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Ground-water resources of the Big Sandy Valley, Mohave County, Arizona

by

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Introduction

The act of the Arizona State Legislature which appropriated funds for ground water studies in Arizona during the fiscal year from July 1, 1939 to July 1, 1940, under a cooperative agreement with the U. S. Geological Survey, requested an examination of the ground-water resources of the Big Sandy Valley, Mohave County, Arizona. This investigation was made by the writer during January, February, and March, 1940, under the supervision of S. F. Turner, engineer in charge of ground-water investigations of the Geological Survey in Arizona. The samples of water collected during the field work were analyzed by John D. Hem, of the Quality of Water Division of the Geological Survey, and the statements concerning the quality of water were prepared in cooperation with Mr. Hem. The particular purpose of the investigation was to determine the possibility of obtaining from artesian wells supplies of water which would be adequate for irrigation of terrace lands above the floodplain of the Big Sandy River. The following is a report of the principal findings.

Location and Geography

The Big Sandy Valley is entirely within Mohave County, Arizona. It is an inter-mountain trough of the type found in the Basin and Range region of the Western United States. This trough trends a few degrees west of north, is over 60 miles long, and lies between the Hualpai, Peacock, Rawhide, and Artillery Mountains on the west and the Cottonwood Cliffs, Aquarius Cliffs, and Aquarius Mountains on the east. It is drained by the Big Sandy River, which receives water from Trout, Burro, and Cottonwood creeks and Little Sandy Wash, as well as many other large and small washes. See plate 1.

Altitudes in the area range from 1,650 feet at the lower end of Signal Basin to over 8,000 feet in the northern Hualpai Mountains, and 6,000 feet on the plateaus east of the Aquarius and Cottonwood Cliffs.

Along the axis of the valley are three topographic basins separated from each other by hilly or low mountainous terrain. Wickieup Basin, the largest, is 24 miles long and from 3 to 11 miles wide. North of Wickieup Basin and separated from it by hills composed of deposits of older fill, is the Round Valley Basin, 9 miles long and from 3 to 7 miles wide. The Signal Basin, 8½ miles long and from 2 to 5½ miles wide, lies south of Wickieup, between the upper and lower granite canyons of the Big Sandy River.

Climate

The general climate of this region is mild and dry, with occasional torrential rains during July, August, and September. The remainder of the precipitation occurs as gentle rains (or snow on the highlands) from

December to March. The average annual precipitation ranges from over 20 inches in the highest portion of the Hualpai Mountains to less than eight inches on the floodplain at the lower end of the valley. The Big Sandy River is subject to large floods which have done much damage to agricultural land on the river floodplain. Snow falls frequently on the highlands during the winter but on the bottom lands freezing temperatures are rare. In the lower portion of the valley midsummer temperatures may exceed 115°F.

Agricultural Land

The lowlands of the Big Sandy Valley are the principal farming area in Mohave County. About 700 acres were under cultivation in 1940 but within the valley approximately 6,500 acres of potential farmland might reasonably be made productive with adequate irrigation. The present farmland is mainly on the lowlands along the river, though most of the potential farmland is on stream-cut terraces above the lowlands. Hay (chiefly alfalfa), grain, and various garden vegetables are the chief agricultural products.

Previous Investigations

Willis T. Lee of the Geological Survey, U. S. Department of the Interior made a preliminary reconnaissance of the geology of the Big Sandy region in 1903-04 in connection with a general reconnaissance of a large region in northwest Arizona[1]. In 1906-07, F. C. Schrader of the Geological Survey visited this region[2]. He was engaged primarily in a study of the mineral deposits and his work added little to the knowledge of the valley-fill deposits.

Geology

Structure. The Big Sandy Valley is within the Basin and Range province, and, in common with other inter-mountain valleys of this region, it is mainly of structural rather than of erosional origin. It is a compound structural trough, formed by normal faulting. This faulting lies along the depressed portions of a series of eastward-tilted fault blocks which include the Hualpai and Peacock Mountains. The faults which caused depression of these blocks bound them on the east near the base of the Cottonwood and Aquarius Cliffs and at the western margin of the Aquarius Mountains. This belt of faulting dies out southward at the lower end of Signal Basin, but continues northward from the Big Sandy Valley across the Colorado River into Utah, along the Cottonwood and Grand Wash Cliffs. This basic structural pattern has been complicated by the formation of the several basins within the valley by up-faulting of interbasin blocks. In addition, the valley-fill deposits are affected by two sets of minor faults, especially on the east side of Wickieup Basin. One of these fault-sets strikes more or less parallel with the elongation of the valley and the other strikes across the valley axis.

