Water-Resources Reconnaissance of Hoopa Valley, Humboldt County California

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GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1576-C

Prepared in cooperation with the U.S. Bureau of Indian Affairs

WATER RESOURCES, HOOPA VALLEY, HUMBOLDT COUNTY, CALIFORNIA—Geological Survey Water-Supply Paper 1576-C

Water-Resources Reconnaissance of Hoopa Valley, Humboldt County California

By J. L. POOLE

WATER SUPPLY OF INDIAN RESERVATIONS

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WATER-RESOURCES RECONNAISSANCE OF HOOPA VALLEY, HUMBOLDT COUNTY, CALIFORNIA

By J. L. Poole

ABSTRACT

The Hoopa Valley area is underlain generally by consolidated rocks of pre-Tertiary age, including quartz-mica schist, slate, and slaty sandstone and shale. These rocks crop out in the channel of the Trinity River and lie at depths ranging from exposures at land surface to about 50 feet beneath the valley floor. In Hoopa Valley the consolidated rocks are overlain by alluvial deposits of sand, gravel, and boulders which reach a maximum thickness of about 50 feet beneath the terraces bordering the Trinity River.

The consolidated rocks are relatively impermeable and are not considered to be a reliable source of ground water in Hoopa Valley. They serve, instead, as a barrier to the downward movement of ground water and form a relatively impermeable surface over which ground water moves toward discharge areas along the Trinity River. The alluvial deposits are moderately to highly permeable and are capable of transmitting water rapidly from areas of recharge along streams and mountain fronts to areas of discharge along the Trinity River. Under these conditions there is little opportunity for natural ground-water storage through the late summer and fall dry period. Development of moderate quantities of ground water from wells, therefore, is feasible only in small areas adjacent to the perennial tributaries of the Trinity River where a substantial thickness of saturated alluvium is maintained by infiltration of streamflow through the highly permeable stream-channel deposits.

An abundant supply of surface water is perennially available from the Trinity River and its four principal tributaries in Hoopa Valley. The perennial flow of Mill, Supply, Hostler, and Soctish Creeks is partly utilized for domestic and irrigation use and for industrial use by several lumber mills in the area. Supply Creek furnishes an ample water supply for U.S. Government installations at Hoopa, for small-scale irrigation, for the public school, and for about 50 private homes and business establishments in the vicinity of Hoopa.

The present water supply for the U.S. Bureau of Indian Affairs Hoopa Indian Agency and for the U.S. Public Health Service Hospital is obtained by pipeline from Supply Creek. Recurring flood damage to the pipeline in the section buried in the channel of Supply Creek requires the development of a ground-water supply in the vicinity of the Hoopa Indian Agency or the rerouting of the pipeline to avoid possible future flood damage. On the basis of observations

of the hydrologic conditions adjacent to Supply Creek and the relative adequacy of ground-water and surface-water supplies, it is concluded that either alternative offers a satisfactory solution to the existing water-supply problem.

INTRODUCTION

PURPOSE AND SCOPE

The present water supply for the installations of the U.S. Bureau of Indian Affairs and U.S. Public Health Service at the Hoopa Indian Agency is obtained by pipeline from Supply Creek at an intake about half a mile west of the agency headquarters. During periods of emergency when the pipeline from Supply Creek is subject to damage by floods and heavy sediment loads, the supply is supplemented by water from Hospital Creek.

Owing to the recurring flood damage to the pipeline, the U.S. Bureau of Indian Affairs desires an alternate source of supply that will be less subject to damage. Accordingly, the Agency requested the U.S. Geological Survey to make a reconnaissance hydrologic study of the Hoopa Valley area, with special reference to the availability of an adequate ground-water supply in the vicinity of the Indian Agency headquarters. As a result of this request the author, during the period April 4–7, 1960, made a field reconnaissance to obtain information on the geologic and hydrologic features of the area.

Because the availability and adequacy of a ground-water supply is determined largely by geologic conditions, the area was mapped to show the thickness, areal extent, and continuity of the water-bearing deposits and to show their relation to the underlying, relatively impermeable consolidated rocks. Hydrologic data were collected to serve as a basis for determining the source, direction of movement, and points of discharge of ground water and to determine the permeability and saturated thickness of the water-bearing deposits in the vicinity of the Hoopa Indian Agency. The fieldwork and the preparation of a report describing the results of the investigation were under the supervision of Harry D. Wilson, Jr., district engineer in charge of ground-water studies by the U.S. Geological Survey in California.

LOCATION AND EXTENT OF THE AREA

Hoopa Valley is in the northeastern part of Humboldt County, about 30 miles by airline and 50 miles by highway northeast of Eureka (fig. 1). It is accessible from Eureka and Redding via U.S. Highway 299 and by a paved county highway that joins U.S. 299 at Willow Creek. From the north the area is reached by a paved county highway that parallels the Trinity and Klamath Rivers and, at its northern terminus, joins U.S. 99 a few miles north of Yreka, Siskiyou County.

