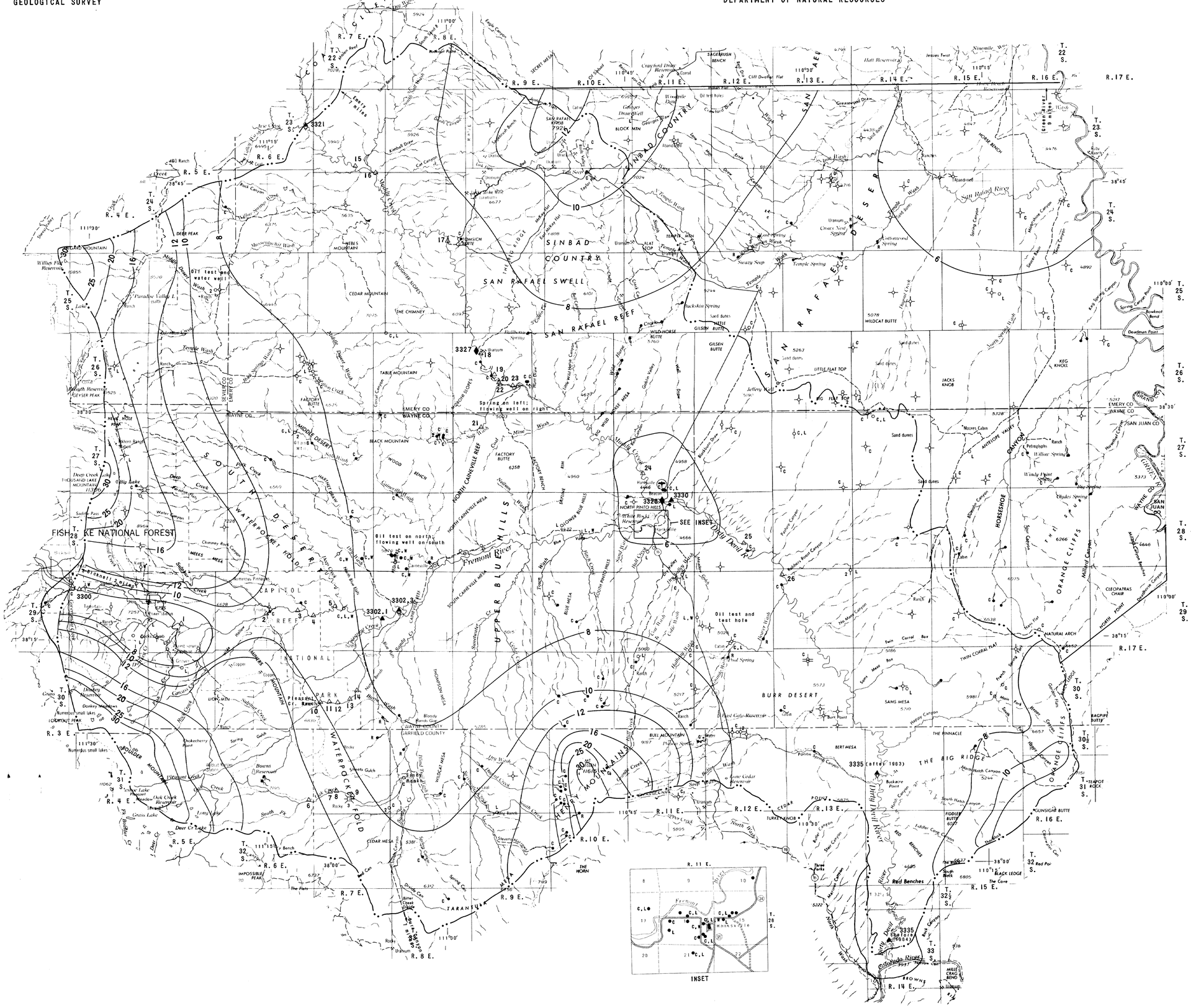
Prepared in cooperation with the
STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES






## EXPLANATION

6 — Line of equal normal annual (1931-60) precipitation. Interval 2, 4, and 5 inches. *From Covington and Williams (1972a)*

**GROUND-WATER SITES**

- Flowing well
- Nonflowing well *See table 6*
- Spring
- Petroleum test-well *See table 8*
- Test hole or core hole *See table 6 and 8*
- Unused or abandoned well *See table 6*

Letter by well, spring, or test-hole symbol indicates type of data:
c, chemical analysis in table 13
L, driller's or lithologic log in table 10
R, record of spring in table 7
W, water-level measurements in table 9

**SURFACE-WATER SITES** *(see also Mundorff, 1979)*

3328 — Stream-gaging station for which discharge and chemical-quality records are available in U.S. Geological Survey (1971-77)

3335 — Stream-gaging station for which discharge and chemical-quality partial records are available in U.S. Geological Survey (1971-77)
*Number is downstream-order number; see text*

26 — Site of miscellaneous stream-discharge measurements made for this study. *Number is the site number listed in table 5*

**SPECIAL TEST SITES**

Shallow test hole for soil-moisture measurements with neutron probe

Rock- or core-sampling site. *See table 12 for characteristics of rock specimens*

Observations at sites include:
horizontal bar, precipitation
diagonal bar up to right, soil moisture (tensiometer)
diagonal bar up to left, soil moisture (neutron probe).
*Number indicates number of soil-moisture holes at or near indicated site*

NOTE: Small number by any symbol indicates more than one data site at location too close to plot separately

Boundary of project area where boundary is not a drainage divide or the Green River

Drainage divide

Base from U.S. Geological Survey
1:250,000 quadrangles

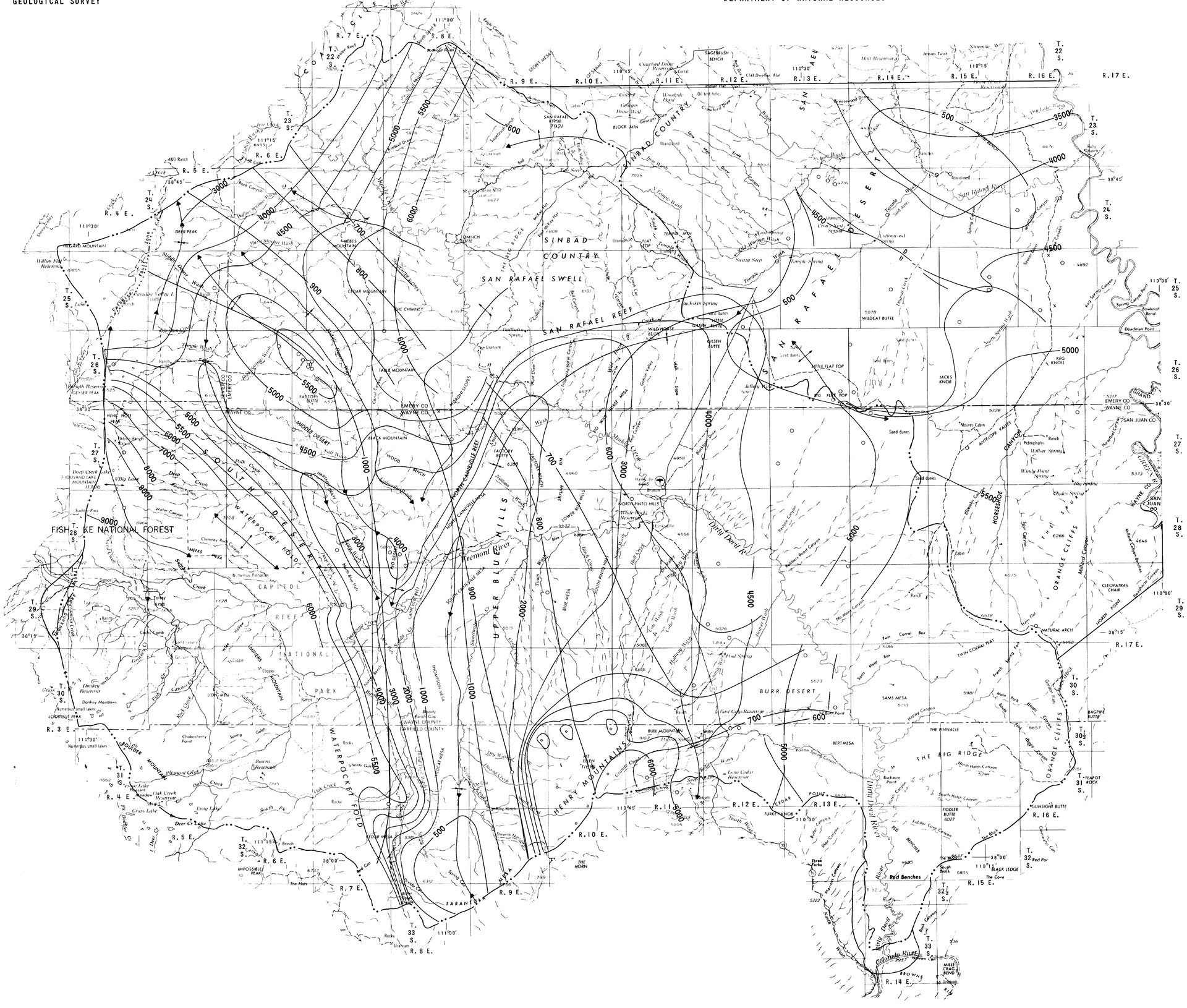
5 0 5 10 15 20 MILES
5 0 5 10 15 20 25 30 KILOMETERS

Compiled by J.W. Hood, 1978

MAP SHOWING LOCATION OF HYDROLOGIC AND GEOLOGIC DATA SITES AND 1931-60 NORMAL ANNUAL PRECIPITATION IN THE LOWER DIRTY DEVIL RIVER BASIN AREA, UTAH

Prepared in cooperation with the
STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES






## EXPLANATION

CONTROL POINTS

- ○ Well
- x Outcrop of Navajo Sandstone
- ◦ Source of data from Hunt and others (1953, pl. 8)

U/D Fault - dotted where concealed; U, upthrown side; D, downthrown side

Anticline - arrow shows direction of plunge

Syncline - arrow shows direction of plunge

800 Line of equal thickness of the Navajo Sandstone. Interval 100 feet

5500 Structure contour - drawn on the top of the Navajo Sandstone. Contour interval 500 and 1000 feet. Datum is mean sea level

Drainage divide

Boundary of project area where boundary is not a drainage divide or the Green River

Base from U.S. Geological Survey
1:250,000 quadrangles

5 0 5 10 15 20 MILES
5 0 5 10 15 20 25 30 KILOMETERS

Compiled by J.W. Hood, 1978
Modified in part from Intermountain
Power Project, written communication, 1978

MAP SHOWING THICKNESS OF THE NAVAJO SANDSTONE AND STRUCTURE CONTOURS ON THE TOP OF THE NAVAJO SANDSTONE IN THE LOWER DIRTY DEVIL RIVER BASIN AREA, UTAH

