Geology and Ground-Water Resources of Comal County, Texas

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1138

Geology and Ground-Water Resources of Comal County, Texas

By WILLIAM O. GEORGE

With sections on

SURFACE-WATER RUNOFF

By SETH D. BREEDING

CHEMICAL CHARACTER OF THE WATER

By WARREN W. HASTINGS

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Prepared in cooperation with the Texas Board of Water Engineers

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1952

UNITED STATES DEPARTMENT OF THE INTERIOR

Oscar L. Chapman, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C.

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GEOLOGY AND GROUND-WATER RESOURCES OF COMAL COUNTY, TEX.

By William O. George

ABSTRACT

The purpose of this report on the geology and ground-water resources of Comal County in central Texas is to determine the sources of the waters that supply Comal Springs, the largest springs in the Southwest, and other springs and wells. Comal County has an area of about 559 square miles and in 1950 had a population of 16,325. Comal Springs discharge within the city limits of New Braunfels, the county seat of Comal County.

With the exception of a small outcrop of basaltic rock near the western boundary of the county, all the rocks in the county are sedimentary in origin and range in age from Cretaceous to Recent. The main water-bearing formations, the Edwards and Glen Rose limestones, are a part of the Comanche series which has a maximum thickness of about 1,900 feet in Comal County. The Gulf series which is about 500 feet thick yields very little water. The Uvalde gravel of Pliocene (?) age is found only on hilltops and is too thin to retain water. Small yields for domestic and stock use are obtained from the Leona formation of Pleistocene age, which occurs as terraces along the main streams and has a maximum thickness of about 50 feet. Extensive faulting has exposed almost all the Cretaceous rocks. Seven main faults which are a part of the Balcones fault zone in central Texas cross the county in a northeasterly direction. They are normal faults with the downthrow to the south or southeast, are roughly parallel, and have a combined displacement of about 1,500 feet. The direction of movement of ground water is largely controlled by these faults.

Studies of hydraulic gradients; chemical analyses; correlation among water levels, rainfall, and discharge measurements of Comal Springs; and relative runoff of streams within the county prove rather conclusively that more than half of the water discharged by Comal Springs is supplied by a large underground reservoir which also supplies many artesian wells in the San Antonio area. The data show that a relatively large proportion of the water comes from recharge areas west of Comal County. Although the volume of water in storage varies considerably in response to droughts or heavy rainfall, it is believed that over a long period recharge and discharge are in approximate balance.

The report contains 385 records of wells and springs, logs of 18 wells, chemical analyses of 350 water samples, and periodic measurements of water levels in 52 wells.

Measurements of stream flow in Comal County are presented; and it is concluded that abundant supplies of water are available from Comal Springs and the Guadalupe River below Comal Springs, but that storage will have to be provided, if a large and continuous supply of water is to be obtained from sources other than Comal Springs.

In general the chemical character of the water from the wells in the county is acceptable for most purposes but because the water-bearing formations are

largely limestones, the waters are moderately hard, generally above 200 parts per million. Calcium bicarbonate is normally the predominant mineral constituent in ground water in Comal County. Most of the deep wells south of the Comal Springs fault yield water with an odor of sulfur.

INTRODUCTION

PURPOSE AND SCOPE

This investigation in Comal County was made possible through cooperation between the Texas State Board of Water Engineers and the United States Geological Survey, and is a part of a State-wide program of underground-water investigations in Texas. In general the purpose of these investigations is to obtain facts regarding the thickness, depth beneath the land surface, and areal extent of the water-bearing formations; to estimate the capacity of the formations to absorb, transmit, and discharge water; and to determine the chemical character of the ground water. In Comal County the principal purpose of this investigation was to determine the source of the water that issues from Comal Springs which have the largest average flow of any known springs in the southwestern part of the United States. The investigation was begun in 1941 by Robert R. Bennett of the Geological Survey, and was taken over by the writer in September 1943, when Mr. Bennett was transferred to another State. The study was interrupted repeatedly by work relating to defense and war projects. In 1947 the report was published by the Texas Board of Water Engineers. The present report contains some additional data and some revisions.

HISTORY OF SETTLEMENT

New Braunfels, the county seat and only large town in the county, had a population of 12,193 in 1950. The settlement was founded by German immigrants in 1845, and the majority of the inhabitants of the county are descendants of those founders. The leader of the group was Carl, Prince of Solms-Braunfels, (1846) a cousin of Queen Victoria. In 1842 he and 20 others founded the Society for the Protection of German Immigrants in Texas. A document bearing the following inscription was placed in the Sophienburg, a fortress built at New Braunfels for the protection of the immigrants:

> In the year of our Lord, One Thousand Eight Hundred and Forty-two, an association of Princes, Counts, and Gentlemen, was formed in Germany, who mindful of the increasing excess of population and the poverty growing therefrom, particularly among the lower classes of people, made it their object to redress this evil by regulating the already considerable immigration.

The first settlers landed at Galveston in 1844 and more arrived at Indian Point in Lavaca Bay on March 1, 1845. On Good Friday, March 21, the immigrants crossed the Gaudalupe and established camp on Comal Creek and from there the town was laid out to which was given the name New Braunfels (Biesele, 1930). The camp was probably near Comal Springs which was then known as Las Fontanas.

This investigation is a part of the study of the discharge, recharge, and movement of ground water along the entire Balcones fault zone, particularly in the Edwards limestone. This fault zone which passes through Comal County is about 250 miles long. The ground-water reservoirs in the Edwards Plateau yield an average of about 400 million gallons of water a day to large springs along the Balcones fault zone at Austin, San Marcos, New Braunfels, San Antonio, and Uvalde.

The investigation was made under the administrative direction of O. E. Meinzer, geologist in charge of the Ground Water Branch of the United States Geological Survey. Mr. Meinzer retired on December 1, 1946, and was succeeded by A. N. Sayre. The field work was done and the report was prepared under the direct supervision of Walter N. White, district engineer in charge of ground-water investigations in Texas, who was succeeded in 1947 by William L. Broadhurst, district geologist.

LOCATION

Comal County is in south-central Texas. The county contains about 559 square miles and its greatest length is about 39 miles, measured east and west, and greatest width about 30 miles, measured north and south. The intersection of latitude 29°50′ north and longitude 98°15′ east falls in the central part of the county. According to the United States Census Bureau, the population of Comal County was 16,357 in 1950.

Transportation facilities include several paved Federal and State highways and an extensive network of farm-to-market roads, many of which are paved. The Missouri Pacific and the Missouri, Kansas, and Texas railway systems serve New Braunfels and other smaller stations in the county.

AGRICULTURE AND INDUSTRIAL DEVELOPMENT

Agriculture in the more rugged upland areas northwest of the Balcones escarpment is limited to the raising of cattle, sheep, and goats, except along stream terraces where supplementary feed and grain crops can be raised. The upland area is well known for the abundance of white-tailed deer which attract many hunters during the deer season, thus adding materially to the income of the ranchers.

The relatively level country southeast of the escarpment is used mostly for farming; cotton, corn, oats, maize, and wheat are the principal crops. No large fields in the county are irrigated.

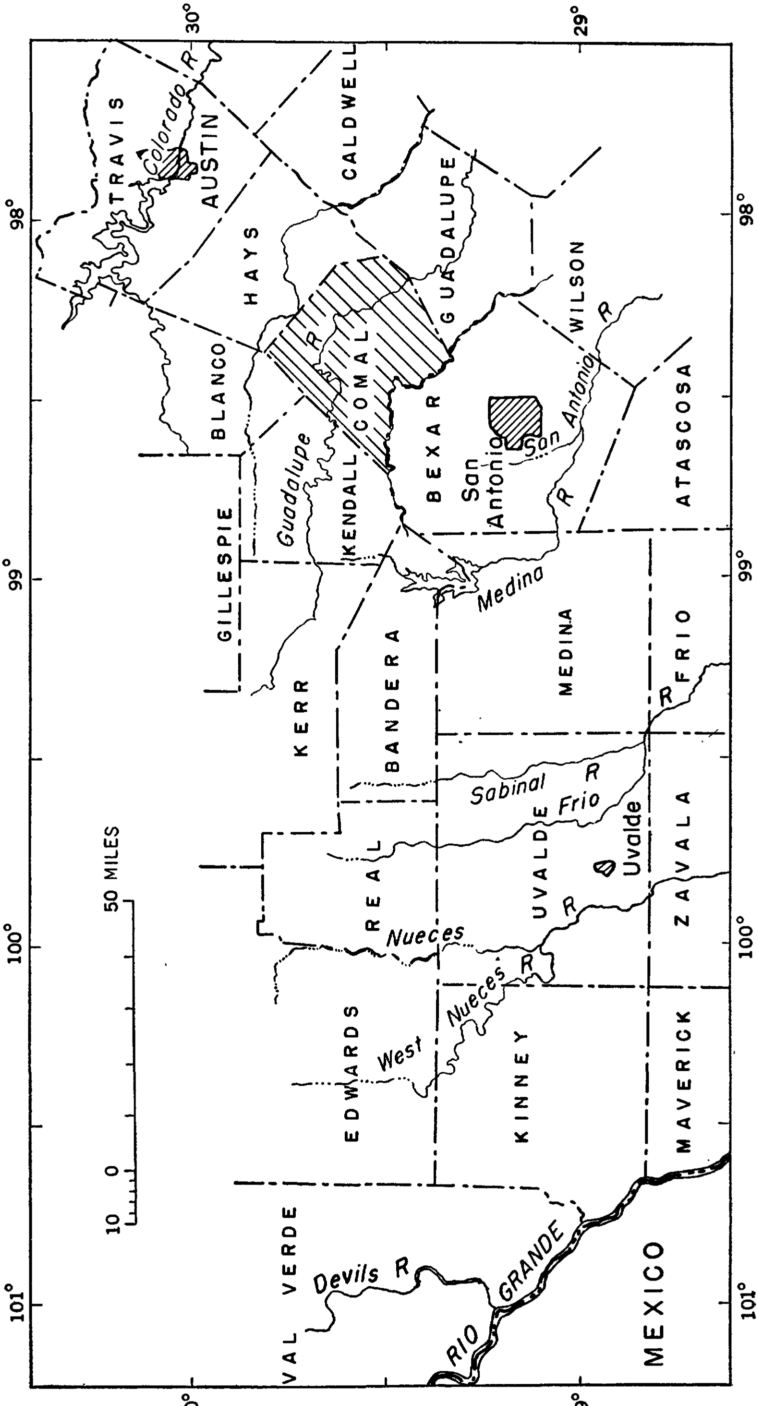

FIGURE 1.—Index map of central Texas showing location of Comal County.

The early settlers of New Braunfels made use of the water power afforded by Comal Springs and the Guadalupe River to operate mills of various kinds. At present, the city of San Antonio has a power plant a few hundred feet below the springs, which has a capacity of 60,000 kilowatts. This plant is operated by steam-driven turbines using natural gas as fuel and spring water for cooling. Flour, feed, cotton textiles, gauze, children's garments, mattresses, cedar oil, dairy products, lime, road-building material, rock, wool, leather goods, furniture, and hoisery are manufactured at New Braunfels. A farmers cooperative association has been established for handling and marketing farm and ranch products.

Landa Park, maintained by the city at Comal Springs, is noted for its recreational facilities, including a large swimming pool supplied by the cool water of the springs, lakes for boating, a baseball park, and a golf course. The park attracts a large number of summer vacationists and tourists.

METHODS OF INVESTIGATION

In mapping the geology of Comal County, use was made of the Geological Survey geologic map of Texas. Detailed geologic information was sketched on topographic sheets and mosaics of aerial photographs on the scale of 2 inches to the mile. The following topographic sheets were used: The Bracken, Boerne, New Braunfels, Leon Springs, and Hunter quadrangles, prepared by the Corps of Engineers of the United States Army; and the Smithson Valley quadrangle, east half of the New Braunfels quadrangle, and southwest quarter of the Hunter quadrangle, prepared by the Topographic Division of the Geological Survey.

In connection with the investigation, current-meter measurements, commonly called seepage measurements, were made at intervals along the Guadalupe River and Cibolo Creek in stretches where these streams cross the outcrops of the water-bearing formations, in order to determine losses by seepage and gains from ground-water inflow in each of these sections. In 1946 three permanent gaging stations were established on Cibolo Creek. Discharge measurements at these stations and other gaging stations in the county are discussed by Seth Breeding in a later section of this report.

Records of about 365 wells and springs, most of which were obtained by Michal (1937) in 1936-37 or by the writer in 1945-46, are tabulated in the table of well records on pages 92 to 115. These records give information about the depths and diameters of the wells, the depths to the water level, the geologic formations from which the water is obtained, the use that is made of the water, and other data. Samples of water were obtained from most of the wells and springs for chemical analyses. The results of the analyses are shown in table 19. Serial numbers of wells are preceded by a capital letter and are shown on plates 2 and 5.

PREVIOUS INVESTIGATION

Records of a few of the wells in the western part of the county, including the altitude of the water levels, were obtained by Livingston (1936) in 1934 as a part of the study of the water resources of the Edwards limestone in the vicinity of San Antonio.

A number of wells have been selected as observation wells, and periodic measurements have been made of the depth to water in these wells. The results of these measurements have been published in a series of water-supply papers of the Geological Survey entitled, "Water levels and artesian pressures in the United States." The water-level measurements for Comal County are given in the tables of this report.

ACKNOWLEDGMENTS

In the compilation of this report, the notes and geologic maps made by Bennett, which covered about half of the county, have been used freely. Although all parts of the county were visited by the writer, only minor changes were made in Bennett's tentative delineation of geologic features. A small area in the vicinity of Bracken was mapped by A. N. Sayre in connection with a ground-water investigation of the San Antonio area (Livingston, Sayre, and White, 1936, pl. 5). These data were also used in a similar manner. Complete cooperation of the Surface Water Branch of the Geological Survey resulted in prompt response to specific requests for stream measurements.

The writer thanks the farmers and ranchers in the county for their cordial cooperation in supplying information about their wells and permitting access to their properties. Well logs furnished by water-well drillers, particularly E. B. Kutscher of San Marcos and J. R. Johnson of San Antonio, have been helpful in the interpretation of the geology of the area.

CLIMATE

The highest and lowest temperatures recorded by the United States Weather Bureau at New Braunfels over a period of 60 years were 107 F and 2 F. The mean monthly temperatures are given in the following table.

TABLE 1.—*Mean monthly temperatures at New Braunfels, Tex.*

	Mean temperature (° F.)		Mean temperature (° F.)
January	53. 4	July	85. 0
February	57. 0	August	85. 6
March	68. 7	September	81. 2
April	68. 4	October	69. 1
May	76. 4	November	65. 4
June	84. 0	December	52. 8

The following table gives the dates of the last killing frost in spring and the earliest killing frost in autumn at New Braunfels for a period of 20 years. On the basis of these figures the average length of the growing season was 265 days.

The altitude of New Braunfels is about 640 feet, which is considerably lower than the average altitude of the hill country of the Edwards Plateau comprising the greater part of the county. For this reason, the average length of the growing season in the county as a whole may be somewhat shorter than the average at New Braunfels.

TABLE 2.—*Frost data for New Braunfels for the years 1930–49, inclusive*

[From publications of U. S. Weather Bureau]

Year	Date of last killing frost in spring	Date of first killing frost in autumn	Year	Date of last killing frost in spring	Date of first killing frost in autumn
1930	Jan. 31 [1]	Nov. 25	1940	Apr. 13	Nov. 13
1931	Mar. 9	Dec. 4	1941	Feb. 28	[1] Dec. 7
1932	Mar. 14	Nov. 12	1942	Mar. 3	Nov. 12
1933	Feb. 12 [1]	[1] Dec. 12	1943	Mar. 3	[1] Nov. 30
1934	Jan. 9	Dec. 1	1944	Mar. 30	Nov. 27
1935	Feb. 28	Dec. 26	1945	Feb. 23	Nov. 22
1936	Feb. 18	Nov. 4	1946	Feb. 10	Dec. 30
1937	Feb. 3(?)	Nov. 20	1947	Mar. 16	Nov. 7
1938	Feb. 1	Nov. 8	1948	Mar. 13	[1] Nov. 10
1939	Feb. 26	Dec. 27	1949	Feb. 1	[1] Dec. 15

[1] No killing frost reported; date of earliest or latest freezing temperatures given.

The average annual precipitation at New Braunfels during a period of 61 years was 31.29 inches. The records show a wide variation from year to year; the lowest precipitation of record was 13.29 inches in 1917 and the highest was 60.21 inches in 1919. During the 61 years of record, periods in which there was no rainfall during the month have been observed 16 times. April, May, and June have had some rainfall during each of the 61 years.

The following table gives the monthly precipitation for New Braunfels and the average rainfall for each month of the period of record.

TABLE 3.—*Monthly precipitation, in inches, at New Braunfels, Comal County, Tex., 1889–1950*

[Compiled by A. C. Cook, engineer, State Board of Water Engineers, from U. S. Weather Bureau reports]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1889	6.00	3.73	4.00	1.93	0.71	7.42	2.60	6.00	7.96	0.90	4.73	Trace	45.98
1890	.70	2.40	1.01	8.41	3.82	4.38	.84	1.58	6.47	2.58	.63	1.24	34.06
1891	6.33	.49	.32	6.35	2.11	2.55	3.19	1.72	2.58	1.14	.81	7.22	34.83
1892	2.03	.54	1.08	1.03	3.86	1.76	2.41	4.92	1.29	2.68	1.48	4.98	28.06
1893	.11	.69	2.27	3.28	2.87	.55	.39	1.27	.07	0	3.35	.58	15.43
1894	.93	.58	1.14	3.07	3.59	3.45	1.03	8.12	.81	1.91	0	0	24.63
1895	1.38	2.75	2.38	.32	7.51	9.39	Trace	1.93	.60	1.17	4.15	1.03	32.61
1896	3.01	2.27	.33	3.34	.64	.12	1.10	Trace	4.59	6.19	0	1.90	23.49
1897	1.56	.14	2.43	3.10	1.75	2.93	1.19	1.91	1.24	1.72	.32	1.84	20.13
1898	.90	1.16	1.31	2.40	4.60	7.60	3.02	3.18	1.83	.29	1.24	1.53	29.06
1899	.31	.46	0	2.20	2.35	5.21	5.94	0	1.17	2.43	2.89	4.29	27.25
1900	4.00	.74	4.45	11.80	3.75	Trace	3.58	2.73	4.55	3.78	1.48	1.22	42.08
1901	.57	.69	1.40	1.30	5.25	1.99	3.16	.86	2.72	.02	.47	.81	19.24
1902	1.08	.66	.63	2.40	3.35	.22	7.89	0	7.31	2.04	4.60	2.31	32.49
1903	2.73	9.87	1.38	1.82	1.89	5.63	6.15	3.19	.55	2.20	0	1.82	37.23
1904	.24	.71	.43	2.99	7.06	2.42	2.13	1.35	5.76	2.84	.73	1.27	27.93
1905	1.77	2.33	4.44	7.66	2.31	4.39	1.81	.26	1.11	2.57	3.94	2.39	34.98
1906	.39	1.31	1.70	2.84	.61	1.84	3.25	3.66	1.45	1.30	1.81	3.60	23.76
1907	.24	.26	2.24	2.11	-----	-----	-----	-----	-----	6.24	9.28	-----	-----
1908	.91	3.19	1.88	3.52	3.90	.21	.43	3.08	3.78	3.04	1.58	3.98	29.50
1909	0	.47	.51	1.31	2.36	1.12	3.77	1.27	.19	4.57	2.48	1.61	19.66
1910	.27	1.03	.19	3.70	2.71	.39	.80	.18	1.40	2.52	.45	2.36	16.00
1911	.04	2.34	5.50	4.64	2.17	.29	.79	1.18	1.00	3.17	1.65	2.79	25.56
1912	.46	5.38	2.76	1.51	2.21	2.54	.77	Trace	1.34	2.51	3.07	3.35	25.90
1913	1.05	2.36	1.48	.95	3.11	5.64	1.40	2.25	4.66	12.78	6.60	8.12	50.40
1914	.19	1.85	2.37	5.41	4.79	1.41	.62	7.35	1.66	5.51	4.09	2.46	37.71
1915	1.23	1.98	1.62	9.75	2.78	.18	.94	3.23	2.66	.49	.63	2.47	27.96
1916	2.67	0	0	3.11	4.99	.71	3.77	3.12	1.41	2.54	1.93	.33	24.58
1917	1.23	1.29	.24	.64	4.51	.11	3.31	Trace	1.39	.57	0	0	13.29
1918	.87	1.04	1.19	2.36	3.72	1.39	.20	.54	1.79	4.55	3.42	4.79	25.86
1919	4.81	1.94	1.47	4.02	5.88	6.72	6.97	3.82	5.54	16.44	1.18	1.42	60.21
1920	3.64	.42	.84	1.00	3.98	3.12	.14	6.98	.88	2.02	2.68	.18	25.88
1921	3.11	.67	5.70	5.60	1.68	5.04	.23	.90	10.07	.98	.38	1.16	35.52
1922	1.36	1.72	5.08	6.81	4.02	3.32	.58	.53	1.33	4.59	1.31	.20	30.85
1923	1.16	4.44	2.48	3.77	3.32	2.25	2.15	1.58	3.77	5.57	3.06	5.98	39.49
1924	1.57	3.32	1.98	4.08	5.77	2.36	Trace	.15	2.30	.61	.05	2.39	24.58
1925	.20	.14	0	.33	1.94	3.13	.30	2.94	4.28	3.70	2.09	1.11	20.16
1926	4.37	.12	6.55	9.64	3.97	1.41	.90	.42	1.61	2.29	2.00	2.98	36.26
1927	1.29	1.64	3.73	1.37	1.71	4.78	1.20	0	1.18	3.87	0	2.17	22.94
1928	.81	5.13	1.18	1.58	3.13	8.36	2.44	.84	4.71	1.58	3.03	3.28	36.07
1929	2.47	.35	4.69	2.59	11.39	2.02	5.37	.64	1.85	3.69	3.35	1.74	40.15
1930	1.58	2.09	2.11	1.64	3.01	7.21	.30	0	1.57	5.24	2.28	1.68	28.71
1931	5.79	4.10	5.34	1.66	.93	2.41	4.34	1.77	.08	.35	.86	3.95	31.58
1932	4.66	2.92	1.61	2.76	1.92	1.61	2.50	4.90	5.19	.28	.75	2.05	31.15
1933	1.48	2.15	1.37	2.36	4.98	1.29	5.69	1.38	1.80	2.53	.83	.89	26.75
1934	7.98	1.94	3.02	1.85	.92	.29	3.02	.58	2.49	.18	2.55	5.98	30.80
1935	.71	2.84	1.87	2.44	11.81	4.21	3.10	.18	9.88	.93	.31	3.39	41.67
1936	.80	.63	1.64	2.51	5.47	3.60	1.29	3.28	4.53	2.55	2.67	1.44	30.41
1937	1.33	.15	4.07	.85	4.43	5.41	.53	.54	.51	3.30	1.90	6.17	29.19
1938	4.12	1.61	2.39	8.81	5.20	.75	2.22	.29	.65	.20	.97	1.11	28.32
1939	1.35	.81	.95	.98	2.15	.90	1.93	1.07	.67	.50	1.32	.72	13.35
1940	.90	2.95	1.57	3.62	3.45	9.89	1.04	1.00	1.43	3.74	4.50	4.02	38.11
1941	2.04	3.17	3.65	8.07	6.28	6.69	1.60	.49	3.70	4.51	1.28	1.51	42.99
1942	.46	2.92	.67	3.63	2.87	2.21	10.44	3.61	6.49	7.15	1.06	.57	42.09
1943	1.44	.22	1.17	.58	3.30	3.32	4.73	0	9.50	1.25	2.46	1.96	29.93
1944	6.24	3.22	4.03	1.58	8.93	1.68	.22	3.94	1.34	.46	6.48	5.02	43.14
1945	3.71	5.33	6.27	2.41	.89	3.29	2.41	1.41	2.11	8.45	1.44	1.66	39.38
1946	4.77	2.58	3.96	2.02	5.75	10.88	1.89	7.14	8.33	3.74	2.60	3.21	56.60
1947	4.83	.42	2.00	1.72	7.32	.71	1.49	4.54	.74	Trace	1.67	2.08	27.52
1948	.56	2.99	1.11	1.98	1.52	1.23	1.59	2.82	1.81	2.69	1.58	-----	-----
1949	3.88	3.72	1.47	9.15	.75	5.43	.97	2.55	1.88	10.36	.06	2.99	43.21
1950	.55	3.76	.42	4.11	3.14	3.02	2.25	.72	1.83	1.20	.13	0	21.13
Av.	2.05	1.99	2.18	3.40	3.73	3.19	2.30	2.06	2.91	3.05	2.04	2.39	31.29

The following table gives the record of precipitation at Fischer Store, near the north end of the county, for a period of 59 years. The annual average is about the same as the average at New Braunfels, but the monthly and yearly totals at the two stations differ materially.

TABLE 4.—*Monthly precipitation, in inches, at Fischer Store, Comal County, Tex., 1890–1950*

[Compiled by A. C. Cook, engineer, State Board of Water Engineers, from U. S. Weather Bureau reports]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1890	1.70	1.55	.20	4.95	4.32	3.91	0	1.77	7.00	1.26	1.56	.81	29.03
1891	5.50	.76	.76	4.40	2.60	1.71	.80	1.65	4.30	.01	1.75	8.40	32.64
1892	2.00	.16	.65	.25	3.90	1.60	1.70	5.46	.28	2.05	1.16	5.05	24.26
1893	0	.10	2.40	.75	2.40	1.55	.25	.05	.01	0	4.85	1.25	13.61
1894	1.25	.50	.50	4.55	3.20	1.30	.45	7.35	1.00	1.75	0	.25	22.00
1895	1.25	2.45	1.35	1.25	5.20	4.90	0	1.25	2.65	1.76	3.30	.60	25.96
1896	4.50	3.60	1.10	4.85	0	1.00	4.20	0	12.25	4.80	.15	2.10	38.55
1897	1.90	0	3.20	2.65	.85	2.10	.50	3.10	.85	2.00	0	1.10	18.25
1898	.75	.75	1.25	1.90	1.50	5.75	3.35	1.50	.50	.15	.75	.25	18.40
1899	0	0	0	1.90	2.15	6.45	3.20	0	.50	4.48	1.50	4.00	24.18
1900	4.50	0	2.40	9.35	5.18	0	5.35	4.15	2.25	1.55	.50	.75	35.98
1901	0	0	.85	.50	4.52	.75	2.25	1.00	3.50	0	.50	0	13.87
1902	.75	.75	1.85	2.25	4.63	1.15	6.00	0	3.95	2.00	5.05	3.50	31.88
1903	2.00	7.25	1.00	2.10	.50	4.00	7.00	2.65	.25	3.75	0	2.00	32.50
1904	0	------	.75	4.13	6.80	4.65	2.75	3.50	3.50	2.50	.25	.75	------
1905	1.75	1.75	3.25	6.75	2.00	2.40	2.50	1.25	2.75	2.50	2.50	1.00	30.40
1906	0	1.00	.50	1.50	1.10	1.50	4.38	.75	3.50	0	1.00	3.50	18.73
1907	.20	.25	1.00	2.53	7.25	1.25	1.00	0	1.50	5.50	5.25	0	25.73
1908	1.50	1.50	1.38	.50	5.00	.25	0	4.65	.50	1.50	.75	1.50	19.03
1909	0	0	.50	1.55	5.65	.80	4.25	.75	1.25	2.50	3.85	1.50	22.60
1910	0	.50	.56	4.00	4.75	1.50	1.50	.87	.90	2.88	1.25	3.33	22.04
1911	0	1.75	2.40	6.75	3.00	0	.50	.25	.65	1.27	2.75	2.00	21.32
1912	0	3.00	1.65	3.00	.95	3.75	.35	1.00	.25	3.75	2.25	1.50	21.45
1913	.75	1.25	1.20	.75	2.75	5.25	0	3.35	11.25	11.75	0	8.40	46.70
1914	0	.75	5.65	5.94	6.75	.75	0	16.85	1.00	2.75	2.40	2.00	44.84
1915	1.25	2.00	1.25	10.75	1.40	.30	2.63	3.00	2.25	0	.75	3.00	28.58
1916	3.90	0	4.15	1.15	7.35	.50	7.00	3.25	2.00	1.70	2.25	.25	33.50
1917	.50	.87	0	1.15	5.98	0	1.00	.75	.50	.25	1.25	0	12.25
1918	.60	2.00	1.10	6.73	1.75	1.15	1.25	3.30	.90	2.75	3.25	6.00	30.78
1919	3.55	2.75	1.95	2.00	4.03	5.50	10.00	5.00	7.40	8.50	.25	.75	51.68
1920	4.25	.35	1.22	0	7.25	2.55	.25	4.85	1.13	2.25	2.75	0	26.85
1921	1.65	1.00	3.50	4.60	1.75	5.60	1.25	0	12.00	.75	.75	0	32.85
1922	1.50	1.05	2.80	6.60	3.25	3.10	.25	3.15	2.00	2.50	1.40	0	27.60
1923	0	5.25	2.85	3.75	1.85	1.75	1.35	1.20	7.30	3.90	3.60	4.55	37.35
1924	1.38	3.30	2.65	3.20	6.20	1.75	1.34	.15	3.50	0	0	1.35	24.82
1925	.60	0	0	2.27	1.35	.67	2.37	3.14	1.76	7.73	2.65	1.00	23.54
1926	4.02	0	4.52	6.90	4.55	3.05	6.95	.90	.90	3.19	2.35	3.36	40.69
1927	1.28	3.02	2.45	2.36	1.40	5.15	2.06	.40	.70	8.15	0	2.95	29.92
1928	.53	3.57	1.38	1.75	5.15	3.28	3.19	.28	3.80	.80	2.85	2.25	28.83
1929	2.87	0	3.00	4.70	15.15	1.40	5.70	0	1.00	1.53	3.85	1.40	40.60
1930	.95	1.15	1.77	1.60	8.90	2.00	1.05	.32	2.27	6.71	2.05	2.03	30.80
1931	4.35	4.53	3.20	5.50	.90	3.27	4.25	1.35	0	.75	1.00	3.47	32.57
1932	5.21	2.12	2.47	1.00	1.52	0.90	1.90	6.20	3.35	.15	.78	1.98	27.58
1933	3.50	2.03	.60	1.38	2.70	1.70	4.20	5.05	1.97	1.97	.60	1.20	26.90
1934	6.77	2.13	2.90	4.70	1.10	.20	2.65	.45	.70	0	3.45	3.57	28.62
1935	1.51	3.68	.50	.50	11.43	7.48	3.80	1.28	5.84	2.75	.20	3.10	42.07
1936	.43	.85	1.18	2.25	8.03	5.85	3.83	1.95	6.65	2.60	1.95	2.29	37.86
1937	3.00	0	2.87	.85	3.44	1.91	1.63	1.22	.51	5.41	1.55	6.55	28.94
1938	3.80	1.43	1.35	5.21	3.05	2.33	2.20	.43	.70	.41	.52	1.70	23.13
1939	10.08	1.23	.41	2.98	1.84	.83	4.89	2.64	.32	1.10	1.82	1.39	29.53
1940	3.95	3.65	1.51	2.50	1.08	2.82	4.00	3.12	1.40	3.30	4.20	5.75	37.28
1941	2.20	2.46	4.23	5.71	3.73	8.75	0	0	2.18	4.98	.60	1.17	36.02
1942	0	1.50	.96	4.64	2.38	2.20	3.14	4.62	6.40	3.48	1.23	.60	31.15
1943	.69	.18	2.55	1.60	5.39	1.78	3.15	1.00	2.68	.45	1.05	2.31	22.83
1944	5.67	3.45	3.17	1.15	6.50	1.84	.38	4.02	2.88	1.35	5.59	5.55	41.55
1945	3.33	4.22	4.55	1.38	.73	3.68	4.10	2.60	3.41	3.40	.80	3.10	29.28
1946	4.42	2.70	4.95	2.78	3.90	3.18	2.91	3.82	6.55	1.50	6.48	3.60	46.79
1947	4.70	.44	2.33	1.08	2.84	1.83	.85	2.90	0	.80	2.03	1.34	21.14
1948	.58	------	------	1.70	------	4.65	------	------	1.91	------	.70	------	------
1949	------	------	2.18	2.64	------	1.84	3.25	------	------	4.93	0	2.33	------
1950	.78	3.60	.15	3.96	3.35	2.06	------	.84	4.05	1.50	.72	0	------
Av.	2.07	1.66	1.88	3.15	3.87	2.54	2.53	2.31	2.79	2.57	1.78	2.26	29.41

Boerne is about 10 miles west of the Comal County line, and it is believed that the rainfall in the vicinity of Boerne and the western part of Comal County contributes a considerable amount of water to the ground-water reservoir that supplies Comal Springs. The following table gives the monthly precipitation at Boerne in Kendall County.

TABLE 5.—*Monthly precipitation, in inches, at Boerne, Kendall County, Tex., 1892–1950*

[Compiled by A. C. Cook, engineer, State Board of Water Engineers, from U. S. Weather Bureau reports]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	2.03	0.54	1.08	1.03	3.86	2.13	0.43	4.44	0.17	4.23	2.16	4.86	26.96
1893	.21	.98	2.10	1.89	2.79	1.34	.91	1.05	.23	.60	3.84	1.02	16.96
1894	1.68	1.16	1.10	7.78	6.05	2.17	.13	6.87	1.97	2.72	.07	.23	31.93
1895	1.48	4.02	2.09	.51	6.30	4.76	.16	1.22	4.30	1.55	4.75	.81	31.95
1896	4.41	2.82	.83	2.95	.98	.37	6.71	.62	5.59	4.86	.31	2.41	32.86
1897	1.56	.10	4.06	3.26	1.45	2.15	1.82	4.03	3.29	2.33	.12	2.29	26.46
1898	1.25	1.24	1.92	3.88	2.71	6.71	1.66	1.70	2.10	3.32	2.16	2.77	31.42
1899	.42	.45	.03	1.77	3.10	4.96	3.29	.39	2.97	8.96	2.59	4.91	33.84
1900	5.31	.25	3.36	12.36	7.71	1.08	8.40	2.46	1.99	4.62	1.35	1.30	50.19
1901	.47	1.08	1.20	1.15	3.74	1.86	6.04	1.18	3.06	.74	.75	.33	21.60
1902	.97	1.02	1.97	2.32	5.94	.39	2.77	.06	2.84	2.78	9.00	3.65	33.71
1903	3.35	8.70	2.21	2.03	2.05	6.15	9.50	.58	1.62	1.59	Trace	.75	38.53
1904	.12	1.33	.88	4.26	8.28	1.84	1.99	4.16	8.83	2.50	.55	1.67	36.41
1905	1.00	1.50	3.30	9.30	.17	4.10	1.30	1.60	3.80	2.10	4.50	1.80	34.47
1906	.40	.90	.45	2.40	1.20	1.05	7.00	1.95	5.60	1.00	1.20	3.00	26.15
1907	.20	1.00	1.40	2.40	7.75	.20	1.50	.60	1.70	7.95	10.40	1.50	36.60
1908	.40	2.10	2.00	2.40	7.60	0	5.50	5.90	1.00	.45	2.35	.83	30.53
1909	0	.30	1.57	2.10	3.89	1.05	6.90	.88	1.94	1.42	2.95	2.76	25.76
1910	.05	.68	3.70	3.38	1.91	.61	.84	Trace	1.43	3.11	1.34	4.41	21.46
1911	.58	2.17	5.45	4.72	1.36	.13	1.70	1.05	.40	1.97	2.95	2.95	25.43
1912	.34	3.55	3.53	2.73	1.15	3.41	.92	.86	1.73	3.47	3.84	2.18	27.71
1913	1.21	1.80	.90	1.94	3.85	6.05	.33	.53	5.64	16.37	8.03	5.82	52.47
1914	.05	1.73	1.32	6.57	15.65	.50	.84	10.00	1.56	2.52	3.80	2.24	46.78
1915	1.68	2.90	1.69	9.94	1.30	.16	1.61	5.20	5.34	1.18	.67	2.04	33.71
1916	4.35	.04	.23	6.76	7.54	.54	3.62	2.63	5.44	4.39	.87	.25	36.66
1917	1.05	1.30	.28	1.14	6.85	3.65	.58	.13	3.05	.95	.79	.05	19.82
1918	.28	1.65	.93	3.72	1.28	2.56	.12	1.27	4.01	3.47	4.72	6.57	30.58
1919	4.14	2.85	1.73	3.84	4.16	5.74	6.27	7.06	13.90	10.49	1.08	1.21	62.47
1920	2.72	.74	.94	1.31	2.44	3.89	1.53	2.99	2.63	3.54	5.04	.22	27.99
1921	2.16	.87	3.35	4.81	2.35	3.87	1.02	.90	9.69	1.02	1.39	1.38	32.81
1922	1.42	1.54	3.18	7.59	3.22	3.15	.28	.41	1.66	2.24	1.41	.13	26.23
1923	.56	5.35	3.28	4.89	1.61	1.48	3.23	1.92	9.97	7.18	4.02	4.74	48.23
1924	1.64	3.61	2.91	3.86	9.82	4.10	0	.10	4.06	.79	.24	1.66	32.79
1925	.42	.12	Trace	1.51	2.35	1.02	.59	2.10	3.17	6.00	2.66	1.07	21.01
1926	2.85	.11	6.04	8.11	4.17	2.96	2.85	.89	.27	4.13	3.10	3.08	38.56
1927	1.54	4.60	2.72	3.48	2.72	5.58	3.17	.15	.86	1.75	.10	3.23	29.90
1928	.64	3.90	.68	1.70	1.01	2.64	4.07	1.64	5.73	1.07	2.06	2.61	27.75
1929	1.58	.62	1.34	2.42	8.04	1.28	6.83	.64	2.02	2.86	3.17	3.26	34.06
1930	1.54	1.22	2.51	1.95	5.20	4.27	1.22	.94	2.01	9.85	2.34	1.40	34.45
1931	6.44	5.53	2.69	7.09	1.62	1.79	3.81	1.60	.17	------	------	3.78	------
1932	4.38	3.84	3.14	3.01	1.94	1.22	5.62	4.49	5.19	0	.47	3.35	36.65
1933	4.13	2.51	.85	1.32	3.75	1.20	2.37	.83	2.52	.13	.48	.49	20.58
1934	6.01	2.33	2.54	2.73	1.74	.55	5.17	.38	.91	.14	.99	3.29	26.78
1935	.42	3.02	.77	2.45	12.59	8.59	6.80	.57	10.40	2.14	1.35	3.81	52.93
1936	.70	.65	1.74	.97	11.17	9.27	2.80	2.44	11.43	2.97	1.77	1.68	47.59
1937	1.98	.15	2.92	1.60	5.94	5.50	3.24	1.49	.10	2.89	1.54	5.46	32.81
1938	4.06	1.61	2.07	4.52	2.59	1.33	1.84	.22	3.97	.16	.48	1.29	24.14
1939	3.54	.86	.65	1.46	2.58	.58	6.55	3.05	.48	3.16	2.33	.96	26.20
1940	.68	3.69	1.59	2.24	3.45	3.90	.79	1.19	1.17	4.71	3.67	5.21	32.29
1941	1.81	5.88	4.71	5.76	4.51	3.03	1.61	.55	5.00	7.02	.85	.87	41.60
1942	.41	1.17	.66	3.53	3.79	1.27	2.62	3.91	4.78	5.65	1.58	1.75	31.12
1943	.86	.07	1.71	1.27	4.26	3.57	5.16	.05	4.76	.39	1.59	2.64	26.33
1944	3.67	3.75	3.70	1.03	8.56	1.88	.87	7.56	2.25	1.37	3.91	4.38	42.98
1945	3.55	2.94	1.98	1.10	1.00	2.65	4.22	2.85	5.01	3.94	1.30	2.96	33.50
1946	3.02	2.35	1.93	3.94	3.65	3.14	2.40	6.62	9.45	4.22	2.29	2.61	45.62
1947	4.09	.37	1.91	1.51	5.92	1.05	1.28	2.49	.15	1.33	1.34	1.19	22.63
1948	.44	3.08	1.49	1.98	1.29	5.47	1.81	.87	3.56	2.43	.57	.78	23.77
1949	3.68	3.72	1.73	7.28	3.18	3.95	3.77	5.54	2.08	3.33	0	2.89	41.15
1950	.70	2.49	.34	3.73	3.08	2.02	4.14	3.88	3.29	.55	.72	0	24.94
Av.	1.88	2.05	1.99	3.54	4.24	2.74	2.96	2.24	3.63	3.25	2.24	2.32	33.08

The following is a record of monthly precipitation at Bulverde, in the western part of Comal County in the drainage area of Cibolo Creek from 1940 to 1950. The record is pertinent to the study of comparative runoff and infiltration in this area.

A. GUADALUPE RIVER AT HUECO SPRINGS FAULT.
B. CAVERN IN FLOOD PLAIN ON CIBOLO CREEK.

TABLE 6.—*Monthly precipitation, in inches, at Bulverde, Comal County, Tex., 1940–50*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1940	-------	[1] 1.14	0.79	2.84	3.69	4.47	1.91	1.50	1.48	2.88	4.94	5.81	[1] 31.45
1941	1.18	4.31	3.85	6.00	3.00	5.48	2.02	.54	3.52	7.05	.48	1.54	38.97
1942	.12	2.76	.20	3.97	2.40	2.17	4.86	2.15	7.17	8.15	1.32	.72	36.99
1943	.55	.15	1.53	1.78	3.62	2.17	7.45	.12	7.57	1.42	1.98	2.78	31.12
1944	3.91	3.81	4.42	4.83	5.87	2.53	.75	4.89	2.33	1.13	5.80	5.61	45.88
1945	3.21	4.08	5.19	1.45	.78	3.00	1.14	.35	2.92	4.43	.78	2.06	29.39
1946	3.55	2.53	5.07	3.77	4.05	3.59	.54	5.33	12.96	2.53	6.69	3.77	54.38
1947	2.86	.37	1.55	.55	2.87	0	.79	4.22	.58	1.01	.85	1.33	16.98
1948	.53	2.91	.88	1.94	2.45	2.25	1.44	.97	1.90	2.00	1.15	.92	19.34
1949	4.24	3.16	2.27	10.23	.98	3.75	4.03	1.50	1.72	4.41	.24	3.02	39.55
1950	.65	3.21	.31	3.96	6.39	1.92	3.07	3.96	3.04	.30	.30	.09	27.20
Av.	2.08	2.58	2.37	3.76	3.28	2.85	2.55	2.41	4.11	3.21	2.23	2.51	33.94

[1] Incomplete record.

TOPOGRAPHY

GENERAL FEATURES

Comal County falls within two physiographic provinces, the Edwards Plateau northwest of the Balcones escarpment and the Coastal Plain southeast of the escarpment.

The Edwards limestone, which is named for the Edwards Plateau, together with remnants of formations of the Washita group, cover most of the surface of the vast area northwest of the Balcones escarpment. Locally the Plateau is dissected so that the Edwards limestone has been removed and only small remnants cap the hills.

On the Edwards Plateau, in the central part of the county, much of the area is rough or rolling and is referred to locally as the "mountains" or "hill country." In certain stretches along the Guadalupe River and Cibolo Creek, canyons have been developed. The canyon along the Guadalupe River a few miles northwest of New Braunfels has almost vertical walls and is known for its scenic beauty. In places the uplands are pitted with sink holes.

The highest point in the county, altitude 1,527 feet, is at the summit of Devil's Hill, 7 miles west of Smithson Valley; the lowest point, altitude about 600 feet, is in the channel of the Guadalupe River where it enters Guadalupe County. The total relief in the county, therefore, is more than 900 feet.

In the western part of the county, beds of massive limestone alternating with softer clays and shales result in steplike terraces which circle the steep slopes like contour lines. In this area there are sharp divides, in contrast to the fairly wide and comparatively flat mesas of the Edwards Plateau.

DRAINAGE

Most of Comal County drains directly into the Guadalupe River. The northernmost part of the county is drained by the Little Blanco River and the southwestern part by Cibolo Creek and Comal Creek.

These streams have wide meanders characteristic of old streams and have apparently held their general courses through the events of recent geologic history. There is much evidence, however, of comparatively recent rejuvenation. The streams are actively degrading their channels within their meander belts. The channels are barren of sediments except for large boulders. Rapids are found where major faults cross the streams (pl. 1*A*), indicating comparatively recent movement along the fault planes.

STRATIGRAPHY

Sedimentary rocks may be seen at the surface in all parts of Comal County, but only small outcrops of igneous rock have been found. Basalt porphyry intrudes the Glen Rose limestone near the Kendall County line. No igneous rock has been reported in the log of any well in the county. Metamorphic rock in the form of schist is reported in the log of the oil test (well F32, see driller's log) on the E. J. Heidrick ranch 6½ miles west of New Braunfels.

The sedimentary rocks are composed of layers of limestone, shale, clay, sandstone, and sand, which for convenience of study and reference have been grouped by geologists into formations and larger units, usually named for the areas in which they were first observed and described. The limestones, sandstones, and sands contain the underground-water reservoirs in Comal County. Openings in rocks such as cavities in limestone caused by solution or fracturing or spaces between grains of sand, permit the movement of water from the surface downward to the ground-water reservoirs and also laterally within the reservoirs. Clays and shales generally transmit little or no water and are regarded as barriers which retard or prevent the movement of water. For a complete classification and discussion of openings in rocks, reference should be made to the work of O. E. Meinzer (1923a, pp. 109–148).

The occurrence of ground water is closely related to the geologic history of Comal County. Gradual elevation or subsidence of the land relative to the level of the sea is clearly shown by the upward succession of strata, marked by the fossil remains of animals contained in them. Breaks in the continuity of sediments that were deposited in the sea are indicated by the absence of strata that are known to occur elsewhere in Texas. This means that Comal County was above the level of the sea while other parts of Texas were still below sea level. In such areas sediments were still being deposited to form strata not found in Comal County. These breaks in sedimentation are called disconformities and are mentioned later in the description of the formations.

More abrupt movements within the earth underlying Comal County have resulted in the dislocation of the rock, so that in some places formations that were deposited early in the geologic history are now found to be in contact with and at the same level as formation that were deposited much later and normally belong at much higher levels. The planes of contact between these formations are called faults and can be traced at the surface in linear patterns. The major faults are shown on the geologic map, plate 2. Deformation along fault lines has caused some strata to dip or to be inclined from their original nearly horizontal position.

Except for a few isolated alluvial deposits of Pleistocene age the water-bearing rocks in Comal County are of Cretaceous age. The following table shows the thicknesses of the various geologic formations and gives brief descriptions of the character of the formations, their water-bearing properties, and the characteristic appearance of the land where the formations are at the surface.

ROCK FORMATIONS AND THEIR WATER-BEARING PROPERTIES

PRE-CRETACEOUS ROCKS

No rocks older than those of Cretaceous age crop out in Comal County and it is believed that no wells in Comal County yield water from such formations.

After the long and complex history of the Paleozoic era, as shown by the rocks which crop out in Llano County and adjacent counties, the sea retreated from central Texas and a large part of Texas became a mountainous land and remained above sea level during the Triassic and Jurassic periods which followed. It is believed that Paleozoic rocks underlie Comal County at considerable depth but Triassic and Jurassic formations are probably absent. The schist reported in the drillers' log of well F32 is probably Paleozoic in age. Sellards (1920, pp, 19–21) and Udden have identified Paleozoic schists in two deep wells in the Leon Springs area, a few miles south of the western part of Comal County, and at other places along the Balcones fault zone (Sellards, 1931, pp. 819–827), indicating a large subsurface area of of these schists.

