcapillary size.

Piezometric (surface). An imaginary surface that coincides with the static water level in an artesian aquifer. The surface to which the water in a given aquifer will rise under its own head.

Porosity. The ratio, stated as a percentage, of the volume of all pore space to the total bulk volume of a given rock.

Recharge. The process by which water is added to an aquifer, either by natural or artificial means.

Specific capacity. The number of gallons per minute that a well produces for each foot of drawdown of the water level during a period in which the well is pumped at a constant rate. Expressed as gallons per foot of drawdown (gpf).

Stratigraphy. The study of formation composition and sequence, and correlation of the stratified rocks as parts of the earth's crust.

Storage, coefficient of. The amount of water in cubic feet that will be released from or taken into storage by a vertical column of the aquifer having a base one foot square when the water level or piezometric surface is lowered or raised one foot.

Syncline. A fold in rocks in which the strata dip inward from both sides toward the axis.

Transmissibility, coefficient of. The amount of water in gallons per day which will pass through a vertical strip of the aquifer one foot wide under a hydraulic gradient of one foot per foot.

Unconformity. A buried surface of erosion or of nondeposition that separates younger strata from older.

Water-table aquifer. An aquifer that is unconfined and in which the water is under atmospheric pressure and will not rise above the point at which it is first encountered.

# APPENDIX C

# DESCRIPTIVE PLATES

# PLATE 1

## Topographic Map of Smith County

A topographic map shows the size, shape, and distribution of physical features on the earth's surface. Towns, roads, relief, and drainage patterns are a few of the main features shown on this map. The relief of the land surface is shown by connecting points of equal elevation by lines, or contours. The highest areas in the County are illustrated by the position of the 600 foot contours and the lowest areas by the 300 foot contours.

This illustration is very valuable in using the succeeding maps that show contours on certain stratigraphic horizons (Plates 7,9,11, and 13). To determine the depth from the land surface to the top or base of a formation at a particular locality, obtain the surface elevation of that locality from the topographic map. Next, determine the elevation of the formation in question at the same locality. Then, to find the depth of that formation at that locality, add the land surface elevation to the formation elevation if the formation elevation is negative (below mean sea level). However, if the formation elevation is positive (above mean sea level), it must be subtracted from the land surface elevation.

Example 1: Assume a well is to be drilled in the city of Tyler, located on the map at the letter "T" in the word "Tyler." How deep will the well have to be drilled to reach the base of the Wilcox Group? From the topographic map, the surface elevation at that location is found to be about half way between the 500 and 600 foot contour; therefore, let us assume an elevation of 550 feet above sea level. From Plate 7, the elevation of the base of the Wilcox Group at this same location is found to be about 1,550 feet below sea level (-1550). Therefore, by adding the two elevations the approximate depth of 2,100 feet is determined.

Example 2: Assuming the same location as in Example 1, what is the approximate depth to the top of the Queen City Formation? From Plate 11 it is seen that the elevation of the top of the Queen City Formation at that location is between a control point marked +286 and the +200 contour. Let us assume the elevation at the desired point is approximately 275 feet above sea level. Therefore, subtracting 275 feet from 550 feet gives a depth of approximately 275 feet to the top of the Queen City. Thus, by using the topographic map with the structural contour maps, it is possible to determine within practical limits the depths to the formations at any particular location.

# PLATE 2

## Geologic Map of Smith County

This map shows the location and extent of the outcrops of the geologic units in Smith County. The pattern of these outcrops indicates some of the geologic structures present in the County. Surface exposures or outcrops of the Carrizo Formation are located in the northwest and southeast corners of the County. Moving from the Carrizo outcrops toward Tyler, progressively younger formations are encountered. Where younger formations are surrounded by progressively older formations, a basin or synclinal structure is indicated. This synclinal structure is the Tyler basin; the city of Tyler is near the center of the basin.