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES

Technical Publication No. 68

# BEDROCK AQUIFERS IN THE LOWER DIRTY DEVIL RIVER BASIN AREA, UTAH, WITH SPECIAL EMPHASIS ON THE NAVAJO SANDSTONE

by

J. W. Hood and T. W. Danielson
Hydrologists, U.S. Geological Survey

Prepared by
the United States Geological Survey
in cooperation with
The Utah Department of Natural Resources
Division of Water Rights

1981

CONTENTS


| | Page |
|---|---|
| Abstract | 1 |
| Introduction | 2 |
| Terminology | 5 |
| Data-site numbering systems | 5 |
| Well-, spring-, and miscellaneous-site numbering system | 5 |
| Surface-water-site numbering system | 6 |
| Geologic setting | 6 |
| Formations and their hydrologic characteristics | 6 |
| Structure and other factors that affect hydrology | 9 |
| Hydrology | 23 |
| Summary statement | 23 |
| Precipitation | 25 |
| Surface water | 25 |
| Fremont River | 27 |
| Muddy Creek | 27 |
| Dirty Devil River | 28 |
| Relation of runoff to precipitation | 28 |
| Chemical quality of surface water | 30 |
| Ground water | 32 |
| Recharge | 32 |
| Occurrence and movement | 33 |
| Storage | 36 |
| Discharge | 37 |
| Navajo Sandstone | 37 |
| Other consolidated rocks | 44 |
| Evapotranspiration | 44 |
| Chemical quality of ground water | 45 |
| Effects of large-scale withdrawal of ground water | 48 |
| Basic assumptions | 49 |
| Effect on the potentiometric surface and natural discharge | 49 |
| Change in ground-water storage | 49 |
| Effect on the Colorado River | 50 |
| Further studies needed | 50 |
| Summary and conclusions | 51 |
| References cited | 53 |
| Publications of the Utah Department of Natural Resources, Division of Water Rights | 134 |


ILLUSTRATIONS

[ Plates are in pocket ]


Plate 1. Map showing location of hydrologic and geologic data sites and 1931-60 normal annual precipitation in the lower Dirty Devil River basin area.

2. Geologic map of the lower Dirty Devil River basin area.

3. Map showing thickness of the Navajo Sandstone and structure contours on the top of the Navajo Sandstone in the lower Dirty Devil River basin area.

Page

Plate 4. Map showing the approximate potentiometric surface of the Navajo Sandstone aquifer and chemical quality of surface inflow and outflow of ground water in the Navajo Sandstone in the lower Dirty Devil River basin area.

Figure 1. Map showing location of the lower Dirty Devil River basin area ..... 3

2. Diagram showing well- and spring-numbering system used in Utah ..... 7

3. Photograph showing sandstone and siltstone of the Entrada Sandstone partly covered with dune sand ..... 8

4. Photograph showing joints or fractures in Navajo Sandstone and Carmel Formation ..... 9

5. Histograms showing grain-size distribution in samples of the Navajo and Wingate Sandstones ..... 10

6. Photographic view down Fremont River canyon showing the Wingate and Navajo Sandstones ..... 18

7. Photograph showing joints in the Wingate Sandstone ..... 19

8. Photograph showing contact between steeply dipping Navajo Sandstone and Kayenta Formation ..... 20

9. Photograph showing fractures in Navajo Sandstone ..... 21

10. Photograph showing igneous dike that cuts Entrada ..... 22

11. Photograph showing igneous dike north of Big Flat Top ..... 23

12. Double-mass curve of runoff at station 3335 versus precipitation in and near the Dirty Devil River drainage basin .... 29

13. Graph showing relation of net runoff to precipitation, 1951-57 ..... 31

14. Photograph showing ephemeral flow from canyon developed along a joint in Navajo Sandstone ..... 34

15. Graphs showing water levels in selected observation wells and cumulative departure from average annual precipitation at Loa, Capitol Reef National Park, and Hanksville .... 38

16. Graphs showing water levels in two wells finished in the Navajo Sandstone near Caineville, 1974-77 ..... 40

Page

Figure 17. Hydrograph of discharge of spring (D-27-8)12caa-S1, one of the Caine Springs ..... 41

18. Photographs of the Caine Springs area ..... 42

19. Photograph showing barren land in Factory Butte area ..... 45

20. Photograph showing xerophytic vegetation in a part of the San Rafael Desert and the southeast side of the San Rafael Swell ..... 46

21. Photograph of the west flank of Mount Ellen showing talus deposits and typical mountain vegetation ..... 47

22. Photograph showing Cathedral Valley with Thousand Lake Mountain in background ..... 48

TABLES

Table 1. Description of geologic units known to underlie the lower Dirty Devil River basin area ..... 12

2. Estimates of transmissivity and hydraulic conductivity at wells for which specific capacity can be calculated ..... 17

3. Summary of hydrologic estimates ..... 24

4. Estimated average annual volumes of precipitation and ground-water recharge from precipitation (1931-60) ..... 26

5. Stream discharge-measuring in the study area ..... 57

6. Records of selected water wells ..... 58

7. Records of selected springs ..... 66

8. Records of selected petroleum-test wells and core holes ..... 68

9. Water levels in observation wells ..... 76

10. Selected logs of wells and test holes ..... 82

11. Description of rock samples collected for analysis of hydrologic properties and grain-size distribution and of sampling sites ..... 119

12. Hydraulic, physical, and statistical characteristics of miscellaneous rock specimens ..... 121

Page

Table 13. Selected chemical analyses of water samples from water wells, springs, and petroleum-test wells ..... 122

14. Selected analyses of trace elements in water samples ..... 130

## CONVERSION FACTORS

Most values in this report are given in inch-pound units followed by metric units. The conversion factors are shown to four significant figures. In the text, however, the metric equivalents are shown only to the number of significant figures consistent with the accuracy of the value in inch-pound units.

| Inch-pound | | | Metric | |
|---|---|---|---|---|
| Unit (Multiply) | Abbreviation | (by) | Unit (to obtain) | Abbreviation |
| Acre | -- | 0.4047 | Square hectometer | $hm^2$ |
| | | 0.004047 | Square kilometer | $km^2$ |
| Acre-foot | acre-ft | 0.001233 | Cubic hectometer | $hm^3$ |
| | | 1233 | Cubic meter | $m^3$ |
| Cubic foot per second | $ft^3/s$ | 0.02832 | Cubic meter per second | $m^3/s$ |
| Foot | ft | 0.3048 | Meter | m |
| Foot per mile | ft/mi | 0.1894 | Meter per kilometer | m/km |
| Gallon per minute | gal/min | 0.06309 | Liter per second | L/s |
| Inch | in. | 25.40 | Millimeter | mm |
| | | 2.540 | Centimeter | cm |
| Mile | mi | 1.609 | Kilometer | km |
| Square foot | $ft^2$ | 0.0929 | Square meter | $m^2$ |
| Square mile | $mi^2$ | 2.590 | Square kilometer | $km^2$ |

Chemical concentration and water temperature are given only in metric units. Chemical concentration is given in milligrams per liter (mg/L) or micrograms per liter (μg/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to 1 milligram per liter. For concentrations less than 7,000 milligrams per liter, the numerical value is about the same as for concentrations in the inch-pound unit, parts per million.

Water temperature is given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation: $°F=1.8(°C)+32$.

# BEDROCK AQUIFERS IN THE LOWER DIRTY DEVIL RIVER BASIN AREA, UTAH, WITH SPECIAL EMPHASIS ON THE NAVAJO SANDSTONE

by

J. W. Hood and T. W. Danielson
Hydrologists, U.S. Geological Survey

## ABSTRACT

The lower Dirty Devil River basin area in southeastern Utah has an area of about 4,300 square miles (11,140 square kilometers) and ranges in altitude from about 3,700 to more than 11,000 feet (1,130 to 3,350 meters) above mean sea level. Precipitation, the main source of water in the area, ranges from slightly less than 6 inches (152 millimeters) per year in the lowlands to more than 30 inches per year (762 millimeters) in the Henry Mountains and along the western boundary.

Rocks that crop out in or underlie the area range from the Precambrian to the Holocene in age. The thickness of the composite section of sedimentary rocks ranges from about 7,300 feet (2,200 meters) to about 23,000 feet (7,000 meters). The Entrada, Navajo, Wingate, and Coconino Sandstones and rocks of Mississippian age are considered major aquifers because of their large areal extent or thickness or their known locally large yields to wells. The chemical quality of the water in these aquifers ranges from fresh to briny.

The permeability of the aquifers in the area is affected by folding, faulting, and igneous intrusion. These geologic processes have locally enhanced ground-water circulation by fracturing or impeded circulation by offsetting permeable beds or sealing some zones with rocks of lower permeability.

The total hydrologic system in the lower Dirty Devil River basin has estimated long-term average annual inflow and outflow of about 1.6 million acre-feet (1,970 cubic hectometers), of which about 1.55 million acre-feet (1,910 cubic hectometers) is derived from precipitation. An estimated 96 percent of the water available to the area is consumed by evapotranspiration.

The estimated gross annual average ground-water recharge is 34,000 acre-feet (42 cubic hectometers), of which 5,000 acre-feet (6.2 cubic hectometers) recharges the Navajo Sandstone. Recoverable fresh to moderately saline water stored in the Navajo, Wingate, and Coconino Sandstones is estimated to be 210 million acre-feet (259,000 cubic hectometers), of which 89 million acre-feet (110,000 cubic hectometers) is stored in the Navajo alone.

Long-term large withdrawals from the Navajo Sandstone are feasible. Withdrawal of 12,000 gallons per minute (757 liters per second) over a period of about 36 years probably would diminish the amount of water in storage by less than 1 percent. The withdrawals would eventually diminish the average annual discharge of the Dirty Devil River by possibly as much as 13 cubic feet per second (0.37 cubic meter per second). A change of this magnitude on the flow of the Colorado River would be too small to measure.

# INTRODUCTION

This report presents the results of a study of bedrock aquifers in the lower Dirty Devil River basin area, Utah (fig. 1), with special emphasis on the Navajo Sandstone of Triassic(?) and Jurassic age. The study was made by the U.S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights. Fieldwork was carried out during July 1975-September 1977.

The principal objectives of this study were to determine (1) well yields of the bedrock formations, (2) the capability of formations to yield, over the long term, water chemically suitable for presently (1977) known uses, and (3) effects of withdrawal from wells on the surface-water supply in the Colorado River basin. Implicit in these objectives is a general definition of the hydrologic system in the project area.

The area studied comprises about 4,300 $mi^2$ (11,140 $km^2$)--about 3,200 $mi^2$ (8,290 $km^2$) within the Dirty Devil River basin and about 1,100 $mi^2$ (2,850 $km^2$) between the Dirty Devil River basin and the Green River (pl. 1). Most of the area was studied by reconnaissance methods. The more detailed work was done principally in the west-central part of the area. Interpretation of conditions near the Green River from the Orange Cliffs to the eastern San Rafael Desert and the upper part of the Muddy Creek basin is based only on preexisting data.

Fieldwork included the accumulation of data on wells, springs, and the chemical quality of ground water, aquifer testing (mainly near Caineville), test drilling, infiltration studies of the Navajo Sandstone, and miscellaneous measurements of streamflow at selected sites.