CRETACEOUS SYSTEM

PRE-COMANCHE ROCKS

As yet not enough deep wells have been drilled to clarify the geologic history of the Early Cretaceous formations in Comal County. From 15 to 20 miles north of the north tip of Comal County, in Blanco County along the Pedernales River, the Travis Peak formation (Cuyler 1939, pp. 625–642) lies directly upon Paleozoic rocks ranging in age from Ordovician to Carboniferous. The Travis Peak formation has

TABLE 7.—*Geologic formations in Comal County, Tex.*

System	Series and group	Formation	Thickness (feet)	Character of rocks	Characteristic appearance at land surface	Water supply
Quaternary	Recent	Alluvium	0–15±	Sand, silt, clay, and gravel	Lowest stream terraces	No dependable reservoirs.
	Pleistocene	Leona formation	0–50±	Sand, silt, and gravel	Wide, flat terraces in stream valleys 30 to 75 feet above beds of streams. Good farm land.	Furnishes good water to many wells in Guadalupe River Valley southeast of New Braunfels, and to a few wells in parts of Cibolo Creek Valley.
Tertiary (?)	Pliocene (?)	Uvalde gravel	0–15±	Coarse flinty gravel	Hilltops and divides	No wells are known to draw water from this formation.
Cretaceous	Gulf	Taylor marl and Anacacho limestone, undifferentiated.	300±	Blue marl, weathers to buff. Nodular, chalky marl.	Rounded hills with clayey soils.	Yields highly mineralized water to a few shallow wells.
		Austin chalk	150±	White to buff chalk and limestone.	Low rounded hills and black-land soils.	Wells generally have small yield.
		Eagle Ford shale	10–25	Yellow clay and sandy clay. Brown arenaceous flagstones. Lignite common in wells.	Slight terraces where flagstones are present.	No wells known to obtain water from this formation in Comal County.
	Comanche. Washita group.	Buda limestone	35–70	Splintery massive limestone. Yellow to buff. Often speckled with darker spots.	Low ridges; generally broken fragments or boulders.	Generally not water-bearing.
		Grayson shale (Del Rio)	40–55	Greenish-yellow clay. Some hard calcareous beds. "Ram's horn" (*Exogyra arietina*) fossils abundant.	Usually partly covered by boulders from overlying Buda limestone. Cultivated in places.	Yields no water to wells in Comal County.
		Georgetown limestone	20–25	Hard massive limestone. Thin marl beds in some places.	Rocky slopes. Arable fields where marl beds are present.	Generally yields little or no water.
	Comanche. Fredericksburg group.	Edwards limestone	500±	Hard white limestone with flint nodules. Honeycombed and cavernous. Some chalky beds.	Deep canyons along streams; upland surface undulating and pitted with sinkholes.	Yields more water than any other formation in Comal County.
		Comanche Peak limestone.	40±	Hard limestone, similar to Edwards limestone. Contains no flint.	Forms part of canyon walls along streams.	Not distinguished from Edwards limestone in wells.
		Walnut clay	1–15	Fossiliferous marl and limestone.	Arable land in valleys. Used for road surfacing.	Small yield to few farm wells.
	Comanche. Trinity group.	Glen Rose limestone. {Upper member. Lower member.}	650±–1, 500±	Alternating beds of hard limestone and dark-blue marl. Thick massive limestone beds at base.	Step terraces and rugged topography; sinkholes and honeycombed rock where lower part of formation is exposed.	Yield usually small. Supplies large number of ranch wells.
		Travis Peak formation	100±–300 (?)	Fine sand, marl, and limestone	The Cow Creek limestone member forms canyon walls. Underlying Sycamore sand member not exposed.	Few good springs in limestone. No large yield from wells.
		Hosston (?) formation	(?)	Dark and red shales and sandstone.	Not exposed in Comal County	Probably not water-bearing.
Pre-Cretaceous rocks.	(?)	(?)	(?)	Schist	do	Do.

long been regarded as the oldest Cretaceous strata in central Texas (Hill, 1901, p. 140).

However, Ralph W. Imlay (1945) of the Geologic Division of the United States Geological Survey, in cooperation with a number of other geologists associated with the oil industry, has presented evidence to indicate that the older basinward strata of Cretaceous age extending from Arkansas to Mexico should be classified as the Hosston, Sligo, and Pearsall formations in ascending order; the Pearsall being the subsurface equivalent of the Travis Peak formation. The Hosston and Sligo have not been positively identified in Comal County wells. There is a possibility, however, that the 177 feet of "red beds" and blue lime shown from 1,518 to 1,795 feet in the drillers' log of well F32 may belong to the Hosston formation.

No potable water has been reported from pre-Trinity rocks in Comal County.

COMANCHE SERIES

TRINITY GROUP

Travis Peak formation

The Travis Peak formation was divided by Hill (1901, pp 141–144) into three members, which in ascending order are: the Sycamore sand member, the Cow Creek limestone member, and the Hensell sand member. These members were described from outcrops near the Travis Peak post office in the northern part of Travis County, Tex.

Rocks that are believed to be the equivalents of the Cow Creek limestone and Hensell sand members of the Travis Peak are exposed near the Guadalupe River in the northwestern part of Comal County. These are the oldest rocks that are exposed in the county. They were observed by Cuyler (1939), who pointed out that these two members are uniform in thickness as compared with Hill's Sycamore sand member. The Sycamore contains materials characteristic of the first deposits of a transgressing sea and differs in thickness according to the topography of the land surface on which it was deposited. In the outcrop areas of the Sycamore sand member in north-central Texas the sands are coarse and some parts of the member are conglomeratic, and east of the outcrop area this member is an important source of ground water for municipalities and industries. The Sycamore does not crop out in Comal County and it is doubtful that such sands are present beneath the sufrace. A number of wells in the Guadalupe River Valley in the vicinity of Spring Branch (wells A13, A15, A17, A20, and others) are deep enough to have entered these sands if they were present but no such sands have been reported. No well logs for these wells are available, however, and no tests have been made to determine the probable maximum yield.

The Cow Creek limestone member consists of massive gray-white fossiliferous limestone and has a total thickness of about 75 feet. The limestone is honeycombed in some places along the outcrop but little is known regarding the permeability of the Cow Creek where it is deeply buried and protected from surface weathering. It is believed that large yield cannot be expected in such places. In well A32, on the south bank of the Guadalupe River near Highway 281, however, honeycombed rock which yields an ample supply of water for domestic and stock use was encountered at a depth of 330–380 feet. It is believed that the honeycombed rock is a part of the Cow Creek member.

Rebecca Creek Spring, A5, 9 miles northwest of Hancock, which at times flows as much as 2,000 gallons a minute, issues from the lower part of the Cow Creek. Here the reservoir that supplies the spring is at or near the surface and is weathered.

The Hensell sand member is composed of buff-colored argillaceous and calcareous fine-grained sand containing siliceous and calcareous geodes locally known as Katzenköpfe (cat heads). There are also sandy limestone beds containing glauconite which adds a greenish tint to the buff color. Within the limited area of exposure in Comal County the contact between the Glen Rose and the Travis Peak formations appears to be comformable and is shown on plate 2. It is arbitrarily placed at the top of the greenish-colored glauconitic limestone of the Travis Peak that is in contact with the overlying gray-white honeycombed rudistid-bearing beds of the Glen Rose limestone. The following section was observed 2.3 miles northeast of the Spring Branch post office, above United States Geological Survey benchmark R26 Texas, 1924; altitude 1,036 feet.

	Thickness (feet)	*Altitude top of bed (feet)*
Glen Rose limestone: Limestone, massive, honeycombed, gray-white; contains rudistids	3	1,089
Travis Peak formation—Hensell sand member:		
Limestone, greenish buff, sandy, nodular, with honey comb texture; glauconite abundant	22	1,086
Sandstone, fine-grained, greenish buff, calcareous; contains white hard siliceous geodes ranging in diameter from 1 to 8 inches, locally known as Katzenköpfe (cat heads)	6	1,064
Sandstone, yellow to buff, calcareous, containing large fossil oysters near top. The fossils (*Exogyra*) have concentric surface markings of secondary siliceous material (beekite)	11	1,058
Sandstone, fine-grained, buff, argillaceous; contains "cat heads." Stratified; some poorly preserved fossils	1½	1,047
Limestone, hard, buff; contains large fossil oysters also covered with beekite like those above	2	1,045½

	Thickness (feet)	Altitude top of bed (feet)
Covered	7½	1, 043½
Fault	----	1, 036
Glen Rose limestone	----	1, 036
Bench mark	----	1, 036

The rocks of the Hensell sand member, buff-colored where weathered, are probably blue where protected from weathering. In wells the member is known as "the blue rock." The member generally yields sufficient water for domestic and stock use, but, because of its relatively low permeability, large yields probably cannot be obtained from wells obtaining water from this source.

Evidence of the lack of permeability in the Hensell sand member of the Travis Peak formation is shown by the fact that at least two fairly large springs (A28, A12) issue near the contact between it and the overlying Glen Rose limestone. The water accumulates in sinkholes and in the honeycombed rudistid bearing limestone bed in the base of the Glen Rose limestone, which covers a fairly large area in the western part of Comal County and the adjacent part of Kendall County. It flows underground on top of the Hensell sand to points where the streams have cut through the contact whence it issues as springs.

Glen Rose limestone

The Glen Rose limestone is exposed at the surface in the northwestern part of the county in an area equal to about one-half of the area of the county. The thickness of the formation ranges from about 650 feet in the northern part of Comal County to about 1,200 (?) feet in the southern part of the county, where the formation has been penetrated by oil test drilling. Where thick sections are exposed at the surface the Glen Rose is easily recognized at a distance because of the characteristic terraces or stair-step topography due to the alternation of limestone and more easily eroded marl beds.

For convenience of reference, the Glen Rose limestone is arbitrarily divided into two parts which are referred to in this report as the upper and lower members of the Glen Rose limestone. The division is made at the top of a well-known fossiliferous zone called the *Salenia texana* zone which occurs somewhat below the middle of the formation. This zone has been studied in detail and been traced in an area covering several counties in central Texas by Prof. F. L. Whitney and associates of the University of Texas. It is an excellent marker because it is easily recognized and several of the contained fossils are not found elsewhere in the Glen Rose.

The locations of the outcrops of the *Salenia texana* zone coincide with the contact between the upper and lower members of the Glen

Rose limestone as shown on plate 2. The following species were collected from the *Salenia texana* zone at a location 2.9 miles south of the Guadalupe River on Highway 281, and have been identified by the members of the United States Geological Survey.

1. *Orbitolina texana* (Roemer).
2. *Salenia texana* Credner.
3. *Tetragramma* sp.
4. *Hemiaster comanchei* Clark.
5. *Enallaster texanus* (Roemer).
6. *Prohinnites*? sp.
7. *Nuculana*?
8. *Panope* cf. *P. henselli* (Hill).
9. *Homomya jurafacies* Cragin.
10. *Arctica medialis* (Conrad).
11. *Arctica roemeri* (Cragin).
12. *Idonearca* cf. *I. terminalis* (Conrad).
13. *Idonearca* sp.
14. *Volsella* sp.
15. *Protocardia*? sp.
16. *Neithea occidentalis* (Conrad).
17. *Pteria* sp.
18. *Trigonia crenulata* Roemer (not Lamarck).
19. *Aporrhais*? sp.
20. *Nerinea* sp.
21. *Nerinea* n. sp.
22. *Lunatia*? *praegrandis* (Roemer).
23. *Tylostoma* sp.
24. *Porocystis globularis* (Giebel).

The echinoids listed above were identified by C. Wythe Cooke; the *Orbitolina* by Lloyd Henbest; all others by R. W. Imlay.

Lower member.—Although alternating limestones and marls are characteristic of the whole formation, the lower member of the Glen Rose contains thicker and more massive limestone beds and is more fossiliferous than the upper member. With the exception of a few small areas, the lower member of the Glen Rose is exposed in Comal County only in the area west of Tom Creek fault. (See geologic map, pl. 2.) The basal limestones in this area are composed almost entirely of poorly preserved fossils and have a total thickness of about 100 feet. In the outcrop area the rock is honeycombed and sinkholes are common; in the northwestern part of the county and the adjacent part of Kendall County these limestones yield a considerable volume of water to springs. Spring Branch Spring, Honey Creek Spring, and Crane's Mill Spring (see nos. A12, A28, and B27, respectively, on geologic map, and in table of well records), and other smaller springs issue from these basal limestones. At Spring Branch Spring, however, the water issues at the contact between the basal limestone and the underlying Travis Peak formation. Above the spring massive fossiliferous limestone forms a cliff about 25 feet in height. Here the fossils have been partly dissolved from the matrix, leaving a honeycomb mass of moulds of rudistids, gastropods, and mollusks. Moulds of the genus *Trigonia* are especially abundant. It is believed that the springs are fed through solutional channels developed along fractures connecting sinkholes. In the areas where these limestones are deeply buried beneath younger rocks, no large yields are reported from wells that penetrate them, and the solutional channels are probably limited to the outcrop area.

Between the basal limestone and the *Salenia texana* zone, the alternating beds of limestone and marl are characterized by casts of large gastropods and mollusks. Fossils with original shell material are seldom found. The casts of the large mollusks are known locally as "ox hearts." This part of the section yields very little water to wells. About 80 feet below the *Salenia texana* zone is a bed containing the large species of Foraminifera *Orbitolina whitneyi* Carsey, believed by some paleontologists to be the same species as *O. texana* (Roemer). In some places this fossil occurs in such numbers as to form a "sand" which yields small amounts of water. Oolitic sands in the lower member of the Glen Rose limestone yield as much as 100 gallons a minute to wells in the vinicity of Wimberly in Hays County, but no such sands have been found in Comal County.

In the western and southwestern parts of the county, particularly in the valley of Cibolo Creek, the lower member of the Glen Rose limestone is cavernous (pl. 1), and much surface water enters these rocks, but it does not return to the surface as springs in the outcrop area of the Glen Rose limestone. Just south of the creek, in Bexar County, and in the Leon Springs military reservation, honeycombed limestone was reported by a well driller at a depth of 199 feet. North of Cibolo Creek in Kendall County, in the same general area, a cave which caused the drill to drop a foot was found at a depth of 269 feet. At this depth the water rose 60 or 70 feet in the drill hole.

The *Salenia texana* zone is associated with some fine-grained sandy beds both above and below and is the source of water in some wells and springs. Seep springs occur in nearly all the valleys where this zone is exposed at the surface, although most of them disappear after long dry seasons. In the western part of the county, however, rocks in this zone are more permeable and the yield to wells is somewhat greater. On the Hohman ranch, a spring (E36) yields about 50 gallons a minute during wet seasons and some water is always available in any season.

Upper member.—No unconformity was observed between the upper and lower members of the Glen Rose limestone. Outcrops of the upper member of the Glen Rose appear in valleys in the central part of the county, cover most of the north-central part of the county, and are found at relatively high altitudes in the extreme northern part of the county. The upper member is comparatively barren of fossils. *Orbitolina texana* occurs irregularly in five or six beds and a few other beds are fossiliferous, but in the upper part of the member no fossils are found. Ripple marks, cross-bedding, and other manifestations of shallow-water deposition are common. Water is found in small quantities in fine-grained sandy marl and sandy limestone and in beds of fine-grained loose sand from 1 to 2 feet thick.

The maximum yield for most water wells in the upper member of the Glen Rose limestone is probably less than 3 gallons a minute. However, in some places where the main channels of the reservoirs in the Edwards and Comanche Peak limestone overlie thin beds of Walnut clay, it is believed that solutional cavities extend down into the upper member of the Glen Rose limestone. (See log of well G49.)

The following section includes parts of both the upper and lower members of the Glen Rose limestone.

Section measured from foot of windmill near ranch house at Byler ranch northward to United States Geological Survey bench mark on flat-topped hill. (United States Geological Survey bench mark 12–T; altitude 1,450± feet.)

	Feet
Glen Rose limestone, upper member:	
Limestone, massive, gray, honeycombed	3
Marl, blue-gray	2
Limestone, massive, honeycombed, forms prominent terrace	8
Limestone, chalky	6
Covered; soil moist from seepage	13
Limestone, hard, gray-brown, brittle, roughly stratified; forms terrace	3
Limestone, soft, yellow to gray, nodular, a few fossil casts in lower part	24
Marl, blue, weathers buff; fossils rare	12
Limestone, hard, buff	2
Limestone, earthy, honeycombed, grading upward into marl containing an abundance of casts of large and small mollusks	16
Limestone, cross-bedded, sandy; forms terrace	2
Marl	5
Limestone, hard, brittle; forms terrace	1
Marl	5
Limestone, hard, brittle; forms terrace	1
Limestone, irregularly bedded, honeycombed	4
Limestone, earthy, in 6-inch beds	2
Marl, blue; weathers buff	4
Limestone, hard, 2-inch to 4-inch flags	2
Marl, platy	5
Limestone, gray-brown, crystalline, composed of fossil fragments	½
Marl, platy	5
Limestone, gray-brown, crystalline, fossil fragments	½
Marl	5
Limestone, light gray, 2-inch flagstones	2
Marl	5½
Limestone, gray, 2-inch flagstones	1
Marl, platy	11
Limestone, blocky with rectangular fracture, some thin flagstones	2
Marl, with thin beds of limestone	18

Glen Rose limestone, lower member:

	Feet
Limestone with an abundance of small fossils (*Nuculana*? sp.) that look like wheat seeds. Generally forms prominent terrace	½
Limestone, fossiliferous, honeycombed	2
Marl, fossiliferous, fine sandy, containing *Salenia texana* Credner, *Hemiaster sp.*, *Nerinea sp.*, *Orbitolina texana* (Roemer), and casts of large mollusks. Source of seep springs in valleys	5
Limestone, irregularly bedded, with an abundance of poorly preserved fossils	2
Marl, fine sandy, source of seep springs in valleys	5
Limestone, poorly stratified, porous; nodular structure	3
Marl	13
Limestone, massive, sandy	1
Marl	6½
Limestone, hard, buff; forms terrace	½
Marl	5
Alternating marl and limestone with casts of large mollusks	11
Limestone, hard, flaggy	2½
Marl	3
Limestone, hard, buff; porcelaneous texture; forms terrace	2
Marl with casts of large mollusks ("ox hearts")	10
Limestone, hard, porous, fossiliferous, massive, containing *Orbitolina whitneyi* Carsey	2½
Marl, fine sandy, buff and blue; contains abundance of *Orbitolina texana* (Roemer)	9
Covered. Broad grassy valley	27
Foot of windmill.	

FREDERICKSBURG GROUP

The Fredericksburg group includes the Walnut clay, the Comanche Peak limestone, and the Edwards limestone. The three formations are shown as a single unit on the geologic map. The Kiamichi formation, the uppermost member of the group, is absent in Comal County.

Adkins (*in* Sellards, Adkins, and Plummer, 1932, p. 323) has offered the following opinion regarding the classification of the formations in the Fredericksburg group.

> Although in this discussion the Fredericksburg is divided into the usual conventional formations, it is the writer's opinion that all formations in this group should be suppressed and only the facies used. However, a decision on this procedure can be reached only after the zonation is better known and the meaning of the term "formation" better clarified.

Hydrologically, in Comal County the Comanche Peak and Edwards limestones may be regarded as a single unit.

Walnut clay

The Walnut clay, the lowest formation of the group, lies conformably on the Glen Rose limestone and marks the change from the alternating marl and limestone of the Glen Rose to the thick, massive beds of the Comanche Peak limestone and the Edwards limestone.

The typical Walnut clay of central Texas includes a buff-colored sandy clay or marl containing a comparatively large fauna characterized by an abundance of *Exogyra texana* Roemer. In Comal County such beds occur only in the northeastern part of the county near the Hays County line. Westward the formation becomes thinner and less fossiliferous. In most places in Comal County it is represented by a bed of sandy marl from 3 to 5 feet in thickness, which contains small white nodules of calcareous material and a few scattered specimens of *Exogyra texana*. In some places the formation is only a few inches thick and fragments of *E. texana* can be found only by diligent searching. The presence of *E. texana* in the marly beds of the overlying Comanche Peak limestone makes the exact position of the Walnut clay uncertain, particularly in faulted areas. The Walnut clay may yield small amounts of water to some wells in Comal County where the marl is sandy, but such occurrences are probably rare. In some parts of the county it is believed to be an effective barrier in the downward percolation of water; in other parts particularly in the southwestern part, solutional activity has probably progressed through the Walnut into the upper member of the Glen Rose formation.

Comanche Peak limestone

The Comanche Peak limestone appears to lie conformably upon the Walnut clay. The range in thickness in Comal County is from 20 to 55 feet but the thickness in most places is about 40 feet. It is composed chiefly of hard gray-white massive limestone, but in some places beds of marl containing *Exogyra texana* Roemer occur in the lower part of the formation. The similarity of these beds to the Walnut clay makes it difficult to define the lower limits of the Comanche Peak limestone. Along the Guadalupe River upstream from Hueco Springs (pl. 3), the basal part of the Comanche Peak is composed of massive, honeycombed caprinid limestone and dolomite. The most distinguishing characteristic of the formation in Comal County is the presence of secondary crystalline calcite in the form of nodules and veins. Honeycomb structure is generally associated with biostroms containing caprinid and other fossils. Well drillers do not distinguish the Comanche Peak from the Edwards limestone.

Edwards limestone

The Edwards limestone lies conformably upon the Comanche Peak limestone. The thickness of the Edwards in Comal County has not been accurately determined but it probably ranges from 350 to 500 feet. The outcrop area is mostly in the southeastern part of the county. The areal distribution is discussed in more detail and in relation to faults under the heading of structural geology. The Edwards is composed almost entirely of hard, massive limestones that are extensively honeycombed. The most distinguishing characteristic of the formation is the occurrence of flint nodules ranging in size from small pebbles to irregularly lenticular-shaped masses as much as a foot in diameter. Flint is not found in any other Cretaceous strata in Comal County. The flint is not uniformly distributed in the Edwards but occurs at a number of horizons. No flint is found at the base of the formation.

Shale or clay lenses as much as 40 feet thick (see log of well G53) occur irregularly in the Edwards but are extensive enough to retard the downward movement of water in some areas, so that a perched water table is found in some areas during wet seasons. Well F59, dug to a depth of 90 feet in the Edwards limestone on the R. J. Haug ranch, 5 miles west of New Braunfels, overflows during wet seasons, whereas water levels in deeper drilled wells in the same area and at approximately the same altitude are from 300 feet to 400 feet below the land surface. Well F59 is not in use, probably because of failure in dry seasons. The Servtex Co. reports a bed of clay 10 feet thick at the bottom of its quarry in the Edwards limestone, about 9 miles southwest of New Braunfels. Some of the clay beds reported by drillers may be old caves that have been filled with mud.

In contrast to the brittle crystalline material of most of the Edwards limestone, a white chalky limestone 15 to 20 feet thick, very similar in appearance to the Austin chalk, occurs in the upper part of the Edwards. Samples from an outcrop 6 miles northeast of New Braunfels were examined under the microscope by Dr. Frank E. Lozo, Jr. (personal communication). They contained an abundance of ostracods and reef-forming organisms but very few Foraminifera. *Chara* seeds were also reported.

A nearly complete section of the Edwards limestone is given in the field description of a core test drilled by the Corps of Engineers, United States Army, 5 miles north of New Braunfels. No clay or shale beds are reported in this section. Most of the limestones are porous and contain many cavities from 1 to 3 feet in depth.

The land surface in the outcrop area of the Edwards limestone is characterized by gentle slopes pitted by sinkholes that range in size from small openings to depressions 15 to 20 acres in extent. In the vicinity of the main streams the slopes are precipitous. The Edwards, together with the Comanche Peak limestone, forms the walls of the Guadalupe River canyon above Hueco Springs.

WASHITA GROUP

The Washita group in Comal County includes the Georgetown limestone of Early Cretaceous age and the Grayson (Del Rio) shale and Buda limestone of Late Cretaceous age.

Georgetown limestone

Present outcrops of Georgetown limestone occur only in a belt from 3 to 6 miles wide lying between the Comal Springs fault and the Bat Cave fault where the formation is exposed in an irregular pattern.

After the Edwards limestone was deposited, a part of the surface of the Edwards was elevated above the level of the sea and was subjected to erosion. During this period some of the upper part of the Edwards was removed and a part of it became honeycombed and probably cavernous as a result of solution by fresh water. When the Edwards was submerged again, the encroaching Georgetown sea first filled the valleys in the partially dissected surface of the Edwards and later covered all of the present outcrop area of the Edwards limestone in Comal County. At present all of the Georgetown limestone south of the escarpment is covered by younger formations. The extent of the disconformity between the Georgetown and the Edwards has not been fully determined, but it is generally recognized that on the broad uplift known as the San Marcos arch the equivalents of the Kiamichi of the Fredericksburg group and the Duck Creek, Fort Worth, Denton, Weno, and Pawpaw formations of the Washita group are either absent or are represented by comparatively thin beds. The formations mentioned above have been described in other parts of Texas by Adkins (*in* Sellards, Adkins, and Plummer, 1932, pp. 359–386). The description includes a provisional zonation of the fossils found in them.

The importance of the disconformity in relation to ground water lies in the probability that the high permeability of the upper part of the Edwards limestone, now buried beneath succeeding formations in the area south and southeast of the Balcones escarpment, may have been caused by solution during the interval indicated by the disconformity. Some drillers, particularly in the San Antonio area, are careful to cement casing in the Georgetown limestone before drilling into the Edwards. Experience in that area has shown that, if the well is drilled into the Edwards before attempting to cement the casing, it is sometimes necessary to mix rags, cotton hulls, and other materials, with the mud to shut off the water long enough to allow the cement to set. As a result of this procedure a considerable part of the potential yield of the well may be permanently lost.

In the report on the San Antonio area Livingston, Sayre, and White (1936) show between waters of good and poor quality a line of demarcation which is believed to be the gulfward limit of free circulation of ground water in the Edwards limestone.

The Georgetown limestone is not water-bearing in Comal County. It serves as one of the upper confining beds in the artesian area of the Edwards limestone.

A. RUDISTID LIMESTONE IN GUADALUPE RIVER CANYON.
B. EDWARDS AND COMANCHE PEAK LIMESTONE IN GUADALUPE RIVER CANYON.

Grayson (Del Rio) shale

Like the Georgetown limestone, the outcrops of the Grayson shale are confined to the belt between the Comal Springs fault and the Bat Cave fault, in many places occurring in isolated patches in depressions in the Edwards limestone. The Grayson appears to lie conformably on the Georgetown limestone.

In the outcrop area the thickness of the Grayson shale is about 30 feet; in wells it is generally reported as 40 feet thick.

In Comal County the Grayson is predominantly a marl. It weathers to a buff color at the surface but drill cuttings are usually blue. Geologists and drillers alike look for the characteristic fossil *Exogyra arietina* Roemer, an oyster having a shell shaped like a ram's horn. This fossil is particularly abundant in the lower part of the formation and in some parts of the formation are cemented together to form beds of limestone 12 to 18 inches thick. The Grayson is probably the most impermeable formation in Comal County and many surface reservoirs or tanks for stock use are constructed in the outcrop area of this formation.

Solutional cavities at unconformable contacts and their relationship to the circulation of ground water in limestones have been recognized by Piper (1932, p. 74) in Tennessee and by Nye (Fiedler and Nye, 1933, p. 88) in New Mexico.

The observed thickness of the Georgetown limestone in the outcrop area in Comal County is about 15 feet, but in wells the thickness reported by drillers is from 40 to 50 feet. This is measured as the thickness between the last clay bed in the Grayson (Del Rio) shale and the appearance of water, presumably in the top of the Edwards limestone. The Georgetown appears to be conformable with the Grayson (Del Rio) shale above it. In many places there is an abundance of well-preserved brachiopods of the species *Kingena wacoensis* (Roemer) in the thin marly beds at the top of the formation. These beds are about 2 feet thick and grade downward into massive limestones that weather to a buff color. In some places the limestone has a brittle porcelaneous texture similar to some beds in the Buda limestone. In the lower beds the fossil oyster of the genus *Alectryonia*, an oyster recognized by the zigzag pattern on the margin of the shell, is fairly abundant. In many places however, it is difficult to distinguish the Georgetown from the Edwards.

Buda limestone

The Buda limestone is believed to lie conformably upon the Grayson shale but there are few good exposures of the contact between the two formations. The thickness of sections lying north and northwest of the Comal Springs fault does not exceed 30 feet. In wells south and southeast of the Comal Springs fault (see logs of H39 and

G75), thickness of 52 feet and 70 feet, respectively, have been reported. In many places in the outcrop area low brushy or wooded ridges are covered by boulders of Buda limestone which extend onto the slopes of the underlying Grayson. The Grayson becomes more or less plastic when wet, and small landslides cause the overlying beds of the Buda to give way and to break up into boulders.

The greater part of the Buda limestone as observed in Comal County is hard and brittle and has a porcelaneous texture. Its color is gray, yellow, and red and in most places it is speckled with small spots of darker-colored rock reported to be oxidized glauconite. Some of the outcrops of the Buda are honeycombed but the formation is not known to yield water to wells in Comal County.

GULF SERIES

The Gulf series is represented in Comal County in ascending order by the Eagle Ford shale, the Austin chalk, and the Taylor marl and its probable age equivalent, the Anacacho limestone.

Eagle Ford shale

The Eagle Ford shale, lowest formation of the Gulf Series, lies unconformably on the Buda limestone of the Comanche series. It is found at the surface only between the Comal Springs fault and the Bat Cave fault.

According to Stephenson (1929) "The * * * Gulf series of Texas is separated from the Comanche series below by an unconformity which certainly represents a considerable interval of geologic time."

In Comal County there appears to be no discordance in dip between the Eagle Ford shale and the Buda limestone but in some places the Buda is very thin. West of the road between Highway 46 and the Hueco Springs road the Eagle Ford appears to rest directly upon the Grayson shale but the Buda may be obscured by land slides in the Grayson and by complex faulting.

In most places in Comal County the Eagle Ford shale is about 30 feet thick and is composed of sandy yellow clay. The black clay or lignitic facies is not conspicuous at the surface but is nearly always reported in well logs. Good exposures of the Eagle Ford are found along the old Austin Post Road east of New Braunfels, near the Hays County line.

The Eagle Ford is not a water-bearing formation in Comal County.

Austin chalk

In Comal County the Austin chalk lies unconformably on the Eagle Ford shale. This wide-spread unconformity has been described by Stephenson.

According to drillers' logs, the Austin chalk is 135 to 150 feet thick in the area south of the Comal Springs fault. In the outcrop area between the Comal Springs fault and the Bat Cave fault only thin remnants are found. Here it is a nearly white chalky and fossiliferous limestone and its characteristic appearance is fairly uniform from top to bottom. Remnants of the formation crop out north of the Comal Springs fault in the vicinity of Bracken; along Highway 36, 6 miles northwest of New Braunfels; and also east of New Braunfels. South of the fault the Austin is exposed in the beds of Cibolo Creek and the Guadalupe River.

The formation is not generally prolific as an aquifier. Eight wells recorded in Comal County are known to draw water from the Austin chalk. One of these (G11) at Hunter, flows a small stream during wet seasons. Some of these wells yield water with a hydrogen sulfide odor. In most of the area where the Austin chalk has been uncovered, surface and ground water have begun to dissolve the rock. Fairly large solutional cavities were observed along Cibolo Creek, just above the bridge on U. S. Highway 81.

Anacacho limestone and Taylor marl

According to Stephenson (1937, pp. 135–136) the Anacacho limestone and the Taylor marl are of the same age, and the limestone facies of the Anacacho west of San Antonio merges with the marl of the Taylor in Comal County. Typical exposures of Taylor marl are found in the eastern part of the county. In the western part of the county the Anacacho limestone also contains marly beds but limestone beds are absent. Only small nodules of lime remain.

Stephenson (1937, p. 136) also states that both formations lie unconformably upon the Austin chalk and describes two sections that were observed at the contact.

According to the drillers' logs of well G75 and G41 the Taylor marl and Anacacho limestone, considered as a unit, has a thickness of about 300 feet. Neither the Taylor nor the Anacacho is found in any part of the area north and northwest of the Comal Springs fault. Southwest of New Braunfels, below the escarpment, a few wells are believed to draw water from the base of the Taylor and Anacacho, where from 0.5 to 2 feet of sandy lime or gravel has been reported. This sand or gravel may be fed through the cavernous limestone in the upper part of the Austin chalk. The spring (G64) on the Altgelt farm 2¼ miles southwest of New Braunfels may be from this source.

TERTIARY (?) SYSTEM

PLIOCENE (?) SERIES

Uvalde gravel

The Uvalde gravel occurs only in small remnants on hilltops. These remnants are effective in retarding erosion in the same manner that ballast protects a railroad track. Because of the small size and thickness of the outcrops and the topographic position which permits the water to seep out rapidly, no water is obtained from wells in the Uvalde gravel.

QUATERNARY SYSTEM

PLEISTOCENE SERIES

Leona formation

The Leona formation is composed of limestone gravels, sand, and clay arranged in terraces by the present streams in their valleys. The terraces overlie all formations crossed by the streams and the formation ranges in thickness from a knife edge to a probable maximum of 65 feet. (See driller's log of G40.) The formation is found mainly in the valleys of the Guadalupe River and Cibolo Creek. In the valleys above the escarpment formed by Comal Springs fault, the Leona fills old abandoned meander channels and is rarely used as a source of water, probably because of leakage into underlying rocks and drainage into the streams. However, one dug well 50 feet deep (G40), 13½ miles southwest of New Braunfels and in the valley of the Cibolo, has served more than 50 years without failure.

Below the escarpment and between the Guadalupe River and Alligator Creek, the Leona formation overlies the relatively impervious Taylor marl and provides a dependable ground-water supply for a considerable number of families. Failures in this area are unknown. The log of well G40, 3 miles northeast of New Braunfels, indicates the kind of material encountered in the Leona. Depth-to-water measurements indicate that normally not more than 10 feet of this material is saturated with water. Because of this fact, the Leona would probably not supply enough water for large-scale irrigation.

STRUCTURAL GEOLOGY

FAULTS

In Comal County the development of ground-water reservoirs, particularly reservoirs in the Edwards, Comanche Peak, and Glen Rose limestone, and the position of the main channels of movement of ground water are closely related to a system of faults in the Balcones fault zone. This zone is 20 miles wide in places and extends from near Waco southwest through Comal, Bexar, and Medina Counties into Uvalde County. The faults are roughly parallel, and in Comal County the zone includes seven major faults that trend in directions ranging from S. 45° to S. 60° W. In general, the hades of the faults are steep. In many places the traces of the faults form nearly straight lines in fairly rough topography indicating that the hade may be nearly vertical. Clinometer measurements at a few places along the Comal Springs fault show that the hade ranges from 20° to 30° from the vertical.

In the following paragraphs the major faults are discussed in the order of their occurrence from southeast to northwest. (See geologic map and cross section, pl. 2.)

COMAL SPRINGS FAULT

The most conspicuous fault in the zone forms the escarpment separating the Coastal Plain from the Edwards Plateau, and is here designated the Comal Springs fault. The fault enters the eastern part of the county near Hunter, passes through Landa Park at New Braunfels, and continues westward through Bracken near the southwestern extremity of the county. Comal Springs issue from fissures along this fault. At some places along the fault the Taylor marl is brought in contact with the Edwards limestone, indicating the possibility of a stratigraphic displacement of 400 to 600 feet. North of this fault, water in the Edwards limestone occurs under water-table (unconfined) conditions and is of good chemical quality. South of the fault the Edwards is buried to a depth of several hundred feet; the water in it is under artesian pressure and is highly mineralized.

HUECO SPRINGS FAULT

The second major fault, called the Hueco Springs fault in this report, enters the eastern boundary of the county about a mile north of the Comal Springs fault, crosses the Guadalupe River at Hueco Springs, about 2½ miles north of Comal Springs, and continues westward across the westward boundary of the county about 4 miles north of Bracken. Structural relations along this fault are complex. Where the fault crosses Highway 46, between wells 227 and 390, the rocks at the contact are crushed into a fault breccia and secondary calcareous material fills the spaces between the boulders. From this point to the river the rocks dip northeastward toward the river at the rate of about 200 feet to the mile. On the east side of the river, opposite Hueco Springs, the fault has brought rocks of the Georgetown limestone, containing an abundance of specimens of the fossil *Kingena wacoensis* (Roemer) in contact with beds containing *Exogyra texana* (Roemer) probably of Walnut age. It is difficult, however, to determine the amount of displacement along the fault because of the thinning of the displaced formations and the unconformities between them. Moreover, there is possibility that a part of the apparent displacement is due to the collapse of roofs of former caverns in the Edwards limestone. In most of the area between the Comal Springs fault and the Hueco Springs fault, the Edwards limestone crops out, and an adequate supply of good water for farm and ranch use may be obtained from wells.

BAT CAVE FAULT

The third fault, called Bat Cave fault, enters the eastern boundary of the county about 2 miles north of the Comal Springs fault, crosses the Guadalupe River about 2 miles north of Hueco Springs, and crosses the western boundary of the county 5½ miles northwest of Bracken in the vicinity of Bat Cave. East of the Guadalupe River this fault forms the south side of a downfaulted block or graben in which a narrow wedge of younger rocks appears between outcrops of Edwards limestone. Actually the graben may be a slump or valley sink produced by the collapse of a former cavern in the Edwards limestone, which lowered the younger rocks below the level of the Edwards limestone, thus protecting the fallen block from erosion. In the western part of the country where the faulting has brought the upper member of the Glen Rose limestone in contact with the Edwards limestone, the displacement is estimated to be about 300 feet. A hole drilled to a depth of 500 feet on the Dietz Ranch about 300 feet northwest of well F33 is believed to have passed through the fault plane. Normally plenty of water is available in the Edwards at this locality, but this well did not strike any water. The dry hole may be due to the presence of relatively impervious pulverized rock which was ground between the two walls of the fault in the process of movement. Another possible explanation is that the underground channels at this point have been filled with mud carried in by infiltrating surface waters. The Edwards limestone is exposed at the surface over most of the area between the Hueco Springs and Bat Cave faults and together with the underlying Comanche Peak limestone is thick enough to transmit large volumes of water. Farm and ranch wells in the area obtain adequate supplies from the limestone.

BEAR CREEK FAULT

The fourth or Bear Creek fault crosses the Guadalupe River about a mile southwest of Sattler. From this point it can be traced more or less continuously southwestward to Bear Creek and thence to Cibolo Creek at the west boundary of the country, where it was observed about 6 miles south of Smithsons Valley. The fault has less displacement than the three already mentioned. Between the Bat Cave and Bear Creek faults the thickness of the Edwards limestone has been considerably reduced by erosion; and in the deeper valleys, the streams have cut through both the Edwards and Comanche Peak limestones into the upper part of the upper member of the Glen Rose limestone. The Glen Rose within this block is believed to dip southeastward and generally is at a higher level than the water level in the Edwards and Comanche Peak limestones southeast of the Bat Cave fault. Thus the ground water in the Edwards limestone between the Bat Cave and Bear Creek faults tends to drain toward the block southeast of the Bat Cave fault. This is indicated by the failure of some wells, such as wells F20 and F16, to obtain an adequate supply of water for ranch use from the Edwards and Comanche Peak limestones.

HIDDEN VALLEY FAULT

The fifth major fault or Hidden Valley fault crosses the Guadalupe River near the lower end of Hidden Valley and thence continues southwestward across the county to a point on Cibolo Creek about 5 miles east of Bulverde. The average displacement of the strata along this fault is estimated to be about 200 feet. Between the Bear Creek and Hidden Valley faults, the Edwards limestone is thin and the areas of the upper member of the Glen Rose limestone exposed at the surface are larger than they are between the Bat Cave and Bear Creek faults. It is believed that most wells in this area must penetrate strata below the Edwards and Comanche Peak limestones to obtain sufficient water for ranch use.

TOM CREEK FAULT

The trace of the sixth major fault or Tom Creek fault passes about half a mile south of Hancock, in the eastern part of the county, and thence crosses the county in a fairly straight line which passes about a quarter of a mile south of Smithsons Valley post office. Tom Creek follows the trace of the fault for about 5 miles between Hancock and Smithsons Valley. In the area between the Hidden Valley and Tom Creek faults, the upper member of the Glen Rose limestone covers most of the surface, and the Edwards and Comanche Peak limestones are found only as caps on the higher hills. Along the river, small areas of the lower member of the Glen Rose limestone are exposed. In this area only small yields are reported from the upper and lower members of the Glen Rose limestone, but satisfactory yields have been obtained from deep wells (as in well F3) in the Travis Peak formation.

SPRING BRANCH FAULT

The seventh fault, called the Spring Branch fault in this paper, is really twin faults that are probably contemporaneous and are closely related to each other. The trace of the first one was observed about a mile north of Fischer Store, and from this point it extends southwestward to the Guadalupe River. The second part of the fault is about 1¼ miles north of the first and extends in the same general direction about 2½ miles each way from Spring Branch post office. The maximum displacement along these faults is probably about 200 feet. In most of the area between the Tom Creek and

Spring Branch faults the lower member of the Glen Rose limestone is exposed over the greater part of the area, the upper member occupying only the areas of higher altitude. The Spring Branch faults mark the southeastern limit of the outcrop of the Travis Peak formation in Comal County. North of the Travis Peak area the lower member of the Glen Rose occupies the valleys and the upper member the more elevated areas. Water for domestic and ranch use is obtained from wells and springs in the lower member of the Glen Rose limestone and from the Travis Peak formation.

MINOR FAULTS AND FOLDS

There are many minor faults parallel to the trend of the major faults, some of which have not been positively identified because of the lack of horizon markers in the area in which they occur. Other small faults diverge from the major faults, notably east and northeast of New Braunfels and in the vicinity of Braken and Selma. Near Bracken there is evidence of folding and faulting in a direction more or less transverse to the trend of the major faults. These structural features appear to have had some effect upon the direction of the movement of water in that area.

CAUSE OF FAULTING

Individual faults in the Balcones fault zone seem to be definitely related to each other in origin because of their roughly parallel pattern. Most of them are normal faults with downthrow to their southeast, and they are generally regarded as having been caused by the gradual sinking of the Coastal Plain with reference to the Llano uplift. Stephenson (1928, p. 899) has pointed out, however, that uplift may have occurred as well as sinking. Foley (1926) produced a group of faults similar to the Balcones faults in laboratory materials by applying tensional forces.

AGE OF FAULTING

The age of the faulting along the Balcones fault zone has not been accurately determined, but it is believed that faulting may have occurred from Early Cretaceous to Recent geologic time. Sayre (1936, p. 29) states that in Medina County the faults are believed to be late Pliocene or early Pleistocene, though possibly early Pliocene or Miocene in age. Bryan (1933, pp. 439–442; 1936, p. 1357) has presented evidence to show that there have been three movements along the Balcones fault zone at Waco, Tex., the first during Early Cretaceous time, the second during Georgetown time, and the third during very recent time. The Comal Springs fault extends the length of the county, through New Braunfels, causing a bold escarpment with an extremely youthful appearance. The escarpment seems to have been only slightly eroded as though it might have been formed very recently. This appearance may be deceptive, however, as much of the Edwards limestone has been removed internally by solution of infiltrating waters instead of by external erosion. None of the other faults in Comal County retains this youthful appearance because the escarpments have been removed by erosion. However, as previously stated, rapids are found in the Guadalupe River at nearly every place that a fault crosses the river (pl. 1*A*).

OTHER STRUCTURAL FEATURES

SAN MARCOS ARCH

One of the older structural features of the area is the broad San Marcos arch, which was pointed out by Stephenson (1928, pp. 887–889) in 1928 and was later named by Adkins (*in* Sellards, Adkins, and Plummer, 1932, p. 266). The axis of this arch extends southeastward from the Llano uplift through San Marcos in Hays County and thence follows the course of the San Marcos River toward Gonzales in Gonzales County. In Comal County the results of this uplift are seen in the thinning or absence of sediments that normally occur between the Edwards limestone and the Taylor marl. Topographic expression of the arch is lacking or is obscured by the more abrupt movements of the Balcones fault zone.

In addition to the deformation related to faults of the Balcones fault zone, a large number of small faults and steep dips are definitely related to sinks and probably bear no relation to deep-seated crustal movements.

REGIONAL DIPS

The regional dip of the Cretaceous rocks on the Edwards Plateau is generally accepted to be about 15 feet to the mile in a southeasterly direction. In the Coastal Plain the dip steepens considerably, particularly at depths where the seaward thickening of the younger formations has taken place. In Comal County, however, as a result of crustal deformation, there are many departures from the regional dip. In the vicinity of faults, the dips are likely to be abnormally steep. Stephenson (1937, p. 136) observed a perceptible northwest dip in the Austin chalk and Taylor marl on the Guadalupe River about 2 miles south of the Comal Springs fault.

In addition to these local irregularities, in the eastern part of the county there is a rather general steepening of the dip of the rocks eastward. For example, the top of the Glen Rose limestone crops out in the small valleys on the east side of the Guadalupe River at an altitude of about 900 feet. In a number of wells east of these valleys, the Edwards limestone is found in wells at considerable depth. In well C12 a limestone reported as Edwards limestone (but probably Comanche Peak) was found at a depth of 482 feet, or at an altitude of 374 feet. This indicates an eastward dip of at least 526 feet in about 5 miles, or more than 100 feet to the mile.

SINKHOLES

The solution of limestone by ground water may result in the development of large caverns. If such a cavern becomes so large that the roof is not able to support its own weight, the roof will collapse, leaving a large hole or pit in the surface of the ground. These holes may be more or less round or elongated or irregular in shape, depending on the shape of the cavern. Large sinkholes with vertical walls were not found in Comal County. A very few, ranging from 5 to 15 acres in area, are circular and have gently sloping sides, suggesting that collapse kept pace with undermining. After heavy rains they are likely to hold water for several weeks. Smaller and less conspicuous sinkholes are more numerous and do not hold water.

Many of the sinkholes in the Edwards limestone in Comal County are filled with Georgetown limestone and Grayson shale. In some places, the Georgetown is completely covered by the Grayson so that only the Grayson appears to be in contact with the Edwards. Because of the lack of observable bedding planes, the dip of the Grayson shale in the sinks could not be determined. The Georgetown limestone generally dips steeply toward the center of the sink. The Edwards limestone on the perimeter of the sink may also dip toward the sink or may be faulted. These fault lines are generally curvilinear and often transverse to the trend of major faults. On the basis of these observations it is assumed that some of the caverns collapsed after the Georgetown was deposited.

Apparently such sinks or slumps are not unusual in Texas. Dumble, (1918, pp. 19–20) observed in the Edwards limestone deep ravines filled with Eagle Ford shale in areas west of the Pecos River, which he ascribed to disconformity. Adkins (*in* Sellards, Adkins, and Plummer, 1932, pp. 361 and 401) believes that these valleys were caused by underground solution and subsequent slumping.