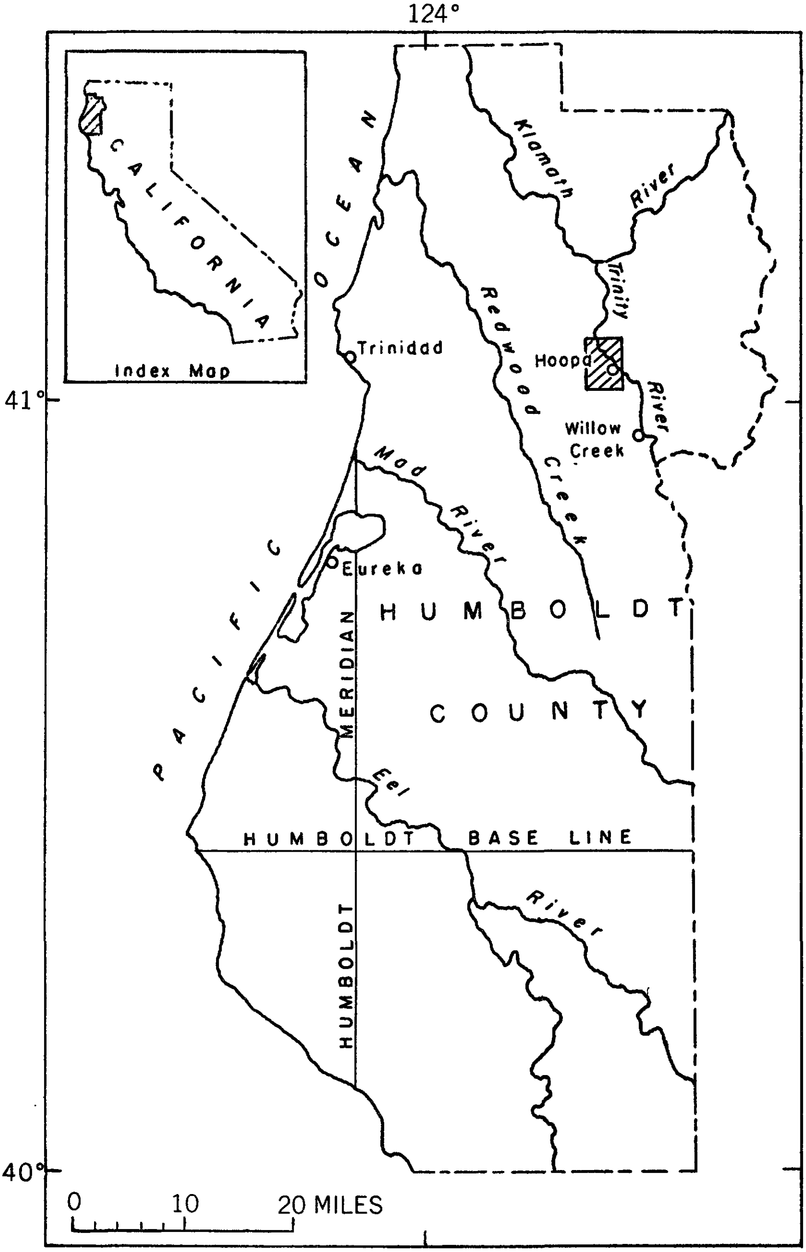

Figure 1.—Index map of Humboldt County, California, showing location of Hoopa Valley.

The valley floor, with which the present study is primarily concerned, is about 5 square miles in area and has a length of about 7 miles and an average width of about three-fourths of a mile. The area is shown on the Geological Survey topographic map of the Hoopa quadrangle at a scale of approximately 1 inch to 1 mile (1: 62,500).

WELL-NUMBERING SYSTEM

Wells in Hoopa Valley are numbered according to their location in the township, range, and section, a system in standard use by the Geological Survey and the California Department of Water Resources. Under this system each section is divided into 40-acre plots that are lettered as shown in figure 2.

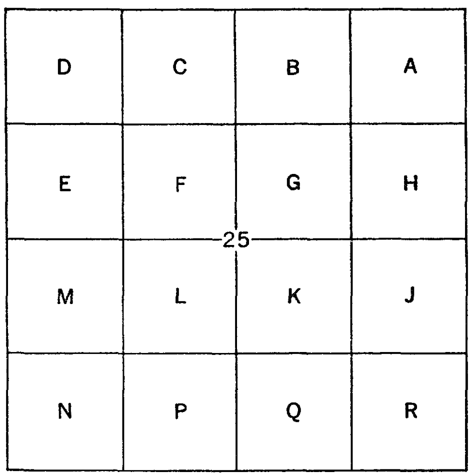

FIGURE 2.—Well-numbering system.

Wells are numbered within each of these 40-acre plots according to the order in which they are located. For example, the well having the number 8/4-25E1 is in sec. 25, T. 8 N., R. 4 E., Humboldt base line and meridian. It is further identified as the first well located in the 40-acre plot lettered E, which is the SW¼NW¼ sec. 25.

GEOGRAPHIC FEATURES

TOPOGRAPHY AND DRAINAGE

Hoopa Valley is a narrow northwest-trending trough along the Trinity River, about 7 to 14 miles upstream from its confluence with the Klamath River. Except for the narrow gorge of the Trinity

River, the valley is enclosed by rugged peaks and ridges of the Klamath Mountains on the east and the South Fork Mountains on the west. The maximum relief within the mapped area (fig. 3) is about 3,900 feet; the highest point, 4,137 feet above sea level, is Telescope Peak in the southwestern part of the area.

