1985

# GROUNDWATER IN THE HASSAYAMPA RIVER VALLEY MARICOPA COUNTY, ARIZONA

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(For presentation at the Rocky Mountain Groundwater Conference, Phoenix, Arizona, September 16, 1986.)

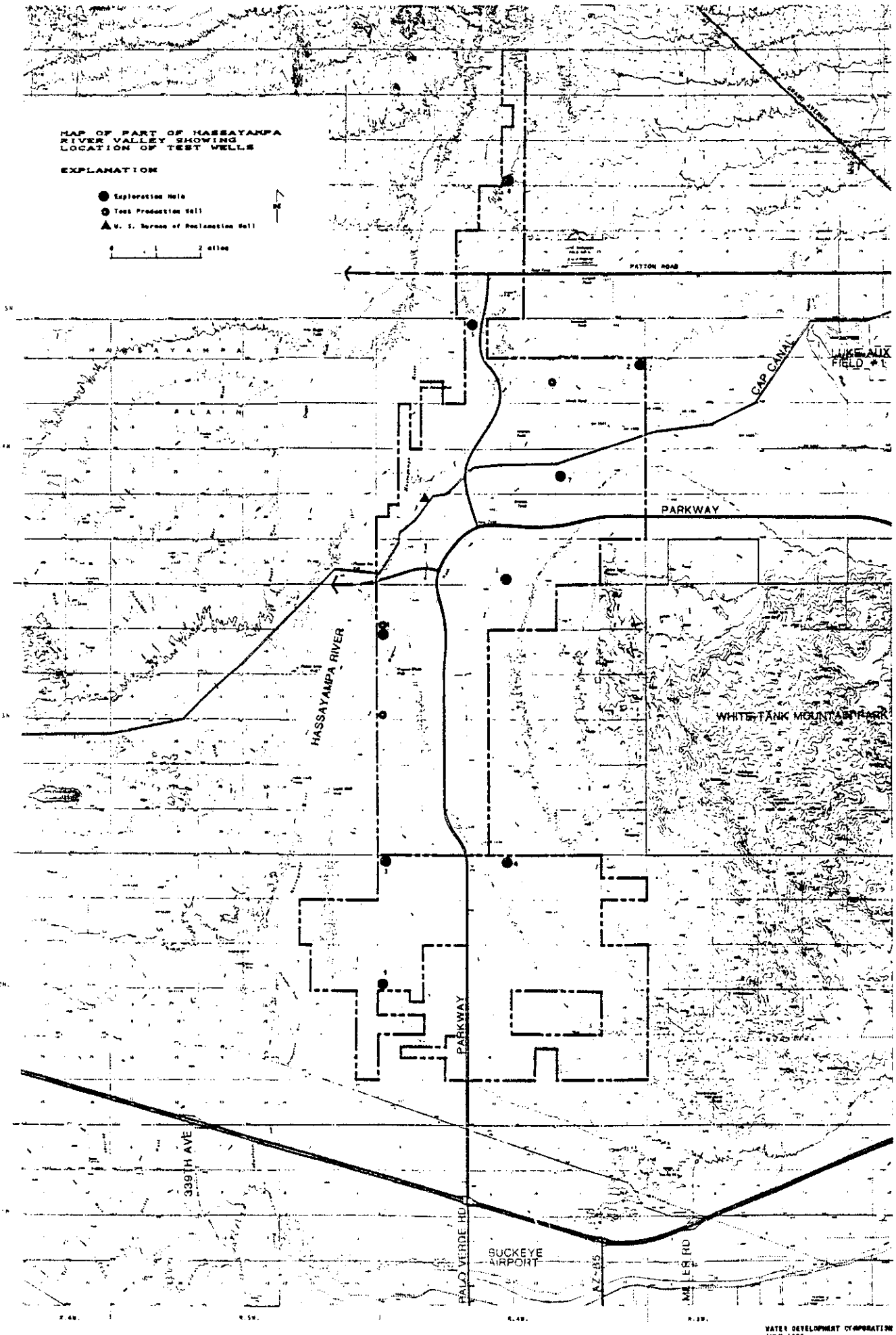
## Introduction

In March of this year our firm was requested by the Sun Valley Property Owners Association of Phoenix to conduct a hydrogeological investigation of a tract of 48,000 acres in the western part of the Hassayampa River Valley. The assignment was a pleasure and a challenge in that the valley is the only remaining groundwater basin in Central, Southern or Southeastern Arizona that has been virtually undeveloped and is hydrologically unknown. This type of exploration basin study was what Oscar Meinzer was able to do 75 years ago, but is no longer possible in this country.

The reason the area is unknown is that until this year the land was in public ownership (State, BLM or other Federal land), and was traded for private land owned by Tenneco along the San Pedro River. The only groundwater data available were records of the few stock wells and two wells drilled to obtain construction water for the CAP Canal. The stock wells were generally drilled only to about 100 feet below the water table. It is truly an untapped potential groundwater supply. The map, Plate 1, shows the location of the 48,000 acres in the project, known as Sun Valley.

## General Description of the Area

The Hassayampa River rises a few miles south of Prescott, flows almost due south through Wickenburg, and joins the Gila River between Buckeye and Arlington. From the headwaters southward to near Morristown the river is in the Mountain Physiographic Province and flows nearly all the time. Near Morristown the river crosses a major fault complex and enters a deep alluvial basin of the Basin and Range Physiographic Province. From this fault southward to the Buckeye Canal crossing the river is dry except briefly after rainstorms. All of the runoff from the headwaters sinks into the ground. At the Buckeye Canal crossing treated wastewater enters the river, which is then perennial for the short distance to the Gila River confluence.




WATER DEVELOPMENT CORPORATION
JULY 1966

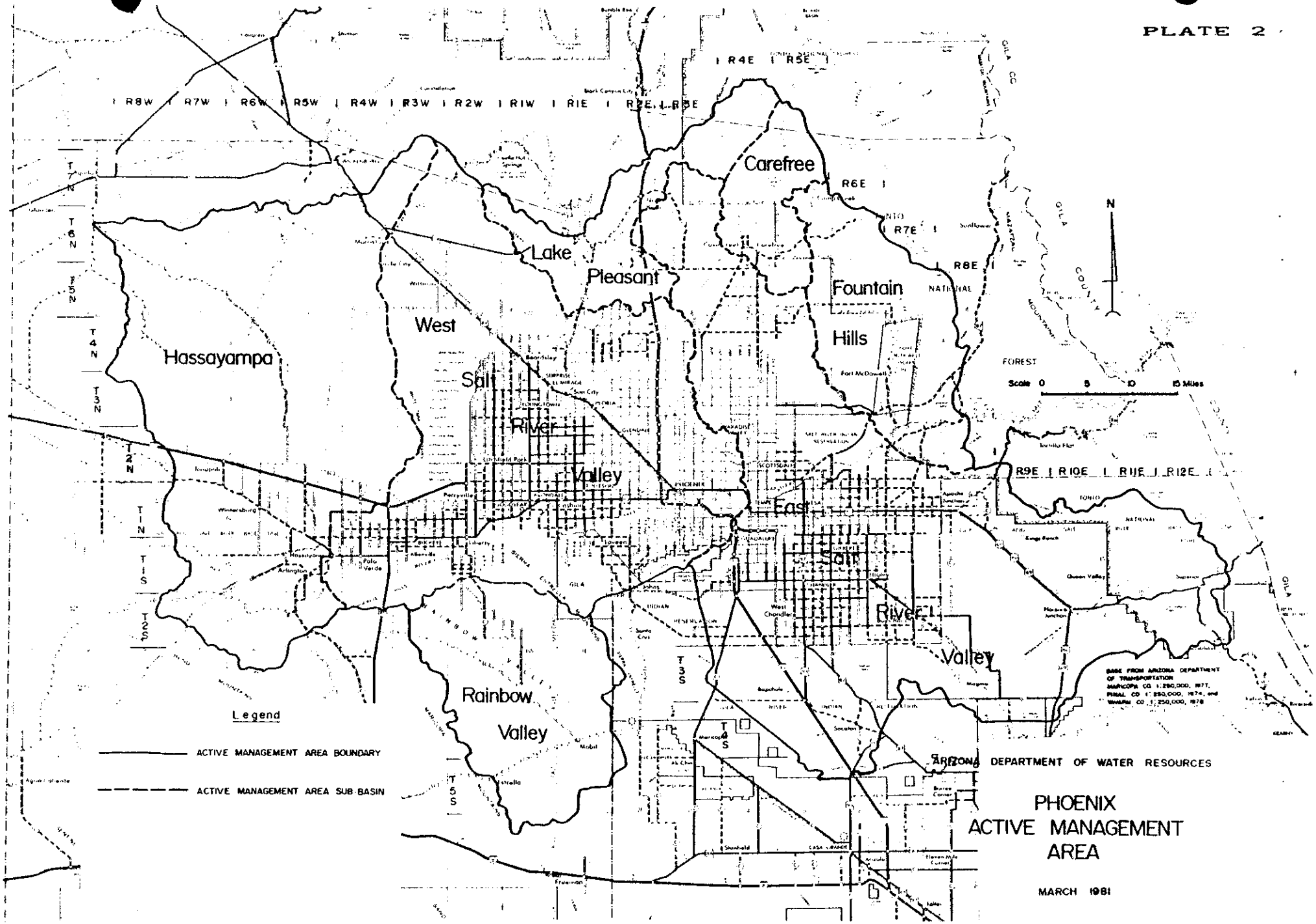
The drainage area near the mouth is 1,470 square miles and, at the gaging station near Morristown, 774 square miles. Thus, the alluvial basin portion occupies almost 700 square miles, about 30 townships.

