GROUND WATER RECHARGE THROUGH IRRIGATION WELLS

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The Maricopa County Municipal Water Conservation District Number One - more commonly known as the Beardsley Project - has recently completed some experiments in ground water recharge by gravity injection into an irrigation well. The experiments were conducted to gain information which would indicate the feasibility of using this method of ground-water recharge as a means of recovering runoff for beneficial use. The whole effort was motivated by the acute shortage of surface water and ground water that is at the present so severe as to cause almost one-fourth of the lands in our project to lie fallow. Of course, before the recharging could be tried, certain physical conditions had to exist. First there had to be a source of water sufficient in quantity to justify its use for recharging; secondly, there had to be a means of collecting the water; and, thirdly, a practical way of injecting the water into the aquifers was essential. These conditions do exist on the project, just a few miles west of Beardsley, Headquarters of the District.

The District comprises about 35,000 acres and lies between the White Tank Mountains a few miles to its west and the Agua Fria River a few miles to the east in western Maricopa County, Arizona. The District was organized in 1925. By 1927, construction of Carl Pleasant Dam, on the Agua Fria River some twenty miles north and east of Beardsley, was completed as were the main canal and the distribution system. A drought period about that time resulted in a shortage of run-off into Lake Pleasant. It was impossible to farm enough acres in the district to produce sufficient revenue to pay its annual debt service requirement.

After refinancing through the R.F.C., the District drilled forty-three irrigation wells of about 500' in depth in 1939 and 1940. Most of the wells in the area are of relatively small yield; however, by supplementing the gravity supply with pump water the District was able to produce enough water for some very good crops. The drought continued, and in order to increase its water supplies the District in 1946 drilled an additional seventeen wells, making sixty in all. The water, although not abundant and comparatively expensive, was of high quality. High yields were made in vegetables, cotton and other crops.

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The quality of water and the favorable crop yields influenced farmers in the District and the lands adjacent to it on the south and east to drill additional private irrigation wells at about that time. As a result the overdraft on the ground water in the District has increased the average pumping lift from 243 feet in 1939 to 443 feet in 1958. The annual increase in lift ranges from ten to twenty feet depending upon the location of the well. Almost two-hundred feet of the ground water reservoir or aquifers has been dewatered. We estimate that the depletion under the District amounts to about 1,000,000 acre feet. With gravity water supplies from Lake Pleasant continuing to be very inadequate, it is easy to see why we are seeking additional sources of water.

Now, characteristic of this part of the southwest, rains of sufficient intensities occur as to cause flash floods of damaging proportions. The Beardsley Project's irrigation facilities, county roads, farm lands, and dwellings were severely damaged on the average of three times a year from flash floods caused by cloudbursts on the White Tank Mountains and on the 220 square miles of desert range land lying north of the project. In August of 1951, one storm originating in this watershed did $3,000,000 worth of direct damage to irrigation facilities, roads, crops, land, military installations, and towns. It is estimated that 18,600 acre feet crossed the district during that flood. A successful effort was made by the District and other local interests in establishing a flood-control project. In 1954, two earth-fill detention dams were constructed near the foot of the White Tank Mountains. Costs were shared equally by the Soil Conservation Service and local interests. These dams are gated and the flood waters are bled into canals and laterals at a controlled rate immediately following a storm. They have a combined capacity of 4,000 acre-feet.

In 1956 the Corps of Engineers, with local interests participating, constructed a large earth-fill detention dam to control the flood waters from the northern end of the White Tanks and the 220-square-mile watershed of Trilby Wash. This structure is ungated and has a gross capacity of 30,500 acre-feet. On September 12 of this year a storm on this watershed resulted in about 4,000 acre-feet of run-off. Unfortunately, because of the ungated outlet most of this water was lost and not put to beneficial use. It flowed from the detention reservoir thru a six-mile outlet channel to a wash that is tributary to the Agua Fria River. The dam functioned perfectly as flood-control structure. The flood crest was subdued and the water leaving the dam was a controlled flow that caused no damage. However, most of the water leaving the dam was or will be lost by evapotranspiration in the shallow sands of the wash and the river bed. We were successful, however, in placing a small temporary plug in the mouth of the outlet works during the discharge period on September 13th and retained enough water to use in a recharge experiment on September 19th.

