GROUND-WATER RESOURCES OF BORDEN COUNTY, TEXAS

By

W. C. Ellis

PREPARED IN COOPERATION BETWEEN THE GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF THE INTERIOR, AND THE TEXAS STATE BOARD OF WATER ENGINEERS

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INTRODUCTION

Location and extent of area

Borden County is in northwestern Texas at the foot of the High Plains escarpment. It is bounded on the north by Lynn and Garza Counties, on the east by Scurry County, on the south by Howard County, and on the west by Dawson County. Its approximate center lies at 101°26' west longitude and 32°45' north latitude. The county consists of 914 square miles of plains and rolling terrain, broken in the western part by the High Plains escarpment and at places in the central part by isolated remnants of the cap rock. Its altitude ranges from about 2,300 to 3,000 feet. The upper reaches of the Colorado River, flowing from west to east through the southern part of the county, and creeks flowing into the river, drain the entire county.

Economic development

Ranching and farming constitute the principal industries. About 90 percent of the area is in ranch land, including about 10 percent under cultivation. It is estimated that about 22,000 cattle and about 23,000 sheep are grazed in the county during an average year. Grain sorghums, wheat, cotton, and various feed crops are grown on the farm land. Two commercial fruit orchards are in operation. There are no manufacturing establishments, but in 1948 some oil was discovered. There are no railroads, but one improved highway (U. S. 180) crosses the center of the county in an east-west direction. The town of Gail (population 200) is the county seat and is its only trading center.

Purpose of report

The Texas State Board of Water Engineers and the Geological Survey, United States Department of the Interior, are engaged in a cooperative investigation of the ground-water resources of Texas. This report is a part of that study. It contains a brief discussion of the ground-water reservoirs that furnish water to wells in the county; the development of water supplies from wells; the chemical character of the ground water; a summary of the results of the investigation; the records of 129 wells and springs; the drillers' logs of 41 wells; the chemical analyses of water from 82 wells and 2 streams; and a map showing the location of all wells for which records were obtained.

GROUND-WATER RESERVOIRS

Sand and sandstone of Triassic age, sand and possibly limestone of Cretaceous age, and sand and gravel of Tertiary and Quaternary age constitute the underground reservoirs from which ground water is withdrawn in Borden County.

Rocks of Triassic age known as the Dockum group (locally called "red beds") crop out in about 75 percent of the surface area of the county (fig. 1). In the remainder the Dockum group lies beneath younger rocks. Ground water in small to moderate quantities can be obtained from wells drilled to the fine-grained sands or sandstones of the Dockum group almost anywhere in the county; however, except in a few localities where the sand is at or near the surface, the water is too highly mineralized for most purposes except watering stock, and in places is too highly mineralized even for that. Analyses of water from 14 of the deeper wells that are believed to draw water from sands or sandstones in the Dockum group show that the dissolved solids range from 2,880 to 17,700 parts per million and that the chloride ranges from 1,050 to 8,020 parts per million. Water from shallower wells in the Dockum group generally ranges from 248 to 3,580 parts per million in dissolved solids and from 8 to 460 parts per million in chloride.

Basal sands, and perhaps limestones, of Lower Cretaceous age are believed to contain ground water in most places where they lie beneath the Ogallala formation of Tertiary age in the northwestern and southwestern parts of Borden County (fig. 1). Little is known about the water-bearing properties of the ground-water reservoirs in the rocks of Cretaceous age in the county. It is believed that two wells (A-9, and A-14) and one spring (A-10) draw water that is highly mineralized from the basal Cretaceous sands in the northwestern part of the county. Analyses of water from the two wells and the spring show that the dissolved solids range from 3,360 to 5,590 parts per million and that the chloride ranges from 1,340 to 2,420 parts per million.

Sand and gravel of the Ogallala formation of Tertiary age are the principal sources of ground water in the parts of northwestern and southwestern Borden County that lie on the High Plains and in a small area along the northeastern edge of the county where remnants of the Ogallala formation are still present. Wells drawing from the Ogallala formation generally furnish adequate amounts of water to supply ranches, farms, and homes, but the supplies are believed to be inadequate for irrigation. The water is better in chemical quality than that found in the underlying reservoirs of Cretaceous and Triassic age. The chemical analyses of water from wells in the southwestern part of the county that are believed to draw from the Ogallala formation show dissolved solids ranging from 538 to 700 parts per million and chloride ranging from 47 to 92 parts per million. The analyses of water from wells in the northwestern part of the county that are believed to draw water from the Ogallala show dissolved solids ranging from 600 to 2,630 parts per million and chloride ranging from 74 to 710 parts per million.

Sand and gravel deposits of Quaternary age in and near the stream beds yield ample supplies of ground water for stock and domestic use, but they are believed to be inadequate for large development of ground water. Most of the wells drawing water from the sands and gravel of Quaternary age yield water of satisfactory quality for domestic use.

USE OF GROUND WATER

Practically all the ground water developed in Borden County has been used to water livestock and supply ranch headquarters and farms. The town of Gail has no municipally owned supply. Water for the residents is supplied from a privately owned shallow well. Water from this well is conveyed by pipe to a hydrant in the central part of town. No ground water is used for irrigation in the county. Small amounts of ground water have been used in drilling oil wells. In all, the total use of ground water in the county probably does not exceed an average of 250,000 gallons a day.

SUMMARY

The Dockum group of Triassic age crops out in about 75 percent of the county. The group contains beds or lenses of fine-grained sand and sandstone that generally yield only small quantities of highly mineralized water to wells. In most places water from the Dockum group is too highly mineralized for most purposes except watering stock, and in some places the water is reported to be too highly mineralized for stock. Where the sands are near the surface, water of fair quality is obtained from shallow wells in the Dockum group.

Little is known about the water in the sands and limestones of Cretaceous age that overlie the Dockum group in the northwestern and southwestern parts of the county. Two wells and a spring that are believed to draw water from the basal Cretaceous sands yield only highly mineralized water.

The Ogallala formation, which yields large quantities of ground water on the High Plains in Texas, is found in the northwestern and southwestern parts and along the northeastern border of the county. The formation is thin and it is unlikely that large quantities of water can be obtained from it. Water from the Ogallala formation is of fair chemical quality in the northwestern and northeastern parts of the county and is of good quality in the southwestern part.

Recent deposits along and near the streams furnish small supplies of ground water of fair to good chemical quality.

The pumpage of ground water in the county is small, averaging perhaps 250,000 gallons a day or less. None of the water-bearing formations in the county can be expected to yield large supplies of water adequate for irrigation or heavy industrial use.

Records of wells in Borden County, Texas

All wells are drilled unless noted in the remarks column

Well	Distance from Gail	Owner	Date completed	Depth of well (ft.)	Diameter of well (in.)	Height of measuring point above ground (ft.) a/	Water level		Method of lift b/	Use of water c/	Remarks
							Below land surface (ft.)	Date of measurement			
A- 1	18 miles northwest	J. W. Stuart	1934	29	8	1.0	26.0	Sept.16, 1948	C,W	D,S	Temperature 66° F.
A- 2	17 miles northwest	--	1948	d/182	4	-	-	--	None	N	Drilled by Gen. Geophysical Co. for geophysical exploration. See log.
A- 3	do.	W. J. Huff	1917	d/90	-	1.0	54.0	Sept.16, 1948	C,W	D,S	Temperature 66° F.
A- 4	15½ miles northwest	Ben Williams	Old	d/60	4	-	d/30	--	C,W	D,S	Cased to 20 feet. Temperature 66° F.
A- 5	16 miles northwest	Mrs. Minnie Scott	Old	36	-	1.5	32	Sept.16, 1948	C,W	D,S	Not cased. Temperature 66° F.
A- 6	17 miles northwest	R. R. Reagan	--	--	--	--	d/30	--	C,W	D,S	Drilled by Anderson-Prichard Oil Co.
A- 7	14 miles northwest	A. M. Clayton et. al.	1941	4,505	--	--	--	--	None	N	Oil test. See log.
A- 8	12½ miles northwest	John Dennis	1947	d/143	6	--	d/75	--	C,W	D,S	Supply reported inadequate.
A- 9	13 miles northwest	A. M. Clayton	1938	d/150	6	1.0	125	Aug. 24, 1948	C,W	S	See log.
A-10	12 miles northwest	do.	--	Spring	--	--	--	--	Flows	S	Flow 1½ gallons a minute.
A-11	13½ miles northwest	C.B. Hays	1924	d/60	--	1.0	28.5	June 29, 1948	C,W	D,S	Waters 70 head of cattle. Temperature 66° F.
A-12	12½ miles northwest	Mary Cantril	Old	81	--	2.0	50	Sept.16, 1948	C,W	D,S	Temperature 67° F.
A-13	14½ miles northwest	Clyde Couch	Old	51	--	.5	48.5	do.	C,W	D,S	Not cased.
A-14	16 miles northwest	John Stevens	--	212	--	1.5	175.2	June 29, 1948	C,W	S	
A-15	11 miles northwest	Mrs. W.S. Street	Old	74	--	1.0	72.4	do.	C,W	S	Not cased.
A-16	9½ miles northwest	N. Salleh	Old	46	--	1.0	29.0	do.	C,W	D,S	
B- 1	13½ miles northeast	J. M. Koonsman	1928	3,791	--	--	--	--	None	N	Oil test. Drilled by E. L. Doheny. See log.
B- 2	6 miles northeast	Burt Dennis	--	55	--	1.0	54.0	June 29, 1948	C,W	D,S	In creek valley.
C- 1	11½ miles northeast	Guthurie & Orill	1927	3,235	--	--	--	--	None	N	Oil test. See log.
C- 2	11 miles northeast	G. A. Milliken	1946	36	--	1.0	16.0	June 30, 1948	C,W	D,S	
C- 3	16 miles northeast	R.V. Dougherty	--	139	--	1.5	110.5	do.	C,W	D,S	Temperature 67° F.

