

United States  
Department of the Interior  
Geological Survey

Ground-water resources of the Santa Cruz Basin, Arizona

by

S. F. Turner and others

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W. S. COOKIN & ASSOCIATES

Tucson, Arizona

May 14, 1943  
With water level  
fluctuations  
through 1946

The major part of the water lost from the surface flows in the stream beds of this basin is recharged to the ground-water supply. The flood flows are of relatively short duration and the amount of water lost to evaporation from the water surface is small. The stream-bed materials are usually fairly coarse and the loss of water by evaporation from the wetted stream beds after flow ceases is small. Experiments conducted in the bed of Queen Creek, a similar stream just north of the Santa Cruz Basin, showed that the evaporation from the wetted stream bed was approximately equal to the evaporation from a water surface for the first 36 hours, but subsequently it decreased very rapidly.<sup>22/</sup> Therefore the

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Babecock, H. M. and Cushing, E. M., Recharge to ground water from floods in a typical desert wash, Pinal County, Arizona. Transactions American Geophysical Union, pp. 49-56, 1942.

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losses by evaporation from the water and wetted sand surfaces are probably within the limits of error of the methods used in measuring the flood flows.

When the flood flows are large enough to spread out of the deep channels and over the surrounding flood plain, or when the flood flows spread out into many shallow channels that are filled with vegetation, the evaporation losses are greater and nearly all of the water that is lost into the ground is transpired by vegetation. Thus most of the water lost from flows in the sand and gravel-bottomed channels can be considered as recharge, but most of the water lost on the flood plains and in the shallow, silty channels is evaporated and transpired and does not recharge the ground-water supply.

#### Upper Santa Cruz area

Most of the recharge to the ground-water reservoir in the Upper Santa Cruz area occurs from losses in surface flow of the Santa Cruz River and its tributary washes. The Santa Cruz River flows through a well-defined channel from the International Boundary near Nogales to Rillito, Arizona. The upper reach is characterized by a steep-sloped, narrow channel with high banks, while below Chavez the channel widens until at Rillito it is over 600 feet wide. About 10 miles below Rillito in the upper part of the Eloy area the flow spreads over a large area composed of many channels and below Red Rock the flow is distributed over a cultivated flood plain.

#### Losses from surface flow between gaging stations

Figure 2 was prepared to show the average losses between gaging stations for floods of various discharges. In the preparation of this graph, both winter and summer floods having no inflow between gaging stations and occurring in wet or dry channels were used.

The similarity of the curves for the upper three reaches of the Santa Cruz River, Nogales to Chavez, Chavez to Continental, and Continental to Tucson, indicates a similarity of the losses in these three reaches. The loss curve of the reach of the Santa Cruz River from Tucson to Rillito indicates small losses for small flows, probably due to the silting of the low-flow channel, and larger losses, increasing rapidly with the increase in volume of flow, due to a spreading out of the flood waters and scouring of the river bed.

Curves of losses on Pantano Wash from Irono to Tucson, and Rillito Creek from Wrightstown to Tucson were included in Figure 2 to indicate the losses that occurred on washes tributary to the Santa Cruz River. Curves for these two

Pool gages at the gage on the Santa Cruz River at Rillito the rate of infiltration varied from 1.64 to 3.77 feet a day.

The upper reach of Rillito Creek, below Wrightstown, had the capacity to absorb large quantities of the surface flow, and recharge took place rapidly when the water occurred after a prolonged drouth or a period of heavy seasonal rainfall. After the first large flood or prolonged flow, the water table in the immediate vicinity of the stream rose to the level of the creek bed, and subsequent flows made over the saturated bed with comparatively small loss. In the lower reaches below the Oracle Road crossing the depth to water was greater and the flood losses were larger as the flow had more opportunity to penetrate to the water table.

In these lower reaches the stream-bed sediments became finer and hindered the penetration downward and outward from the wetted channel, but the higher infiltration rates as shown by the seepage run show that the depth to water below the stream bed is a very important factor affecting the infiltration rate.

The runs of seepage measurements for this investigation were made after the autumn floods and winter flows had recharged the ground-water reservoir in the upper reaches, and for this reason the infiltration rates of the upper reaches are not as high as those of the reaches below Oracle Road.