Plate 2 shows the relationship between the alluvial basins of the Hassayampa and the Salt River Valley. The White Tank Mountains limit the Hassayampa basin on the east side in Townships 2, 3, and part of 4 North. Farther north the alluvial basins of the Hassayampa and Agua Fria Rivers merge, and the line between them is a groundwater divide. Westward, the basin is nearly 30 miles wide. It is bounded on the west by the Vulture Mountains at the northern end, the Belmont Mountains near the center, and by the Palo Verde Hills at the southern end.

The land surface gradient gradually decreases southward from about 65 feet per mile near the northern end to about 25 feet per mile near the southern end.

Annual precipitation averages about 8 inches, of which about 40 percent occurs in the summer and about 60 percent in the winter. Summer temperatures are in the range of 75°F at night and 105°F in the daytime. In the winter, night-time temperature is about 35°F and, in the daytime, about 65°F.

PLATE 2


Hassayampa
West
Salt
River
Valley
Lake
Pleasant
Carefree
Fountain
Hills
East
Salt
River
Valley
Rainbow
Valley
R8W
R7W
R6W
R5W
R4W
R3W
R2W
R1W
R1E
R2E
R3E
R4E
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R10E
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T3S
T4S
T5S
N
Scale 0 5 10 15 Miles
Legend
ACTIVE MANAGEMENT AREA BOUNDARY
ACTIVE MANAGEMENT AREA SUB-BASIN
ARIZONA DEPARTMENT OF WATER RESOURCES
PHOENIX
ACTIVE MANAGEMENT
AREA
MARCH 1981

## Plan of the Investigation

At the beginning of the investigation the only available subsurface information was geophysical. These data indicated the basin fill could be as much as 1,600 feet thick along the axis of the river. North of the White Tank Mountains (T.5N., R.3W., Sec. 28) an oil test drilled in 1982 was drilled in basin fill to a depth of 4,500 feet with "fresh water" to a depth of 2,400 feet. We decided that the first data we needed was geological. Accordingly, Phase I of the overall investigation was planned to construct nine test holes to a depth of 1,200 feet or to bedrock if shallower, with the objective of learning whether the subsurface materials are mainly clay, or silt, or water-bearing sand and gravel.

Phase II of the project is planned to collect data on the ability of the system to yield water to wells. It is planned to conduct a 3-day aquifer test at a well along the the CAP Canal, which is owned by the U.S. Bureau of Reclamation. Following this, three test production wells will be drilled at selected sites. These wells will be developed and then tested for 3 days for yield and drawdown. We have completed Phase I, are just beginning Phase II, and in the meantime have been collecting field data at existing wells for depth to the water table and and for quality of the water.

Phase III will be an analysis of all the availble data and preparation of a comprehensive hydrogeological report of the results of the entire investigation.

## Results of the Phase I Investigation

The Sun Valley Project map (Plate 1) shows the locations of the nine test holes. The holes were drilled without casing, except for temporary surface casing. They were drilled mostly by air hammer, switching to conventional rotary if caving occurred. The diameter was 6-inches. Samples of drill cuttings were collected in cloth sample bags at 10-foot intervals. After each hole was drilled, the depth to static water level was measured. The hole was then backfilled and abandoned as required under DWR (Arizona Department of Water Resources) regulations. We were able to collect water samples from four holes.

The samples of drill cuttings were examined and described Errol L. Montgomery and Associates. The samples have been retained for possible future re-examination by an enterprising graduate student. Three of the holes were drilled close to the west flank of the White Tank Mountains at sites where we considered that bedrock might be encountered at depths shallower than 1,200 feet. One hole was drilled near the northeast corner of the Project lands. The remaining five were drilled along the west side, not too far from the Hassayampa River.

The graphs illustrate the type of materials encountered. The cross-hatched portion is the sand and gravel fraction of the basin alluvial fill. At holes 1, 6, and 7 we found very coarse piedmont debris rocks and fragments underlying the basin fill, lying on top of bedrock. The depths to bedrock were 937 feet at Hole No. 1, 800 feet at Hole No. 6, and 790 feet at Hole No. 7. The remaining six holes were in basin fill to the target depth of 1,200 feet.