METHODS OF WATER-WELL CONSTRUCTION

Most of the water wells in Comal County have been drilled by the cable-tool percussion method. Ordinary farm and ranch wells are mostly from 5 inches to 6 inches in diameter. Most wells that started in the Georgetown limestone or older formations, including in descending order the Edwards limestone, the Glen Rose limestone, and the Travis Peak formation, do not require casing to prevent the caving of the softer beds. These are usually equipped with a short piece of galvanized iron casing to prevent soil from entering the well at the surface. Many uncased wells that have been drilled in to these older formations are more than 50 years old and are still giving service. Some wells are equipped with one or two joints of wrought steel casing cemented around the outside of the casing from the surface of the ground to the bottom; from 1 to 2 feet of the casing protrudes above the ground. This not only provides a seat for a water-pipe clamp but it affords better protection from pollution or surface contamination.

Wells that penetrate the Grayson (Del Rio) shale, however, must be cased to solid limestone at the time the well is drilled because the clay in this formation will invariably cave as soon as it becomes wet.

Wells that are drilled in the Taylor marl or Anacacho limestone require casing. No caving beds are found in the underlying Austin chalk, but some clay beds in the Eagle Ford shale may cave if no casing is used.

In the Pleistocene alluvial deposits, the wells have an average depth of less than 60 feet. A few of the older wells have been dug by hand and are lined with rock. Drilled wells obtaining water from the alluvium require casing to prevent caving.

Most farm or ranch wells are equipped with a 2-inch drop pipe and cylinder pump. The cylinder is usually 1⅞ inches in diameter and is placed near the bottom of the 2-inch drop pipe, with a short piece of suction pipe below the cylinder. The bottom of the suction pipe extends almost the full depth of the well except in wells in which the yield and specific capacity (yield per unit of drawdown) are high.

Windmills are extensively used for power, but some pumps are powered by 1½- to 5-horsepower gasoline engines. The wind is fairly dependable in Comal County, but emergency power or storage tanks holding 3 or 5 days' supply are needed in case the wind does not blow. Some ranchers equip their wells with a jack and pulley so that a tractor or automotive equipment can be used when the wind does not provide adequate power. Recently, as a result of the growth of the rural electrification system, electric power is being used for pumping on several farms and ranches. Where large amounts of water are needed, such as for the public supply for the city of New Braunfels, wells of larger diameter are drilled and turbine-type pumps powered by electric motors are used.

OCCURRENCE OF GROUND WATER, WITH SPECIAL REFERENCE TO DISCHARGE AND SOURCE OF COMAL SPRINGS

The occurrence of ground water in all classes of rocks and the conditions that control the movement of water from areas of intake toward areas of discharge have been described by Meinzer (1923a, pp. 2–192; 1923b, 68 pp.; 1942, pp. 385–497) and Wenzel (1942, 192 pp.). The section that follows is limited to a brief discussion of the occurrence of ground water in Comal County. The springs and most of the wells in the county are supplied with water from ground-water reservoirs in limestones, of which the reservoir in the Edwards limestone is by far the most important.

DEVELOPMENT OF THE RESERVOIR IN THE EDWARDS LIMESTONE

The permeability of most limestones as deposited is low. Small openings called primary openings are those that remain after consolidation. Limestones that are composed largely of fossil shells or skeletons of sea animals, particularly corals, are likely to contain primary openings. The larger openings, however, are developed after deposition by fracturing and solution along the fractures. Slight earth movements or shrinkage during consolidation can cause fractures in limestone. These fractures or joints generally are developed in two planes at a considerable angle from one another, and, if they intersect, continuous openings in a zigzag pattern may develop. The openings may be only as thick as a knife blade at the surface and still narrower at depth. These are the original passages from which larger channels are later developed by solution. Solutional cavities are generally classified as secondary openings.

Solution may take place during the over-all period of deposition in sea water by reason of slight physical or chemical changes. Sea water at 30° C. is generally saturated with carbon dioxide. Revelle (1934) states:

> Except for water in equilibrium with the atmosphere, the most important factor controlling the solubility in sea water is the CO_2 content of the water which in turn is chiefly dependent on the nature and extent of biological activity. The order of importance of the other factors is temperature, salinity, and hydrostatic pressure.

In the process of the formation of limestone reefs which are generally permeable, it seems possible that solution may begin with the release of carbon dioxide when the animals that secrete the shells begin to decay. The molecular structure of calcium carbonate may also be a factor in the relative solubility of limestones. Many species of sea animals secrete shells composed of aragonite instead of calcite. According to Foote (1900, pp. 740–759), aragonite is more soluble than calcite under similar conditions. In Comal County there are many exposures of limestones in which the original shell material of the fossils has been dissolved, leaving only moulds of the shells.

After the limestone has been elevated and removed from its original environment it becomes subject to solution by meteoric waters. It is generally recognized that an increase in the carbon dioxide in meteoric waters increases the solvent action on limestones manyfold. Water acquires carbon dioxide while passing through the air and through soils containing decaying vegetable matter. As pointed out by Swinnerton (1932, pp. 658-660), the chemical process is complex, depending on a number of physical factors.

Solution and deposition are in delicate balance, depending on such factors as small changes in temperature and pressure, so that underground streams may dissolve calcium carbonate at one place and at the same time deposit calcium carbonate at another. In the cores obtained from well G39 (see log) large vugs lined with crystals of secondary calcite were found at a depth of about 300 feet below the present water table.

Originally the Edwards limestone in Comal County may have contained beds of gypsum which have been removed by solution, gypsum being much more soluble than calcium carbonate. Barnes (1943, pp. 35–46) reports beds of gypsum in the Edwards limestone in Gillespie County as much as 35 feet in thickness; he named these the Kirschberg evaporite. These deposits are about 60 miles northwest of New Braunfels.

Some idea of the solvent action of ground water on the limestones in Comal County may be obtained from the chemical character of the water that issues at Comal Springs. The dissolved solids in the water at the spring average about 285 parts per million. The average flow of the springs over a period of about 20 years has been 320 cubic feet per second. On this basis an average of more than 200 tons of rock material is carried away daily in solution by the water that issues from these springs.

Ordinarily the development of underground limestone reservoirs is related to surface drainage. When a thick, dense, soluble limestone, such as the Edwards limestone, has been elevated above the lines of regional drainage, the development of underground drainage channels progresses much in the same manner that surface drainage is developed from an initial stage to maturity. This analogy has been described by Davis (1930, pp. 475–628), Swinnerton (1932, pp. 663–627), and Piper (1932, pp. 79–86). Just as the surface streams are first developed more rapidly along main drainage channels and grow by headward erosion, the underground streams in limestone are first larger and develop most rapidly in the vicinity of the main streams, and gradually work back to underground divides. In Comal County the normal development has been modified by faulting. It is believed that the main underground channels in the Edwards and Comanche Peak limestones that lead water toward Comal Springs are more or less parallel to the lines of major faulting, which are more or less transverse to the direction of flow of the main surface streams.

It is difficult to determine the area of Edwards limestone exposed to surface drainage during the encroachment of the Georgetown sea. However, the outcrop area of the Edwards limestone was probably much larger during that time than it is now. The permeability of the upper part of the Edwards limestone in the San Antonio area (Livingston, Sayre, and White, 1936, pps. 58–113), now faulted down and covered by younger formations, may have been caused in part by solution in marine waters, but such extensive cavities are more likely to have been caused by the solutional action of meteoric waters.

At the outcrop in Comal County, the Edwards limestone and the Comanche Peak limestone beneath it are thoroughly honeycombed from top to bottom. In the log of test hole G17 (see logs of wells) drilled by the Corps of Engineers, United States Army, to the bottom of the Comanche Peak limestone, nearly all of the 237 feet of material was described as porous; the total footage of caves was 24 feet, the largest cave being 3 feet deep, between 179 and 182 feet.

DEVELOPMENT OF RESERVOIRS IN THE GLEN ROSE LIMESTONE

In the lower member of the Glen Rose limestone, the earlier stages of the development of a limestone reservoir in relation to surface drainage lines are more celarly shown. This development could not progress rapidly until much of the cover of Edwards limestone and upper member of the Glen Rose limestone had been removed. This condition exists in western Comal County.

Although the Guadalupe River and Cibolo Creek have youthful characteristics at present, the wide meanders and broad terraces on the Guadalupe above Sattler and on the Cibolo above Bracken suggest that these streams have passed through mature stages and that the limestones in these areas have been exposed to erosion and underground solution since early Pleistocene time or possibly for a longer period. Along the main stream the lower member of the Glen Rose is honeycombed at the surface and caverns have developed, particularly along Cibolo Creek, where the surface runoff is negligible except after very heavy rains. However, in the interstream areas where the massive limestones are protected by overlying shale beds solutional cavities are small and the lower member of the Glen Rose limestone yields only small amounts of water.

GROUND-WATER DISCHARGE

COMAL SPRINGS (F63)

Comal Springs have the largest average discharge of any known springs in the southwestern part of the United States. The average flow during the 19-year period 1928–46 was 324 second-feet (cubic feet a second) or about 210,000,000 gallons a day. This is equivalent to 640 acre-feet a day or 235,000 acre-feet a year. It is greater than the average surface runoff from the 1,423 square miles drained by the Guadalupe River above the Spring Branch gaging station during the same period. The lowest recorded discharge of the springs was 245 second-feet, which was greater than the discharge of the Colorado River at Austin (drainage area 38,200 square miles) during dry periods before the Buchanan and Lake Travis reservoirs were put into operation. For example, the average daily flow of the river at Austin was less than 245 second-feet for periods of varying length aggregating 98 days during the water year from October 1929 to September 1930.

The discharge of the springs is better sustained than that of any other of the large springs of the Balcones fault zone; the minimum flow is about 58 percent of the maximum flow and about 76 percent of the average. The minimum, maximum, and average recorded discharge of the most inportant springs of the fault zone, including Comal Springs, together with the ratio of the minimum discharge to the maximum and average discharge are given in the table which follows. (See also table 17.)

TABLE 8.—*Comparison of minimum, maximum, and average discharge of Comal Springs and other important springs of the Balcones fault zone, Texas*

Springs	Discharge in second-feet			Ratio of minimum to maximum discharge (percentage)	Ratio of minimum to average discharge percentage)
	Minimum	Maximum	Average		
Comal at New Braunfels	245	420	324	58	76
San Marcos at San Marcos	51	286	153	18	33
Barton at Austin	12	139	41	8. 7	30
Las Moras near Brackettville	5. 8	60	22	9. 6	27
San Felipe [1] at Del Rio	41	150	76	27	54
Goodenough [1] near Comstock	96	700±	179	14	54

[1] In westward monoclinal extension of Balcones fault zone.

The water from Comal Springs issues crystal clear at a temperature of about 74° F. from the foot of the escarpment formed by the Comal Springs fault. The water has been observed after relatively long dry periods and after heavy rains, in winter and in summer, and no trace of turbidity has been detected. The maximum observed variation in temperature is not more than a degree.

Roemer (1849, p. 139) observed the temperature of Comal Springs at different times of the year between December 1845 and April 1847, and was impressed by their constant temperature which he reports as 19½° R. (19½° Reumur=75.83° F.).

The water rises from a large number of openings in the Edwards limestone along a distance of 500 yards at the base of the Comal Springs fault escarpment. There is no spectacular rush of water, no discharge of gas with the water, and no travertine deposits in the vicinity of the springs. The springs supply nearly all of the water that flows in Comal River which joins the Guadalupe River at a point about 1 mile east of the Springs and at a level about 40 feet below the level of the springs (pl. 4*A*).

The facts observed at Comal Springs reveal much of the story of ground water in Comal County. In order to account for such a large and constant volume of discharge, the conclusion is inescapable that the area of intake must be of the magnitude of many hundreds of square miles. In view of the limited area within the county that is favorable for rapid infiltration of rainfall or stream water to the ground-water reservoir supplying the spring, the source of some of the water must be beyond the corporate limits of the county.

The lack of turbidity suggests that the water moves slowly underground and that a part of its course is through an intricate network of small openings rather than through large tubular caverns, so that the rate of flow is retarded and sediment has an opportunity to settle out. The temperature of the water at the springs, which is 6 degrees higher than the average air temperature observed by the United States Weather Bureau at New Braunfels, suggests that the paths of circulation within the reservoir may reach depths of 300 to 500 feet below the surface because the temperature of ground water generally increases with depth. Cores from well G49, near Comal Springs, contained solutional cavities at the bottom of the hole, 320 feet below the surface.

HUECO SPRINGS (G18)

Hueco Springs appear on the west side of the Guadalupe River about 3 miles north of Comal Springs. The water issues from stream gravels in two places, one about 400 and the other about 200 feet west of the river.

The westernmost spring comes to the surface at an altitude of about 645 feet and is about 4 feet above the bed of the river; the other spring is nearer the river and is about 10 feet higher than the stream bed. The springs appear to rise a few feet north of a fault having several hundred feet of displacement, the trace of which can be seen in the bed of the river (pl. 1*A*). In dry years the springs are dry for months at a time. From August 1944 to February 1947 a period in which the average rainfall was exceptionally high, 25 discharge measurements showed a range in the flow of the springs from 13.2 to 96.0 second-feet or about 7 to 62 million gallons a day. (See table 13 and discussion by S. D. Breeding on p. 139.)

In contrast to that of Comal Springs, the temperature of Hueco Springs fluctuates as much as 3°. In 23 observations made between January 22, 1944, and December 30, 1945, the temperature ranged from 68° in winter to 71° in summer (table). The water is ordinarily clear but becomes slightly turbid during the first flow after heavy rains, particularly after a dry period. No gas issues from the water and no

A. COMAL SPRINGS.
B. PRIVATE POWER PLANT BELOW HUECO SPRINGS.

travertine deposits are found in the vicinity of the springs. The water is used by the owner, R. W. Gode, to operate a small power plant (pl. 4). Observations of Hueco Springs indicate that the area of recharge is relatively small.

OTHER SPRINGS

A number of other springs were observed in the county, but it is believed that their occurrence is not related to the underground reservoir that supplies Comal Springs.

Two springs (B35 and B36) issue from fault crevices in the lower member of the Glen Rose limestone in the bed of the GuadalupeRiver about 2 miles southwest of Hancock. The springs make only a slight bulge in the surface of the stream and are most conspicuous when the river is muddy because the spring water is clear. The combined discharge of these two springs, computed from the difference in the discharge of the river above and below the springs, was 14 second-feet or about 6,500 gallons a minute on Sept. 18, 1944 (U. S. Geol. Survey, 1946, p. 301). The spring water at that time was reported to be much colder than the river water.

Farther upstream, on the Guadalupe River, 3½ miles west of Hancock, on the J. D. Nixon ranch, a spring (B29), called Big Spring, issues from solution cavities in the lower member of the Glen Rose limestone about 10 feet above the level of the river. Two discharge measurements (U. S. Geol. Survey 1931 p. 76; 1932, p. 75) made at periods of low flow of the river, indicate a flow of 3.9 second-feet (1,750 gallons a minute) on January 18, 1928, and 2.9 second-feet (1,290 gallons a minute) on February 21, 1929. The average discharge of the spring may be somewhat greater than is indicated by these measurements, which were made during periods of low rainfall.

Rebecca Creek Spring (A5), 9 miles northwest of Hancock, had an estimated discharge of 1,500 to 2,000 gallons a minute on October 7, 1943. The temperature of the water on that date was 70° F. The spring issues from fissures and solution cavities in the Cow Creek limestone member of the Travis Peak formation.

The discharge of Spring Branch, which enters the Guadalupe River near Spring Branch post office in the northwestern part of the county, is maintained by two springs, one at the head of the branch (A12), and the other a smaller spring (A16), about a mile downstream. Spring A20, on the H. C. Plumly ranch, issues from a cavern at the base of the lower member of the Glen Rose limestone. Records of additional discharge measurements show a flow of 1.5 second-feet on January 18, 1928, and 0.9 second-foot February 20, 1929. When visited by the writer on March 28, 1945, the discharge was estimated to be about 11 second-feet or 5,000 gallons a minute. The lower spring (A16), visited on the same day, issues from a crevice in the Cow

Creek limestone member of the Travis Peak formation at an estimated rate of 50 gallons a minute. It supplies a school house and a small community by means of a hydraulic ram.

Honey Creek Spring (A28), on the Weidner ranch, 7 miles northwest of Bulverde, flows from a cavern at the base of the Glen Rose limestone, near the contact with the underlying Travis Peak formation. On July 20, 1944, the discharge of the spring was estimated to be 1,000 to 1,500 gallons a minute, and the temperature of the water was 69° F.

One spring (F66) is believed to have its source in the Austin chalk, although the water rises through an opening in the Taylor marl. This spring, the property of the Altgelt Farm Association, is 2¼ miles southwest of New Braunfels. The average discharge of the spring is estimated to be 50 gallons a minute.

A fault spring (F5), on the south side of Bear Creek near the Bear Creek road, issues from the upper members of the Glen Rose limestone, not far below its contact with the Edwards limestone. The water probably seeps from the Edwards limestone into the Glen Rose limestone along the fault plane. The flow was estimated to be 2,000 to 2,500 gallons a minute on March 28, 1945, but only 200 gallons a minute on September 29, 1945.

Eleven other springs (nos. B12, B17, B32, A2, B53, B52, E22, E36, E54, E58, and F4) which have maximum yields of less than 50 gallons a minute, are listed in the table of well and spring records. All of them issue from the Glen Rose limestone, generally from thin beds of fine-grained sandy marl. Some of the larger springs are associated with joint planes or faults with small displacements.

DISCHARGE FROM WELLS

Comparatively little water is withdrawn through wells from ground-water reservoirs in Comal County. The city of New Braunfels pumps from 1,000,000 to 2,000,000 gallons of water daily from three wells (G46, G47, and G81) in the Edwards limestone along the escarpment: and the Servtex Materials Company pumps an average of 1,250,000 gallons a day from a well (H29), also in Edwards limestone, in the western part of the county. Total withdrawals by pumpage from wells probably does not exceed 4,000,000 gallons a day.

GROUND-WATER RECHARGE

Ground water is derived chiefly from water that falls as rain or snow. A part of the precipitation runs off in streams; a part is returned to the atmosphere by evaporation and by transpiration of trees and other plants; and a part sinks into the zone of saturation, in which the openings in the rocks are filled with water. In a given drainage basin the proportion of the rainfall that is carried away directly by the streams can be determined accurately by stream gaging, but for a large area the proportions that are dissipated by evaporation and transpiration relative to the proportion that sinks to the water table as recharge can be only roughly estimated.

Perhaps the most important objective in the study of ground-water in the Balcones fault zone is the delineation of the intake areas of Comal Springs. On the basis of water-level measurements correlated with the discharge of the springs, hydraulic gradients, and surface-water runoff it is believed that the greater part of Comal County can be eliminated as recharge area for Comal Springs.

WATER LEVELS IN WELLS IN RELATION TO RAINFALL AND DISCHARGE OF SPRINGS

Upward or downward movements of the surface of the water underground are positive indications of increase or decrease of the volume of water in storage in the underground reservoir. Such movements are revealed by water-level measurements in wells. Estimates of recharge to sand or sandstones under water-table conditions can be made by measuring the rise in the level of the water in wells following each rain if the sand is fairly uniform in texture and if the water-table lies below the reach of the plant roots. In limestones, however, there is no uniformity in the size or the distribution of the openings, and the volume of voids, or space, available to receive the recharging rainfall can not be estimated. For example, the wide variations in water-levels recorded in well E24 (fig. 2), in Glen Rose limestone in Comal County were probably owing to the fact that the openings in the limestone are small and consequently a relatively small amount of local recharge produces a large rise in water levels. In such wells a large decline in water-levels results from a small amount of pumping. Conversely, the graph of well A34, shown in the same figure, shows little variation in water levels, indicating large underground storage space in the vicinity of the well. The discharge of Comal Springs is the overflow from a ground-water reservoir, and the flow of the springs increases as the levels of the water in the wells tapping the reservoir rise.

A number of wells in Comal County have been selected as permanent observation wells in which the depths to water have been measured periodically since 1934 at intervals ranging from 1 month to 1 year. The records for 54 wells, which have been measured 5 times or more, are given in table 20. Of the 54 wells, 3 draw water from the Travis Peak formation, 8 from the lower member of the Glen Rose limestone, and 39 from the Edwards limestone.

The maximum difference between highest and lowest levels recorded in any of the wells in the Travis Peak is 52.64 feet, the minimum is 20.87 feet, and the average is 36.41 feet; in wells in the lower member of the Glen Rose the maximum is 264.53 feet, the minimum 5.66 feet, and the average 87.55 feet; and in wells in the Edwards limestone the maximum is 149.28 feet, the minimum 2.22 feet, and the average 14.08 feet.

Hydrographs for five of these wells are shown in figure 2. The graph for well E24 shows a range in water levels of 49.19 feet. The well is in the lower member of the Glen Rose limestone, is 248 feet deep, and is in an interstream area about 3½ miles northeast of Bulverde. The water level can be lowered several feet by hand with a bucket and rope even though the lift is, at times, as much as 200 feet. The graph for well A34 gives the range between the maximum and minimum water levels of record as only 5.66 feet. This well is 9½ miles northeast of Bulverde and only about a quarter of a mile from the Guadalupe River. It also draws water from the lower member of the Glen Rose limestone, at a depth of 108 feet. The well is equipped with a cylinder pump and windmill and there is no measurable drawdown in the water level when the windmill is turning rapidly. These two wells illustrate the difference in yield and water-level fluctuations between wells that are near the main lines of drainage and wells in the interstream areas where solution channels have been poorly developed.

The water-level fluctuations in wells F44, G33, and G34 are more or less typical of those recorded from wells in the outcrop area of the Edwards limestone. The wells range in depth from 140 to 242 feet, and the fluctuations of water levels in them are of moderate range. None of the three wells in the Edwards has been tested for yield, but no shortage of water has been reported from any of them.

Heavy rainfall causes the water levels in wells in the limestone reservoir to rise, indicating an increase in the volume of water in storage. As the water in storage increases, the discharge from Comal Springs also increases. Figure 3 shows the monthly precipitation near the spring at New Braunfels and at Boerne in the upper part of the drainage area of Cibolo Creek, about 35 miles west of the springs. Hydrographs of the fluctuations in the average monthly discharge of Comal Springs from 1932 to 1945, inclusive, and the monthly average water level in the Beverly Lodges well at San Antonio, about 28 miles southwest of the springs, are also shown. The Beverly Lodges well is an artesian well in the Edwards limestone, 756 feet deep. The hydrograph of the water level in this well is the only long continuous record available in the area and seems to correlate with the variations

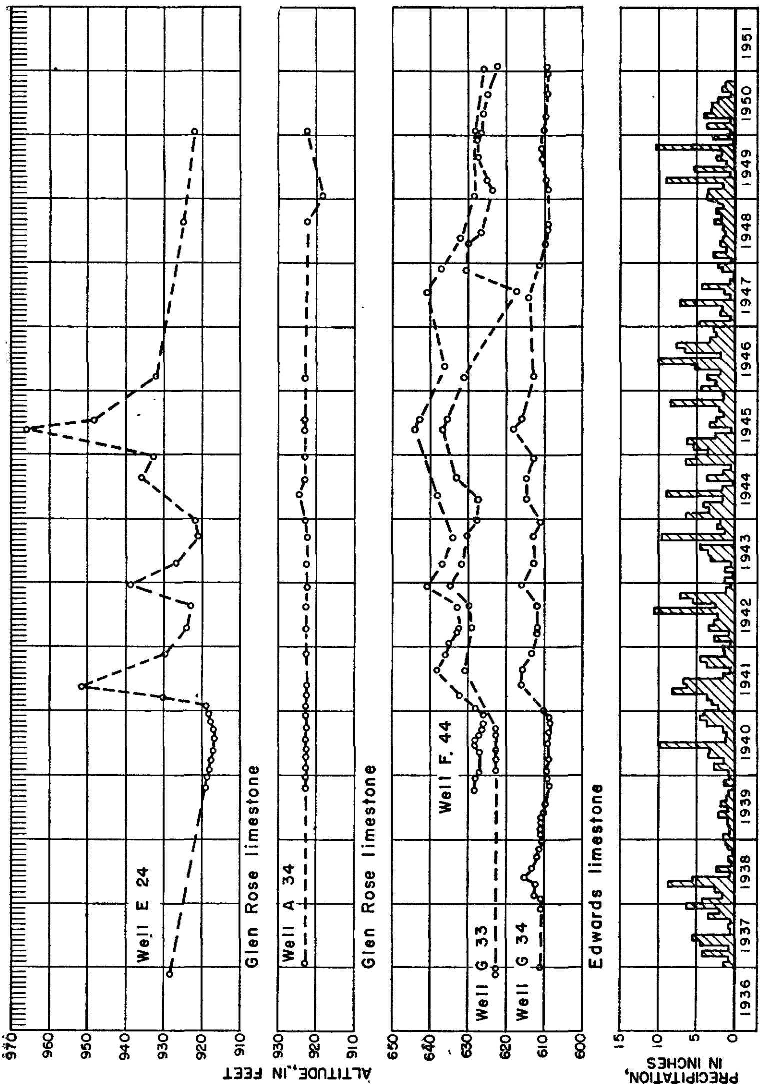

FIGURE 2.—Altitudes of water levels in wells in the Glen Rose and Edwards limestones and monthly precipitation at New Braunfels from 1936–50.

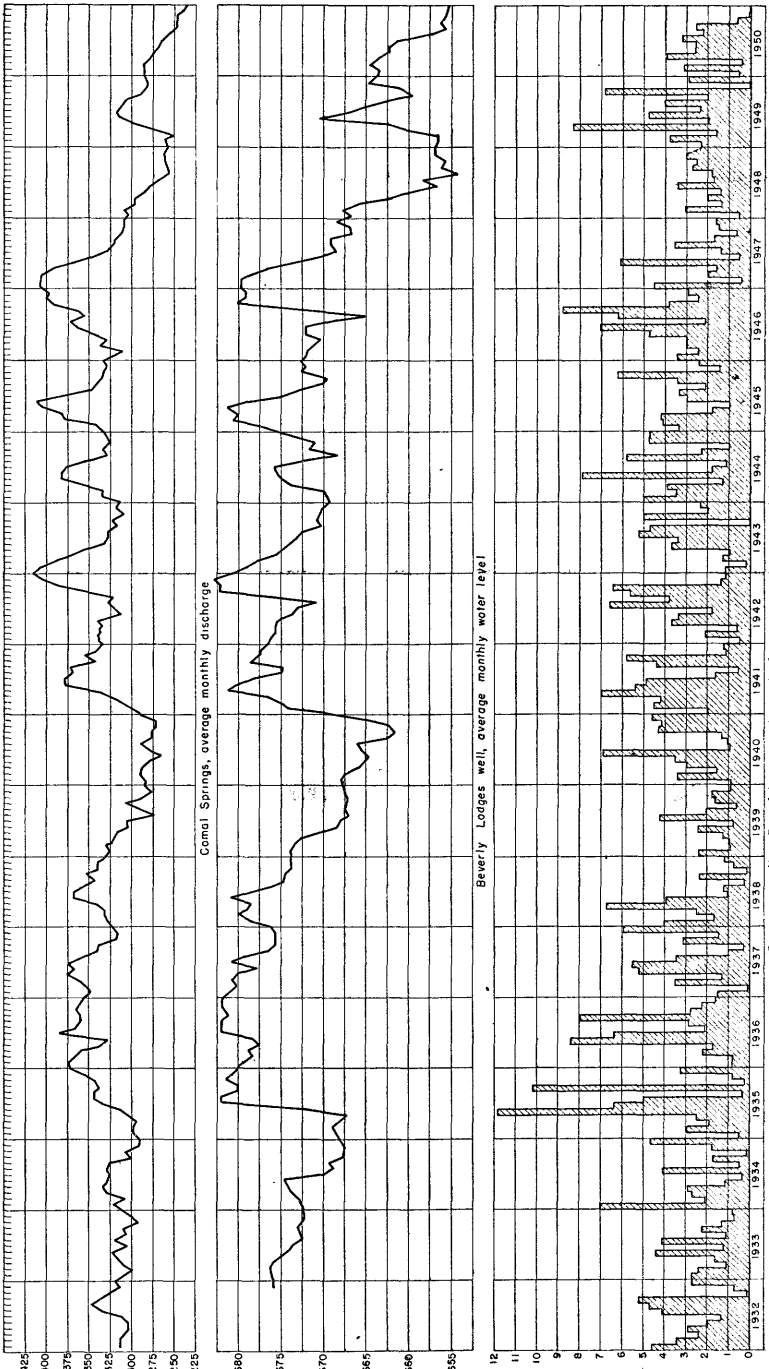

FIGURE 3.—Discharge of Comal Springs, altitude of water levels in Beverly Lodges well, San Antonio, and precipitation by months, 1932–50.

in the discharge of Comal Springs. The water level in the well during the period of record has ranged from 38 to 69 feet below the land surface.

At the time of heavy general rains such as those of the periods May–July 1935, May–September 1936, and July–September 1942, the water level in the Beverly Lodges well rises quickly after each rain and finally reaches a high level which may be maintained from 1 month to 2 months after the period of heavy precipitation. The reservoir seems easily repleted and the changes in the volume of water in storage respond more readily to rainfall than to withdrawals. As indicated by the water levels in the Beverly Lodges well there was a steady decline in the amount of water in storage during the dry years from 1936 to 1940. Withdrawals for consumption also increased and the rate of withdrawals is still increasing in the San Antonio area but the heavy rains of 1941 and 1942 caused the water level to rise to the highest recorded level.

The increase in the discharge of the Comal Springs after rains follows a pattern that is similar in most respects to that of the rise in the Beverly Lodges well, except that the rise in the water level in the well occurs much sooner than the increase in discharge of the springs. The lag is especially pronounced after a long period of drought, but is much less during wet periods. For example, the water level in the Beverly Lodges well rose nearly 9 feet in three stages immediately after each heavy rain between October 23 and December 13, 1940, preceded by a relatively dry period of 30 months. In contrast to this the discharge of Comal Springs, which was at an exceptionally low stage, remained practically unchanged aside from slight temporary increases throughout October, November, and the first half of December, and finally had a sustained increase of about 10 percent on December 18. Once a rise takes place, however, it is likely to be sustained for weeks or months, even through periods of unusually low rainfall.

It will be observed that the rise in water level and increase in the discharge of the springs is not always proportional to the amount of precipitation. In 1935 the average precipitation at Boerne and New Braunfels was 47.30 inches. Heavy rains in May started an upward movement in the water level in the Beverly Lodges well, culminating at 682 feet above sea level in July, whereas the peak in the discharge curve for Comal Springs did not come until January 1937, when it reached 375 second-feet. In 1942, after the relatively heavier rainfall of 1941, the average precipitation at Boerne and New Braunfels was 36.60 inches or 10.70 inches less than in 1935, yet the water level in the well rose to an altitude of nearly 681 feet and the discharge of Comal Springs at the end of the year was 418 second-feet or 43 second-feet greater than maximum discharge after the heavier rains of 1935. This is not surprising, however, as the surface runoff and the ground-water recharge are greatly affected by the distribution and the intensity of rainfall.

The relationship among precipitation, water levels, and the discharge of Comal Springs is shown in greater detail in figure 4, which gives the daily precipitation at New Braunfels, the daily fluctuations in discharge of the springs, and a hydrograph of the daily water levels in well F44 for 1942. Well F44 is about 2½ miles west of Comal Springs, is 242 feet deep, and draws from the Edwards limestone. The hydrograph, obtained by means of a continuous recorder, show the fluctuations in water level under water-table conditions.

During the first half of 1942 there was a steady decline in water level in the well in response to relatively low rainfall. The decline was interrupted by several slight rises, notably in the second week of April, the last week of May, and the first week of July. The rise in both the water levels and the discharge of the springs began within a day or two after the rains but the general trend seemed to depend upon the backlog of storage in the reservoir. In spite of the low rainfall in November and December, the rises that occurred after heavy rains in September and October were maintained until the end of the year.

MOVEMENT OF GROUND WATER

Ground water may be classified in regard to its origin as connate water or meteoric water. The water that is trapped in sediments at the time of their deposition is called connate water. This water may be a brine similar to present sea water, or even more concentrated. After the formation has been exposed to the surface, or lifted above sea level, the sea water may be gradually flushed out and replaced by water from rain or snow and only such minerals as may be dissolved from the rock in the process of circulation will be found in the water. For example, the Edwards limestone yields potable water to Comal Springs but contains salt water, petroleum, and gas in the oil fields of Caldwell County. Intermediate between these two kinds of water is that of poor quality found in areas where the circulation of meteoric water is comparatively slow as a result of structural features or because of clay or shale beds between beds of limestone. South of the Comal Springs fault a number of wells (for example, nos. G75 and G38) have been drilled to the Edwards limestone but have been abandoned because the water is too highly mineralized or has a hydrogen sulfide odor. This is strong evidence that there is very little circulation of water in the Edwards south of the Comal Springs fault in Comal County. In Bexar County (Livingston, Sayre, and White, 1936, p.

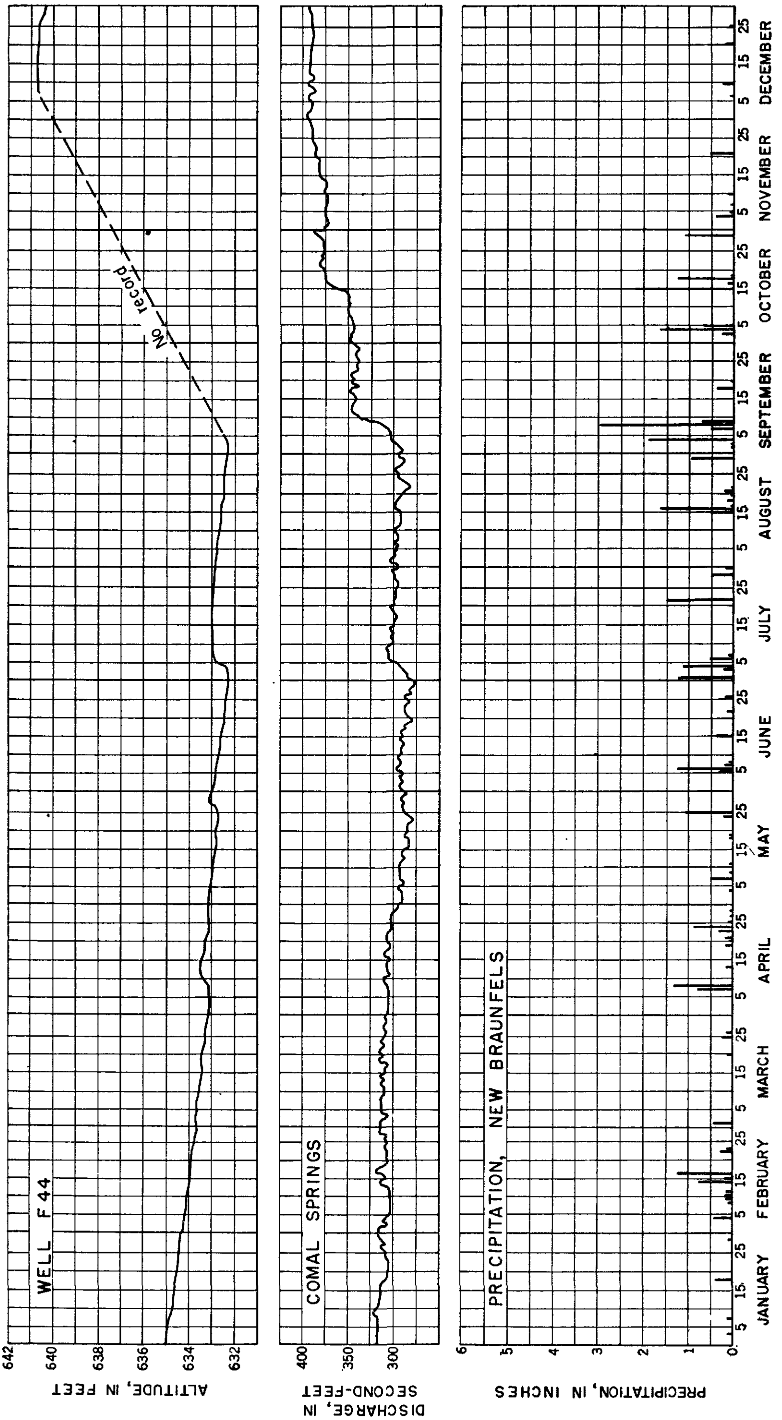

FIGURE 4.—Rise and fall of water level in well F44, daily discharge of Comal Springs, and precipitation at New Braunfels, 1942.

104), however, there is a large area, not defined by any one fault, which yields potable water.

In the upper member of the Glen Rose limestone many wells yield water of comparatively poor quality owing to the alternating beds of clay and shale that prevent the free circulation of meteoric water. In general, circulation decreases with depth and water obtained at great depths is likely to be of poor quality although there are many exceptions to this rule. Circulation of water in limestones may be retarded by natural puddling when solution channels become filled with clay or other detrital material carried into the formation by infiltrating meteoric waters after heavy rains. Weathering within the limestone usually produces a residue of red clay, which may also be washed into previously formed caverns. Beds of red clay are found in a number of places in the Edwards limestone. Natural puddling occurs, however, after connate waters have been flushed out of the limestone.

RATE OF MOVEMENT

The lack of turbidity in the water that issues from Comal Springs suggests that the water moves slowly underground and that a part of its course is through an intricate network of small openings that retard the velocity of the water to the extent that sediments are not carried along as in open streams. Locally, however, at some distance from the springs constricted openings may cause turbulent flow. The temperature of the water from Comal Springs is constant at about 74° F., whereas the mean annual temperature of the air recorded by the United States Weather Bureau at New Braunfels is 68° F. This suggests that the paths of circulation within the reservoir may reach depths of 300 to 500 feet below the surface at no great distance from the spring.

Cores obtained from G49, near Comal Springs and on the upthrow side of the fault, show that the Glen Rose limestone is vuggy at a depth of 320 feet. The presence of solutional cavities at 320 feet is not proof that water is circulating at this depth at the present time, but geologic evidence does not indicate that the water table has ever been lower, relative to the land surafce, than it is now—at least not since the faulting took place.

The water from Hueco Springs, conversely, becomes slightly turbid after heavy rains and the temperature of the water fluctuates within a range from 3° to 6° lower than that of Comal Springs. These conditions, together with the fact that the springs have a wide range in discharge, suggest that the springs are supplied by a ground-water reservoir that is quite separate from that supplying Comal Springs, and that the intake area for this reservoir is smaller and closer to the point of discharge than the intake area of the Comal Springs reservoir.

The Hueco Springs fault is believed to divide the two reservoirs. This is indicated by a comparison between the altitudes of the water levels in wells in the Edwards limestone on either side of the fault and the altitude of Hueco Springs. On the southeast side of the fault in the vicinity of the spring the maximum altitudes of water levels on record in wells G33, G32, F27, and G29 are approximately 636, 637, 641, and 636 feet, respectively (see table of water levels), whereas the altitude of the lowest point of discharge for Hueco Springs is 645 feet. Just northwest of the fault the water level in well F26 has been recorded as high as 665 feet. Hueco Springs obviously could not be fed by a reservoir having a water level lower than the point of discharge, so that the reservoir must be northwest of the fault. It is not proved, however, that the fault acts as a barrier to the movement of ground water for the entire width of the county.

Springs in the Balmorhea area of Texas are believed to be close to the intake area and it was observed by White, Gale, and Nye (1941, p. 100), that an increase in discharge was accompanied by a decrease in the temperature and in the mineralization of the water. In table 9 the records of temperatures, hardness, and discharge measurements for Hueco Springs show no direct relationship among these factors.

The apparent lag in the increase in discharge of Comal Springs (figs. 3 and 4) following heavy rains and rises in water levels does not mean that the water actually moves from the vicinity of San Antonio to Comal Springs within the 1- or 2-month period indicated by the lag. Only the change in head due to added water in the intake area and in the reservoir itself is transmitted at this rate. The time required for the water that falls as rain on the intake area west of Comal County to reach Comal Springs would probably be expressed in years rather than in days or months. Much research has been directed toward the rate of movement of ground water, and with considerable success where the character and permeability of the materials that form the ground-water reservoirs are fairly uniform. As a result of this, research methods have been developed by Thiem (1906) and Theis (1935, pp. 519–524) by which it is possible to make quantitative estimates as to the possible yield of ground-water reservoirs. The methods are more generally applicable to sand and sandstone reservoirs because of the more nearly uniform character of such aquifers. The application of formulas for the determination of the permeability of the limestones in Comal County would be difficult not only because of the irregularities in the character of the openings in the limestones but because it is believed that the movement of the water may be under artesian conditions in a part of its course and under water-table conditions in other parts.

TABLE 9.—*Temperatures, hardness, and discharge of Hueco Springs, Tex.*

Date	Temperature of spring water (° F.)	Air temperature (° F.)	Hardness as $CaCO_3$ (parts per million)[1]	Discharge in second-feet [2]
1944				
Jan. 22	70		326	
Sept. 14	71.5		260	
Oct. 9	71		333	
Nov. 22			294	
Dec. 5 [3]	71	45	264	
Dec. 7	71	45	316	
Dec. 11	69	45		
Dec. 12	69	49		
Dec. 13	69	52		
Dec. 20	69	35		
1945				
Jan. 8	69			
Jan. 22	69	44	279	90.3
Jan. 27	68	34		
Feb. 14	68		322	92.4
Mar. 5	68.5		288	
Mar. 23	69		308	80.4
Apr. 1			286	
Apr. 27	69		337	84.5
May 31	69.5		254	77.7
July 5	70		272	59.0
Aug. 9	70		221	32.1
Sept. 13	70		336	23.3
Oct. 19	69.5		282	46.8
Nov. 23	70		326	17.6
Dec. 20	70			16.5

1 For more complete analyses see table 19.
2 More complete discharge data given in table 13.
3 About 8 hours after heavy rain.

DIRECTION OF MOVEMENT

Plate 5 (in pocket) is a map of Comal County showing the altitude of the water surface in a number of observation wells in the Edwards limestone for the period January 5–16, 1951. This was obtained by determining the altitude of the land surface at each well and subtracting therefrom the depth to water in the well. The slope of the hydraulic gradient is indicated by contours.

These records show that the general slope of the water table in the wells in the Edwards limestone in Comal County is from the southwest boundary of the county toward the northeast boundary of the county, although locally the gradients may not conform to this general direction. Relatively high water levels recorded for a few wells (not shown on pl. 5) along the northwest side of the Hueco Springs fault show the impounding effect of the fault. From the general direction of the gradient it may be assumed that some water enters Comal County from the Edwards limestone in Bexar County. Livingston, Sayre, and White (1936, pl. 5) show the slope of the artesian head for wells in the Edwards limestone in the San Antonio area in 1934. The general direction of the movement of water probably varies but little from time to time. As indicated by the contours on their map, the general slope of the pressure surface is southeastward but at the Comal County line the contours swing rather abruptly northward, indicating an eastward slope of the pressure surface. In this area the water appears to move out from under its confining bed and continues northeastward under water-table conditions, as indicated by the relative elevations of the water surface shown on the map of the San Antonio area and in plate 5 of the present report.

The fact that the chemical character of the water southeast of the Comal Springs fault is poor compared with the quality of the water that issues from Comal Springs is further proof that the main body of water flows along the north side of the fault under water-table conditions rather than on the downthrow side of the fault. This change in the direction of flow of the water in the Edwards was probably caused by structural uplift and transverse faulting in the vinicity of Bracken, modifications which may have formed a barrier diverting the water from its normal course in the artesian area. Following the general direction of the slope in Comal County, the water appears to move from the vicinity of Bracken toward and beyond Comal Springs. In the vicinity of the springs the slope is toward the springs from north, west, and south, indicating a cone of depression caused by the discharge of the spring (pl. 5).

In wells drawing from the Glen Rose limestone the altitude of the water levels indicate that the water table slopes eastward and southeastward toward the outcrop of the Edwards. On the divide between Cibolo Creek and the Guadalupe River, however, wells in the Glen Rose show a pronounced irregularity in the altitude and slope of the water table. This is characteristic of the water table in limestones in which the solution channeling is poorly developed.

STREAM LOSSES AND GAINS

In some localities recharge from larger streams to ground-water reservoirs can be measured directly with fair accuracy by stream gaging. For example, it has been estimated from stream-flow records that the combined losses into the Edwards artesian reservoir in Uvalde and Medina Counties from the Nueces, Frio, Dry Frio, Sabinal, and Medina Rivers and Hondo Creek may average as much as 150,000 acre-feet annually (Sayre, 1936, p. 83; Livingston, Sayre, and White, 1936, p. 77), the equivalent of a continuous flow of 207 second-feet or 134 million gallons a day. These estimates, of course, did not take into account the recharge in the interstream areas.

Records showing losses from streams and gains to streams from ground-water reservoirs are useful, but in the Comal County area comparison of the records of the total runoff from the different drainage subdivisions provides a more adequate basis for estimating the total ground-water recharge, especially if the data are correlated with the facts regarding the geology and opportunities for infiltration to the underground reservoir in the different sections.

Most of Comal County is drained by the Guadalupe River and Cibolo and Dry Comal Creeks. Gaging stations have been in operation on the Guadalupe River at Comfort, Spring Branch, and New Braunfels for many years. Figure 5 shows graphically the discharge at the three stations from January 1939 to December 1950. The discharge varied over a wide range during the period, and at all stages except the very low stage of September and October 1940, it showed a fairly uniform increase at successive downstream stations. The loss during the period of low flow could be readily accounted for by losses from evaporation.

Above Comfort the Edwards limestone crops out in the higher parts of the drainage area, comprising about two-thirds of it, and the Glen Rose limestone is exposed in the lower parts. A perennial flow of considerable size is maintained by springs that issue from the Edwards limestone. The average runoff from this area of nearly 1,000 square miles for the period from 1923 to 1932 was 110 acre-feet per year per square mile, and 138 acre-feet per year per square mile for the period from 1939 to 1946.

Between the stations at Comfort and Spring Branch, the river cuts deeper into the section, exposing the lower member of the Glen Rose limestone and leaving remnants of the Edwards limestone on the hilltops. Near Spring Branch the upper and middle members of the Travis Peak formation are exposed in the bed of the stream, but the outcrop is terminated by a fault about 2½ miles upstream from the Spring Branch station. The average runoff from the drainage area of 1,432 square miles above Spring Branch for the period from 1923 to 1946 was 150 acre-feet per year per square mile.

Between Spring Branch and New Braunfels the Guadalupe River crosses successively younger formations, because of the series of downfaulted blocks, beginning with the lower member of the Glen Rose limestone at Spring Branch gaging station and crossing the Edwards limestone at New Braunfels. (See cross section, pl. 2.) At New Braunfels the average runoff for the years 1928-50 from the drainage area of 1,666 square miles was 165 acre-feet per year per square mile, and the average pickup between the two stations including the discharge of Hueco Springs, but not that of Comal Springs, amounted to 63,370 acre-feet a year, representing an average runoff of 271 acre-feet per square mile per year.