#### Pool tests

In an effort to obtain a check upon the rate of loss obtained by runs of seepage measurements, and by losses between gaging stations, the drop in water level was measured in pools remaining in the channel after floods. The procedure was as follows: As soon as surface flow had ceased, a stake was driven in the lowest part of the pool and the depth to the water level below the top of the stake was measured at various intervals of time to determine the rate of lowering of the water level in the pool in feet a day.

The pools left after floods were usually in the low-flow channel and had a thick cover of silt over the bottom. The rate of lowering of the water level in pools in a reach was apparently inversely proportional to the amount of silt in the pools, but a comparison of the rates in the various reaches is of value. The average rate obtained from 25 pools in the Upper Santa Cruz near Chavez was 1.80 foot a day, with a variation from 0.16 to 3.20 feet a day. (See Table 6). The rate for 14 pools in the Santa Cruz River near Tucson was 1.20 feet a day. Below Tucson, as the stream gradient lessened and the deposits became finer, the average rate was only 0.31 foot a day in 14 pools.

The average rate was 1.00 foot a day in Pantano Wash east of Tucson, and 0.50 foot a day in Rillito Creek north of Tucson. This loss of 0.50 foot a day from pools in Rillito Creek should be compared with an infiltration rate of 2.00 to 2.20 feet a day obtained in the same reach by runs of seepage measurements. The water was almost clear during the runs of seepage measurements and this probably accounts for the higher rate obtained.

For similar tests made in Queen Creek<sup>24</sup>, the rate of loss for pools was

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Babcock, H. M. and Cushing, E. M., op. cit., pp. 54-56.

3.9 foot a day and the rate for seepage measurements was more than 4 foot a day.

Table 6. Rates of lowering of water surfaces in pools after surface flow ceased.

| Date   | Location   | Pool | Rate of infiltration (feet a day) | Length of test (hours) |
|--|--|------|-----------------------------------|------------------------|
| July 30-Aug. 1<br>1940                                     | Santa Cruz River<br>at Chavez                            | 1    | 0.22                              | 44½                    |
|  |  | 2    | 0.16                              | 30                     |
| Aug. 20, 1940  | do.  | 1    | 0.30                              | 4                      |
|  |  | 2    | 1.55                              | 1½                     |
|  |  | 3    | 0.51                              | 3                      |
|  |  | 4    | 0.42                              | 4                      |
|  |  | 5    | 1.08                              | 3                      |
|  |  | 6    | 0.69                              | 4                      |
|  |  | 7    | 0.48                              | 2                      |
|  |  | 8    | 0.96                              | 4                      |
|  |  | 9    | 0.50                              | 2                      |
| Aug. 24, 1940  | do.  | 1    | 3.00                              | 3½                     |
|  |  | 2    | 0.48                              | 3½                     |
|  |  | 3    | 0.36                              | 3½                     |
|  |  | 4    | 0.40                              | 3½                     |
|  |  | 5    | 0.34                              | 3½                     |
|  |  | 6    | 1.15                              | 3½                     |
|  |  | 7    | 0.96                              | 2½                     |
|  |  | 8    | 3.20                              | 3                      |
| Sept. 12, 1940   | do.  | 1    | 2.00                              | 2                      |
|  |  | 2    | 2.60                              | 2                      |
|  |  | 3    | 2.25                              | 2                      |
| Sept. 13, 1940   | do.  | 1    | 0.36                              | 1½                     |
|  |  | 2    | 0.55                              | 1½                     |
|  |  | 3    | 0.30                              | 1                      |
| Average rate for 25 pools at Chavez: 1.00 foot a day.      |  |      |                                   |                        |
| Aug. 21, 1940  | Santa Cruz River<br>at Indian School<br>Road, Tucson     | 1    | 0.84                              | 4                      |
|  |  | 2    | 0.85                              | 4                      |
|  |  | 3    | 0.90                              | 4                      |
|  |  | 4    | 0.20                              | 4                      |
|  |  | 5    | 2.75                              | 2                      |
| Do.  | Santa Cruz River<br>at Congress Street<br>Bridge, Tucson | 1    | 2.07                              | 2                      |
|  |  | 2    | 1.75                              | 2                      |
|  |  | 3    | 1.20                              | 2                      |
|  |  | 4    | 0.24                              | 2                      |
|  |  | 5    | 3.20                              | 2                      |
|  |  | 6    | 1.70                              | 2                      |
| Aug. 21-22,<br>1940  | do.  | 1    | 0.16                              | 13½                    |
|  |  | 2    | 0.28                              | 4                      |
| Average rate for 14 pools in Santa Cruz River near Tucson: |  |      |                                   | 1.20 feet a day        |