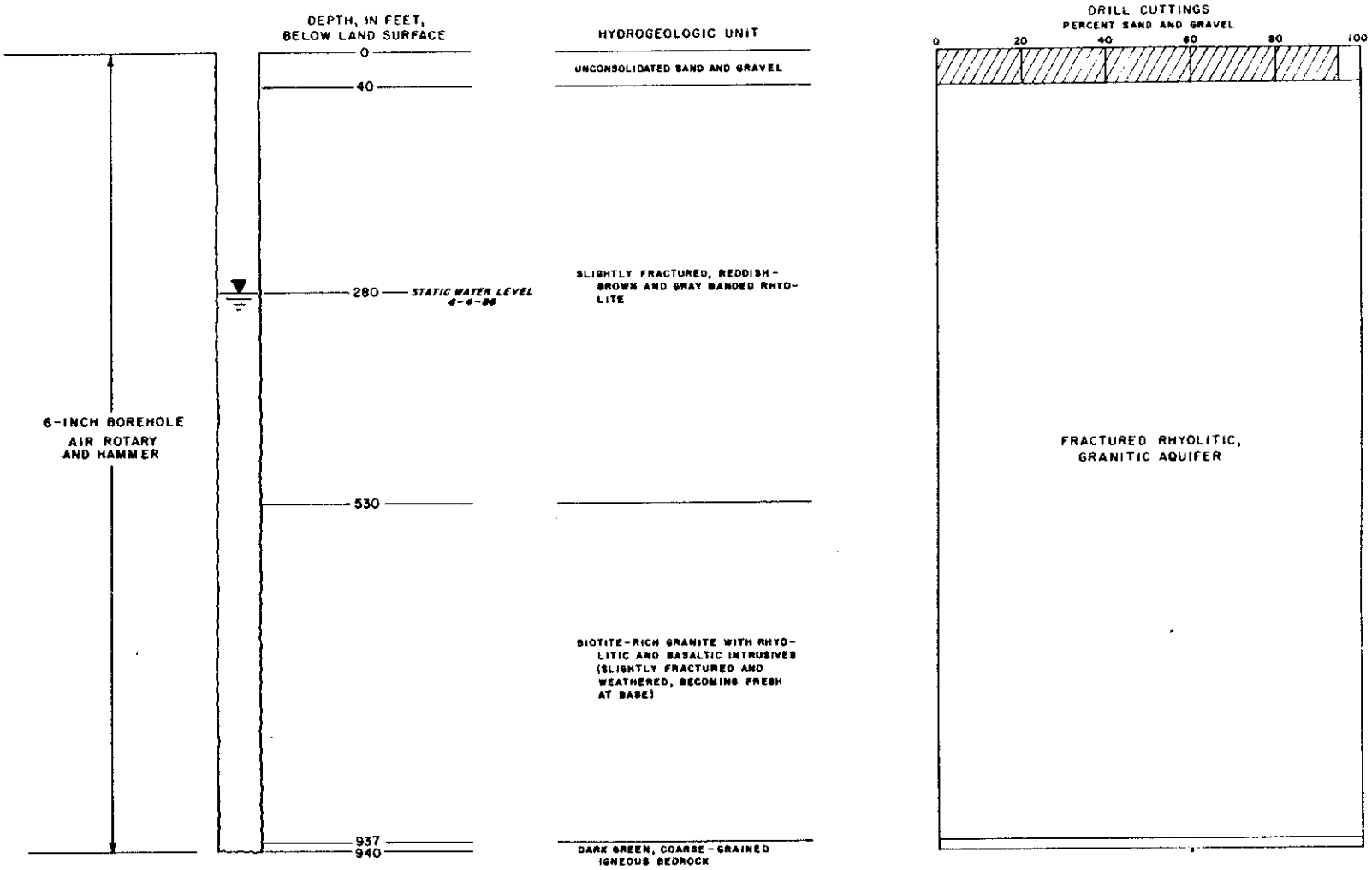


FIGURE 3-1. SCHEMATIC DIAGRAM AND PERCENT SAND AND GRAVEL IN DRILL CUTTINGS FOR TEST HOLE (B-4-4)33ddd [No. 1]

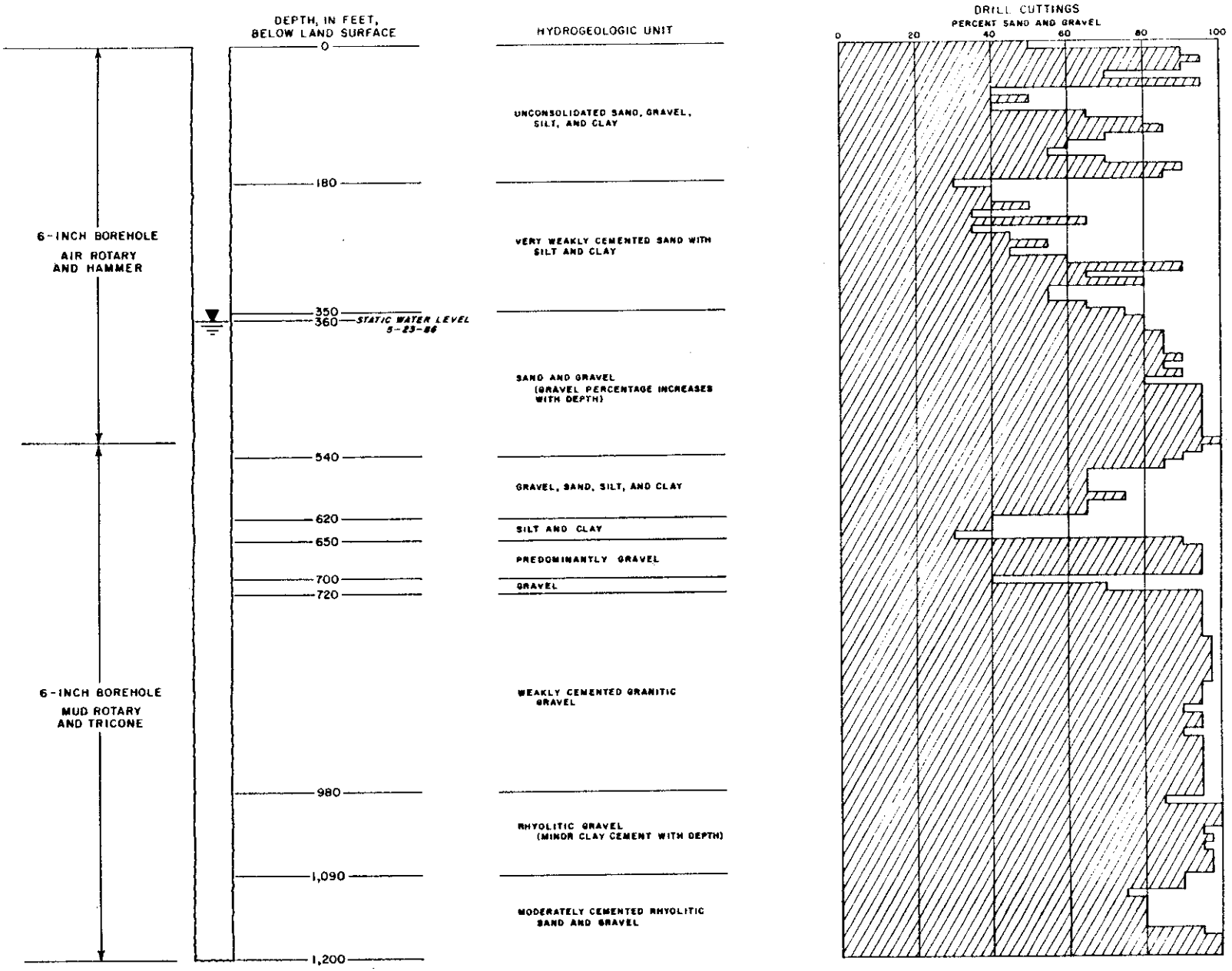


FIGURE 3-2. SCHEMATIC DIAGRAM AND PERCENT SAND AND GRAVEL IN DRILL CUTTINGS FOR TEST HOLE (8-4-4)12aaa [No. 2]