1

Lee, W. T., Geological Reconnaissance of a Part of Western Arizona: U. S. Geological Survey Bull. 352, 1908.

2

Schrader, F. C., Mineral Deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Arizona: U. S. Geological Survey Bull. 397, 1909.

Basement Rocks. In the highlands of the area the principal exposures are gneiss, schist, and gneissoid granitic rocks, sparsely intruded by small stocks of granite. These rocks are traversed by numerous dikes of pegmatite, as well as by less frequent ~~strikes~~ dikes of granite, lamprophyre, and aplite. These basement rocks underlie the whole region, though in places they are buried beneath later volcanics or valley-fill sediments.

Where unfractured the basement rocks are relatively impervious to water. Pervious zones along joints and faults may feed springs and wells but the water supplies are generally small. The water is generally of good quality and non-saline, though in places it may be moderately hard. As interconnection between fracture zones is poor, these rocks act as barriers to ground-water movement.

Volcanics. In places along the eastern border of the valley and at its southern end the basement rocks are covered by lava flows and associated tuffs which range in composition from rhyolite to basalt. The latest of these volcanics are in some places interbedded with the older valley-fill sediments. The lavas that have prominent jointing, such as the basalts, are at least moderately pervious to water and may feed small springs. Such lavas generally overlie tuffs and older, more siliceous, and less well-jointed lavas which are usually relatively impervious. The water from the volcanics appears to be generally of good quality though in places it is hard.

Older Fill. The older valley-fill deposits directly overlie the basement rocks and earlier volcanics. They consist of two principal members of similar age, which grade laterally from one into the other. Exposed near the highlands is the fanglomerate-breccia member, an indistinctly stratified piedmont deposit which includes more or less angular fragments of all sizes. It is so poorly sorted that it locally resembles a glacial till. This member grades laterally toward the interior of the valley from coarse to finer-sized material and into lake beds. The latter are chiefly silt, fine silty sandstone, and clay, laid down while the Big Sandy River was temporarily dammed by faulting and thus formed lakes within the several basins. In some places there are beds of concretionary limestone, volcanic ash, gypsum, analcite sandstone, diatomite, and bentonite. Along the eastern margin of Wickiup Basin the lake beds are locally interbedded with basaltic lavas. Here the lake beds are also in many places deformed by small closely-spaced faults (see structural section along Lambert Wash, Fig. 1). Because the faults are normal and nearly all dip westward the aggregate effects of the faulting have unquestionably been large, for the displacements were cumulative and involved successive downdrops to the west. In Signal Basin the lake beds have remained comparatively undisturbed.

Both members of the older fill are relatively impervious. No well-sorted "clean" beds of sand or gravel which would make good aquifers were seen in either the fanglomerate-breccia or the lake beds. In a few places wells have obtained water from the fanglomerate-breccia, but the capacities of nearly all of these wells are relatively small. While it is probable that in places water supplies adequate for domestic uses can be developed from the older fill, this formation is probably incapable of furnishing sufficient water for extensive irrigation. Water from the fanglomerate-breccia is somewhat variable in quality and is often hard, but water from the lake beds may be highly mineralized owing to contamination by saline substances present within these beds.

Intermediate sand. Overlying the older fill and separated from it by a small angular unconformity is a formation consisting of well-sorted stream-laid sand and silty sand with local lenses of gravelly sand and silt. It occurs only in the lower portions of Wickieup and Signal basins and varies in thickness from a very thin layer to possibly as much as 1,000 feet. Near Wickieup two wells drilled a short distance into this formation encountered water under small artesian pressure. Water from these wells is soft and non-saline.

Terrace-gravel. Within the several basins the valley is a broad V-shaped trough with sides formed by graded alluvial slopes from the bordering mountains. These slopes are termed the upper terrace. Subsequent to the formation of the upper terrace two main stages of downcutting have occurred. They are represented by a lower terrace and by the present lowlands. Both terraces are deeply dissected by washes and in places the upper terrace has been deformed by faulting since its development.

The upper terrace is underlain by a veneer of gravel 10 to 150 feet thick which rests in apparent conformity upon the intermediate sand, or unconformably upon the older fill. It is a fanglomerate consisting chiefly of fine to coarse sand, gravel, cobbles, and a few boulders. Surficial caliche cementation is well-developed in it and usually extends as deep as 10 or 15 feet below the surface.

The lower terrace occurs mainly as a narrow belt along the river between the upper terrace and the lowlands, but is also present along tributary washes. In many places the lower terrace is lacking and the escarpment rises directly from the lowlands to the upper terrace.