The floor of Hoopa Valley averages about three-fourths of a mile in width—a distinct contrast to the gorgelike character of the narrow valley of the Trinity River throughout most of its course. The altitude of the valley floor along the river channel ranges from about 250 feet above sea level at the northern end to about 350 feet at the southern end. Prominent terraces, formed by entrenchment of the river, flank the present channel and locally stand 100 feet or more above the river level. The altitude of the surfaces of these terraces generally ranges from about 350 feet to about 400 feet above sea level near the central part of the valley and from about 300 to 450 feet from north to south, respectively, along the length of the valley. The northward slope of the flatter part of the valley floor thus is about 20 feet per mile and the gradient of the Trinity River about 10 feet per river mile.

About 110 square miles of rugged, heavily timbered mountains surrounding Hoopa Valley is drained by the Trinity River and its tributaries between Campbell Creek (NE¼ sec. 6, T. 7 N., R. 5 E.) and Beaver Creek (SW¼ sec. 3, T. 8 N., R. 4 E.). The principal streams, Mill, Supply, Hostler, and Soctish Creeks, flow throughout the year and furnish water for many domestic, irrigation, and industrial requirements in Hoopa Valley. Most of the smaller streams drain relatively smaller areas and are either dry during the low-flow period of summer and fall or are incapable of furnishing dependable water supplies throughout the year.

Flooding of areas immediately adjacent to the mountain streams commonly occurs during the high runoff period from winter to early spring. Over a long period of recurring winter floods, however, the major streams have cut deeply into the alluvial deposits of the valley floor, and thus flooding is generally confined to the narrow flood plain of the river. Only infrequently does a stream overflow its banks and cause significant damage to homes or other installations. During the reported record high flow of January 1960, for example, the waters of Supply Creek did not leave the stream channel. The principal damage during this flood was the rupture of the Indian Agency's main water-distribution line which is buried in the channel of Supply Creek northwest of the Indian Agency headquarters.

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CLIMATE

Long-term averages of precipitation and temperature in the Hoopa Valley area have not been established owing to the short period of complete record at the Hoopa U.S. Weather Bureau Station. During 1959 the total precipitation was 42.97 inches, of which 38.58 inches, or about 90 percent, fell in the period December through March, and 0.01 inch fell during June, July, and August.

Compared with records at other stations in the area with similar geographic settings and at comparable altitudes, the 1959 precipitation recorded at Hoopa was somewhat less than the long-term average for the general area. The indicated seasonal distribution at Hoopa also differs from that indicated by the long-term records at Orleans, 18 miles to the northeast, and at Salyer Ranger Station, 12 miles to the southeast. Records at these stations show that 64 percent and 67 percent of the rainfall, respectively, falls during the period December through March. The comparison also indicates that the 1959 rainfall deficiency at Hoopa may not be representative because records for April through November for the period 1931–52 for Orleans and Salyer Ranger Station show that 36 percent and 33 percent of the precipitation, respectively, fell during this period, as compared with about only 10 percent at Hoopa in 1959.

Moderate temperatures were characteristic of the Hoopa Valley area in 1959, with a monthly average high of 74.8 in July, an average of 40.6 in December, and an annual average of 56.7. These averages are closely comparable with the mean temperature at the Orleans Weather Bureau Station, which has a 21-year period of record (1939–59). The 21-year mean temperature at Orleans was 76.1 in July and 40.3 in December, and the mean annual temperature was 57.1.

WATER RESOURCES

SURFACE WATER

The surface-water resources of Hoopa Valley consist of the perennial flow of the Trinity River and its four principal tributaries between the north end of the valley and the Trinity River gaging station 1¾ miles southeast of Hoopa. Flow from streams entering the valley from the bordering mountains at points upstream is included in the discharge recorded at the gaging station.

The discharge of the Trinity River, based on 28 years of record (1911–13, 1931–57) at the Hoopa gaging station, has averaged 5,613 cubic feet per second (cfs), or more than 4 million acre-feet per year. During this period the maximum discharge of 190,000 cfs occurred on December 22, 1955, and the minimum of 162 cfs occurred on October

4, 1931 (Wells, 1959, p. 595). A flow-duration summary for the Hoopa gaging station, adjusted to the base period 1927-52, shows that the Trinity River discharge equals or exceeds 160 cfs for 99.9 percent of the time, and 32,000 cfs for 1 percent of the time. For the 2,846 square mile drainage area of the Trinity River above the Hoopa gaging station this summary shows the streamflow contribution per square mile of drainage area to be 0.97 cfs for 50 percent of the time and 0.20 cfs for 80 percent of the time (Rantz, 1956, p. 71).

There are no continuous records of streamflow for the principal tributaries of Trinity River in the Hoopa Valley drainage area. These streams, Mill, Supply, Hostler, and Soctish Creeks, drain areas of about 50, 18, 12, and 10 square miles, respectively—a total area of about 90 square miles. Current-meter measurements of discharge have been made on occasion, however, at all four of these perennial streams. The discharge of Supply Creek was measured nine times during the period 1911 to 1918 and twice in 1960. Each of the other three streams was measured twice in 1960.

Correlation of concurrent discharge of Supply Creek and Trinity River near Hoopa indicates a curvilinear discharge relationship at the lower flows. The few concurrent measurements available for the other streams indicate the following approximate discharge relationships:

Hostler Creek = 0.30 × Supply Creek
Soctish Creek = 0.30 × Supply Creek
Mill Creek = 3.9 × Supply Creek

On the basis of these relationships and the flow-duration data for Trinity River, a flow-duration summary for each of the four tributary streams has been synthesized. This summary, shown in the following table, is limited to durations ranging from 60 to 99 percent of time, because the discharge relationships for the several streams are too poorly defined to warrant extrapolation beyond this range. The discharges shown in the table are far from precise, but they are useful in evaluating the potential of these tributary streams to provide continuous and dependable water supplies in Hoopa Valley.