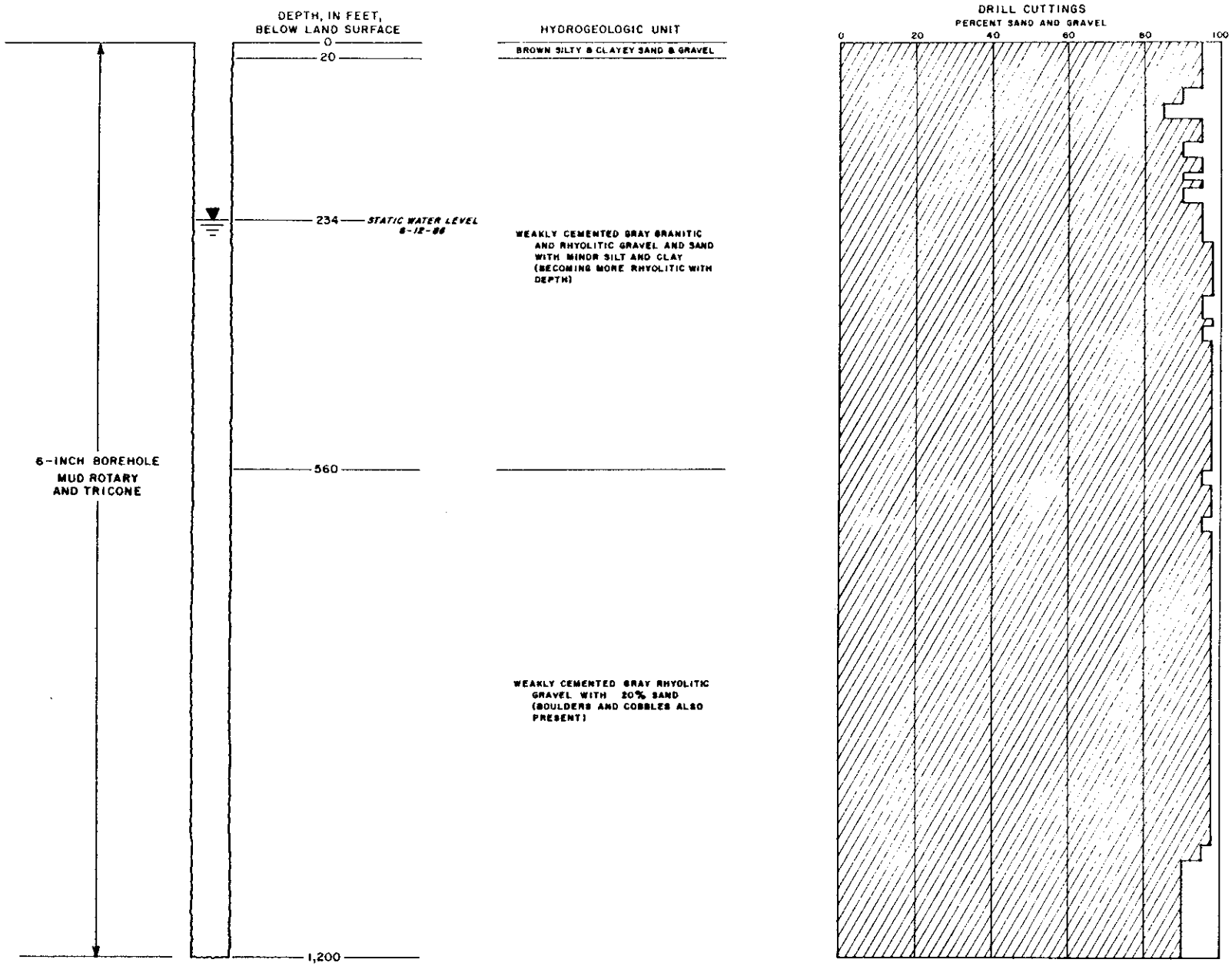


FIGURE 3-3. SCHEMATIC DIAGRAM AND PERCENT SAND AND GRAVEL IN DRILL CUTTINGS FOR TEST HOLE (B-2-4)6bbb [No. 3]

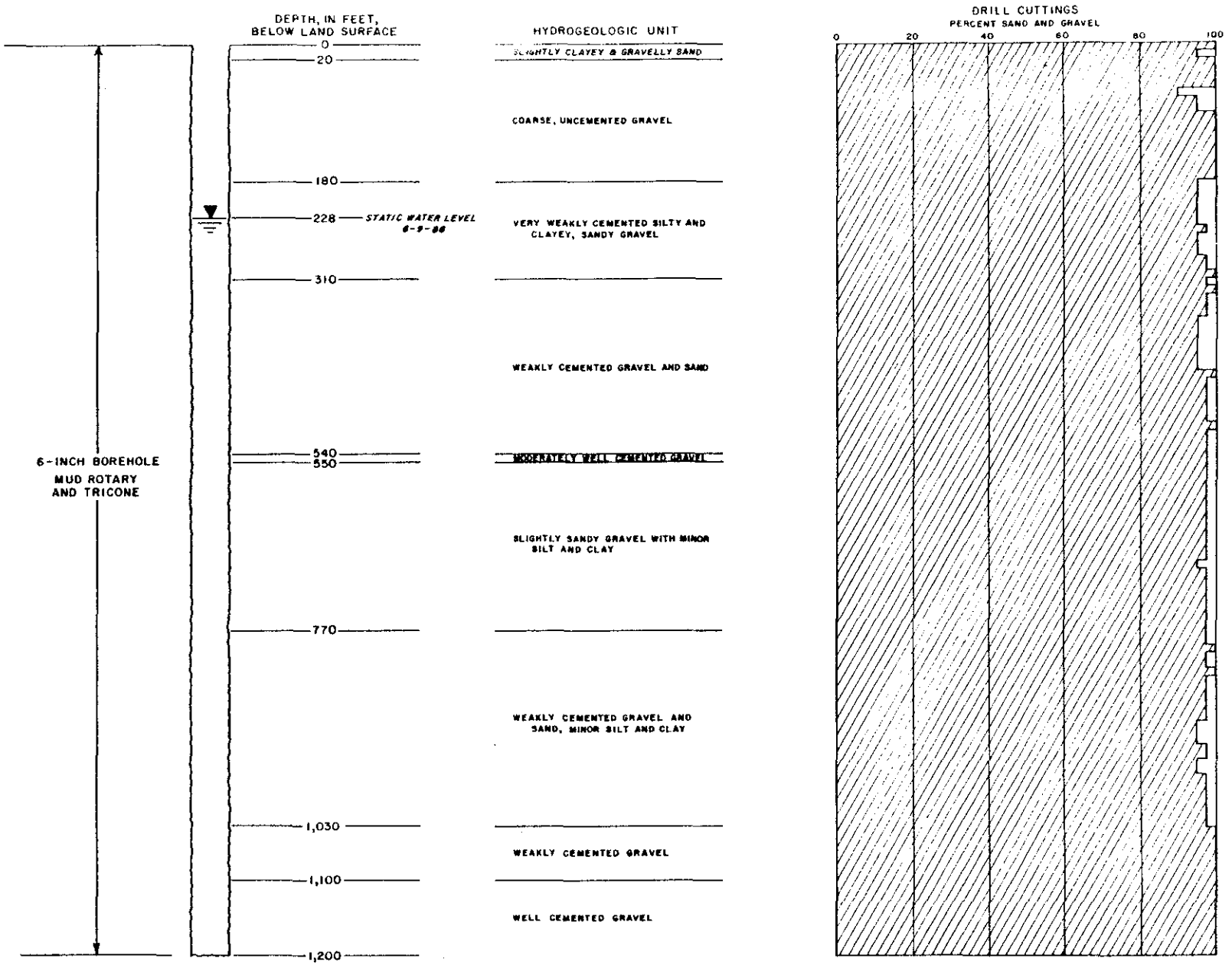


FIGURE 3-4. SCHEMATIC DIAGRAM AND PERCENT SAND AND GRAVEL IN DRILL CUTTINGS FOR TEST HOLE (B-3-4)7bbb [No.4]

