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# Memorandum regarding the El Paso water supply

by

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## Results of investigations in 1935-36

A manuscript report which contains the results of investigations of the ground-water resources of the El Paso area made in 1935-36 by the Geological Survey of the United States Department of the Interior, was released in 1937. It was estimated that the pumpage from all of the wells in the El Paso area had increased from about one-half million gallons a day in 1906 to 15,400,000 gallons in 1935 and that the total pumpage during that period had been about 300,000 acre-feet of which 90,000 was from wells on the Mesa and 210,000 from wells in the El Paso Valley. During the pumping of this water two cones of depression were formed which, although imperfectly delimited, were obviously not large enough to have supplied all of the water that was pumped. Hence it was evident that although part of the water came from storage and the total amount of water in storage in the ground-water reservoir was thereby reduced, the larger part of the water that was pumped was perennially replenished by recharge from the land surface. The belief was expressed that one-quarter to one-third of the pumpage was from storage and the remainder was from recharge.

There is a very large amount of ground water in storage in the water-bearing sands beneath the Mesa. Not all of this water can be recovered by wells, but an idea of the amount that could be recovered was obtained by calculating the amount of water that would be released from storage if a series of wells were drilled in a line extending due north of the Mesa well field for a distance of ten miles and pumped until the static water level in each had declined the same amount as the water level has declined in the Mesa field. The figure reached as the approximate amount of stored water that would be recovered thereby was 130,000 acre-feet. This water would be supplemented by water obtained by recharge during the period of pumping. It was computed that at the average rate of pumping of 18,000,000 gallons a day somewhat over 20 years would be required to reduce the static water level in the new wells an amount equal to the reduction in the existing wells in the Mesa field, about one-third of the water being taken from storage and two-thirds derived by recharge. Of course, the amount of water that could be withdrawn from storage could be greatly increased by lowering the static level of the pumped wells to a greater depth than that postulated, but such a lowering would require greater pumping lifts, which would increase the cost of pumping. It might also cause salt water to rise and eventually contaminate the wells. There would be additional water available from storage in the areas outside of the area affected by these wells.

In the El Paso Valley beds that contain highly mineralized water occur both above and below beds that contain fresh water, and therefore it was considered inadvisable to make large new ground-water developments in the valley, but it was suggested that plans should be made so that all of the fresh water that is available to wells in the valley will be used.

## Results of investigations since 1936.

Water level measurements, pumpage data and chemical analyses.

In accordance with recommendations in the report, a program of periodic measurements of the water level in selected observation wells and periodic analyses of samples of the water from some of them has been carried out. The water level measurements were made chiefly by Robert H. Colvin, of the El Paso Department of Water and Sewerage, under the direction of A. N. Sayre, of the Geological Survey. Miss Margaret Foster, of the Geological Survey, has made the chemical analyses.

According to the records, the water levels rose during the period in some places, as in the Montana well field, where pumpage was less than in the period before 1935, but, in general, the water level declined and the cone of depression expanded.

Contour maps of the water table in January of each year were drawn and from these maps the reduction in the amount of water in storage was calculated. Pumpage records for the years 1936, 1937, and 1938 show that about 56,000 acre-feet of water were pumped during the period, but the computed reduction of the amount of water in storage between January 1936 and January 1939 was less than one-quarter of the pumpage.

The analyses of waters from a number of wells show that there has been no significant change in mineralization of the water from most of the wells on the Mesa or from many of the wells in the El Paso Valley. Noteworthy changes have occurred, however, in the mineralization of the water from certain wells in the valley and on the edge of the Mesa.

In Well 67 (T. & M. C. Well No. 1) the chloride increased from 33 parts per million in 1921 to 233 parts per million in 1937. In Well 68 (T. & M. C. Well No. 2) it increased from 42 parts per million in 1922 to 232 parts in 1936. Both of these wells are close to the edge of the Mesa. In Well 49 (El Paso Well 4) it increased from 256 parts in 1935 to 274 parts in 1938. In Well 50 (El Paso City Well 1) the chloride increased from 236 parts in 1935 to 250 parts in 1937 and to 305 parts in 1939. In Well 44 (Mitchell Brewing Co.) it increased from 158 parts in 1935 to 202 parts in 1938 and 209 parts in 1939. In Well 31 (El Paso City Well 7) the hardness increased from 260 parts per million in 1935 to 362 parts in 1938 and 447 parts in 1939 and the chloride increased from 94 parts per million in 1935 to 176 parts per million in 1938 and declined to 163 parts in 1939. The water from Well 52 (El Paso City Well 3) contained 152 parts per million of chloride in 1936 immediately after it was repaired. After about 1½ hours of pumping it contained about 190 parts per million and after a month of pumping it contained 253 parts. It contained 188 parts in the spring of 1937 and 252 parts in the fall of that year and in the fall of 1938 it contained 246 parts per million of chloride.