The discharges summarized above appear to be valid, at least in their order of magnitude, as indicated by reports of the adequacy and permanence of these streams. Supply Creek is a perennial stream that has furnished an adequate water supply for many years for the Hoopa Indian Agency, the U.S. Public Health Service Hospital, the public school, and about 50 private homes and business establishments. Even during relatively dry years and periods of low flow during wet years the discharge from Supply Creek reportedly has exceeded the local water requirements and has furnished, in addition, sufficient water to irrigate a small parcel of Indian land in the vicinity of the Indian Agency headquarters. Mill, Hostler, and Soctish Creeks also flow throughout the year and provide sufficient water for local domestic, irrigation, and industrial uses.

Estimated flow duration summary for the principal tributaries of the Trinity River in Hoopa Valley

Stream	Drainage area (sq mi)	Discharge (cfs) expected to be equaled or exceeded during percent of time indicated					
		99	95	90	80	70	60
Mill Creek	50	10.0	13.0	16.0	20.0	28.0	51.0
Supply Creek	18	2.6	3.4	4.0	5.2	7.1	13.0
Holster Creek	12	.8	1.0	1.2	1.6	2.1	3.9
Soctish Creek	10	.8	1.0	1.2	1.6	2.1	3.9
Total	90	14.2	18.4	22.4	28.4	39.3	71.8

GROUND WATER

GEOLOGIC UNITS AND THEIR WATER-BEARING PROPERTIES

For the purposes of this report the geologic formations in the Hoopa Valley area are divided into two distinct types, on the basis of their lithology and water-bearing properties. These are consolidated rocks of pre-Tertiary age and unconsolidated alluvial deposits of Quaternary age. The areal distribution of these formations is shown on the geologic map (fig. 3) and their stratigraphic and physiographic relations are shown on the geologic sections (figs. 4 and 5).

CONSOLIDATED ROCKS

Consolidated rocks form the mountains surrounding Hoopa Valley and underlie, at shallow depth, the unconsolidated alluvial deposits on the valley floor. These consolidated rocks consist principally of quartz-mica schist, slate, and slaty sandstone and shale of pre-Tertiary age. The quartz-mica schist is similar in most respects to the Abrams schist, described by Hershey (1901, p. 225–245), and the Kerr Ranch schist, described by Manning and Ogle (1950, p. 13–18). Manning and Ogle (1950, p. 15) recognized the similarity between the Abrams schist and the schist in the Bluke Lake quadrangle; however, they proposed the new geologic name, Kerr Ranch schist, principally because of differences in the degree of metamorphism. The slate and slaty sandstone and shale appear to be a southward extension of the Galice formation in Del Norte and northern Humboldt Counties as described by Hershey (1911, p. 468), and by Irwin and Tatlock (1955, pl. 1).

As the scope of this report precluded detailed geologic studies and correlations, the consolidated rocks in the Hoopa Valley area are included in previously recognized geologic units. On the basis of its lithologic character, the quartz-mica schist is thus considered equivalent to the Abrams schist of Hershey (1901, p. 225–245) and the slate and slaty sandstone and shale to the Galice formation of Hershey (1911, p. 468).