Records of wells in Borden County -- Continued

Well	Distance from Gail	Owner	Date completed	Depth of well (ft.)	Diameter of well (in.)	Height of measuring point above ground (ft.) a/	Water level: Below land surface (ft.)	Water level: Date of measurement	Method of lift b/	Use of water c/	Remarks
C- 4	16 miles northeast	J. J. Belew	--	65	--	1.0	58.4	June 30, 1948	C,W	D,S	
C- 5	14½ miles northeast	R. B. Wills	1932	d/141	--	--	d/130	--	C,W	D,S	See log.
C- 6	15½ miles northeast	V. A. Wills	1900	d/260	6	--	d/200±	--	C,W	S	
C- 7	do.	Bunyon L. Evans	1945	50	36	2.0	44.0	Aug. 25, 1948	C,W	D,S	
C- 8	13½ miles northeast	Roy Reeder	1944	122	6	1.5	92.5	do.	C,W	D,S	
C- 9	14 miles northeast	T. J. Rea	1901	d/104	--	--	d/65	--	C,W	D	
D- 1	14 miles west	J. S. Marley	1945	64	6	--	Dry	Aug. 24, 1948	C,W	N	Reported livestock will not drink water. See log.
D- 2	do.	W. C. Orson	1928	d/60	6	--	d/52	--	C,W	D	Yield 2 gallons a minute.
D- 3	do.	do.	1947	d/70	6	--	d/55	--	C,W	S	Yield 7 gallons a minute.
D- 4	do.	C. C. Cannon	--	d/130	6	1.0	71.6	June 17, 1948	C,W	D	
D- 5	11½ miles southwest	do.	--	d/19	--	--	d/15	--	C,W	D,S	
D- 6	7½ miles northwest	Johnson-Clayton	1928	3,550	--	--	--	--	None	N	Oil test. See log.
D- 7	4¼ miles northwest	do.	1947	3,711	--	--	--	--	None	N	Do.
D- 8	4¾ miles west	A. M. Clayton	1941	77	6	.4	70.5	June 29, 1948	C,W	D,S	See log.
D- 9	6½ miles southwest	Jerry Clayton	--	15	--	1.5	13.5	June 16, 1948	C,W	S	In creek valley.
D-10	8 miles southwest	A. M. Clayton	1944	3,346	--	--	--	--	None	N	Oil test. See log.
E- 1	1¾ miles northwest	do.	--	49	6	3.0	42.3	Aug. 25, 1948	C,W	S	
E- 2	In Gail (north side)	J. R. Roper	1920	63	36	2.0	40.4	do.	C,W	S	
E- 3	½ mile southeast	A. J. Cantrell	1910	d/60	--	--	d/40	--	C,W	D	
E- 4	3 miles southwest	Mrs. E. W. Hollers	--	16	36	3.0	14.5	Sept. 16, 1948	None	N	
E- 5	2 miles southeast	V. R. Clark	1925	d/42	--	--	d/40	--	C,W	D,S	
E- 6	3 miles southeast	do.	1945	179	6	1.0	120.6	June 7, 1948	C,W	N	
E- 7	5½ miles southeast	A. J. Long	1927	3,895	--	--	--	--	None	N	Oil test. See log.

Records of wells in Borden County-- Continued

Well	Distance from Gail	Owner	Date completed	Depth of well (ft.)	Diameter of well (in.)	Height of measuring point above ground (ft.) a/	Water level: Below land surface (ft.)	Water level: Date of measurement	Method of lift b/	Use of water c/	Remarks
E-8	5½ miles south	S. I. Munger	1929	2,220	--	--	--		None	N	Oil test. See log.
E-9	do.	A. M. Clayton	1943	1,560	20-10	--	--		Flows	N	One of five wells drilled to supply brine for mineral extraction. Wells flowed 2 to 35 gallons a minute. Project abandoned. See log.
E-10	7 miles south	do.	1948	d/335	7	1.0	134.6	Sept. 16, 1948	C,G	Ind	Supplies water for oil-well drilling. Yield 7 to 10 gallons a minute.
F-1	13½ miles northeast	Mrs. Myrtle McKnight	1947	62	6	1.3	47.0	Aug. 25, 1948	C,W	D,S	Temperature 68° F. See log.
F-2	14½ miles northeast	Morris Miller	1947	d/86	6	--	d/30	--	E	S	Yield 4 gallons a minute. See log.
F-3	11½ miles northeast	-- Miller	1929	4,010	--	--	--	--	None	N	Oil test. See log.
F-4	6½ miles east	--	--	--	--	--	--	--	--	--	Sample of water taken from pool in 5-mile creek.
F-5	8½ miles east	Margaret Gray	1942	3,214	--	--	--	--	None	N	Oil test. See log.
F-6	9 miles east	Billy Askins	--	--	--	--	--	--	C,W	D,S	
F-7	13½ miles east	Fred Miller	1943	d/7	36	--	d/3	--	C,W	D	Dug.
F-8	do.	Frank Strom	1944	d/20	36	--	d/12	--	C,W	D,S	Do.
F-9	11½ miles southeast	J. H. Wicker Estate	--	d/125±	--	--	d/100	--	C,W	N	
F-10	10½ miles southeast	R. L. Gray	1915	d/25	36	--	d/24	--	C,W	S	Dug.
F-11	9½ miles southeast	do.	1915	d/20	36	--	d/19	--	C,W	S	
F-12	11 miles southeast	J. C. McDavid	1928	3,500	--	--	--	--	None	N	Oil test. See log.
F-13	15 miles southeast	J. R. Canning	Old	d/20	36	1.5	12.4	June 23, 1948	C,W	D,S	
F-14	15½ miles southeast	Canning-Davis	1941	2,660	--	--	--	--	None	N	Oil test. See log.

Records of wells in Borden County -- Continued

Well	Distance from Gail	Owner	Date completed	Depth of well (ft.)	Diameter of well (in.)	Height of measuring point above ground (ft.) a/	Water level		Method of lift b/	Use of water c/	Remarks
							Below land surface (ft.)	Date of measurement			
G-1	15 miles southwest	W. L. Miller	1942	3,936	--	--	--	--	None	N	Oil test. See log.
G-2	do.	R. H. Looney	1932	3,680	--	--	--	--	None	N	Do.
G-3	13½ miles southwest	W. L. Miller	Old	d/60	6	--	d/50	--	C,W	D,S	Good supply.
G-4	12 miles southwest	R. M. Clayton W.D. Johnson	1936	3,450	--	--	--	--	None	N	Drilled by Continental Oil Co. Oil test.
G-5	11 miles southwest	Clayton-Johnson "A"	1938	3,514	--	--	--	--	None	N	Oil test. Drilled by Continental Oil Co. See log.
G-6	9 miles southwest	Jerry Clayton	--	20±	--	2.0	17.4	June 16, 1948	C,W	D,S	In river flood plain.
G-7	12 miles southwest	Clayton-Johnson	1934	3,375	--	--	--	--	None	N	Oil test. Drilled by Continental Oil Co. See log.
G-8	13 miles southwest	Jerry Clayton	1941	--	--	--	--	--	C,W	S	In flood plain.
G-9	16½ miles southwest	W. L. Miller	1936	3,805	--	--	--	--	None	N	Oil test. See log.
G-10	18 miles southwest	T. J. Good	--	d/125	6	1.5	79.5	June 17, 1948	C,W	S	
G-11	do.	do.	--	--	--	--	--	--	C,W	S	
G-12	20 miles southwest	G. F. Ingram	1942	d/135	6	--	d/100	--	C,W	D,S	
G-13	19½ miles southwest	R. B. Wiggins	1929	d/120	6	--	d/80	--	C,W	D,S	
G-14	21 miles southwest	Fred Thomas	1925	141	6	1.5	138.5	Aug. 24, 1948	C,W	D,S	Cased to 140 feet.
G-15	do.	do.	1945	179	6	1.5	137	do.	C,W	S	See log.
G-16	21½ miles southwest	H. G. Fambrough	1941	d/130	6	--	--	--	C,W	D,S	
G-17	17½ miles southwest	T. J. Good	1932	d/120	6	--	d/80	--	C,W	D	Cased to 100 feet.
G-18	16 miles southwest	Ellis A. Hall	1929	3,822	--	--	--	--	None	N	Oil test. See log.
G-19	do.	T. J. Good	1936	d/525	6	--	300	Aug. 23, 1948	C,W	N	
G-20	13½ miles southwest	J. A. Phillips	1945	3,214	--	--	--	--	None	N	Oil test. Drilled by The Texas Co. See log.
G-21	16 miles southwest	T.J. Good	1944	d/440	6	--	d/200	--	C,W	S	