## Well explorations

Some study was given to the problem of the increasing mineralization of some of the El Paso City wells during the ground-water studies made in 1935 and 1936, and the results then obtained are given in the 1937 report. In August 1939 Mr. Livingston began making tests in City Wells 7 and 1 to determine the cause of the increase in mineralization in these wells. The wells were pumped and samples of the water were caught and analyzed at frequent intervals to determine the changes in the mineral content of the water as pumping progressed. Electrodes were lowered into the wells to find the contact between fresh and salty water. Fresh water was turned into the wells at different depths for the purpose of flushing out the salty water at those levels and assist in finding holes in the casing. Two sizes of samplers were used to take water samples at various depths in the well. Water was pumped for several days from individual beds of sand. This was accomplished by inserting water tight packers in the well above and below the sand from which it was desired to pump. A deep-well meter was used from time to time to observe whether water was flowing through the well from one sand to another or was leaking around the packers. A record of all water levels was kept and changes were made in methods and equipment during the test until satisfactory results were obtained. The test on City Well 7 covered a period of about one month and the test on City Well 1 about two months.

Tests on City of El Paso Well 7. A short test was made on City Well 7 in 1936 to determine the changes in chloride content during pumping. That test indicated that no very salty water was leaking into the well and that in general the well was in good condition. However, the mineralization of the water, particularly the hardness, increased and by 1938 the water was unsatisfactory for public use and was especially unsatisfactory for laundry use. More elaborate tests on this well were made in August and September 1939. The results have been tabulated and studied and will be given in full in a later report.

The well was reported to have been 525 feet deep originally, but to have been filled to a depth of 430 feet. The casing was said to be slotted from 100 to 430 feet. The tests showed that the pump pit and the well casing down to a depth of 130 feet are practically water tight and the increase in the mineral content during the past years is therefore not due to leakage into the well in this section. The well was found to be 320 feet deep, indicating that it had filled up to that depth with sand. It was cleaned out to a depth of 500 feet, and swabbed and agitated between 320 and 430 feet, but no appreciable increase in the yield of the well was noted. Therefore, the water pumped from this well must enter it mainly between the depths of 100 and 320 feet, and it is believed that part or all of the water-bearing formations between 100 and 320 feet have become more highly mineralized during recent years either by lateral movement of highly mineralized water through the water-bearing beds from distant sources, or by downward movement of mineralized water from overlying sands. It seems likely that the bad water has seeped down from above and perhaps only the upper part of the sands that yield water to the well contains highly mineralized water. However, the determination of the exact point of entrance of the highly mineralized water into the well was not considered of sufficient value to warrant the cost of the work to determine it since it does not seem practicable to repair the well. Any attempt to seal off a part of the slotted portion of the casing would not be practicable and since the original casing was set with considerable difficulty, it would probably not be advisable to attempt to deepen the well. Therefore, it is believed that this well should be abandoned and sealed as soon as it is no longer needed as a stand-by well.

Tests on City of El Paso Well 1. In 1935 a short pumping test was made on City Well 1. The results of the test given in the 1937 report showed that highly mineralized water in moderate quantities was coming into the well just below the end of the pump suction. It was pointed out that although there were leaks in the upper part of the well, the principal cause for the high mineral content of the water was the fact that one or more of the principal water-bearing sands were yielding a fairly large quantity of moderately mineralized water. During the period from 1935 to 1939 the mineral content of the water increased. This well is situated in the Montana well field and the matter of encroachment of salty water in this field is of vital importance. In the tests during the fall of 1939, therefore, every possible effort was made to determine the source of the contamination.