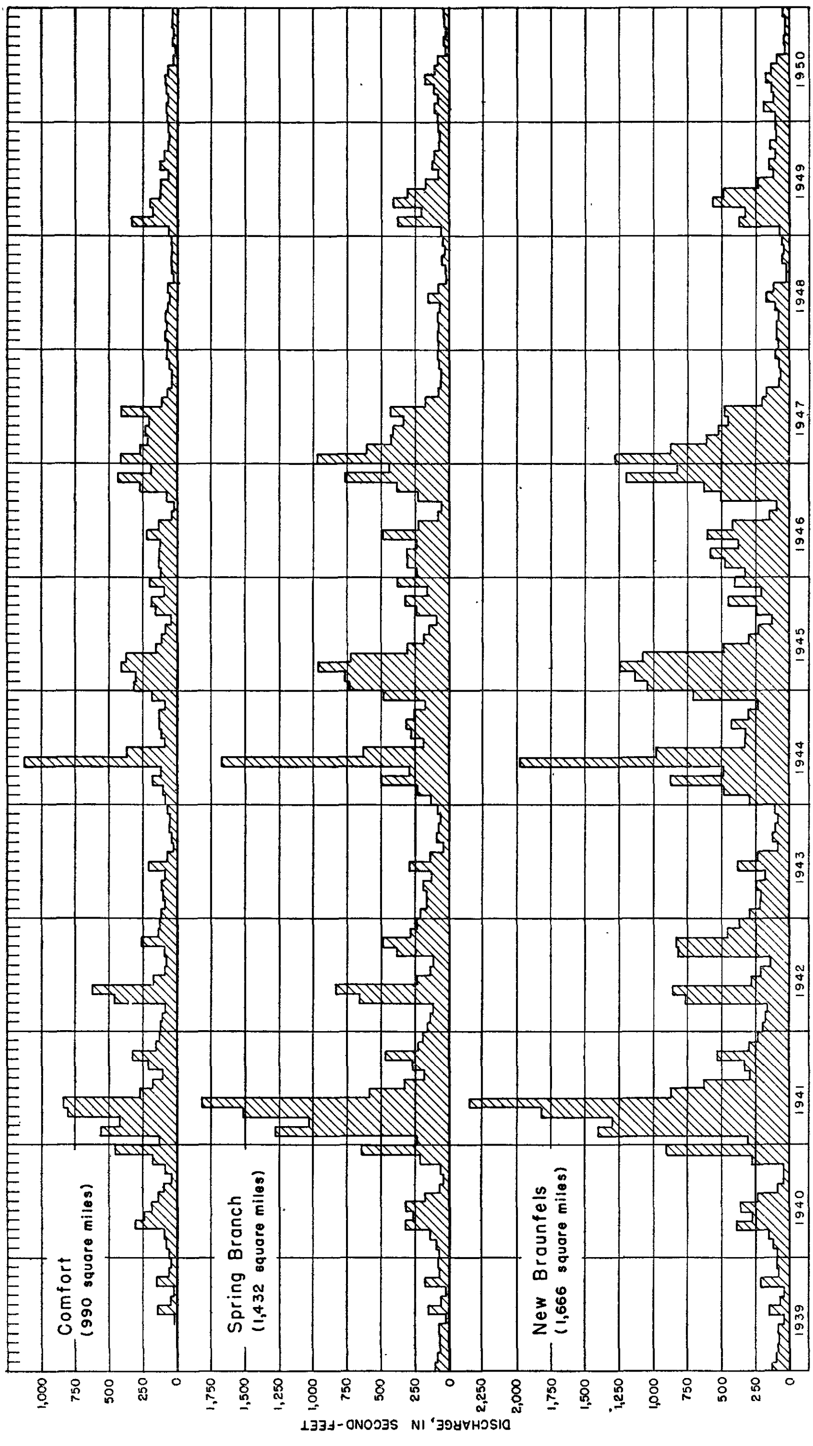

FIGURE 5.—Average monthly discharge of the Guadalupe River at Comfort, Spring Branch, and New Braunfels stations, 1939–50.

In addition to the discharge measurements at the regular stations, several series of measurements have been made at intermediate points during periods of low flow to determine the pickup or losses between stations. These are shown in tables 13 to 16. The series of seepage measurements made on January 18–19, 1928, showed a net gain of 12.9 second-feet between the Comfort and Spring Branch stations and a net gain of 0.3 second-foot between the Spring Branch station and New Braunfels. The total net gain, therefore, was 13.2 second-feet. The series of February 20–22, 1929, showed a net gain of 3.0 second-feet between Comfort and Spring Branch and a net loss of 1.4 second-feet between Spring Branch and New Braunfels. The overall net gain for the two sections, therefore, was 1.6 second-feet. The discharge of the Guadalupe River at New Braunfels above Comal River for February 22, 1929, was 49 second-feet, and the discharge of Comal Springs for the same date was 270 second-feet.

Water levels in most of the wells along the Guadalupe River are above the level of the river except in the section of the river between the Hueco Springs fault and the Comal Springs fault, where the bed of the river is in the Edwards limestone. Here, however, the water-table gradient is eastward, away from Comal Springs (pl. 5). On the basis of the foregoing data it is concluded that very little, if any, water is lost from the surface flow of the Guadalupe River to the ground-water reservoir that supplies Comal Springs or Hueco Springs.

In contrast to the Guadalupe River, Cibolo Creek shows much evidence of large losses to the underground reservoirs along most of its course from Boerne to Selma, of which about 30 miles is in the Glen Rose limestone and about 5 miles at the lower end of the section is in the Edwards limestone (fig. 6).

Losses from Cibolo Creek have been observed as far upstream as the mouth of Balcones Creek. About a hundred yards above the junction of the two creeks a crevice 18 inches wide crosses Balcones Creek. During periods of high stage, a part of the water from Cibolo Creek backs upstream in the bed of Balcones Creek and disappears in the crevice. Downstream along the Cibolo, losses have been reported in the vicinity of the crossing of Highway 281 and have been observed by the writer in a pool about 5 miles east of Bulverde. Evidence of losses in the flood plain of the Cibolo may be seen on the O. Weidner farm, half a mile east of Highway 281, and on the Rompel farm, 4½ miles east of Highway 281, in the form of small caves opening at the surface (pl. 1*B*). In one cave the hard limestone at the mouth of the cave has been rounded and smoothed by the abrasive action of sand washed into the hole (pl. 1*B*).

Three gaging stations were established on the Cibolo in March 1946, and the brief records of discharge for two of these stations are

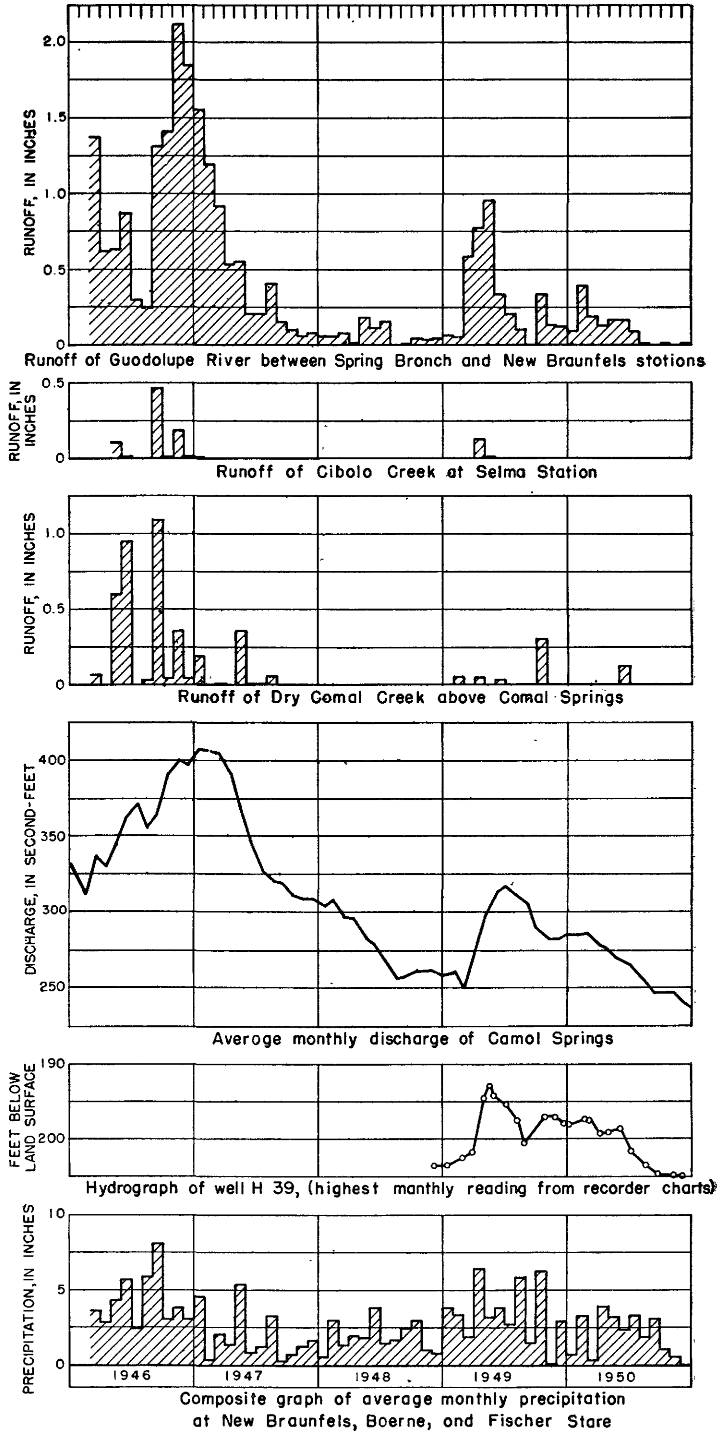

FIGURE 6.—Simultaneous runoff, discharge, water level, and precipitation records, 1946–50.

given in table 18, and are shown in plate 6 (in pocket). Between the mouth of Balcones Creek, at the west corner of the county, and the Bulverde station the bed of the creek is in the lower member of the Glen Rose limestone and the losses in this part of the stream appear to be large. Between the Bulverde station and the Bracken station about 5 miles northwest of Bracken, the bed of Cibolo Creek is in the upper member of the Glen Rose limestone and the losses in this area are relatively small, although some loss was observed by the writer at the edge of a pool about 8 miles northwest of Bracken. Between the Bracken station and the bridge at Bracken the bed of the creek is in the Edwards limestone which is honeycombed and broken by many small faults. Here the losses are believed to be large in proportion to the amount of water that reaches this stretch of the stream. Most of the rainfall in the upper reaches of the Cibolo, however, is intercepted by infiltration into the Glen Rose limestone before it reaches the Edwards limestone at Bracken station. Between the bridge at Bracken and the Selma station about 1 mile below the crossing, the bed is in the Austin chalk and the losses in this stretch are probably small.

A striking example of infiltration into the lower member of the Glen Rose limestone above Bulverde station is shown in the records for the last 4 days of August 1946. Official rainfall records of the United States Weather Bureau are as follows:

[Precipitation in inches]

	Bulverde	Randolph Field	Boerne	New Braunfels
1946				
August 28	1.05	0.17	1.30	1.56
29	3.80	2.57	4.79	3.06
30	.67	.26	.19	.77
31	.06	.04	.01	.10
	5.58	3.04	6.29	5.49

The heaviest precipitation occurred in the vicinity of Boerne in the headwaters of Cibolo Creek. The rains occurred after a relatively long dry period and it is probable that much of this water was intercepted by vegetation, by the wetting of soils and rock surfaces, by depressions that form pools in the bed of the stream, and by the sands and gravels in the Leona formation that occur as broad terraces on either side of the Cibolo, but an estimated discharge of 300 second-feet was observed in the stream near the junction of Bexar, Kendall, and Comal Counties on August 29. As shown by the discharge records (table 18), none of this water reached the station at Bulverde.

It is believed that most of the water entered caverns in the lower member of the Glen Rose limestone and thence passed laterally through underground channels into the Edwards limestone.

Water seldom flows in the channel of Dry Comal Creek which drains the greater part of the outcrop area of the Edwards limestone north and west of New Braunfels and flows into the Comal River near Comal Springs.

Records of runoff and rainfall are given in table 18. For the 58 months beginning March 1, 1946, and ending December 31, 1950, the runoff for the three drainage areas was as follows: 1,200 acre-feet per square mile from the area drained by Guadalupe River between the Spring Branch and New Braunfels gaging stations; 48.9 acre-feet per square mile from the basin of Cibolo Creek above Selma; and 267.2 acre-feet per square mile from the drainage basin of Dry Comal Creek (excluding spring discharge). These figures, expressed as depth of runoff in inches, are 22.5, 0.92, and 4.8 inches, respectively. Assuming a fairly uniform distribution of rainfall for the period, the large difference in runoff indicates that the rate of infiltration into the underlying reservoir from the basin of Comal River and Cibolo Creek above Selma is markedly high as compared with infiltration from the area drained by the Guadalupe River between the Spring Branch gaging station and New Braunfels gaging station (fig. 6).

From the rainfall records it is reasonable to assume that the distribution and intensity of rainfall for the 58-month period was similar for all three drainage areas. The striking differences in runoff must then be attributed to evaporation, transpiration, and infiltration. In the drainage area of the Guadalupe River between Spring Branch station and the New Braunfels station there are sharp divides and steep, almost barren slopes; in the other two areas there is probably more vegetation and, consequently greater transpiration. If there are any differences in evaporation and transpiration among the three areas, these must be slight in comparison to the differences in infiltration. If most of the differences in runoff are attributed to infiltration, as seems reasonable, it is possible to estimate by differences the relative recharge among the three reservoirs to the reservoir that supplies Comal Springs. The difference in runoff for the 58-month period of the Guadalupe River drainage area (1,200 acre-feet per square mile), and the Cibolo Creek area (49 acre-feet per square mile) times the drainage area of the Cibolo basin (280 square miles) is 322,280 acre-feet. The difference for Dry Comal basin is (1,200−254) 946 acre-feet per square mile times the 45 square miles of drainage area or 42,570 acre-feet. The total infiltration would then be: Guadalupe 0+Cibolo 322,280+Dry Comal 42,570=364,850 acre-feet.

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The total infiltration is about 34 percent of the 1,073,910-acre-foot discharge of Comal Springs for the 58-month period. The average discharge of Comal Springs for this period was 308 cubic feet per second or slightly less than the average for a 23-year period of record which is 320 cubic feet per second. This suggests that the recharge may have been slightly under average.

Making some allowance for the fact that transpiration and evaporation in the Cibolo and Dry Comal basins may have been somewhat greater than in the Guadalupe drainage area it appears that about one-fourth to one-third of the water that flows from Comal Springs comes from the rainfall and recharge in the Cibolo and Dry Comal basins.

SUMMARY OF CONCLUSIONS

The facts presented in this report suggest that Comal Springs are a point of discharge for an immense ground-water reservoir which also supplies wells and springs in the San Antonio area, and that the discharge of the springs varies with the volume of water in the reservoir. The large size of the reservoir is indicated by the remarkably constant rate of discharge of the springs, by the uniform temperature and lack of turbidity of the water, and by the relation among fluctuation in discharge, rainfall, and rise and fall in water levels in wells. The geological information, together with the runoff and seepage data available, seems to justify the conclusion that a relatively large part of the discharge of Comal Springs comes from sources outside of Comal County and beyond the adjacent parts of Bexar and Kendall Counties drained by Cibolo Creek.

The water is not coming from the north, because the intake and transmission facilities are unfavorable in that direction; it is not coming from the east, because the hydraulic gradient shown by the altitude of the water level in wells is eastward from the springs; it is not coming from the south because it is shut off by the Comal Springs fault as indicated by the difference in the chemical character of the water on the two sides of the fault. Therefore, it must be coming from the west and southwest and a major part of it must be coming from areas beyond the drainage basin of Cibolo Creek.

It has been shown that recharge to the reservoir within Comal County is limited to parts of the drainage area of Cibolo and Comal Creeks, and that even under the most favorable conditions this recharge is too small to supply the springs. It is estimated that the entire drainage area of Comal and Cibolo Creek contributes about one-third of the water that reaches Comal Springs; the rest, therefore, must come from areas to the west, beyond these drainage basins.

SURFACE-WATER SUPPLIES

By Seth D. Breeding

About 420 square miles of the 567 square miles in Comal County drains directly into Guadalupe River. About 60 square miles in the northeastern part of the county is drained by Blanco River, a tributary of San Marcos River which enters the Guadalupe at Gonzales about 60 miles below New Braunfels, and a strip of about 90 square miles along the southwestern border of the county is drained by Cibolo Creek, a tributary of the San Antonio River.

Continuous records of the discharge of these streams were being obtained in January 1951 at the gaging stations listed in table 10 except the one on Guadalupe River at New Braunfels, below Comal River, which was discontinued in 1927. All the stations except the one at Wimberley are in Comal County.

Table 10.—*Gaging stations in the Comal County area, Tex.*

Station	Drainage area (square miles)	Period of record
Guadalupe River near Spring Branch.	1, 432	June 1922 to December 1950.
Guadalupe River above Comal River at New Braunfels.	1, 666	December 1927 to December 1950.
Guadalupe River at New Braunfels (below Comal River).	1, 770	January 1915 to December 1927.
Comal River at New Braunfels	[1] 94	December 1927 to December 1950.
Blanco River at Wimberley	378	August 1924 to September 1926 and June 1928 to December 1950.
Cibolo Creek near Bulverde	198	April 1946 to December 1950.
Cibolo Creek at Selma	280	March 1946 to December 1950.

[1] Measurements include flow from Comal Springs which receive water from beyond this drainage area.

These records were collected by the Surface Water Branch of the United States Geological Survey in cooperation with the Texas State Board of Water Engineers, and have been published in Geological Survey Water-Supply Papers.

GUADALUPE RIVER

A few pertinent facts about the flow of Guadalupe River as measured at gaging stations in Comal County are given in table 11.

Peak rates of flow recorded for the Guadalupe River near Spring Branch during the period 1923–50 were 121,000 second-feet on July 3, 1932, and 114,000 second-feet on June 15, 1935. The minimum flow recorded was 2.2 second-feet on July 11, 1939. Peak rates of flow recorded for the Guadalupe River at New Braunfels during the period 1916–50 were 95,200 second-feet on July 3, 1932, and 101,000

TABLE 11.—*Runoff of the Guadalupe River*

Gaging station	Period of record (calendar years)	Average during period (acre-feet[1] per day)	Average during 12 consecutive months of lowest flow (acre-feet per day)	Minimum in 1 day (acre-feet)
Spring Branch	1923–50	549	96	5. 6
New Braunfels (above Comal River)	1928–50	753	127	19
New Braunfels (below Comal River)	1916–27	1, 486	682	536

[1] An acre-foot is the amount of water required to cover 1 acre to the depth of 1 foot and is equivalent to about 326,000 gallons.

second-feet on June 15, 1935. Floods of considerably greater magnitude occurred in 1869 and in December 1913. The minimum flow recorded for the Guadalupe River above Comal River at New Braunfels between 1928 and 1950 was 9.6 second-feet on July 9–11, 1939. As the floods in July 1932 and June 1935 originated above Spring Branch, the decrease in the peak rates of flow between Spring Branch and New Braunfels is considered to be due to temporary channel storage and to have no relation to possible losses to the ground water reservoir.

Table 12 gives the annual discharge of the Guadalupe River at the gaging stations near Spring Branch and at New Braunfels, above Comal River, and the runoff from the 234 square miles drained by the river between these stations (expressed in acre-feet and in depth in inches), together with the annual rainfall at New Braunfels and Fischer Store for the years 1928 to 1950.

During the 23-year period (1928–50) the minimum annual runoff from the drainage area between the two stations (234 square miles) was 0.34 inch or 18 acre-feet per square mile, the maximum runoff was 12.00 inches or 640 acre-feet per square mile, and the average was 5.08 inches or 271 acre-feet per square mile. The runoff from this area during period of normal and low flow is considerably affected by the flow from several springs, of which the Hueco Springs are by far the largest. Results of current-meter measurements of the flow of Hueco Springs, which enter Guadalupe River 3 miles above the gage at New Braunfels, show a discharge ranging from 0 to 96.0 second-feet. These measurements are listed in table 13.

Most of the measurements in table 13 were made in 1945–50 when the rainfall over Comal County, based on records at Fischer Store and New Braunfels, averaged 32.36 inches annually, compared to a 61-year average of 30.57 inches. The maximum annual rainfall during the period 1945–50 at New Braunfels was 56.60 inches in 1946 and the minimum was 20.34 inches in 1948.

TABLE 12.—*Discharge of the Guadalupe River near Spring Branch and at New Braunfels and pickup between stations; rainfall at Fischer Store and New Braunfels, Tex., 1928–50*

Calendar year	Flow of Guadalupe River in acre-feet		Runoff between Spring Branch and New Braunfels		Rainfall in inches	
	Spring Branch	New Braunfels	Acre-feet	Depth in inches	Fischer store	New Braunfels
1928	45,400	64,800	19,400	1.55	28.83	36.07
1929	143,000	208,000	65,000	5.21	40.60	40.15
1930	142,000	170,000	28,000	2.24	30.80	28.71
1931	235,000	336,000	101,000	8.09	32.57	31.58
1932	395,000	425,000	30,000	2.40	27.58	31.15
1933	102,000	114,000	12,000	.96	26.90	26.75
1934	54,490	87,680	33,190	2.66	28.62	30.80
1935	459,800	573,700	113,900	9.13	42.07	41.67
1936	619,300	691,900	72,600	5.82	37.86	30.41
1937	181,200	233,400	52,200	4.18	28.94	29.19
1938	140,800	232,400	91,600	7.34	23.13	28.32
1939	60,310	64,580	4,270	.34	29.53	13.35
1940	152,400	174,300	21,900	1.75	37.28	38.11
1941	485,100	620,600	135,500	10.86	36.02	42.99
1942	227,800	318,000	90,200	7.23	31.15	42.08
1943	98,570	136,300	37,730	3.02	22.83	29.93
1944	315,100	450,100	135,000	10.82	37.53	43.14
1945	302,200	420,700	118,500	9.49	35.30	39.38
1946	228,500	378,200	149,700	12.00	46.79	56.60
1947	225,000	299,700	74,700	5.99	19.77	27.52
1948	55,280	65,310	10,030	.80	23.24	20.34
1949	124,100	170,600	46,500	3.73	30.69	43.21
1950	57,130	72,770	15,640	1.25	24.34	21.13
Average	210,800	274,300	63,420	5.08	31.41	33.59

TABLE 13.—*Discharge measurements, Hueco Springs, 3 miles north of New Braunfels, Tex.*

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
Jan. 19, 1928	0	Mar. 1, 1946	71.4	Oct. 16, 1947	[1] 13.3	June 16, 1949	50.9
Feb. 22, 1929	0	Apr. 4, 1946	71.3	Nov. 22, 1947	[1] 10.1	July 23, 1949	[1] 19.2
Oct. 8, 1937	[1] 1.5	May 9, 1946	55.9	Dec. 18, 1947	[1] 8.72	Aug. 26, 1949	[1] 13.4
Aug. 4, 1944	61.0	June 14, 1946	54.4	Jan. 22, 1948	[1] 6.62	Sept. 28, 1949	[1] 7.88
Sept. 18, 1944	56.8	July 18, 1946	[1] 22.3	Feb. 26, 1948	[1] 5.83	Nov. 4, 1949	[1] 14.6
Jan. 22, 1945	90.3	Aug. 21, 1946	[1] 13.2	Apr. 1, 1948	[1] 4.23	Dec. 8, 1949	[1] 6.47
Feb. 16, 1945	92.4	Sept. 26, 1946	93.6	May 6, 1948	[1] 3.93	Jan. 12, 1950	[1] 4.38
Mar. 23, 1945	80.4	Oct. 31, 1946	88.8	June 10, 1948	[1] 5.09	Feb. 16, 1950	53.3
Apr. 27, 1945	84.5	Dec. 7, 1946	85.5	July 22, 1948	[1] 2.84	Mar. 22, 1950	[1] 9.62
May 31, 1945	77.7	Jan. 12, 1947	96.0	Aug. 26, 1948	[1] 1.22	Apr. 21, 1950	[1] 5.38
July 5, 1945	59.0	Feb. 13, 1947	88.7	Sept. 30, 1948	0	May 24, 1950	[1] 11.4
Aug. 9, 1945	32.1	Mar. 20, 1947	77.4	Nov. 5, 1948	0	June 28, 1950	[1] 5.33
Sept. 13, 1945	[1] 23.3	Apr. 24, 1947	64.6	Dec. 9, 1948	0	Aug. 2, 1950	[1] 3.20
Oct. 19, 1945	46.8	May 29, 1947	45.6	Jan. 22, 1949	0	Sept. 9, 1950	[1] 0.16
Nov. 22, 1945	[1] 17.6	July 2, 1947	25.0	Feb. 22, 1949	0	Oct. 11, 1950	0
Dec. 20, 1945	[1] 16.5	Aug. 7, 1947	[1] 19.3	Apr. 1, 1949	[1] 26.8	Nov. 15, 1950	[1] 0.48
Jan. 24, 1946	38.0	Sept. 11, 1947	[1] 16.9	May 16, 1949	91.5	Dec. 21, 1950	0

[1] Flow of West Springs only; no flow in East Springs.

Tables 14 and 15 show discharge measurements made to determine seepage losses and returns on the Guadalupe River between the Comfort and New Braunfels gaging stations during period of low flow in 1928 and 1929. The records show a net seepage gain of 0.3 second-feet in 1928 and a net seepage loss of 1.4 second-feet in 1929 between the Spring Branch and New Braunfels stations.

The seepage investigations in 1928 and 1929, as recorded in tables 14 and 15, show that the flow at New Braunfels was 2 to 4 second-feet greater than it was at Spring Branch. In these tables the discharge of Hueco Springs is shown in the Elm Creek measurements, for which the discharge was zero, indicating that the springs were dry during both investigations.

In 1944 a seepage investigation was made between the Spring Branch and New Braunfels stations which showed a net gain of 98 second-feet between Spring Branch and New Braunfels, of which 61 second-feet came from Hueco Springs. Table 16 is a record of this investigation.

TABLE 14.—*Discharge measurements to determine seepage on Guadalupe River from Comfort to New Braunfels, Tex., in January 1928*

[During the investigation the river was at a constant stage and the measurements represent the natural conditions]

Date	Stream	Location	Approx. distance (miles) from initial point	Discharge in second-feet			
				Main stream	Tributary	Gain or loss in section [1]	Total gain or loss [1]
Jan. 16	Guadalupe River	At gaging station 2 miles above Comfort.	0	52.0			
Do	Cypress Creek	0.25 mile above mouth at Comfort.	3.0		1.5		
Do	Holiday Creek	0.12 mile above mouth	4.8		.3		
Do	Guadalupe River	At railroad bridge near Comfort	6.4	58.6		+4.8	+4.8
Do	do	At Waring	12.2	58.7		+.1	+4.9
Jan. 17	Joshua Creek	2 miles above mouth near Waring	16.0		1.6		
Do	Sister Creek	0.5 mile above mouth near Sisterdale.	19.7		.4		
Do	Gaudalupe River	Just below mouth at Sister Creek near Sisterdale.	19.7	65.4		+4.7	+9.6
Do	Wasp Creek	At mouth 6 miles below Sisterdale.	29.5		.2		
Do	Sabino Creek	At mouth 8 miles northeast of Boerne.	31.2		.5		
Do	Gaudalupe River	Just below mouth of Sabine Creek at Ammans Crossing.	31.2	70.9		+4.8	+14.4
Do	do	At Schillers Crossing, 4 miles north of Bergheim.	45.6	68.3		−2.6	+11.8
Jan. 18	Currys Creek	0.5 mile above mouth, 4 miles above Spring Branch.	55.8		2.6		
Do	Guadalupe River	At Specks Crossing, 2.5 miles southwest of Spring Branch.	57.5	71.9		+1.0	+12.8
Do	Spring Branch	1.5 miles above mouth near Spring Branch.	59.0		1.5		
Do	Guadalupe River	At gaging station near Spring Branch.	61.7	73.5		+.1	+12.9
Do	Big Spring	At Cranes Mill	78.5		3.9		
Do	Guadalupe River	Just below Big Spring, at Cranes Mill.	78.5	72.3		−5.1	+7.8
Do	do	2 miles northeast of Sattler	92.7	88.9		+16.6	+24.4
Jan. 19	Jacobs Creek	At mouth 2 miles below Sattler	95.9		0		
Do	Guadalupe River	4 miles below Sattler	97.4	83.2		−5.7	+18.7
Do	Isaacs Creek	At mouth 5.5 miles above New Braunfels.	103.5		0		
Do	Guadalupe River	0.4 mile above Elm Creek near New Braunfels.	103.9	81.6		−1.6	+17.1
Do	Elm Creek	At mouth near New Braunfels	104.3		0		
Do	Guadalupe River	At gage 1 mile above mouth of Comal River.	108.7	77.7		−3.9	+13.2

[1] Computed from discharge of main stream and tributaries.

TABLE 15.—*Discharge measurements to determine seepage on Guadalupe River from Comfort, Tex., to New Braunfels, Tex., in February 1929*

[During the investigation the river was at a constant stage and the measurements represent the natural conditions]

Date	Stream	Location	Approx. distance (miles) from initial point	Discharge in second-feet: Main stream	Tributary	Gain or loss in section [1]	Total gain or loss [1]
Feb. 18	Guadalupe River	Gaging station 2 miles above Comfort.	0	41.1			
Do	Cypress Creek	0.25 mile above mouth at Comfort.	3.0		0.2		
Do	Holiday Creek	0.25 mile above mouth below Comfort.	4.8		0		
Do	Guadalupe River	San Antonio and Aransas Pass Railroad bridge near Comfort.	6.4	42.5		+1.2	+1.2
Do	do	Waring	12.2	36.4		−6.1	−4.9
Feb. 19	Joshua Creek	2 miles above mouth near Waring.	16.0		.7		
Do	Sister Creek	0.5 mile above mouth near Sisterdale.	19.7		.2		
Do	Guadalupe River	Just below mouth of creek at Sisterdale.	19.7	45.2		+7.9	+3.0
Do	Wasp Creek	Mouth, about 6 miles below Sisterdale.	29.5		0		
Do	Guadalupe River	Just above mouth of Sabino Creek at Ammans crossing.	31.0	40.7		−4.5	−1.5
Do	Sabino Creek	0.25 mile above mouth 8 miles northeast of Boerne.	31.2		.3		
Do	Guadalupe River	Unknown crossing about 4 miles north of Oberlys crossing.	34.2	38.2		−2.8	−4.3
Feb. 20	do	Schillers crossing 4 miles northeast of Bergheim.	45.6	43.0		+4.8	+0.5
Do	Currys Creek	0.5 mile above mouth, 4 miles above Spring Branch.	55.8		1.0		
Do	Guadalupe River	Specks crossing 2.5 miles southwest of Spring Branch.	57.5	47.7		+3.7	+4.2
Do	Spring Branch	1.5 miles above mouth near Spring Branch.	59.0		.9		
Do	Guadalupe River	Gaging station near Spring Branch.	61.7	47.4		−1.2	+3.0
Feb. 21	do	In Demijohn Bend east of Spring Branch.	73.3	34.3		−13.1	−10.1
Do	Big Spring	Cranes Mill	78.5		2.9		
Do	Guadalupe River	Below Big Spring at Cranes Mill	78.5	39.2		+2.0	−8.1
Do	do	5 miles northwest Sattlers store near Craasies gin.	86.2	48.8		+9.6	+1.5
Feb. 22	do	2 miles northeast of Sattlers store	94.0	48.2		−.6	+.9
Do	Jacobs Creek	Mouth 2 miles below Sattlers store.	95.9		.1		
Do	Guadalupe River	4 miles below Sattlers store	97.4	53.1		+4.8	+5.7
Do	Isaacs Creek	Mouth about 5.5 miles above New Braunfels.	103.5		0		
Do	Guadalupe River	2 miles above confluence of Elm Creek above New Braunfels.	104.1	53.0		−.1	+5.6
Do	Elm Creek	Mouth near New Braunfels	104.3		0		
Do	Guadalupe River	At gage 1 mile above mouth of Comal River.	108.7	[2] 49.0		−4.0	+1.6

[1] Computed from discharge of main stream and tributaries.
[2] Mean discharge for 24-hour period used because of fluctuation caused by Gode's small power plant.

COMAL SPRINGS

A complete record of the flow of Comal River below Comal Springs since 1933 is available and a partial record is available for the period 1928–32 indicating the flow of Comal Springs during that time.

During the period 1933–50, the average flow of the river was 332 second-feet. Of this, it is estimated that an average of 324 second-feet came from Comal Springs; and an average of 8 second-feet was surface-water runoff, representing an annual runoff of 1.2 inches from the 94

TABLE 16.—*Discharge measurements to determine seepage on Guadalupe River from Spring Branch to New Braunfels, Tex., in August 1944*

[During the investigation the river was at a constant stage and the measurements represent the natural conditions]

Date	Stream	Location	Discharge in second-feet			
			Main stream	Tributary	Gain or loss in section[1]	Total gain or loss[1]
Aug. 3	Guadalupe River	Lat. 29°51′40″, long. 98°23′00″, at gaging station near Spring Branch, Tex.	92			
Do	do	Lat. 29°53′35″, long. 98°14′40″, 100 feet below Sorrel Creek and 1½ miles southwest of Hancock, Tex.	102		+10	+10
Do	do	Lat. 29°52′10″, long. 98°11′25″, 500 feet below Hidden Valley crossing and 1.8 miles northwest of Sattler, Tex.	113		+11	+21
Do	do	Lat. 29°48′35″, long. 98°10′40″, ½ mile below Bear Creek and 2.7 miles south-southwest of Sattler, Tex.	119		+6	+27
Aug. 4	do	Lat. 29°45′50″, long. 98°09′10″, 0.7 mile above Isaac Creek, 0.8 mile above first crossing on New Braunfels-Sattler Road, and 4.6 miles northwest of New Braunfels, Tex.	124		+5	+32
Do	Hueco Spring	Lat. 29°43′35″, long. 98°08′25″, 3.8 miles north of New Braunfels, Tex.		61.0		
Do	Guadalupe River	Lat. 29°42′55″, long. 98°06′40″, at gaging station above Comal River at New Braunfels, Tex.	190		+5	+37

[1] Computed from discharge of main stream and tributaries.

square miles of drainage area above the station. The average rainfall at New Braunfels for the period 1933–50 was 33.60 inches, which is 3 inches above normal for that place. Monthly and annual discharges for Comal Springs for the years 1928–50 are given in table 17.

TABLE 17.—*Average monthly and annual discharge, in second-feet,[1] of Comal Springs at New Braunfels, Tex.*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1928	299	295	300	298	295	295	289	275	274	283	277	280	288
1929	282	274	273	277	275	300	320	310	300	290	293	285	290
1930	287	270	257	262	295	295	299	269	265	260	260	269	273
1931	280	316	337	330	341	345	336	322	329	315	296	296	320
1932	315	315	327	305	303	311	334	347	335	324	316	321	321
1933	311	299	311	340	325	305	320	306	311	292	299	309	311
1934	320	307	330	332	328	325	330	325	299	309	287	287	315
1935	296	297	294	300	310	330	343	342	335	342	355	370	326
1936	375	369	358	335	325	385	365	359	360	366	361	354	359
1937	348	351	362	375	365	375	359	341	337	319	315	322	347
1938	326	330	330	340	367	366	354	342	352	340	338	331	343
1939	324	329	320	316	304	305	270	289	308	287	276	286	301
1940	285	288	286	277	264	278	287	276	276	271	271	287	279
1941	297	313	322	340	377	377	358	361	342	354	342	335	343
1942	338	333	335	342	313	318	328	319	357	388	405	416	349
1943	408	390	374	356	333	328	328	317	322	307	317	314	341
1944	333	334	359	383	383	377	355	328	333	325	314	333	346
1945	344	378	382	406	414	376	346	341	335	334	331	336	360
1946	327	312	338	331	347	364	374	356	365	392	401	398	359
1947	408	407	406	394	368	345	329	323	320	312	309	309	352
1948	305	308	297	296	285	278	267	257	258	258	261	256	277
1949	259	244	271	278	313	315	312	306	288	281	282	284	286
1950	284	286	279	275	270	267	255	246	247	247	239	235	261
Av.	319	319	324	326	326	328	324	315	315	313	311	314	320

[1] 1 second-foot=448.8 gallons a minute.

BLANCO RIVER

The gaging station on Blanco River at Wimberley in Hays County records the runoff from a drainage area of 378 square miles, including 60 square miles in Comal County. Simultaneous records of the discharge of Blanco River at Wimberley and the Guadalupe River at Spring Branch and New Braunfels (above Comal·River) are available for the calendar years 1929–50. The average annual runoff from the Blanco River basin during this period was 209 acre-feet per square mile, as compared with 280 acre-feet per square mile for the part of the Guadalupe River basin between the Spring Branch and New Braunfels stations (computed from the difference in the discharge recorded at the two stations.)

COMAL CREEK

Comal Creek drains 94 square miles above Comal Springs, all of which is in Comal County. Below Comal Springs the stream is called Comal River; above the springs it is called Dry Comal Creek. Figures for the runoff of Dry Comal Creek are obtained by subtracting the flow of Comal Springs from the discharge of Comal River.

CIBOLO CREEK

Cibolo Creek drains as area of 280 square miles above the Selma gaging station. The Bulverde, Bracken, and Selma gaging stations were established on the Cibolo in March and April 1946 (fig. 2). Records for the Bracken station are not included in this report as only records of low flows are available at that station. The unusually heavy rainfall during 1946 emphasized the rather remarkable differences in runoff for the various drainage basins in Comal County.

SIMULTANEOUS RECORDS

Simultaneous records of the discharge of Dry Comal Creek and Cibolo Creek, as well as the discharge of Guadalupe River, are available for the period March 1946 to December 1950 at the Selma, Spring Branch, and New Braunfels stations, and Cibolo Creek at the Bulverde station from May 1946 to December 1950. During this 58-month period the total runoff of Cibolo Creek amounted to 13,710 acre-feet at Selma, representing a depth of 0.92 inch over the drainage area. The runoff of Comal Creek for the period was 24,230 acre-feet, representing a depth of 4.8 inches. In contrast to these low figures, the runoff of the Guadalupe River from the drainage area between Spring Branch and New Braunfels amounted to 280,900 acre-feet, or a depth of 22.5 inches.

The total rainfall during the 58-month period was 152 inches at Boerne, 154.41 inches at Bulverde, 138.71 inches at Fischer store, and

161.44 inches at New Braunfels. The average annual rainfall for the period March 1946 to December 1950, shown by the records for these four stations, is 31.37 inches. The normal annual rainfall for the area, based on records for the last 61 years, is about 31 inches.

The monthly rainfall at Boerne, Bulverde, Fischer store, and New Braunfels for March 1946 to December 1950; the monthly runoff of Cibolo Creek near Bulverde, and at Selma, of Dry Comal Creek at New Braunfels, and of the area tributary to Guadalupe River between Spring Branch and New Braunfels for March 1946 to December 1950 are given in table 18.

TABLE 18.—*Rainfall and runoff, Comal County, Tex., 1946–50*

	Rainfall (depth in inches)				Runoff in acre-feet per square mile			
					Cibolo Creek			
	Boerne	Bulverde	Fischer store	New Braunfels	Bulverde (drainage area 198 square miles)	Selma (drainage area 280 square miles)	Dry Comal Creek, New Braunfels (drainage area, 94 square miles)	Guadalupe River between Spring Branch and New Braunfels (drainage area, 234 square miles)
1946								
March	1.93	5.07	4.95	3.96	(1)	0	3.30	72.99
April	3.94	3.77	2.78	2.02	(1)	0	0	33.29
May	3.65	4.05	3.90	5.75	1.73	5.71	31.91	33.63
June	3.14	3.59	3.18	10.88	0	.44	50.11	46.28
July	2.40	.54	2.91	1.89	0	0	0	15.98
August	6.62	5.33	3.82	7.14	0	0	2.02	13.12
September	9.45	12.96	6.55	8.33	36.87	24.79	57.98	70.26
October	4.22	2.53	1.50	3.47	3.63	.28	1.91	75.21
November	2.29	6.69	6.48	2.60	9.14	9.50	18.93	113.50
December	2.61	3.77	3.60	3.21	1.83	.95	1.81	98.59
Total for year	40.25	48.30	39.67	49.25	53.20	41.67	167.97	572.85
1947								
January	4.09	4.42	4.70	4.83	5.15	0.03	9.50	83.21
February	.37	.37	.25	.42	.01	0	0	63.29
March	1.91	1.55	2.33	2.00	0	0	.73	49.36
April	1.51	.55	1.08	1.72	0	0	0	28.38
May	5.92	2.87	2.84	7.32	0	0	18.94	29.15
June	.31	0	1.83	.71	0	0	.45	11.11
July	1.28	1.09	.85	1.49	0	0	.26	11.28
August	2.49	4.22	2.90	4.54	0	0	2.85	21.54
September	.15	.58	0	.74	0	0	0	8.16
October	1.33	1.01	.80	Trace	0	0	0	6.11
November	1.34	2.03	.85	1.67	0	0	0	3.72
December	1.19	1.33	1.34	2.08	0	0	0	4.19
Total for year	21.89	20.02	19.77	27.52	5.16	.03	32.73	319.50
1948								
January	.44	.53	.58	.56	0	0	0	3.25
February	3.08	2.91	2.92	2.99	0	0	0	3.21
March	1.49	.88	1.29	1.11	0	0	0	4.02
April	1.98	1.94	1.70	1.98	0	0	0	1.03
May	1.29	2.45	2.55	1.52	0	0	0	9.87
June	5.47	2.25	4.65	1.23	0	0	0	6.45
July	1.81	1.44	.94	1.59	0	.02	0	8.16
August	.87	.97	1.26	2.82	0	0	0	.04
September	3.56	1.90	1.91	1.81	0	0	0	.51
October	2.43	2.00	3.62	2.69	0	.01	0	2.52
November	.57	1.15	.70	1.58	0	0	0	1.58
December	.78	.92	1.12	.46	0	0	0	2.22
Total for year	23.77	19.34	23.24	20.34	0	.03	0	42.86

[1] No records at Bulverde during March and April.

TABLE 18.—*Rainfall and runoff, Comal County, Tex., 1946–50*—Continued

	Rainfall (depth in inches)				Runoff in acre-feet per square mile			
					Cibolo Creek			
	Boerne	Bul-verde	Fischer store	New Braun-fels	Bulverde (drainage area 198 square miles)	Selma (drainage area 280 square miles)	Dry Comal Creek, New Braunfels (drainage area, 94 square miles)	Guadalupe River between Spring Branch and New Braunfels (drainage area, 234 square miles)
1949								
January	3.68	4.24	3.78	3.88	0	0	0	3.72
February	3.72	3.16	2.61	3.72	0	0	2.87	2.74
March	1.73	2.27	2.18	1.47	.01	0	0	31.62
April	7.28	10.23	2.64	9.15	15.20	6.86	24.68	41.41
May	3.18	.98	5.74	.75	.81	.29	0	51.07
June	3.95	3.75	1.84	5.43	0	0	1.61	17.86
July	3.77	4.03	3.25	.97	0	0	.11	11.32
August	5.54	1.50	2.06	2.55	0	0	0	5.51
September	2.08	1.72	.33	1.88	0	0	0	0
October	3.33	4.41	4.93	10.36	0	.06	20.85	19.53
November	0	.24	0	.06	0	0	0	7.39
December	2.89	3.02	2.33	2.99	0	0	0	6.67
Total for year	41.15	39.55	31.69	43.21	16.02	7.21	50.12	198.84
1950								
January	.70	.65	.78	.55	0	0	0	5.21
February	2.49	3.21	3.60	3.76	0	0	0	20.64
March	.34	.31	.15	.42	0	0	0	10.30
April	3.73	3.96	3.96	4.11	0	0	0	6.97
May	3.08	6.39	3.35	3.14	0	0	0	9.06
June	2.02	1.92	2.06	3.02	0	0	6.88	9.23
July	4.14	3.07	3.33	2.25	1.32	0	0	4.36
August	3.88	3.96	.84	.72	0	0	0	.60
September	3.29	3.04	4.05	1.83	0	0	0	(2)
October	.55	.30	1.50	1.20	0	0	0	.56
November	.72	.30	.72	.13	0	0	0	(2)
December	0	.09	0	0	0	0	0	.43
Total for year	24.94	27.20	24.34	21.13	1.32	0	6.88	67.36

[2] Loss of 60 acre-feet from Spring Branch to New Braunfels.

CONCLUSION

The data show that an abundant and dependable supply of water is furnished by Comal Springs and the Guadalupe River below Comal Springs, and that rather large supplies of surface water are available from other streams in the county, but that storage will have to be provided if a large continuous supply of water is to be obtained from sources other than Comal Springs.

CHEMICAL CHARACTER OF THE WATER

By WARREN W. HASTINGS

Partial chemical analyses of water from 328 wells and springs in Comal County are given in the table of chemical analyses included on pages 74–82. . In addition, analyses of 44 samples collected periodically from Comal Springs (G50) and Hueco Springs (G18) are listed to show the possible relationship of the chemical character, the rate of discharge, and the temperature of the water. The data indicate no apparent pronounced differences in chemical composition or temperature of the water with changes in the rate of flow.

Most of the water obtained from wells in Comal County is acceptable for stock and domestic purposes but, because the water-bearing formations are largely limestones, the waters are moderately hard, generally above 200 parts per million. Calcium bicarbonate is normally the predominant mineral constituent of ground water of Comal County.

The Travis Peak formation yields water that ranges in quality from exceptionally good, as shown by the analysis of the water from well A13, to water that is too highly mineralized for most purposes, such as the water from well A20. However, most wells in the Travis Peak formation yield water containing less than 500 parts per million of dissolved solids.

Wells in the Glen Rose limestone generally yield water acceptable for domestic purposes. The more highly mineralized waters from the lower member of the Glen Rose are high in sulfates and are very hard, as shown by the analyses of water from wells C3 and E8. Water in the upper member of the Glen Rose in many wells is rather high in sulfates and hard, but most of the water had dissolved solids below 1,000 parts per million. An exception is found in the analysis of water from well G55, which is 1,200 feet deep and yields water having 4,170 parts per million of dissolved solids.

All the analyses of water from wells in the Edwards limestone northwest of the Comal Springs fault show that the water is of good quality; although the water is hard, dissolved solids are generally less than 500 parts per million. The wells (G46 and G47) that supply the city of New Braunfels yield water that has an average hardness of 252 parts per million and dissolved solids of 282 parts per million (pl. 6). The water supply has been approved by the State Board of Health for public consumption.

As previously stated, it is believed that the water southeast of the Comal Springs fault is of poor quality because the fault has prevented the free circulation of meteoric water in the Edwards limestone. In the Glen Rose limestones and in the Austin chalk, circulation is also the controlling factor in the quality of water. Where solution has developed a reservoir with a system of connecting passages permitting the free movement of water, characteristic limestone waters prevail, as illustrated by wells E50 and G46 in plate 6.

Water from the Leona formation of Pleistocene age is high in nitrate, as in well G60, but the nitrate content of the water differs widely from one well to another. It is frequently stated that well water high in nitrates indicates pollution from sources at or near the surface, but studies of waters in various parts of Texas (George and Hastings, 1951, pp. 450–456) indicate that Pleistocene formations may contain nitrate where there is no possibility of contamination.