Records of wells in Borden County -- Continued

Well	Distance from Gail	Owner	Date completed	Depth of well (ft.)	Diameter of well (in.)	Height of measuring point above ground (ft.) a/	Water level		Method of lift b/	Use of water c/	Remarks
							Below land surface (ft.)	Date of measurement			
G-22	17½ miles southwest	Dewey Hanks	1944	d/22	--	1.0	11.0	June 15, 1948	C,W	D,S	On creek bank.
G-23	19 miles southwest	C. H. Zant	1946	63	6	1.0	56.0	June 16, 1948	C,W	D,S	On edge of draw.
H-1	9 miles southwest	A. M. Clayton	1944	9,499	--	--	--	--	None	N	Oil test. See log.
H-2	10 miles south	Jerry Clayton	--	15	6	2.0	15.5	June 16, 1948	C,W	S	In river flood plain.
H-3	10½ miles south	do.	--	28	6	3.0	28.0	June 11, 1948	C,W	N	Do.
H-4	10 miles south	-- Munger	1939	3,405	--	--	--	--	None	N	Oil test. See log.
H-5	9 miles southeast	A. J. Long	1924	3,209	--	--	--	--	None	N	Do.
H-6	12 miles southeast	H. D. Beal	Old	46	6	.5	46.0	Aug. 24, 1948	None	N	
H-7	14 miles southeast	do.	1945	90	6	1.0	78.0	do.	C,W	N	
H-8	13 miles south	do.	1929	3,602	--	--	--	--	None	N	Oil test. See log.
H-9	14 miles south	do.	1925	d/18	--	--	d/14	--	C,W	S	In stream flood plain.
H-10	13½ miles south	J.M.Higginbotham	1929	3,757	--	--	--	--	None	N	Oil test. See log.
H-11	14 miles south	do.	1938	d/450	6	1.2	159.0	June 15, 1948	C,W	S	
H-12	15½ miles south	Wilson Bros.	1931	d/585	6	2.0	231.7	June 10, 1948	C,W	S	Cased to 510 feet. See log.
H-13	15 miles southeast	John Whitmire	1925	d/35	--	--	d/30	--	C,W	D,S	
H-14	16 miles southeast	Morgan Coates	1945	d/70	6	--	d/45	--	C,W	D,S	
H-15	16½ miles southeast	do.	1929	d/30	--	2.0	25.0	June 7, 1948	C,W	D,S	
J-1	16 miles southeast	J. R. Channing	1947	4,302	--	--	--	--	None	N	Oil test. See log.
J-2	17 miles southeast	N. C. von Roeder	--	30	--	--	Dry	June 9, 1948	C,W	N	
J-3	16 miles southeast	do.	--	d/56	--	--	d/55	--	C,W	D	

Records of wells in Borden County -- Continued

Well	Distance from Gail	Owner	Date completed	Depth of well (ft.)	Diameter of well (in.)	Height of measuring point above ground (ft.) a/	Water level		Method of lift b/	Use of water c/	Remarks
							Below land surface (ft.)	Date of measurement			
J-4	14 miles southeast	Mrs. F. M. Long	1920	514	--	--	--	--	None	N	Oil test. See log.
J-5	15½ miles southeast	Ed. Murphy	1937	d/24	36	--	d/18	--	C,W	S	Dug. In river flood plain.
J-6	17 miles southeast	do.	1937	d/25	36	--	d/20	--	C,W	D	Dug.
J-7	do.	N. C. von Roeder	1943	39	6	1.5	35.5	June 9, 1948	C,W	D	
J-8	do.	do.	1946	40	6	1.5	30.0	do.	C,W	D	
J-9	do.	--	--	--	--	--	--	--	--	--	Sample of water from pool in Colorado River at Vincent Road crossing. See analyses.
J-10	17½ miles southeast	J. G. Davis	1903	--	--	--	d/24	--	--	N	
J-11	do.	L. B. Conrad	--	--	--	--	--	--	Flows	N	
J-12	18½ miles southeast	E. M. Conrad	1941	3,874	--	--	--	--	None	N	Oil test. See log.
J-13	20½ miles southeast	Conrad Ranch No. 1	1931	791	--	--	--	--	None	N	Do.
J-14	20 miles southeast	Conrad Ranch No. 2	1931	750	--	--	--	--	None	N	Do.
J-15	19½ miles southeast	Borden County	1936	29	36	3.0	19.0	Aug. 25, 1948	H	P	Dug.
J-16	do.	B. O. Williams	1885	d/23	36	--	d/8	--	C,W	D,S	Do.
J-17	18½ miles southeast	Ida Anderson Smith	1943	4,000	--	--	--	--	None	N	Oil test. See log.
J-18	18 miles southeast	J. L. McNiel	1944	d/205	6	--	d/160	--	C,W	S	
J-19	18½ miles southeast	J. C. Sheppard	1933	d/190	--	--	d/115	--	C,W	D,S	
J-20	18 miles southeast	A. L. Holly	1943	d/260	6	1.5	116.0	Sept. 15, 1948	C,W	D,S	
J-21	17 miles southeast	T. L. Griffin	1910	d/18	36	--	d/16	--	C,W	D,S	Dug.
J-22	16½ miles southeast	T. A. Bade	1943	113	5	0	55.0	June 10, 1948	None	N	Cased to bottom. See log.

Records of wells in Borden County -- Continued

Well	Distance from Gail	Owner	Date completed	Depth of well (ft.)	Diameter of well (in.)	Height of measuring point above ground (ft.) a/	Water level		Method of lift b/	Use of water c/	Remarks
							Below land surface (ft.)	Date of measurement			
J-23	16 miles southeast	T. A. Bade	1940	119	--	0	79.0	June 10, 1948	None	N	Temperature 73.5° F.
J-24	do.	M. E. Bacon	--	45	--	1.5	46.0	do.	C,W	D,S	
J-25	16½ miles southeast	W. L. Cain	--	--	--	1.0	45.0	June 7, 1948	C,W	D,S	
J-26	18½ miles southeast	T. L. Griffin	1943	d/96	6	1.0	57.0	do.	C,W	S	
J-27	21 miles southeast	Charles Brown	1943	d/240	6	2.0	d/85.0	Sept. 15, 1948	None	N	Cased to 100 feet.
J-28	21½ miles southeast	Pat Harding	1941	d/190	6	--	d/75	--	C,W	S	
J-29	do.	C. H. Garner	1942	139	--	1.5	126.5	Aug. 25, 1948	C,W	S	
J-30	22 miles southeast	Charles Brown	1910	160	6	1.5	74.0	Sept. 15, 1948	C,W	D,S	Cased to bottom.

a/ Measuring point is usually above ground at top of casing, pump base, pipe clamp, or well curb. If below ground the figures are preceded by a minus (-) sign.

b/ C, cylinder; G, gasoline, natural gas, or butane; H, hand; Ind, industrial; W, windmill.

c/ D, domestic; N, not used; S, stock.

d/ Reported by owner or drilled.

Table of drillers' logs, Borden County, Texas

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well A-2					
General Geophysical Co., 17 miles northwest of Gail.					
Clay	10	10	Sand and gravel, little water	18	146
Caliche	10	20	Light-blue shale	6	152
Limestone	28	48	Red beds	30	182
Hard blue shale	80	128			
Well A-7, partial log					
A. M. Clayton et. al., 14 miles northwest of Gail. Driller, Anderson-Prichard Oil Co.					
Surface soil	70	70	Anhydrite, shale, and salt	300	1,895
Shaly sand	120	190	TOTAL DEPTH		4,505
Shale and shells	1,405	1,595			
Well A-9					
A. M. Clayton, 13 miles northwest of Gail. (From memory)					
Limestone (cavernous in places)	138	138	Water sand	8	150
Blue clay	4	142	Red bed (Triassic)		150
Well B-1, partial log					
J. M. Koonsman, 13½ miles northeast of Gail. Driller, E. L. Doheny.					
Surface soil	14	14	Blue shells	15	500
Red clay	19	33	Red rock, shells	330	830
Jointed red clay	107	140	Shells	10	840
Red rock, shells	168	308	Red rock	40	880
Sand	52	360	White lime	7	887
Little water at 308 feet, hole filled at 360 feet			Rock	13	900
Rock	5	365	Salt	120	1,020
Gray lime, shell	5	370	Red rock	10	1,030
Sandy lime	5	375	Salt	30	1,060
Blue shale	85	460	Two bailers water 1,030-40 feet		
Water sand, hole full of water	25	485	TOTAL DEPTH		3,791

Table of drillers' logs, Borden County -- Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well C-1, partial log					
Guthrie & Orill, 11½ miles northeast of Gail.					
Surface soil	5	5	Light slate	5	580
Red rock	120	125	Lime	40	620
Light shale	5	130	Sand	102	722
Red rock	225	355	Red rock	38	760
Light slate	45	400	Dark slate	30	790
Sand	30	430	Sand	30	820
Red rock	70	500	Sand and shale, hole full of water at 825 feet	10	830
Light sand	5	505	Red rock	230	1,060
Light slate	10	515	Salt and red rock, four bailers water	390	1,450
Light sand	30	545	Sand	40	1,490
White slate	5	550	Salt and red rock	395	1,885
Water sand, hole full of water	25	575	TOTAL DEPTH		3,235
Well C-5					
R. B. Wills, 14½ miles northeast of Gail. Driller, R. B. Wills. (From memory)					
Caliche	16	16	Water sand, gravel	8	138
Sand and gravel	4	20	Red clay	3	141
Clay	110	130			
Well D-1					
J. S. Marley, 14 miles west of Gail. (From memory)					
Sandstone	46	46	Hard rock	10	106
Clay	50	96	Water sand	9	115
Well D-6, partial log					
Johnson-Clayton, 7½ miles northwest of Gail. Driller, Dixon Creek Oil Co.					
Soil	10	10	Brown shale	25	725
Lime	10	20	Red mud	25	750
Red rock	50	70	Red rock	25	775
Lime	15	85	Sandy brown shale	25	800
Rock	57	142	Sandy shale	10	810
Sand	3	145	Red mud	50	860
Red rock	220	365	Brown shale	40	900
Quicksand	8	373	Gray sand, water	50	950
Red rock	122	495	Blue shale	10	960
Brown shale	25	520	Red mud	72	1,032
Sand	15	535	Red rock	63	1,095
Blue shale	15	550	Red shale	100	1,195
Brown shale	30	580	Lime, gypsum, and red rock	60	1,410
Brown sand, water	20	600	Red rock	15	1,425
Sandy lime	20	620	Salt	115	1,540
Gray sand	50	670	TOTAL DEPTH		3,550
Blue shale	30	700			