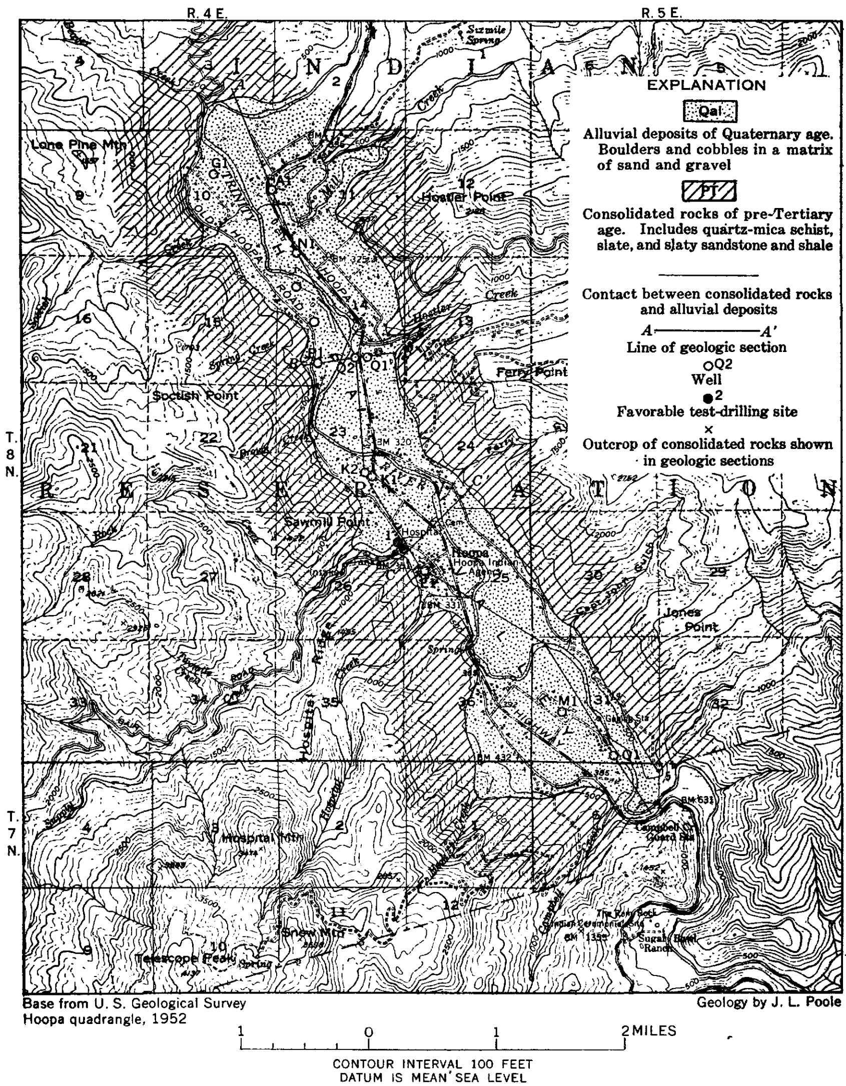

FIGURE 3.—Geologic map of the Hoopa Valley area, Humboldt County, Calif., showing locations of wells and favorable sites for test drilling.

Dark-gray to black slate and slaty sandstone and shale are the predominant consolidated rock types in the Hoopa Valley area. They are exposed in the banks of the Trinity River throughout the length of the valley about 30 to 50 feet below the general level of the bordering terraces. The Trinity River has entrenched itself to a depth of 20 to 30 feet in the consolidated rocks and now flows on these rocks except along reaches where the river bed is partly filled with coarse channel deposits.

The least common of the consolidated rock types is the quartz-mica schist observed in roadcuts at the south end of Hoopa Valley and in the channel of Supply Creek southwest of the Hoopa highway bridge. The schist, ranging from gray to green in color, probably is the "blue shale" or "blue clay" reported in drillers' logs of wells in the valley.

The consolidated rocks are of little significance with respect to the development of ground water, because they are relatively impermeable and can transmit water only very slowly along bedding planes and through zones of jointing and faulting. For this reason they are not differentiated and are shown on the geologic map and sections as a single consolidated rock unit. Owing to the small scale of the geologic map (fig. 3), it was not possible to show the small areas of consolidated rock outcrop along the Trinity River and its larger tributaries.

UNCONSOLIDATED ALLUVIAL DEPOSITS

The floor of Hoopa Valley is underlain by unconsolidated alluvial deposits that range in thickness from a few feet along the valley margins to a maximum of about 50 feet along the terraces bordering the Trinity River (figs. 4 and 5). The unconsolidated deposits consist of alluvial-fan deposits at the mouths of the principal streams that enter the valley, talus-slope deposits along the steep mountain fronts, channel deposits of the Trinity River, and terrace deposits flanking the Trinity River along its course through the valley. The alluvial-fan and talus-slope deposits are composed of poorly sorted sand, gravel, and angular to subangular cobbles and boulders derived from weathering and erosion of the consolidated rocks in the surrounding mountains. River-channel and terrace deposits are generally well sorted, consist mostly of subrounded gravel, cobbles, and boulders, and contain relatively little fine-grained material.

The alluvial deposits are exposed in their maximum known thickness along the banks of the Trinity River, where they range in thickness from about 40 feet at the south end of Hoopa Valley to about 50 feet at the north end (fig. 4). The alluvial deposits are nowhere continuous across the valley, because the Trinity River has trenched through them and into the underlying bedrock all along its course

