CONTAMINATION OF LAKE WEWOKA AND FRESH-WATER SANDS BY DISPOSAL OF OIL-WELL BRINES NEAR WEWOKA, SEMINOLE COUNTY, OKLAHOMA

U.S. GEOLOGICAL SURVEY

Open-File Report 41-xxxx

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Norman, Oklahoma
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Contamination of Lake Wewoka and fresh-water sands by disposal of oil-well brines near Wewoka, Seminole County, Oklahoma

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This report deals with ground-water conditions in an area about 5 miles wide from east to west and 8 miles long from north to south, in Tps. 8 and 9 N., Rs. 7 and 8 E., in Seminole County, Oklahoma, including the town of Wewoka and Lake Wewoka. The possible contamination of the lake waters from oil-well brines disposed through a well 3.75 miles north of the lake, and other effects of brine disposal, are considered.

The investigation was made at the request of Frank Raab, member of the Oklahoma Planning and Resources Board, and Don McBride, Chief Engineer of the Division of Water Resources who has the responsibility of preventing contamination of water supplies in Oklahoma.

Field work was done July 5 and 6, 1941, by Robert H. Dott, Director of the Oklahoma Geological Survey; C.G. Lalicker, Department of Geology, University of Oklahoma; and S.L. Schoff, Assistant Geologist in the Ground Water Division, Water Resources Branch, of the U.S. Geological Survey.

Lalicker spent both days studying the rocks exposed in the vicinity and measuring their thicknesses. A copy of the composite section measured by him is attached. Dott and Schoff spent one day collecting the well information summarized in Table I, and one day with Lalicker on the stratigraphy.

Statement of Problem

The purpose of the investigation was to determine whether the disposal of oil-well brines through a 384-foot disposal well in the NE 1/4 sec. 14, T. 9 W., R. 7 E. could contaminate the waters of Lake Wewoka, and whether the disposal of the brine might damage ground-water supplies in the general vicinity.

General Geology

The rocks exposed in the area are the middle and upper parts of the Francis formation below (360 feet thick), overlain in turn by the Belle City limestone (1-3 feet thick), the Ochelata shale (30-50 feet thick), and the lower part of the Vamoosa formation. The outcrops of these formations trend roughly north-south across the area.

The Francis formation consists of four groups of sandstones separated by shales. Each group of sandstones

contains thin shale beds, but sandstone predominates and the four groups therefore make ridges or escarpments that can be traced long distances. These sandstones are numbered from the bottom up, and the position of the bases of the sandstones thought to represent numbers 2 and 3 are shown on the map accompanying this report. The brine disposal well and most of the deeper water wells in the area stop in this formation.

The Belle City limestone ranges from a few inches to a few feet in thickness, and was used in this investigation for determining the stratigraphic position of widely separated outcrops. The places at which it was found are shown on the map.

The Ocheleta shale is a relatively thin unit. The Vamoosa, above it, consists of sandstones and shales. The brine disposal well begins on the outcrop of the Vamoosa and therefore penetrated the lower part of it and the Ochelata, before entering the lower formations.

The dip of the rocks is generally westward, with local irregularities that may reflect subsurface structures that account for the oil-production of the area. In the brief period available for field investigation, these local irregularities could not be worked out, but the dip was measured on the Belle City limestone at three localities as

follows:

(1) South line of sec. 12, T. 9 N., R. 7 E.: 120 feet per mile, westward.

(2) South line of sec. 25, T. 9 N., R. 7 E.: 160 feet per mile, westward.

(3) Secs. 14-15, 22-23, T. 8 N., R. 7 E.: 100-110 feet per mile, northwestward.

Disposal Well, Lake Wewoka, and Geologic Formations

The location of the disposal well in sec. 14, T. 9 N., R. 7 E., and location of Lake Wewoka are shown on the map.

The well begins at an elevation of 972 feet above sea level, and is 384 feet in depth. Fresh water was encountered in a sandstone between depths of 170 and 210 feet, and salt water was found in sandstones from 230 to 260 feet, 280 to 332 feet, and 336 to 352 feet. To protect the fresh water, 8-inch casing was set at a depth of 212 feet and cemented to the top. The elevation of the bottom of this casing 760 feet; and of the top of the first sand below it into which brine could be disposed, 742 feet; of the bottom of the lowest sand in the

well, 620 feet above sea level.

Lake Wewoka is about 3.75 miles south-southeast of the disposal well. The elevation of the base of the downstream face of the dam at the lowest point in the valley was determined by hand level and aneroid as about 800 feet above sea level. Thus the lowest part of the lake bottom, through which the brine from the disposal well would have to come if it were to contaminate the lake water, is 40 feet higher than the bottom of the casing in the disposal well; 58 feet higher than the top of the highest sandstone that could transmit water from the well to the vicinity of the lake; and 180 feet higher than the base of the lowest sand used for brine disposal. Only if brine in a very large volume were introduced continuously under pressure in the vicinity of the disposal well, producing an artificial artesian head, could the salty water be made to rise through the sandstones into the lake. Even under such conditions, most of the salt water would move westward down the dip.