As stated before, the need for water prompted us to try this recharging experiment. We had a source of water - the water from the flash floods in the White Tanks, and from the Trilby Wash drainage area. The detention dams collected the water and there were irrigation wells nearby into which we could inject the water. The District wells are located along the main canal, or along the laterals and sublaterals. Flood water can be routed from the flood-control dams to the canal and to all laterals and sub-laterals in the project and can be injected into the underground thru all 60 of the irrigation wells. Most privately owned wells are located so that they, too, can be used for recharging.

Mr. Thornton Jones, Water Commissioner of the Superior Court, Maricopa County, a man with keen interest and broad knowledge of water conditions in Arizona and the Southwest, and Mr. Sol Resnick, hydrologist and head of the Institute of Water Utilization at the University of Arizona, were instrumental in getting the District to try recharging through an irrigation well. On hand to help in collecting data was Mr. Kenneth J. De Cook, Research Associate, Institute of Water Utilization. Mr. De Cook has prepared a preliminary report, subject to revision, on the results of the experiments.

In all, three tests have been made. Water in all three tests was pumped from the lateral adjacent to the main canal by a gasoline - powered centrifugal pump that discharged into the well casing. The submersible irrigation pump was left in the well during the tests. The centrifugal pump delivered water to the well at a rate of about 1400 G.P.M. During the first and second tests water released from Lake Pleasant and conveyed by the main canal to the project was used. In the third test, flood water caught behind the detention dam was used. During the first test four wells within a mile radius were used as observation wells.

Mr. De Cook states in the conclusion of his Preliminary Report as follows:

1. The three recharge tests on well 3-26 demonstrated the ability of the well to receive water at a constant and fairly high rate for periods of 48 hours or less. The specific intake of the well dropped rapidly each time recharge was started, but became relatively stable after 3 to 4 hours and dropped very slowly for the remainder of each test period. In both the first and third tests, the value of specific intake was 7.8 (gallons per minute per foot of head) after 24 hours of recharge.

2. The suspended -silt and dissolved-salts content of the canal water and flood water did not appear to decrease appreciably the intake capacity of the well during the tests. The possible effects of these factors under continual recharge are not known; it has been shown in other areas, however, that periodic pumping is a feasible method of clearing wells of silt for further recharge. During long-term tests, microbial clogging may also occur, necessitating occasional chlorination.

3. Both the drillers' logs of the wells and the calculated coefficients of storage indicate the presence of a large amount of clay or other relatively impermeable material in the ground-water reservoir. The transmissibility coefficients computed from data from all the wells, however, indicate that some of the strata of coarser sand or gravel have very high permeability.

4. As recharge water becomes available, recharge may be continued on an experimental basis, accompanied by measurements and observations similar to those described above. Longer recharge periods are needed on well 3-26 and other wells in the vicinity, to provide additional information on the following:

   (1) The long-range effects of the physical, chemical and microbial quality of the recharge water, and possible treatments;
   (2) The intake capacities of other wells in the area, and
   (3) The gross hydraulic characteristics and storage capacity of the ground-water reservoir, which can be more soundly evaluated as more data are collected.

Now, the District believes that it can very easily and inexpensively construct a conduit from the lateral to the well. Recharge water can then flow by gravity and need not be pumped as we have done in the experiments. We have not determined how much water we can recover from floods and inject into the ground-water reservoirs, but whatever it may ultimately be it will be worth many times the effort and expense of capturing it. We know it will not be enough to solve our water shortage problem, but along with other conservation measures it will be a great contribution toward that end.