Two outcrops of Cretaceous rocks are shown on the map. These outcrops are blocks of Cretaceous rocks which have been pushed to the surface by the upward movement of salt domes. The Cretaceous outcrop in the southwestern part of the County is the result of the Brooks Dome, and the outcrop in the northern part of the County is a result of the Steen Dome.

Small isolated outcrops of the Weches Formation, often capped by the Sparta Formation, are shown on the map. These isolated outcrops can readily be identified on the ground by the small isolated hills which they form.

# PLATE 3

## Typical Electric and Lithologic Log of Strata in Smith County

This illustration is a composite of the typical electric and lithologic characteristics of the formations discussed in this report.

From the illustration it can be seen that the electrical properties of the rocks differ greatly. On the basis of these electrical properties, the position of the top and base of a geologic bed, formation, or other geologic unit can be determined from an electric log. By studying more than 190 electric logs and several sample logs from wells throughout the County, the altitude, thickness, and relative quality of water for each of the formations were determined. This typical log illustrates the electrical characteristics used for these determinations, the lithology, and the geologic names and ages of the rock units.

## PLATE 4

### Northwest-Southeast (A-A') Geologic Section, Smith County

The geologic section along A-A' is a dip section, being at right angles to the regional strike of the beds. A simple way of orienting and understanding this illustration and other geologic sections is to imagine them as being road cuts. In other words, imagine that a road is constructed along the line A-A' and that the earth was cut away to a depth of 2,500 feet to allow the road to be built. Therefore, starting at point A and driving toward point A' and looking at the road cut on the left side, or north side, the altitude, thickness, lithology, and structure of the rock units could be seen.

Several of the major geologic structures are clearly illustrated by the section. Beginning in the northwest part of the County, the first is the normal fault dipping east, then the normal fault dipping west which results in a down-thrown block between the faults. Southeast of the fault the formations dip into a structural low, then rise onto a ridge and then drop once more into another low. The formations then rise steeply upward and over the Tyler salt dome. East of the Tyler salt dome the beds flatten out, and the Carrizo crops out in the extreme southeastern part of the County. It is seen that the Weches, Reklaw, and Carrizo Formations maintain a uniform thickness throughout the geologic section, except in the southeastern part of the County where the Carrizo thickens and thins. The Sparta, Queen City, and Wilcox vary in thickness throughout the section.

In preparing this and the following two geologic sections, the contour maps of the formations (Plates 7,9,11, and 13), the geologic map (Plate 2), and the topographic map (Plate 1) were used to determine the altitude and thickness of the geologic formations, the topographic features, and the relation between the topography and the geology.

# PLATE 5

## West-East (B-B') Geologic Section,
## Smith County

Viewing this section from B to B', or west to east, several important features are noted. First, the formations are cut by a fault system which creates a downthrown block about 2-1/2 miles in width. The beds then dip into a structural low, then rise onto a ridge and dip once again into a low. In the far eastern part of the section the formations dip gently westward. The Weches, Reklaw, and Carrizo Formations are relatively uniform in thickness along the section but the Queen City Formation and the Wilcox Group vary considerably.

# PLATE 6

## West-East (C-C') Geologic Section, Smith County

This geologic section begins in the structural low between the Brooks and Tyler salt domes, near the deepest part of the Tyler basin. The region between the Brooks and Tyler salt domes has the thickest deposit of Eocene formations and the formations are deeper than at any other place in the County. Moving eastward from the center of the basin, the section cuts the northern flank of the Whitehouse salt dome. This section also shows the flat structural high in the eastern part of the County.

# PLATE 7

## Contour Map on the Base of the Wilcox Group, Smith County

This map is a structural contour map of the base of the Wilcox, illustrating the altitude of the base of this geologic group in Smith County. The map was constructed by connecting points of equal elevation on the base of the Wilcox by lines called contours. A minus sign before the control-point numbers and contour numbers indicates that the elevation is that number of feet below sea level.