The chemical composition of ground waters from several aquifers in Comal County is shown graphically in figure 7. The heights of the several sections correspond to the quantities of the ions, such as calcium, magnesium, and chloride, expressed in terms of equivalents per million. One equivalent per million corresponds to 20 parts per million of calcium, 12 of magnesium, 23 of sodium, 39 of potassium, 61 of bicarbonate, 48 of sulfate, 35.5 of chloride, 62 of nitrate, and 50 of hardness as calcium carbonate. The total hardness is the sum of the blocks for calcium and magnesium. As an illustration, if the bicarbonate block extends above the magnesium block, all the hardness

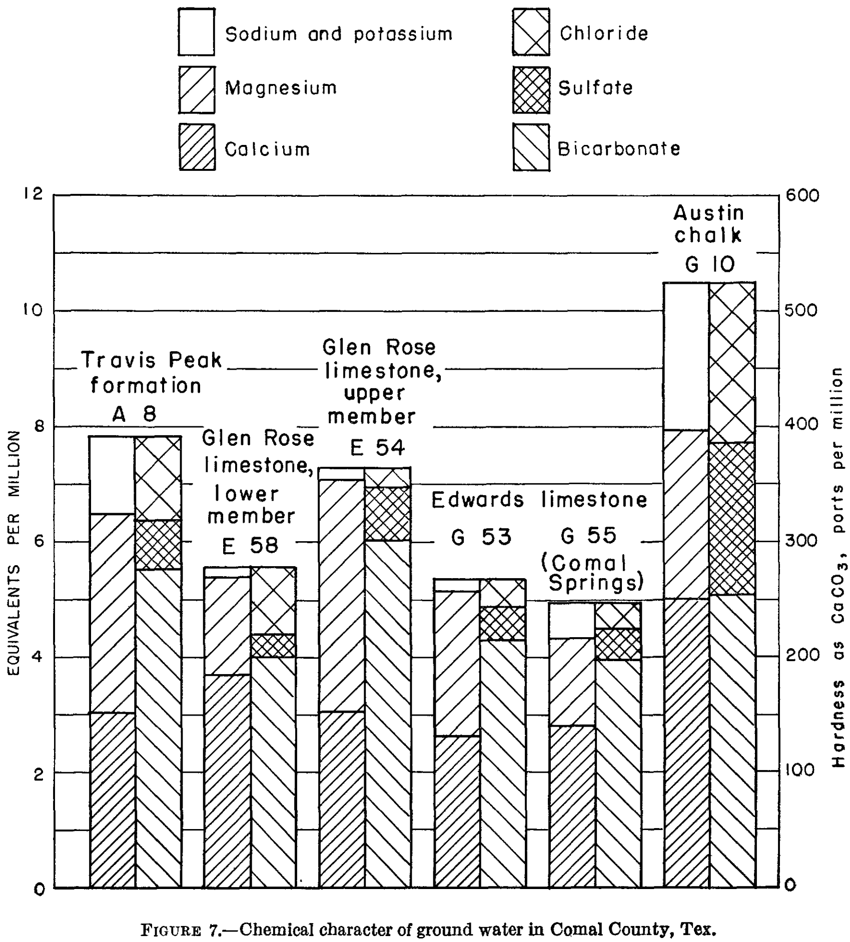

FIGURE 7.—Chemical character of ground water in Comal County, Tex.

is carbonate hardness; but if the top of the bicarbonate is lower than the top of the magnesium, part of the hardness is due to sulfate, or even chloride if the chloride extends below the top of the magnesium.

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TABLE 19.—*Partial analyses of water from wells and springs in Comal County, Tex.*

[Results are in parts per million]

Well	Owner	Depth of well (feet)	Date of collection	Total dissolved solids	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K) (calculated)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Total hardness as $CaCO_3$ (calculated)
Travis Peak formation												
A1	T. J. Byler	930	Oct. 10, 1944					129	[1] 60	39		[2] 246
A4	Otto Schwope	300	Oct. 7, 1943	504	110	32	37	418	[1] 60	57	1.8	406
A5	H. B. Thompson	Spring	do	329	84	24	11	352	[1] 17	16	3.8	308
A5	do	Spring	Mar. 28, 1945					271	[1] 9	13	1.8	[2] 201
A7	Hugo Wunderlich	120	Oct. 6, 1943	589	115	25	55	355	[1] 28	59	132	390
A7	do	120	May 3, 1943	457				292	[1] 6	38	112	394
A8	do	142	Oct. 6, 1943	394	63	40	32	322	[1] 36	64	.2	322
A9	J. W. Heard	100	Dec. 9, 1936	360	118	16	1	470	16	11		360
A10	Mrs. R. J. Remler estate	184	do	329	21	38	55	311	42	20	0	208
A11	Ed Gass	140	do	174				116	26	27		
A13	Frich Specht	412	Nov. 20, 1936	105	20	12	5	92	0	23		97
A15	Wm. Neugebauer	163	do	445				445	35	19	0	
A16	Harry Knibbe	Spring	do	136	23	17	8	140	0	19	0	125
A17	Arno Knibbe	225	Dec. 10, 1936	512	85	26	66	214	93	137	0	321
A18	do	124	do	437	168	19		317	47	47	[3]	497
A19	D. L. Knibbe	120	do	340				183	103	28		
A20	Alfred Jonas	280	do	1,348	71	71	325	171	237	560	0	469
A22	J. I. Baretta	280	Dec. 9, 1936	168	23	24	6	122	28	27	[3]	155
A25	Alfred Gass	175	Nov. 20, 1936	598	43	47	108	171	138	178		299
A26	Wm. Specht	250	do	136	52	42		159	35	41	[3]	301
A27	Erich Specht	200	Nov. 27, 1936	394	27	44	60	262	71	63		247
[4] A31	Ed. Bartels	80	Dec. 10, 1936	336				323	28	20		
A32	Albert Marek	380	Nov. 16, 1936	339	115	9	8	403	0	9		326
A33	Alfred Beierle	157	Nov. 20, 1936	148	11	1	50	134	0	20		30
A35	Mrs. John Stricker	200	Nov. 19, 1936	230	51	25	6	268	0	16	0	230
B12	H. Fischer	327	Nov. 4, 1936	178				146	20	19		
B14	Willard Hill	410	Jan. 20, 1944					324	146	20	1.0	
B27	W. D. Hill	120	Dec. 9, 1936	196				153	28	20		
B28	Ed. Kaderli	112	do	193	27	24	14	183	20	18		165
B46	Henry Pantermuehl	300	Nov. 4, 1936	1,557				317	870	41		
B47	Theo. Kraft	428	Nov. 3, 1936	504	72	57	32	378	138	19		412
D4	Herman Laubach	750	Nov. 30, 1936	486	39	71	26	226	209	30		389
D4	do	750	May 11, 1945	724	116	49	26	388	121	47	47	491
E1	Alfred Wehe	350	Nov. 21, 1936	237	70	20		98	35	64	[3]	257
[4] E3	Joe E. Sheldon	450	Nov. 2, 1936	203				220	0	15		
E40	Walter Schaeffer	816	Jan. 22, 1945					328	[1] 210	17		[2] 258

Lower member of the Glen Rose limestone

A2	Fred and Richard Schaeferkoeter	Spring	Dec. 10, 1936	141	36	10	6	146	0	17	(3)	132
A12	H. C. Plumly	Spring	Nov. 20, 1936	121	26	12	6	122	0	17	0	122
A12	do	Spring	Mar. 28, 1945					308	[1] 9	14	8.2	[2] 212
A14	Frich Specht	75	Nov. 20, 1936	110				98	0	19		
A21	Edwin Elbel	100	Dec. 9, 1936	190				165	16	21		
A23	J. W. Heard	244	Dec. 21, 1944					284	[1] 11	18		[2] 246
A28	— Weidner	Spring	July 19, 1944	322	107	7.8	9.0	352	[1] 4	16	4.5	299
A29	Wm. Gast	115	Nov. 27, 1936	102				92	0	17		
A34	Roland Benzeil	108	Jan. 26, 1937	323				250	24	54		
A36	Julius Bremer	185	Nov. 25, 1936	302	54	49		372	0	16	0	335
B1	Adolph Preiss	121	Oct. 4, 1944					148	[1] 7	12		[2] 249
B2	C. L. Meserole	220	Nov. 13, 1936	227				250	0	14		
B3	do	5	do	251	76	17	0	290	0	15	0	[2] 260
B4	do	217	do	250	56	24	11	293	0	15		237
B4	do	217	Dec. 14, 1944					338	[5] 3	10		[2] 294
B6	Eddie Pape	89	Oct. 10, 1944					169	[1] 11	11		[2] 273
B7	W. O. Fischer	218	Dec. 31, 1936	293				323	0	18	0	
B8	H. Pantermuehl	275	Nov. 4, 1936	276				244	39	13		
B10	R. O. Fischer	Spring	Dec. 31, 1936	301	161	9	6	342	0	17		291
B11	Emil Doell	300	do	166				134	12	25	0	
B13	E. Kaderli	265	Oct. —, 1943	612	102	37	67	381	181	37	0.2	406
B15	H. C. Nelson	300	Nov. 13, 1936	176	46	10	10	183	0	20		157
B15	do	325	Oct. —, 1943	287	66	32	4.1	349	[1] 1	12	0.2	296
B16	Otto Treuer	350	Dec. 4, 1936	389	60	57		230	114	35	(3)	385
B17	do	Spring	Dec. 31, 1936	177	41	9	15	159	16	18		140
B19	John A. Schlameus	220	Dec. 8, 1936	290				195	71	19	0	
B20	W. H. Stanley	385	Dec. 31, 1936	295	32	42	22	275	42	22	0	251
B21	do	320	Dec. 8, 1936	431	63	55	21	378	83	23	0	384
B22	Tom Sumners	325	do	455	42	73	18	329	138	22	0	406
B23	do	374	Oct. 30, 1944	820	77	106	26	420	305	16	0	628
B24	Carroll Hall	Spring	Nov. 4, 1936	228	74	13	0	256	0	15		238
B25	do	240	do	258	65	14	17	256	16	20	0	218
B26	D. C. McIver	Spring	Nov. 10, 1944	274	72	11	2.8	239	11	14	4.6	224
B29	J. D. Nixon	Spring	Nov. 13, 1936	323	94	19	9	372	0	18	0	312
B30	Frank Gunther	169	Nov. 4, 1936	166	25	23	7	165	16	14		155
B31	Mrs. T. P. Shelly	350	Nov. 9, 1944	483	88	41	9.0	390	66	14	0	388
B34	Max Linartz	228	Nov. 3, 1936	446	68	49	27	329	103	37		370
B36	State of Texas	Spring	Aug. —, 1944	338	98	16	9.0	340	[1] 14	16	18	310
B39	A. J. Monier	297	Dec. 21, 1944					324	[1] 14	12		[2] 246
B40	do	240	Dec. 15, 1936	335				329	26	18	0	
B41	do	20	do	154				146	0	22		
B42	do	50	do	289				311	0	22		
B43	Mrs. D. N. Riegler	260	Nov. 13, 1936	338				372	0	21		
B44	J. M. Block	175	Dec. 31, 1936	144				92	20	26		
B45	Miss Elise Leuhlfing	102	Jan. 31, 1945	322				314	[1] 10	10		304
B48	Otto Krause	221	Sept. 29, 1944					245	[1] 2,200±	10	0.2	
B50	O. C. Trout	108	Feb. 1, 1945	333				313	[1] 20	9.0	1.2	314

See footnotes at end of table.

TABLE 19.—*Partial analyses of water from wells and springs in Comal County, Tex.*—Continued

[Results are in parts per million]

Well	Owner	Depth of well (feet)	Date of collection	Total dissolved solids	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K) (calculated)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Total hardness as $CaCO_3$ (calculated)
	Lower member of the Glen Rose limestone—Continued											
B51	H. W. Kraft Estate	69	Nov. 13, 1936	218				232	0	18		
B52	do	Spring	Nov. 16, 1936	265	70	19	7	275	16	18	0	252
B53	M. Leaghling	Spring	Nov. 5, 1936	174				165	10	16		
[4] C3	H. E. Nessly	154	Dec. 8, 1944	2,140	326	220	17	360	1,380	17	0	1,720
C8	Miss Carrie George	100	do					277	[1] 350±	13		[2] 1,130
D1	E. A. Moos	96	Dec. 7, 1936	391				415	12	22		
D2	Eugene Scheel	280	do	131				122	0	20	0	
D5	E. A. Laubach	350	do	164	24	26	3	171	12	15	0	166
D6	do	25	do	139				92	24	19		
D7	Mrs. Chas. Erben	235	do	200				171	26	15	0	
D8	George Bros	216	Dec. 23, 1936	328				354	8	17	0	
D9	F. Neugebauer	300	Dec. 7, 1936	158	19	23	10	159	12	16		144
D10	Joseph Offer	200	Dec. 23, 1936	357	85	26	17	366	32	17	0	321
D11	Mrs. Emma Sauer	218	do	222				226	12	13	0	
D13	G. S. McFarland	300	do	261	51	24	18	275	20	13	0	225
D14	Bruno Klar	25	do	313				354	0	15		
D15	Mrs. C. L. Ellsworth	217	do	151				134	16	12	0	
D16	Aug. Scholz estate	265	Nov. 30, 1936	226	32	31	12	238	20	14		209
D18	do	236	do	165				177	0	13	0	
E2	Ed. Kuebel	210	Nov. 16, 1936	194				195	0	22		
E4	Joe S. Sheldon	344	Sept. 23, 1943	355	72	39	8.5	353	[1] 36	17	9.0	340
E6	A. J. Walser	85	Nov. 2, 1936	224				183	24	26		
[4] E8	R. P. Holt	620	Dec. 11, 1936	2,608	346	201	179	232	1,642	126	0	1,689
E9	J. J. Arrechea	300	Nov. 16, 1936	214	66	7	10	244	0	11		194
E10	George Fronne	185	Dec. 10, 1936	263				220	32	24		
E11	J. A. Laubach	25	Nov. 27, 1936	217				238	0	14		
E12	do	60	do	298				232	28	44		
E13	O. Wehe	350	do	142	12	18	21	153	0	16		101
E14	L. A. Allen	480	Nov. 21, 1936	173	45	18		85	24	44	(3)	186
E15	Alex P. Scheel	350	Dec. 7, 1936	293	83	23	1	342	0	18	0	304
E18	Aug. Scheel	15	do	385				390	24	20		
E19	do	318	do	360				342	28	26	(3)	
E21	O. Wehe	110	Nov. 27, 1936	112				110	0	14		
E22	V. F. Moos	320	do	281	78	13	14	293	20	12		248
E24	Mrs. Mattie Shelburne	248	Nov. 16, 1936	302				342	0	14	0	
E26	Alex Licata	360	Dec. 11, 1936	200	62	18	0	220	0	12	0	232
E27	O. A. Doeppenschmidt	446	Jan. 26, 1937	368	52	57	8	378	53	12	0	365
E29	Ed. Adam	600	Dec. 11, 1936	481	97	45	10	329	150	17	0	428
E30	W. E. Green	635	do	314	77	24	12	336	24	12	0	290
E31	Milton Y. Jones	437	May 30, 1945					335	[1] 8	10		[2] 195

E32	G. W. Kurz	348	Dec. 11, 1936	138	30	13	7	146	0	16	0	128
E33	Edgar Bremer	100	Nov. 21, 1936	111				98	0	20		
E34	Mrs. M. K. Hohman	315	Nov. 30, 1936	240	36	30	13	226	36	14		213
E35	Paul Kurz	300	do	334				336	24	16	0	
E36	Mrs. M. K. Hohman	Spring	do	265	86	10	6	305	0	13	0	256
E37	do	30	do	113				110	0	15		
E38	Arthur Hitzfelder	414	Dec. 15, 1936	312				281	36	20	0	
E39	Benno Bose	348	Dec. 11, 1936	235	69	17	1	268	0	16	0	240
E41	Clemens Scholz	245	do	219	18	36	16	220	28	13	0	192
E42	Elmer Kleck	450	Dec. 15, 1936	574	117	46	19	348	195	26	0	
E43	Mrs. Anita Lux	320	do	169				140	24	13	0	
E44	Aug. Wehe	375	Nov. 12, 1936	357				305	39	33		
E49	Aug. Scholz	336	Nov. 27, 1936	278	74	21	3	244	19	41	0	272
E53	Richard Hitzfelder	630	Jan. 22, 1945					334	[1] 3	10		[2] 264
F9	O. A. Doeppenschmidt	615	Nov. 2, 1936	742	151	62	11	336	323	15		633
F22	— Tian	630	Feb. 28, 1945					314	[1] 28	97	0	[2] 435
F37	Melvin Westerfer	507	Sept. 19, 1944					282	[1] 1,400±	12	0	
[4] G55		1,200	Aug. 20, 1941	4,170	390	220	737	319	1,467	1,200		1,878
	Upper member of the Glen Rose limestone											
B32	D. R. Semmes	Spring	Dec. 31, 1936	187	30	21	13	189	16	14	0	163
B33	do	110	do	223	55	24	0	256	0	18		235
B54	E. S. Schroeder	60	Nov. 22, 1944					380	[1] 28	16		[2] 246
61	George Faber	250	Dec. 8, 1936	227	34	36		207	40	15	0	232
C2	H. E. Nessl	101	Dec. 8, 1944	372	61	50	3.4	370	43	12	0.2	358
[4] C4	do	101	Nov. 9, 1944					338	[1] 320	14		[2] 606
C5	George Faber	455	Nov. 26, 1944					336	[1] 24	10		[2] 172
C7	C. B. Crawford	256	Dec. 14, 1944					242	[1] 12	15		[2] 312
C9	V. and C. D. Prassel	170	Nov. 3, 1936	777				293	366	12		
C10	C. B. Crawford	200	Dec. 14, 1944					250	[1] 55	10		[2] 294
C14	Udo Haarman and R. Wright	640	Dec. 14, 1944					264	[1] 2	8.0		[2] 234
E41	Clemens Scholz	245	Dec. 11, 1936	219	18	36	16	220	28	13	0	192
E52	Adam Myer Est	90	Nov. 15, 1936	348	144	4		268	0	68	(3)	378
E54	Otto Hitzfelder	Spring	Nov. 11, 1936	297	95	10	9	342	10	15	0	281
E55	do	15	do	180				171	12	15		
E56	do	381	Nov. 12, 1936	911				67	590	13		
E57	— Tian	Spring	do	143	51	10		159	0	4	(3)	171
E58	do	+200	do	1,277				299	716	11		
F7	H. Conrads	180	Jan. 26, 1937	414				384	28	38		
F8	O. A. Doeppenschmidt		Nov. 2, 1936	394				390	28	22		
F11	B. Stapper	480	do	634	98	75	7	287	299	14		551
F17	E. Herbst	425	Jan. 25, 1937	264	56	30	5	287	18	14	0	263
F18	Robert Heimer	178	Nov. 2, 1936	230	58	23	2	281	0	9		239
F20	H. Conrads	208	Jan. 26, 1937	400	72	49	12	390	55	20	(3)	380
F20	do	208	Apr. 6, 1945	298	59	33	6.2	330	[1] 7	12	1.5	282
F23	E. J. Heidrick	350	Apr. 28, 1945	463				233	66	23	77	354
F35	A. Kabelmacher	475	Nov. 9, 1936	222				189	35	11		
F36	Wm. Zeucher	535	Nov. 12, 1936	593	122	48	10	293	260	9		501
F43	Hilmar Doehne	265	Jan. 18, 1937	180	35	15	13	171	20	13	0	150
[4] G5	Udo Haarman and R. Wright	440	Dec. 15, 1944					280	[1] 2	19		[2] 300

See footnotes at end of table.

TABLE 19.—*Partial analyses of water from wells and springs in Comal County, Tex.*—Continued

[Results are in parts per million]

Well	Owner	Depth of well (feet)	Date of collection	Total dissolved solids	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K) (calculated)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Total hardness as $CaCO_3$ (calculated)
	Edwards limestone (may include Comanche Peak in some wells)											
C6	C. B. Crawford	290	Nov. 3, 1936	303				305	24	12		
E59	Ed Reeh	325	Dec. 1, 1936	49				12	0	25	(3)	
F4	H. Conrads	Spring	Nov. 5, 1936	172	27	26	5	201	0	15		
F5	Bear Creek Ranch Association	Spring	Sept. 29, 1943	294	80	21	5.8	325	[1] 8	14	5.2	286
F14	H. D. Stronberg	Spring	Nov. 5, 1936	232	45	25	13	275	0	14		216
F15	Alwin Jahns	300	Jan. 18, 1937	195	48	21		232	0	12	0	208
F24	Paul Dietz	300	Nov. 5, 1936	237	52	31		293	0	10	(3)	259
F25	Jerome Schumann	365	Jan. 18, 1937	261	64	28	2	317	0	11	0	272
F26	F. D. Hutcheson	251	Dec. 21, 1936	291				311	12	12	0	
F27	Henry Heise	290	do	304	91	16	6	336	12	14	0	295
F28	Herman Borcher	300	Oct. 28, 1936	228	69	18		256	0	15		246
F30	B. Borchers	402	Nov. 2, 1936	183				183	0	21		
F33	H. W. Dietz	314	Dec. 4, 1944	414	106	76	23	260	[1] 4	21	124	296
F38	Paul Tonne	320	Nov. 9, 1936	239	59	17	14	281	0	11		215
F39	Otto Uhlrich	265	do	298				348	0	8		
F40	do	350	do	741	212	29		329	295	43	(3)	648
F41	Krueger Bros	250	Jan. 25, 1937	296	94	11	4	281	22	27	0	282
F42	Gus Vogel	325	Dec. 20, 1936	285	85	18	1	311	16	12	0	286
F44	Walter Kabelmacher	242	Sept. 15, 1944					330	[1] 13	14	73	[2] 420
F46	Ed. C. Heidrich	340	Oct. 27, 1936	120	35	8		122	0	16	(3)	120
F47	Edward Nowothy	325	Dec. 22, 1936	240	59	16	12	250	16	14	0	215
F48	Hilmar Staats	450	do	253	47	26	13	244	32	15	0	226
F49	Richard Gesche	313	Dec. 16, 1936	345	141	9		329	0	33	(3)	391
F50	Henry Ludwig	375	Jan. 21, 1937	329	111	10	6	390	0	10	0	320
F52	Chas. Wuest	320	May 10, 1945	480	117	20	2.8	314	[1] 6	35	83	374
F55	Herman Vogel	300	Jan. 21, 1937	235	80	7	3	244	0	25	0	229
F56	Herbert Kreusler	300	Nov. 24, 1936	198				214	0	15	0	
F57	Rubin Moeller	330	Jan. 21, 1937	280	119	8		73	51	66	(3)	305
F58	Mrs. Wm. Hillert	390	Nov. 9, 1936	212				238	0	11		
F59	R. J. Haug	50	Oct. 27, 1936	516				500	35	36		
F60	do	420	do	331	81	24	13	317	31	26		300
F61	O. C. Brehmer	304	Dec. 1, 1936	139				116	0	28	(3)	
F62	R. R. Coreth	275	Dec. 15, 1936	288	99	9	3	336	0	12	0	286
F63	U. S. Gypsum Co.	125	Dec. 4, 1936	262	50	18	25	244	32	17		202
[6] F64	Charles Mergele	611	Sept. 16, 1941	540	43	26	109	288	94	83	0	214
F64	do	611	Dec. —, 1944					502	[1] 85	345		[2] 260
F65	W. E. F. Eilers	240	Oct. 27, 1936	302	11	24	78	299	24	18		125
F66	Harry Dauer	300	Dec. 6, 1944					218	[1] 40	15		[2] 249

F67	Wm. Fey	89	Dec. 5, 1936	169				183	0	12		
F68	Schaeffer Bros.	255	Dec. 18, 1936	318	118	7		372	0	10	0	324
F70	Eugene Krause	288	Oct. 26, 1936	130	34	6	5	79	31	15		108
G1	Jesse Posey	280	Dec. 15, 1944					172	[1]65	11		[2]228
G2	F. T. Lackey	500	Nov. 3, 1936	234	64	19	3	281	0	10		237
G7	Udo Haarman and R. Wright	333	Dec. 15, 1944					248	[1]4	10		[2]282
G8	Albert Pfeuffer	400	Nov. 3, 1936	279	83	18	3	329	0	13		281
G12	Hilmar Doehne	250	Jan. 5, 1937	564				268	162	73	0	
G13	Wm. Posey	160	Oct. 21, 1936	697	79	55	94	311	197	119		424
G14	Erich Rosenthal	212	Jan. 5, 1937	310				287	32	19	0	
G15	do	230	do	380	76	21	38	305	65	30	0	278
G16	Edward Lackey	440	Dec. 15, 1944					242	[1]3	12		[2]294
G18	R. W. Gode	Spring	June 24, 1941	322	97	11	13	334	11	16	9.8	287
G18	do	Spring	Aug. 13, 1941					334	[1]11	12		
'G18	do	Spring	Sept. 16, 1941	320	102	14	1.6	334	13	13	12	312
G18	do	Spring	Jan. 22, 1944	335	109	13	2.5	358	[1]9	13	12	326
G18	do	Spring	Sept. 14, 1944	291	88	9.8	.7	282	6.7	12	8.0	260
G18	do	Spring	Oct. 9, 1944		107	16						333
G18	do	Spring	Nov. 22, 1944		98	12						294
G18	do	Spring	Dec. 5, 1944		76	18						264
G18	do	Spring	Dec. 7, 1944		100	16						316
G18	do	Spring	Jan. 22, 1945		96	9.6						279
G18	do	Spring	Feb. 14, 1945		109	12				11		322
G18	do	Spring	Mar. 5, 1945		99	10						288
G18	do	Spring	Mar. 23, 1945		107	10			[1]2			308
G18	do	Spring	Apr. 1, 1945		98	10						286
G18	do	Spring	Apr. 27, 1945		112	14						337
G18	do	Spring	May 31, 1945		79	14						254
G18	do	Spring	July 5, 1945		86	14						272
G18	do	Spring	July 9, 1945		64	15						221
G18	do	Spring	Sept. 13, 1945		102	20					1.5	336
G18	do	Spring	Oct. 19, 1945		93	12			[1]11			282
G18	do	Spring	do	317	89	11	2.8	294	[1]8	10	12	267
G18	do	Spring	Nov. 23, 1945		104	16			[1]3.0			326
G20	Jack Kretzmeyer	168	Oct. 22, 1936	303	82	19	10	317	20	16		282
G21	Alvin Kraft	138	Oct. 21, 1936	253	60	19	12	256	20	16		227
G22	C. Conrads	145	Oct. 20, 1936	319	73	25	15	311	35	18		285
G23	Chas. Soechting	210	Jan. 5, 1937	714				354	213	78	0	
G25	O. E. Gruene	210	Oct. 20, 1936	856	112	59	98	159	307	202		521
G26	Emil Preusser	330	do	981	24	29	289	201	326	214	0	178
G27	Brund Raabe		Dec. 30, 1936	303				293	26	17		
G28	Albert Hantzmann	175	Oct. 22, 1936	162	33	17	6	153	16	15		150
G30	L. S. Davis	320	Dec. 21, 1936	206				207	12	12	[3]	
G31	W. H. Harborth estate	265	Oct. 28, 1936	421	86	20	35	207	130	48		298
G32	Wm. Kraft	190	do	266	83	15		268	12	24	[3]	270
G33	Albert Simon	186	Dec. 21, 1936	286				305	12	12		
G34	Albert Wallhoeffer	140	Dec. 30, 1936	309				293	30	17		
G44	Wm. D. Wiemers	80	do	287	68	15	21	268	32	19		234
[7]G46	City of New Braunfels	116	Dec. 4, 1943	281	73	17	6.7	263	24	14	5.8	252
[7]G47	do	102	do	283	73	17	5.5	261	24	13	5.5	252
G50	do	Spring	Nov. 22, 1944		102	13						308

See footnotes at end of table.

TABLE 19.—*Partial analyses of water from wells and springs in Comal County, Tex.*—Continued

[Results are in parts per million]

Well	Owner	Depth of well (feet)	Date of collection	Total dissolved solids	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K) (calculated)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Total hardness as $CaCO_3$ (calculated)
Edwards limestone (may include Comanche Peak in some wells)—Continued												
G50	City of New Braunfels	Spring	Jan. 22, 1945		74	17						254
G50	do	Spring	Feb. 14, 1945		82	18						278
G50	do	Spring	Mar. 5, 1945		72	17						250
G50	do	Spring	Mar. 23, 1945		78	18						268
G50	do	Spring	Apr. 28, 1945		43	18						182
G50	do	Spring	May 31, 1945		75	18						261
G50	do	Spring	July 6, 1945		75	16						253
G50	do	Spring	Sept. 13, 1945		77	17						262
G50	do	Spring	Oct. 9, 1945	292	76	18	2.8	274	20		5.6	264
G50	do	Spring	Oct. 18, 1945		76	19			[1] 423			268
G50	do	Spring	Nov. 23, 1945		50	16			1.5			191
G50	do	Spring	Sept. 13, 1945		80	19						278
G50	do	Spring	Oct. 27, 1936	253	56	19	15	244	26	17		219
G50	do	Spring	Apr. 10, 1938	267	75	17	3.3	266	23	13	5.0	257
G50	do	Spring	June 24, 1941	271	63	17	18	272	23	12	3.7	227
G50	do	Spring	Aug. 13, 1941					272	[1] 23	11		
[8] G50	do	Spring	Sept. 16, 1941	280	73	17	28	264	24	12	4.4	202
[8] G50	do	Spring	Apr. 2, 1942	288	70	17	11	274	22	12	4.0	244
G50	do	Spring	Jan. 10, 1944	280	78	17	5.5	280	23	13	5.5	264
[9] G50	do	Spring	Jan. 22, 1944	287	74	16	9.2	270	23	12	5.5	250
G50	do	Spring	Sept. 14, 1944		86	23						309
G50	do	Spring	Oct. 11, 1944		81	22						292
G52	R. R. Coreth	290	Dec. 16, 1936	304				311	20	13	0	
G54	Mrs Meta Penshorn	25	Dec. 22, 1936	285				268	28	16		
G56	Ad. Tausch		Jan. 6, 1937	281				262	32	13		
G57	Albert Soefje	57	Oct. 20, 1936	386				403	0	36		
G61	A. H. Hoffer	24	Nov. 18, 1936	234				268	0	9		
G63	Altgelt Farm Association	335	Dec. 20, 1943	265	74	17	3.9	266	[1] 22	14	3.2	254
G65	Max Altgelt	345	Dec. 4, 1936	203				128	47	20	0	
G67	Walter Sippel	502	Jan. 22, 1944	360	56	33	33	256	58	54	.2	276
G68	Arthur Bergfeld		Dec. 3, 1943	370	66	32	27	262	59	56	.5	296
G69	Edwin Soefje	427	Jan. 6, 1937	3,852	334	209	701	207	1,306	1,200	([3])	1,694
G75	Paul Schneider	503	Dec. 4, 1936	368	27	38	57	220	75	63		224
G77	L. Jentsch	485	do	1,647	114	107	322	207	422	580		726
G78	Ernst Voight	510	Oct. 26, 1936	1,148	119	72	194	354	287	302		594
H1	Gus Reinarz	500	Dec. 4, 1936	1,983	156	117	387	281	505	680		872
H2	F. A. Burket	450	Oct. 26, 1936	1,957	166	110	380	348	500	630		868
H3	Hanno Welsch	542	Jan. 6, 1937	1,019	132	33	193	348	245	245	0	466

H4	Erwin R. Goebel	498	do	2,300	246	136	390	293	574	820	(3)	1,148
H5	Otto Reinartz	463	Dec. 3, 1936	101	29	2	9	110	0	7		81
H6	A. W. Feick	700	Oct. 26, 1936	425	58	36	54	293	47	86		292
H7	Roland Welsch	372	Dec. 4, 1936	314	49	25	37	281	43	22		226
H8	Oscar Jonas	360	Dec. 18, 1936	296				281	26	19	0	
H9	Adolph Mueller	160	do	181				140	26	19		
H12	Ed Rech	390	Dec. 1, 1936	142				153	0	11	0	
H13	Ernst George		Dec. 17, 1936	143				159	0	8		
H14	Edw. Gerhardt Est	326	do	241				275	0	10	0	
H16	Servtex Materials Co	125	Dec. 19, 1936	256	79	14	4	299	0	12		254
H17	Westley Hier Holzer	117	do	344	88	13	64	311	12	14		273
H18	Joseph Friesenhahn	360	Dec. 18, 1936	412				200	103	55	0	
H20	Wm. Schaeffer	300	Dec. 3, 1936	233	33	28	16	195	32	28		198
H21	Alvin Schaeffer	360	Dec. 16, 1936	758	58	66	136	360	99	222	0	416
H22	Ben Jahn	395	Dec. 18, 1936	1,020	82	75	190	378	197	290	0	512
H23	O. Penshorn	428	Dec. 3, 1936	2,081	339	84	223	79	971	425		1,192
H24	Wm. Strateman		Jan. 6, 1937	1,576				226	375	550		
H28	Percy Hansman	350	Dec. 3, 1936	617	72	57	85	439	63	124		416
H29	Servtex Materials Co	160	Sept. 19, 1944	282	82	12	5.8	290	7.7	11	6.8	254
H30	Glen Wilson		Dec. 19, 1936	448				323	75	49		
H31	Lena Binzeil Est	240	Dec. 17, 1936	243				281	0	8	0	
H32	Lavine Hoffman	215	do	136				146	0	10		
H35	Henry W. Simon	246	do	266	83	17	0	293	8	14	0	275
H37	A. B. Burkhardt	250	Oct. 26, 1936	278				299	12	10		
H38	Egar Burkhardt	180	Nov. 24, 1936	265				293	0	16	0	
H40	R. R. Schneider	192	Oct. 26, 1936	278	60	12	33	250	20	30		197
H41	Otto Klaerner	109	do	260				293	0	13		
H43	Jack Alesci	400	Nov. 24, 1936	305	102	7	3	232	31	48		284
H44	— Rogers	225	Dec. 17, 1936	336				232	49	49	(3)	
H46	Walter Mueller	476	Nov. 24, 1936	194	30	19	14	122	51	20		152
H47	Herbert Riedel	306	Dec. 17, 1936	321	85	15	16	281	40	27	0	275
H48	Joe Sleitz	310	Dec. 12, 1936	298				232	42	31	0	

Austin chalk

G9	Phoenix Life Insurance Co	145	Oct. 21, 1936	648	111	32	77	275	169	124		410
G10	Travis Tate	152	Jan. 6, 1937	573	99	37	58	305	130	99	0	398
G11	Missouri Pacific R. R	140	Dec. 22, 1944	394	109	11		319	35	20	17	317
G64	Altgelt Farm Association	Spring	Dec. 4, 1936	270				171	71	19		
G64	do	Spring	Aug. 20, 1941	298	72	19	30	269	27	15	3.0	208
G64	do	Spring	Dec. 20, 1943	260	72	18	3.2	268	117	15	2.8	254
[4] G66	A. H. Werner	148	Dec. 4, 1936	553				329	130	63		
H19	Bruno Schwab	150	Dec. 18, 1936	368				287	40	49		
H25	Gus Klaener	131	Dec. 4, 1936	2,220				128	908	530		
H27	Albert Richner	130	Dec. 1, 1936	547				85	170	151		
[4] H40	Joe Gleitz	200	Dec. 12, 1936	225				165	39	22	0	

See footnotes at end of table.

TABLE 19.—*Partial analyses of water from wells and springs in Comal County, Tex.*—Continued

[Results are in parts per million]

Well	Owner	Depth of well (feet)	Date of collection	Total dissolved solids	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K) (calculated)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Total hardness as $CaCO_3$ (calculated)
				Taylor marl								
[4] G37	Carl Kutscher Est.	50	Oct. 21, 1936	680				458	98	106		
[4] G39	H. Kickeritz	36	Nov. 18, 1936	792	132	33	104	354	248	101		469
[4] G62	Max Walther	31	Oct. 27, 1936	329				323	24	19		
[4] H26	Fred Schwab	38	Dec. 16, 1936	604	91	22	106	390	118	75		319
				Leona formation								
G35	Arthur Bartels	65	Oct. 22, 1936	352				256	0	91		
G36	H. Mittendorf	32	Oct. 21, 1936	228	78	6	5	256	0	13		218
G40	Mrs. Lidia Kirmse	65	Dec. 3, 1943	467	112	10	40	302	[1] 8	52	96	320
G42	Iwan Wallhoefer	Spring	Dec. 30, 1936	260	94	7		232	24	21	0	264
G55	Ad. Tausch		Jan. 6, 1937	281				262	32	15		
G57	Albert Soefji	57	Oct. 20, 1943	386				403	0	36		
G57	do	57	Dec. 3, 1943					270	[1] 4	72	165	
G58	Emma Rose	32	Nov. 18, 1936	519				268	59	138		
G60	August Timmerman	50	do	238				256	0	0		
G60	do	50	Dec. 3, 1943					240	[1] 10	21	90	
G61	A. H. Hoffer	24	Nov. 18, 1936	234				268	0	9		
G70	R. Kraft	40	do	239				250	0	0		
G71	E. W. Mueller	35	Oct. 10, 1936	163				134	0	34		
G72	Mrs. H. Oelkers	40	do	257				250	0	34		
G73	D. Werner	30	do	291	106	6		244	35	24	(3)	288
G74	W. C. Startz	27	Dec. 3, 1943					272	[1] 20	15	82	
H33	Henry Schmidt	50	Dec. 17, 1936	207	93	2		146	8	32	(3)	241

[1] Turbidity.
[2] Hardness determined by soap method.
[3] Nitrate less than 20 parts per million.
[4] Doubtful geologic classification.
[5] Sulfate less than 10 parts per million.
[6] Fluoride 0.5 ppm.
[7] Fluoride 0.2 ppm.
[8] Fluoride 0.1 ppm.
[9] Fluoride 0.4 ppm.

TABLE 20.—*Records of water levels in observation wells*

[All altitudes are for land-surface datum in feet above mean sea level. Measurements are in feet below land-surface datum.]

A32. Albert Marek, 19½ miles northwest of New Braunfels; altitude, 1,029.34

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Nov. 16, 1936	74.10	May 23, 1940	80.20	Dec. 5, 1940	75.06	Dec. 20, 1943	76.31
Oct. 29, 1939	77.77	June 27, 1940	85.33	May 22, 1941	67.03	Dec. 18, 1944	72.96
Dec. 19, 1939	78.13	July 25, 1940	82-05	Nov. 18, 1941	75.15	May 17, 1945	72.90
Jan. 29, 1940	77.80	Aug. 27, 1940	87.90	Apr. 3, 1942	79.88	July 12, 1945	76.40
Feb. 28, 1940	79.51	Aug. 28, 1940	83.26	Dec. 8, 1942	73.33	Mar. 20, 1946	72.64
Mar. 26, 1940	80.15	Sept. 26, 1940	81.87	Apr. 19, 1943	76.19	Aug. 11, 1948	83.64
Apr. 30 1940	80.08	Oct. 29, 1940	83.40	Sept. 10, 1943	75.83	Jan. 23, 1950	77.09

A33. Alfred Beierle, 18½ miles northwest of New Braunfels; altitude, 1,006.57

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Nov. 20, 1936	119.10	Apr. 30, 1940	131.39	Oct. 29, 1940	125.77	May 17, 1945	95.30
Oct. 11, 1939	124.98	May 23, 1940	130.80	Dec. 5, 1940	131.25	July 12, 1945	102.00±
Dec. 19, 1939	132.68	July 1, 1940	133.26	Jan. 24, 1941	131.77	Mar. 20, 1946	120.46
Jan. 29, 1940	134.07	July 26, 1940	147.94	Apr. 3, 1942	129.33	Aug. 11, 1948	124.30
Feb. 27, 1940	135.06	Aug. 28, 1940	128.96	Sept. 10, 1943	123.24	Jan. 10, 1949	122.20
Mar. 26, 1940	130.86	Sept. 27, 1940	126.72	Dec. 20, 1943	122.87	Jan. 25, 1950	123.63

A34. A. B. Cavender 18½ miles northwest of New Braunfels; altitude, 1,015.85

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Jan. 26, 1937	92.70	July 26, 1940	92.74	Nov. 18, 1941	92.66	Aug. 24, 1944	92.63
Oct. 11, 1939	92.70	Aug. 28, 1940	92.67	Apr. 3, 1942	92.73	Dec. 18, 1944	92.63
Dec. 19, 1939	92.72	Sept. 27, 1940	92.68	Aug. 7, 1942	92.68	May 17, 1945	93.00
Jan. 29, 1940	92.69	Oct. 29, 1940	92.68	Dec. 8, 1942	92.64	July 12, 1945	92.63
Feb. 27, 1940	92.72	Dec. 5, 1940	92.69	Apr. 19, 1943	92.65	Mar. 20, 1946	92.61
Mar. 26, 1940	92.69	Jan. 24, 1941	92.66	Sept. 10, 1943	92.66	Aug. 11, 1948	92.66
Apr. 30, 1940	92.69	Mar. 25, 1941	92.61	Dec. 20, 1943	92.67	Jan. 10, 1949	96.82
May 29, 1940	92.69	May 22, 1941	92.08	May 2, 1944	91.16	Jan. 23, 1950	92.66
July 1, 1940	92.71						

A35. Mrs. John Striker, 18 miles northwest of New Braunfels; altitude, 1,031.68

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Nov. 19, 1936	166.70	July 25, 1940	173.92	Nov. 18, 1941	162.92	Aug. 24, 1944	155.55
Oct. 11, 1939	172.47	Aug. 27, 1940	173.93	Apr. 3, 1942	168.48	Dec. 18, 1944	161.29
Dec. 19, 1939	173.13	Sept. 26 1940	174.04	Aug. 7, 1942	171.46	May 17, 1945	138.40
Jan. 29, 1940	173.35	Oct. 28, 1940	173.79	Dec. 8, 1942	165.72	July 12, 1945	138.80
Feb. 27, 1940	173.33	Dec. 5, 1940	174.13	Apr. 19, 1943	167.85	Mar. 20, 1946	162.75
Mar. 26, 1940	173.66	Jan, 24, 1941	173.94	Sept. 10, 1943	170.89	Aug. 11, 1948	169.18
Apr. 30, 1940	173.67	Mar. 25, 1941	172.27	Dec. 20, 1943	171.37	Jan. 10, 1949	171.49
May 23, 1940	173.74	May 22, 1941	167.18	May 2, 1944	166.82	Jan. 23, 1950	170.72
June 27, 1940	173.86						

D17. Vincent Laubach, 23 miles west of New Braunfels; altitude, 1,264.3

Date	Water level	Date	Water level	Date	Water level	Date	Water level
May 11, 1945	188.7	May 24, 1945	208.0	July 5, 1945	253.8	Jan. 25, 1950	281.2
May 19, 1945	188.7						

E9. J. H. Pyke, 19 miles northwest of New Braunfels; altitude, 1,204.47

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Nov. 16, 1936	116.30	June 27, 1940	119.32	Mar. 25, 1941	116.00	Dec. 20, 1943	116.19
Oct. 12, 1939	117.76	July 25, 1940	119.33	Nov. 18, 1941	109.80	Aug. 24, 1943	106.82
Jan. 29, 1940	118.41	Aug. 27, 1940	119.48	Apr. 3, 1942	112.53	Dec. 18, 1943	109.88
Feb. 27, 1940	118.61	Sept. 27, 1940	119.71	Aug. 7, 1942	114.39	July 12, 1945	101.88
Mar. 26, 1940	118.84	Oct. 29, 1940	119.87	Dec. 8, 1942	109.56	Mar. 20, 1946	108.68
Apr. 30, 1940	119.08	Dec. 5. 1940	120.02	Apr. 19, 1943	111.98	Aug. 11, 1948	116.61
May 29, 1940	119.26	Jan. 24, 1941	119.23	Sept. 10, 1943	115.58	Jan. 23, 1950	117.56

E10. Roy Akers, 19 miles northwest of New Braunfels; altitude, 1,241.44

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Dec. 10, 1936	83.00	May 23, 1940	115.95	Jan. 29, 1941	115.83	Aug. 24, 1944	119.52
Jan. 29, 1939	120.30	July 1, 1940	116.03	Mar. 25, 1941	41.40	May 17, 1945	114.70
Oct. 12, 1939	114.85	Jnly 25, 1940	115.92	May 22, 1941	42.47	July 12, 1945	116.60
Dec. 19, 1939	115.89	Aug. 27. 1940	116,00	Apr. 3, 1942	85.30	Mar. 20, 1946	113.1
Feb. 28, 1940	115.61	Sept. 26, 1940	116.12	Sept. 11, 1943	116.04	Aug. 11, 1948	115.41
Mar. 26, 1940	115.90	Oct. 28, 1940	115.96	Dec. 20, 1943	115.48	Jan. 23, 1950	115.65

TABLE 20.—*Records of water levels in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
E24. Mrs. Mattie Shelburne, 7.8 miles northwest of New Braunfels; altitude, 1,156.94							
Nov. 16, 1936	228.4	June 27, 1940	239.21	May 22, 1941	204.00	Aug. 24, 1944	220.27
Oct. 12, 1939	238.16	July 25, 1940	239.19	Nov. 19, 1941	226.46	Dec. 18, 1944	223.78
Dec. 19, 1939	238.44	Aug. 27, 1940	239.33	Apr. 3, 1942	232.41	May 18, 1945	190.50
Jan. 29, 1940	238.53	Sept. 26, 1940	239.69	Aug. 7, 1942	233.86	July 5, 1945	207.75
Feb. 28, 1940	238.61	Oct. 28, 1940	239.40	Dec. 8, 1942	217.54	Mar. 20, 1946	224.55
Mar. 26, 1940	238.95	Dec. 5, 1940	238.85	Apr. 19, 1943	229.41	Aug. 11, 1948	231.31
Apr. 30, 1940	238.97	Jan. 24, 1941	237.56	Sept. 11, 1943	236.03	Jan. 23, 1950	233.80
May 23, 1940	239.04	Mar. 25, 1941	226.60	Dec. 20, 1943	234.50		
E44. Aug. Wehe, 20 miles west of New Braunfels; altitude, 1,096.21							
Nov. 12, 1936	217.50	May 23, 1940	278.47	Sept. 11, 1943	265.31	Mar. 20, 1946	217.14
Oct. 11, 1939	286.04	July 1, 1940	276.94	Dec. 20, 1943	271.17	Aug. 11, 1948	278.50
Jan. 29, 1940	281.02	Aug. 27, 1940	282.55	May 18, 1945	121.80	Jan. 25, 1950	273.70
Feb. 27, 1940	278.21	May 22, 1941	44.40	July 5, 1945	211.90		
E50. Charles Willig, 18 miles west of New Braunfels; altitude, 1,052.40							
Nov. 12, 1936	213.10	June 27, 1940	323.44	Mar. 25, 1941	83.4	Dec. 18, 1944	136.94
Oct. 11, 1939	322.09	July 25, 1940	322.41	May 22, 1941	60.47	May 4, 1945	79.00
Dec. 19, 1939	322.35	Oct. 29, 1940	322.25	Apr. 19, 1943	270.00	May 18, 1945	111.00
Jan. 30, 1940	325.00	Jan. 29, 1941	298.35	Sept. 11, 1943	286.24	Mar. 20, 1946	183.4
Feb. 27, 1940	322.17	Mar. 25, 1941	83.28				
E58. W. B. Ethridge, 13½ miles west of New Braunfels; altitude, 955.94							
Nov. 12, 1936	153.7	May 23, 1940	224.57	Dec. 5, 1940	216.92	Aug. 7, 1942	216.24
Oct. 12, 1939	226.55	June 27, 1940	223.55	Jan. 24, 1941	201.11	Dec. 8, 1942	100.07
Dec. 19, 1939	224.75	July 25, 1940	225.61	Mar. 25, 1941	79.86	Apr. 19, 1943	201.47
Jan. 30, 1940	225.13	Aug. 27, 1940	224.88	May 22, 1941	49.30	Sept. 11, 1943	208.14
Feb. 28, 1940	224.51	Sept. 26, 1940	225.81	Nov. 19, 1941	180.03	Dec. 20, 1943	220.04
Apr. 30, 1940	225.11	Oct. 29, 1940	225.77	Apr. 3, 1942	213.30		
F18. Robert Heimer, 10 miles northwest of New Braunfels; altitude, 1,090.3							
Jan. 29, 1940	49.30	Sept. 26, 1940	61.48	Dec. 6, 1940	49.28	July 5, 1945	49.32
Feb. 27, 1940	49.35	Sept. 27, 1940	49.36	Sept. 10, 1943	49.11	Jan. 23, 1950	49.31
Apr. 29, 1940	49.35	Oct. 29, 1940	49.35	May 19, 1945	49.70	Jan. 4, 1951	49.38
June 27, 1940	49.27						
F20. H. Conrads, 11 miles northwest of New Braunfels; altitude, 1,174.06							
Jan. 29, 1940	139.11	Aug. 27, 1940	148.44	Nov. 18, 1941	138.20	Dec. 18, 1944	136.62
Feb. 27, 1940	139.25	Sept. 27, 1940	139.91	Dec. 8, 1942	136.5	Apr. 6, 1945	131.40
Mar. 26, 1940	139.48	Oct. 28, 1940	139.45	Apr. 19, 1943	138.68	May 17, 1945	137.40
Apr. 29, 1940	139.41	Jan. 29, 1941	138.39	Nov. 29, 1943	141.32	July 5, 1945	139.50±
May 23, 1940	139.39	Mar. 25, 1941	132.11	Aug. 24, 1944	138.59	Mar. 19, 1946	134.4
July 1, 1940	137.79	May 22, 1941	132.80				
F26. F. D. Hutcheson, 4.5 miles northwest of New Braunfels; altitude, 849.17							
Dec. 31, 1936	229.98	Apr. 13, 1945	179.10	May 23, 1945	183.50	July 3, 1945	190.00
Dec. 18, 1937	212.36						
F27. Henry Heise, 4 miles northwest of New Braunfels; altitude, 878.59							
Dec. 21, 1936	259.2	Jan. 29, 1940	250.07	July 1, 1940	249.68	May 23, 1941	236.89
Oct. 9, 1939	261.40	Feb. 27, 1940	250.32	Oct. 29, 1940	251.25	Aug. 15, 1941	236.64
Dec. 18, 1939	249.58	Mar. 26, 1940	250.57	Dec. 5, 1940	251.31	Apr. 9, 1942	242.21