Comparison of the log of the disposal well with the measurements that were made of surface exposures nearby to the east suggests that the brines are being put into the third Francis sand. It is thought that this sand underlies Lake Wewoka, but this probability does not mean that contamination of the lake with salt water can occur. The lake is about 2

miles east of the stratigraphic position from which the disposal well begins, and therefore is farther up the dip of the rocks. This is brought out by the relative elevations given in the preceding paragraph. The lower and thicker sand into which the oil-well brines are being put probably crops out beneath the lake but is separated from the lake bottom, and from the sand immediately under the lake, by about 20 feet of shale.

New Disposal Well

The oil operator has stated his intention of drilling a deeper disposal well. On July 5, the drillers were preparing to move the rig to the new site, and said that a depth of 1,000 feet was planned.

Deep Water-Bearing Sands

Records of the more important deep water wells in the area were obtained, and are listed in Table I. The more significant wells are described below:

Brick plant (7). The well at the brick plant, (sec. 11, T. 3[8] N., R. 7 E.) is 230 feet in depth, begins about 5 feet below the top of the Belle City limestone, and probably taps water in the third sand of the Francis formation. The water is

considered satisfactory for drinking purposes. The bottom of the well is about 20 feet lower in elevation than the bottom of the lowest sand used for the disposal of brines in the disposal well.

Magnolia pumping plant. (9, 10, 11) Three wells at the Magnolia pumping station (secs. 14 and 15, T. 8 N., R. 7 E.) begin about 5 feet below the estimated position of the Belle City, and appear to tap water in the third sand of the Francis formation. Two of them are 220 feet in depth, and one is 260 feet in depth. A maximum of about 210 gallons a minute can be obtained from them by pumping. If they are left idle for two or three days, the water will flow at the surface. A sample from the north well in sec. 15, T. 8 N., R. 7 E., was tested in the chemical laboratory of the Oklahoma Geological Survey, and found to have less than 25 parts per million of chlorine, which indicated a very low salt content. The bottoms of the 220-foot wells are about 13 feet lower than the bottom of the lowest sand in the disposal well; the bottom of the 260-foot well is 53 feet lower.

Albert Norvell farm. Well 3, at the Norvelle farm in sec. 23, T. 8 N., T. 7 E., apparently begins somewhat below the Belle City. It was drilled to a depth of 259 feet, and probably draws water from the third sand in the Francis formation. The water is considered satisfactory for drinking.

Farm Security Administration wells. Wells 4, 5, and 6 were drilled for farmers in sec. 13, T. 9 N., R. 7 E. under the supervision of the Farm Security Administration. They begin on the outcrop of the Francis formation, and Nos. 4 and 6, at least, doubtless obtain water from the third sand. They are 1.25 to 1.5 miles southeast of the disposal well, and obtain fresh water, as should be expected in locations up the dip from that well.

Swimming pool well (1). The well, located in sec. 12, T. 8 N., R. 7 E., and formerly used to furnish water for the swimming pool at Lake Wewoka Park is 497.6 feet in depth, cased to 425.5 feet, and taps water in strata 230-300 feet below the base of the third Francis sand. The yield is reported as about 100 gallons a minute, and the water is said to be of good quality. The record of this well indicates that fresh water is to be found in some parts of this area at depths greater than the lowest sand in the disposal well, and in lower formations than the disposal sand.

Conclusions

1. The sand used for disposal of brine is the same as the sand underlying Lake Wewoka, but the lake cannot be contaminated with salt water from the brine disposal well in sec. 14, T. 9 N., R. 7 E. because the bottom of the lake is above the

top of the highest sand stratum into which the brine is being put. Furthermore, only the upper part of the brine-disposal sand is in contact with the lake water. The lower and thicker sands that probably receive most of the brine occur at greater depths below the lake and under a shale zone.

2. The good quality of the water from the wells at the brick plant, the Magnolia pumping station, and the Norvell farm, all of which appear to tap water in the number 3 sand, show that this sand is not now salt-water-bearing in the entire area considered here.

3. The salt water originally found in the number 3 sand in the disposal well may be due to local contamination of the sand by leakage of salty water from improperly cased and improperly plugged holes drilled in that vicinity for oil and gas.

4. The brine added to the water in the number 3 sand of the Francis formation through the disposal well to date probably has not substantially increased the damage, nor will continued use of the disposal well for a limited period. The brine so added may be only a small fraction of the total entering the sand from other sources. On the other hand, although the damage already done probably cannot be rectified, the long-continued use of the number 3 sand for disposal of oil-field brines in the vicinity would aggravate an already bad

situation, and should be stopped as soon as practicable.