Analyses in the office included computation of aquifer coefficients for the Navajo Sandstone (Hood and Danielson, 1979), and evaluation of the infiltration studies of the Navajo Sandstone and digital modeling of the Navajo Sandstone aquifer. The digital model was constructed using the methods of Trescott, Pinder, and Larson (1976). Simplifying assumptions included the use of a uniform value for hydraulic conductivity and restriction of the model to those parts of the area where the Navajo is fully saturated or nearly so. Because few data are available and time for model development was limited, the model is considered to be a reasonable representation of the hydrologic system only for the part of the study area west of Muddy Creek and the Dirty Devil River. The model could not be calibrated because of a lack of water-level data, both areally and over time. However, the model was useful in guiding analysis of the aquifer by other methods, and it was useful as a general guide to delimit the rates and significant areas of recharge and discharge and to set an approximate value on the areal hydraulic conductivity of the Navajo.

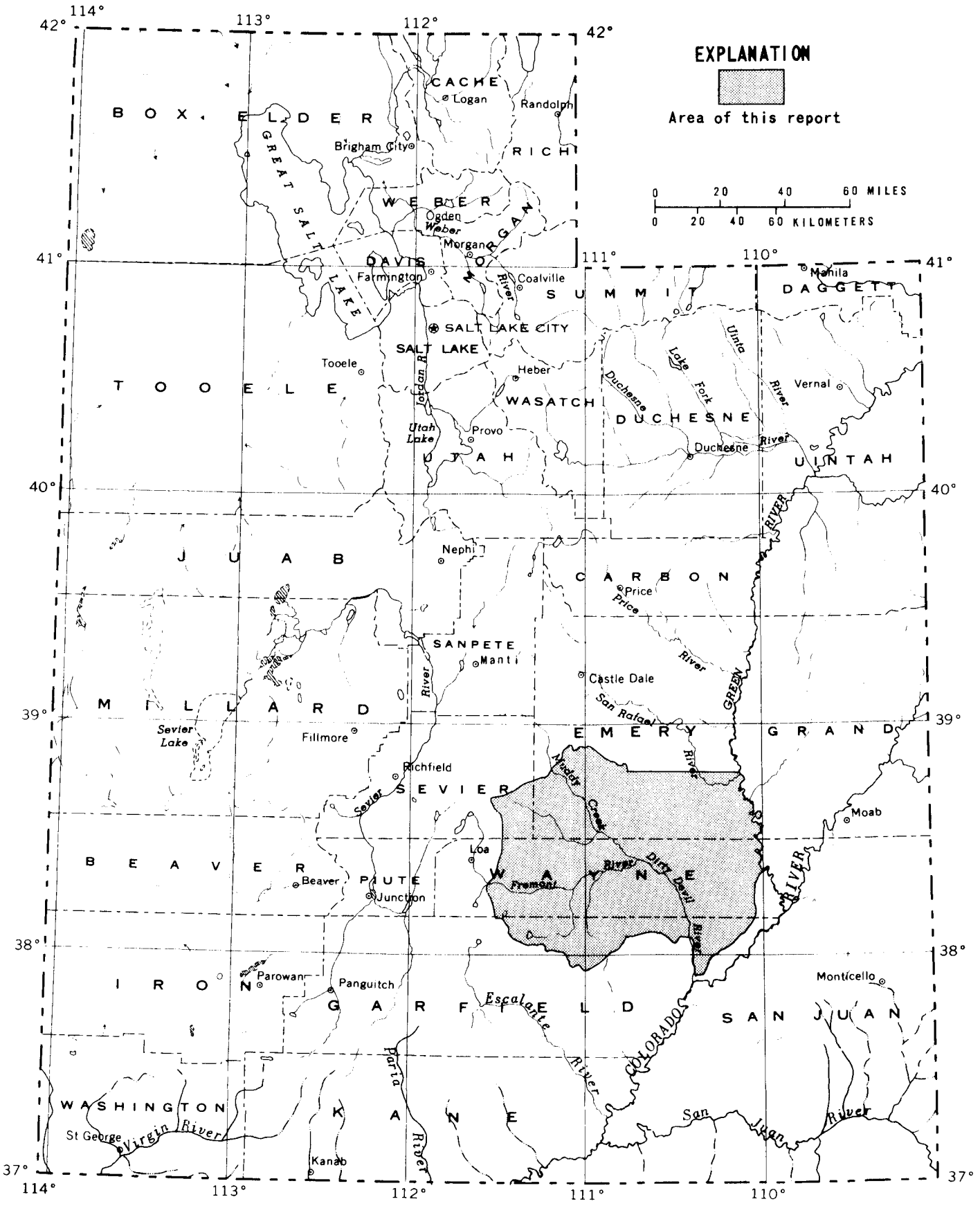



Figure 1.— Location of the lower Dirty Devil River basin area.

The lower Dirty Devil River basin area reaches from the arid canyonlands, about 3,700 ft (1,130 m) above mean sea level, where Lake Powell inundates the mouth of the Dirty Devil River canyon, to 7,921 ft (2,414 m) in the San Rafael Swell, and to more than 11,000 ft (3,350 m) in the Henry Mountains and along the drainage divide that marks the western edge of the study area. Within this diverse area, the population is sparse, being concentrated mainly along the Fremont River. Most of the area is given over to grazing and recreation; some mining and much petroleum exploration has been done. Cultivated crops are limited to small tracts, mainly along the Fremont River from the Teasdale area to Hanksville. For a more thorough discussion of economic geography of the project area, see Hunt (1953, p. 10-26) and Utah Division of Water Resources (1975, p. 32-37).

Records of data used in this report are given in tables 2 and 5-14. The locations of all data sites mentioned in this report are shown on plate 1.

The writers extend thanks to the well and spring owners, well drillers, and companies who provided hydrologic and geologic data. Special thanks are due to the officials and technical staff of the Intermountain Power Project (IPP) who cooperated in ground-water studies near Caineville, to Mr. R. V. Hunt of Hanksville, whose intimate knowledge of the area assisted in finding water sources and little-known routes of access to remote areas, and to Mrs. Barbara Ekker, the local observer at Hanksville for the National Weather Service, who lent copies of her daily records and assisted in special observations for the project.

Published information on the geology of the study area is abundant. The principal references used for description of the geology are Baker (1946), Gilluly (1929), Hunt (1953), and Smith, Huff, Hinrichs, and Luedke (1963). Their mapping, as modified by others, has been summarized by Stokes (1964) and subsequently by Williams and Hackman (1971). Because of the extensive search for petroleum and uranium in the region, numerous other studies are available that range from broad regional analyses, such as that by Newman (1962), to more localized detailed studies like that of Hawley, Robeck, and Dyer (1968).

Published information on water in the study area is less abundant. A report by Hood and Danielson (1979) pertains to specific aspects of the study described by this report. Mundorff (1979) discusses the quality of surface water in the Dirty Devil River basin. Several other references cited in this report apply to specific parts of the area or include it as a part of larger regional studies. They are Price and Arnow (1974), Feltis (1966), Iorns, Hembree, Phoenix, and Oakland (1964), Iorns, Hembree, and Oakland (1965), Marine (1962), Mundorff (1971), and Price and Waddell (1973). The study immediately adjoins or overlaps parts of areas described by Bjorklund (1969), Goode and Olson (1977), Waddell, Vickers, Upton, and Contratto (1978), and Waddell, Contratto, Sumsion, and Butler (1980).

## Terminology

The term permeability is used in this report to denote the relative ease with which a water-bearing formation can transmit water. The specific measure of permeability is hydraulic conductivity (K)[1]. The following ranges of measured or estimated hydraulic conductivity are used in this report:

| Range | K, in feet per day |
|---|---|
| Very low | Less than 0.5 |
| Low | 0.5 to 5 |
| Moderate | 5 to 50 |
| High | 50 to 500 |
| Very high | More than 500 |

The terms used in this report to classify water according to the concentration of dissolved solids, in milligrams per liter, are as follows:

| | | |
|---|---|---|
| Fresh | | Less than 1,000 |
| | Slightly saline | 1,000-3,000 |
| Saline | Moderately saline | 3,000-10,000 |
| | Very saline | 10,000-35,000 |
| Briny | | More than 35,000 |

## Data-site numbering systems

### Well-, spring-, and miscellaneous-site numbering system

The system of numbering wells and springs in Utah is based on the cadastral land-survey system of the U.S. Government. The number, in addition to designating the well or spring, describes its position in the land net. By the land-survey system, the State is divided into four quadrants by the Salt Lake base line and meridian, and these quadrants are designated by the uppercase letters A, B, C, and D, indicating the northeast, northwest, southwest, and southeast quadrants, respectively. Numbers designating the township and range (in that order) follow the quadrant letter, and all three are enclosed in parentheses. The number after the parentheses indicates the section, and is followed by three letters indicating the quarter section, the quarter-quarter section, and the quarter-quarter-quarter section--generally 10

---

[1]The hydraulic conductivity (K) of a water-bearing material is the volume of water that will move through a unit cross section of the material in unit time under a unit hydraulic gradient. The units for K are cubic feet per day per square foot [$(ft^3/d)ft^2$], which reduces to ft/d. The term hydraulic conductivity replaces the term field coefficient of permeability, which was formerly used by the U.S. Geological Survey and which was reported in units of gallons per day per square foot. To convert a value for field coefficient of permeability to the equivalent value of hydraulic conductivity, divide by 7.48; to convert from hydraulic conductivity to coefficient of permeability, multiply by 7.48.

acres (4 $hm^2$);[1] the letters a, b, c, and d indicate, respectively, the northeast, northwest, southwest, and southeast quarters of each subdivision. The number after the letters is the serial number of the well or spring within the 10-acre (4-$hm^2$) tract; the letter "S" preceding the serial number denotes a spring. If a well or spring cannot be located within a 10-acre (4-$hm^2$) tract, one or two location letters are used and the serial number is omitted. Thus (D-28-8)29cdc-1 designates the first well constructed or visited in the SW¼SE¼SW¼ sec. 29, T. 28 S., R. 8 E., and (D-28-7)11cdb-S1 designates a spring in the NW¼SE¼SW¼ sec. 11, T. 28 S., R. 7 E. The numbering system is illustrated in figure 2. Other sites where hydrologic data were collected are numbered in the same manner, but no serial number is used. Thus, in table 11 location (D-27-4)36dca is a tensiometer site in the NE¼SW¼SE¼ sec. 36, T. 27 S., R. 4 E.

### Surface-water-site numbering system

Surface-water gaging stations, where continuous records are available, are numbered in downstream order; for descriptions of this system, see U.S. Geological Survey (1977, p. 9). In this report, the part number (09) and the ending sequence number are deleted. Thus, the gaging station on the Fremont River near Bicknell, 09330000, is numbered 3300. Sites of miscellaneous measurements are numbered sequentially, as shown in table 5.

## GEOLOGIC SETTING

### Formations and their hydrologic characteristics

Rocks that crop out in or underlie the lower Dirty Devil River basin area range in age from Precambrian to Holocene (pl. 2 and table 1). Most of the sedimentary formations exhibit substantial variations in lithology due mainly to different depositional conditions, and in thickness due to depositional conditions and to the events that followed deposition. The composite section of sedimentary rocks in the area has a maximum thickness of about 23,000 ft (7,000 m) and a minimum thickness of about 7,300 ft (2,200 m).