The structural position of the Eocene formations is best seen on this map. The major structural features are the faults and the salt domes with their related basins and ridges. The domes are shown by a series of closed circular contours. Six salt domes are present in the County. Beginning in the north part of the County east of Lindale is the Steen dome; southwest of the Steen dome on the Neches River is the Mt. Sylvan dome; at Tyler is the Tyler dome; in the southwest corner of the County is the Brooks dome; west of Whitehouse in the south part of the County is the Whitehouse dome; and south of the Whitehouse dome and northeast of Bullard is the Bullard dome. These domes are aligned in northeast-southwest trends. Between and around the domes are deep basins. Separating the series of domes and their related basins are north-south trending ridges. In the eastern part of the County there is a relatively flat structural high with isolated depressions. Several faults are indicated on the map.

The base of the Wilcox Group coincides with the lower limit of fresh water in Smith County. Hence, this map has both geologic and hydrologic functions. Fresh water is used here to denote all water having a concentration of total dissolved solids that is 3,000 parts per million (ppm) or less.

## PLATE 8

### Isopach Map of the Wilcox Group, Smith County

An isopach map illustrates the thickness of a geologic unit. Points of equal thickness are connected by contour lines thus showing the varying thickness of the unit. Values shown at the control points indicate the thickness of the Wilcox at that point and also the percentage of sand in this thickness.

This group ranges in thickness in Smith County from 755 feet to more than 1,320 feet. It averages 900 to 1,000 feet in thickness. On an average, 42 percent of this thickness is sand in layers of 5 feet or more.

# PLATE 9

## Contour Map on the Top of the Carrizo Formation, Smith County

The geologic structures which were discussed in relation to Plate 7 are also shown on this map. Even though all the structures indicated by Plate 7 are present at the top of the Carrizo Formation, it is noted that the changes in the elevation of the top of the Carrizo Formation are not as severe as the elevation changes of the base of the Wilcox Group.

This map is important to anyone interested in drilling a well into the Carrizo-Wilcox aquifer. The approximate depth at which the aquifer will be encountered can be determined from this map when used in conjunction with Plate 1. Also, the total thickness of the Carrizo-Wilcox interval can be determined by calculating the difference in elevation between the top of the Carrizo and base of the Wilcox, the elevations being obtained from this map and Plate 7 respectively.

# PLATE 10

## Isopach Map of the Carrizo Formation, Smith County

The Carrizo, as shown by this map, ranges in thickness from 0 feet at its basal outcrop to 225 feet. On an average, the formation is 100 feet thick and 95 percent of the section is sand.

Greater thicknesses occur in the basins around the domes and on the flat structural high in the eastern part of the County. Deposition appears to have occurred more on the south, southeast, and eastern flanks of the structural lows, as the thickness of the formation is greater at these localities; deposition was less on the ridges between the domes and lows and on the western flanks of the lows.

Although the total thickness of the Carrizo-Wilcox aquifer may be derived by adding the thicknesses shown on this map to those on Plate 8 (Isopach map of the Wilcox), somewhat more accurate values for the total thickness may be obtained by comparing the elevations of the top of the Carrizo (Plate 9) with those on the base of Wilcox (Plate 7). This map and Plate 8 serve as convenient guides in determining the variation in thickness of the Carrizo Formation and the Wilcox Group in the County.

# PLATE 11

## Contour Map on the Top of the Queen City Formation, Smith County

The Queen City Formation follows the structural patterns of the older, deeper formations in the County. Few points of data control were available for constructing this map but it is an approximation as to the elevation and attitude of the formation.

# PLATE 12

## Isopach Map of the Queen City Formation, Smith County

The Queen City Formation crops out in more than 75 percent of the County. Thickness of the formation in the outcrop is controlled by the topography to a great extent. In the part of the County in which a complete section of Queen City is believed to be present, the thickness is a reflection of depositional and structural control. The formation ranges in thickness from 0 feet at its basal outcrop to more than 700 feet. Approximately 55 percent of the thickness is sand in layers of 5 feet or more. The thickest section of Queen City can be found west of the Whitehouse dome and in the structural lows southwest, northwest, and northeast of Tyler.