Table of drillers' logs, Borden County -- Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well D-7, partial log					
Clayton-Johnson, 4¼ miles northwest of Gail. Driller, Ed McAdams, et.al.					
Surface soil	3	3	Blue shale	10	725
Gray bentonite	10	13	Red shale	72	797
Red bed	62	75	Blue shale	52	849
Dry sand	10	85	Soft sand, 200 feet of water in hole	7	856
Red bed	360	445	Water sand	29	885
Water sand	25	470	Red shale	195	1,080
Red bed	60	530	Red and blue shale	25	1,105
Sand, hole full of water	35	565	Red shale	100	1,205
Red bed	8	573	Anhydrite	5	1,210
Brown shale	10	583	Lime and anhydrite	6	1,216
Blue shale	77	660	Red shale	46	1,262
Gray lime	15	675	Shale and salt	51	1,313
Gray shale	5	680	Salt	2	1,315
Sandy shale	3	683	Anhydrite	5	1,320
Dark sand	5	688	Salt	35	1,355
Red shale	27	715	TOTAL DEPTH		3,711
Well D-8					
A. M. Clayton, 4¾ miles west of Gail. (From memory)					
Red sandstone	69	60	Water sand	20	80
Well D-10, partial log					
A. M. Clayton, 8 miles southwest of Gail. Driller, Northern Ordnance Co.					
Surface sand and clay	37	37	Anhydrite and shale	57	1,133
Sand and gravel	13	50	Anhydrite	7	1,140
Red beds	445	395	Salt, anhydrite, and shells	467	1,607
Red beds and shale	240	635	Anhydrite and shells	99	1,706
Shale and shells	158	793	Anhydrite, shells, and salt	89	1,795
Shells	52	845	Salt, gypsum, and anhydrite shells	132	1,927
Red beds and shells	161	1,006	TOTAL DEPTH		3,346
Shells	70	1,076			
Well E-7, partial log					
A. J. Long, 5½ miles southeast of Gail. Driller, Julian Petroleum Co.					
Red mud	200	200	Red rock	40	635
Gray sand	40	240	Sand, hole full of water	5	640
Red mud	20	260	Red rock	5	645
Brown mud	5	265	Sandy lime	15	660
Sandy shale	5	270	Brown shale	30	690
Sand, water	30	300	Gray sandy lime	5	695
Red clay	15	315	Blue gumbo	5	700
Blue shale	35	350	Sand, water	15	715
Sharp sand	10	360	Sandy shale	8	723
Lime	20	380	Sand, water	7	730
Red clay	45	425	Conglomerate	3	733
Lime	5	430	Blue gumbo	2	735
Sand, heavy flow water	20	450	Conglomerate, gravel	10	745
Gray lime	5	455	Blue gumbo	10	755
Gray sand	25	480	Sand	5	760
Blue shale	5	485	Red clay	5	765
Clay	15	500	Red rock	105	870
Light lime	5	505	Red sand	5	875
Red shale	20	525	Shale, lime	65	940
Light shale	10	535	Red rock and shale	30	970
Sand	10	545	Sandy lime and salt	20	990
Light brown shale	15	560	Anhydrite, potash, and salt	5	995
Brown shale	10	570	Salt	15	1,010
Light lime	5	575	TOTAL DEPTH		3,895
Blue gumbo	20	595			

Table of drillers' logs, Borden County -- Continued

	Thickness (feet)	Depth (feet)

Well E-8, partial log

S. I. Munger, 5½ miles south of Gail. Driller, W. A. Moncrief, et. al.

Surface red rock	40	40
Red rock	160	200
Red and blue rock	15	215
Red rock	60	275
Water sand	15	290
Red rock	20	310
Blue clay	15	325
Water sand	20	345
Red rock	15	360
Blue clay	20	380
Water sand	20	400
Brown clay	10	410
Water sand	30	440
Sand	35	475
Brown clay	165	640
Brown sand	10	650
Red rock	160	810
Red rock and gypsum shells	35	845
Red rock	25	870
Red rock and gypsum shells	30	900
Red rock	125	1,025
Gypsum, lime, and shells	10	1,035
Sandy red rock	30	1,065
Red sand	15	1,080
Red rock	5	1,085
Red shale	35	1,120
Red mud	5	1,125
Red rock	10	1,135
Shale and red rock	40	1,175
Salt	5	1,180
Gray sand	5	1,185
Salt and red rock	40	1,225
Red sand	20	1,245
Salt and red shale	55	1,300
Gray and black lime	10	1,310
Red shale	5	1,315
Black lime, shells, and salt	10	1,325
Shale, salt	25	1,350
Red shale and salt	35	1,385
Red shale	5	1,390
Red sand	10	1,400
Red beds	10	1,410
Salt	5	1,415
Anhydrite	25	1,440
TOTAL DEPTH		2,220

Well E-9

A. M. Clayton, 5½ miles south of Gail. Driller, Ozark-Mahoning Chemical Co.

Red clay	195	195
Red clay and shale	5	200
Light-red shale and soft gray lime, sandy	10	210
Light-red clay	5	215
Red clay becoming darker with depth	50	265
Red clay and some gray sand, water at 269 feet	5	270
Red clay, dry	60	330
Gray sand and water. Water gravity 1.006. Inflow at bottom 8 barrels per hour. Static head at 220 feet	25	355
Red shale	25	380
Red shale, embedded gravel	5	385
Mixed colored shales with embedded gravel	5	390
Brown sand	10	400
Shaly brown sand	5	405
Blue shale	5	410
Shaly gray sand	5	415
Gray sand	5	420
Sandy red shale	25	445
Red and blue shale	5	450
Limy gray sand. Water inflow more than 40 gallons a minute having specific gravity 1.012	30	480
Mixed shales, predominantly red	10	490
Brown shale, some limy inclusions -- dry hole	115	605
Brown shale, slightly sandy, dry hole	55	660
Red shale. Brown shale, probably sloughing in from above	75	735
Red shale	15	750
Red shale and sand. Sand at 752 feet	6	756
Red sand, very fine-grained. Water, specific gravity 1.011	4	760
Sandy red shale	5	765
Red shale	10	775
Red shale, limy inclusions	60	835
Red shale, dry hole	205	1,040
Red shale and anhydrite	5	1,045
Anhydrite and red shale	10	1,055
Red shale	5	1,060
Red shale, traces sand, anhydrite, and soluble salt	50	1,110
Salt, red shale contamination	45	1,155
Salt, anhydrite and red shale contamination	150	1,305
Anhydrite, salt and shale contamination	10	1,315
Dark red shale, salt. Apparently salt formation interbedded with thin layers of shale and anhydrite ranging from few inches to several feet in thickness	10	1,325
Red shale, contamination	40	1,365
Shale, anhydrite contamination	70	1,435
Anhydrite, salt and shale, contamination	30	1,465
Anhydrite, shale	20	1,485
Red shale, anhydrite contamination	10	1,495
Red shale	15	1,510
Red shale, gray and red sand, brine	5	1,515
Red sand, typical "Yates" formation carrying brine, specific gravity 1.212 to 1.216	12	1,527
Sand and brine. Hole casing. Did not complete penetration of sand. Hole filled with brine and flowed 6 gallons a minute	33	1,560

Table of drillers' logs, Borden County -- Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well F-1					
Mrs. Myrtle McKnight, 13½ miles northeast of Gail. (50 feet east of Well F-1).					
Clay	4	4	Gravel	20	46
Sandstone	22	26			
Well F-2					
Morris Miller, 14½ miles northeast of Gail. Driller, Boyd Yarbough.					
Clay	30	30	Clay	50	82
Sandstone, some water	2	32	Sandstone	4	86
Log of well 100 yards east of F-2					
Clay	28	28	Sandstone	4	32
Well F-3, partial log					
-- Miller, 11½ miles northeast of Gail. Driller, Louisiana Oil Refining Co.					
Red beds	55	55	Shale	15	800
Red shale	10	65	Sand	10	810
Blue shale	5	70	Red shale	20	830
Red shale	325	395	Gray sand	10	840
Lime	5	400	Sand	25	865
Red shale	52	452	Gypsum	10	875
Blue shale	3	455	Sticky blue shale	10	885
Water sand	20	475	Hard sand	5	890
Red shale	3	478	Lime	2	892
Blue slate	4	482	Red beds	8	900
Sandy shale	6	488	Shale	10	910
Gray sand	27	515	Red beds	10	920
Water sand	7	522	Red shale	150	1,070
Blue shale	8	530	Anhydrite and salt	50	1,120
Red shale	66	596	Red shale	10	1,130
Sand	19	615	Red shale and salt	60	1,190
Red shale	50	665	Salt	20	1,210
Brown shale	10	675	Red shale and gray shells	60	1,270
Blue shale	10	685	Anhydrite	10	1,280
Red shale	10	695	Red shale	10	1,290
Gray sand	50	745	Red sand	10	1,300
Gravel	15	760	Red shale	90	1,390
Gray shale	3	763	Anhydrite	5	1,395
Hard sand	17	780	Salt	5	1,400
Hard blue shale	5	785	TOTAL DEPTH		4,010
Well F-5					
Margaret Gray, 8½ miles east of Gail. Roy Lee, Trustee.					
Sand, gravel, and red beds	240	240	Anhydrite and sand	100	2,420
Red beds	580	820	Sandy dolomite and anhydrite	20	2,440
Anhydrite, salt, and red beds	490	1,310	Dolomite and some anhydrite	470	2,910
Sand, anhydrite, and salt	980	2,290	Cherty dolomite	160	3,070
Dolomite and anhydrite	30	2,320	Partly porous dolomite	144	3,214

Table of drillers' logs, Borden County -- Continued

Well F-12, partial log

J. C. McDavid, 11 miles southeast of Gail. Driller, Marland Oil Co.

	Thickness (feet)	Depth (feet)
Red rock	6	6
Red sand	29	35
Red rock	45	80
Sand	10	90
Red rock	65	155
Blue shale	35	190
Water sand, 5 bailers of water at 210 feet	20	210
Red rock	30	240
Blue and red rock	10	250
Sand	80	330
Red rock, hole full of water	15	345
Lime	5	350
Red rock	10	360
Shelly shale, 100 feet of water in hole	55	415
Red rock	25	450
Sand, hole full of water 440-515 feet	50	490
Blue shale	30	520
Lime	15	535
Sand	25	560
Blue shale	20	580
Sand	20	600
Sand, gravel	25	625
Sand	5	630
Red rock	15	645
Red rock, shells	175	820
Anhydrite	20	840
Anhydrite and salt	245	1,085
Total depth		3,500

Well F-14, partial log

Canning & Dennis, 15½ miles southeast of Gail. Driller, B. C. Mann - J. R. Canning.