In Wickieup and Signal basins this lower terrace is well defined, but it appears to be absent in Round Valley Basin. The terrace gravel which underlies it probably does not exceed 100 feet in thickness and is similar in character to the terrace gravel underlying the upper terrace. The lower terrace was formed after the cessation of the faulting which in places displaced the upper terrace.

The terrace gravel is somewhat pervious and contributes water to several springs and wells. The water may be fairly soft and non-saline, but much of it is hard and some is contaminated by saline substances from the lake beds.

Younger Alluvium. The alluvium that underlies the lowlands along the present streams consists of moderately well-sorted silt, sand, gravel, cobbles, and occasional boulders. Along the tributary washes the deposits are generally coarser than those of the river lowlands.

The younger alluvium contains abundant lenticular beds of gravel and sand which are good aquifers. Water may be obtained at a depth of generally less than 20 feet at almost any place on the river lowlands. In a few places the water in the deeper water-bearing strata in the alluvium is under very small artesian pressure.

Water from the alluvium is generally of good quality, though in places it is hard, and locally it is moderately or strongly saline, probably owing to contamination by salts from the lake beds. The contaminated horizons seem generally to be near the surface, and in a few places water of good quality has been obtained by sinking a well to fresh water-bearing strata beneath a contaminated aquifer and sealing it off.

Wells and Springs

Most of the wells in the valley derive their water from the younger alluvium. Several wells are situated at the base of the lower terrace escarpment, and some are on the lower terrace. Very few are on the upper terrace.

In Wickieup and Signal basins most of the wells are less than 50 feet deep and the deepest one is only 105 feet deep. In Round Valley Basin the water lies deeper beneath the surface, and the few wells in this basin range from 180 feet to over 300 feet in depth.

Most of the wells were dug by hand, though a few of the deeper ones were drilled with a hand-operated slush-bucket. There are only six churn-drilled wells within the valley, all located in the Little Sandy Wash drainage area. From most of the domestic wells water is withdrawn by buckets and hand-ropes, by hand-operated lift or pitcher pumps, or by lift pumps operated by windmills. The larger irrigation wells are generally equipped with centrifugal pumps powered by gasoline engines.

Samples of water from several wells were found to contain fluoride in amounts commonly reported to be sufficient to cause mottled enamel on the teeth of young children regularly drinking the waters.

Many temporary or small permanent springs issue from pervious fracture zones in the basement rocks or from lavas. These springs nearly all occur in the highlands and are sometimes developed for watering livestock. A few unimportant seeps occur in fanglomerate-breccia where washes cut this member of the older fill. Likewise, only minor seeps issue from the lake beds, except a few springs along faults. One of these, Cofers Hot Spring, is a moderate-sized warm artesian spring. Numerous seeps and small springs occur at the contact of the relatively impervious older fill with terrace gravel along terrace escarpments near the river. The water from many springs in the interior of the valley is more or less saline, doubtless owing to contamination by saline substances from the lake beds.

The largest springs are the "sloughs" which occur on the lowlands along the river in Wickieup Basin. The geologic relations of some of these springs suggest that they are fed by water rising along pervious faults underlying the alluvium. Others are not so obviously fed from faults but may actually be so. A few, however, are perhaps fed through the younger alluvium by the river itself.

