OCCURRENCE OF GROUND WATER

IN THE PALANGANA BRINE FIELD

DUVAL COUNTY, TEXAS

by

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Geologist

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C O N T E N T S

T A B L E

I L L U S T R A T I O N S

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INTRODUCTION

Location and Description

The Palangana Brine Field, located in east central Duval County, Texas, is about five miles north of Benavides, 11 miles southwest of San Diego, and 23 miles southeast of Freer. An area of approximately 80 square miles surrounding Palangana is included in this discussion.

The Goliad formation crops out over the entire area. The land in general is covered by a red sandy soil. Nearly everywhere caliche is present either at the surface or under a thin mantle of soil. The area is cut from west to east by Santa Gertrudis Creek.

Purpose and Scope

This memorandum report summarizes little known facts about ground-water conditions in a part of Duval County, Texas, and is submitted for use in long range planning by the Board of Water Engineers. Specifically, this report is submitted to the Board to assist in determining the feasibility of a fresh-water-supply district at Freer, Texas, to determine the justification for expending public funds for detailed investigations, and to determine necessary protection measures for fresh-water strata in routine oil exploration and production.

This report evaluates electric logs, water analyses, drillers' logs, and available geologic data, and contains discussions of geology of fresh-water-bearing rocks, chemical character of ground water, quantitative aspects of ground-water supply, present utilization of ground water, and conclusions.

GEOLOGY OF FRESH WATER BEARING ROCKS

A possible source of fresh, ground water in the area is a sand section near the base of the Goliad formation. This sand averages about 150 feet in thickness with a characteristic shale break near the center. It occurs at depths ranging from about 200 to 400 feet and is present over the entire area. The northern and southern limits of this sand, beyond the field area, have not been investigated; but the sand appears to be extensive.

A second fresh-water-bearing section in the Goliad is encountered at depths between 100 and 200 feet over most of the area. It does not appear, however, in water wells 10, 11, and 12, and oil test 7 (Plate 2, Table 1). It is stratigraphically higher than the lower Goliad sand and consists of sand and gravel. North of the area it is not definitely recognizable, and its southern extent has not been investigated.

A deeper sand section, which is probably the base of the Oakville, is also present over the area. This section averages 100 feet in thickness and is encountered at depths ranging from 800 feet to 1300 feet. Northwest of a line running approximately through the center of the area (Plate 2), water from this section becomes too highly mineralized to be usable. This sand is found at 1,100 feet in water well #14, Columbia Southern Chemical Corporation, (Plate 2, Table 1) and at a depth of about 1,200 feet immediately east of Benavides. To the northwest and in the immediate vicinity of the Palangana salt dome it is found at shallower depths. It is absent in water well #15 (Plate 2, Table 1) where the salt was encountered at 455 feet.

CHEMICAL CHARACTER OF GROUND WATER

An analysis of water from the lower Goliad sand at Palangana made in 1937 shows the total dissolved solids to be about 800 ppm. An analysis of water taken from 370 to 390 feet in Test Well #2, (Plate 2, Table 1), July 19, 1955, shows the total dissolved solids to be 1,087 ppm with the chloride content

333 ppm. Complete chemical analysis is shown below:

Test Well Number 2

Parts per Million

Calcium Bicarbonate	218
Magnesium Bicarbonate	84
Sodium Bicarbonate	88
Sodium Sulfate	268
Sodium Chloride	333
Silica	53
Iron Oxide	0.1
Aluminum Oxide	4.9
Volatile & Organic Matter	38
Total Dissolved Solids	1,087

An old analysis of water from the 100 to 200 foot sand section of the Goliad at Benavides made in 1937 showed only 640 ppm total dissolved solids.

Overlying shallower sands of the Goliad formation contain water which is moderately to highly mineralized; in all cases being more mineralized than the deeper sands. Sayre (A. N. Sayre, Water-Supply Paper 776, U. S. Geological Survey) explains the common occurrence of water less mineralized in the deeper sands than in the shallower sands.