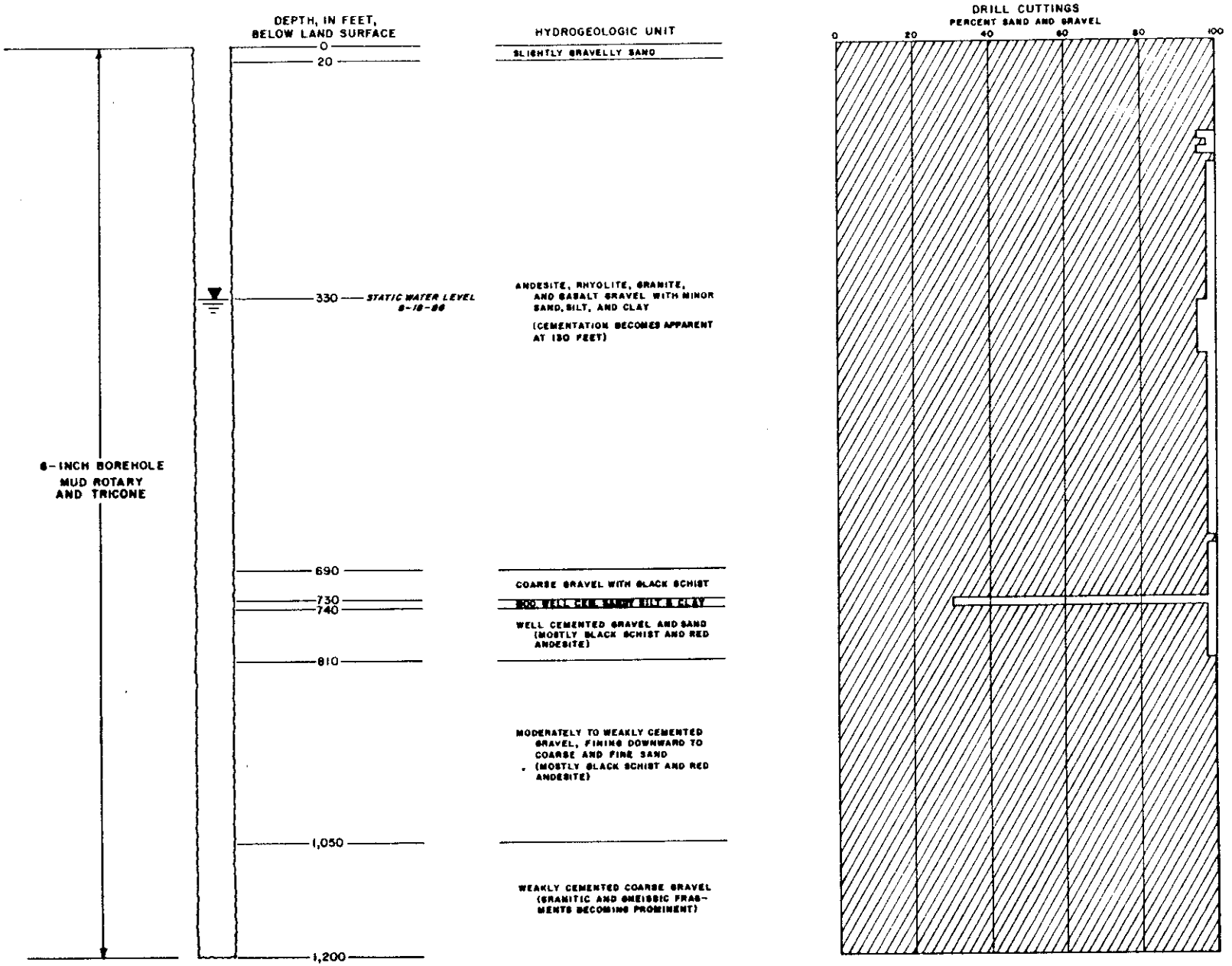


FIGURE 3-5. SCHEMATIC DIAGRAM AND PERCENT SAND AND GRAVEL IN DRILL CUTTINGS FOR TEST HOLE (B-4-4)4bbb [No. 5]

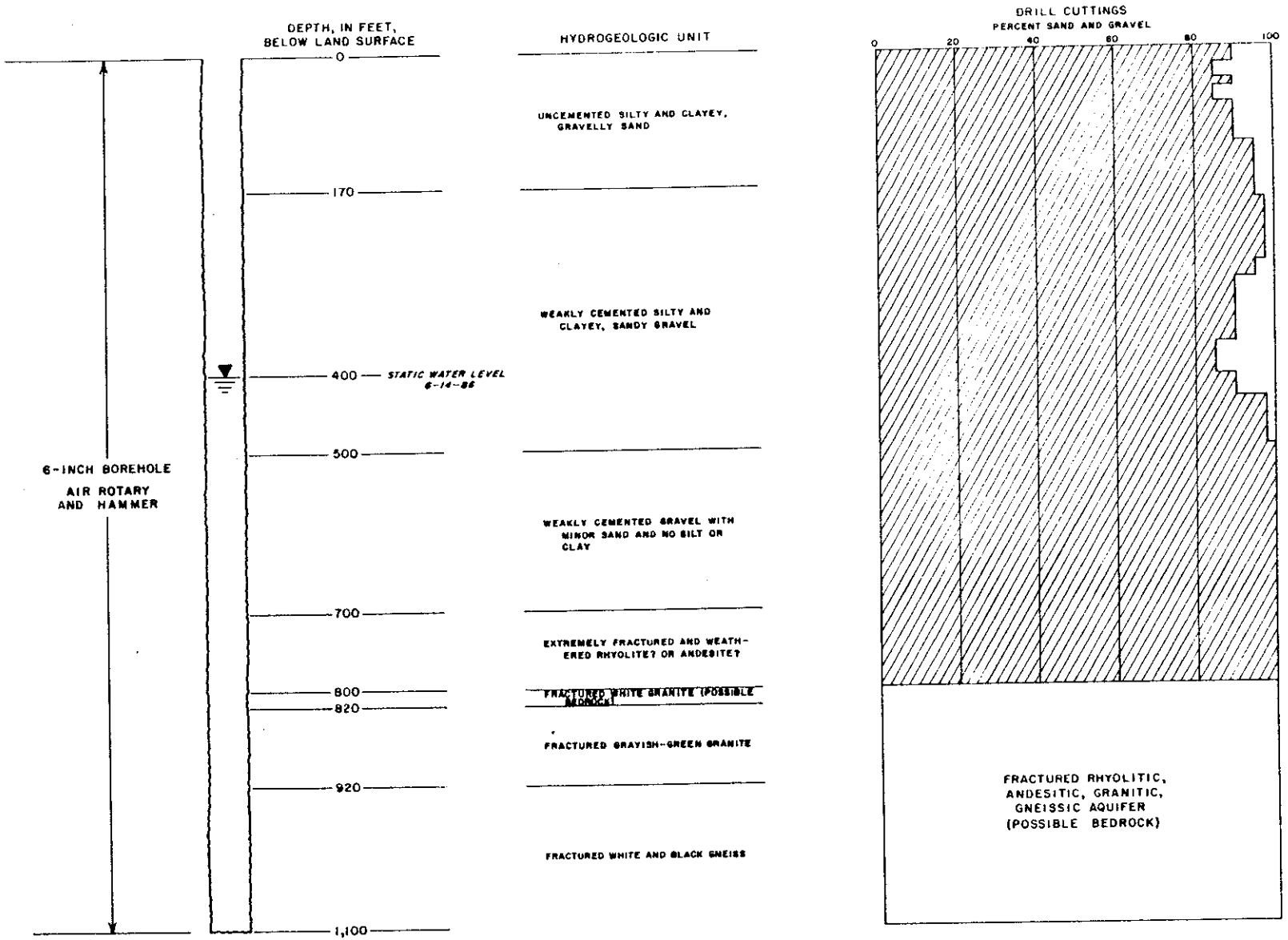


FIGURE 3-6. SCHEMATIC DIAGRAM AND PERCENT SAND AND GRAVEL IN DRILL CUTTINGS FOR TEST HOLE (B-2-4)4aaa [No. 6]

