Does Irrigation Pumping Affect Stream Flow?

By W. E. Code

Does irrigation pumping affect stream flow? Do the hundreds of pumping plants located in irrigation sections, especially in the neighborhood of the main irrigation canals, rob water from users farther down the valley? Are ditch water irrigation rights being jeopardized by the increasing number of well pumps being installed? Should there be a law prohibiting or limiting the sinking of additional irrigation wells in certain areas? These are some of the questions uppermost in the minds of not a few western growers who have spent hard-earned cash for ditch water rights to assure their crops of adequate moisture.

It is difficult to acquire data on the amount of water flowing under the ground, since we cannot see it and make direct measurements. No method yet devised can be considered other than approximate. The rate of flow depends on the character of the soil materials and the slope of the water table. Since the character of the materials changes rapidly from place to place, analyses of sands and gravels would be nearly valueless, and although the fall of the water surface can be ascertained, it also is variable.

The movement of underground water is surprisingly slow, amounting to from but a few feet to seldom over 100 feet a day. Assuming a fairly high rate of 50 feet a day, it would take 100 days for a given drop of water to move 1 mile. From this it will be seen that the effect of one season's pumping may not reach the region of ground-water escape for a long time, probably many months or years. The lowering effect on the ground-water table is immediate in the vicinity of a well being pumped and therefore the effect on return flow of pumping plants situated close to a stream, may be very rapid.

This time delay or uncertain movement of ground water prevents comparison of quantities of water removed by pumping and stream flow. The immediate results are not discernible and as they are masked by other conditions, it will be only through a study of records covering a long period of time that definite trends will be recognized.

Records of ground-water fluctuation show very definitely that lowering is taking place in the Box Elder Valley, near Wellington, Colorado, and in the Lone Tree Valley east and north of Eaton, Colorado. The maximum depression of the water-table since 1929 is about 14 feet near Wellington and about 8 feet near Eaton. Those wells within a mile or two of the main tributaries of the South Platte show very little change, a condition which may be considered as a fair index of what changes may be expected in the return seepage to the river.

When considering the effect of irrigation pumping, a somewhat definite area of the watershed of the South Platte Valley above Kersey, Colorado,
was studied. There are probably between 800 and 900 pumping plants in use above this point at present, which is approximately double the number in 1933. Many of these are of small capacity, serving only 10 acres or so, while others are serving 160 acres or more. On many of these farms no other water is used, but since nearly all are under some irrigation system, many use their well water as a supplemental supply to that received through the ditches.

**Pump 65,000 Acre-Feet.**

It is difficult, therefore, to estimate the amount of water pumped each season but as an approximation, it is assumed that each plant will deliver about 80 acre-feet each year (sufficient for 40 acres) and the total amount pumped in this area will be in the neighborhood of 65,000 acre-feet annually. The rate of growth in pumping during the past 10 years is evident from the following numbers of plants being served by an electric power company at Greeley:

- 1927—84 plants
- 1933—138 plants
- 1934—192 plants
- 1935—277 plants
- 1936—295 plants
- 1937—384 plants

Several charts are given which show in various ways, data on stream flow and return flow and from which some correlations and certain deductions may be made. The hydograph shown in figure 1 (above) indicates the combined flows for 15 years of the Poudre River, Thompson River, Boulder Creek, St. Vrain Creek, Clear Creek, Bear Creek and South Platte River above the points of the first diversion from the streams, in nearly all cases high up where practically no diversions have been made. These values of discharge do not represent all the available water because some of the smaller streams have been omitted and the surface run-off from precipitation on the lower area is not accounted for.

It will be observed that (Continued on Page 23)
Pumping vs. Stream Flow

(Continued from Page 5)

for the period 1929-1936, the average combined flow of these streams for the years 1922-1936 was exceeded in 1936 only and equalled but once in 1933. The lower portion of the same diagram, on a different scale, shows the winter flows for the months of December, January, February and March of the South Platte at Kersey. The river flow during this period is least affected by headgate manipulation and is composed almost entirely of return water.

It will be noticed that there is some relationship to the upper diagram, especially if a year's time delay is allowed. The wide annual fluctuation of the total flow is ironed out in the return flow, but the decrease is apparent after 1930. The lowest combined flow is in 1934, but the lowest winter flow at Kersey occurred in 1933.

Return Flow Increases.

Figure 2 (Page 5) shows in chart form the direct flow supply and return flow from seepage as compiled by Miles E. Bunker. These data were taken from a detailed study of the water supply of the water districts affected by the Colorado-Big Thompson transmountain diversion project. The solid blocks show the number of acre-feet inflow to Districts 3, 4, 5, 1, 2, and 64, and the hatched blocks the return flow.

There are a few irregularities, but in the main the return water fluctuated with the inflow. The area involved which extends from near Denver to the state line, is larger than for the data shown in Figure 1 and no doubt return water lost appeared again as return water in the lower reaches of the river.

Here it is found that for the first 6 years, the average return flow was 75 per cent of the average inflow for the period, and in the last 5-year period, the return flow was 82 per cent of the inflow. Were pumping a large factor in reducing return flow, the percentage of return in the second period should be less. If the data are trustworthy, they indicate that water stored in the ground during the first period was bolstering up the return flow in the second period.

Inflow Vs. Return Flow.

In the third chart, Fig. 3, above, are shown data gathered by the state engineer of Colorado on return flow to the South Platte River data obtained by what is known as progressive spot measurements. The measuring is done with a current meter in the fall or spring of the year, when the river is steady. Also all diversions and major contributions along the stream are measured. The accumulations of return flow in five reaches of the South Platte are shown, as follows: No. 1, Sand Creek to Henderson; No. 2, Henderson to Fort Lupton; No. 3, Fort Lupton to Western Ditch heading; No. 4, Western Ditch to Kersey; and No. 5, Kersey to Hardin, a total distance of 56 miles.

When time delay is assumed as a factor, it will be seen that the return flow in all of these years is fairly closely related to the total flow shown in Figure 1. The year 1926 appears low, but was preceded by a very dry year. Both 1929 and 1934 were preceded by normal years, but the 1929 measurements were made in July and cannot be considered so reliable. The year 1927 seems to be the farthest out of line. The incomplete data for 1931 and 1932 show the flow in these years to be the least, yet the extent of pumping in 1934 was much greater than in 1931 and the total stream flow less.

Partial Conclusion.

Even though the data here presented are known not to be accurate because it would be almost physically impossible to obtain a high degree of accuracy, by approaching the problem from three different angles, one becomes convinced that pumping has not affected return flow to a serious degree. Diminished stream flow, or in other words precipitation, is responsible for diminished return flow to a much larger degree than pumping. Pumping does affect return flow in time, but that effect has not yet become serious. It is expected that as the rate of pumping increases, the effect will become more apparent.

This evidence shows the great value of underground waters as a reservoir in time of shortage, a reservoir capable of being drawn upon in many places without regard to the origin of the water. If the effect on other water users is dubious or slight and the benefit to a large number great, it would be more equitable not to deny the well owner the right to pump.

The right to use the public waters of streams generally involves mutual interference with the pumping conditions of the group. They all are adversely affected as the water table recedes. Many state laws recognise this unavoidable condition and no recourse can be had from the courts. In Colorado, the pumpers have no legal status and my be enjoined should it be proved that his pumping affects stream flow.