TABLE 20.—*Records of water levels in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
F29. Henry Rahe, 6 miles northwest of New Braunfels; altitude, 966.94							
Apr. 13, 1945	274.6	July 4, 1945	297.9	Jan. 24, 1950	304.0	Jan. 5, 1951	304.77
May 16, 1945	289.8						
F34. H. W. Dietz, 7½ miles northwest of New Braunfels; altitude, 968.07							
Apr. 27, 1945	268.1	July 4, 1945	269.45	Jan. 24, 1950	267.3	Jan. 4, 1951	267.23
May 19, 1945	269.3						
F38. Paul Tonne, 9 miles west of New Braunfels; altitude, 954.06							
Nov. 9, 1936	255.64	May 4, 1945	246.00	July 11, 1945	266.90	Jan. 4, 1951	276.9
Jan. 10, 1937	254.87	May 18, 1945	254.10	Jan. 22, 1950	271.00		
F41. Krueger Brothers, 6 miles northwest of New Braunfels; altitude, 941.79							
Jan. 25, 1937	188.75	Sept. 26, 1940	176.87	Aug. 7, 1942	176.62	July 4, 1945	181.48
Oct. 10, 1939	171.89	Oct. 28, 1940	184.91	Dec. 8, 1942	177.21	Mar. 19, 1946	168.00
Jan. 29, 1940	179.90	Dec. 5, 1940	187.22	Apr. 19, 1943	167.92	July 6, 1947	188.86
Feb. 27, 1940	175.49	Jan. 24, 1941	175.16	Sept. 10, 1943	167.70	Nov. 23, 1947	192.74
Apr. 29, 1940	177.54	Mar. 25, 1941	170.54	Dec. 20, 1943	174.36	May 2, 1948	197.12
May 23, 1940	180.37	May 22, 1941	168.19	May 1, 1944	177.03	Aug. 11, 1948	196.14
June 27, 1940	180.93	Nov. 18, 1941	177.36	Aug. 24, 1944	175.19	Jan. 23, 1950	195.67
July 26, 1940	182.46	Mar. 6, 1942	172.81	Dec. 18, 1944	176.28	Jan. 3, 1951	197.77
Aug. 27, 1940	178.43	Apr. 3, 1942	180.42	May 18, 1945	182.40		
F44. Walter Kappelmacher, 3.5 miles west of New Braunfels; altitude, 861.68							
Oct. 10, 1939	233.09	Aug. 27, 1940	234.41	Mar. 6, 1942	227.92	May 24, 1945	217.80
Dec. 18, 1939	233.80	Sept. 23, 1940	234.85	Apr. 3, 1942	228.50	July 3, 1945	219.10
Jan. 29, 1940	234.05	Oct. 29, 1940	235.27	Aug. 7, 1942	228.82	May 19, 1946	225.1
Feb. 28, 1940	234.19	Dec. 5, 1940	235.30	Dec. 7, 1942	220.85	July 6, 1947	220.58
Mar. 26, 1940	234.42	Jan. 24, 1941	233.64	Dec. 8, 1942	220.86	Nov. 23, 1947	225.16
Apr. 29, 1940	234.42	Mar. 28, 1941	229.87	Apr. 19, 1943	224.61	May 2, 1948	229.69
May 23, 1940	234.28	Aug. 14, 1941	223.22	Apr. 29, 1943	224.91	Jan. 11, 1949	233.90
June 27, 1940	233.48	Nov. 19, 1941	225.58	Sept. 10, 1943	227.85	Jan. 23, 1950	233.05
July 26, 1940	233.84	Jan. 14, 1942	226.90	May 1, 1944	223.98	Jan. 4, 1951	235.65
F49. Richard Gesche, 7.5 miles west of New Braunfels; altitude, 916.65							
Oct. 11, 1933	267.35	July 3, 1945	240.48	Nov. 23, 1947	241.61	Jan. 23, 1950	267.02
Dec. 16, 1936	259.82	July 5, 1947	239.34	Apr. 23, 1947	254.80	Jan. 3, 1951	266.39
May 24, 1945	233.00						
F50. Henry Ludwig, 7½ miles west of New Braunfels; altitude, 920.9							
Apr. 13, 1945	221.5	July 11, 1945	244.5	Nov. 27, 1947	246.3	Jan. 25, 1950	266.22
May 18, 1945	231.9	July 3, 1947	244.53	Apr. 23, 1948	261.18	Jan. 3, 1951	269.38
F52. Charles Wuest, 11½ miles west of New Braunfels; altitude, 976.9							
Apr. 27, 1945	266.8	July 4, 1945	276.1	Jan. 25, 1950	280.95	Jan. 8, 1951	285.81
May 18, 1945	276.3						
F61. O. C. Brehmer, 5 miles west of New Braunfels; altitude, 916.87							
May 25, 1934	283.63	Jan. 10, 1937	278.37	July 13, 1945	265.04	Jan. 4, 1951	284.50
Dec. 1, 1936	278.53	May 23, 1945	262.14				
F68. Schaeffer Brothers, 7 miles southwest of New Braunfels; altitude, 886.1							
May 28, 1934	241.69	May 25, 1945	231.84	July 13, 1945	234.74	Jan. 23, 1950	233.22
Dec. 18, 1936	243.50						

TABLE 20.—*Records of water levels in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
F70. Eugene Krause, 9½ miles west of New Braunfels; altitude, 904.27							
Oct. 11, 1933	259.71	May 25, 1945	229.80	Apr. 23, 1948	249.37	Jan. 4, 1951	266.60
May 25, 1936	255.54	July 3, 1945	232.05	Jan. 23, 1950	266.35		
G13. William Posey, 8.5 miles northeast of New Braunfels; altitude, 671.5							
Oct. 21, 1936	123.4	Apr. 22, 1938	154.18	Sept. 28, 1938	181.38	Jan. 25, 1939	161.50
Nov. 24, 1937	130.19	May 18, 1938	138.40	Nov. 21, 1938	168.19	Apr. 23, 1939	181.52
Feb. 2, 1938	123.70	June 22, 1938	185.37	Dec. 13, 1938	179.73	May 26, 1939	166.33
Mar. 30, 1938	158.92	Aug. 26, 1938	149.60				
G19. John Karbach, 4¼ miles northeast of New Braunfels; altitude, 783.77							
Dec. 20, 1937	173.32	May 26, 1939	173.26	Oct. 28, 1940	176.74	Dec. 20, 1943	173.22
Jan. 22, 1938	172.50	July 3, 1939	174.68	Dec. 6, 1940	175.88	Dec. 19, 1944	170.37
Feb. 2, 1938	170.90	Dec. 20, 1939	176.04	Jan. 29, 1941	173.85	May 23, 1945	165.71
Mar. 30, 1938	171.14	Jan. 24, 1940	176.19	Mar. 27, 1941	171.80	Mar. 20, 1946	171.42
Apr. 22, 1938	171.46	Feb. 28, 1940	176.97	May 23, 1941	167.33	Nov. 22, 1947	171.01
May 19, 1938	168.76	Mar. 22, 1940	176.35	Aug. 8, 1941	168.18	May 2, 1948	174.59
June 23, 1938	169.39	Apr. 30, 1940	176.19	Nov. 19, 1941	170.12	Feb. 10, 1949	175.69
July 20, 1938	169.93	May 28, 1940	176.18	Mar. 6, 1942	172.30	Dec. 7, 1949	173.43
Aug. 30, 1938	171.20	June 25, 1940	175.78	Apr. 9, 1942	172.68	Jan. 23, 1950	174.00
Sept. 28, 1938	176.52	July 29, 1940	175.47	Aug. 3, 1942	172.45	Aug. 1, 1950	174.84
Dec. 12, 1938	172.21	Aug. 27, 1940	176.01	Dec. 7, 1942	167.36	Dec. 7, 1950	176.24
Jan. 25, 1939	173.29	Sept. 23, 1940	176.50	Apr. 19, 1943	171.01	Jan. 5, 1951	176.03
Apr. 22, 1939	173.98						
G23. Charles Soechting, 6 miles northeast of New Braunfels; altitude, 758.31							
Jan. 5, 1937	157.53	Mar. 28, 1939	152.91	Nov. 18, 1941	148.23	Apr. 24, 1948	152.25
Dec. 15, 1937	151.49	Apr. 23, 1939	152.75	Mar. 6, 1942	150.33	June 25, 1948	153.03
Jan. 21, 1938	149.81	May 26, 1939	152.86	Apr. 9, 1942	150.94	Aug. 6, 1948	153.10
Feb. 2, 1938	151.49	July 3, 1939	152.50	Aug. 7, 1942	150.81	Feb. 10, 1949	154.66
Mar. 30, 1938	149.06	Oct. 4, 1939	153.73	Dec. 4, 1942	145.32	Mar. 9, 1949	153.79
Apr. 22, 1938	149.29	Dec. 18, 1939	156.02	Sept. 10, 1943	149.72	Apr. 18, 1949	153.31
May 18, 1938	146.67	Jan. 23, 1940	155.10	Dec. 20, 1943	151.36	Aug. 25, 1949	151.30
June 22, 1938	146.78	Feb. 27, 1940	154.91	Apr. 30, 1944	146.40	Oct. 10, 1949	151.75
July 20, 1938	148.13	Mar. 22, 1940	155.17	Aug. 23, 1944	146.65	Nov. 8, 1949	152.84
Aug. 26, 1938	150.50	Apr. 29, 1940	154.52	Dec. 18, 1944	148.51	Dec. 7, 1949	151.13
Sept. 28, 1938	149.12	June 27, 1940	154.82	May 23, 1945	144.08	Jan. 23, 1950	152.61
Nov. 2, 1938	150.79	Aug. 27, 1940	154.45	July 6, 1945	145.60	Apr. 10, 1950	152.31
Dec. 13, 1938	151.20	Oct. 30, 1940	155.71	Mar. 20, 1946	149.42	Aug. 1, 1950	153.12
Jan. 24, 1939	151.83	Jan. 24, 1941	152.22	July 5, 1947	147.22	Dec. 7, 1950	154.05
Feb. 28, 1939	154.21	Mar. 27, 1941	149.85	Nov. 19, 1947	150.45	Jan. 5, 1951	154.30
G25. O. E. Gruene, 7.5 miles northeast of New Braunfels; altitude, 752.70							
Oct. 20, 1936	146.63	Apr. 22, 1939	149.68	Jan. 24, 1941	149.19	July 2, 1947	146.73
Dec. 6, 1937	149.04	May 26, 1939	149.99	Mar. 27, 1941	146.55	Nov. 19, 1947	147.74
Jan. 21, 1938	148.15	July 3, 1939	150.37	May 23, 1941	142.35	Apr. 23, 1948	148.40
Feb. 2, 1938	146.34	Oct. 5, 1939	151.33	Nov. 18, 1941	145.86	Aug. 6, 1948	151.90
Mar. 30, 1938	146.62	Jan. 23, 1940	151.97	Mar. 6, 1942	147.75	Feb. 10, 1949	151.55
Apr. 22, 1938	146.77	Feb. 27, 1940	152.08	Apr. 3, 1942	148.25	Aug. 25, 1949	148.67
May 18, 1938	143.89	Mar. 22, 1940	152.23	Apr. 19, 1943	146.51	Oct. 10, 1949	148.75
June 22, 1938	144.46	Apr. 29, 1940	152.32	Sept. 10, 1943	147.16	Nov. 8, 1949	149.16
July 20, 1938	145.46	May 24, 1940	152.24	Dec. 20, 1943	148.71	Dec. 7, 1949	148.50
Sept. 28, 1938	148.43	July 1, 1940	151.34	Apr. 30, 1944	144.03	Jan. 23, 1950	149.22
Nov. 2, 1938	148.00	July 27, 1940	151.21	Aug. 23, 1944	144.01	Apr. 10, 1950	149.43
Dec. 13, 1938	148.50	Aug. 27, 1940	151.89	Dec. 18, 1944	145.63	Aug. 1, 1950	149.32
Jan. 24, 1939	148.99	Sept. 27, 1940	152.56	May 22, 1945	141.01	Dec. 7, 1950	151.03
Feb. 28, 1939	148.99	Oct. 29, 1940	152.76	July 6, 1945	143.25	Jan. 5, 1951	151.64
Mar. 22, 1939	149.41	Dec. 5, 1940	151.50	Mar. 20, 1946	146.93		
G29. R. W. Gode, 3¾ miles northwest of New Braunfels; altitude, 675.5							
Apr. 13, 1945	38.8	May 23, 1945	37.2	July 2, 1950	38.8	July 4, 1951	52.2
May 16, 1945	36.8	May 24, 1945	38.8				

TABLE 20.—*Records of water levels in observation wells*—Continued

G30. L. S. Davis, 3¾ miles northwest of New Braunfels; altitude, 840.07

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Dec. 21, 1936	211.08	Aug. 28, 1940	214.30	Dec. 7, 1942	199.47	Feb. 10, 1949	213.60
Dec. 19, 1939	214.03	Oct. 29, 1940	215.19	Sept. 10, 1943	206.92	Apr. 19, 1949	212.84
Jan. 29, 1940	214.33	Dec. 5, 1940	215.06	Dec. 18, 1944	209.89	Aug. 25, 1949	209.20
Feb. 27, 1940	215.66	Jan. 29, 1941	212.99	Apr. 23, 1945	197.55	Dec. 7, 1949	208.67
Mar. 26, 1940	215.33	Aug. 15, 1941	203.05	July 6, 1945	199.18	Jan. 23, 1950	209.85
Apr. 29, 1940	214.72	Nov. 18, 1941	204.75	Mar. 19, 1946	209.08	Apr. 10, 1950	211.00
May 24, 1940	214.84	Mar. 6, 1942	207.41	Apr. 23, 1948	208.62	Aug. 1, 1950	212.28
July 1, 1940	214.07	Apr. 9, 1942	208.04	June 25, 1948	210.06	Dec. 8, 1950	217.55
July 26, 1940	213.48	Aug. 7, 1942	206.21	Aug. 11, 1948	210.75	Jan. 4, 1951	214.72

G31. W. H. Harborth Estate, 3½ miles northwest of New Braunfels; altitude, 809.05

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Oct. 28, 1936	158.37	Dec. 5, 1940	184.16	Sept. 10, 1943	174.78	June 25, 1948	177.80
Dec. 18, 1939	183.71	Jan. 29, 1941	182.21	Dec. 20, 1943	177.05	Aug. 11, 1948	178.82
Jan. 29, 1940	183.10	Mar. 28, 1941	179.37	May 2, 1944	168.58	Feb. 10, 1949	182.10
Feb. 27, 1940	183.32	May 23, 1941	171.65	Aug. 23, 1944	172.14	Apr. 19, 1949	181.80
Mar. 26, 1940	183.57	Aug. 15, 1941	169.20	Dec. 18, 1944	163.12	Aug. 25, 1949	177.90
Apr. 29, 1940	183.62	Nov. 18, 1941	172.26	May 23, 1945	164.95	Dec. 7, 1949	177.95
May 24, 1940	183.79	Mar. 6, 1942	175.39	July 3, 1946	173.09	Jan. 23, 1950	178.45
June 27, 1940	183.14	Apr. 9, 1942	176.06	Mar. 19, 1946	167.01	Apr. 10, 1950	178.45
July 29, 1940	182.60	Aug. 7, 1942	174.63	July 6, 1947	172.40	Aug. 1, 1950	179.72
Aug. 28, 1940	183.20	Dec. 7, 1943	165.0	Nov. 23, 1947	172.40	Dec. 8, 1950	183.14
Sept. 26, 1940	183.75	Apr. 20, 1943	171.51	Apr. 23, 1948	176.42	Jan. 4, 1951	182.45
Oct. 29, 1940	184.13						

G32. William Kraft, 3¼ miles northwest of New Braunfels; altitude, 806.50

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Dec. 19, 1939	182.50	Aug. 28, 1940	182.79	Apr. 9, 1942	177.24	Dec. 18, 1944	174.58
Jan. 29, 1940	182.71	Sept. 23, 1940	183.28	Aug. 7, 1942	176.73	Apr. 23, 1945	168.68
Feb. 27, 1940	182.82	Oct. 29, 1940	183.62	Dec. 7, 1942	170.46	July 3, 1945	170.50
Mar. 26, 1940	182.99	Jan. 24, 1941	181.50	Apr. 19, 1943	174.58	Mar. 19, 1946	175.30
Apr. 29, 1940	182.87	Mar. 28, 1941	178.43	Sept. 10, 1943	176.76	June 25, 1948	179.59
May 24, 1940	183.04	May 23, 1941	172.53	Dec. 20, 1943	178.59	Dec. 7, 1949	178.35
July 1, 1940	181.96	Nov. 19, 1941	174.41	Apr. 30, 1944	173.10	Aug. 1, 1950	181.37
July 29, 1940	181.99	Mar. 6, 1942	176.72	Aug. 23, 1944	172.50	Dec. 8, 1950	184.55

G33. Albert Simon, 3¼ miles northwest of New Braunfels; altitude, 792.99

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Nov. 3, 1936	170.00	Aug. 15, 1941	161.33	Aug. 23, 1944	159.19	Apr. 18, 1949	167.54
Dec. 19, 1939	169.46	Apr. 9, 1942	163.91	Dec. 18, 1944	161.01	Aug. 25, 1949	165.01
Jan. 29, 1940	169.71	Aug. 7, 1942	163.09	May 23, 1945	155.72	Dec. 7, 1949	164.50
Mar. 26, 1940	169.89	Dec. 7, 1942	157.73	July 2, 1945	157.05	Jan. 23, 1950	165.80
Apr. 29, 1940	169.73	Apr. 19, 1943	161.09	Mar. 19, 1946	161.94	Apr. 10, 1950	166.60
May 24, 1940	169.96	Sept. 10, 1943	162.99	Apr. 24, 1948	172.77	Aug. 1, 1950	167.69
Aug. 28, 1940	169.64	Dec. 20, 1943	165.00	June 25, 1948	166.06	Jan. 4, 1951	170.35
Sept. 23, 1940	170.20	Apr. 30, 1944	165.90	Feb. 10, 1949	169.00		

G34. Albert Wallhoefer, 4 miles northeast of New Braunfels; altitude, 700.60

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Dec. 30, 1936	89.60	July 3, 1939	90.74	Aug. 8, 1941	85.92	Nov. 19, 1947	89.25
Dec. 15, 1937	90.11	Oct. 4, 1939	92.57	Nov. 18, 1941	87.84	Apr. 24, 1948	90.58
Jan. 22, 1938	89.51	Dec. 18, 1939	91.78	Mar. 6, 1942	89.31	June 25, 1948	91.03
Feb. 2, 1938	88.23	Jan. 23, 1940	92.22	Apr. 3, 1942	89.56	Aug. 6, 1948	91.25
Mar. 30, 1938	88.36	Feb. 27, 1940	92.40	Aug. 7, 1942	89.41	Feb. 10, 1949	92.10
Apr. 22, 1938	88.56	Mar. 22, 1940	92.48	Dec. 4, 1942	85.23	Mar. 9, 1949	91.71
May 18, 1938	86.40	Apr. 27, 1940	92.38	Apr. 19, 1943	88.23	Apr. 18, 1949	91.37
June 22, 1938	86.86	May 29, 1940	92.36	Sept. 10, 1943	88.81	Aug. 25, 1949	89.94
July 20, 1938	87.44	June 27, 1940	92.01	Dec. 20, 1943	90.07	Oct. 10, 1949	90.43
Sept. 29, 1938	88.98	July 29, 1940	91.86	Apr. 30, 1944	86.57	Nov. 8, 1949	89.74
Nov. 2, 1938	89.38	Aug. 27, 1940	92.31	Aug. 23, 1944	86.50	Dec. 7, 1949	89.94
Dec. 13, 1938	90.76	Sept. 27, 1940	92.68	Dec. 18, 1944	87.76	Jan. 23, 1950	90.94
Jan. 24, 1939	90.09	Oct. 29, 1940	92.79	May 22, 1945	83.64	Apr. 10, 1950	90.64
Feb. 28, 1939	90.16	Dec. 5, 1940	92.13	July 6, 1945	85.23	Aug. 1, 1950	91.13
Mar. 28, 1939	90.18	Jan. 24, 1941	90.58	Mar. 20, 1946	88.48	Dec. 7, 1950	92.16
Apr. 23, 1939	90.41	May 23, 1941	85.19	June 23, 1947	86.68	Jan. 5, 1951	92.27
May 26, 1939	90.91						

TABLE 20.—*Records of water levels in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
G43. Bruno Preiss, 2½ miles northeast of New Braunfels; altitude, 672.17							
Oct. 21, 1936	51.23	July 3, 1939	55.01	Aug. 8, 1941	50.44	July 6, 1947	52.25
Dec. 6, 1937	52.93	Oct. 5, 1939	54.65	Nov. 14, 1941	51.41	Nov. 22, 1947	52.93
Jan. 21, 1938	52.39	Dec. 18, 1939	54.78	Mar. 6, 1942	52.46	Aug. 6, 1948	54.91
Feb. 2, 1938	51.43	Jan. 24, 1940	54.85	Apr. 3, 1942	52.73	Feb. 10, 1949	55.47
Mar. 30, 1938	51.53	Feb. 27, 1940	54.95	Aug. 7, 1942	52.71	Mar. 9, 1949	55.03
May 18, 1938	49.76	Mar. 22, 1940	55.04	Dec. 4, 1942	49.57	Apr. 18, 1949	54.90
July 19, 1938	51.23	Apr. 27, 1940	54.99	Apr. 19, 1943	51.77	Aug. 25, 1949	53.86
Aug. 26, 1938	51.80	June 27, 1940	54.53	Sept. 10, 1943	52.49	Oct. 10, 1949	53.84
Sept. 28, 1938	52.22	July 29, 1940	54.72	Dec. 20, 1943	55.82	Nov. 8, 1949	53.38
Nov. 2, 1938	52.57	Aug. 27, 1940	55.18	Apr. 30, 1944	50.93	Dec. 7, 1949	53.68
Dec. 12, 1938	52.77	Sept. 23, 1940	55.42	Aug. 23, 1944	51.26	Jan. 23, 1950	54.01
Jan. 24, 1939	53.02	Oct. 28, 1940	55.43	Dec. 19, 1944	51.51	Apr. 10, 1950	54.32
Feb. 28, 1939	53.26	Dec. 5, 1940	54.80	May 23, 1945	49.97	Aug. 1, 1950	54.92
Mar. 28, 1939	53.37	Jan. 24, 1941	53.76	July 6, 1945	50.09	Dec. 7, 1950	45.65
Apr. 23, 1939	53.64	Mar. 28, 1941	52.18	Mar. 20, 1946	51.96	Jan. 4, 1951	55.77
May 26, 1939	53.89	May 23, 1941	49.47				
G48. Dean Word, 1¼ miles northwest of New Braunfels; altitude, 747.83							
Jan. 6, 1937	119.55	May 19, 1945	122.10	July 2, 1945	122.75	June 25, 1948	124.84
Apr. 13, 1945	121.90	May 24, 1945	122.30	July 5, 1947	122.97	Jan. 4, 1951	125.13
G53. A. Swanson, in New Braunfels; altitude, 736.05							
Jan. 6, 1937	100.80	May 24, 1945	110.34	Nov. 23, 1947	112.65	Jan. 23, 1950	113.20
Apr. 13, 1945	110.09	July 2, 1945	110.85	Apr. 24, 1948	113.30	Jan. 4, 1951	114.20
May 19, 1945	110.06	July 5, 1947	111.58				
G67. Walter Sippel, 1½ miles southwest of New Braunfels; altitude, 649.7							
Dec. 20, 1943	16.0	July 13, 1945	9.0	Nov. 22, 1947	12.2	Jan. 23, 1950	11.3
May 30, 1945	6.6	July 5, 1947	10.0	May 2, 1948	16.1	Jan. 4, 1951	17.33
July 4, 1945	7.9						
G77. L. Jentsch, 3.0 miles southwest of New Braunfels; altitude, 661.45							
Dec. 4, 1936	16.44	Apr. 26, 1940	24.94	Apr. 20, 1943	20.36	Feb. 11, 1949	29.46
Dec. 15, 1937	19.99	May 23, 1940	26.00	Dec. 21, 1943	23.11	Mar. 9, 1949	28.72
Jan. 21, 1938	19.46	Sept. 25, 1940	27.02	Aug. 24, 1944	22.98	Apr. 20, 1949	28.40
Feb. 2, 1938	18.27	Oct. 29, 1940	27.06	Dec. 19, 1944	21.61	Aug. 25, 1949	26.16
Mar. 30, 1938	18.33	Jan. 29, 1941	24.45	May 23, 1945	18.83	Oct. 10, 1949	27.31
Apr. 22, 1938	18.95	Mar. 25, 1941	21.39	July 13, 1945	20.14	Nov. 8, 1949	25.73
May 19, 1938	17.25	May 23, 1941	17.33	Mar. 19, 1946	22.24	Dec. 7, 1949	25.96
Jan. 25, 1938	21.87	Aug. 11, 1941	19.76	July 5, 1947	21.75	Jan. 23, 1950	26.02
Apr. 23, 1939	23.41	Nov. 14, 1941	19.81	Nov. 22, 1947	24.45	Apr. 10, 1950	26.40
May 26, 1939	23.90	Mar. 6, 1942	21.10	Apr. 24, 1948	26.67	Aug. 1, 1950	27.91
July 3, 1939	24.65	Apr. 9, 1942	20.34	June 25, 1948	28.97	Dec. 8, 1950	29.05
Oct. 5, 1939	25.13	Aug. 7, 1942	22.19	Aug. 6, 1948	29.03	Jan. 3, 1951	29.03
Mar. 22, 1940	25.41	Dec. 3, 1942	16.82				
H5. Otto Reinartz, 4 miles southwest of New Braunfels; altitude, 666.77							
May 24, 1934	15.90	Aug. 5, 1935	15.90	Aug. 10, 1935	15.00	Dec. 3, 1936	9.41
Oct. 8, 1934	19.07						

TABLE 20.—*Records of water levels in observation wells*—Continued

H6. A. W. Feick, 5 miles southwest of New Braunfels; altitude, 728.13

Dote	Water level	Date	Water level	Date	Water level	Date	Water level
May 28, 1934	69.94	May 26, 1939	84.94	May 23, 1941	78.14	Nov. 27, 1947	85.58
Oct. 26, 1936	77.08	July 3, 1939	86.96	Aug. 7, 1931	79.72	Apr. 24, 1948	89.00
Dec. 15, 1937	80.52	Oct. 5, 1939	86.60	Nov. 14, 1941	79.77	June 25, 1948	91.32
Jan. 21, 1938	79.43	Dec. 19, 1939	86.05	Mar. 6, 1942	81.19	Aug. 6, 1948	92.30
Feb. 2, 1938	77.85	Jan, 30, 1940	85.72	Apr. 9, 1942	81.69	Feb. 11, 1949	92.27
Mar. 30, 1938	78.13	Feb. 20, 1940	86.07	Aug. 6, 1942	82.61	Mar. 9, 1949	90.54
Apr. 22, 1938	78.87	Mar. 22, 1940	86.74	Dec. 3, 1942	76.70	Apr. 20, 1949	86.05
May 19, 1938	76.83	Apr. 20, 1940	86.94	Apr. 20, 1943	80.67	Aug. 25, 1949	90.20
June 23, 1938	78.16	May 23, 1940	87.46	Sept. 10, 1943	84.11	Oct 10, 1949	89.79
July 20, 1938	80.00	June 21, 1940	86.97	Dec. 21, 1943	84.19	Nov. 8, 1949	87.34
Aug. 25, 1938	80.76	July 25, 1940	86.81	Aug. 24, 1944	83.97	Dec. 7, 1949	87.71
Sept. 28, 1938	82.68	Aug. 28, 1940	88.40	Dec. 19, 1944	81.87	Jan 23, 1950	87.95
Dec. 12, 1938	82.18	Sept. 26, 1940	88.75	May 23, 1945	78.44	Apr. 10, 1950	88.99
Jan. 24, 1939	83.20	Oct. 29, 1940	88.63	July 4, 1945	80.05	Aug. 1, 1950	91.62
Feb. 28, 1939	82.66	Dec. 4, 1940	87.31	Mar, 19, 1946	83.66	Dec. 8, 1960	92.13
Mar. 28, 1939	83.26	Jan. 29, 1941	85.37	July 5, 1947	82.76	Jan. 3, 1951	92.14
Apr. 22, 1939	84.18	Mar. 25, 1941	81.78				

H14. Edward Gerhardt Estate, 12½ miles southwest of New Braunfels; altitude, 967.4

Dote	Water level	Date	Water level	Date	Water level	Date	Water level
Oct. 11, 1933	306.8	May 18, 1945	290.5	July 3, 1947	295.36	Jan. 3, 1951	319.79
May 5, 1945	291.1	July 4, 1945	294.5	Jan. 25, 1950	311.6		

H20. William Shaeffer, 6½ miles southwest of New Braunfels; altitude, 684.45

Dote	Water level	Date	Water level	Date	Water level	Date	Water level
May 24, 1934	34.48	July 3, 1939	38.65	Aug. 7, 1941	30.52	Apr. 24, 1948	40.17
Jan. 7, 1937	28.48	Oct. 5, 1939	38.57	Nov. 14, 1941	30.40	June 25, 1948	42.18
Jan. 21, 1938	30.41	Jan. 30, 1940	37.37	Mar. 6, 1942	31.66	Aug. 6, 1948	43.91
Feb. 2, 1938	29.00	Feb. 20, 1940	37.53	Apr. 9, 1942	32.27	Feb. 11, 1949	43.74
Mar. 30, 1938	29.37	Mar. 22, 1940	38.42	Aug. 7, 1942	33.94	Mar. 9, 1949	42.14
Apr. 22, 1938	29.61	Apr. 26, 1940	38.84	Apr. 20, 1943	31.26	Apr. 20, 1949	41.70
May 19, 1938	27.47	May 23, 1940	38.95	Sept. 10, 1943	34.24	Aug. 25, 1949	40.60
June 23, 1938	29.44	June 21, 1940	38.12	Dec. 21, 1943	35.06	Oct. 10, 1949	41.65
July 20, 1938	30.93	July 25, 1940	38.34	Aug. 24, 1944	35.19	Nov. 8, 1949	38.44
Aug. 25, 1938	33.00	Aug. 28, 1940	40.34	Dec. 19, 1944	31.97	Dec. 7, 1949	39.06
Sept. 28, 1938	32.45	Sept. 24, 1940	40.54	May 23, 1945	28.32	Jan. 23, 1950	39.77
Jan. 24, 1939	33.45	Oct. 29, 1940	39.76	July 4, 1945	30 90	Apr. 10, 1950	40.35
Feb. 28, 1939	34.88	Dec. 4, 1940	38.48	Mar. 19, 1945	32 94	Aug. 1, 1950	44.05
Mar. 28, 1939	34.29	Jan. 29, 1941	36.64	July 5, 1947	33.90	Dec. 8, 1950	44.91
Apr. 23, 1939	35.67	Mar. 25, 1941	31.93	Nov. 22, 1947	36.66	Jan. 3, 1951	45.12
May 26, 1939	36.78	May 23, 1941	27.38				

H22. Ben Jahn, 5½ miles southwest of New Braunfels; altitude, 728.63

Dote	Water level	Date	Water level	Date	Water level	Date	Water level
May 28, 1934	82.86	Aug. 9, 1935	73.63	Jan. 19, 1936	78.21	Jan. 8, 1951	92.22
Oct. 8, 1934	85.24	Nov. 21, 1935	77.14	Dec. 18, 1936	79.61		

H23. O. Penshorn, 5½ miles southwest of New Braunfels; altitude, 694.67

Dote	Water level	Date	Water level	Date	Water level	Date	Water level
May 28, 1934	53.00	Nov. 21, 1935	30.96	Jan. 7, 1937	36.58	July 5, 1947	18.06
Oct. 9, 1934	43.25	Jan. 19, 1936	31.92	July 13, 1945	34.58	Nov. 23, 1947	29.00
Aug. 10, 1935	35.50	Dec. 3, 1936	29.49				

TABLE 20.—*Records of water levels in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
H28. Percy Hansman, 8 miles southwest of New Braunfels; altitude, 786.53							
May 24, 1934	133.93	Dec. 3, 1936	127.36	Jan. 7, 1937	128.88	Jan. 9, 1951	145.12
H31. Lena Binzeil Estate, 13 miles southwest of New Braunfels; altitude, 844.2							
Dec. 17, 1936	174.3	July 4, 1945	170.7	Nov. 23, 1947	182.0	Jan. 25, 1950	191.0
May 5, 1945	174.6	July 3, 1947	170.8	Apr. 23, 1947	185.8	Jan. 5, 1951	194.15
May 18, 1945	165.8						
H34. Paul J. Marbach, 13 miles southwest of New Braunfels; altitude, 804.6							
May 5, 1945	130.6	July 4, 1945	135.3	Nov. 23, 1947	145.1	Jan. 3, 1951	156.70
May 18, 1945	132.0	July 3, 1947	135.12	Apr. 23, 1948	148.99		
H39. Davenport School, 12 miles southwest of New Braunfels; altitude, 851.7. Highest monthly reading from record chart							
Dec. 10, 1948	203.5	July 4, 1949	195.2	Jan. 3, 1950	198.0	July 3, 1950	201.5
Jan. 3, 1949	203.7	Aug. 5, 1949	197.6	Feb. 24, 1950	197.4	Aug. 19, 1950	203.6
Feb. 28, 2949	202.6	Sept. 1, 1949	200.3	Mar. 5, 1950	197.5	Sept. 28, 1950	204.5
Mar. 26, 1949	201.9	Oct. 31, 1949	197.0	Apr. 12, 1950	199.1	Oct. 1, 1950	204.6
Apr. 30, 1949	194.5	Nov. 1, 1949	197.0	May 1, 1950	199.2	Nov. 19, 1950	204.9
May 16, 1949	192.9	Dec. 20, 1949	198.0	June 7, 1950	198.7	Dec. 4, 1950	205.0
June 1, 1949	194.1						
H44. D. N. Barnett, 9 miles southwest of New Braunfels; altitude, 836.5							
Dec. 9, 1937	178.95	Dec. 12, 1938	177.10	Dec. 19, 1939	185.90	Aug. 6, 1948	192.18
Jan. 2, 1938	179.05	Jan. 24, 1939	180.87	Jan. 30, 1940	185.59	Feb. 11, 1949	193.44
Feb. 2, 1938	175.50	Feb. 28, 1939	181.28	May 25, 1940	187.41	Mar. 9, 1949	192.78
Mar. 30, 1938	175.56	Mar. 28, 1939	181.50	June 21, 1940	187.35	Jan. 23, 1950	191.50
Apr. 22, 1938	176.24	Apr. 22, 1939	182.76	Aug. 24, 1944	182.08	Apr. 10, 1950	192.60
May 19, 1938	175.10	May 25, 1939	183.75	May 2, 1945	175.61	Aug. 1, 1950	197.80
June 23, 1938	176.15	July 4, 1939	184.15	June 25, 1948	191.71	Dec. 8, 1950	193.60
July 19, 1938	177.18	Oct. 5, 1939	188.18	July 2, 1948	191.79	Jan. 3, 1951	193.80
Aug. 25, 1938	177.20						

993963—52——7

TABLE 21.—*Records of wells and springs*

[Method of lift: B, bucket; C, cylinder; E, electric; G, gasoline engine; H, hand; T, turbine; W, windmill. Number following letter indicates horsepower. Use of water: D, domestic; Ind., industrial; N, not used; P, public supply. † Water level reported]

Well	Distance (miles) and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
A1	22 NW	T. J. Byler			930		Travis Peak
A2	22½ NW	Fred and Richard Schaeferkoeter.			Spring		Glen Rose limestone, lower member.
A3	22 NW	do	W. Neugebauer	1906	125	6	Travis Peak
A4	21 NW	Otto Schwope	Willie Rust		300		do
A5	do	H. B. Thompson			Spring		do
A6	20½ NW	Frank Porter		1890	226	6	do
A7	19 NW	Hugo Wunderlich		1900	120		do
A8	do	do		1910	142	6	do
A9	18½ NW	J. W. Heard		Old	86	6	Travis Peak (?).
A10	19 NW	Mrs. P. J. Remler estate.	Vogel and Paige	1880	184	6	Travis Peak
A11	22½ NW	Ed Gass		Old	140	6	do
A12	23½ NW	H. C. Plumly			Spring		Glen Rose limestone, lower member.
A13	do	Erich Specht	Ed Adair	1932	412	6	Travis Peak
A14	do	do		1926	75	6	Glen Rose limestone, lower member.
A15	22½ NW	William Neugebauer.		1886	163	6	do
A16	do	Harry Knibbe			Spring		Travis Peak
A17	22 NW	Arno Knibbe		1900	225	6	do
A18	do	do		1885	124	6	do
A19	21½ NW	D. L. Knibbe		Old	120	6	do
A20	do	Alfred Jonas		Old	280	6	do
A21	19 NW	Edwin Elbel		Old	100	6	Glen Rose limestone, lower member.
A22	18 NW	J. K. Baretta		Old	280	6	Travis Peak
A23	17½ NW	J. W. Heard	T. E. Owens		244	6	Glen Rose limestone, lower member.
A24	20½ NW	H. A. Knippe	E. B. Kutscher	1937	200	6	Travis Peak
A25	do	Alfred Gass		1918	175		do
A26	23 NW	William Specht			250	6	do
A27	22½ NW	Erich Specht		Old	200	6	do

in Comal County, Tex.

[Measuring point was usually top of casing, top of pipe clamp, or top of pump base or foundation. All wells are drilled unless noted in remarks column. Numbers in parentheses refer to numbers previously published in waters-supply papers]

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level		Method of lift	Use of water	Remarks
			Below land surface (ft)	Date of measurement			
A1		0.5	154.4	Oct. 3, 1944	None	N	Oil test: upper 300 ft of casing removed. Water from sand at 240–260 ft. Black rock reported at 550–600 ft.
A2					do	D, S	Estimated yield 50 gpm, Sept. 25, 1943.
A3		.5	113.4	Dec. 10, 1936	C, W	D, S	Cased to 20 ft. Yield approximately 1 gpm per foot of draw-down.
A4			†170		C, G		Cylinder set at 280 ft; pump breaks suction in 2 hours when pumped at 5 gpm.
A5					Flows	D, C	Rebecca Creek Spring. Estimated yield 1,500 to 2,000 gpm. Temp., 70 F, Oct. 7, 1943.
A6		1.1	150.8	Dec. 9, 1936	None	N	Water reported from blue clay at 220–226 ft.
A7					C, W	D, S	Cylinder set at 115 ft.
A8					C, W, G	D, S	Cylinder set at 120 ft; has pumped all day at 5 gpm.
A9		2.0	72.8	Sept. 23, 1943	C, W	D, S	Original depth reported 100 ft.
A10		0	94.2	Oct. 8, 1943	C, W	D, S	Estimated yield 5 gpm, cased to 10 ft.
A11		.5	50.3 84.0	Dec. 9, 1936 Sept. 25, 1943	C, W	D, S	Breaks suction easily.
A12					Flows	D, S	Spring Branch Spring. Flows from cavernous limestone. Temp 70 F, Jan. 18, 1943. Volume varies with rainfall. Estimated flow 5,000 gpm Mar. 28, 1945.
A13		.6	177.3	Nov. 20, 1936	C, W	D, S	Cased to about 325 ft. Cylinder set at 250 ft, 20 ft east of well 185.
A14		1.2	63.5 61.5	Nov. 20, 1936 Jan. 18, 1943	C, W	D, S	
A15		.4	45.4	Nov. 20, 1936	C, W	D, S	Some water reported from blue clay at 69 ft.
A16					Flows		Hydraulic ram pumps water to school and nearby houses; water flows from crevice in limestone.
A17		1.1	111.5	Dec. 10, 1936	C, W	D, S	Water has slight sulfur odor.
A18			43		C, W	D, S	
A19		2.2	46.2	Dec. 10, 1936	C, W		
A20		.3	113.5	do	C, W	S	On river terrace; some of the water may come from alluvium.
A21		1.2	60.1 66.3	Dec. 9, 1936 Oct. 8, 1943	C, W	D, S	
A22		.7	197.5	Dec. 9, 1936	C, W2, G	D, S	Estimated yield, 10 gpm. 2 ft of casing.
A23					C, W	S	Casing: 6-in. from 140 to 180 ft.
A24			†100		C, W	D, S	Tested 24 hr at 10 gpm. Water from sand at 196–220 ft; struck dark blue rock at 220 ft.
A25		0	58.1	Nov. 20, 1936	C, W	D, S	
A26		2.6	58.0	do	C, W	D, S	Cased to bottom. Water from sandstone at 240–245 ft. Originally 70 ft; failed in 1891. Deepened to 250 ft in 1933.
A27		.5	157.3	do	C, W	D, S	

TABLE 21.—*Records of wells and springs*

Well	Distance (miles) and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
A28	24 NW	Weidner			Spring	6	Travis Peak
A29	21 NW	William Gast		Old	115	6	
A30	20½ NW	Alvin Gass		Old	78	6	
A31	19½ NW	Ed Bartels		1886	80	6	
A32 (120)	do	Albert Marek		1935	380	6	Travis Peak
A33 (117)	18½ NW	Alfred Bierle		1928	157	6	do
A34 (118)	do	A. B. Cavender		1901	108	6	Glen Rose limestone, lower member.
A35 (119)	18 NW	Mrs. John Stricker		Old	200	6	Travis Peak
A36	16 NW	Julius Bremer		1906	185	6	Glen Rose limestone, lower member.
B1	24½ NW	Adolph Preiss	Willie Fisher	Old	121		do
B2	23 NW	C. L. Meserole			220	6	do
B3	do	do			5	60	do
B4	do	do		Old	217	6	do
B5	do	do		1940	226	6	Travis Peak (?)
B6	do	Eddie Pape		Old	89		Glen Rose limestone, lower member.
B7	21/NW	W. O. Fischer	W. O. Fischer	1922	218	6	do
B8	20 NW	H. Pantermuehl		Old	275	6	do
B9	do	Paul Schlameus		Old	253	6	do
B10	20½ NW	R. O. Fischer			Spring	48	do
B11	do	Emil Doell	Emil Doell	1895	300	6	do
B12	do	H. Fischer	H. Fischer	Old	327	6	Travis Peak (?)
B13	20 NW	E. Kaderli	E. Kaderli	1914	265	6	do
B14	20½ NW	Williard Hill			410		Travis Peak
B15	19 NW	H. C. Nelson		Old	325	6	Glen Rose limestone, lower member.
B16	do	Otto Treuer	R. Page	Old	350	6	do
B17	do	do			Spring		do
B18	do	Hugo Halm		Old	49	6	do
B19	18½ NW	John A. Schlameus		Old	220	6	do
B20	18 NW	W. H. Stanley		Old	385	6	do
B21	17½ NW	do		Old	320	6	do
B22	16½ NW	Tom Summers		Old	325	6	do
B23	do	do	— Williams	1941		6	do
B24	18 NW	Carrol Hall			Spring		do
B25	do	do	R. Page	Old	240	6	do

in Comal County, Tex.—Continued

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
A28					Flows	S	Estimated flow 1,000 to 1,500 gpm from cavern 6-8 ft above creek level. Temp. 69 F, July 20, 1944. Honey Creek Spring.
A29		0.6	106.5	Nov. 27, 1936	C, W	D, S	Yield reported small.
A30		0	67.4	Dec. 6, 1943	C, W	D, S	Auxiliary electric motor, ⅓ hp.
A31		.8	65.8	Dec. 10, 1936	C, W	D, S	
A32 (120)	1,029.3	.8	74.0	Nov. 16, 1936	C, W	D, S	Water level, table 20. Water reported from honeycomb limestone at 330-380 ft.
A33 (117)	1,006.6	0	119.1	Nov. 20, 1936	C, W	D, S	Water from sandstone at 150-157 ft. Water levels, table 20.
A34 (118)	1,015.9	.5	93.0	Jan. 26, 1937	C, W	D, S	Cased to 20 ft. Water levels, table 20.
A35 (119)	1,031.7	.2	166.7	Nov. 19, 1936	C, W	D, S	Water levels, table 20.
A36		0	85.0	Nov. 25, 1936	C, G1½	D, S	
B1			† 110		C, W	D, S	
B2			† 200		C, W	S	Steel casing to 10 ft.
B3				Nov. 13, 1936	Flows	N	Dug well in bottom of creek, rock curb, seepage water only.
B4		0	155.7	do	C, W	S	Concrete curb and 10 ft steel casing at top. Water level measured while pumping. Continued pumping lowers water to level below suction pipe.
B5			† 125	Sept. 4, 1944	C, G	D, S	Temp 71 F, has been pumped for 60 hr at 4 gpm.
B6		1.0	67	Oct. 7, 1944	C, W	D, S	
B7		0	175	Dec. 31, 1936	C, E 1½	D, S	Steel casing to 15 ft.
B8		.6	155.6	Nov. 4, 1936	C, W	D, S	
B9			† 85		C, W	D, S	
B10				Nov. 4, 1936	C, W, flows	D, S	Estimated flow Nov. 4, 1936, 60 gpm. Water level about 5 ft below land surface Sept. 13, 1943.
B11			† 160		C, W	D, S	Steel casing to 10 ft.
B12			123.5	Nov. 4, 1936	C, G 3	D, S	Measuring point 0.7 ft below land surface. Steel casing to 20 ft. Deepened from 250 ft to 327 ft in 1908. Water from sandstone at 250 ft and from sand at 320-327 ft.
B13		.7	36.1	Nov. 13, 1936	C, W	D, S	Concrete curb.
B14					C, W	S	
B15		0			C, W	D, S	Increase in yield obtained in 1942 by deepening from 300 to 325 ft.
B16		0	144.1	Dec. 4, 1936	C, W	D, S	
B17				Dec. 21, 1930	Flows	D	Estimated flow, 75 gpm from 3 openings in limestone Dec. 31, 1936.
B18			† 16		C, W	D, S	
B19		.9	47.1	Dec. 3, 1936	C, H	D, S	Steel casing to 30 ft.
B20		1.0	139.4 154.5	Dec. 31, 1936 Sept. 18, 1944	C, W	D, S	
B21		.2	121.9	Sept. 18, 1944	C, W	D, S	
B22		.4	171	Dec. 8, 1936	C, W	S	
B23			† 190	Oct. 30, 1944	C, W, G		Sands at 311 ft and 328-360 ft.
B24				Nov. 4, 1936	Flows	S	Estimated flow 20 gpm on Nov. 4, 1936. Reported to flow about 6 months each year; dry on Sept. 17, 1943.
B25		.8	44.9	do	C, W	D, S	Steel casing to 22 ft. Water sands reported at 80 and 240 ft.