> ***the deeper sands are more extensive. They are coarser and therefore have higher permeability and the water moves down dip through them rather readily, supplying the artesian wells (farther) to the east, whereas the shallower beds may be more or less lenticular, and the water in them does not circulate readily and has therefore dissolved a large amount of mineral matter. The presence of caliche over most of the outcrop area of the Goliad also appears to affect the quality of the water. By reducing the permeability of the surface soil and formations immediately underlying the soil, it prevents the ready access of water from the surface to the water-bearing beds. Consequently the water in the shallower beds tends to be not only small in quantity but rather highly mineralized, because of the slow rate at which the formation received fresh water. In certain places, however, where the formation is especially permeable and caliche is either absent or not abundant enough to form an impermeable barrier to the passage of water, a considerable amount of water finds its way from the surface into the formation, and wells in such areas yield water of low mineral content. These areas where caliche is absent are apparently much localized and may exist only where streams have cut through the caliche, where the caliche is absent as in the numerous 'sinks', or where conditions for the formation of caliche have not been favorable. It is in these areas that the greatest proportion of the recharge to the water-bearing beds occurs.

An analysis of the water in the Oakville sand section taken on December 8, 1955, from 1,106 to 1,252 feet in water well #14 is shown below:

Water Well Number 14

Parts per Million

R_2O_3	1
Calcium Sulfate	19
Remaining Sulfate as Sodium Sulfate	746
Calcium Chloride	-
Magnesium Chloride	2
Actual Sodium Chloride	493
Sodium Carbonate	53
Sodium Bicarbonate	286
Total Dissolved Solids	1,558

This sand is separated from the Goliad water-bearing sections by about 500 feet of Lagarto clay which prevents communication between the two.

According to analyses, the water in the Oakville section is comparable in quality to that of the lower Goliad section. This comparison is not evidenced, however, on electric logs where the sands of the Oakville appear to contain fluids considerably higher in mineral content than those of the Goliad formation. No explanation for this was found during the study.

QUANTITATIVE ASPECTS OF GROUND WATER SUPPLY

Recharge and Discharge

Recharge to the several aquifers containing fresh, ground water comes mainly from downward percolation of precipitation and runoff on the areas of their outcrop. The amount of recharge has not been determined. The ground water moves generally downdip in an easterly and southeasterly direction toward points of natural discharge. With no withdrawal from wells, the amount of annual recharge is about the same as the natural discharge. Artificial discharge from wells reduces the natural discharge; when well withdrawals exceed recharge, water is taken from storage and the water level in the affected part of the ground-water reservoir declines. The amount of water in storage in the aquifers and the amount being added by recharge are, therefore, important factors in determining whether an adequate supply of ground water can be obtained.

As previously stated, vertical percolation through overlying shallower beds is almost negligible in the Palangana area because of the presence of caliche which reduces the permeability of the surface soil and the beds immediately below the soil thereby preventing the ready access of water from the surface to the deeper water-bearing beds.

To the west-northwest of the Palangana area the Oakville is found at increasingly shallow depths. The Lagarto clay thins to a wedge-shaped edge, and the Oakville in places is in contact with the overlying Goliad formation. As the Oakville is completely overlapped by the Goliad, it seems apparent that recharge to the Oakville must come from downward percolation in those areas where no clay is present between the Goliad and Oakville to prevent communication. This common source of recharge probably explains the similarity in quality of water in the two sands as found at Palangana.

The occurrence of fresh water in the Oakville downdip from brackish water may be due partly to the presence of the salt dome which has penetrated the Oakville in the area. As the Oakville increases in shale content toward the west it is difficult to determine whether or not it contains fresh water up dip and away from the salt. In any case no explanation has been found for the method of recharge to the fresh-water section downdip from the dome.