	Thickness (feet)	Depth (feet)
Surface soil and red beds	45	45
Red rock	15	60
Blue shale	10	70
Water sand	5	75
Brown shale	25	100
Red beds	50	150
Red rock	60	210
Brown shale and anhydrite	30	240
Water sand	10	250
Red beds	30	280
Blue shale	100	380
Water sand	20	400
Lime	2	402
Brown shale and gravel	3	405
Brown shale	5	410
Red beds	2	412
Brown shale	18	430
Water sand	40	470
Sandy blue shale	20	490
Blue shale	30	520
Sandy shale	20	540
Blue shale	20	560
Anhydrite and blue shale	25	585
Sandy blue shale	40	625
Blue shale and anhydrite shells	8	633
Anhydrite and shale	32	665
Red rock	25	690
Red beds	25	715
Red shale	35	750
Red beds	20	770
Red rock	7	777
Red beds	5	782
Red rock, anhydrite	33	815
Shale, anhydrite and lime shells	45	860
Salt, anhydrite and red shale	80	940
Red rock	5	945
Red shale, anhydrite and salt	35	980
Shale, salt, anhydrite and shells	45	1,025
Red rock and anhydrite shells	40	1,065
Red rock and anhydrite	50	1,115
Red shale, salt and anhydrite shells	55	1,170
Red sand, salt and anhydrite shells	50	1,220
Red rock and anhydrite	60	1,280
Red shale, salt and anhydrite shells	35	1,315
Salt, shale	10	1,325
Red shale, salt and anhydrite	40	1,365
Anhydrite and red shale	35	1,400
Salt	7	1,407
Anhydrite	18	1,425
Salt	15	1,440
Total depth		2,660

Table of drillers' logs, Borden County -- Continued

Well G-1, partial log

W. L. Miller, 15 miles southwest of Gail. Driller, Texas Pacific Coal & Oil.

	Thickness (feet)	Depth (feet)
Cellar and red rock	30	30
Water sand	7	37
Red beds, sand, and blue shale	103	140
Shale and red rock	110	250
Red rock	225	475
Sand, water	5	480
Red rock	25	505
Red beds and red rock	25	530
Red beds	60	590
Water sand	5	595
Red rock	32	627
Sand, hole full of water	20	647
Lime	5	652
Blue shale	18	670
Red beds	10	680
Red rock	40	720
Red and blue shale	5	725
Blue shale	5	730
Water sand, hole full	40	770
Gray sand	5	775
Blue shale	20	795
Red and blue shale	35	830
Red rock	20	850
Red rock and blue shale	25	875
Gray sandy shale	20	895
Gray hard sand	5	900
Blue shale	10	910
Red rock	38	948
Brown water sand, hole full	12	960
Dark brown sand	25	985
Red rock	20	1,005
Sandy red rock	35	1,040
Red soft sand	15	1,055
Gray hard sand	5	1,060
Red rock	30	1,090
Red beds	15	1,105
Red rock	75	1,180
Red rock and shells	110	1,290
Red rock	25	1,315
Red rock and anhydrite	5	1,320
Anhydrite and broken rock	45	1,365
Anhydrite and red rock	40	1,405
Red rock and salt	15	1,420
Salt	15	1,435
Red rock and salt	10	1,445
Salt, potash and anhydrite	55	1,500
Total depth		3,936

Well G-2, partial log

R. H. Looney, 15 miles southwest of Gail. Driller, Westhyde Investment Co.

	Thickness (feet)	Depth (feet)
Caliche	15	15
Water sand	60	75
Red beds	315	390
Water sand	15	405
Red beds	25	430
Red rock	60	490
Red beds	70	560
Water sand, 9 barrels water per hour	15	575
Red beds	70	645
Blue shale	10	655
Red rock	225	880
Sand, hole full of water	55	935
Red rock	10	945
Sand, water	48	993
Red rock	257	1,250
Anhydrite	65	1,315
Salt	245	1,560
Salt and potash	85	1,645
Anhydrite	45	1,690
Salt	10	1,700
Total depth		3,680

Table of drillers' logs, Borden County - Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)

Well G-4, partial log

R. M. Clayton & W. D. Johnson, 12 miles southwest of Gail. Driller, Continental Oil Co.

Caliche	20	20	Red rock	4	682
Red rock	20	40	Blue shale	8	670
Red beds	20	60	Red rock	20	690
Red rock	20	80	Sand, hole full of water	30	720
Red beds	15	95	Broken sand	15	735
Red rock	15	110	Blue shale	33	768
Blue shale	10	120	Sand, hole full of water	12	780
Red beds	24	144	Blue-brown shale	25	805
Red rock	166	310	Blue shale	29	834
Sand, hole full of water	20	330	Sand	4	838
Red rock	20	350	Blue shale	6	844
Red beds	10	360	Lime	6	850
Red rock	65	425	Red rock	17	867
Water sand, hole full of water	10	435	Red beds	18	885
Red rock	137	572	Red rock	215	1,100
Red beds	8	580	Red beds and broken anhydrite	50	1,150
Sand	15	595	Red beds, anhydrite, and shells	20	1,170
Soft white water sand	25	620	Red beds	5	1,175
Blue shale	12	632	Salt	303	1,478
Red rock	13	645	White lime	9	1,487
Lime	4	649	Salt	56	1,543
Red rock	3	652	Total depth		3,450
Red rock and sand, ½ barrel water per hour	6	658			

Well G-5, partial log

Clayton-Johnson, 11 miles southwest of Gail.

Caliche and red rock	25	25	Blue shale	10	610
Red shale	55	80	Red shale	15	625
Red beds	40	120	Brown shale	10	635
Red shale	85	205	Red rock	77	712
Red rock	70	275	Water sand	28	740
Gray sand	15	290	Red sandy shale	45	785
Red rock	60	350	Gray shale	20	805
Lime	5	355	Red beds	115	920
Red rock	65	420	Red shale	260	1,180
Red beds	60	480	Salt	280	1,460
Lime shells	2	482	White lime	10	1,470
Red rock	33	515	Brown shale	5	1,475
Water sand, hole full of water	45	560	Salt and anhydrite	25	1,500
Blue shale	35	595	Salt	40	1,540
Red shale	5	600	Total depth		3,514

Table of drillers' logs, Borden County -- Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well G-7, partial log					
Clayton-Johnson, 12 miles southwest of Gail. Driller, Continental Oil Co.					
Surface soil	10	10	Sand, heavy flow water	35	480
Red rock	50	60	Sand and blue shale	15	495
Sand	15	75	Blue shale and gumbo	17	512
Red rock, water 155-160	180	255	Blue shale	8	520
Red beds	45	300	Red rock	43	563
Brown clay	15	315	Sand, hole full of water	62	625
Blue clay	15	330	Sandy shale	70	695
Blue shale	55	385	Red rock	290	985
Lime, 2 barrels water per hour	11	396	Anhydrite and red rock	90	1,075
Red beds	22	418	Salt and red rock	135	1,210
Sandy lime	7	425	Salt	40	1,250
Sand, 5 bailers water per hour	5	430	Total depth		3,375
Red rock	15	445			
Well G-9, partial log					
W. L. Miller, owner, 16½ miles southwest of Gail. Driller, C. E. Hyde, Hugh G. White and G. L. Wilbanks.					
Clay and sand	7	7	Anhydrite	19	995
Water sand	62	69	Red rock and shells	28	1,023
Red beds	571	640	Hard sand	42	1,065
Red beds, blue shale, and shells	85	725	Hard sand	25	1,090
Sand	65	790	Brown shale	20	1,110
Sandy shale	20	810	Red shale	275	1,385
Red shale	25	835	Red rock	5	1,390
Anhydrite	20	855	Anhydrite	30	1,420
Red shale	7	862	Red rock	15	1,435
Red shale and shells	18	880	Anhydrite	10	1,445
Anhydrite	10	890	Anhydrite and chalk	30	1,475
Red shale	10	900	Anhydrite	10	1,485
Anhydrite	20	920	Salt, anhydrite, and shells	25	1,510
Sand	20	940	Salt	30	1,540
Red rock and shale	36	976	Total depth		3,805
Well G-15					
Fred Thomas, 21 miles southwest of Gail. Driller, J. T. Cook. (From memory).					
Soil	5	5	Clay	80	115
Caliche	30	35	Water sand and gravel	73	188