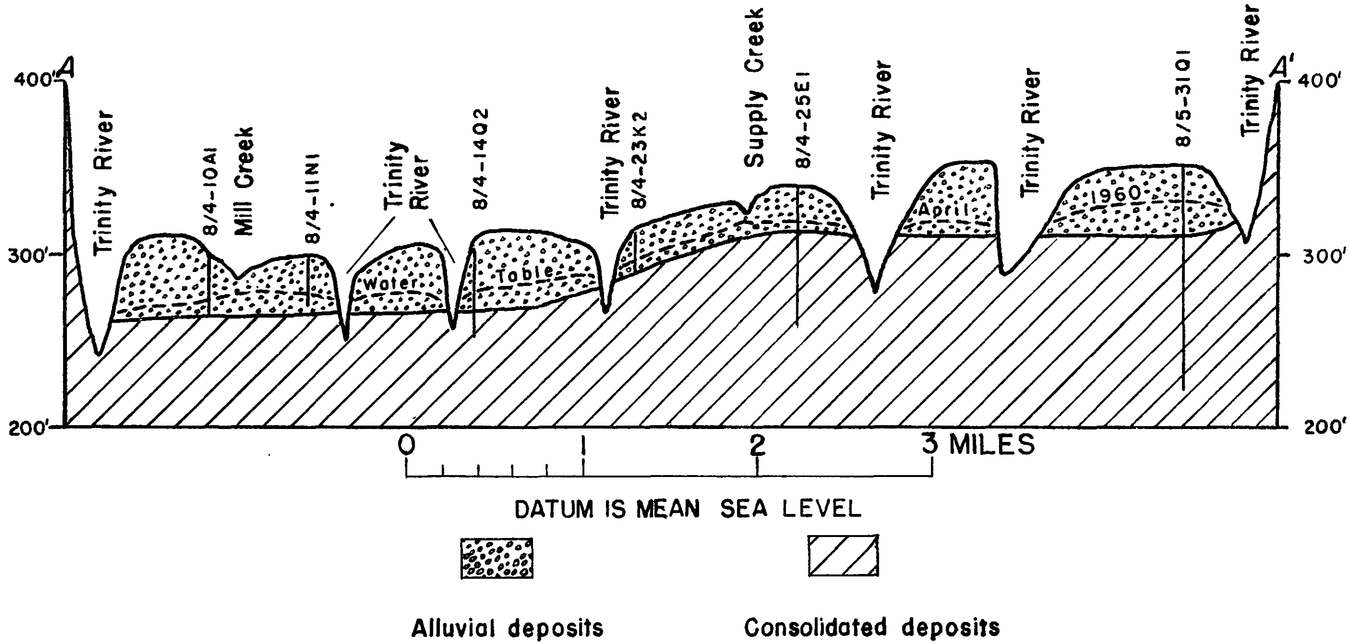

FIGURE 4.—Generalized northwest-southeast geologic section along line *A–A'* through Hoopa Valley. Line of section shown on figure 3.

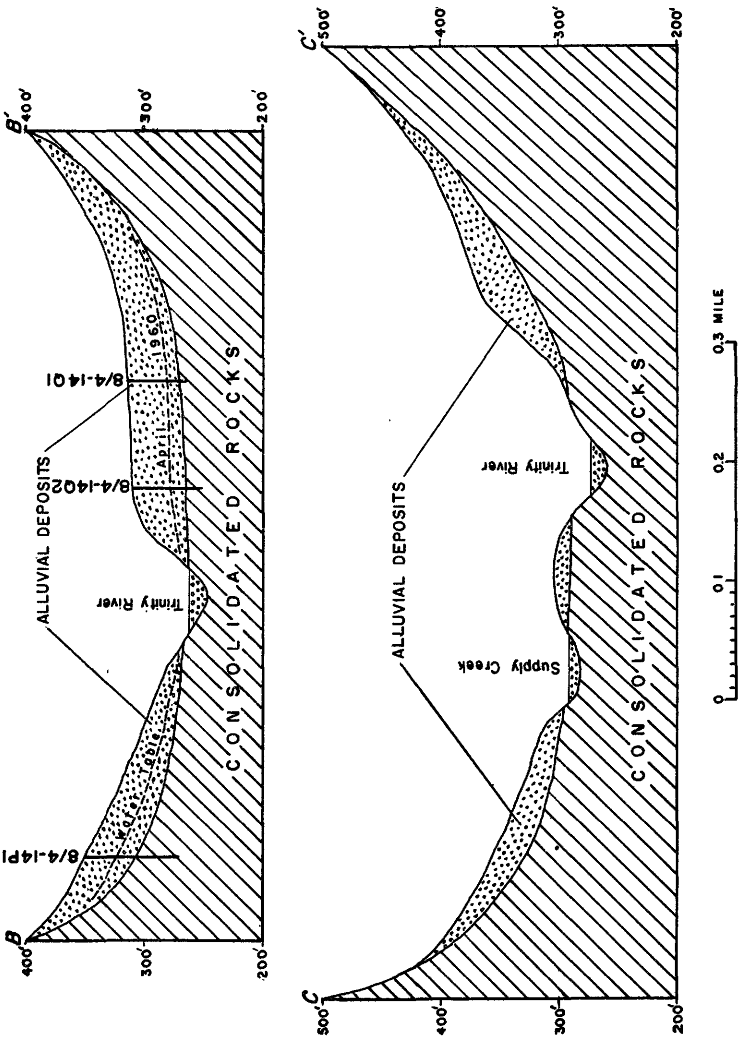

FIGURE 5.—Generalized east-west geologic sections along lines *B–B'* and *C–C'* across Hoopa Valley. Line of sections shown on figure 3.

(fig. 4). The geologic sections (figs. 4 and 5) indicate that the thickness of the alluvial deposits does not exceed that observed in the banks of the river.

The alluvial deposits are moderately to highly permeable and therefore are capable of transmitting water rapidly from areas of recharge to areas of discharge. A high permeability is shown by reports of rapid infiltration of water applied for watering lawns and for other irrigation in the valley. According to reports, large volumes of water allowed to flow from pipelines seep into the ground with little or no ponding at the point of discharge.

SOURCE, MOVEMENT, AND DISCHARGE

The source of all ground water in Hoopa Valley is the precipitation that falls on the valley floor and in the surrounding mountains. Part of this precipitation percolates directly into the soil and part flows into the mountain streams and upon reaching the valley floor percolates into the ground-water body through the highly permeable channel-fill deposits. The remainder either becomes surface runoff or is lost to the atmosphere by evaporation.

Part of the water that percolates into the soil moves slowly down the mountain slopes as ground water and seeps into streams or directly into the alluvium underlying the floor of Hoopa Valley. The soil cover on the slopes provides the storage and slow transmission of water essential to the maintenance of perennial flow in the streams that drain the area. After reaching the valley floor, ground water moves downgradient through the alluvium to points or areas of discharge, the rate of movement depending on the slope of the ground-water surface and the permeability of the alluvial deposits. Highly permeable material, such as the terrace deposits covering much of the floor of Hoopa Valley, permits rapid movement toward the central part of the valley. Owing to the low permeability of the consolidated rocks in contrast to the higher permeability of the alluvial deposits, most of the water that reaches the ground-water body moves rapidly through the alluvium just above the surface of the underlying consolidated rocks and discharges into the Trinity River. Consequently there is little opportunity for sufficient accumulation of ground water in storage in the valley to sustain heavy withdrawals during dry seasons of the year when it is needed the most.