5. Because the number 3 Francis sand carries fresh water in part of the area, oil-well brines in the eastern half of Tps. 8 and 9, R. 7 E. should be disposed in rocks below it.

6. The record of the swimming-pool well at Lake Wewoka Park indicates that fresh water in fairly large quantities may be available in sandstones as much as 300 feet below the base of the third sand in the Francis formation. This would be a depth of at least 650 feet at the present disposal well.

Table I. Significant Wells in the Vicinity of Wewoka

(Numbers correspond with numbers of map)

Well No.	Location	Depth (feet)	Water level (feet)	Depth of casing (feet)	Producing zone in Francis fm.	Approx. Elev. of bottom of sand
1	12-8-7	497.5	45	425.5	Pre-Francis sands	
2	"	90	25	---	3d sand	
3	23-8-7	259	100	210	2d sand ?	
4	SE 13-9-7	96	---	96	3d sand	
5	SE 13-9-7	58	---	58	3d sand	
6	NE 13-9-7	110	---	110	3d sand	
7	11-8-7	230	15	?	3d sand	599
8	31-9-8	67	---	67	3d sand	
9	15-8-7	260	Flows	161	3d sand	567
10	15-8-7	220	"	148? 184?	3d sand	607
11	14-8-7	220	"	148? 184?	3d sand	607
12	14-9-7	384	---	212	Disposal in 3d sand	620

July 15, 1941

[Report retyped September 13, 1988]