Table of drillers' logs, Borden County -- Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well G-18, partial log					
Ellis A. Hall, 16 miles southwest of Gail. Driller, Condor Petroleum Co.					
Surface soil	4	4	Gray shale and lime	15	775
White sand	14	18	Lime	15	790
Gravel	12	30	Gray sticky shale	2	792
Red mud	90	120	Conglomerate and red gravel	63	855
Red shale	177	297	Sandy red shale	25	880
Sand, 1 barrel water per hour	18	315	Gray shale	9	889
Sand	15	330	Red shale	15	904
Red shale	117	447	Gray shale, caving hole	3	907
Water sand, hole full of water	18	465	Red shale, caving hole	258	1,165
Shale	170	635	Anhydrite	9	1,174
Blue shale	2	637	Anhydrite and red shale	7	1,181
Sand	18	655	Firm anhydrite	9	1,190
Blue shale	2	657	Anhydrite and red shale	38	1,228
Red shale	16	673	Salt, anhydrite, and red shale	102	1,330
Brown shale and lime	7	680	Salt and potash	138	1,468
Brown shale	20	700	Red potash	9	1,477
Sand, some water	52	752	Salt, potash, and anhydrite	63	1,540
Blue shale	8	760	Total depth		3,822
Well G-20, partial log					
J. A. Phillips, 13½ miles southwest of Gail. Driller, The Texas Co.					
Surface shale and red rock	67	67	Red rock and salt	110	1,330
Red rock	713	780	Anhydrite, salt, and shale	230	1,560
Red rock and shale	260	1,040	Total depth		3,214
Shale and shells	180	1,220			
Well H-1, partial log					
A. M. Clayton, owner, 9 miles southwest of Gail. Driller, Northern Ordnance Co.					
Caliche and gravel	25	25	Red beds and shell	6	894
Red beds	25	50	Red beds	51	945
Red rock and shell	75	125	Red beds and shell	60	1,005
Red beds and boulders	61	186	Red beds and blue shale	41	1,046
Red beds	15	201	Red beds and shell	24	1,070
Red beds and shell	105	306	Shale, anhydrite, and shell	56	1,126
Red beds and boulders	33	339	Shale	74	1,200
Red beds and shell	61	400	Sand	27	1,227
Red beds	67	467	Anhydrite and shale	63	1,290
Red beds and shell	133	600	Salt, anhydrite, shell, and potash	132	1,422
Sand and shell	40	640	Anhydrite and potash	38	1,460
Red beds and shell	10	650	Anhydrite, pink and blue shale	30	1,490
Red beds	5	655	Brown and blue shale	40	1,530
Lime and shell (?)	5	660	Salt and anhydrite	45	1,575
Shale and sand	110	770	Anhydrite and streaks of shale	45	1,620
Red beds	20	790	Anhydrite	15	1,635
Shale and shell	50	840	Sand, streaks of shale	15	1,650
Shale and red beds	48	888	Anhydrite and shale	57	1,707
			Anhydrite and salt	13	1,720
			Total depth		9,499

Table of drillers' logs, Borden County -- Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well H-4, partial log					
-- Munger, 10 miles south of Gail. Driller, Continental Oil Co.					
Surface	8	8	Shale and red rock	133	830
Sandy red rock	7	15	Shale and shells	102	932
Red beds	160	175	Anhydrite and shale	38	970
Shale and shells	275	450	Anhydrite and salt	111	1,081
Sand	20	470	Shale and anhydrite	24	1,105
Shale and shells	30	500	Salt and shale	105	1,210
Red rock and shale	134	634	Total depth		3,405
Shale, red rock, and gypsum	63	697			
Well H-5, partial log					
A. J. Long, 9 miles southeast of Gail. Driller, Anderson-Parkhurst-Reeves.					
Soil	3	3	Blue slate	45	560
Sand rock	27	30	Sand, water	10	570
Red rock, water	160	190	Sand and coal	5	575
Sand	15	205	Blue slate	15	590
Red rock	75	280	Sand, water	15	605
Water sand, 9 barrels per hour	45	325	Sand	15	620
Lime	6	331	Brown shale	15	635
Blue slate	29	360	Red rock	45	680
Slate	5	365	Red beds	30	710
Sand, water, 10 barrels per hour	25	390	Sand, heavy flow water	10	720
Slate	20	410	Red rock and mud	290	1,010
Sand	10	420	Salt	270	1,280
Blue shale	5	425	Lime	15	1,295
Sand	20	445	Red rock	95	1,390
Sandy lime	20	465	Salt	20	1,410
Light shale	10	475	Total depth		3,209
Red rock	40	515			
Well H-8, partial log					
H. D. Beal, 13 miles south of Gail. Driller, C. E. Hyde.					
Red mud	39	39	Red rock	5	445
Red rock	156	195	Blue shale	40	485
Sandy shale, trace water	10	205	Brown shale	5	490
Red mud	74	279	Blue shale	55	545
Blue shale	5	284	Red rock	30	575
Red mud	6	290	Blue shale	25	600
Brown shale	10	300	Brown shale	40	640
Blue shale	35	335	Sandy lime	5	645
Sandy shale	22	357	Red rock	335	980
Brown sand, 3 bailers water per hour	11	368	Anhydrite	25	1,005
Blue shale	17	385	Anhydrite and red rock 4 barrels water per hour	25	1,030
Brown sand, 1 bailer water per hour	3	388	Gypsum	7	1,037
Lime	5	393	Anhydrite and salt	13	1,050
Blue shale	12	405	Gypsum and salt	55	1,105
White sand, water	15	420	Total depth		3,602
Blue shale	20	440			

Table of drillers' logs, Borden County -- Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well H-11, partial log					
J. M. Higginbotham, 13½ miles south of Gail.					
Red mud	70	70	Blue sandy shale	40	655
Red beds	50	120	Blue shale	32	687
Red mud	30	150	Lime	8	695
Red beds	113	263	Broken lime	5	700
Red mud	42	305	Blue shale	35	735
Red beds	85	390	Lime	3	738
Brown mud	20	410	Sand, hole full of water	17	755
Blue shale	15	425	Red beds	195	950
Water sand, hole full of water at 428 feet	40	465	Sandy red rock	10	960
Red rock	10	475	Gummy red bed	65	1,025
Sand, water	30	505	Red beds	35	1,060
Brown shale	5	510	Gypsum and red rock	10	1,070
Blue muck	15	525	Red mud	65	1,135
Sandy blue shale	14	539	Salt and red rock	75	1,210
Hard gray lime	6	545	Salt	25	1,235
Blue shale	65	610	Total depth		3,757
Broken brown sand	5	615			
Well J-1, partial log					
J. R. Canning, 16 miles southeast of Gail. Driller, Honolulu Oil Co., et. al.					
Sand and Caliche	25	25	Water sand, hole full of salt water	35	580
Red shale	220	245	Sand and gravel	180	760
Gray shale	25	270	Red sand and shale	116	876
Gravel and sand	15	285	Anhydrite and red shale	35	911
Sand, ½ barrel water per hour	10	295	Salt and shale, water broke in, reset 10¾-inch casing at 942 feet	59	970
Gray and broken shale	50	345	Anhydrite and salt	46	1,016
Water sand, hole full of water	55	400	Anhydrite, salt, and sand	44	1,060
Shale	70	470	Total depth		4,302
Water sand, hole full of water	45	515			
Shale	30	545			
Well J-4					
Mrs. F. M. Long, 14 miles southeast of Gail. Driller, Jones Drilling Co.					
Red clay and shale	80	80	Salt-water sand	5	311
Salt-water sand	11	91	Lime	15	326
Sandy shale	40	131	Dry sand	14	340
Water sand	5	136	Lime and shale	158	498
Gumbo and shale	40	176	Hard sand	2	500
Water sand	2	178	Soft sand	12	512
Sandy lime shells	52	230	Shale (slight oil and gas showing)	2	514
Fresh water sand	8	238			
Blue shelly lime	68	306			

Table of drillers' logs, Borden County -- Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well J-12					
E. M. Conrad, 18½ miles southeast of Gail. Driller, Coffield and Guthrie, Inc.					
Clay	5	5	Anhydrite	55	810
Red rock	20	25	Salt	330	1,140
Red beds	130	155	Anhydrite	260	1,400
Brown shale	70	225	Red beds	130	1,530
Gray shale	15	240	Anhydrite	205	1,735
Sand, water	35	275	Red sand	170	1,905
Shale	185	460	Potash and salt	110	2,015
Sand, water	35	495	Sand and shale, water	70	2,085
Shale	135	630	Lime	920	3,005
Gravel	5	635	Shale	5	3,010
Red beds	120	755	Gray and brown lime	864	3,874
Well J-13					
Conrad Ranch, 20½ miles southeast of Gail. Driller, Geo. Goodrum.					
Dry sand	15	15	Salt water, hole full of water		
Gravel	10	25	Gray sandy shale	10	500
Red sandy shale	105	130	Gray lime	30	530
White sand, water	85	215	Gray shale	8	538
Red sandy shale	35	250	Red beds	5	543
Gray sand, dry	32	282	Sandy gray shale	12	555
Blue shale	10	292	Sand, hole full of salt water	15	570
Shale	54	346	Gray lime	31	601
Red sandy shale	4	350	Red beds	94	695
Blue shale	67	417	Gray sand, salty water	7	702
Gray sand	9	426	Gray shale	7	709
Gray shale	9	435	Gray lime	4	713
Gray slate	11	446	Sandy gray shale	34	747
Gray sandy lime	9	455	Sand and gravel, hole full of water	22	769
Sandy gray shale	23	478	Red beds	15	784
Gray sand, water	12	490	Sand, water	7	791
Well J-14					
Conrad Ranch, 20 miles southeast of Gail. Driller, Geo. Goodrum.					
Red beds	45	45	Gray shale	28	434
Gray shale	20	65	Blue shale, caving	12	446
Gray lime	6	71	Gray sand, hole full of water	49	495
Sand, water	24	95	Gray lime	10	505
Red beds	70	165	Red beds	175	680
Gray shale	15	180	Salt and potash	6	686
Sand, water	30	210	Gray lime	3	689
Red beds	40	250	White salt	25	714
Gray sand	10	260	Anhydrite	12	726
Red beds	35	295	Light-gray shale	2	728
Sand, salty water	90	385	Red beds	6	734
Sand	15	400	White salt rock	16	750
Lime	6	406			