All the formations in the geologic section contain some ground water, but much of the section, from the practical standpoint of well yields, is not considered to contain useful aquifers. Some of the hydrologic, structural, and physical characteristics of the aquifers are readily measurable or visible in outcrops. Other characteristics of both the exposed and unexposed formations can be evaluated only from well drilling, aquifer testing at wells, chemical analyses of water from wells and springs, and laboratory testing of rock samples from formations that are known to transmit water. A brief evaluation of each formation is given in table 1.

---

[1]Although the basic land unit, the section, is theoretically 1 $mi^2$ (2.6 $km^2$), many sections are irregular. Such sections are subdivided into 10-acre (4-$hm^2$) tracts, generally beginning at the southeast corner, and the surplus or shortage is taken up in the tracts along the north and west sides of the section.

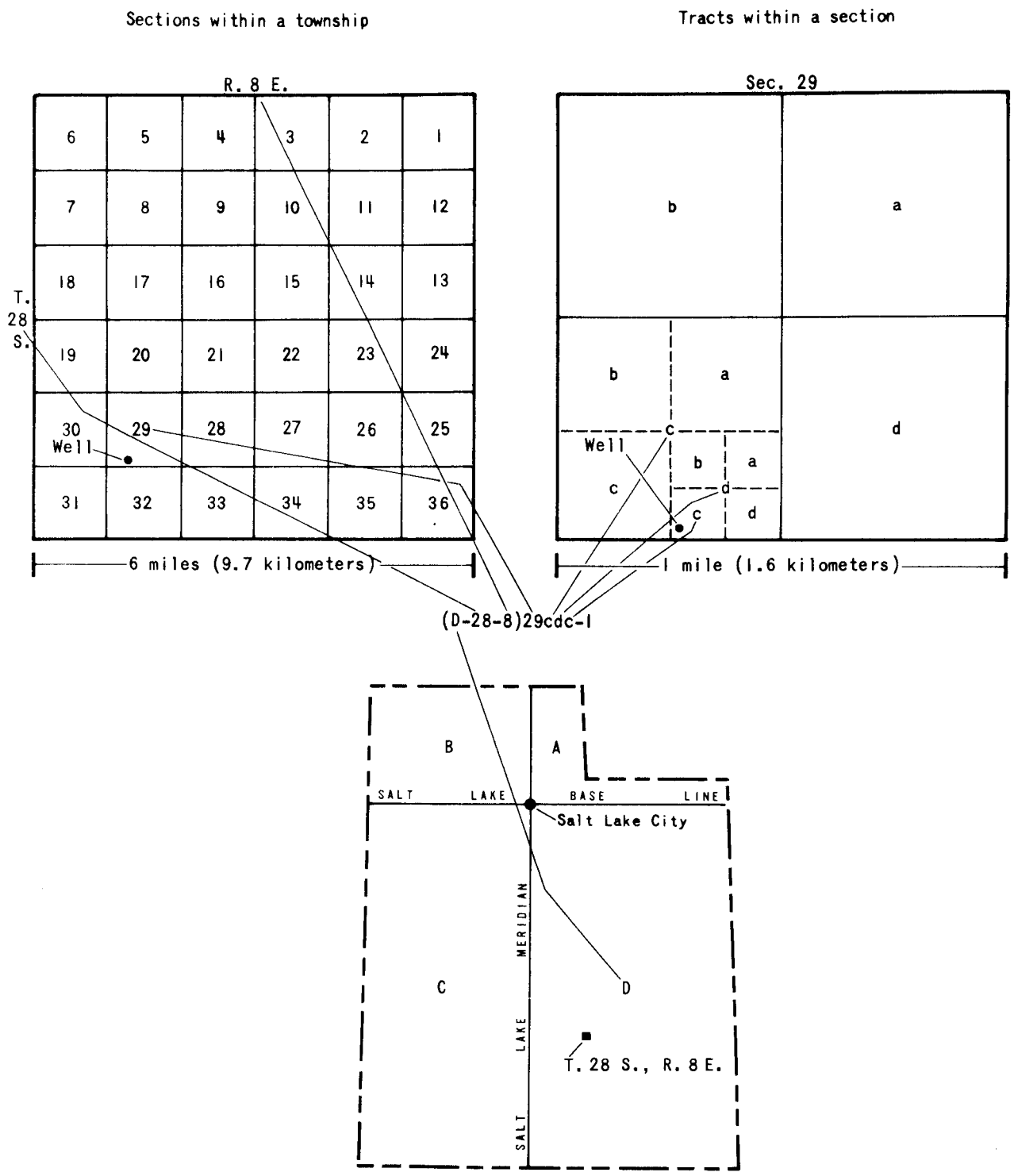



Figure 2.— Well- and spring-numbering system used in Utah.

Figure 3.—View southward from the NW¼NW¼SW¼ sec. 27, T. 27 S., R. 11 E., on State Highway 24 showing sandstone and siltstone of the Entrada Sandstone partly covered with dune sand. The thin white bed (arrow) in bluff, one of several markers that persist for miles, consists of a fine-grained white sandstone between two layers of sandstone with a dense ferruginous cement. The dunes in this area can rapidly absorb water from heavy thunderstorms and retain the water long enough to provide local recharge to the underlying bedrock. A thunderstorm hangs over the Henry Mountains in background.

Of the geologic units listed in table 1, five are considered to be major aquifers because of their large areal extent or thickness or their known locally large yields to individual wells. These units are the Entrada, Navajo and Wingate Sandstones, the Coconino Sandstone, including its lateral facies equivalents in the Cutler Formation, and rocks of Mississippian age. Several other lithologic units are considered locally important aquifers, but they are restricted in potential development owing to their thinness, distribution, or chemical quality of water. They include unconsolidated older alluvium and terrace deposits, the Emery and Ferron Sandstone Members of the Mancos Shale, the Salt Wash Sandstone Member of the Morrison Formation, and the Carmel Formation.

The Carmel Formation has a special importance to the ground-water hydrology of the lower Dirty Devil River basin area for several reasons. First, it is widely exposed in the area, both east and west of the San Rafael Swell, and can receive direct recharge. Second, it overlies the Navajo Sandstone, and locally can give up water to or receive water from the Navajo.

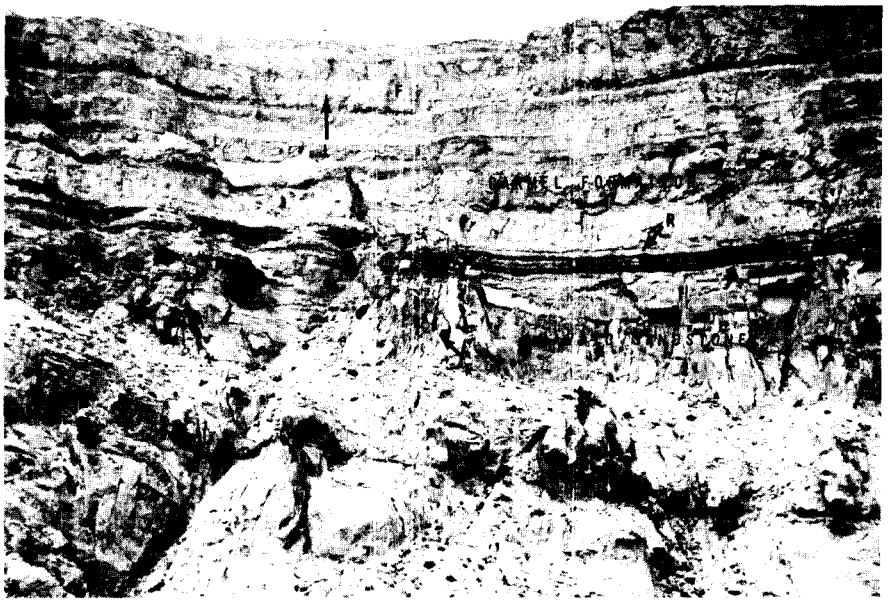


Figure 4.—View northward from Fremont River falls in the SE¼SW¼NE¼ sec. 16, T. 29 S., R. 7 E., on State Highway 24, showing joints or fractures (F) in Navajo Sandstone and Carmel Formation. Top of Navajo Sandstone underlies red shale bed (R), basal sandstone (S), and limestone (L) of Carmel Formation. The red shale is about 10 feet (3 m) thick.

Third, the formation contains large quantities of evaporites--mainly gypsum and some salt--which contribute to the deterioration of the chemical quality of both ground and surface waters in the area. The Carmel Formation locally is a good aquifer, yielding as much as 3 $ft^3/s$ (0.08 $m^3/s$) of water to individual wells. (See Hood and Danielson, 1979, tables 9 and 11.) However, most discharges from wells and springs in the Carmel Formation range from seepage to about 20 gal/min (1.3 L/s).

## Structure and other factors that affect hydrology

Folding, faulting, and igneous intrusion are the principal recognizable factors that alter the permeability of consolidated rocks in the study area. Secondary factors include the movement of gypsum, either by solution or differential pressure on the rock, and the development of cavernous zones in limestone.

The principal structural feature that distorts the rocks is the large monocline that trends southward through the area and includes both the San Rafael Swell and the Waterpocket Fold. The monocline developed mainly as a result of horizontal compression from the west. (See Kelley, 1955, fig. 10.) In the Thousand Lake Mountain area, essentially horizontal beds of the Navajo Sandstone crop out at an altitude of 9,100 ft. (2,774 m). The beds are bent down along the Waterpocket Fold to the extent that they are at or near sea level along the axis of the Henry Mountain structural basin. (See pls. 2 and