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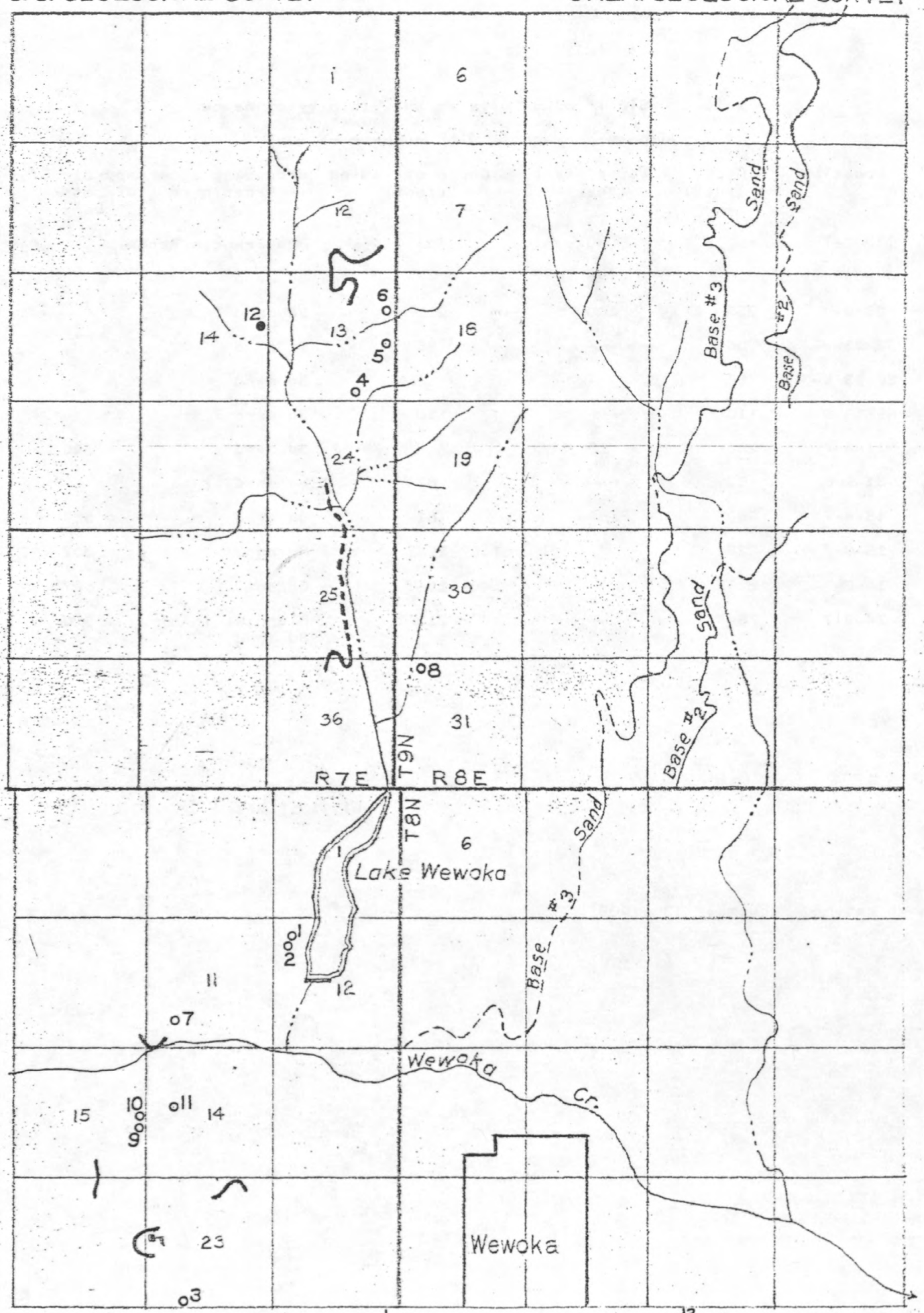
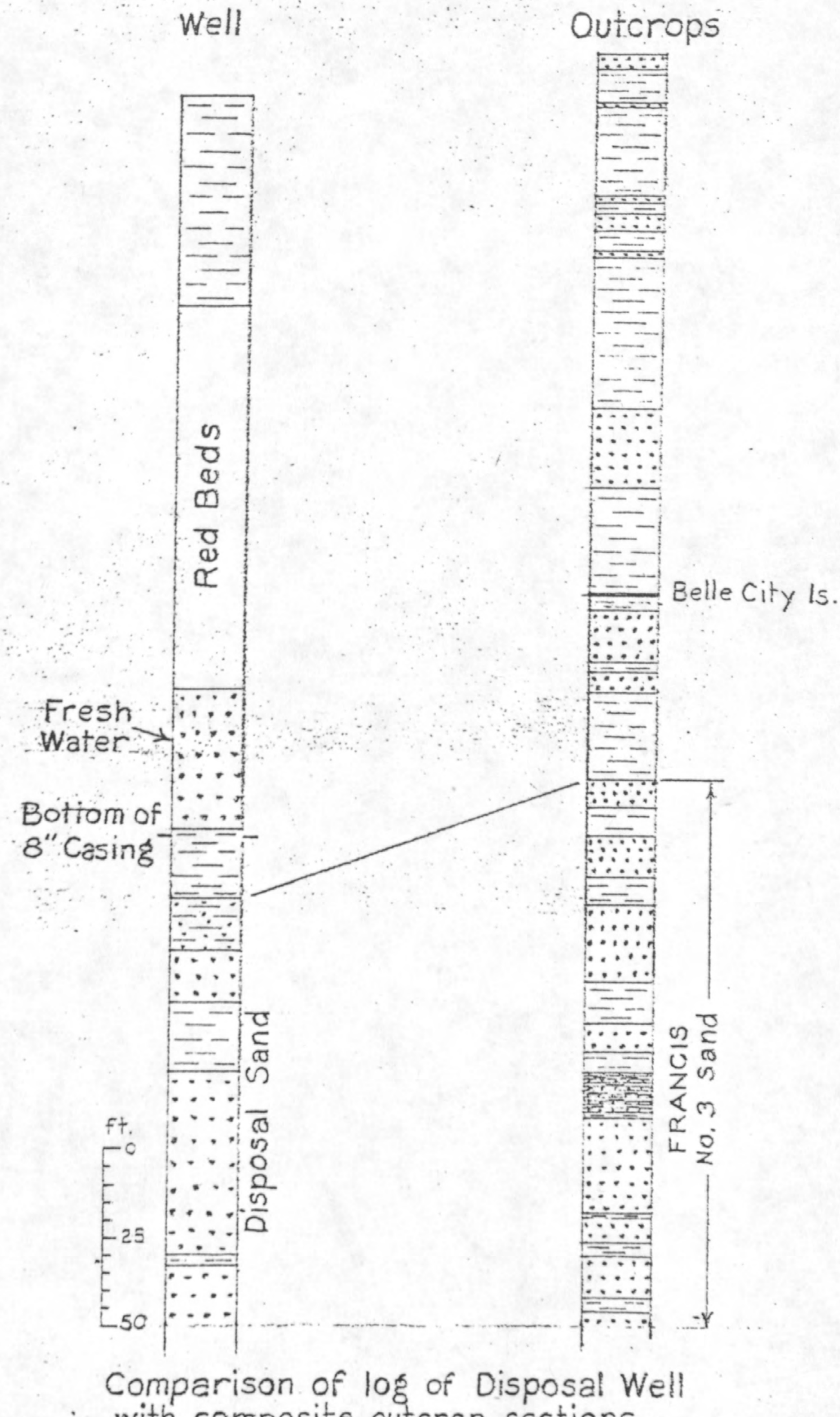


Outcrop of Belle City ls. d Water well listed in table ●12 Brine disposal well

DISPOSAL WELL, WATER WELLS, AND OUTCROPS - NEAR WEWOKA

Pate ?? acc. Memo on salt-water disposal well near [illegible]
7/10/41



Comparison of log of Disposal Well
with composite outcrop sections