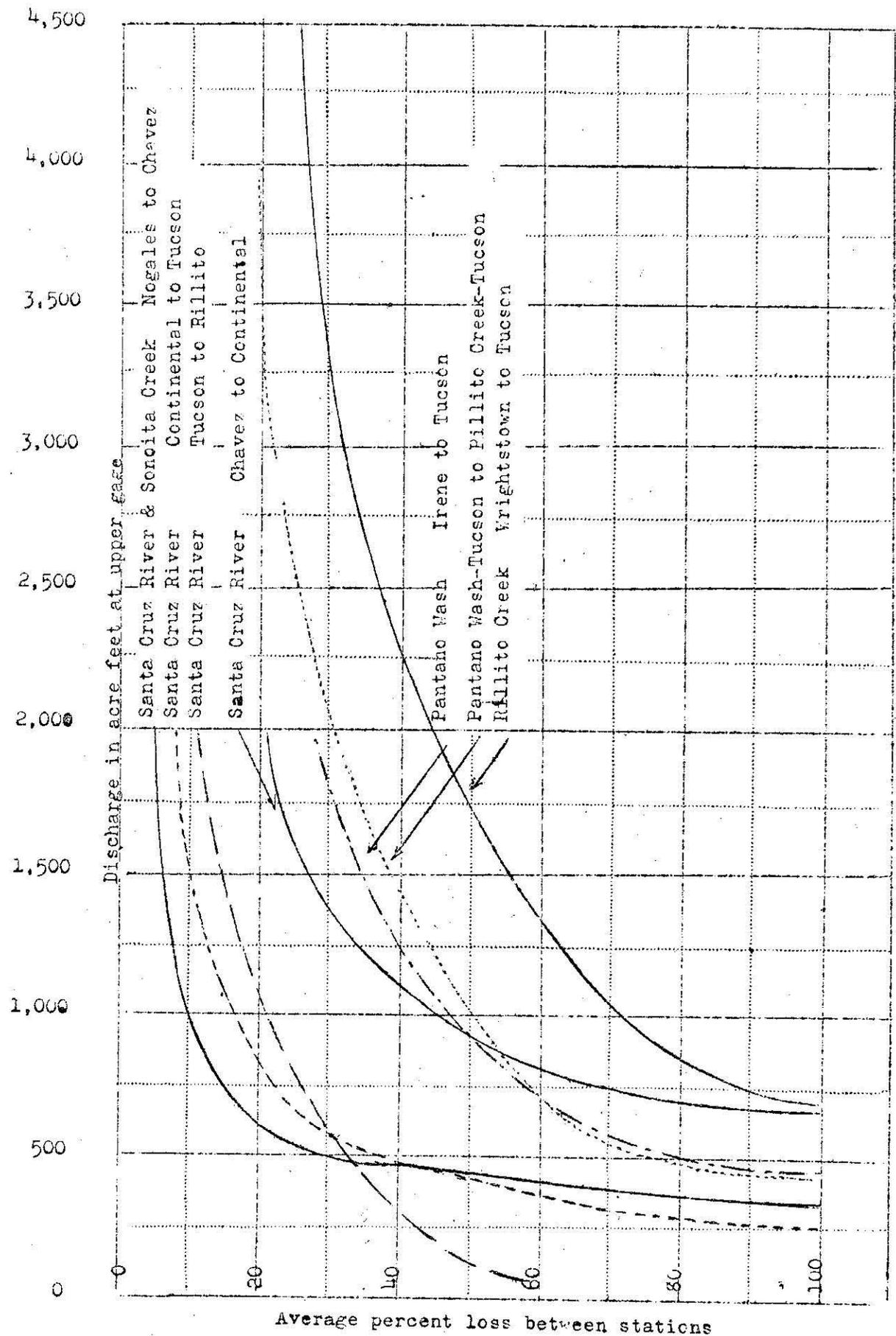


FIGURE 2. CURVES SHOWING AVERAGE LOSSES BETWEEN GAGING STATIONS