Table of drillers' logs, Borden County -- Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well J-17, partial log					
Ida Anderson Smith, 18½ miles southeast of Gail. Driller, Cosden Petroleum Corp.					
Surface	12	12	Shale	30	525
Red rock	28	40	Sand and shells	230	755
Shale and shells	195	235	Shale and anhydrite	835	1,590
Water sand	30	265	Shale and shells	130	1,720
Red rock	45	310	Anhydrite	275	1,995
Shells	140	450	Total depth		4,000
Sand	45	495			
Well J-22					
T. A. Bade, 16½ miles southeast of Gail. Driller, Cecil Murdock.					
Sandy clay	25	25	Water sand	8	108
Red clay	75	100	Hard blue rock	5	113

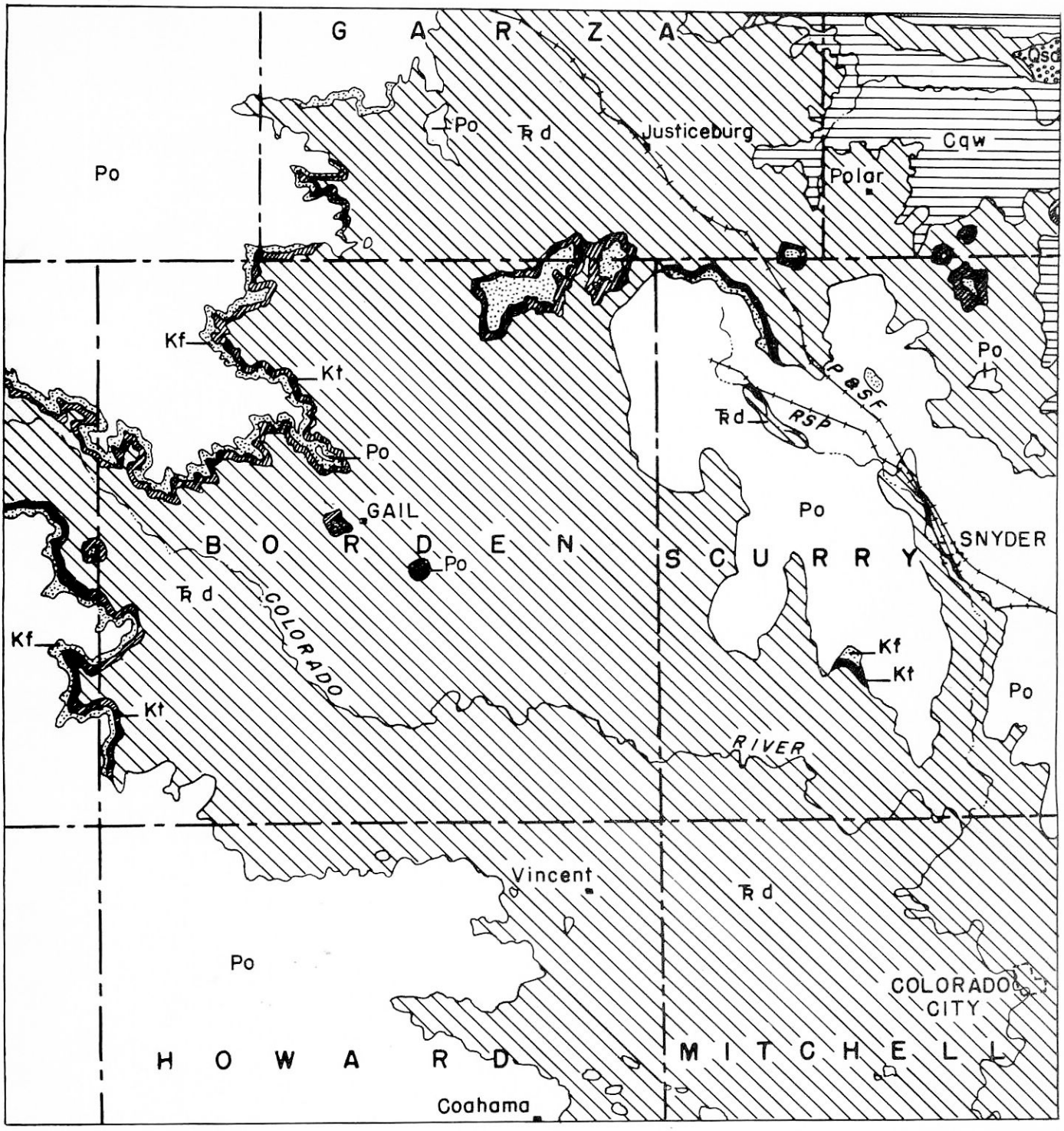
Partial analyses of water from wells in Borden County, Texas

Analyzed in the laboratory of the Quality of Water Branch, U. S. Geological Survey, Austin, Texas, under the direction of Burdge Irelan, District Chemist. Results are in parts per million. Well numbers correspond to numbers in table of well records.

Well	Owner	Depth of well (ft.)	Date of collection	Dissolved solids	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium ($Na + K$)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Total hardness as $CaCO_3$
A-1	J. W. Stuart	30	Sept. 16, 1948	1,680	56	123	66	353	296	488	392	53	578
A-3	W. J. Huff	90	do.	986	56	125	43	141	312	195	229	16	489
A-4	Ben Williams	60	do.	1,100	50	129	57	161	265	260	282	28	556
A-5	Mrs. Minnie Scott	36	do.	2,630	53	236	96	509	248	848	710	4	984
A-6	R. R. Reagan	--	June 29, 1948	2,250	48	199	72	464	248	757	526	34	792
A-8	John Dennis	143	do.	1,860	8.5	31	17	624	314	547	440	2.2	148
A-9	A. M. Clayton	150	Aug. 24, 1948	5,590	11	96	73	1,890	286	955	2,420	1.0	540
A-10	do.	Spring	do.	5,480	14	110	78	1,810	294	927	2,380	2.5	595
A-11	C. B. Hays	60	June 29, 1948	600	36	56	42	91	292	128	74	16	312
A-12	Mary Cantril	81	Sept. 16, 1948	1,600	44	216	50	269	270	355	508	28	744
A-13	Clyde Couch	51	do.	1,530	46	142	53	300	332	373	325	130	572
A-14	John Stevens	214	June 29, 1948	3,360	8	26	16	1,220	336	551	1,340	5	131
A-15	Mrs. W. S. Street	74	do.	1,270	38	112	42	273	328	317	305	19	452
A-16	N. Salleh	46	do.	1,280	46	136	100	144	440	181	238	222	750
B-2	Burt Dennis	55	do.	850	15	30	15	274	466	136	124	13	136
C-2	G. A. Milliken	36	June 30, 1948	366	52	74	31	7	306	12	8	0	312
C-3	R. V. Dougherty	139	do.	388	38	35	15	83	302	35	30	2.8	149
C-4	J. J. Belew	65	do.	415	35	68	19	25	170	26	52	78	247
C-5	R. B. Wills	141	do.	314	34	54	17	32	240	21	17	2.2	208
C-6	V. A. Wills	200+	Aug. 25, 1948	3,740	11	78	28	1,310	204	349	1,860	3.5	310
C-7	Bunyon L. Evans	50	do.	267	53	42	16	15	212	12	2.8	13	171
C-8	Roy Reeder	122	do.	607	12	12	5.9	213	360	54	101	4.2	54
C-9	T. J. Rea	104	June 30, 1948	988	14	27	9.9	331	330	123	285	1.0	108
D-2	W. C. Orson	60	June 29, 1948	986	10	17	19	325	552	218	90	0.0	120
D-4	C. C. Cannon	130	June 17, 1948	978	12	8.4	6.6	357	508	227	90	0	48
D-5	do.	19	do.	1,010	34	50	33	268	418	245	148	5.0	260
D-8	A. M. Clayton	77	June 29, 1948	975	13	21	9.7	336	538	235	83	.5	92
D-9	Jerry Clayton	15	June 16, 1948	884	15	48	21	256	270	244	138	4.7	206
E-1	A. M. Clayton	49	Aug. 25 1948	776	9.2	14	8.5	273	446	107	117	2.2	70
E-2	J. R. Roper	63	do.	3,580	10	112	76	1,020	570	1,620	460	1.2	574
E-3	A. J. Cantrell	60	June 9, 1948	1,140	18	18	8.8	397	474	297	110	13	81
E-4	Mrs. E. W. Hollers	15	Sept. 16, 1948	530	22	129	24	24	451	68	18	9.2	420
E-5	V. R. Clark	42	June 7, 1948	2,160	31	284	101	248	294	718	265	373	1,120
E-9	A. M. Clayton	1,560	--	--	--	5,800	28,900	48,950	--	850	169,400	--	133,000
E-10	do.	335	Sept. 16, 1948	10,800	7.2	185	94	3,660	279	2,410	4,300	--	848
F-1	Mrs. Myrtle McKnight	61	Aug. 25, 1948	2,380	11	46	21	835	206	208	1,140	4.5	202
F-2	Morris Miller	86	Sept. 15, 1948	806	40	158	45	59	241	59	309	17	580
F-4	Standing pool in 5-mile Creek	--	June 30, 1948	115	6.5	21	2.5	13	90	12	2.0	3.2	63
F-6	Billy Askins	--	do.	351	56	36	12	62	204	15	48	1.8	140
F-7	Fred Miller	7	do.	959	24	41	30	256	364	253	118	2.4	226
F-8	Frank Strom	20	June 23, 1948	959	47	18	9.0	288	310	137	119	144	82
F-11	R. L. Gray	20	June 8, 1948	1,230	24	48	23	334	202	303	195	188	214
F-13	J. R. Canning	20	June 23, 1948	248	20	52	12	20	194	11	9.0	8.8	179
G-3	W. L. Miller	60	June 16, 1948	829	67	60	43	144	296	172	90	48	326
G-6	Jerry Clayton	20	do.	766	15	24	19	230	316	221	74	1.5	138
G-8	do.	--	do.	1,210	14	11	6.6	438	430	278	208	2.2	54
G-10	T. J. Good	125	June 17, 1948	577	58	48	36	96	278	104	73	5.3	268
G-11	do.	--	June 16, 1948	700	60	109	46	51	288	175	92	4.8	461