Quantity of Water

Very little information is available on the quantity of water in the lower Goliad sand, but several wells producing from this sand section have been pumped for considerable periods at a rate of over 100 gallons a minute. Mr. W. A. Pumprey of the Columbia Southern Chemical Corporation reports that water wells one through nine produce an average of 60 gpm each, while water wells 10, 11, and 12 average 300 gpm each, and water well 13 produces an average of 200 gpm (Plate 2, Table 1).

No information is available as to the quantity of water in the upper Goliad sand section.

Water well #14, pumping from the Oakville formation between 1,106 and 1,252 feet, yielded over 600 gpm when tested in January 1956 with a maximum drawdown of 10 feet for a 24-hour period.

PRESENT UTILIZATION OF GROUND WATER

The only known wells producing water from the lower Goliad sand are those of the Columbia Southern Chemical Corporation as previously mentioned, wells at the town of Benavides, and local ranch and farm wells. Two Benavides wells produce from depths of 328 and 356 feet and yield about 100 gallons per minute.

The Columbia Southern Chemical Corporation is reportedly also using water from the Oakville sections for production and domestic purposes.

The upper Goliad sand supplies water to ranches and farms in the areas where it is encountered.

CONCLUSIONS

Mineralized but usable water is available from a sand section near the base of the Goliad formation in the Palangana Brine Field area of east central Duval County. The average thickness of the sand is about 150 feet, and its areal extent is greater than the 80 square miles covered in this report. The capacity of the aquifer to store and transmit water is not precisely known. However, data show that sustained production of about 100 gpm or more from individual wells can be expected over a substantial period of time if the wells are widely spaced.

Quality of water data are too meager to predict the trend of mineralization that may occur with sustained production. However, recharge to the potential water producing horizon is adversely affected by the presence of caliche which reduces the permeability of the surface and near-surface rocks. Therefore, the quality of water in the sand probably will not improve with pumpage and will likely increase in total dissolved solids. In the southeastern portion of the area studied, water is available in the Oakville sand section. However, because of the erratic nature of this sand and the questionable source of its recharge, it appears that it would be satisfactory for limited use only.

TABLE 1. Depths below land surface of lower Goliad and Oakville fresh-water-bearing sand sections.

Test Wells	Top Goliad section	Base Goliad section	Top Oakville section	Base Oakville section
1	355	520	1300	1350
2	365	520	1280	1325
5	250	385	995	1025
6	245	355	980	1070
7	300	400	1078	1248
8	265	405	1098	1250
Water Wells				
1	255	349	--	--
2	223	355	--	--
3	267	380	--	--
4	252	365	--	--
5	257	360	--	--
6	--	--	--	--
7	265	367	--	--
8	395	556	--	--
9	272	565	--	--
10	310	445	1240	1325
11	330	460	--	--
12	340	430	--	--
13	315	460	--	--
14	265	405	1100	1255
*15	260	385	--	--
Oil Tests				
1	--	545	1235	1300
2	--	490	1225	1370
3	360	480	1180	1210
4	335	470	1180	1330
5	320	450	1195	1320
6	350	490	1275	1380
7	430	475	1060	1135
8	--	510	900	990
9	--	415	1040	1140
10	200	415	1080	1170
11	--	--	1105	1205
12	--	--	1095	1252
13	--	440	1107	1260
14	--	570	1195	1336
15	300	565	1320	1430
16	--	535	1245	1368
17	--	525	1235	1370
18	--	--	1240	1310
19	--	575	1270	1370
20	220	560	1225	1310
21	--	545	1260	1370
22	--	560	760	900
23	--	540	960	1105
24	220	290	--	--
25	245	420	990	1040

* Brine well. Depths for water wells 1 through 8 were obtained from drillers' logs. All others were taken from electric logs.