# PLATE 13

## Contour Map on the Base of the Sparta Formation, Smith County

Control data is very limited for constructing a map on the base of the Sparta Formation in Smith County. On the basis of available data an approximation of the elevation of the base has been made so that at least some information will be available on this formation. It can be seen that the Sparta follows the general structural pattern found in the older formations. Three structural lows shown on this map correspond to the Tyler, Noonday, and Swan areas of Plate 15.

# PLATE 14

## Isopach Map of the Sparta Formation, Smith County

This map is an approximation because of limited control data. It can be noted that the Sparta Formation averages less than 150 feet in thickness in the County. The thickness ranges from 0 to more than 250 feet of which an average of 70 percent is sand thickness. The three areas in which the Sparta attains a thickness of 200 feet or more are considered to be potential development areas for Sparta water.

Thickness of the Sparta is largely controlled by the surface elevation or topography. A change in surface elevation of 50 feet, which is not uncommon, reflects a change in the thickness of the Sparta by 50 feet. When a close determination on the thickness is needed, the surface elevation (Plate 1) should be compared with the map showing elevation of the base of the Sparta (Plate 13).

# PLATE 15

## Areas Suitable for Potential Large-Scale Development of Ground Water, Smith County

Various areas of the County are designated as having best, good, or fair potential for sustaining additional large-scale withdrawals of ground water. Two areas, Noonday and Swan, have best potential in all of the three aquifers, Carrizo-Wilcox, Queen City, and Sparta. The Tyler area has best potential for the Queen City and Sparta, but has only good potential for the Carrizo-Wilcox. This area is considered only good for additional Carrizo-Wilcox development because of the existing 8-well field of the city of Tyler. Only small additional development of the Carrizo-Wilcox is considered practical for this area. The Winona area is considered to have best potential for the Carrizo-Wilcox but only good for the Queen City. The Sparta in the Winona area is essentially nonexistent. An area in the eastern part of the County is indicated to be best for additional large-scale development. The city of Kilgore has a 6-well field in this area but there is a potential for additional large-scale development of ground-water supplies.

Two areas are labeled as having good potential in the Carrizo-Wilcox. The one in the northwest part of the County has the greater ability to sustain large-scale development and may prove in the future to be in the best potential category.

All other areas of the County, shown in white, are considered to be fair to good in potential for development of ground water from the aquifers that are present.

Given below is the estimated potential increase in sustained water yield, in millions of gallons per day, from the aquifers in four areas designated as having best potential for ground-water development.

| Aquifer | Noonday area | Swan area | Winona area | Tyler area |
|---|---|---|---|---|
| Carrizo-Wilcox | 5 to 10 | 8 to 16 | 5 to 10 | (undetermined) |
| Queen City | 1 | 1 | (undetermined) | 1 |
| Sparta | 5 | 2.5 | 0 | 2 |

In each area the available water is determined to some extent by the pumping level that may be desired by the development.

# PLATE 16

## Location of Selected Water Wells,
## Smith County

A representative number of water wells were inventoried in the course of this investigation. Symbols on this map not only show the location of these wells but also denote the use of each well and the aquifer in which each well is completed. Complete information on the wells is given in Table 1. Well numbers on the map correspond with the well numbers in the tables. Appendix A discusses the well-numbering system in detail. An example is the number 34-46-101 for the city of Tyler well 9. The number indicates that it is well 01 in the 2-1/2 minute quadrangle 1, of the      minute quadrangle 46, of the 1-degree quadrangle 34.

# PLATE 17

## Location of Selected Oil Tests,
## Smith County

This map shows the location of selected oil tests in Smith County from which electric logs were used in determining the thickness, elevation, and attitude of the various geologic formations. These wells and corresponding logs were numbered by the statewide well-numbering system which is discussed in detail in Appendix A.

Table 3 is a tabulation of data from wells showing operator, lease, survey, date of log, and whether the log is filed with the Texas Water Commission.