Partial analyses of water from wells in Borden County -- Continued

Well	Owner	Depth of well (ft.)	Date of collection	Dissolved solids	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Total hardness as $CaCO_3$
G-12	G. F. Ingram	135	June 16, 1948	546	54	34	33	109	324	81	47	8.2	220
G-13	R. B. Wiggins	120	June 15, 1948	574	45	28	27	131	322	96	49	7.5	181
G-14	Fred Thomas	141	Aug. 24, 1948	538	42	48	31	83	294	92	63	3.8	248
G-15	do.	179	do.	562	44	30	28	118	318	101	57	3.8	190
G-16	H.C.Fambrough	130	June 16, 1948	580	44	43	27	122	314	108	64	7.3	218
G-17	T. J. Good	120	June 15, 1948	654	54	41	35	138	360	115	74	5.9	246
G-21	do.	440	do.	5,780	10	80	36	1,980	278	1,560	1,980	1.5	348
G-22	Dewey Hanks	22	do.	273	25	69	9.8	8.5	184	18	12	18	212
G-23	C. H. Zant	63	June 16, 1948	1,160	56	103	62	211	330	239	312	14	512
H-2	Jerry Clayton	15	do.	1,160	17	123	52	213	402	377	164	.0	521
H-9	H. D. Beal	18	June 7, 1948	418	19	27	13	103	198	96	42	13	121
H-11	J.M.Higginbotham	450	June 15, 1948	5,300	14	41	24	1,860	406	1,460	1,680	4.5	201
H-12	Wilson Bros.	585	June 10, 1948	6,440	5.0	26	28	2,300	476	1,730	2,080	.5	180
H-13	John Whitmire	35	do.	572	29	32	18	149	340	86	49	34	154
H-15	Morgan Coates	30	June 7, 1948	385	32	19	31	69	276	29	8.0	2.2	175
J-6	Ed Murphy	25	June 8, 1948	712	44	84	20	119	258	138	48	100	292
J-7	N.C. von Roeder	39	June 9, 1948	2,210	52	382	81	246	177	500	760	104	1,290
J-8	do.	40	do.	2,070	38	345	74	266	198	387	795	71	1,170
J-9	Standing water in Colorado River	--	Aug. 25, 1948	246	9.5	20	4.5	64	155	59	12	15	68
J-11	L. B. Conrad	--	Nov. 22, 1948	808	64	55	24	208	620	106	49	.0	236
J-15	Borden County	29	Aug. 25, 1948	288	20	64	13	19	258	15	3.8	8.8	213
J-16	B. O. Williams	23	June 7, 1948	268	18	67	14	4.0	216	19	5.0	20	225
J-18	J. L. McNiel	205	June 10, 1948	8,780	6	192	91	2,740	237	3,560	2,070	1.5	853
J-19	J.C.Sheppard	190	June 7, 1948	5,770	15	109	44	1,920	386	1,650	1,820	1.5	453
J-20	A. L. Holly	260	do.	5,960	8.5	66	35	2,070	430	1,570	1,980	3.5	308
J-21	T. L. Griffin	415	do.	415	22	64	21	61	384	37	11	.0	246
J-22	T. A. Bade	113	Sept. 15, 1948	2,880	5.8	6.0	12	1,040	10	701	1,050	9.5	64
J-23	do.	119	do.	17,700	9.2	679	341	5,390	214	3,200	8,020	--	3,100
J-24	M. E. Bacon	46	do.	1,060	21	106	59	188	581	323	65	15	507
J-25	W. L. Cain	50	June 7, 1948	360	24	48	21	49	234	50	30	2.2	206
J-26	T. L. Griffin	96	do.	2,920	15	37	47	903	525	1,430	218	4.0	286
J-27	Charles Brown	240	Sept. 15, 1948	7,900	1.1	136	77	2,640	146	1,980	2,990	--	656
J-28	Pat Harding	190	June 10, 1948	9,840	12	211	193	3,090	253	2,560	3,640	9.6	1,320
J-29	C. H. Garner	139	Aug. 25, 1948	8,320	9.2	160	81	2,750	265	2,210	2,970	--	732
J-30	Charles Brown	160	June 10, 1948	9,040	5.5	189	92	3,000	202	2,090	3,540	--	850



EXPLANATION

- Qsd — Sand dunes
- Po — Ogallala formation
- Kf — Fredericksburg group
- Kt — Trinity group
- Trd — Dockum group
- Cqw — Quartermaster formation and Whitehorse sandstone, undifferentiated

Quaternary-Tertiary; Cretaceous; Permian Triassic

FIGURE 1

GEOLOGIC MAP OF BORDEN COUNTY, TEXAS, AND SURROUNDING AREA.

0 10 Miles

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From geologic map of Texas, U. S. Geological Survey, 1937

mlc-1949

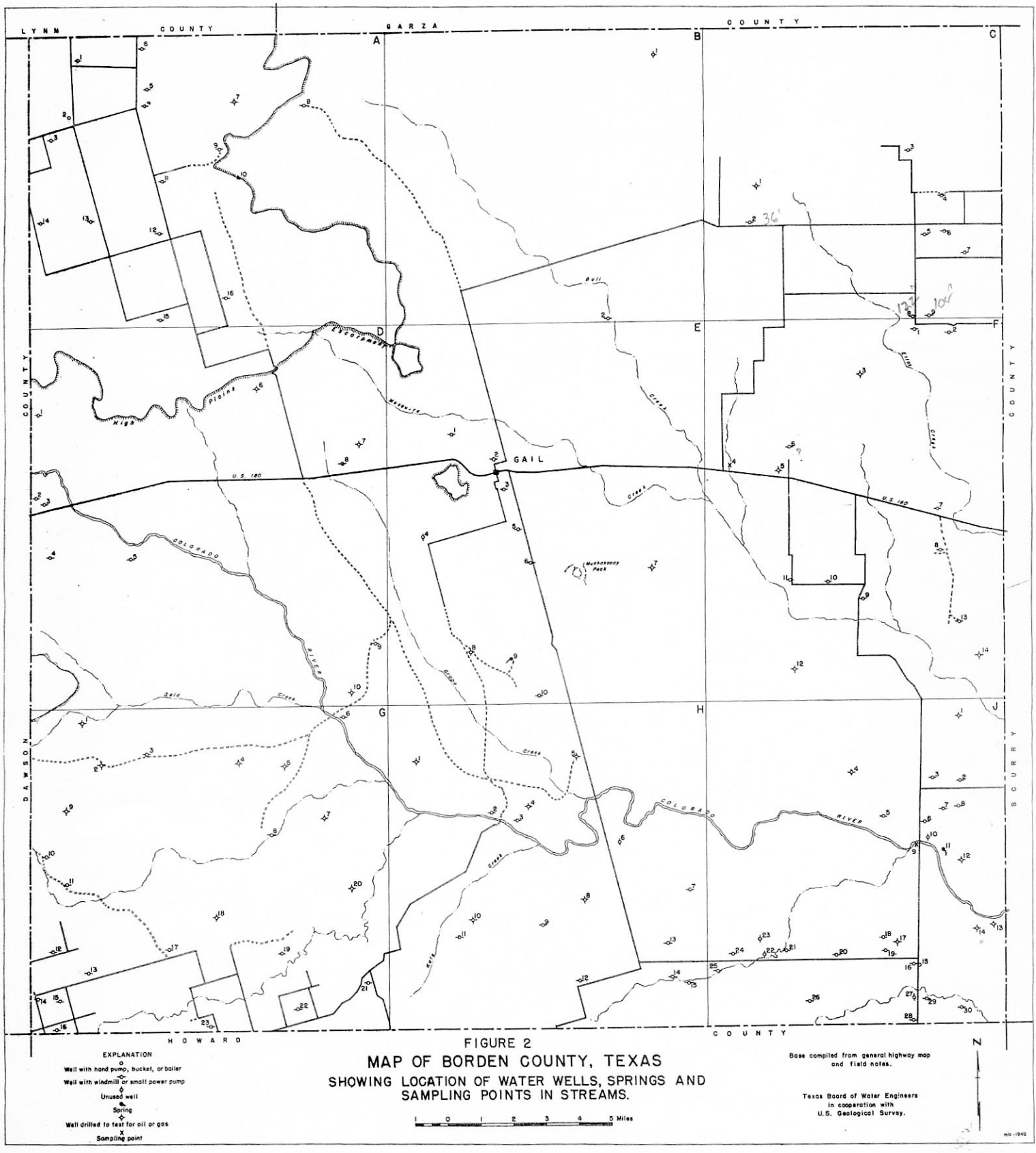

FIGURE 2

MAP OF BORDEN COUNTY, TEXAS

SHOWING LOCATION OF WATER WELLS, SPRINGS AND SAMPLING POINTS IN STREAMS.

Base compiled from general highway map and field notes.

Texas Board of Water Engineers in cooperation with U.S. Geological Survey.