TABLE 21.—*Records of wells and springs*

Well	Distance (miles) and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
B26	17½ NW	D. C. McIver			Spring		Glen Rose limestone, lower member.
B27	19 NW	W. D. Hill	Tom Adare		140	6	Travis Peak
B28	18½ NW	Ed Kaderli	Jesse Page	1903	112	6	do
B29	17 NW	J. D. Nixon			Spring		Glen Rose limestone, lower member.
B30	15½ NW	Frank Gunther		1915	169	6	do
B31	16 NW	Mrs. T. P. Shelly	T. E. Owens		350		do
B32	15 NW	D. R. Semmes			Spring		Glen Rose limestone, upper member.
B33	do	do		Old	110	6	do
B34	14½ NW	Max Linartz		1902	228	6	Glen Rose limestone, lower member.
B35	15 NW	State of Texas			Spring		do
B36	do	do			Spring		do
B37	16½ NW	M. Engle		Old	96		do
B38	17½ NW	Ben F. Welle		Old	120		do
B39	16½ NW	A. J. Monier	E. B. Kutscher	1943	297		do
B40	do	do		Old	240	6	do
B41	do	do		Old	20	36	do
B42	16 NW	do		Old	50	24	do
B43	15½ NW	Mrs. D. N. Riegler		1906	260	6	do
B44	14 NW	J. M. Block		1902	175	6	do
B45	13 NW	Miss Elsie Leuhlfing.	Willis Fischer	1898	102		do
B46	12½ NW	Henry Pantermuehl.		Old	300	6	Travis Peak
B47	11½ NW	Theo. Kraft		1896	428	6	do
B48	do	Otto Krause	Frank Guntner	1929	221	6	Glen Rose limestone lower member.
B49	do		Corps of Engineers, U. S. Army.	1949			do
B50	do	O. C. Trout	Frank Gunther	1923	109		do
B51	14 NW	H. W. Kraft Estate		Old	69		do
B52	do	do		Old	Spring		do
B53	11 NW	M. Leaghling			Spring		Walnut clay
B54	do	E. S. Schroeder		1900	60	6	Glen Rose limestone, upper member.
C1	14 NW	George Faber		Old	250	6	do
C2	do	H. E. Nessly		Old	101		do
C3	13½ NW	do	E. B. Kutscher	1944	154		Glen Rose limestone, lower member(?).
C4	13 NW	do	— Schmidt	1944	101	5	Glen Rose limestone, upper member.
C5	do	George Faber	E. B. Kutscher	1941	455	6	do
C6	12 N	C. B. Crawford		Old	290		Edwards limestone.

in Comal County, Tex.—Continued

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
B26					Flows	S	Water flows from crevices in limestone at fault. Reported dry in 1925. Temp 64 F, Nov. 10, 1944.
B27		0.6	64.1	Dec. 9, 1936	C, W	D, S	Water level recovered 5 ft in 15 min. after pumping 3½ gpm for 3 hr.
B28		.1	55.4	do	C, W	D, S	Galvanized 6-in. casing to 40 ft.
B29				Nov. 13, 1936	Flows	D, S	Big Spring; also called Bishop Spring, Gumtree Spring, and Flugrath Spring. Measured flow, 1,750 gpm, Jan. 18, 1938.
B30		.8	87.2	Nov. 4, 1936	C, W	D, S	
B31			† 162		C, W½, G	D, S	
B32						S	Small perennial spring. Seasonal fluctuation.
B33		2.1	11.3	Dec. 31, 1936	C, W	D, S	
B34		.6	128.2	Nov. 3, 1936	C, W	D, S	
B35					Flows		
B36					do		From crevices in river bottom. Combined flow of B35 and B36 on Sept. 18, 1944, 14 cfs or about 6,300 gpm.
B37		1.3	40.9	Nov. 13, 1936	C, W	D, S	
B38			(†)		C, W	D, S	Pump breaks suction in ½ hour of hard pumping.
B39			260		C, W	D, S	Water reported from blue rock at 287 ft. Log.
B40			† 190	Dec. 15, 1936	None	N	Cased to 10 ft.
B41		3.0	4.7	Dec. 15, 1936	do	N	Dug.
B42		.3	2.1	do	B, H	D, S	Do.
B43		1.0	78.7	Nov. 13, 1936	C, W	D, S	
B44		.4	41.0	Dec. 31, 1936	C, W	D, S	Cased to 8 ft.
B45			† 57		C, W	D, S	
B46		.5	32.3	Nov. 4, 1936	C, W	D, S	Estimated capacity 2 gpm.
B47		.6	38.8 36.4	Nov. 3, 1936 Nov. 11, 1944	C, W	D, S	Deepened to present depth in 1905. Fine sand at 420 to 428 ft. Some water at 80 ft.
B48					Flows	D, S	Irrigates small garden. Flows about 3 gpm from 4-in. pipe about 3 ft above land surface Sept. 29, 1944.
B49	1,009.0				None	N	Core test well; 3-in. casing to 16 ft. Log.
B50			†78		C, W	D, S	
B51			55.8	Feb. 3, 1944	C, W	S	
B52		1.7		Nov. 13, 1936	Flows	D, S	One of a number of small springs along Tom Creek. Many cypress trees in ½ mile stretch upstream from this spring.
B53				do	do	S	Small contact spring.
B54			†55		C, W½, G	D, S	
C1					C, W	D, S	Some water at 21 ft.
C2			†40		C, W	S	Cylinder set at 70 ft. Yield reported small
C3		.7	41.0	Dec. 8, 1944	C, W	S	First water at 83 ft. Water from "shell rock" at 150 ft.
C4		1.0	15.9	Nov. 9, 1944	C, W	D, S	
C5		0	298.3	May 19, 1945	C, W	D, S	Some water at top of Walnut clay. Log.
C6		.5	232.5	Dec. 14, 1944	C, W	D, S	Well probably penetrates part of upper Glen Rose limestone.

TABLE 21.—*Records of wells and springs*

Well	Distance (miles) and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
C7	11½ N	C. B. Crawford		Old	256	6	Glen Rose limestone, upper member.
C8	do	Miss Carrie George		1890	100		Glen Rose limestone lower member.
C9	11 N	V. and C. D. Prassel		Old	170	6	Glen Rose limestone, upper member.
C10	do	do		Old	200		do
C11	10½ NE	Udo Haarman and R. Wright.	E. B. Kutscher		440	6	Edwards limestone (?).
C12	11½ NE	R. Wegner		1890	380	4	Edwards limestone.
C13	11 NE	R. R. Williams	E. B. Kutscher	1943	422	6	do
C14	9½ NE	Udo Haarman and R. Wright.		Old	640	6	do
D1	25 NW	E. A. Moos		1922	96	6	Glen Rose limestone, lower member.
D2	24 NW	Eugene Scheel	Schwartz and Nickols.	1898	280	6	do
D3	22½ NW	Lauback Bros	Oscar Dietz	1914	650	6	Travis Peak
D4	do	Herman Laubach	— Dietz	1930	750		do
D5	24 NW	E. A. Laubach		Old	350	6	Glen Rose limestone, lower member.
D6	do	do		Old	25	36	do
D7	24 W	Mrs. Chas. Erben	— Brown	1895	235	6	do
D8	25 W	George Bros		1885	216	6	do
D9	25½ NW	F. Neugebauer		1885	300	6	do
D10	26 W	Joseph Offer			200		do
D11	28½ W	Mrs. Emma Sauer		Old	218	6	do
D12	31 W	Ralph Fair			240		do
D13	29½ W	G. S. McFarland		Old	300	6	do
D14	28½ W	Bruno Klar		1860	25	36	do
D15	25½ W	Mrs. C. L. Ellsworth		Old	217		do
D16	23½ W	Aug. Scholz Estate	R. Schwartz	1906	265	6	do
D17 (98)	23 W	Vincent Laubach			300		do
D18	23½ W	Aug. Scholz Estate		1906	236	6	do
E1	21½ NW	Alfred Wehe	A. Brown	1901	350		Travis Peak
E2	19 NW	Ed Kuebel		1916	210	6	Glen Rose limestone, lower member.
E3	16½ NW	Joe E. Sheldon		Old	450	6	Travis Peak
E4	do	Joe S. Sheldon	E. B. Kutscher	1943	344	5	Glen Rose limestone, lower member.
E5	14½ NW	A. J. Walser		Old	475	6	do
E6	do	do			85	6	Glen Rose limestone, upper member.
E7	15 NW	Joe E. Sheldon			350	6	do

in Comal County, Tex.—Continued

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
C7		0.5	119.5	Dec. 4, 1944	C, W	S	
C8		1.5			C, H	D, S	Water level one-half foot above land surface Dec. 8, 1944.
C9		.4	67.5	Nov. 3, 1936	C, W5, G	D, S	Estimated capacity 3 gpm.
C10		2.0	192.0	do	C, W	S	
C11					C, W	S	Circle Dot Ranch No. 2; probably drilled into Glen Rose limestone. Bottom of suction pipe set at 400 ft.
C12	942.5	13.3	337.8	Mar. 11, 1943	None	N	
C13					C, W	S	Well penetrates upper part of Glen Rose limestone. Water level approximately 370 ft below surface Dec. 1, 1943. Estimated yield 3 gpm. Log.
C14					C, W	D, S	Circle Dot Ranch No.1 headquarters well. Probably be drilled into Glen Rose limestone.
D1	1,403.2	.7	53.4 52.0 54.0	Dec. 7, 1936 May 16, 1945 July 12, 1945	C, W	D, S	
D2		.6	133.9	Dec. 7, 1936	C, W2, G	D, S	
D3	1,411.6	1.0	320.2 374.4	Dec. 7, 1936 Jan. 25, 1950	C, W	D, S	Cased to 60 ft. Not enough water at 400 ft; deepened to 650 ft in 1930.
D4	1,413.4	.6	243.6 95.2 95.2 89.5	Nov. 30, 1936 May 19, 1945 May 24, 1945 Jan. 25, 1950	C, W	D, S	Water level reported 150 ft below land surface when drilled. Cylinder lowered several times. Water reported from blue clay at 680–700 ft.
D5			†250		C, W	D, S	
D6		2.9	6.4		C, W	S	Dug.
D7			†220		C, W	D, S	
D8			†180		C, G	D, S	Well has been pumped 10 hrs at 7 gpm with tractor.
D9		1.0	135.5	Dec. 7, 1936	C, W	D, S	
D10		0	125.6	Dec. 23, 1936	C, W	D, S	
D11		.3	210.1	do	C, W	D, S	Cased to 6 ft.
D12			†100		C, W	D, S	No indication of exhaustion after being pumped 18 hrs with power pump having 2¾-in. cylinder and 12-in. stroke.
D13		0	124.6	Dec. 23, 1936	C, W	D, S	Cased to 10 ft.
D14		1.0	13.7	do	C, W	D, S	Well flows in wet seasons.
D15			187.3	do	C, G3	D, S	
D16		.4	209.3	Nov. 30, 1936	C, W	S	
D17 (98)	1,264.3	1.0	188.7	May 11, 1945	C, W	D, S	Water levels, table 20.
D18		.2	216.0	Nov. 30, 1936	C, W	D, S	Cased to 5 ft.
E1			†315		C, W	D, S	
E2		.9	168.0	Nov. 16, 1936	C, W	D, S	
E3		.3	278.1	Nov. 2, 1936	C, W2, G	D, S	Drawdown 8 ft when pumped at 2 gpm.
E4		1.0	317.1	Sept. 23, 1943	C, W	D, S	Seep at 60 ft; main water-bearing sand at 338–344 ft. Cased to 60 ft.
E5	1,303.1	.5	236.3 234.3 239.7	Nov. 2, 1936 May 17, 1945 July 12, 1945	C, W	D, S	
E6		.3	14.3	Nov. 2, 1945	C, W	D, S	
E7		3.0	258.6	Nov. 25, 1936	C, W	S	

TABLE 21.—*Records of wells and springs*

Well	Distance (miles) and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
E8	16½ NW	R. P. Holt		Old	620	6	Glen Rose limestone, lower member.
E9 (131)	19 NW	J. H. Pyke		Old	300	6	do
E10 (155)	do	Roy Akers		Old	185	6	do
E11	19½ NW	J. A. Laubach		Old	25	36	do
E12	do	do		1896	60	6	do
E13	20 NW	O. Wehe		Old	350		do
E14	21½ NW	L. A. Allen		Old	480		do
E15	23 NW	Alex P. Scheel		1913	350		do
E16	do	T. R. Darst		Old	225		Glen Rose limestone, upper member.
E17	22 NW	Alfred H. Scheel		1897	305		do
E18	21½ NW	Aug. Scheel		1870	15	36	Glen Rose limestone, lower member.
E19	do	do		1892	318		do
E20	21 NW	Henry Wehe	A. Scheel				
E21	20 NW	O. Wehe		Old	110		do
E22	19½ NW	V. F. Moos		Old	320		do
E23	19 NW	Herman Kneupper		Old	320	6	do
E24	18½ NW	Mrs. Mattie Shelburne.		1935	248		do
E25	do	H. A. Bagby		1941		6	do
E26	18 NW	Alex Licata		Old	360	6	do
E27	14 NW	O. A. Doeppenschmidt		Old	446		do
E28	14½ NW	Ed Adam		Old	24	36	Glen Rose limestone, upper member.
E29	do	do		1885	600	6	Glen Rose limestone, lower member.
E30	15 NW	W. E. Green		Old	635	6	do
E31	do	Milton X. Jones			437	6	do
E32	16½ NW	G. W. Kurz		Old	348	6	do
E33	20½ NW	Edgar Bremer		1890	100	6	do
E34	21½ NW	Mrs. M. K. Hohman.		1996	315	6	do
E35	22½ NW	Paul Kurz		Old	300	6	do
E36	21½ NW	Mrs. M. K. Hohman.			Spring		do
E37	21 NW	do		Old	30	6	do
E38	17½ NW	Arthur Hitzfelder		1890	414	6	do
E39	16½ NW	Benno Bose		1892	348	6	do
E40	13½ NW	Walter Schaeffer			816	6	Travis Peak
E41	15½ NW	Clemens Scholz		Old	245	6	Glen Rose limestone, upper member.

in Comal County, Tex.—Continued

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
E8					C, W	D, S	Water level reported more than 300 ft below land surface.
E9 (131)	1,204.5	1.0	116.8	Nov. 16, 1936	C, W1¼, G	D, S	Water levels, table 20.
E10 (155)	1,241.4	.7	83.0	Dec. 10, 1936	C, W	D, S	Do.
E11		1.3	8.3	Nov. 27, 1936	C, H	N	
E12		0	33.4	do	C, W	D, S	
E13	1,261.2	1.0	277.4 302.8	May 17, 1945 July 12, 1945	C, W	D, S	
E14	1,298.5	1.0	248.0 312.5 322.1	Nov. 21, 1936 May 3, 1945 July 5, 1945	C, W2, G	D, S	
E15					C, W	D, S	Water level reported more than 300 ft below land surface.
E16		.5	138.6	May 16, 1945	C, W	D, S	
E17	1,247.5	0	123.0 98.7	May 17, 1945 July 12, 1945	None	N	
E18		2.0	7.0		C, W	N	Dug.
E19	1,256.4	.7	262.8 241.9 269.3	Dec. 7, 1936 May 18, 1945 July 12, 1945	C, W1½, G	D, S	
E20	1,189.1	.5	178.7 220.8	May 31, 1945 July 5, 1945	C, W	D, S	
E21	1,249.6	.4	67.4 69.8 70.4	Nov. 29, 1936 May 17, 1945 July 12, 1945	C, W	S	
E22		.2	262.1	Nov. 27, 1936	C, W	D, S	
E23	1,206.5	1.0	223.7 245.7	May 17, 1945 July 5, 1945	C, W	D, S	
E24	1,156.9	.4	228.5	Nov. 16, 1936	None	N	Water levels, table 20
E25	1,145.8	1.0	68.3 68.8 68.9	May 17, 1945 July 5, 1945 July 12, 1945	C, H	D, S	
E26			†240		C, W	S	
E27	1,247.9		288.4	May 31, 1945	C, E	D, S	Deepened from 383 ft to 446 ft in 1944, by E. B. Kutscher. Yield was increased.
E28		0	9.0	Dec. 11, 1936	C, H	S	Dug. Overflows during wet season.
E29					C, W4, G	D, S	Water level more than 300 ft below surface Dec. 11, 1936.
E30					C, W	D, S	
E31	1,121.3	1.2	259.8 300.5	May 26, 1945 July 11, 1945	C, G	D, S	Recovered 3.8 ft in 5 min after pumping ½ hour at 3 gpm.
E32			†311		C, W3, G	D, S	Water from gray sandstone at 338-348 ft. Cased to 20 ft.
E33		.6	85.3	Nov. 21, 1936	C, W1½, G	D, S	Cased to 10 ft.
E34		.5	247.1	Nov. 30, 1936	C, W7, G	D, S	
E35		.5	264.1	do	C, W	D, S	
E36					Flows	D	Estimated flow 40-50 gpm, Feb. 22, 1945.
E37		.8	10.8	Nov. 30, 1936	None	N	
E38		.7	298.4	Dec. 15, 1936	C, G	D, S	Tractor used for pumping.
E39			†320		C, W	D, S	Pump equipped with jack for use with tractor. Water from gray sandstone at 300-320 ft.
E40					C, W	D, S	Cylinder set at about 700 ft. Water level more than 470 ft below surface Jan. 22, 1945.
E41			227.3	Dec. 11, 1936	C, W	D, S	

TABLE 21.—*Records of wells and springs*

Well	Distance (miles) and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
E42	17 NW	Elmer Kleck			450	6	Glen Rose limestone, lower member.
E43	17½ W	Mrs. Anita Lux			320	6	do
E44 (183)	20 W	Aug. Wehe	— Vogues	Old	375	6	do
E45	21 W	August Klar	Fritz Rust	1918	385		do
E46	do	Philip Lux		1924	348	6	do
E47	22 W	W. O. Stahl		Old	308	6	do
E48	20½ W	Mrs. William Scholz		1896	360	6	do
E49	20 W	Aug. Scholz		1896	336	6	do
E50 (184)	18 W	Charles Willig		1914	371	6	do
E51	16½ W	Adolph Kappelmann.			444	6	do
E52	16 W	Adam Meyer Estate		Old	90	6	Glen Rose limestone, upper member.
E53	13½ NW	Richard Hitzfelder		1935	630	6	Glen Rose limestone, lower member.
E54	14½ W	Otto Hitzfelder			Spring		do
E55	do	do		Old	15	36	do
E56	do	do	— Scharwtz	1900	381	6	do
E57	13½ W	— Tian			Spring		do
E58	do	W. B. Ethridge			200+	6	do
E59	13 W	Ed Reeh		Old	325		Edwards limestone.
F1	9 NW		Corps of Engineers, U. S. Army.	1948	230	7-2	do
F2	14½ NW	A. J. Walser	San Antonio Machine & Supply Co.	1941	450	6	Glen Rose limestone, lower member.
F3	13½ NW	do	R. (Bob) Johnson	1937	747	6	Travis Peak
F4	9½ NW	H. Conrads			Spring		Edwards limestone.
F5	9 NW	Bear Creek Ranch Association.			Spring		Glen Rose limestone, upper member.
F6	8½ NW	Fred R. Loth	E. B. Kutscher	1944	297		do
F7	11 NW	H. Conrads		Old	180		do
F8	12 NW	O. A. Doeppenschmidt.		Old		6	do
F9	13½ NW	do		Old	615	6	Glen Rose limestone, lower member.
F10	do	do		Old	80	8	Glen Rose limestone, upper member.
F11	do	B. Stapper		1882	480	6	do
F12	11 NW	H. Conrads					
F13	10 NW	Henry Rompel	E. B. Kutscher	1939	240	6	Glen Rose limestone, upper member.

in Comal County, Tex.—Continued

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
E42			†250+		C, W	D, S	Cased to 50 ft.
E43			†280		C, W	D, S	
E44 (183)	1,096.2	0.2	217.8	Nov. 12, 1936	C, W	D, S	Cased to 40 ft. Water levels, table 20.
E45	1,143.4	1.0	107.7 112.8 128.1	May 4, 1945 May 18, 1945 July 5, 1945	C, W	D, S	Heavy pumping breaks suction.
E46			141.4	Nov. 27, 1936	C, W4, G	D, S	Cased to 10 ft.
E47		.4	88.1	do	C, W, G	D, S	Draw-down more than 200 ft at 8 gpm.
E48			†250		C, W	D, S	
E49			†300		C, W1½, G	D, S	Yellow sand reported at 334–336 ft. Cased to 16 ft.
E50 (184)	1,052.4	1.0	213.1	Nov. 12, 1936	C, W	D, S	Cased to 60 ft. Water levels, table 20.
E51	1,015.3	.8	61.4 94.1 147.9 250.9	May 4, 1945 May 18, 1945 July 11, 1945 Jan. 25, 1950	C, W	D, S	
E52		.3	48.9	Nov. 12, 1936	C, W	D, S	
E53			†530		C, W	S	
E54					Flows	S	Seep spring. Maximum flow reported 60 gpm.
E55		.7	10.2	Nov. 12, 1936	C, W	D, S	Dug; 12 ft of caliche reported at surface underlain by limestone.
E56			†160		C, W	D, S	Cased to 10 ft. Water reported from sand at 373–375 ft.
E57					Flows	S	Small fault spring in bottom of Cibolo Creek.
E58	955.9	.2	153.7	Nov. 12, 1936	C, G	D, S	Water levels, table 20.
E59	962.1	.0	156.6 250.3 266.9	Dec. 1, 1936 May 18, 1945 Jan. 16, 1951	None	N	
F1	864.7	1.0	18.3	Nov. 4, 1948	do	N	Core test for dam site. Log.
F2		.1	289.9	May 25, 1945	C, W	S	Casing: 7-in. to 25 ft.
F3		.1	401.0	do	C, W	S	Log.
F4					Flows	D, S	Measured flow 1½ gpm, Nov. 5, 1936; 20 ft above bed of Bear Creek.
F5					do	S	Estimated flow 200 gpm, Sept. 29, 1943; 2,000–2,500 gpm, Mar. 28, 1945. Fault spring.
F6			†60		C, W	D, S	Estimated yield 500 gal. a day; bottom of suction pipe set 285 ft.
F7			†100		C, W	S	
F8			24.4	Nov. 2, 1936	C, W	D, S	
F9					C, W	D, S	Water level reported more than 300 ft below land surface.
F10			46.4	Nov. 2, 1936	B		
F11					C, W	D, S	Water level more than 300 ft below surface, Nov. 2, 1936.
F12	1,231.0	1.0	227.0	May 31, 1945	C, W	S	Water level rose 6.35 ft in 15 min after windmill was turned off.
F13			†210		C, W	S	Driller reports Edwards limestone to 103 ft. Only enough water in Edwards for drilling. Yield reported 2 gpm from sand at 228–240 ft. Log.

TABLE 21.—*Records of wells and springs*

Well	Distance (miles) and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
F14	6 NW	H. D. Stronberg			Spring		Edwards limestone.
F15	do	Alwin Jahns		1906	300	6	do
F16	8½ NW	Oscar C. Brehmer	E. B. Kutscher	1946	601	6	Glen Rose limestone, upper member.
F17	do	E. Herbst		Old	425	6	do
F18 (195)	10 NW	Robert Heimer		1926	178	6	do
F19	do	Adolph Henne	— Williams	1943	302	6	do
F20	11 NW	H. Conrads		1937	208		do
F21	12½ NW	do		1933	240	6	do
F22	do	— Tian	Ed Schmidt	1934	630	6	Glen Rose limestone, lower member.
F23	8 NW	E. J. Heiridck		Old	350	6	Glen Rose limestone, upper member.
F24	6 NW	Paul Dietz		Old	300	6	Edwards limestone.
F25	5½ NW	Jerome Schumann	Alex Fabian	1915	365	6	do
F26 (283)	4½ NW	F. D. Hutcheson		Old	251	6	do
F27	4 NW	Henry Heise		1923	290	6	do
F28	4¼ NW	Herman Borchers		Old	300	6	do
F29 (390)	6 NW	Henry Rahe				6	do
F30	do	B. Borchers		1902	402		do
F31	6½ NW	E. J. Heidrick	E. B. Kutscher	1938	405	6	do
F32	do	do	R. Johnson	1937	1,867		
F33	7½ NW	H. W. Dietz	Frank Hillert	1926	314	6	Edwards limestone.
F34 (385)	do	do	Doehne Bros	1900	306	6	do
F35	11 W	A. Kabelmacher			475	6	Glen Rose limestone, upper member.
F36	12 W	William Zeucher		1922	535	6	do
F37	10 W	Melvin Westerfer	E. B. Kutscher	1945	507	5	Glen Rose limestone, lower member.
F38 (210)	9 W	Paul Tonne		1929	320		Edwards limestone.
F39	8½ W	Otto Ohlrich		Old	265	6	do
F40	do	do		1897	350	6	do
F41 (232)	6 NW	Kreuger Bros		Old	250	6	do
F42	4¾ NW	Gus Vogel		1915	325	6	do
F43	4½ NW	Hilmar Doehne		Old	265	6	Edwards limestone (?).
F44	3½ NW	Walter Kappelma-Chev		1932	242	8	Edwards limestone.
F45	3 NW	Ed Dischinger	Frank Hillert	1925	305	6	do
F46	4 W	Ed C. Heidrich	do	1922	340	8	do
F47	4½ NW	Edward Nowotny		Old	325	6	do
F48	5 NW	Hilmar Staats		1895	450	6	do
F49 (233)	7½ W	Richard Gesche		1902	313	6	do
F50 (254)	do	Henry Ludwig	—Schumann	1934	375	6	do

in Comal County, Tex.—Continued

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level		Method of lift	Use of water	Remarks
			Below land surface (ft)	Date of measurement			
F14					Flows	N	Yield estimated 1 gpm, Nov. 5, 1936.
F15		0.7	272.3	Jan. 18, 1936	C, W	D, S	
F16		.5	†275		C, W	D, S	Reported yield 15 gpm from sand at 585-601 ft. Walnut clay reported at 365 ft.
F17	1,166.4		256.3	May 24, 1945	C, W	D, S	Edwards limestone at sur ace. Cylinder set at 350 ft.
F18	1,090.3	.7	49.3	July 5, 1945	C, W 1¾, G.	D, S	Water levels, table 20.
F19	1,085.8	.7	51.3 55.7 54.7	Sept. 21, 1943 May 19, 1945 Jan. 4, 1951	C, E2	D	
F20	1,174.1	.6	139.1	Jan. 29, 1940	C, W	S	Well may be drawing also from Edwards limestone. Water levels, table 20.
F21					C, G6	D, S	Water level more than 300 ft below surface Nov. 2, 1936.
F22					C, W	S	
23	998.2	.5	244.0 254.1 255.9	Apr. 28, 1945 May 19, 1945 July 4, 1945	C, W	D, S	
F24		.2	251.5	Nov. 15, 1936	C, W	D, S	
F25			†285		C, W 3, G		Cased to 10 ft.
F26 (283)	849.2	.8	229.9	Dec. 21, 1945	C, W	D, S	Water levels, table 20.
F27	878.6	.5	295.2	Dec. 21, 1936	C, W	D, S	Do.
F28		.5	248.8	July 6, 1945	C, G3	D, S	
F29 (390)	966.4	.5	274.6	Apr. 13, 1945	C, G2	S	Do.
F30			†332		C, W1½, G.	D, S	
F31	1,005.2	.5	302.4 303.0	May 19, 1945 July 4, 1945	C, W	S	Reported yield 20 gpm.
F32					None	N	Large supply of water reported at 800-1,000 ft. Log.
F33	998.8	.5	289.0 289.0 291.6	Apr. 27, 1945 May 19, 1945 July 4, 1945	C, W	D, S	
F34 (385)	968.1	0	268.0	Apr. 27, 1945	None	N	Water levels, table 20.
F35			†400		C, G2	D, S	Tested 24 hr at 6 gpm.
F36			†121		C, W4, G	D, S	Cased to 6 ft.
F37	964.1	.5	239.5 282.9	May 4, 1945 July 11, 1945	C, W	S	Deepened from 360 to 507 ft in 1945. Increase in yield.
F38 (210)	954.1	.5	255.6	Nov. 9, 1936	C, W	D, S	Water levels, table 20.
F39			†250	do	C, W, G4	D, S	
F40		.7	195.7	do	C, W1½, G.	D, S	
F41 (232)	941.8	.4	188.7	Jan. 25, 1937	None	N	Do.
F42					C, W	D, S	Caves reported at 80 ft and 120 ft.
F43	894.2	.5	214.1 241.2	May 23, 1945 July 3, 1945	C, W	D, S	
F44	861.7	.8	223.9	May 1, 1944	C, E	D	See figures 4 and 5, and table of water-level measurements.
F45			†293		C, G2	D, S	
F46			†328		C, W	D, S	Reported that water supply encountered near the surface was lost at 200 ft. Deepened from 335 ft to 340 ft in 1941. Cased to 150 ft.
F47			†300		C, W, G6	D, S	
F48			†300		C, G3	D, S	Cased to 130 ft.
F49 (233)	916.55	1.0	259.9	Dec. 16, 1936	C, W	D, S	Water levels, table 20.
F50 (254)	920.9	.5	221.5	Apr. 13, 1945	C, W2, G	D, S	Casing to 220 ft. Waters levels, table 20. Log.

TABLE 21.—*Records of wells and springs*

Well	Distance (miles) and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
F51	10 W	Eugene Kaub			320	6	Edwards limestone.
F52 (95)	11½ W	Charles Wuest	Henry Schwab	1911	320	6½	do
F53	12 W	Ed Reeh			400		do
F54	9 W	—Kopplin		Old		36	
F55	8 W	Herman Vogel	Emil Fey	1916	300	6	Edwards limestone.
F56	do	Herbert Kruesler		1900	300	6	do
F57	7½ W	Rubin Moeller		1919	330	6	do
F58	6 W	Mrs. William Hillert.		1915	390	6	do
F59	do	R. J. Houg		1865	50	36	do
F60	do	do		1906	420		do
F61 (261)	5 W	O. C. Brehmer		1898	304	6	do
F62	3½ W	R. R. Coreth			275	6	do
F63	3¼ SW	U. S. Gypsum Co.		1925	125		do
F64 (383)	4 SW	Charles Mergele	Edmund Wehe		611	5	do
F65	do	W. E. F. Eilers		Old	240	6	do
F66	4¼ SW	Harry Dover			300		do
F67	5 SW	William Fey	P. Schumann	Old	89	6	
F68 (251)	7 SW	Schaeffer Bros		Old	255	6	Edwards limestone.
F69	9½ SW	Herman Tonne		1901	295	6	do
F70 (237)	do	Eugene Krause			288	6	do
F71	11½ SW	Louis Forsage	Herman Moos	1907	363	6	do
F72	2½ SW	—Triesch		1950	150	6	do
F73	7½ SW	Harrison Ranch				6	do
F74	2¾ SW	— Simon		Old		6	do
G1	9 NE	Jesse Posey		Old	280	6	do
G2	8½ N	E. T. Lackey		1911	500	6	do
G3	9 N	Alfred Pantermuhl	E. B. Kutscher	1937			do
G4	9 NW	H. Kanz		Old	50		Alluvium
G5	8 N	Udo Haarman and R. Wright.	E. B. Kutscher	1937	440	6	Edwards limestone.
G6	7 N	do			15	36	
G7	do	do	E. B. Kutscher	1937	333	6	Edwards limestone.
G8	7½ NE	Albert Pfeuffer		Old	400	6	do
G9	8½ NE	Jesse Posey			250±	6	do
G10 (281)	9½ NE	Travis Tate			152(?)		Austin chalk(?)
G11	do	Missouri Pacific R. R.	E. B. Kutscher	1944	140	6	do
G12	8½ NE	Hilmar Doehne		Old	250	6	Edwards limestone.

in Comal County, Tex.—Continued

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
F51	930.6	0.5	225.5 247.1 260.9 271.6	Apr. 18, 1945 May 18, 1945 July 3, 1945 Jan. 8, 1951	C, W	D, S	
F52 (95)	976.9	.5	266.8	Apr. 27, 1945	C, W	D, S	Originally drilled to 1,240 ft. and cased to 1,100 ft, 6½-in. casing perforated from 260 to 320 ft, 2¼-in. cylinder set at about 295 ft. Water levels, table 20.
F53		.9	242.0	Dec. 1, 1936	C, W	N	
F54		1.0	23.3	Jan. 27, 1937	C, W	D, S	Dug; rock curb.
F55		.9	252.7	Jan. 21, 1937	C, W	D, S	
F56		.6	273.5	Nov. 24, 1936	C, W6, G	D, S	Cased to 70 ft.
F57			†300		C, G	D, S	
F58			†330		C, G2	D, S	
F59		3.5	7.4 †12.5	Oct. 26, 1936 Dec. 13, 1943	H, B	N	Well was overflowing Apr. 13, 1935.
F60			†400		C, G	D, S	
F61 (261)	916.9	.5	283.5	May 25, 1934	C, W	D, S	Water levels, table 20.
F62	869.6	2.5	228.2 235.0 244.0 242.8	May 25, 1934 July 2, 1945 Jan. 23, 1950 Jan. 8, 1951	C, W	S	
F63		0	51.5	Dec. 4, 1936	None	N	Yellow clay reported at 58-62 ft.
F64 (383)		0	63.9	Aug. 20, 1940	C, E¾	D, S	Irrigates small garden.
F65	675.5	1.0	24.9 41.1	Oct. 27, 1936 Jan. 9, 1951	C, W	D, S	Sulfur odor. Water levels, table 20.
F66			†51		C, W	D, S	
F67	714.6	.1	66.3	Dec. 4, 1936	C, W	S	
F68 (251)	886.1	.7	241.6	May 28, 1934	C, W3, G	D, S	Water levels, table 20.
F69					C, W	D, S	Water level reported more than 200 ft below land surface.
F70 (237)	903.7	1.4	250.1	Oct. 11, 1933	C, G7	D, S	Water levels, table 20.
F71	993.4	.5	305.1 303.9 307.0	May 5, 1945 May 18, 1945 July 14, 1945	C, W	D, S	
F72	691.6	.5	58.8	Jan. 9, 1951	C, W	S	
F73	889.7	1.0	254.3	Jan. 3, 1951	C, G	D, S	
F74	674.4	.7	41.5	Jan. 9, 1951	C, W	D, S	
G1	825.7	.5	232.8	Jan. 16, 1951	C, W	D, S	
G2					C, W6, G	D, S	Water level reported more than 300 ft below land surface.
G3					C, W	S	Water level more than 340 ft. below surface Dec. 14, 1944.
G4		1.2	42.7	Nov. 4, 1936	C, H	S	Dug well in Guadalupe River bottoms.
G5		.5	350	Dec. 15, 1945	C, W	S	Circle Dot Ranch well 3. Probably drilled into Glen Rose limestone.
G6		2.0	6.9	Oct. 22, 1936	B, H	D, S	Dug. Circle Dot Ranch.
G7	910.7	.4	300.9	Jan. 16, 1951	C, E	S	Circle Dot Ranch well 4.
G8	977.0	.3	382.2	do	C, G6	D, S	Water level reported more than 300 ft below land surface. Reported yield 16 gpm with pump having 3-in. cylinder and 21-in. stroke.
G9	823.3	.9	233.0	do	C, W	S	
G10 (281)		.6	27.5	Jan. 5, 1937	C, W	S	
G11				Dec. 25, 1944	Flows	D	Casing: 18 ft of 6-in. cemented in Austin chalk. Supplies railroad community. Estimated flow Dec. 25, 1944, 3 gpm Does not flow in dry seasons.
G12		.9	97.2	Jan. 5, 1937	C, W	D, S	

TABLE 21.—*Records of wells and springs*

Well	Distance (miles) and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
G13 (279)	8½ NE	William Posey		1891	160	6	
G14	7 NE	Erich Rosenthal		1898	212		Edwards limestone.
G15	6½ NE	do		1901	230	6	do
G16	6½ N	Edward Lackey	E. B. Kutscher	1937			do
G17	5 NW	— Bretzke		1938	237	4	do
G18	4 N	R. W. Gode			Spring		
G19 (399)	4¼ NE	John Karbach		1893	181	6	Edwards limestone.
G20	4¾ NE	Jack Kretzmeyer			168	6	do
G21	5 NE	Alvin Kraft		1932	138	6	do
G22	5½ NE	C. Conrads			145	6	do
G23 (274)	6 NE	Chas. Soechting		1896	210	6	do
G24	7 NE	Charlie Crawford		Old		6	do
G25 (278)	7½ NE	O. E. Gruene		Old	210	6	do
G26	9 NE	Emil Preusser			330	6	do
G27	4½ NE	Bruno Raabe		Old		6	do
G28	4 NE	Albert Hantzmann	C. A. Corring	1900	175	6	do
G29 (398)	3¾ NW	R. W. Gode			90		Edwards limestone (?).
G30	3¾ NW	L. S. Davis			320	6	Edwards limestone.
G31	3½ NW	W. H. Harborth		1895	265	6	do
G32	3¼ NW	William Kraft		1906	190	6	do
G33 (221)	do	Albert Simon		1931	186	6	do
G34 (271)	4 NE	Albert Wallhoeffer		1901	140	6	do
G35	do	Arthur Bartels			65	36	Leona
G36	5½ NE	H. Mittendorf		1925	32	36	do
G37	8 NE	Carl Kutscher Estate.		1930	50	36	Taylor marl (?)
G38	7 NE	A. Brinkoetter	E. B. Kutscher	1930	920		Edwards limestone.
G39	6 NE	H. Kickeritz		1933	36	6	Taylor marl (?)
G40	3¼ NE	Mrs. Lydia Kirmse		Old	65	36	Leona
G41	do	Mrs. B. Gruene Estate.	Killam & Hicks	1939	2,350	10–5	
G42	2¾ NE	Iwan Wallhoeffer			Spring		Leona
G43 (291)	2½ NE	Bruno Preiss	—Gunther		65	6	Edwards limestone.

in Comal County, Tex.—Continued

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
G13 (279)	671.5	0.9	123.4	Oct. 21, 1936	C, W	D, S	Drawdown 7 ft when pumped at 2½ g. p. m. Water levels, table 20.
G14		0	189.9	Jan. 5, 1937	C, W	D, S	
G15			†165		C, W	D, S	
G16					C, W	S	
G17	894.8						U. S. Army Engineers test well. Cored from top to bottom, 2¼-in. core. Log.
G18					Flows	Power	Hueco Spring, also spelled Waco and Huaco. 2 openings, altitudes of land surfaces, 657.9 and 652.2 ft. Temp. varies from 68 F in winter to 71½ F in summer. See table 13 for flow measurements.
G19 (399)	783.8	.8	173.3	Dec. 20, 1937	C, W1½, G	D, S	Water levels, table 20.
G20		.9	160.9 151.4	Sept. 22, 1936 Oct. 22, 1936	C, W	D, S	
G21		.2	132.2	Oct. 21, 1936	C, W	D, S	
G22	726.7	1.1	126.9	Oct. 20, 1936	C, W	D, S	Drawdown 8.5 ft when pumped at 3 gpm.
G23 (274)	758.3	1.0	157.5	Jan. 5, 1937	C, W2, G	D, S	Casing to 200 ft. Water levels, table 20.
G24		0	202.4	Dec. 30, 1936	C, W3, G	D, S	
G25 (278)	752.7	1.0	146.2	Oct. 20, 1936	C, W	S	Water levels, table 20.
G26	606.5	2.1	12.1	Jan. 5, 1937	C, W	N	
G27		1.5	153.8	do	C, W	D, S	
G28		.4	150.4	Oct. 22, 1936	C, W	D, S	Cased to 77 ft. Cave 10 ft deep reported at 150–160 ft. Water at 162 ft.
G29 (398)	675.5	.7	38.8	Apr. 13, 1945	C, W	D, S	Water levels, table 20.
G30	840.1	.9	211.1	Dec. 21, 1945	C, W	D, S	Do.
G31	809.1	1.1	187.0	Dec. 28, 1936	C, W	D, S	Do.
G32	806.5	.5	161.0	Oct. 28, 1945	C, W	D, S	Do.
G33 (221)	793.0	1.0	157.0	July 2, 1945	C, W	D, S	Water levels, table 20. Cased to 134 ft; cave at 160 ft and blue shale at 180–190 ft.
G34 (271)	700.6	.6	89.6	Dec. 30, 1936	C, W	D, S	Draw down 3.5 ft when pumped at ½ gpm. Water levels, table 20.
G35		1.0	47.6	Oct. 22, 1936	C, W	D, S	Dug. Said to have been drilled to 600 ft and plugged because water was salty and sulfurous.
G36		0	12.0	Oct. 21, 1936	C, W	D, S	Water from yellow clay at 23 ft; blue clay encountered at 32 ft.
G37		.9	37.4	do	C, W	D, S	Dug. Water from blue clay.
G38			†90		None	N	Some water reported from Austin chalk. Sulfur water from Edwards limestone at 912 ft.
G39		.2	28.0	Nov. 18, 1936	C, H	N	Water from yellow clay at 36 ft. Supply fails in dry seasons.
G40		2.0	54.3	Dec. 3, 1943	C, W	D, S	Dug well, rock curb. Water from gravel at 58–65 ft. Log.
G41	688				None	N	Oil test. Altitude of land surface reported by Killam & Hicks. Log.
G42					C, W	D, S	Flows from alluvium in east bank of Guadalupe River. Estimated flow 25 gpm Sept. 29, 1943.
G43 (291)	672.2	1.1	53.0	Oct. 21, 1936	C, W	D, S	Water levels, table 20.