ADEQUACY AND PERMANENCE OF THE GROUND-WATER SUPPLY

The water table, or upper surface of the zone of saturation in the unconsolidated alluvium, averages about 20 to 30 feet below the land surface throughout most of the Hoopa Valley area and is at or near the land surface along the principal streams flowing into the Trinity River. It conforms generally with the surface topography; it slopes toward the central part of the valley and the discharge area along the Trinity River and thus indicates the direction of ground-water movement.

The water table fluctuates from season to season; it rises during rainy periods in response to recharge through permeable soils and stream-channel deposits and declines during dry periods when recharge is at a minimum and is exceeded by ground-water discharge. The water level therefore is highest and the saturated thickness of the alluvial deposits is greatest during the December to April period of heavy precipitation. During the dry season of July through September the water table is lowest and in prolonged dry periods may decline sufficiently to leave the lowermost alluvial deposits locally unsaturated.

Water levels observed in April 1960 were at or near their maximum height and were highest along the principal streams where they enter the valley floor. Along these perennial streams, water percolates through the permeable channel deposits and builds up ground-water mounds beneath the stream course where it is underlain by alluvium. These mounds vary in height and areal extent and depend on the amount and duration of streamflow; they are persistent along the perennial streams near the margins of the valley.

The saturated thickness of the alluvial deposits decreases toward the interstream areas of the tributary streams and locally may be less than 5 feet even during periods of high water levels. Water-level measurements made in April 1960 showed that the saturated thickness ranged from about 5 to 19 feet and averaged about 12 feet (figs. 3 and 4). It was least along the Trinity River where ground-water discharge was occurring at the bedrock outcrop, and greatest at the valley margins near the principal tributaries. Records of water levels during dry periods are not available, but the water table probably declines so much during late summer and fall that the alluvial deposits probably are virtually dewatered. Reports of inadequate yields from wells drilled to bedrock confirm the contention that a minimum saturated thickness of the alluvium exists during late summer and fall. The following table contains water-level data and other information for representative wells in Hoopa Valley that summarize the hydrologic conditions as observed in April 1960. The wells indicated are identified according to the previously-described well-numbering system and are shown on figure 2.

The adequacy and permanence of a ground-water supply in Hoopa Valley depend on how much water a well will yield when the thickness of the saturated section is least, usually in the autumn. This dependence on the thickness of the saturated section becomes even more critical when it is considered that a pumped well must lower the water level in the vicinity to establish a cone of depression that will cause ground water to move into the well from all directions. The amount the water level is lowered depends on the specific capacity of the well, or the yield in gallons per minute (gpm) per foot of water-level decline. Thus, in order to pump 100 gpm from a well with a specific capacity of 10 gpm per foot, the water level must be lowered 10 feet in the well. Yields of wells in Hoopa Valley, therefore, are limited by the relatively thin saturated alluvial section at the times when water levels are lowest. As the saturated thickness of the alluvium probably ranges from 1 to 10 feet and may average less than 5 feet in most of the valley during late summer and fall, only small to moderate yields could be obtained from wells, except locally along the perennial streams.

Data for selected wells showing general hydrologic conditions in Hoopa Valley

Well	Depth (feet)	Depth to bedrock (feet)	Water level (feet below land surface)	Date of water-level measurement	Saturated thickness of alluvium (feet, rounded)
8/4-10G1		[1] 40	31.4	4-6-60	9
10H1	37	37	27.6	4-5-60	9
11N1	28	28	22.3	4-5-60	6
14P1	78	42	24.7	4-6-60	17
14Q1	50		34.0	4-5-60	16±
14Q2	58	44	32.0	4-6-60	12
23K1	21		18.9	4-6-60	
23K2	25	25	20.3	4-5-60	5
25E1	82	26			
8/5-31M1	37		18.0	4-6-60	19±
31Q1	127	40			

[1] Estimated from outcrop nearby.

EXISTING WATER-SUPPLY FACILITIES

The greatest concentration of population in Hoopa Valley is in the vicinity of Hoopa (fig. 3) where most of the water for domestic use is furnished by pipeline from Supply Creek. About 200 residents, in addition to the Hoopa Indian Agency, the U.S. Public Health Service Hospital, and the public school, obtain water from this source. There is no ground-water development at the agency; moreover, little ground-water development has been attempted elsewhere in Hoopa Valley owing to the ready availability of surface-water supplies and the difficulty of developing adequate supplies from wells. Most residents of the valley obtain their domestic supplies from streams or springs, which are reported to be more dependable than existing wells and, in addition, are capable of furnishing sufficient water for small-scale irrigation and the industrial requirements of several lumber mills.

The present Hoopa Indian Agency water system is dependent on the perennial surface flow in Supply Creek, which supplies more than 600 gpm continuously through an 8-inch pipeline. This quantity is usually in excess of actual needs, however, and much of the flow is diverted back into Supply Creek except during periods of peak demand.