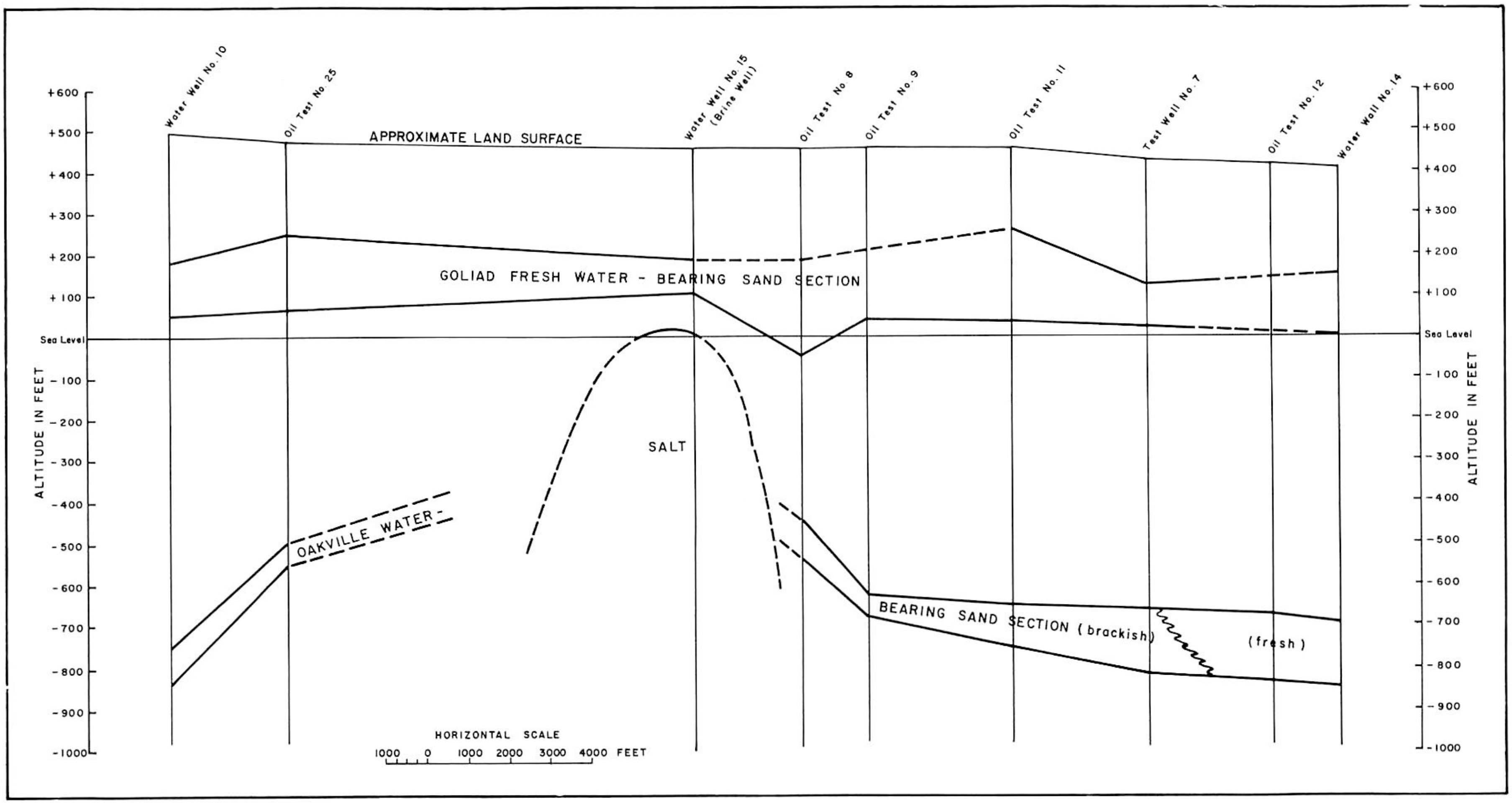

PLATE I - GENERALIZED CROSS SECTION A - A', DUVAL COUNTY, TEXAS

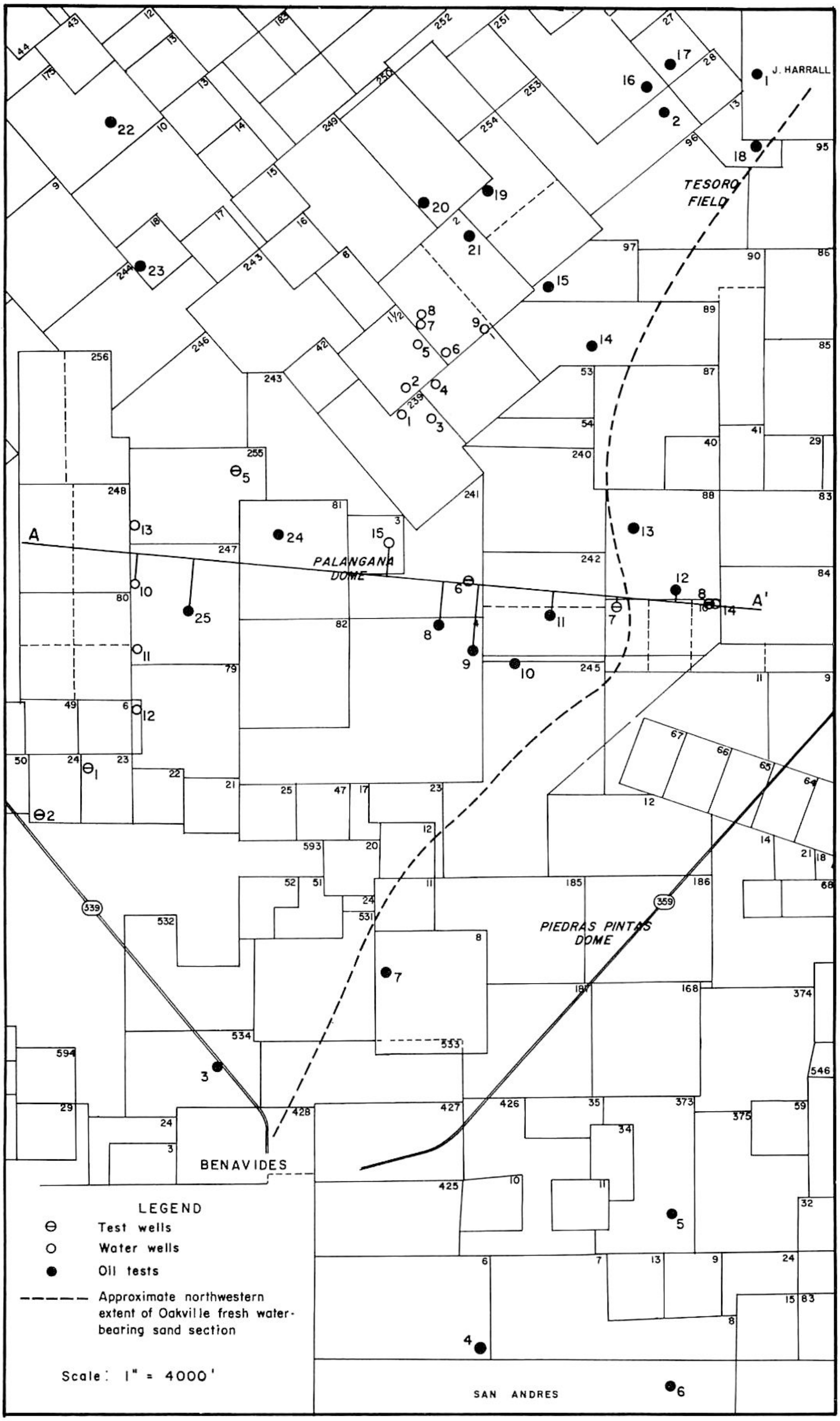

PLATE 2 - MAP SHOWING LOCATIONS OF TEST WELLS, WATER WELLS, OIL TESTS AND APPROXIMATE NORTHWESTERN EXTENT OF OAKVILLE FRESH WATER-BEARING SAND SECTION, PALANGANA BRINE FIELD, DUVAL COUNTY, TEXAS