The results of the tests confirmed the statements made in the 1937 report concerning this well. The pump pit casing, 24 inches in diameter, and the well casing, 13 inches in diameter, are reported to be riveted pipe. The well casing is reported to be slotted from 435 to 605 feet, 695 to 715 feet, and 775 to 815 feet. The well was found to be about 790 feet deep instead of 860 feet as reported. During the tests the parts of the well between the following depths were isolated by means of packers and pumped and tested for chloride: 0 to 220 feet; 220 to 450 feet; 450 to 590 feet; 640 to 714 feet; 740 to 790 feet. The pump pit was water tight and no undesirable water was entering the well above a depth of about 220 feet. Mineralized water was found to be entering the well at about 220, 260, and 390 feet below the ground, through holes in the casing, and it is believed that the entire section of casing from 220 to about 500 feet is in poor condition and contains many small holes. Highly mineralized water containing between 2,000 and 2,500 parts per million of chloride was entering the well through these holes. It is likely that several of the holes in the casing were enlarged during the test. The parts of the well between 220 and 450 feet, with only 8 feet of drawdown, yielded 27 gallons a minute of very salty water. This is more salty water than leaked into the well while it was being pumped prior to the test. It appears, therefore, that the well probably will yield more highly mineralized water if it is again used than it did before the tests were made.

The best water was found between 450 and 590 feet, and contained an average of about 250 parts per million of chloride and about 285 parts of hardness. However, samples obtained from this section during the test ranged from 180 to 700 parts per million of chloride. The water having the highest chloride content entered the well at a depth of approximately 570 feet. It apparently came from a bed of sand at this depth, although it might have come from sands at 600 or even 650 feet and moved upward outside of the casing before entering the well. This section of the well yielded about 110 gallons a minute with about 14 feet of drawdown.

The section from 640 to 714 feet was pumped at the rate of 50 gallons a minute and the section from 740 to 790 feet at the rate of about 100 gallons a minute. The water from each of these sections contained about 675 parts per million of chloride and about 500 parts per million of hardness.

Apparently most of the moderately mineralized water was entering the well through the slotted pipe between 695 to 715 feet and 775 to 790 feet. (The slots from 730 to 815 feet were covered up). And a small amount of very salty water was entering the well through the holes at 390, 200 and 220 feet. The entrance of water from the section of the well below 600 feet could be prevented by plugging the well below that depth but this probably would reduce the yield by about one third. The flow from 220, 200 and 390 feet could probably be stopped by setting a liner in the well, and grouting the well from about 200 to 435 feet, but this would be a difficult and expensive job. If it were done successfully, there still would be the inflow of salty water into the well at about 600 feet, which may increase markedly. The entrance of salty water at the 600-foot level probably can not be effectively stopped since the well is reported to have been artificially gravelled on the outside of the casing.

Viewing the problem from all angles it is not considered advisable to attempt to repair this well in order to improve the quality of the water. It is recommended that the pump be reinstalled in the well and that it be pumped at a rate of not more than one million gallons a day. A careful record should be kept of the quality of water yielded by the well and when the mineral content becomes too great to be used in the city supply, the well should be abandoned and sealed.

The Montana Well Field. Tests made on Well 3 in 1936 indicated that conditions were about the same in that well as they are in Well 1. It does not necessarily follow that the other wells in the Montana field (Nos. 2 and 4) have the same characteristics pertaining to contamination, but it seems likely that such is the case. To determine this definitely would require exhaustive tests on Wells 2 and 4 similar to those made in Well 1, and probably further tests on Well 3.

It is impossible to predict, with the data at hand, how soon the wells in the Montana field will yield water too highly mineralized for city use. However, all the evidence now available indicates that the conclusions set forth in the 1937 report were substantially correct and that less and less dependence should be placed on the Montana field as a source of water supply for El Paso.

Test wells drilled by El Paso Water Department

After the El Paso ground-water report was released the El Paso Water Department drilled about 25 test wells of which 3 have been in the El Paso Valley and 22 on the Mesa. Two new supply wells in the mesa area and two new supply wells in the valley have been drilled at sites which were indicated as favorable by the test drilling. With the exception of three wells drilled one-half, three-fourths, and one mile north of the Mesa field, all of the test wells have shown favorable conditions for obtaining ground-water supplies, but conditions are less favorable east of the Mesa field than north because the salt water - fresh water contact becomes gradually higher in that direction. At El Paso City Well 16 the first salt water occurred at a depth of 1,110 feet (2,780 feet above sea level) according to a Schlumberger electric log of the well, and in test well 19, 3.5 miles east of well 16, it was found at a depth of 780 feet (3,175 feet above sea level). This represents an average rise of a little more than 100 feet per mile. In most of the test wells samples of the water were not collected, reliance being placed upon the Schlumberger tests to show whether or not salty water was present. In test well 19, however, four samples were collected. The total dissolved solids, chlorides and total hardness of these samples and the depth from which they were collected is shown below.