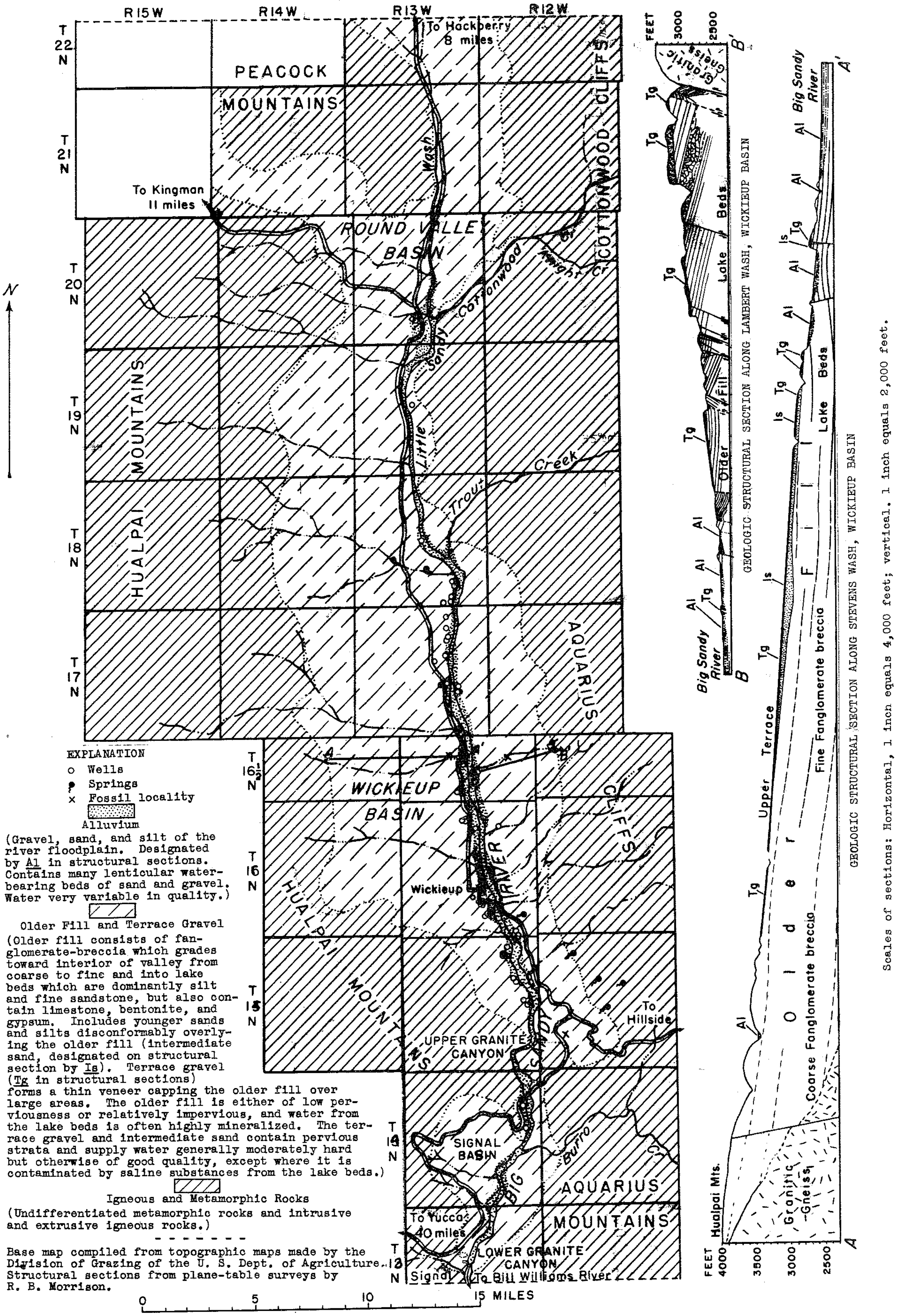
Outlook for Development of Additional Water Supplies from Wells

In Wickieup and Signal basins wells drilled almost anywhere on the river lowlands will probably encounter water at shallow depth. Though in a few areas the water may be too heavily mineralized to be fit for domestic consumption or for irrigation, in most places it is of good to fair quality. Small or moderate supplies may be obtained from low-lying terrace-gravel near the river. It is unlikely that water supplies adequate for continued large pumpage can be developed from wells drilled into either the fanglomerate-breccia or the lake bed members of the older fill, though in places this formation will furnish ample water for domestic purposes or for livestock.

It is probable that water under moderate artesian head can be developed in a limited area in the vicinity of Wickieup. The artesian-water possibilities in the intermediate sand can be tested by a well drilled somewhere within the NW¼, NE¼, or SE¼ of sec. 27 or the SW¼ of sec. 22, T. 16 N., R. 13 W. Here the intermediate sand is especially thick and it is likely that artesian pressures in the water-bearing strata in this formation will generally increase with depth. To make a thorough test the well should be drilled at least 400 feet and perhaps as much as 1,000 feet deep, but suitable water supplies may be encountered before the maximum depth is attained.

Well logs and surface exposures suggest that the water-bearing strata in the intermediate sand are largely rather fine sand, and their permeability is doubtless not high. The yield of water is likely to be small and it is not certain that sufficient water for extensive irrigation could be obtained. Although flowing wells may possibly be obtained in the designated area near Wickieup, it is probable that for large production the wells will have to be pumped, though the artesian pressure may be sufficient materially to reduce the pumping lift. On account of the fineness and loosely consolidated character of the sand in the water-bearing horizons, well screens may be required in place of the usual type of perforated casing.

In Round Valley Basin small supplies of water, sufficient for domestic uses or for watering cattle but probably not for extensive irrigation, may be developed from coarse deposits of older fill in the interior portions of the valley. The water level is at a fairly great depth, however, and wells must be drilled from 150 feet to over 300 feet deep, depending upon their location. Probably only small supplies can be obtained from the younger alluvium underlying the lowlands along Little Sandy Wash.



MAP OF BIG SANDY VALLEY, MOHAVE COUNTY, ARIZONA, SHOWING WELLS, SPRINGS, AND GENERALIZED GEOLOGY