TABLE 21.—*Records of wells and springs*

Well	Distance (miles) and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
G44	1¾ NE	William D. Weimers.		Old	80	6	Edwards limestone.
G45	2 N	Max Linnartz		1912	85	6	do
G46	In New Braunfels.	City of New Braunfels.	—Cravens	1941	116	12	do
G47	do	do	do	1941	102		do
G48	1¼ NW	Dean Word				6	do
G49	In New Braunfels.	City of New Braunfels.	U. S. Army, Corps of Engineers.	1948	320	7	do
G50	do	do			Spring		do
G51	1¾ NW	Marvin Scheel		1938	220	6	do
G52 (265)	2¼ NW	R. R. Coreth			290	8	do
G53 (266)	In New Braunfels	A. Swanson		1936	152	6	do
G54	do	Mrs. Meta Penshorn.		Old	25	36	
G55	do	Clements Estate			1,200		Glen Rose limestone (?), lower member.
G56	2 NE	Ad. Tausch		Old		36	Leona
G57	3 NE	Albert Soefje		1895	57	36	do
G58	4½ NE	Emma Rose			32	60	do
G59	3½ NE	H. J. Ludwig		1898	55	36	do
G60	do	August Timmerman.		Old	50	36	do
G61	2¾ NE	A. H. Hoffer		1915	24	36	do
G62	¾ W	Max Walther		1898	31	36	Taylor marl (?)
G63	1¼ SW	Altgelt Farm Association.	E. B. Kutscher	1939	335	6	Edwards limestone.
G64	1½ SW	do			Spring		Austin chalk (?)
G65	1¾ SW	Max Altgelt		1934	345	6	Edwards limestone.
G66	2¼ SW	A. H. Werner		1900	148	6	Austin chalk (?)
G67 (393)	1½ SW	Walter Sippel		Old	502	6	Edwards limestone.
G68	do	Arthur Bergfeld	Arthur Schuman	1927			Edwards limestone (?).
G69	2 E	Erwin Soefje		Old	427	6	Edwards limestone.
G70	4 E	R. Kraft		Old	40	36	Leona.
G71	3 E	E. W. Mueller		1918	35	36	do
G72	2½ E	D. Werner		Old	30	60	do
G73	2¾ SE	Mrs. H. Oelkers		Old	40	36	do
G74	2 SE	W. G. Startz		1938	27	48	do

in Comal County, Tex.—Continued

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
G44		1.4	47.1	Dec. 30, 1936	C, W3, G	D, S	
G45	670.0	1.3	54.0	Oct. 28, 1936	C, W	D, S	
G46					T, E100, 75		Public supply, city of New Braunfels no. 1, 30 ft south of no. 2. Casing: 12-inch to 58 ft; cemented by Halliburton Oil Well Cementing Co.; open hole, 58 ft to bottom. Draw down 7 ft after pumping 12 hr at 2,300 gpm with 2 centrifugal pumps. Log.
G47					T, E100, 40		Public supply, city of New Braunfels no. 2. Casing: 8-in. to 58 ft, open hole to bottom.
G48	647.8	1.1	119.5	Jan. 6, 1937	C, W	D, S	Water levels, table 20.
G49	642.7	1.0	18.36	Nov. 4, 1948	None	N	Do.
G50	623.1				Flows		Comal Springs. Discharge measurements, in table 17.
G51	843.5	1.0	204.7 200.9 202.2 211.8	Dec. 20, 1943 May 17, 1945 July 2, 1945 Jan. 4, 1951	C, W	D, S	
G52 (265)	909.9	1.0	272 273.0 291.4	May 23, 1945 July 2, 1945 Jan. 24, 1950	C, W	D, S	Water levels, table 20.
G53 (266)	736.1	1.0	100.8	Jan. 6, 1937	C, W	D, S	Water levels, table 20. Said to have been tested with boiler at 60 gpm for 6 hr without lowering water-level. Log.
G54		.2	8.1	Dec. 22, 1936	C, W	D, S	Dug; rock curb.
G55					Flows	N	Estimated flow 100 gpm in 1941.
G56		1.4	21.2	Jan. 7, 1936	C, W	D, S	Dug; rock curb.
G57		.4	52.4 52.3	Oct. 20, 1936 Dec. 3, 1943	C, W	D, S	Dug; rock curb. Water from gravel at 55–57 ft.
G58		.2	33.7	Nov. 18, 1936	C, W	D, S	Dug; brick curb to 8 ft. Water from gravel at 30–32 ft. Log.
G59			†49		C, W	D, S	Dug; brick curb. Has supplied eight families at one time.
G60		3.1	41.1 41.5	Nov. 18, 1936 Nov. 30, 1943	C, W	D, S	Dug; rock curb.
G61		.7	24.4	Nov. 18, 1936	C, W	D, S	Dug; brick curb, water from gravel at 23–24 ft.
G62		.5	28.4	Oct. 27, 1936	C, W	D, S	Dug.
G63	648.5		†15		T, E½	D, S	First water at 282 ft; stronger flow at 326–330 ft. Casing: 287 ft of 5-in.
G64					Flows	S	Estimated average flow 50 gpm Has been pumped at 700 gpm for irrigation.
G65		.8	52.5 57.7	Dec. 4, 1936 Dec. 20, 1943	C, G4	D, S	Blue clay reported from 50 ft to 345 ft.
G66	641.2	2.1	.1	Dec. 4, 1936	C, G	D, S	Well flows as much as 3 ft above ground in wet seasons.
G67 (393)	649.2	.5	16.0	Dec. 20, 1943	C, W	D, S	Draw-down about 20 ft when pumped at 2 to 3 gpm. Slight odor of sulfur. Water levels, table 20.
G68			† 20		C, G	Ind	Formerly supplied hosiery mill. Slight sulfur odor.
G69	653.2	0	30.8 33.7	Dec. 1, 1943 Jan. 10, 1951	None	N	Strong odor of sulfur.
G70		3.2	24.7	Nov. 18, 1936	B, H	D, S	Dug; concrete curb.
G71		1.4	34.5	Oct. 10, 1936	C, W	D, S	Dug. Irrigates garden.
G72		.5	25.6	do	C, W	D, S	Dug.
G73		2.2	34.1 30.2	Oct. 10, 1936 Nov. 30, 1943	C, W	D, S	Dug; brick curb.
G74		1.0	20.4	Nov. 30, 1943	C, W	D, S, Ind	Dug; used at slaughter house

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TABLE 21.—*Records of wells and springs*

Well	Distance (miles and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
G75	1¾ SW	W. S. Suttle	E. B. Kutscher	1935	610	6	Edwards limestone.
G76	2¼ SW	Paul Schneider		Old	503	6	do.
G77 (373)	3 SW	L. Jentsch		Old	485	6	do.
G78	2½ SW	Ernest Voight		1898	510	6	do.
G79	7 NE	A. O. Hoffman		Old	307	6	do.
G80	4 NE	Hilmar Pfeifer			190	6	do.
G81	1¼ NW	City of New Braunfels.	Layne-Texas Co., Inc.	1950	160	24, 20	do.
G82	1½ W	Erwin Scheel		1932	148	6	do.
H1	3½ SW	Gus Reinarz			500	6	do.
H2	do.	F. A. Burket		Old	450	6	do.
H3	do.	Hanno Welsch		Old	542	6	do.
H4	4 SW	Erwin R. Goebel		1924	498	6	do.
H5 (339)	do.	Otto Reinartz		Old	463		do.
H6	5 SW	A. W. Feick	Paul Schumann	Old	700	6	do.
H7	5½ SW	Roland Welsch	do.	1934	372	6	Edwards limestone (?).
H8	7½ SW	Oscar Jonas		1890	360	6	Edwards limestone.
H9	8 SW	Adolph Mueller		1911	160	6	do.
H10	11 SW	Elder Dierks	Frank Hillert	1932	45	6	
H11	11½ SW	Willie Georg		1925	322	6	Edwards limestone.
H12	12 SW	Ed Reeh		1916	390		do.
H13	13 SW	Ernest Georg		Old		6	do.
H14 (243)	12½ SW	Edward Gerhardt Estate.			326	6	do.
H15	11 SW	H. Blank		1926	240	6	do.
H16	8½ SW	Servtex Materials Co.			125	6	do.
H17	do.	Westley Hierholzer		Old	117	6	do.
H18	7 SW	Joseph Friesenhahn.		1895	360	5	do.
H19	do.	Bruno Schwab		1916	150	6	Austin chalk.
H20 (326)	6½ SW	William Schaeffer			300	4	Edwards limestone.
H21	6 SW	Alvin Schaeffer		1900	360	6	do.
H22 (332)	5½ SW	Ben Jahn		Old	395	6	do.
H23 (333)	do.	O. Penshorn		Old	428	6	do.
H24	5 SW	William Strateman.		Old			
H25	6 SW	Gus Klaener		1914	131	6	Austin chalk.
H26	7 SW	Fred Schwab			38	36	Taylor marl (?).

in Comal County, Tex.—Continued

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
G75			† 90		None	N	Formerly supplied suburban community. Strong sulfur odor. Log.
G76		0.7	7.1	Dec. 4, 1936	C, W	D, S	Slight sulfur odor.
G77 (373)	661.5	1.5	16.4	do	None	N	Sulfur odor. Estimated yield 1 gpm. Water levels, table 20.
G78	715.9	2.2	73.8 86.5	Oct. 26, 1936 Jan. 10, 1951	C, W	S	Sulfur odor.
G79	841.5	.9	239.0	Jan. 16, 1951	C, W	D, S	
G80	784.8	1.2	178.8	Jan. 5, 1951	C, W	D, S	
G81			† 50	Feb. 2, 1950	T, E	D, S	Draw-down 1 ft after pumping 48 hr at 4,000 gpm.
G82	763.2	.4	132.3	Jan. 10, 1951	C, W	D, S	
H1		.9	29.8	Dec. 4, 1936	C, W	S	Sulfur odor.
H2	733.5	.6	92.7 102.6	Oct. 26, 1936 Jan. 9, 1951	C, W	S	Cased to 450 ft. Sulfur odor.
H3		1.4	113.7	Jan. 6, 1938	None	N	Sulfur odor.
H4		0	52.3	do	C, G	S	Do.
H5 (339)	666.8	0	15.9	May 24, 1934	None	N	Sulfur odor. Water levels, table 20.
H6	728.1	.7	69.7	do	C, W	D, S	Do.
H7		1.6	38.2 32.1	May 25, 1934 Dec. 4, 1936	C, W	D, S	Blue clay reported from top to bottom.
H8	724.7	1.2	67.2	Dec. 4, 1936	C, W	D	Cylinder set at 130 ft. Pump breaks suction at high speed.
H9		.9	86.8 94.3	Dec. 18, 1936 Dec. 21, 1943	C, W	D, S	No sulfur taste or odor.
H10		.6	20.0	Nov. 24, 1936	C, W		Cased to 35 ft. Water encountered in red sand at 30 ft. Irrigates small garden.
H11			† 300		C, G	D, S	Cased to 315 ft. Large cave reported at 300 ft.
H12			† 360		C, W	D, S	Cave in limestone reported at 360 ft.
H13		.3	231.0	Dec. 17, 1936	C, W	S	Depth reported more than 320 ft.
H14 (243)	967.4	.3	306.8	Oct. 11, 1933	C, W	D, S	Water levels, table 20.
H15		.8	296.7	Nov. 24, 1936	C, W	D, S	
H16		0	79.4 87.7	Dec. 19, 1936 Dec. 21, 1943	None	N	
H17		.7	80.9	Dec. 19, 1936	C, W	D, S	Cased to 40 ft.
H18		0	56.1	Dec. 18, 1936	C, W2, H	D, S	Cased to 40 ft, cylinder set at 125 ft.
H19		1.0	16.0	Dec. 1, 1936	C, W4, G	D, S	Casing to 20 ft.
H20 (326)	684.5	1.1	35.1	May 24, 1934	C, W	S	Water levels, table 20. Slight sulfur odor.
H21		.4	31.9	Dec. 16, 1936	C, W	D, S	Sulfur odor.
H22 (332)	728.6	1.1	79.6	Dec. 18, 1936	C, W	S	Sulfur odor. Water levels, table 20.
H23 (333)	694.7	.8	53.0	May 28, 1934	C, W	D, S	Slight sulfur odor. Water levels, table 20.
H24		.5	60.3	Jan. 6, 1937	C, W	S	Sulfur odor.
H25		1.1	46.7	Dec. 4, 1936	C, W	S	Do.
H26		2.1	23.0	do	C, W	D, S	

TABLE 21.—*Records of wells and springs*

Well	Distance (miles and direction from New Braunfels	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in)	Water-bearing formation
H27	8 SW	Albert Rechner		1911	130	6	Austin chalk
H28 (319)	do	Percy Hansman			350	6	Edwards limestone.
H29	9½ SW	Servtex Materials Co.	Ed Gerfers	1941	160	30, 15	do
H30	10½ SW	Glen Wilson		Old		6	do
H31 (244)	13 SW	Lena Binzeil Estate.			240	8	do
H32	13½ SW	Lavine Hoffman		Old	215	6	do
H33	13 SW	Henry Schmidt		1880	50	36	Leona
H34 (380)	do	Paul J. Marbach	Valentine & Friesenhahn.	1920	185	6	Edwards limestone.
H35	do	Henry W. Simon	H. T. Schwab	1905	246	6	do
H36	do	Missouri Pacific R. R.	McMasters & Pomeroy.	1900	292	8	do
H37	12½ SW	A. B. Burkhardt	Charles Donoubauer.	1910	250	6	do
H38	12 SW	Edgar Burkhardt		Old	180	6	do
H39	do	Davenport School	Ted Norred	1948	225	6⅝	do
H40	11 SW	R. P. Schneider		1928	192	6	do
H41	10½ SW	Otto Klaerner		Old	109	6	do
H43	9 SW	Jack Alesci		Old	400	6	do
H44	do	D. N. Barnett		1934	378	6	do
H45	10½ SW	— Rogers		1925	225	6	do
H46	11½ SW	Walter Mueller		1910	476	6, 4½	do
H47	12 SW	Herbert Reidel		Old	306	5	do
H48	11 SW	E. N. Moore		Old	300+		do

in Comal County, Tex.—Continued

Well	Altitude of land surface (ft)	Height of measuring point above ground (ft)	Water level: Below land surface (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
H27		0.7	68.6	Dec. 1, 1936	C, W	D, S	Casing to 50 ft.
H28 (319)	786.5	1.2	134.0	May 24, 1934	None	N	Sulfur odor. Water levels, table 20.
H29					T, E	Ind	Casing: 15 ft of 30-in., 30 ft of 15-in. Pumped 700 gpm., 22 hr daily except Sunday for 2 years.
H30					C, W	D, S	Water level more than 242 ft below land surface
H31 (244)	844.2	.8	174.3	Dec. 17, 1936	C, W	D, S	Water levels, table 20.
H32		.6	151.3	do	C, W	D, S	
H33		1.5	41.9	do	C, W	D, S	Dug; water from terrace deposits of Cibolo Creek.
H34 (380)	804.6	.6	130.6	May 5, 1945	C, W	D, S	Water from 165 to 185 ft. Water levels, table 20.
H35	800.1	1.5	130.2 129.9 130.8	Dec. 17, 1936 May 5, 1945 May 18, 1945	C, W	D, S	Cased to 200 ft.
H36		.7	131.5	May 5, 1945	C, G1½	D	Casing: 8-in. from surface to bottom; brass wire screen from 220 to 240 ft, perforated casing from 272 to 292 ft. Supplies railroad community.
H37		1.0	148.2	Dec. 26, 1936	C, W	D, S	Has been pumped with gasoline engine 24 hr.
H38		.5	169.0	Nov. 24, 1936	C, W	D, S	
H39	851.7	1.0	203.5	Dec. 10, 1948	None	N	Water levels, table 20.
H40		.6	118.8	Oct. 26, 1936	C, W	D, S	
H41		1.0	80.2	do	C, W	D, S	
H43		.8	63.0	Nov. 24, 1936	C, E½	D, S	
H44	836.5	.7	179.6	Dec. 9, 1937	None	N	Do.
H45		.2	133.0	Dec. 17, 1936	do	N	
H46	809.6	1.1	155.0 149.3 164.4	Nov. 24, 1936 Dec. 6, 1944 Jan. 9, 1951	C, W	D, S	Casing: 20 ft of 6-in., 450 ft of 4½-in. Water at 455-457 ft.
H47		0	141.5	May 24, 1936	None	N	
H48	825.1	.7	182.4	Jan. 9, 1951	C, E	D	

LOGS OF WELLS

[Lithologic terms for some wells are those of drillers and may not correspond to Geological Survey usage.]

Well B39

[Owner, A. J. Monier 16½ miles northwest of New Braunfels]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Hard yellow limestone	15	15	Slightly pink limestone	10	65
Blue marl	5	20	Light-gray marl	30	95
Clay and marl, light blue	5	25	Dark-blue marl	6	101
Light-gray soft limestone	5	30	Alternating beds of limestone and marl; water at 287 feet	196	297
Light-blue clay	20	50			
Hard white limestone	5	55			

Well B49

[11½ miles northwest of New Braunfels. Core test. Driller, U. S. Army, Corps of Engineers]

	Thickness (feet)	Depth (feet)
Soft lime boulders (taken from driller's log)	4.0	4.0
Glen Rose formation:		
Limestone, hard argillaceous, weathered, variably light yellow and tan, with occasional very hard, slightly crystalline, very vuggy tan limestone phases	10.6	14.6
No core recovery; used rock bit	1.4	16.0
Limestone, very hard, slightly argillaceous, weathered, light yellow with many solution cavities partly to filled with yellow marl, with a highly inclined slickensided fracture from 23.5 ft to 23.8 ft and with very argillaceous, yellow limestone phases from 24.2 ft to 25.9 ft and 26.8 ft to 27.2 ft	17.7	33.7
Limestone, hard, argillaceous, weathered, light yellow, with occasional solution cavities partly filled with yellow marl; occasional, very argillaceous, yellowish-tan limestone phases; medium hard, calcareous, weathered, yellowish-brown shale seams from 42.3 ft to 42.7 ft, 44.1 ft to 44.6 ft, 45.7 ft to 46.2 ft and 47.6 ft to 47.8 ft	5.9	49.6
Limestone, hard, argillaceous, light gray (almost gray), with a very argillaceous phase in the middle and extreme lower parts; occasional very irregular, tight, thin partings of medium hard, very calcareous, gray shale having many grains of dark-gray limestone from 53.8 ft to 55.1 ft and with vertical fractures from 52.6 ft to 53.6 ft	6.6	56.2
Limestone, hard, argillaceous, weathered, light yellow, with many irregular, tight, thick, and thin partings of medium-hard, calcareous, yellowish-brown shale from 56.4 ft to 57.0 ft; very argillaceous phases having highly numerous *Orbitolina texana* from 59.8 ft to 60.7 ft, 61.8 ft to 63.6 ft and 69.5 ft to 72.5 ft; highly inclined fractures from 70.9 ft to 71.1 ft and 73.6 ft to 74.0 ft; a few scattered solution cavities from 67.0 ft to 67.7 ft	18.6	75.2
Limestone, hard, argillaceous, light gray, with numerous *Orbitolina texana* in the extreme lower part, and with an inclined, slickensided fracture at 78.1 ft	3.0	78.2
Shale, hard, very calcareous, gray	1.3	79.5
Limestone, hard, very argillaceous, light gray (almost gray), with many small grains of dark-gray lime; numerous *Orbitolina texana* fossils; inclined fractures at 80.0 ft and 80.5 ft, and with medium-hard, calcareous, gray shale seams from 80.3 ft to 80.5 ft and 80.6 ft to 81.4 ft	5.8	85.3
Limestone, hard, argillaceous, light gray with many small grains of gray lime	2.7	88.0
Shale, medium hard, calcareous, gray	.4	88.4
Limestone, hard, very argillaceous, massive, light gray, with many small grains of dark-gray lime on the extreme upper part; many vertical and inclined fractures from 89.0 ft to 90.6 ft and 93.8 ft to 96.7 ft	9.8	98.2
Limestone, hard, very argillaceous, weathered, light yellow, transitional to a medium-hard, very calcareous, weathered, yellow shale in the lower part	3.5	101.7
Limestone, hard, slightly argillaceous (becoming argillaceous below 104.3 ft), weathered, highly fossiliferous (bordering on shell agglomerate in the upper-part), light yellow, with numerous solution cavities partly to tightly filled with yellow lime from 101.6 ft to 104.8 ft, with a very hard, crystalline, fossiliferous, weathered, reddish-brown limestone seam from 101.7 ft to 102.6 ft, with numerous *Orbitolina texana* fossils in the lower part, and with a highly inclined, iron-stained, slickensided fracture from 117.9 ft to 118.4 ft	17.8	119.5
Limestone, medium hard, very argillaceous, weathered, yellow, with highly numerous *Orbitolina texana* fossils. (Bordering on shell agglomerate)	2.3	121.8
Limestone, hard argillaceous, weathered, light yellow, with numerous *Orbitolina texana* fossils, with numerous solution cavities tightly filled with yellow argillaceous lime having numerous *Orbitolina texana* fossils	.9	122.7
Limestone, hard, argillaceous, light gray, with many *Orbitolina texana* fossils, and with many irregular masses of medium-hard, calcareous, gray shale having many *Orbitolina texana* fossils	1.5	124.2
Limestone, hard, argillaceous, weathered, yellow, with abundant *Orbitolina texana* fossils; highly inclined, parallel, iron-stained fractures from 124.8 ft to 125.2 ft	2.0	126.2

Well B49—Continued

	Thickness (feet)	Depth (feet)
Glen Rose formation—Continued		
Limestone, hard, argillaceous, light gray, with abundant *Orbitolina texana* fossils	6.3	132.5
Limestone, hard slightly argillaceous, fossiliferous, light gray, with occasional solution cavities partly to tightly filled with argillaceous, gray lime; occasional irregular, tight, thin, and hairline partings of gray shale; many small grains of dark-gray limestone from 137.2 ft to 139.3 ft; a highly inclined fracture from 134.0 ft to 134.3 ft; irregular, light-yellow, weathered zones from 133.8 ft to 135.9 ft	6.7	139.2
Limestone, hard, very argillaceous, gray, with many tight, thin partings of gray shale from 139.2 ft to 139.6 ft	4.1	143.3
Limestone, hard, argillaceous, variably light gray and gray, with a few scattered solution cavities; many small grains of gray limestone from 143.3 ft to 144.1 ft, 1946.2 ft to 150.8 ft, and 152.3 ft to 154.7 ft, with occasional fossils; inclined slickensided fractures at 143.5 ft, 143.8 ft and 145.6 ft	11.4	154.7
Limestone, hard, argillaceous, gray, with abundant minute grains of dark-gray lime; a highly inclined, slickensided fracture from 154.7 ft to 155.1 ft; medium-hard, very calcareous, gray shale seams from 155.9 ft to 156.2 ft and 156.5 ft to 156.5 ft	1.8	156.5
Limestone, hard, argillaceous, gray, with abundant small grains and small concretionary masses of hard, argillaceous, gray limestone; many irregular, tight, thick and thin partings of medium-hard, very calcareous gray shale in the lower part	2.5	159.0
Limestone, hard, very argillaceous, gray; occasional irregular seams of hard, argillaceous, light-gray limestone, and occasional irregular, tight, thick and thin partings of medinm-hard, very calcareous gray shale	1.2	160.2
Limestone, hard, very argillaceous, gray; occasional fractures in the extreme upper part	4.1	164.3
Limestone, hard argillaceous, light gray, with many small grains of gray limestone	1.7	166.0
Shale, medium hard, calcareous, weathered, yellowish brown	0.5	166.5
Limestone, hard, argillaceous, weathered, light yellow; occasional fracture zones; occasional very argillaceous phases in the lower part; a medium-hard, very calcareous, weathered yellow shale phase from 193.0 ft to 194.1 ft; a very hard, slightly argillaceous, weathered, somewhat brittle and fractured, light-tan limestone phase from 191.8 ft to 192.8 ft; and a very hard crystalline, weathered, brown limestone seam from 192.3 ft to 192.6 ft	30.0	196.0
Limestone, hard, very argillaceous, gray, with a vertical fracture from 197.8 ft to 198.3 ft	2.3	198.3
Shale, medium hard, very calcareous, dark gray	1.0	199.3
Limestone, medium hard, very argillaceous, fossiliferous, gray, with occasional concretionary masses of hard, argillaceous, light-gray limestone	1.0	200.2
Limestone, hard, argillaceous, partly fossiliferous, light gray; a hard, very argillaceous, light gray (almost gray) limestone phase having highly numerous *Orbitolina texana* fossils from 203.3 ft to 212.8 ft; numerous small solution cavities from 201.0 ft to 201.8 ft; a few small solution cavities in the extreme lower part which is hard, very argillaceous, limestone	14.2	214.4
Limestone, hard, argillaceous, light gray (almost gray); with a light-gray limestone phase in the middle part having scattered pin-hole vugs and a few small solution cavities; a very argillaceous gray limestone phase in the extreme lower part	4.4	218.8
Limestone, hard, argillaceous, light gray, with a medium-hard very argillaceous gray limestone phase from 200.0 ft to 220.7 ft	2.9	222.7
Limestone, hard, argillaceous, light gray (almost gray), with many small concretionary masses of hard, argillaceous, light-gray limestone in the extreme lower part, and with a light-gray and gray banded appearance in the middle part	7.4	230.1
Shale, medium hard, calcareous, gray	0.1	233.0
Limestone, hard, argillaceous, light gray, with many irregular masses of hard, argillaceous gray limestone	3.6	236.6
Limestone, hard, argillaceous, light gray	0.8	237.4
Limestone, hard, very argillaceous, gray	1.3	238.8
Shale, medium hard, very calcareous, gray	1.7	240.4
Limestone, hard, argillaceous, light gray, with occasional fossils with a few scattered solution cavities and open shell casts becoming numerous from 241.6 ft to 242.6 ft, and with scattered small grains of gray limestone in the lower part	9.0	250.1

NOTE: After the classification by James K. Mortlock, Corps of Engineers, U. S. Army. Published by the permission of the District Engineer.

Well C5

[Owner, George Faber. 13 miles northwest of New Braunfels. Driller, E. B. Kutcher.]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Dobie	10	10	Blue clay and limestone	20	150
Boulders	20	30	Yellow clay and limestone	55	205
Red boulders	23	53	Blue-gray limestone	45	250
Yellow clay (water at 87 ft)	83	130	Gray and blue limestone	205	455

Well C13

[Owner, R. R. Williams. 11 miles northeast of New Braunfels. Driller, E. B. Kutcher]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Edwards limestone	220	220	White limestone (hard)	15	310
Caves, red, no water	40	260	Yellow marl	40	350
White rock	10	270	Blue shale and blue limestone, water at 200, 365, 400 and 420 ft.	70	420
Yellow clay and mud	25	295			

Well F1

[9 miles northwest of New Braunfels. Core test. Driller, U. S Army, Corps of Engineers. Altitude of land surface 864.7]

	Thickness (feet)	Depth (feet)
Glen Rose formation:		
Limestone, hard, broken and weathered, yellowish white, fishtailed	2.4	2.4
Limestone, hard, broken and weathered, yellowish white with occasional iron stains, and with many pinhole vugs and minute calcite crystals, especially in basal part	3.5	5.9
Limestone, hard, partly broken, weathered yellowish white, with occasional open iron-stained partings and open calcite-lined vugs throughout	15.6	21.5
Limestone, hard, partly broken and weathered yellowish white, with many solution cavities tightly filled with very calcareous yellow shaly clay or marl	3.3	24.8
Shale, medium hard, very calcareous, yellow	1.4	26.2
Limestone, variably hard and medium hard, massive, argillaceous throughout; some transitional phases bordering on very calcareous shale or marl, yellow and yellowish white, with occasional small solution cavities filled with very calcareous yellow shaly clay or marl	10.1	36.3
Shale, medium hard, calcareous, yellow	.3	36.6
Limestone, hard (almost medium hard), massive, slightly argillaceous throughout, light yellowish white, with 1-in. calcite-lined vug at 41.7 ft	5.3	41.9
Shale, medium hard, calcareous, yellow	.2	42.1
Limestone, hard, massive, slightly argillaceous throughout, light yellowish-white, with occasional thin, tight horizontal partings of calcareous yellow shaly clay or marl	6.2	48.3
Limestone, hard (almost medium hard), argillaceous. containing numerous pinhole vugs, yellowish white, with occasional thin horizontal bands or partings of medium hard, calcareous yellow shaly clay or marl	1.2	49.5
Shale, medium hard, calcareous, yellow	.1	49.6
Limestone, hard, argillaceous, light yellowish white	.5	50.1
Limestone, medium hard, argillaceous, light yellow with numerous vugs ¼ in. in diameter and smaller, throughout	.8	50.9
Limestone, hard, massive, slightly argillaceous throughout, light yellowish white, mottled with occasional solution cavities tightly filled with hard, yellow argillaceous limsetone; occasional very small calcite-lined vugs, especially in upper part, and with ¼ in. horizontal parting of calcareous, yellow shale at 55.1 ft	11.4	62.3
Limestone, medium hard, very argillaceous, yellowish white, with numerous pinhole vugs throughout	2.0	64.3
Limestone, medium hard, (almost hard), argillaceous, yellowish white, with some pinhole vugs scattered throughout; ¼ in. bands of calcareous yellow shale at 64.3 ft. and 65.9 ft	1.6	65.9
Limestone, hard, massive, white with very occasional fossils scattered throughout and with ½ in. band of calcareous yellow shale at 69.6 ft	4.8	70.7
Limestone, hard (almost medium hard) slightly argillaceous, yellowish white with pinhole vugs scattered throughout. Note: The "contact" shown at 70.7 ft. is transitional	.6	71.3
Limestone, hard, massive, slightly argillaceous, yellowish white to yellowish gray. Note: The "contact" shown at 71.3 ft. is transitional	1.4	72.7
Limestone, hard, variably argillaceous and very argillaceous, partly broken, yellowish white, with some pinhole vugs; occasional medium sized calcite crystals, many minute calcite crystals throughout, and with a ½ in. stained vug at 75.2 ft. Note: The "contact" shown at 72.7 ft is transitional and solution action is becoming increasingly apparent with depth	3.5	76.2

Well F1—Continued

	Thickness (feet)	Depth (feet)
Glen Rose formation—Continued		
Limestone, hard, with many solution cavities, yellowish gray	1.0	77.2
Limestone, variably hard and medium hard, broken probably, with very numerous solution cavities throughout, gray. Note: Only a few limestone fragments were recovered between 77.2 ft and 80.8 ft. Core may have been broken by drilling operation	3.6	80.8
Limestone, hard (almost medium hard), massive, very argillaceous, light yellowish gray	4.8	85.6
Limestone, medium hard, chalky, white, containing occasional calcite crystals; vugs filled with clay; thin partings of calcareous yellow shaly clay or marl	2.7	88.3
Limestone, medium hard, very argillaceous, with many "pin-hole" vugs throughout, yellowish white	1.6	89.9
Limestone, medium hard or soft, very argillaceous, yellowish white, with many small solution cavities partly filled with calcareous, yellow shaly clay or marl	.7	90.6
Limestone, medium hard, massive, argillaceous, yellowish white, with many "pin-hole-vugs throughout and with small solution cavities filled and partly filled with calcareous, yellow shaly clay or marl	4.2	94.8
Limestone, hard, generally massive, argillaceous, light gray, with irregular (wavy) transitional phases, becoming argillaceous and darker gray; occasional small solution cavities filled with calcareous, gray shaly clay, especially in upper part	4.3	99.1
Limestone, hard, massive, argillaceous, light yellow, with very occasional small solution cavities filled with calcareous, yellow shaly clay or marl; a few calcite crystals scattered throughout the basal part. Note: This material is similar to that from 94.8 ft to 99.1 ft except for color	3.6	102.7
Limestone, hard, broken, argillaceous, light yellow, with a very thin diagonal parting of calcareous yellow shaly clay which shows slickenside	.3	103.0
Limestone, hard, (almost medium hard), massive, somewhat chalky and slightly argillaceous, variably yellowish white and white, with occasional solution cavities filled with calcareous yellow shaly clay or marl	6.3	109.3
Limestone, hard, massive, argillaceous, light gray. Note: The "contact" shown at 109.3 ft is transitional	2.9	112.2
Limestone, hard, argillaceous, light gray, with irregular (wavy) transitional phases becoming very argillaceous and darker gray, and with solution cavities partly filled with calcareous gray shaly clay and partly lined with calcite crystals	2.1	114.3
Limestone, hard (almost medium hard), massive, light gray in upper part; white in basal part, with transitional phases containing many pin-hole vugs. Note: The "contact" shown at 114.3 ft is transitional	6.0	120.3
Limestone, hard, massive, argillaceous, variably light gray and white, with transitional phases becoming argillaceous and darker gray; very thin irregular (wavy) tight partings of dark gray shaly clay, especially at about 128 ft. Note: The "contact" shown at 114.3 ft is transitional	1.4	121.7
Limestone, hard (almost medium hard), massive, slightly argillaceous, somewhat chalky, white, with a very thin diagonal parting of dark gray shaly clay at 125.2 ft which shows slickenside and with ½ in. solution cavity or vug at 132.3 ft	2.5	134.2
Limestone, hard, massive, variably argillaceous and partly argillaceous, variably light gray and white, with occasional fossils scattered throughout; some transitional phases contain very thin (wavy) tight partings of dark gray shaly clay, and with an isolated ½ in. vug at 142.2 ft. Note: The "contact" shown at 134.2 ft is transitional	40.6	174.8
Limestone, hard argillaceous, variably gray and dark gray, and almost hard, calcareous dark gray shale, with concretionary nodules of argillaceous, light gray limestone. Note: The "contact" shown at 174 ft is transitional	.8	175.6
Limestone, hard, massive, slightly argillaceous, somewhat chalky, white	5.5	181.1
Limestone, medium hard, variably light gray and white, argillaceous, almost calcareous shale throughout and especially so from 181.8 ft to 182.1 ft	1.0	182.1
Limestone, hard, massive, slightly argillaceous, somewhat chalky, white	1.9	184.0
Shale, medium hard, calcareous, gray, with occasional small concretionary nodules of argillaceous, light gray limestone in basal part	1.9	185.9
Limestone, hard, massive, slightly argillaceous, somewhat chalky, white, with occasional irregular (wavy) transitional phases of argillaceous limestone	3.3	189.2
Limestone, hard, argillaceous, light gray, with many irregular (wavy) tight partings of hard, very calcareous, shaly clay	1.3	190.5

NOTE: After the classification by Jack Colligan, U. S. Army, Corps of Engineers. Published by permission of the District Engineer.

Well F3

[Owner, A. J. Walser. 13½ miles northwest of New Braunfels. Driller, J. R. Johnson.]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface	1	1	Sticky gray shale with beds of limestone.	140	560
Broken limestone and clay	44	45	Sticky clay	11	571
Blue limestone	64	109	Blue limestone	24	595
Blue-gray chalk and limestone	121	230	Sticky shale	5	600
Blue chalk and limestone	100	330	Yellow limestone	100	700
Gray limestone	85	415	Gray shells	35	735
Chalky limestone and clay	5	420	Black and white sandstone	12	747

Well F13

[Owner, Henry Rompel, 10 miles northwest of New Braunfels. Driller, E. B. Kutcher.]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	17	17	Hard white rock, enough water for drilling.	32	135
Boulders	8	25	Yellow clay	75	210
Boulders and clay	25	50	Blue clay	18	228
Sandy clay, hard, seep water	22	72	Sand	12	240
Cave	2	74			
Hard limestone	29	103			

Well F32

[Owner, E. J. Heidrick, 6½ miles northwest of New Braunfels. Driller, J. R. Johnson.]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface	2	2	White limestone	105	295
Hard limestone, Edwards	10	12	Blue limestone	25	320
Hard boulder	2	14	Yellow clay	75	395
Red clay	2	16	Blue limestone	261	656
Boulder, hard	4	20	Glen Rose	237	893
Dobie	8	28	Blue and gray limestone	85	978
Boulder, hard	6	34	Brown limestone (gas)	85	1,063
Dobie	22	56	Trinity group [Travis Peak]	99	1,162
Rock, hard	4	60	Blue mud	16	1,178
Cave, no returns	3	63	Blue limestone	102	1,280
Limestone	32	95	Blue mud, water sand	62	1,342
Hard rock	10	105	Gray limestone (sulphur water at 1,363 feet).	21	1,363
Dry sand	10	115	Green shale	153	1,516
Hard rock	2	117	Gray limestone	2	1,518
Honeycomb rock	3	120	Red bed	182	1,700
Hard limestone	20	140	Limestone	66	1,766
Red clay	4	144	Red bed	5	1,771
Pink lime	11	155	Blue limestone	24	1,795
Red clay	5	160	Black limestone	20	1,815
Red dobie	4	164	Schist	52	1,867
Red clay	16	180			
Cave, no returns	10	190			

Well G17

[Owner, —— Bretzke. 5 miles northwest of New Braunfels. Core test. Driller, U. S. Army, Corps of Engineers]

	Thickness (feet)	Depth (feet)
Limestone, lower 4.0 ft. soft	6.0	6.0
Limestone, slightly porus	.5	6.5
Limestone with chert inclusions	.7	7.2
White chalky limestone, slightly porus	3.6	10.8
White porus limestone, pores coated with iron oxide, small chert inclusions at 12.2 ft	2.2	13.0
Iron stained, brown limestone	.5	13.5
Light gray limestone, small cavity at 16.0 ft	.5	16.0
Porus limestone	1.0	22.0
Gray porous limestone, pores colored by iron oxide	3.6	25.6
Gray limestone, non-porous	2.4	28.0
Porous limestone	1.4	29.4
Gray limestone, slightly porous	2.1	31.5
Porous light gray limestone, pores stained with iron oxide	1.5	33.0
Gray limestone	1.4	34.4
Gray porous limestone	.6	35.0
Brown-gray limestone, chert at 37.0 ft	2.0	37.0
Gray limestone	7.0	44.0
Cavity partly filled with red clay	1.0	45.0
Gray, very porous limestone, slightly cavernous	12.0	57.0
Porous limestone with cavities 2 and 3 in. deep	21.0	78.0
Gray porous limestone	9.0	87.0
Gray limestone, non-porous	2.7	89.7
Cavity	.3	90.0
Porous gray limestone	3.0	93.0
Cavity	.8	93.8
Porous gray limestone	2.2	96.0
Cavity	1.0	97.0
Porous limestone	1.0	98.0
Cavity	1.0	99.0
Gray porous limestone	8.0	107.0
Cavity	.8	107.8
Gray porous limestone	2.2	110.0
Cavity	1.8	111.8
Porous limestone, cavern	1.0	112.8
Porous gray limestone, cavern crystals	6.8	119.6
Gray limestone	1.6	121.2
Porous limestone	.8	122.0
Gray slightly porous limestone	3.0	125.0
Gray limestone	4.1	129.1
Gray porous limestone	.4	129.5
Gray limestone	.5	131.0
Gray slightly porous limestone, chert at 131.3 ft	2.6	133.6
Dark-gray porous limestone, pores stained with iron oxide	3.4	137.0
Chert	.1	137.1
Cavity	4.0	140.1
Dark-gray crystalline, porous, limestone, chert seams at 141.0 ft	0.9	141.0
Gray crystalline limestone, slightly porous	6.8	147.6
Gray porous limestone	2.2	150.0
Cavity	.8	150.8
Gray porous limestone	1.2	152.0
Cavity	1.0	153.0
Gray porous limestone	2.0	155.0
Cavity	1.0	156.0
Porous limestone	2.0	158.0
Cavity	1.0	159.0
Porous limestone	1.0	160.0
Cavity	.8	160.8
Very porous limestone	4.2	165.0
Cavity	1.0	166.0
Gray porous limestone	3.0	169.0
Cavity	1.0	170.0
Brown and gray porons limestone	2.0	172.0
Cavity	.7	172.7
Gray porous limestone	1.3	174.0
Cavity	.9	174.9
Very porous limestone	1.1	176.0
Cavity	3.0	179.0
Brown, very porous limestone	1.0	180.0
Cavity	.7	180.7
Porous limestone, stained with iron oxide	1.3	182.0
Brown very porous limestone, cherty	3.3	185.3
Cavity	.8	186.1
Brown porous limestone with chert	7.5	193.6
Cavity	.4	194.0
Gray porous limestone	3.0	197.0
Cavity	2.0	199.0
Brown porous limestone	4.0	203.0
Cavity	.7	203.7
Gray porous limestone, chert inclusions	.3	204.0
Gray porous limestone	2.1	206.1
Gray limestone	1.4	207.5
Brown porous limestone	2.5	210.0
Gray limestone	1.4	211.4
Porous gray limestone	1.6	213.0
Porous crystalline limestone	3.0	216.0
Porous limestone	2.0	218.0
Cavity	.9	218.9
Gray porous limestone	5.2	224.1
Cavity	.5	224.6
Brown porous limestone	7.4	232.0
Cavity	.9	232.9
Brown porous limestone	1.1	234.0
Cavity	1.0	235.0
Gray, porous, broken, cherty limestone	2.0	237.0

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Well G40

[Owner, Mrs. Lydia Kirmse. 3¼ miles northeast of New Braunfels.]

	Thickness (feet)	Depth (feet)
Sand	5	5
Gravel, hard	2	7
Sand, clay, and gravel	58	65

Well G41, partial log

[Owner, Mrs. B. Gruene Estate. 3¼ miles northeast of New Braunfels. Drillers, Killern and Hicks.]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Taylor marl	292	292	Edwards and Comanche Peak limestone	459	1,059
Austin chalk	193	485	Glen Rose limestone	(?)	(?)
Eagle Ford shale	20	505	Total depth		2,350
Buda limestone	35	540			
Grayson (Del Rio) shale	40	580			
Georgetown limestone	20	600			

Well G46

[Owner, City of New Braunfels. In New Braunfels. Driller, ___ Cravens.]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface rock	9	9	Georgetown limestone	30	58
Red clay	6	15	Edwards limestone	58	116
Gravel (water)	13	28			

Well G49

[In New Braunfels. Core test and observation well. Driller, U. S. Army, Corps of Engineers.]

	Thickness (feet)	Depth (feet)
No samples	6.4	6.4
Limestone, gray white, crystalline	1.6	8.0
Limestone, gray white, lithographic, solution cavities filled with red clay or pink lime	4.0	12.0
Limestone, lithographic texture, brownish gray; some chert	1.2	13.2
Limestone, gray white vugs contain secondary calcite crystals; lower part, white with milioline fossils	7.1	20.3
Limestone, dense brownish gray	4.0	24.3
Limestone, white, milioline fossils	4.7	29.0
Limestone, brownish gray, fine texture; vugs (core less 1.8 ft) chert at 36 ft	7.0	36.0
Limestone, gray white, fine texture, cavities filled with red clay and calcite crystals	6.0	42.0
Limestone, brownish gray, coarsely crystalline; cavities contain red clay and calcite crystals	9.0	51.0
Limestone, dark gray, coarsely crystalline, some red clay	9.0	60.0
Limestone, gray white to pink, lithographic texture. Part of core replaced by dense calcareous pink clay. Contact between clay and limestone irregular. Logged as "broken limestone"	10.0	70.0
Limestone, gray, coarsely crystalline; vugs and fractures filled with dogtooth spar and some real clay; about one half of core is secondary material	8.0	78.0
Limestone, gray, fine grained; vugs small, contain small crystal of calcite core less 1.3 ft	6.3	84.3
Limestone, fine-grained, and red clay; core less 1 ft	1.0	85.3
Limestone, mostly coarsely crystalline; large vugs lined with small calcite crystals; large crystals and red clay in lower part of core	3.8	89.1
Limestone, upper part badly broken, with much replacement by red clay; lower part fine in texture	1.4	90.5
Limestone, with red clay; 2-in. dark-gray bank containing fossils	2.0	92.5
Limestone, dense gray; no vugs or fossils; some fractures filled with red clay	10.0	102.5
Limestone, light gray, finely crystalline, Foraminifera and small megascopic fossils	4.0	106.5
Limestone, light gray, fine texture, small open vugs, red clay in fractures. (4 cores loss 6 ft)	16.9	123.4
Limestone, gray, medium texture, small vugs, no red clay	3.6	127.0
Limestone, gray, lithographic texture, breaks and large vugs filled with red clay	8.5	135.5
Limestone, gray, medium texture, fractures filled with red clay, some open vugs lined with small calcite crystals	2.0	137.5
Limestone, hard, dense, vuggy, gray to brownish gray; much pink argillaceous secondary material; some fossils	4.1	141.6
Limestone, gray, lithographic texture, not vuggy, rudistied(?) fossils	4.4	146.0
Limestone, light gray, fine texture, contains small white elongate pellets about ½ in. in diameter. 2 cores, loss 1.1 ft	5.6	151.6
Limestone, fine texture, vuggy, partly replaced by pink calcareous material	8.7	160.3
Limestone, vuggy, without crystals, fine texture, much pink calcareous clay	2.6	162.9
Clay or marl, red (loss 4.7 ft)	7.1	170.0

Well G49—Continued

	Thickness (feet)	Depth (feet)
Limestone, brownish gray to gray, vuggy, almost spongy, fine texture, elastic(?)	4.5	174.5
Cavity	3.0	177.5
Limestone, gray to brownish gray, no cavities	2.5	180.0
Limestone, light gray, few small vugs. (2 cores)	11.4	191.4
Limestone, dense, brownish gray, vugs lined with calcite crystals and clay, (4 cores), cavity ½ ft	19.0	220.4
Limestone, gray, lithographic texture, vuggy with calcite and clay fossiliferous (crinoid stems and *Pecten* (?) at 227 feet)	7.1	227.5
Limestone, brownish gray, vugs lined with dripstone (?) or earthy lime	4.9	232.4
Limestone, gray to brownish gray, fine texture, vugs filled with earthy lime. (4 cores)	18.6	251.0
Limestone, gray, lithographic texture, very few vugs and fossils	1.0	252.0
Limestone, mottled light and dark gray; fossils abundant; Probably equivalent of Walnut clay	1.0	253.0
Limestone, mottled light and dark gray, fewer fossils than above and no vugs	7.0	260.0
Limestone, gray to white, mottled with nearly black limestone, few fossils, no vugs	10.0	270.0
Limestone, medium-dark gray, finely porous to vuggy, largely dolomitized; few fossils (2 cores)	18.9	288.9
Limestone, medium dark gray, vuggy, some calcite crystals. (2 ft of core lost)	4.1	293.0
Limestone, gray, fine texture, mostly tight	7.2	300.2
Limestone, light gray, fine texture, somewhat dolomitized, large vugs nearly filled with calcite crystals	5.8	306.0
Limestone, mottled light and dark gray, mostly dense, with few cavities	5.0	311.0
Limestone, dense, light gray, few large vugs lined with calcite crystals	19.0	320.0
Total depth		320.0

Well G53

[Owner, A. Swanson. In New Braunfels]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Gravel and red clay	28	28	Coarse honeycomb (water)	4	132
Hard limestone	52	80	Hard limestone	16	148
Red clay	40	120	Very coarse honeycombed limestone, water	4	152
Hard limestone	8	128			

Well G58

[Owner, Emma Rose. 4½ miles northeast of New Braunfels]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Top soil	3	3	Blue shale	2	30
Yellow clay and gravel	25	28	Gravel	2	32

Well G75

[Owner, W. S. Suttle. 1¾ miles southwest of New Braunfels. Driller, E. B. Kutcher]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Yellow clay	60	60	Buda (limestone)	70	540
Blue clay	255	305	Del Rio (Grayson shale)	40	580
Austin chalk	150	455	Georgetown (limestone)	20	600
Eagle Ford (shale)	15	470	Edwards (limestone)	5	610

Well H39

[Owner, Davenport School. 12 miles southwest of New Braunfels. Driller, Ted Nored.]

	Thickness (feet)	Depth (feet)
Austin chalk:		
Chalk, cream colored, slightly sandy, small amount of ferruginous and carbonaceous (?) material; *Inoceramus* prisms, ostrocods, *Globorotalia?*	10	10
Similar to sample above	10	20
Similar to above, Foraminifera abundant, poorly preserved, *Inoceramus* prisms, sponge spicules, echinoid spines	10	30
Similar to above, Foraminifera abundant, some well-preserved hyaline and calcareous tests. Sponge spicules, prisms, and echinoid spines	10	40
Somewhat sandy limestone, with some dark-gray shale particles; Foraminifera abundant and well preserved. Probably includes contact between Austin chalk and Eagle Ford shale	10	50
Eagle Ford shale:		
Shale, dark blue-gray sandy; secondary calcite, echinoid spines, abundant Foraminifera	10	60
Buda limestone:		
Limestone, cream colored, white under bright light, calcite crystals, some mica and ferruginous material; fossils poorly preserved	10	70
Similar to above, more shaly and ferruginous material; Foraminifera apparently abundant but poorly preserved	10	80
Limestone, cream colored with typical small brown specks; secondary calcite and a few grains of glauconite present. Sponge spicules, echinoid spines, and abundant poorly preserved Foraminifera	10	90
Similar to above. Some Foraminifera could probably be identified	10	100
Shale, blue, containing shell fragments, washed sample contains poorly preserved Foraminifera. Secondary calcite and a bright green material—probably glauconite	10	110
Grayson (Del Rio) shale:		
Shale, blue, containing shell fragments. Washed residue contains much pyrite, some replacing Foraminifera, Ostracoda, and other groups	10	120
Same as above	10	130
Same as above. Rosettes of marcasite conspicuous	10	140
Clay, dark-blue. Washed sample contains blue-gray shell fragments, much pyrite and many microfossils	10	150
Clay dark-blue; dries hard; washed residue, probably 0.05 of original volume. Secondary calcite and pyrite. Foraminifera abundant, poorly preserved shell fragments	10	160
Georgetown limestone:		
Clay, dark-blue; shell fragments. Washed sample contains much pyrite, many poorly preserved microfossils and fragments of yellow limestone	5	165
Probably top of Georgetown. Dry sample is hard blue-gray mud. Washed sample nearly white limestone containing some secondary calcite and a few poorly preserved Foraminifera. Milioline forms inconspicuous or absent. Individual pieces of limestone yellowish in contrast to white of Edwards limestone	4	169
No sample	11	180
Yellow chalky marl and limestone, somewhat granular but texture not coarse. Small shell fragments. Under microscope some grains are clear like quartz. Acid-treated residue contains limonite only	2	182
Limestone, yellow, powdery. Washed sample shows white and yellow iron-stained fragments of limestone, microfauna poorly preserved	5	187
Edwards limestone:		
Limestone, yellow, powdery. Washed residue shows hard yellow limestone and few grains of limonite; microfauna unrecognizable	5	192
Limestone, yellow. Dry drill cuttings powdery and marly. Washed sample: dense white and yellow limestone, with a few grains of quartz and limonite. Ostrocoda and shell fragments	5	197
Limestone, yellow. Dry cuttings fine light yellow powder. Washed sample contains few grains of quartz and limonite. No evidence of fossils. May be interformational tufa	5	202
Similar to above except that small shell fragments were found	5	207
Gray and white limestone containing some clear quartz	4	211
Hard gray limestone, some lithographic limestone, shell fragments	6	217
Hard lithographic lime and shell fragments, some mica and quartz	5	221
Total depth		225

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