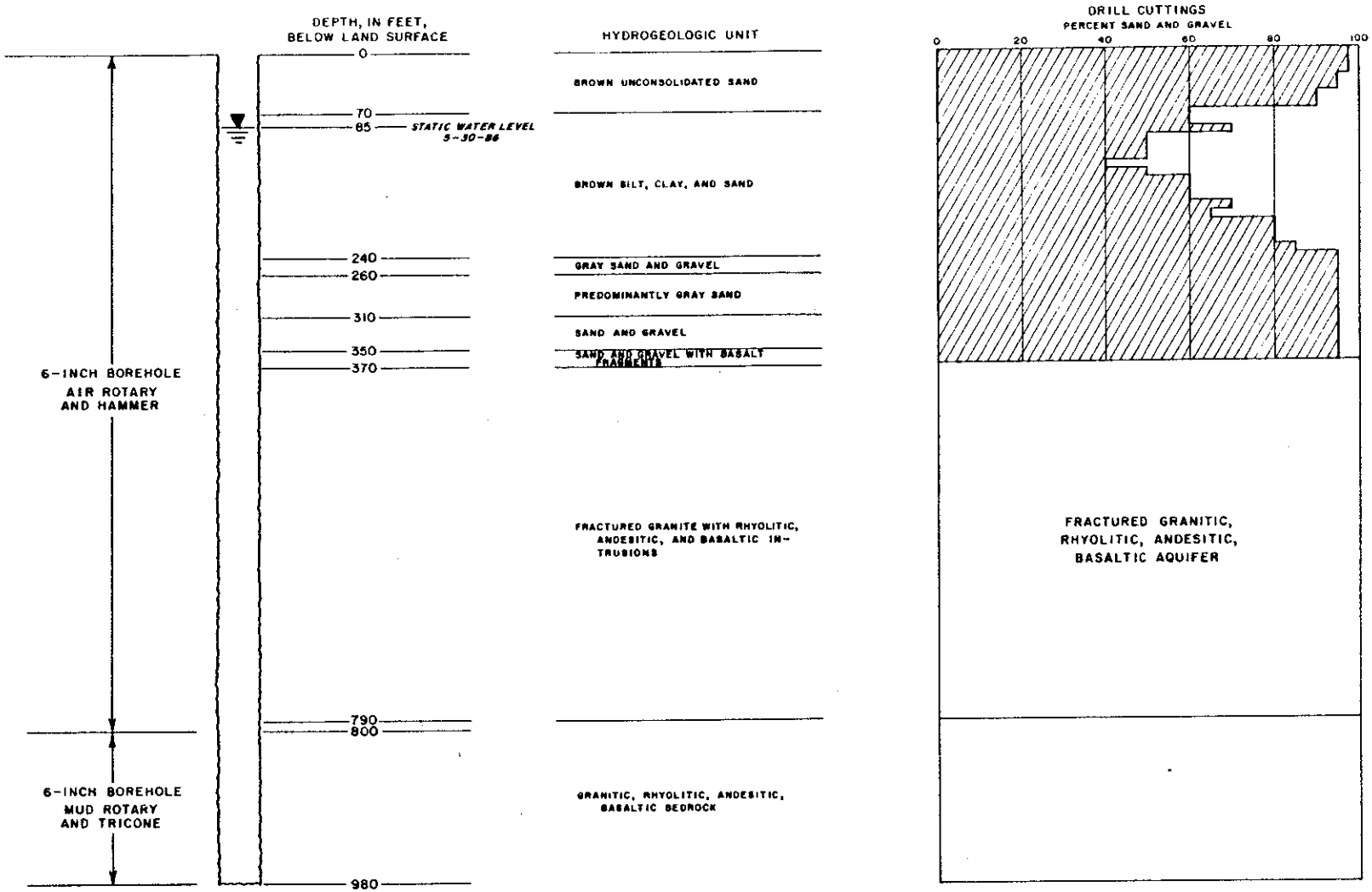


FIGURE 3-7. SCHEMATIC DIAGRAM AND PERCENT SAND AND GRAVEL IN DRILL CUTTINGS FOR TEST HOLE (B-4-4)23cbb [No. 7]

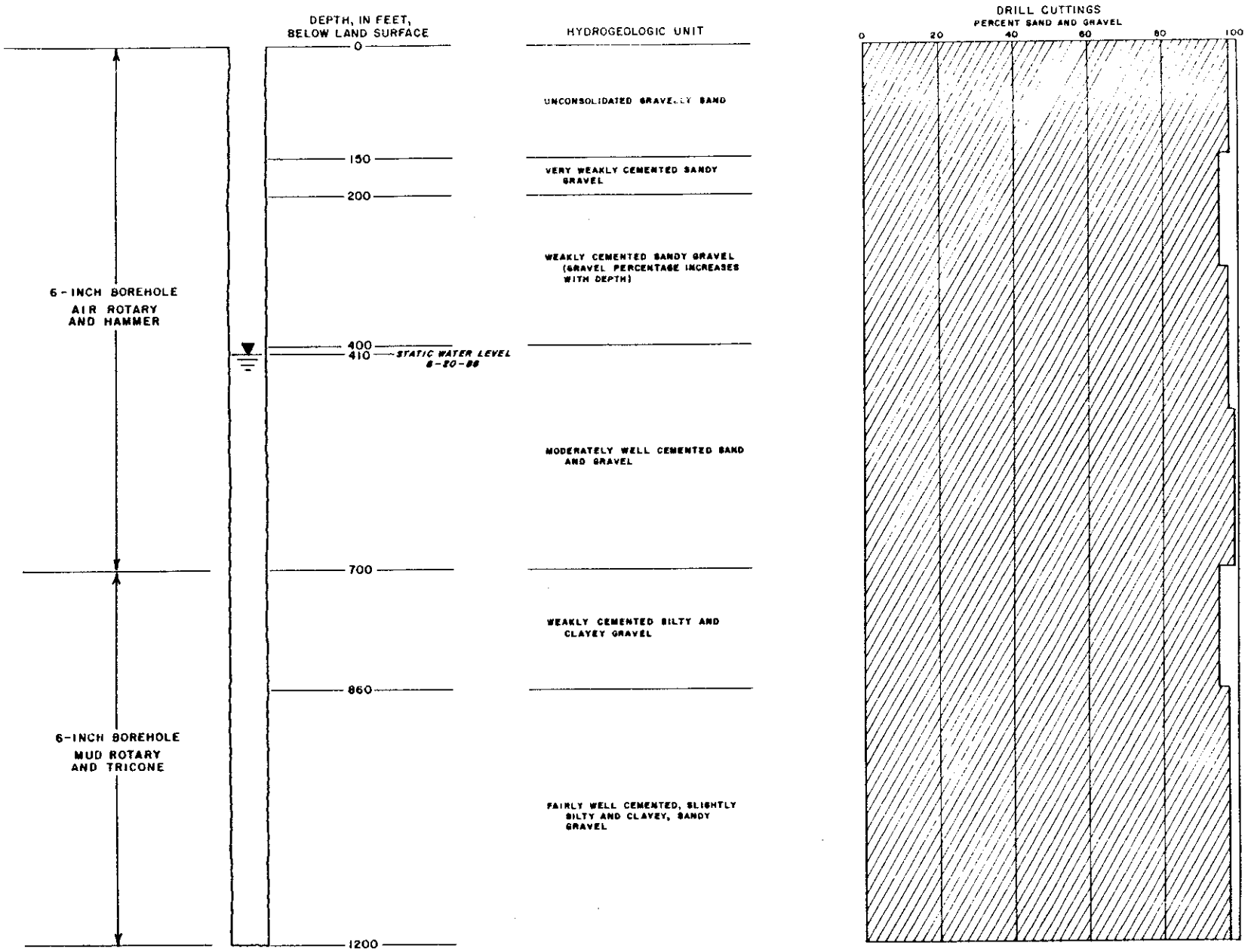


FIGURE 3-8. SCHEMATIC DIAGRAM AND PERCENT SAND AND GRAVEL IN DRILL CUTTINGS FOR TEST HOLE (B-5-4)15dcc [No. 8]