Total dissolved solids, chloride and total hardness

of water samples from El Paso City Test Well 19.

| Depth (feet) | Total dissolved solids | Chloride | Total hardness |
|---|---|---|---|
| | parts per million | | |
| 517 | 520 | 120 | 148 |
| 652 | 756 | 320 | 107 |
| 737 | 1,277 | 604 | 104 |
| 877 | 5,208 | 2,133 | 1,320 |

The three wells drilled immediately north of the Mesa field encountered considerably less water-bearing sands than was considered desirable for developing city supply wells. Test well 6, one-half mile north of the field, encountered 68 feet of sand between 204 and 930 feet, that is below the water table. Test well 5, three-fourths mile north, encountered 108 feet of sand, including "pack sand", between 200 and 698 feet, and Well 4, one mile north of the Mesa field, encountered 126 feet of sand between 197 and 800 feet. A well one-half mile west of test well 4, on the other hand, encountered 308 feet of sand between 200 and 967 feet, and eight additional wells drilled in a line directly north of the Mesa field encountered water-bearing sands of similar thickness. The Schlumberger logs of the test wells north of the Mesa field showed no highly mineralized water. From two of the test holes, No. 27, five miles north of the Mesa plant, and No. 28, six miles north of the Mesa plant, samples of water were pumped from depths of 497 and 500 feet respectively. The samples contained 394 and 374 parts of total dissolved solids per million respectively. From the results of the test drilling, it is evident that much of the western part of the Mesa area is underlain by thick water-bearing sands. However, a few more test wells should be drilled east and north of the existing wells in order to delimit the productive area more extensively. The location at which test wells are recommended are shown on the accompanying map. The sites recommended are in northwest corners of Secs. 41, 39, and 37, Block 80, Township 1, and in the northwest corner of Sec. 16, Block 80, Township 2, near the Rio Grande between Concepcion Street and Glenwood Drive, in the northwest corner of Sec. 20, Block 81, Township 1, and directly north of this location on or near the New Mexico-Texas line. It would be desirable to equip the wells near the Rio Grande, in the northwest corner of Block 16 and in the northwest corner of Block 20, with a screen and pipe so that periodic observations of the water level may be made. Of course, if it is not possible to obtain well sites in exactly the locations specified and indicated on the accompanying map, the test wells should be drilled as close to those sites as is feasible.

## Conclusions

From the data available, it is evident that the ground-water reservoir in the El Paso area is now being pumped at a rate greater than the rate at which the supply is being replenished. However, the rate at which the ground water is being depleted appears to have been somewhat less since 1936 than it was in the period before 1936. It is believed that unless there are changes in conditions that would result in an increase in the use of water beyond the normal increase that is to be expected as the city and the nearby communities, such as Fort Bliss and Juarez, grow in population, ground water can be economically supplied to the area for a period considerably longer than was indicated in the 1937 report. New developments of ground-water supplies on the Mesa north of the Mesa plant should materially enlarge the cone of depression in that area and allow the recovery of ground water derived from recharge that might otherwise escape from the area.

The gradual increase in the mineralization of several of the wells in and near the El Paso Valley and the fluctuation in the mineralization with the pumping season in some of the wells suggests that ultimately it will be necessary to abandon most of the wells in the El Paso Valley. However, it is probable that if the pumping of these wells is continued, but at a somewhat reduced rate, the total amount of water that is recovered from them will be greater than if the present rate of pumping is maintained. Furthermore, it is evident that all of the available fresh water can not be salvaged by the existing wells. Therefore, if at least one additional well were drilled in the valley at some distance from the existing wells, a part of the fresh water that might otherwise be lost would be salvaged. The site of test well No. 14, in the Hadlock addition, would be suitable for a new supply well and the log indicates that an adequate thickness of water-bearing sand containing water of satisfactory quality will be encountered there.