With few exceptions, existing wells throughout Hoopa Valley are capable of yielding only small quantities of water for domestic use. Most of these wells tap the unconsolidated alluvium, but many were drilled a few feet into the underlying consolidated rocks, generally in unsuccessful attempts to obtain additional and more permanent water supplies. Yields of domestic wells, as limited by the small capacities of presently used pumping equipment, are generally less than 10 gpm. Wells of greater capacity can be developed, however, in favorable areas where the water table remains 10 feet or more above the top of the consolidated rocks. The largest reported yield is 75 gpm from the Sugar Pine Lumber Co. well 8/5–31M1, at the south end of Hoopa Valley.

DEVELOPMENT OF A GROUND-WATER SUPPLY

ADEQUACY OF THE ALLUVIAL DEPOSITS AS A STORAGE RESERVOIR

Development of wells capable of producing moderate quantities of ground water from the alluvial deposits would require the selection of well sites having the maximum possible saturated thickness of alluvium. The vicinity of Hoopa is considered to be typical of potential ground-water development sites in Hoopa Valley. In this area the maximum thickness of the alluvial deposits is about 30 feet, as shown by geologic section *C–C′* (fig. 5). This estimate is based on outcrops of the consolidated rocks in the channel of Supply Creek and a reported depth to bedrock of 26 feet at well 8/4–25E1. The thickness is somewhat less along Supply Creek west of the Hoopa Highway, because the stream channel is entrenched from 5 to 15 feet below the general level of the terrace. The maximum thickness of the alluvium along Supply Creek thus is estimated to be about 20 to 25 feet in the vicinity of the bridge in the NE¼ sec. 26, T. 8 N., R. 4 E. (fig. 3).

The continuing infiltration of water through the permeable deposits in the stream channel presumably maintains the water table at a high level along Supply Creek. During the rainy season, ground water is forced to the surface and is discharged into Supply Creek along the bedrock outcrop at the Hoopa Highway bridge. In April 1960, ground water was ponded in a depression at the base of the terrace bordering Supply Creek and, although no surface inflow to the pond was observed, water was discharging into the creek through a small channel cut into the consolidated rock surface. As the flow of Supply Creek decreases, the rate of infiltration in the upstream segment also declines and causes a lowering of the water table and a decrease in the rate of ground-water discharge into the stream east of Hoopa Highway.

Similar geologic and hydrologic conditions exist along Mill, Hostler, and Soctish Creeks where they cross the valley floor. The most favorable sites for development of ground-water supplies are along these perennial streams, which are the principal sources of recharge to the ground-water body. Because of this recharge the water levels are expected to be highest and the thickness of saturated alluvium greatest in these areas.

Few wells have been drilled in Hoopa Valley in which ground-water levels can be observed. The depth to the water level and the thickness of saturated alluvium therefore are estimated on the basis of the projected profile of the consolidated rocks (figs. 4 and 5) and the predicted effects on the ground-water body of recharge from the mountain streams and from ground-water movement along the buried bedrock surface to discharge areas. During periods of maximum streamflow, the alluvium along the streams is almost fully saturated and the water level is within a few feet of the land surface. Because of the high permeability of the alluvium and the proximity of discharge areas, however, ground water drains out rapidly and the water table declines as streamflow and streambed infiltration decrease. It is estimated, therefore, that along Mill, Supply, Hostler, and Soctish Creeks the maximum saturated thickness of alluvium during the normally dry months of July through September is perhaps less than 10 feet, and at short distances from these streams may be less than 5 feet. Elsewhere in Hoopa Valley adequate supplies may be available, but only during part of the year, because the water table declines to near the bedrock surface during the late summer and fall. A minimum thickness of less than 1 foot is indicated by the driller's log of well 8/4-25E1, in which the ground-water level coincides approximately with the level of the bedrock surface at a depth of 26 feet. This well was drilled near the Indian Agency headquarters, in the interstream area between Supply and Hospital Creeks, in an attempt to develop a ground-water supply for the public school.

METHODS OF DEVELOPING A GROUND-WATER SUPPLY

As shown previously, the maximum saturated thickness of alluvium along the principal tributary streams during the period July through September may be 5 to 10 feet. Assuming a maximum drawdown of about 5 feet and a specific capacity of 10 gpm per foot of drawdown in wells completed in the alluvium, a maximum yield of 50 gpm could be pumped from a single large-diameter well. Larger quantities could be obtained readily by the use of large-diameter collectors that penetrate the entire thickness of the alluvium and have perforated collector pipes extending horizontally along the bedrock surface from the collector well. This method pumps water from a larger area with less resultant drawdown and affords the maximum yield from the available thickness of saturated alluvium. Should the water table decline to near the bedrock surface, the system, of horizontal collector pipes would provide a margin of safety that cannot be achieved by standard vertical wells.

Before supply wells or collectors are installed, however, test wells should be drilled to determine the thickness of the alluvium and the depth to water adjacent to the streams. Water-level measurements also should be made during the period of low streamflow to determine the approximate lowest water level and thus the minimum thickness of saturated alluvium during the dry season.

Sites for such test and observation wells should be selected near enough to the streams to take full advantage of the maximum thickness of saturated alluvium, yet far enough away to eliminate the effect on the ground-water body of pollutants which may be carried by streams. Additional wells should be drilled at greater distances from the streams to provide information on the slope of the ground-water surface and thus show the effect of recharge from the streams.

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