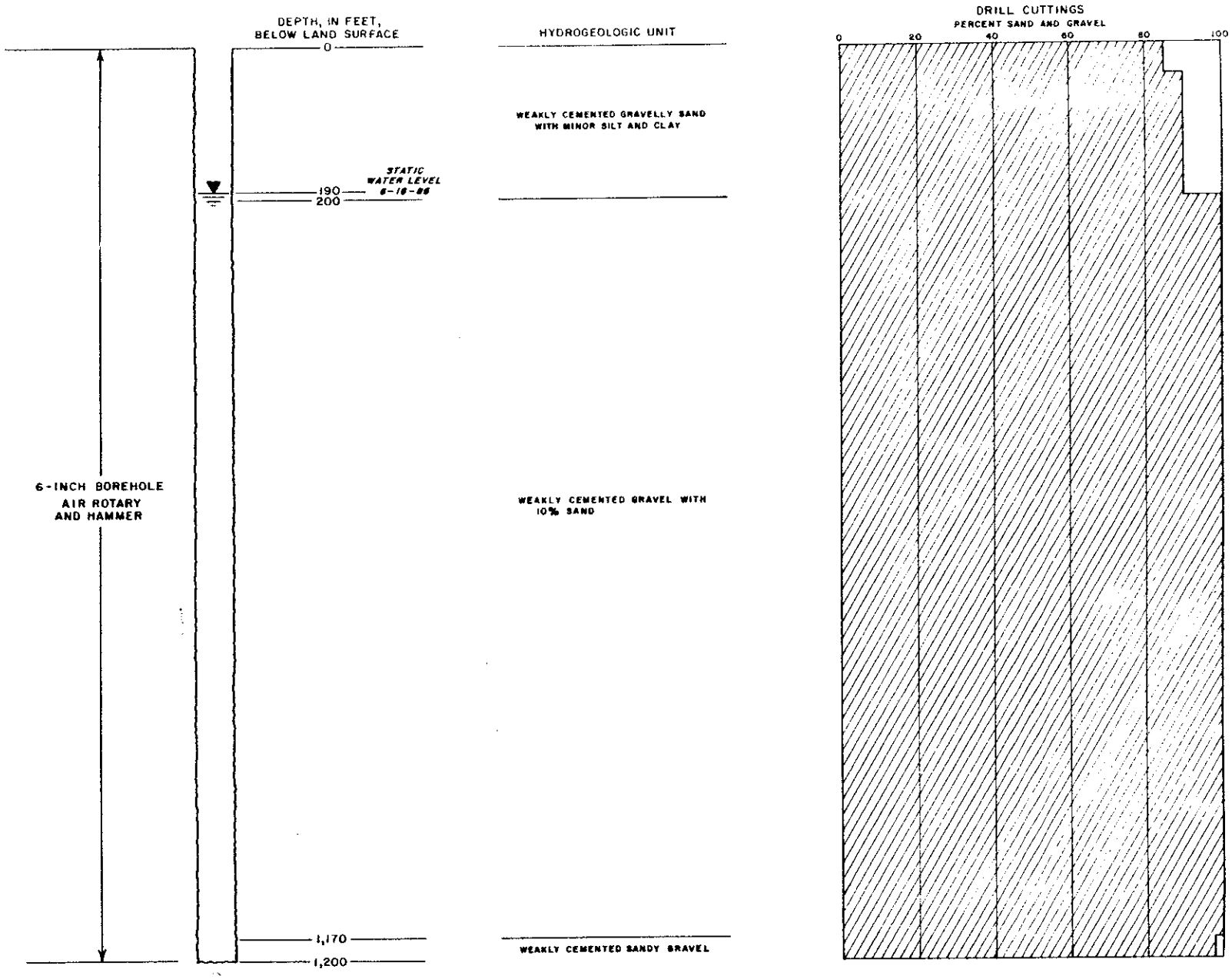


FIGURE 3-9. SCHEMATIC DIAGRAM AND PERCENT SAND AND GRAVEL IN DRILL CUTTINGS FOR TEST HOLE (B-2-4)18ccc [No. 9]

Interpretation of the data from the test holes has been set forth in four tabulations. Table 4-1 develops the saturated thickness at each hole, which ranged from 400 feet at Hole No. 6 to greater than 1,010 feet at Hole No. 9. Table 4-2 develops the area in acres represented by each of the nine test holes. This was done by drawing lines on a work map midway between holes, and measuring the nine areas. Table 4-3 sets forth the computation of total saturated volume in acre-feet represented by each of the nine holes. In developing this table, it was assumed that a vertical wall surrounds the property and along the lines between holes; no groundwater would drain into the property from adjoining lands as a result of dewatering the lands to a maximum depth of 1,200 feet. The table indicates there are about 39,000,000 acre-feet of saturated sediments underlying the 48,000 acres. Table 4-4 relates to the volume of water that could be recovered from beneath the 48,000 acres of Project lands under the "bath tub" theory of a vertical wall around the perimeter of the Project lands. The computation is based on a 15 percent coefficient of storage and indicates that about 5,850,000 acre-feet of recoverable groundwater underlies the Project lands between the 1986 water table and a depth of 1,200 feet or bedrock where shallower.

## Chemical Quality of Groundwater

Although many more samples of groundwater will be collected and analyzed for chemical quality, the preliminary data indicate that the water is of excellent quality. The area is "virgin" in terms of having been spared contamination from downward seepage of herbicides, pesticides, or undesirable waste materials of any type. Moreover, unlike the Western Salt River Basin at Buckeye, the Hassayampa does not carry the waste products of extensive upstrem urbanization and agriculture.

TABLE 4-1

SATURATED THICKNESS OF AQUIFER
AT EXPLORATION HOLES

| Hole No. | Depth (ft) | Depth to Water Level (ft) | Land Surface Altitude (ft) | Water Level Altitude (ft) | Depth to Bedrock (ft) | Saturated Thickness (ft) |
|---|---|---|---|---|---|---|
| 1 | 940 | 280 | 1,550 | 1,270 | 937 | 657 |
| 2 | 1,200 | 260 | 1,610 | 1,350 | 1,200+ | 940+ |
| 3 | 1,200 | 234 | 1,280 | 1,046 | 1,200+ | 966+ |
| 4 | 1,200 | 228 | 1,400 | 1,172 | 1,200+ | 972+ |
| 5 | 1,200 | 325[1] | 1,560 | 1,235 | 1,200+ | 875+ |
| 6 | 1,100 | 400 | 1,445 | 1,045 | 800 | 400 |
| 7 | 980 | 85 | 1,540 | 1,455 | 790 | 705 |
| 8 | 1,200 | 386 | 1,680 | 1,294 | 1,200+ | 814+ |
| 9 | 1,200 | 190 | 1,210 | 1,020 | 1,200+ | 1,010+ |

[1] Interpolated between No. 4 and No. 8:
field measurement was affected by drilling fluid in hole.

TABLE 4-2

SUMMARY OF AREA REPRESENTED BY
EACH EXPLORATION HOLE

| Township and Range | Hole Number 1 (ac) | 2 (ac) | 3 (ac) | 4 (ac) | 5 (ac) | 6 (ac) | 7 (ac) | 8 (ac) | 9 (ac) | Total Area (ac) |
|---|---|---|---|---|---|---|---|---|---|---|
| 5N.-4W. | 0 | 0 | 0 | 0 | 2,240 | 0 | 0 | 1,200 | 0 | 3,440 |
| 4N.-4W. | 2,780 | 2,920 | 0 | 3,140 | 3,700 | 0 | 4,300 | 0 | 0 | 16,840 |
| 3N.-4W. | 2,480 | 0 | 2,800 | 4,080 | 0 | 1,200 | 0 | 0 | 0 | 10,560 |
| Subtotal | 5,260 | 2,920 | 2,800 | 7,220 | 5,940 | 1,200 | 4,300 | 1,200 | 0 | 30,840 |
| 2N.-4W. | 0 | 0 | 2,030 | 0 | 0 | 6,010 | 0 | 0 | 6,320 | 14,360 |
| 2N.-5W. | 0 | 0 | 1,060 | 0 | 0 | 0 | 0 | 0 | 1,660 | 2,720 |
| Subtotal | 0 | 0 | 3,090 | 0 | 0 | 6,010 | 0 | 0 | 7,980 | 17,080 |
| TOTAL | 5,260 | 2,920 | 5,890 | 7,220 | 5,940 | 7,210 | 4,300 | 1,200 | 7,980 | 47,920 |