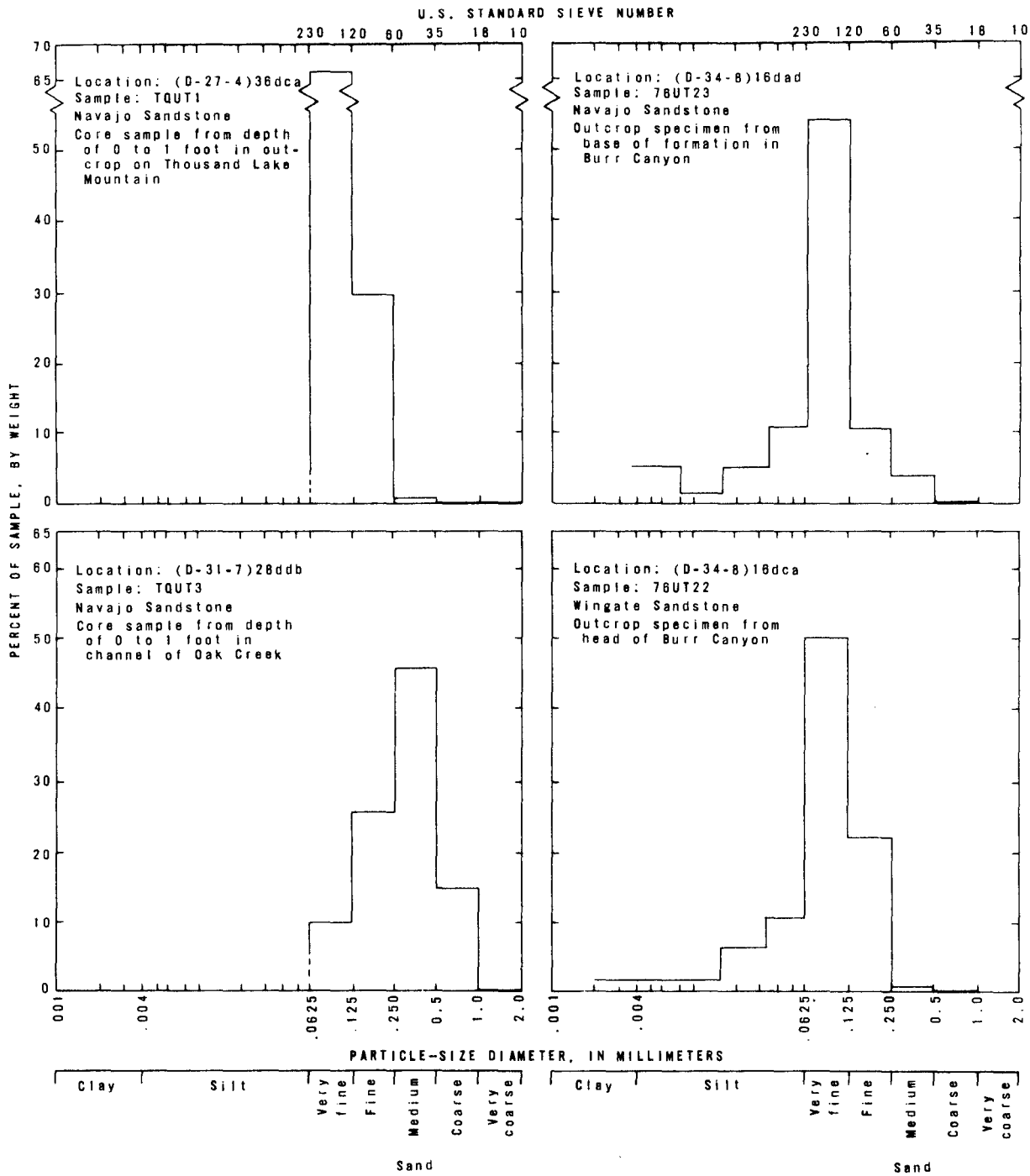



Figure 5.— Grain-size distribution in samples of the Navajo and Wingate Sandstones. (Left side of graph dashed where percentage of smaller grain-size fractions was not determined; see tables 11 and 12 and Hood and Danielson, 1979, tables 2 and 3.)

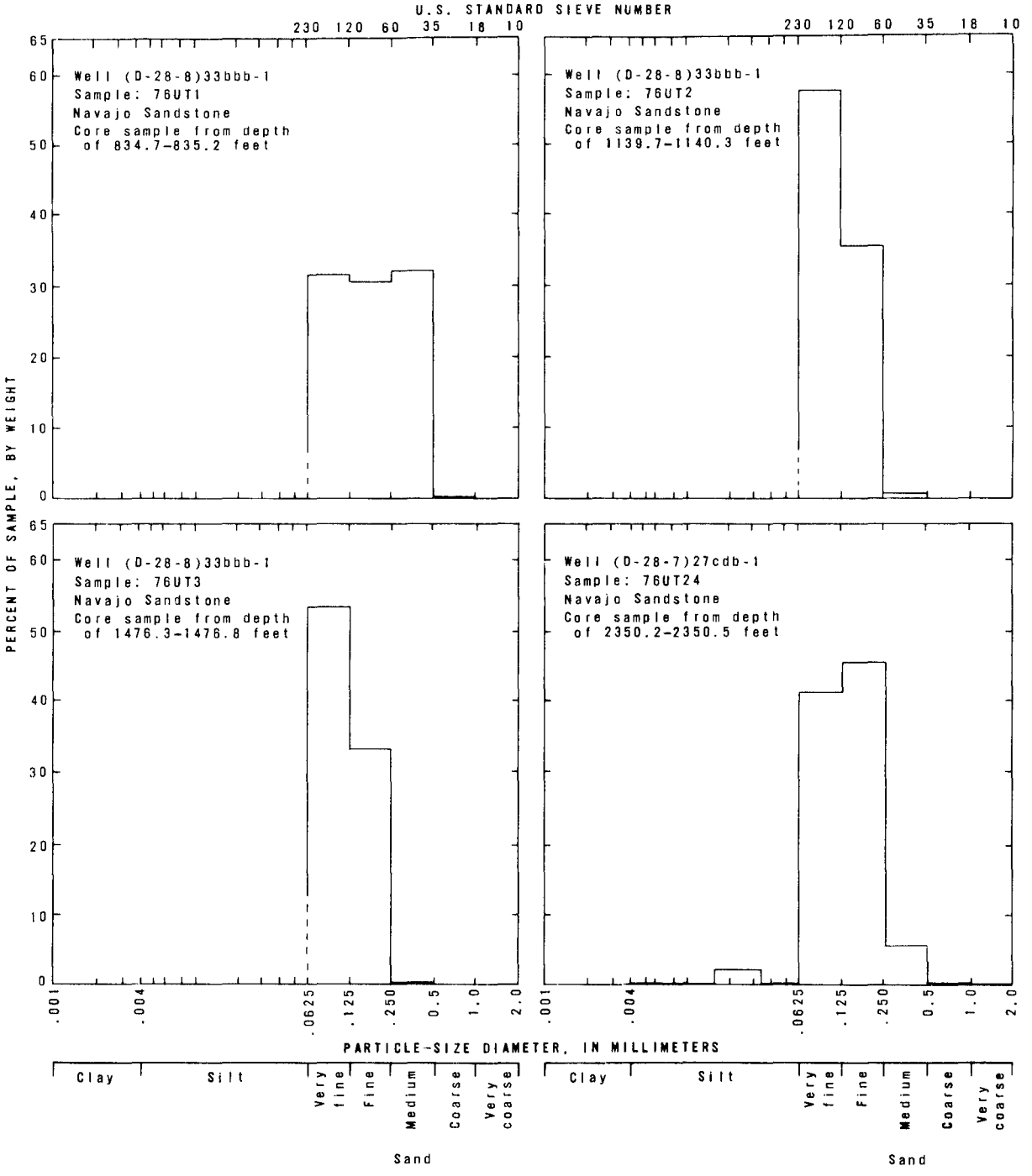



Figure 5.— Continued.

Table 1.--Description of geologic units known to underlie parts of the lower Dirty Devil River basin area

Geologic unit: The codes shown by or below unit names (as well as in the columns for Erathem, System, and Series) are used to identify aquifers, formations, or other geologic units listed in table 2, 6-8, 12, and 13. The code consists of three numbers generally ranked according to increasing age and a four-letter mnemonic abbreviation of the unit name. Thus 100VLFL is valley fill of Cenozoic age.
Character of material and hydrologic characteristics: See text for description of data-site numbering systems. Location of data sites are shown on plate 1.
Hydrologic characteristics: Ranges of permeability and salinity are defined on page 5. Interpretations of chemical quality of water are based on analyses in tables 12 and 13 or on known lithologic characteristics of formations. Ranges of permeability are partly based on estimates of hydraulic conductivity as given in table 2.