TABLE 4-3

SATURATED VOLUME OF SEDIMENTS

| Hole No. | Area Represented (ac) | Saturated Thickness (ft) | Saturated Volume (ac-ft) |
|---|---|---|---|
| Ts. 3, 4, and 5N. | | | |
| 1 | 5,260 | 657 | 3,455,820 |
| 2 | 2,920 | 940+ | 2,744,800 |
| 3 | 2,800 | 966+ | 2,704,800 |
| 4 | 7,220 | 972+ | 7,017,840 |
| 5 | 5,940 | 875+ | 5,197,500 |
| 6 | 1,200 | 400+(?) | 480,000 |
| 7 | 4,300 | 705 | 3,031,500 |
| 8 | 1,200 | 814+ | 976,800 |
| 9 | 0 | 1,010+ | 0 |
| Subtotal | 30,840 | | 25,609,060 |
| T.2N. | | | |
| 1 | 0 | 657 | 0 |
| 2 | 0 | 940+ | 0 |
| 3 | 3,090 | 966+ | 2,984,940 |
| 4 | 0 | 972+ | 0 |
| 5 | 0 | 875+ | 0 |
| 6 | 6,010 | 400+(?) | 2,404,000 |
| 7 | 0 | 705 | 0 |
| 8 | 0 | 814+ | 0 |
| 9 | 7,980 | 1,010+ | 8,059,800 |
| Subtotal | 17,080 | | 13,448,740 |
| TOTAL | 47,920 | | 39,057,800 |
| | | Round to: | 39,000,000 |

TABLE 4-4

VOLUME OF STORED RECOVERABLE GROUNDWATER
UNDERLYING SUN VALLEY PROJECT LANDS

(Excludes spread of withdrawal cone outside of the project lands:
excludes recharge along Hassayampa River and along desert washes:
excludes mountain front recharge:
excludes artificial recharge of treated wastewater.)

| Item | Acre Feet |
|---|---|
| Ts. 3, 4, and 5N. | |
| Saturated Volume of Sediments | 25,609,060 |
| Unit Volume Recoverable: 15 percent | |
| Total Stored Volume Recoverable (25,609,060 x .15) | 3,841,359 |
| T.2N. | |
| Saturated Volume of Sediments | 13,448,740 |
| Unit Volume Recoverable: 15 percent | |
| Total Stored Volume Recoverable (13,448,740 x .15) | 2,017,311 |
| Total Project | |
| Saturated Volume of Sediments (rounded) | 39,000,000 |
| Unit Volume Recoverable: 15 percent | |
| Total Stored Volume Recoverable (39,000,000 x .15) (rounded) | 5,850,000 |
| Annual Volume Recoverable During 100 Years of Withdrawal | 58,500 |

## Potential Methods for Goundwater Utilization

The groundwater supply of the Salt River Valley is well known to have been overdeveloped. The Groundwater Management Act of 1980 has mandated that the groundwater supply of the Phoenix and Tucson Active Management Areas shall be brought into balance with average annual recharge ("safe yield") by the year 2025. The methods of accomplishing this objective are threefold, as follows: (a) Gradual elimination of irrigated agriculture by conversion to urban land that uses less water; (b) strict imposition of water conservation techniques; and (c) importation of Colorado River water via the Central Arizona Project.

Considering the groundwater supply of the Hassayampa River Valley, three possibilities for utilization are apparent. One is to let the supply stay there untouched, and consider it to be a theoretical credit that offsets the groundwater overdraft in the Salt River Valley. This is a political subterfuge in that the Hassayampa water would not actually be used to lessen the overdraft in the Salt River Valley portion of the Phoenix AMA.

The second possibility is to use the water in the overdeveloped Salt River Valley portion of the Phoenix AMA. This is hydrologically infeasible, because the direction of movement of the Hassayampa groundwater is southward into the Buckeye area of the Salt River Valley. The groundwater in the Buckeye area is so salt-laden and waterlogged from westward movement of groundwater from the main part of the Salt River Valley that it cannot meet Drinking Water Standards. The underflow from the Hassayampa Valley enters and merges with this effectively unusable water, thereby becoming unusable itself, and is therefore not utilizable in offsetting the water shortage in the upstream eastern Salt River Valley. The contaminated Hassayampa water eventually moves downstream along the lower Gila River.

The only direct way to utilize the groundwater supply of the Hassayampa Valley for the direct benefit of the Phoenix overdraft would be to construct a well field and transport the water. Could it be transported via the CAP Canal? I doubt it. The CAP Canal has already been constructed under a design capable of carrying available Colorado River water to Central and Southern Arizona. Could it transport an additional 150,000 acre-feet per year? And Scottsdale of course plans on using the Canal to transport water from farther west. The alternative would be a pipeline around the north or south end of the White Tank Mountains. How much would that cost? It would be a mini-CAP all over again.

The area of course could be annexed by a contiguous town and the service area extended by incremental expansion, but presumably this is a opportunity available only to the Town of Buckeye. This possibility does make hydrologic sense and our firm in the past has encouraged the town to utilize the good quality Hassayampa water available northwest of the town. This utilization however does nothing to diminish the overdraft in the Eastern Salt River Valley.

There is however one way, and possibly only one way, that the Hassayampa water supply could usefully lessen pressure on the overdraft in the Phoenix area, and contribute to achievement of the goal of "safe yield" in the AMA. Let the people moving into Central Arizona live where the water is rather than in the overdraft areas where it is necessary to transport the water to them at great expense and in conflict with the rules concerning transport of water in the Groundwater Act. Settlement of the Hassayampa Valley would relieve that amount of future demand on the overdrafted areas of the Eastern Valley--the climate is the same, the topography and scenic beauty are the same or possibly much better, and transportation access provides much less pressure on the overstressed portions of the Valley transportation system. As of today there is no smog in the Hassayampa, and with development there will be some, but that amount will be just so much less added to the Central Valley.

## Groundwater Potential in the Valley

There are roughly 6½ townships of basin fill deposits in the Hassayampa Valley west of the Sun Valley Project lands and north of the Belmont Mountains. The 48,000 acres of Project lands occupy the equivalent of 2.1 townships. The 5.85 million acre-feet of recoverable groundwater underlying the Project lands is equivalent to about 2.8 million acre-feet per township. Let us make a conservative assumption that the recoverable groundwater underlying the other 6½ townships of basin-fill deposits to a depth of 1,200 feet in the valley is only half the amount underlying the Sun Valley Project lands, or 1.4 million acre-feet per township. This would amount to 9.1 million acre-feet. Thus, it is apparent that at least 15 million acre-feet of recoverable groundwater exists above a depth of 1,200 feet in the basin fill deposits of the Hassayampa Valley.

Under the First Management Plan of the Phoenix Active Management Area, administered by DWR, the allowable daily usage per resident in a new subdivision is 140 gallons per day. Using this figure, the groundwater supply of the Hassayampa valley could provide water for 956,000 people for 100 years without considering recharge. If the 6½ townships to the west were found to be underlain by as much stored groundwater as the Sun Valley Project lands, more than 1,500,000 people could be supplied. Compare these figures with the 1985 total population of Maricopa County of 1,840,000.

The Maricopa County Board of Supervisors has said that the county must consider that some 3 million additional people are expected to be living in the Phoenix area by 2025. It appears that a substantial fraction of them could be supplied with the water they will need by living in and using the groundwater supply of the alluvial valley of the Hassayampa River.

POPULATION OF MARICOPA COUNTY
(October 1, 1985)

| | |
|---|---|
| Phoenix | 881,640 |
| Tempe | 132,942 |
| Glendale | 122,392 |
| Mesa | 239,587 |
| Chandler | 63,817 |
| Maricopa County | 1,837,956 |

Source: Arizona Republic
August 25, 1986