| Erathem | System | Series | Geologic unit | | | Character of material | Hydrologic characteristics |
|---|---|---|---|---|---|---|---|
| CENOZOIC (100CNZC) | Quaternary (110QRNR) | Holocene (111HLCN) | Valley fill (100VLFL) | Pediment, terrace, and other deposits (110PTOD) | Younger alluvium (111ALVM), dune sand and other windblown deposits (111DUNE), landslide and talus deposits (111LDLD), upper parts of colluvium (111CLVM), and gravel surfaces (110PTOD) | Surficial deposits of clay, silt, sand, gravel, and angular blocks. Along stream valley, young alluvium is often well-sorted, but generally is fine grained and 20 feet or less thick. Dune sand generally is a well-sorted veneer 6 to 20 feet thick; principal area of occurrence is in the San Rafael Desert northeast of Hanksville. (See fig. 3.) Landslide and talus deposits are found only in higher areas of Henry Mountains and the western mountain area (see Smith and others, 1963, p. 51). Landslides are chaotic mixtures of soils and other fine-grained debris, blocks of rock and other materials of indeterminate thickness. Talus deposits are accumulations of angular blocks at the bottoms of cliffs and steep slopes. Colluvial deposits in mountain areas are locally mixed with alluvium; the grains are generally smaller than that of landslide deposits and better sorted. Gravel surfaces are the upper parts of terrace deposits and pediments, which include older sediments. | Low to high permeability. In many areas, these deposits are not saturated, but in some stream valleys are part of the deposits that yield water to shallow wells and are less permeable than the underlying older alluvium or valley fill. Dune sand is a good recharge medium but only locally stores water. Landslide deposits, because of poor sorting, have low permeability but locally might yield enough water to supply domestic wells or support springflow. Talus deposits (fig. 19) generally are above the water table but are good recharge media for other underlying formations. Colluvium yields water to springs in the highlands of the Henry Mountains and the western mountains. The upper part of terrace deposits generally is a good recharge medium. Chemical quality of water in most of the younger deposits is variable depending on the sources of debris making up the deposit. Generally, the water is fresh in the mountains and saline in the lower desert areas. |
| | | Pleistocene (112PLSC) | | | Older alluvium (112ALVM), colluvium and terrace deposits, glacial outwash (112OTSH), and undivided glacial deposits (112GLCL) | Alluvium consisting mainly of sand, gravel, and some cobbles underlie the Fremont River valley and probably the largest of the tributary valleys; maximum known thickness is about 90 feet at Hanksville. Colluvium on the east side of Thousand Lake Mountain has a maximum known thickness of 170 feet. Terrace and related deposits consist mainly of sand and gravel; known thickness ranges from 34 feet at the Hanksville airport to 55 feet on the west slope of the Henry Mountains. Glacial outwash in the Bicknell-Torrey-Grover area (pl. 2) and southeastward along the lower slopes of Boulder Mountain consist mainly of sand and gravel, generally well-bedded and well-rounded; the coarsest of the deposits beneath the lower Fremont River valley may also include outwash. Undivided glacial deposits include till and unsorted, unstratified moraines of several ages (Williams and Hackman, 1971, sheet 1). | Very low to high permeability. Estimated hydraulic conductivity (K) for older alluvium is about 100 ft/d (see table 2). Terrace deposits probably vary widely in permeability depending on source of debris and grain size. Glacial outwash probably has a K similar to that of the older alluvium (table 2). Other glacial deposits probably have very low to high permeability depending on sorting and grain size. Chemical quality of water in deposits of this unit is same as in the above-described units. Water in older alluvium from vicinity of Caineville to Hanksville is variously described as unfit for domestic use, salty, and alkaline (see tables 6 and 10). |
| | Tertiary and Quaternary | | | Igneous rocks | Basalt flows and minor intrusives | Small exposures on Thousand Lake Mountain and Boulder Mountain; include cinder cones around necks of diabase. | Unknown; however, cinder cones and basalt probably are a good recharge medium. Probably not saturated. |
| | Tertiary (120TRTR) | Eocene(?) to Miocene(?) | Igneous rocks | | Intrusive and extrusive rocks | Diorite porphyry in stocks, laccoliths, bysmaliths, and sills in Henry Mountains (Hunt, 1953). Syenite and diabase sills and diabase dikes (fig. 10) in area from southwestern San Rafael Swell to northern Waterpocket Fold (Gilluly, 1929, p. 120; Smith and others, 1963, p. 37-40) and a dike north of Big Flat Top (fig. 15). Undivided extrusive rocks are mainly basaltic andesite on Thousand Lake and Boulder Mountains (Smith and others, 1963, p. 40-42; Rowley and others, 1975). | Very low to very high permeability. Intrusive rocks in Henry Mountains inhibit recharge and movement of ground water in the intruded sedimentary rocks; conversely, surface exposures enhance runoff directly to streams. Rock is sufficiently rigid that local open fractures may yield water to wells. Such water as may be obtained from the porphyry should be fresh.<br><br>Dikes and sills near the San Rafael Swell where unjointed probably have very low permeability, and their intrusion has locally lowered permeability of the country rock by baking.<br><br>Hydrologic properties of the extrusive igneous rocks in the area are unknown; however, those rocks probably are a good recharge medium. Locally they may transmit water in large quantities. Spring (D-29-3)14bcb-S1 (tables 7 and 12) in the upper Fremont River valley supplies several cubic feet per second of freshwater to irrigators and supports the flow of the Fremont River. |
| MESOZOIC (200MSZC) | Cretaceous (210CRSC) | Upper Cretaceous | Mesaverde Formation or Group (221MVRD) | | | Pale-yellow thick-bedded sandstone and thin interbedded dark-gray shale west of the Henry Mountains. More than 300 feet thick. | Low(?) permeability. Yields an estimated 10 gal/min of slightly saline water to spring (D-33-8)2ccd-S1 (table 7). Formation might produce more water to wells that penetrate fully saturated sections, but water probably would be saline. |
| | | | Mancos Shale (200MNCS) Total thickness 3,200 to 4,900 feet; thickens from east to west | | Masuk Member (211MSUK) | Dark-gray to black carbonaceous and sandy shale interbedded with pale-yellow sandstone and shaly sandstone. 600 to 800 feet thick. Full thickness present only in remnants west of Henry Mountains and northwest of study area. | Very low permeability. Shale inhibits drainage of water from overlying unconsolidated rocks. Unleached debris from this member, where present in alluvium, contributes to salinity of the ground water in the alluvium. |
| | | | | | Emery Sandstone Member (211EMRY) | Pale-yellow thin- to thick-bedded lenticular sandstone and minor interbedded carbonaceous shale and impure coal. Thickens westward from 250 to 800 feet; 200 to 300 feet thick in Henry Mountains area. | Very low(?) permeability. Yield small quantities of slightly saline water to spings such as (D-31-8) 27dab-S1 (tables 7 and 12). May be fully saturated in Henry Mountain structural basin, but water from wells is expected to be more saline than the spring water and yields probably would be low as at well (D-31-9)32ddd-1 (table 6). |
| | | | | | Blue Gate Member (211BLGT) | Dark-gray to black carbonaceous marine shale with minor thin pale-yellow sandstone beds. 1,400 to 2,000 feet thick. In areas around Factory Butte (fig. 17) and the North and South Caineville Mesas, member has characteristic badlands topography that is almost devoid of vegetation. | Very low permeability. Debris from this member, where present in alluvium, contributes to salinity of ground water in the alluvium. |

Table 1.--Description of geologic units known to underlie parts of the lower Dirty Devil River basin area--Continued

| Erathem | System | Series | Geologic unit | | Character of material | Hydrologic characteristics |
|---|---|---|---|---|---|---|
| MESOZOIC (200MSZC) | Cretaceous | Upper Cretaceous | Mancos Shale | Ferron Sandstone Member (211FRRN) | Pale-yellow thin- to thick-bedded lenticular sandstone and interbedded carbonaceous shale and coal. Thickens westward from 50 to 750 feet; 150 to 300 feet near Henry Mountains. | Low permeability. Yields small amounts of fresh to slightly saline water to springs such as (D-29-10)22ccb-S1 and (D-24-5)13bcd-S1. May be fully saturated in Henry Mountain structural basin, but water from wells in that area would be saline. |
| | | | | Tununk Member (211TNNK) | Dark-gray to black carbonaceous shale interbedded with thin beds of pale-yellow sandstone. Thickens westward from 250 to 650 feet; 525 to 650 feet thick west of Henry Mountains. Forms nearly barren badlands as in center of North Blue Flat. | Very low permeability. |
| | | | Dakota Sandstone (210DKOT) | | Light-yellow and yellowish-brown friable to quartzitic coarse-grained cross-bedded fluvial sandstone, conglomeratic sandstone, and conglomerate, with minor interbedded carbonaceous shale and impure coal. 0 to 125 feet thick; occurs mainly as discontinuous lenses. | Low(?) permeability. May be a source of water locally, but thinness and discontinuity indicate formation is not important as an aquifer in study area. |
| | | Lower Cretaceous | Cedar Mountain Formation (217CDMR) | Shale Member | Light-gray, grayish-green, and purple lacustrine shale and mudstone, with minor sandstone lenses and limestone beds. Some minor coarser material. 0 to 250 feet thick. | Very low permeability. |
| | | | | Buckhorn Conglomerate Member (217BCKR) | Dark-brown irregularly bedded ledge-forming fluvial conglomerate with minor lenses of conglomeratic sandstone. Pebbles are mainly of black chert, averaging slightly more than 1 inch in diameter. Maximum thickness 100 feet; thins and pinches out southward. | Very low(?) to low(?) permeability. May contain water in structurally low areas but is not known to be an aquifer. Well (D-28-7)36bbb-1 reportedly penetrated the formation at the east edge of North Blue Flat; the driller reported no water. |
| | Jurassic (220JRSC) | Upper Jurassic | Morrison Formation (221MRSN) Total thickness 0 to 750 feet | Brushy Basin Shale Member (221BRSB) | Light-red, purple, and grayish-green bentonitic lacustrine mudstone; minor limestone lenses; minor white, gray, and buff crossbedded sandstone lenses; minor conglomerate lenses. Thickens northeastward from 0 to 400 feet. | Very low permeability. Bentonitic surfaces prevent deep infiltration; these barren surfaces contribute much sediment to surface runoff during torrential thunderstorms; sediment seals surfaces of otherwise permeable alluvium and reduces permeability when mixed with alluvium. |
| | | | | Salt Wash Sandstone Member (221SLWS) | Light-gray, tan, and white thickly crossbedded fine- to coarse-grained lenticular fluvial sandstone with thin beds of conglomerate; contains interbeds of variegated sandy mudstone. Contains gypsum beneath North Blue Flat, and northeast of Henry Mountains as much as 50 feet of massive gypsum occurs at the base. Thickens southeastward from 0 to 400 feet. | Low(?) permeability, but potential aquifer in areas where it is fully saturated. Supplies small amounts of slightly saline water to springs such as (D-27-6)23cba-S1 and flowing wells (D-26-9)24dbc-1 and (D-28-7)36bbb-1. The water mainly is of the sodium sulfate type.<br><br>Freshwater was found in the Morrison Formation at only one spring, which is in the Henry Mountains. |
| | | Middle Jurassic | San Rafael Group (221SRFL) | Summerville Formation (221SMVL) | Reddish-brown even- and thin-bedded siltstone, sandstone, and mudstone. Local small channel(?) sandstone. Thin beds and veinlets of gypsum. Character as seen about 1 mile west of Hanksville extends over most of area. 100 to 300 feet thick. | Very(?) low permeability. May supply water to a few seeps. Such water as may occur probably is at best slightly saline and of the calcium sulfate type. |
| | | | | Curtis Formation (221CRTS) | Greenish-gray and brown fine- to coarse-grained thin- to thick-bedded glauconitic marine sandstone and siltstone with minor greenish-gray to red shale and local thin lenses of conglomerate. Forms prominent marker bed between the darker Summerville Formation and Entrada Sandstone. Caps many of the bluffs from the Red Desert northwestward to the Last Chance Desert. (See fig. 20 and Smith and others, 1963, fig. 14.) 0 to 240 feet thick; near Caineville about 80 feet thick. | Very(?) low permeability. Not known to be an aquifer. Any water in the formation probably is saline. |
| | | | | Entrada Sandstone (221ENRD) | In the northeastern part of area, light-reddish-brown to tan massive crossbedded eolian sandstone dominates (fig. 3); changes westward to an earthy reddish-brown thin- to thick-bedded fine-grained sandstone with substantial amount of clay (fig. 20). Thickens westward and probably southward from about 300 feet to nearly 800 feet in Capitol Reef National Park. | Very low to moderate permeability. Western facies not known to be an aquifer. At Hanksville, the formation is the only source of fresh ground water; there, the estimated values for K range from 2 to 16 ft/d (table 2). The area of freshwater occurrence is limited, however, and the chemical quality of the water deteriorates within a mile westward from Hanksville. The freshwater is generally of the sodium bicarbonate sulfate type. In the Burr and San Rafael Deserts, the sandstone is the source of small amounts of slightly to moderately saline water, in which sulfate is the dominant anion. |
| | | | | Carmel Formation (221CRML) | Removal of limestone and gypsum has lead to considerable distortion of the formation and overlying rocks. Two examples (pl. 2) are the Gypsum Sink (also called Meteorite Crater), a karst feature in the Entrada Sandstone (in the SW¼SW¼ sec. 36, T. 26 S., R. 5 E.), and Glass Mountain, a mass of hydrothermally(?) emplaced gypsum (in the NW¼NW¼NW¼ sec. 20, T. 27 S., R. 7 E.).<br><br>For the purpose of this report, the base of the formation is defined as the bottom of a red shale and siltstone that occurs throughout the area. It can be seen along the flanks of the San Rafael Swell as flatirons (fig. 18 and Baker, 1946, pls. 16 and 17A) and the canyon of the Fremont River in Capitol Reef National Park (fig. 4). It has a distinctive configuration on gamma-ray and resistivity logs, which provide part of the basis for discussion of structural distortion in the text. | Very low to locally high(?) permeability. Formation in undisturbed state probably has very low permeability, but where the rocks are fractured or exposed, water, which percolates from the surface or rises from below, dissolved gypsum and limestone. Circulation of ground water accelerates the local development of highly permeable zones in the formation. For example, Caine Springs, at the crest of an anticline, discharge about 2 $ft^3/s$ from limestone and gypsum. (See also the ICPA well in Hood and Danielson, 1979, table 8.)<br><br>The basal siltstone of the Carmel Formation impedes drainage of ground water downward into the Navajo Sandstone. Thus, Robbers Roost Spring, (D-28-14)22cad-S1, discharges water from the formation where the underlying Navajo has been partly or completely drained. Other similar occurrences probably include Swazys Seep, (D-25-12)4aac-S1, at the edge of the San Rafael Swell. |

Table 1.--Description of geologic units known to underlie parts of the lower Dirty Devil River basin area--Continued

| Erathem | System | Series | | Geologic unit | Character of material | Hydrologic characteristics |
|---|---|---|---|---|---|---|
| MESOZOIC (200MSZC) | Jurassic (220JRSC) | Middle Jurassic | San Rafael Group | Carmel Formation (221CRML)--Continued | | Water in the Carmel Formation in the easternmost part of the area ranges from fresh to slightly saline and consists of mixed types. In the central and western parts, the water ranges from slightly saline to very saline. Brine probably occurs locally in the northwestern part, as at petroleum test (D-25-5)14dbb-2 (table 8). In most of the water, sulfate is the dominant anion, but some of the moderately to very saline water is of the sodium chloride type. |
| | Jurassic (220JRSC) | Lower Jurassic | Glen Canyon Group (220GLNC) | Navajo Sandstone (220NVJO) | White, tan, and buff thickly and intricately crossbedded very fine to fine-grained eolian sandstone (fig. 5). Locally light-orange or yellow. Grain size may be slightly greater in eastern part of area. Calcareous cement in some outcrops but poorly to well-cemented with silica where deeply buried. (See Hood and Danielson, 1979, for description of character in T. 28 S., Rs. 7 and 8 E.) In eastern part of area, Baker (1946, p. 68) found thin lenticular beds of red to purplish shale and occasional lenses of light-brown limestone as much as 6 feet thick. The shale beds were found in test hole (D-27-11)34ddb-1D (tables 6 and 10); they apparently diminish in occurrence where the formation is thicker to the west. Limestone lenses also were noted by Gilluly (1929, p. 98) in the San Rafael Swell. Such limestone was found at the bottom of well (D-26-8)6aab-1. In addition to the shale at the base of the Carmel Formation, a second shale or shaly sandstone zone was found 60 to 90 feet below the first; the second shale marker also persists through much of the area. Thickness ranges from about 450 feet near the Green River to about 1,100 feet in the western mountains. (See pl. 3.) | Very low to moderate permeability. Undisturbed, unfractured, and unleached parts of formation have a K of about 0.5 ft/d. (See Hood and Danielson, 1979.) Fracturing where formation is folded or faulted has effectively increased K, but areas of higher K are erratically distributed. In the Red Desert, the average K is 1.7 ft/d. At two wells in T. 29 S., R. 4 E. (table 2), K is estimated to be 11 to 60 ft/d in an area where the sandstone stands nearly on edge at a fault zone. Large yields can be obtained from the formation where it is fully saturated, thick, and under confined conditions. Well (D-28-8)33bbb-1 discharged 2,800 gal/min for 35 days, with a total drawdown of 512 feet. At test holes drilled by the Geological Survey, the yields by air-lift pumping were estimated to be 200 gal/min, the maximum that the air pressure and volume would yield (see table 6). Chemical quality of water in most of the sandstone ranges from freshwater of mixed types to moderately saline water, also of mixed types. A sodium chloride brine was found in test hole (D-27-7)7bcc-2. |
| | Triassic(?) | Upper Triassic(?) | Glen Canyon Group (220GLNC) | Kayenta Formation (231KYNT) | Irregularly interbedded red, reddish-brown, buff, gray, and lavender shale, siltstone, and fine- to coarse-grained sandstone, in part conglomeratic, with minor beds of limestone. Contact with overlying Navajo Sandstone is transitional in some areas. 180 to 350 feet thick, increasing from northwest to southeast. Shale diminishes southeastward. | Very low(?) to low(?) permeability. Formation is a confining bed of lower permeability relative to the adjacent sandstone aquifers. Leakage through the formation is probably where it is sandiest or fractured. Springs or seeps occur near the contact with the Navajo Sandstone in the bottoms of canyons tributary to the Dirty Devil and Green Rivers. Water sample from spring (D-27-16)20bdc-S1 was fresh, but the formation, where deeply buried, probably contains saline water. |
| | Triassic | Upper Triassic | | Wingate Sandstone (231WNGT) | Reddish-brown, buff, and grayish-orange very fine- to fine-grained thickly crossbedded calcareous eolian sandstone. Formation is poorly to well-indurated. Most exposures are vertical cliffs (fig. 6) with dark-brown desert varnish on weathered surfaces. 270 to 400 feet thick, increasing from west to east. | Very low to moderate(?) permeability. Based on single sample (table 11), K may be 10 to 20 times lower than most permeable samples of Navajo Sandstone tested. Permeability can be inferred to be low to moderate where formation is strongly jointed or fractured (fig. 7). Yields small quantities of fresh to moderately saline water to a few springs where rock is jointed. Because of low permeability, the sandstone, where buried, probably contains water more saline than that in the Navajo. |
| | Triassic | Upper Triassic | Chinle Formation (231CHNL) | Church Rock(?) Member (231CCRK)<br>Owl Rock Member (no code assigned)<br>Petrified Forest Member (231PFDF)<br>Moss Back Member (231MBCK)<br>Monitor Butte Member (231MNRB)<br>Shinarump Member (231SRMP)<br>Temple Mountain Member (231TMPM) | Seven members or lithologic equivalents mostly of fluvial and lacustrine origin; not all members present in any given locality. Mudstone, siltstone, sandstone, and some conglomerate in various shades of purple, red, and brown. See also Stewart and others (1972) and Williams and Hackman (1971, sheet 1).<br><br>Moss Back Member: Yellowish-gray fine- to medium-grained lenticular conglomeratic sandstone; minor mudstone seams, limestone conglomerate, and coaly material.<br><br>Shinarump Member: Light-gray to yellow fine- to coarse-grained sandstone and conglomerate sandstone with minor mudstone lenses and plant remains. In vicinity of Capitol Reef National Park, thickness ranges from 0 to 90 feet, and locally the member consists of discontinuous channel fillings (Smith and others, 1963, p. 16-20).<br><br>Total thickness of Chinle Formation is 215 to 550 feet, increasing from northeast to southwest. | Very low to low(?) permeability. Most of formation is too fine grained to accept much recharge; conversely, it enhances surface runoff and contributes much sediment to surface water. May yield small amounts of water to seeps. Water recovered from two petroleum-test wells ranged from moderately saline of the sodium bicarbonate type to very saline with chloride being the dominant anion. |
| | Triassic | Middle Triassic(?) | Moenkopi Formation (230MNKP) | Upper part of Moenkopi Formation | Reddish-brown even-bedded fissile mudstone and siltstone and fine-grained sandstone with thin layers and veins of gypsum and anhydrite. Locally petroliferous. 200 to 775 feet thick. | Moenkopi as a whole has very low to low(?) permeability. Sandstone(?) units in and near outcrop areas yield small quantities of fresh to slightly saline water. Well (D-24-9)7dab-1S (table 6) indicates same is probably true for higher areas of outcrop in the San Rafael Swell and mountainous areas. Records from petroleum-test wells show that the formation, where deeply buried, yields moderately to very saline water of mixed types. |
| | Triassic | Lower Triassic | Moenkopi Formation (230MNKP) | Sinbad Limestone Member (237SNBD) | Yellowish-gray and tan thin- to medium-bedded oolitic dolomite and limestone with minor amounts of siltstone and sandstone. 12 to 200 feet thick. | Probably very low permeability in most areas; where the limestone is near the surface or has been strongly fractured, ground-water circulation probably has caused cavernous development and thus enhanced the permeability. The estimated K at well (D-29-5)32bad-1 is 10 ft/d (table 2). Samples from petroleum-test wells indicate the limestone, where deeply buried, contains moderately to very saline water. |

Table 1.--Description of geologic units known to underlie parts of the lower Dirty Devil River basin area--Continued

| Erathem | System | Series | Geologic unit | Character of material | Hydrologic characteristics |
|---|---|---|---|---|---|
| MESOZOIC | Triassic | Lower Triassic | Moenkopi Formation: Lower part of Moenkopi Formation | Light-reddish-brown, yellow, and green even-bedded siltstone and sandstone containing gypsum veinlets; a chert pebble conglomerate at base 20 to 140 feet thick.<br><br>Total thickness of the Moenkopi Formation is 360 to 1,000 feet or more, increasing from east to west. | Similar to Upper part of Moenkopi Formation. |
| PALEOZOIC (300PLZC) | Permian (310PRMN) | Lower Permian | Kaibab Limestone (310KIBB) | Light-gray to brown cherty silty limestone, white calcareous siltstone, white thin beds of cross-bedded fine-grained sandstone, and some dolomite. Missing in eastern part of area; 0 to 100 feet in San Rafael Swell, thickening to 350 feet in Capitol Reef area. | Very low to moderate(?) permeability. Undisturbed formation probably has very low permeability; where fractured by folding or faulting, secondary permeability may be at least moderate. Petroleum-test well (D-31-7)36dad-1W yielded freshwater of the calcium sulfate type from a depth of 3,414 feet. Other petroleum-test wells to the east yielded slightly to moderately saline water of mixed types. |
| | | | Coconino Sandstone (310CCNN): | The Coconino Sandstone, in western part of area, interfingers with members of the Cutler Formation in eastern part of area. (See pl. 2.) Coconino consists of light-gray to buff friable to hard fine-grained thickly crossbedded eolian sandstone; grit and considerable limestone in lower 40 feet. 700 to 1,200 feet thick, increasing southward. | Very low to moderate(?) permeability. No direct data available, but formation estimated to have characteristics similar to Navajo Sandstone, including effects of fracturing. Records of petroleum-test wells (table 8) indicate water in formation in most areas tested. Where deeply buried, water probably is slightly to moderately saline, but in and near outcrops, as in central part of Capitol Reef National Park, water may be fresh. |
| | | | Cutler Formation (310CTLR): White Rim Sandstone Member (310WTRM) of Cutler Formation | Equivalent to upper part of Coconino Sandstone. White, gray, and buff fine- to medium-grained eolian sandstone. 0 to 230 feet thick. | See above discussion of Coconino Sandstone. Testing of this sandstone in petroleum-test wells produced water at most locations. Most samples were slightly to moderately saline; two samples from wells in T. 30 S., R. 15 E., were fresh. Water was mostly of mixed types, but several were of the sodium sulfate type. |
| | | | Organ Rock Tongue or Member (310ORGK) | Reddish-brown siltstone and thin-bedded fine-grained sandstone. 0 to 900 feet thick. | Very low(?) permeability. Water sample from well (D-29-10)8ccb-1 was moderately saline and of the calcium sulfate type. |
| | | | Cedar Mesa Sandstone Member (310CDRM) | Yellowish-gray, reddish-orange, and reddish-brown friable fine- to coarse-grained thickly crossbedded eolian sandstone, with minor beds of red sandy shale and gray cherty limestone. 750 feet thick. | See above discussion of Coconino Sandstone. No water samples, but water probably is saline. |
| | | | Halgaito Tongue or Member (310HLGT) | Thin-bedded mudstone and siltstone. This unit may not be present in area but was identified as such in well (D-29-10)8ccb-1 (table 8), where the unit is 295 feet thick. | Very low(?) permeability. Characteristics unknown. The only available water sample was moderately saline and of the sodium sulfate type.<br><br>Another sample reportedly from the Cutler Formation (possibly this member) was slightly saline and of the calcium sodium sulfate type. |
| | Pennsylvanian and Permian | | Rico Formation (310RICO) / Elephant Canyon Formation (of Baars, 1962) (319ELPC) | Rico Formation: Reddish-brown and greenish-gray fine- to coarse-grained crossbedded sandstone; gray and grayish-green thin- to thick-bedded cherty limestone; red and purple shale and siltstone. 600 feet thick at east edge of area, thinning westward to 0 feet. Absent in San Rafael Swell. In some petroleum tests, this section is identified as the Elephant Canyon Formation, or simply as "Wolfcamp" or "Wolfcamp carbonates." | Very low(?) permeability. No water samples, but water probably is saline. |
| | Pennsylvanian (320PSLV) | Middle and Upper Pennsylvanian | Hermosa Formation (321HRMS) (Hermosa Group of Wengard and Matheny, 1958): Upper member (includes Honaker Trail Formation (321HKTL) of Wengerd and Matheny, 1958) | Gray thin- to thick-bedded dense to coarsely crystalline cherty limestone, interbedded with gray and brown massive to thin-bedded sandstone, siltstone, and sparse beds of gray and red shale. 200 to 1,300 feet, increasing eastward.<br><br>Note: A small exposure of the top of this unit is mapped in Straight Wash near the central east edge of the San Rafael Swell. | Very low(?) permeability. Water sample from petroleum-test well (D-25-15)22aca-1 was very saline and of the sodium chloride sulfate type. |
| | | Middle Pennsylvanian | Paradox Member of the Hermosa Formation (324PRDX) | Salt, gypsum, anhydrite, black shale, and gray sandstone and limestone. Thickness increases eastward from 0 to 2,500 feet as determined from well logs. Absent in San Rafael Swell. (See also Hanshaw and Hill, 1969.) | Very low to moderate(?) permeability; permeability very low except where fracturing has allowed water circulation to dissolved salt, gypsum, and limestone. Water samples analyzed were moderately saline of the sodium sulfate type and very saline to briny water of the sodium chloride type. |
| | | | Lower member (Pinkerton Trail Formation (327PKRT) of Wengerd and Strickland, 1954) | Mainly dark-gray limestone, dolomite, and shale. 0 to 200(?) feet thick. | Very low(?) permeability. Water sample from well (D-30-13)4dcb-1 was brine of sodium chloride type. |
| | | Lower Pennsylvanian | Molas Formation (320MOLS) | Variegated claystone and shale; siltstone and conglomerate. Includes limestone and chert regolith on karst surface in upper 10 to 100 feet of underlying Mississippian rocks, wherever Mississippian is or was present. 20 to about 580(?) feet thick. | Very low permeability; probably confines water in Mississippian rocks. No water-quality data. |

Table 1.--Description of geologic units known to underlie parts of the lower Dirty Devil River basin area--Continued

| Erathem | System | Series | Geologic unit | Character of material | Hydrologic characteristics |
|---|---|---|---|---|---|
| PALEOZOIC (300PLZC) | Mississippian (330MSSP) | | Equivalent of Redwall Limestone (330RDLL) — Terms used by various petroleum companies: Redwall Limestone (330RDLL); Leadville Limestone (330LDVL); Madison Limestone or Group (330MDSN) | Mainly limestone and dolomite. Upper surface has karst topography and some internal zones are locally(?) cavernous. 200(?) to about 1,150 feet thick at wells in area. Thins across San Rafael Swell. (See also Cooper, 1955, p. 63, 65.) | Very low to high(?) permeability. Most of formation should be of very low permeability, but where solution of limestone and dolomite has created cavernous zones, permeability may be high. Almost all petroleum-test wells that penetrated and were tested in these rocks recovered relatively large amounts of water. Well (D-26-17)5ccc-1 flowed during testing. Water samples recovered from wells nearest the western boundary of the study area and San Rafael Swell were slightly to very saline of the sodium sulfate, magnesium chloride, and sodium calcium chloride types. The remaining samples were moderately saline to briny and are of the sodium chloride or sodium magnesium chloride type. |
| | Devonian (340DVNN) | Upper Devonian | Pinyon Peak Limestone (no code) (westward equivalent); Eastward equivalents(?) reported by petroleum companies: Ouray Limestone (341OURY) | Massive dense argillaceous limestone and thin clayey shale; locally sandy, with sandstone. Thickness reported from wells in area ranges from about 90 to about 400 feet. | Very low(?) permeability. No water-quality data. |
| | | | Elbert Formation (341ELBR) | Limestone, shale, and (?) basal sandstone. Thickness reported for wells in area ranges from 260 to about 850 feet. | Very low(?) permeability. Water sample from well (D-26-7)19bbd-1 contained moderately saline water of the sodium sulfate type. The petroleum-test well was sampled across the Elbert-Lynch contact. |
| | Cambrian (370CMBR) | Upper Cambrian | Lynch Dolomite (371LYNC) | Chiefly dolomite and limestone. About 500 feet thick. | Very low(?) permeability. Water quality assumed to be similar to that in Elbert Formation. |
| | | Middle Cambrian | Ophir Shale (374OPHR) | Micaceous(?) shale and dark limestone. 600 to 700 feet thick. | Very low permeability. No water-quality data. |
| | | Lower Cambrian | Tintic Quartzite (374TNTC) | Mainly reddish quartzite or quartzitic sandstone, some (?)siltstone and (?)conglomerate. About 200 feet thick. | Very low(?) permeability. No water-quality data. |
| PRECAMBRIAN (400PCMB) | | | Precambrian (400PCMB) | Found at relatively shallow depths in San Rafael Swell. Two logs available for well (D-23-11) 27bbd-1; one log records "quartz biotite schist," the other records granite at 4,370 feet below land surface (Baker, 1946, p. 120). Rock undescribed but found at greater depths in wells (D-25-13)14bbc-1 and (D-25-14)22cdd-1 (table 8). | Do. |

1/Term used by Bjorklund (1969, p. 15) for unconsolidated deposits in and near the adjacent upper Fremont River valley. This all-inclusive unit may contain equivalents to part, or all, of the Pleistocene and Holocene deposits described.

Table 2.--Estimates of transmissivity and hydraulic conductivity at wells for which specific capacity can be calculated
[See table 6 for well records]

Well number: See text for description of data-site numbering systems. D, well deepened, or S, well plugged back from original depth of hole.
Aquifer: See table 1 for formation name and description of lithology.
Occurrence of water: C, confined; U, unconfined.
Discharge: EA, estimated while drilling with air; B, bailed yield reported by driller; E, estimated; O, pipe orifice; V, measurement by unspecified method, but generally with bucket or barrel and stopwatch.
Storage coefficient: Estimated from the occurrence of water and known lithologic characteristics.
Transmissivity (T): Estimated by method of Theis, Brown, and Meyer (in Bentall, 1963), except as noted for (D-27-11)34ddb-1D.
Saturated thickness: See remarks for some restrictions on thickness used.
Hydraulic conductivity (K): Calculated by dividing T by saturated thickness.
NOTE: The reader is reminded that individual values of transmissivity that were estimated from values for specific capacity are, at best, approximations. Because individual values for hydraulic conductivity are calculated from the estimates for T, those individual values for K also are approximations. The principal value of T and K values listed in this table lies in their indication of relative permeability; they should be used with discretion.

| Well number | Aquifer | Occurrence of water | Discharge (gal/min) | | Specific capacity [(gal/min)/ft] | Estimated storage coefficient[1] | Estimated transmissivity units[2] ($ft^2/d$) | Saturated thickness (ft) | Estimated hydraulic conductivity (ft/d) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| (D-30-11)5adb-1 | 110PTOD | U | 25 | EA | 1.3 | 0.2 | 200 | 20 | 10 | Estimated value may be slightly high because consolidated rocks may contribute some of the water. |
| (D-25-5)14dda-1 | 112ALVM | U | 30 | B | 6 | .2 | 1,100 | 10 | 110 | |
| (D-28-9)29bdb-1 | do. | C | 50 | B | 16.7 | .2 | 3,300 | 38 | 90 | |
| 30dad-1 | do. | C | 60 | V | 15.0 | .2 | 3,300 | 28 | 120 | |
| (D-28-10)22abc-1 | do. | U | 600 | O | 31.6 | .2 | 6,700 | 62 | 110 | |
| (D-29-5)34ddb-1 | 112GLCL | C | 6 | B | <.1 | .01 | <14 | 14 | <1 | Perforated zone is gravel packed. Well bailed down to bottom in 2 hours. |
| (D-30-5)10abb-1 | do. | C | 35 | B | 1.8 | .01 | 400 | 12 | 30 | |
| (D-28-11)15bdc-1 | 221ENRD | C | 60 | V | 1.3 | .0001 | 400 | 25 | 16 | |
| 16cba-1 | do. | C | 16 | V | .1 | .0001 | 30 | 5 | 6 | Thickness shown is amount of open hole. |
| 16dad-1 | do. | C | 32 | B | .2 | .0001 | 50 | 19 | 3 | Thickness shown is amount of perforated interval. |
| 21abd-1 | do. | C | 19 | V | .15 | .0001 | 40 | 10 | 4 | Do. |
| 28bdd-2 | do. | C | 15 | B | .4 | .0001 | 120 | 69 | 2 | Thickness shown is amount of sandstone in open hole. |
| (D-29-11)1bbc-1 | do. | C | 15 | B | 1.5 | .0001 | 530 | 180 | 3 | Do. |
| 36daa-1D | do. | C | 15 | B | 1.3 | .0001 | 470 | 188 | 2 | Thickness shown is amount of perforated pipe and open hole. |
| (D-27-7)7bcc-1 | 221CRML | U | 4 | EA | .6 | .0001 | 200 | 7 | 30 | Yield probably from cavernous zones in gypsum. |
| (D-27-14)5acc-1S | do. | U | 10 | V | .4 | .0001 | 11 | 57 | .2 | Thickness shown is amount of perforated interval and of open hole. |
| (D-26-8)6aab-1 | 220NVJO | U | 11 | B | .3 | .05 | 27 | 81 | .3 | Thickness shown is amount of saturated sandstone. |
| | | | | | | | | 57 | .5 | Thickness shown is amount of perforated interval. |
| (D-27-11)34ddb-1D | do. | C | 74 | E | - | .007 | 1,700 | 600 | 2.8 | Data from 84-minute recovery test of USGS test hole 2, for zone 605-750 ft (upper 24 percent of formation). Discharge given is weighted average for estimated natural flow and air-lift discharge while drilling. Estimated T is obtained by straight-line method, after corrections for partial penetration. Thickness of formation is estimated from data for adjacent wells. Test hole is near inferred fault. |
| (D-27-15)21aad-1 | do. | U | 12 | B | .2 | .05 | 270 | 86 | 3 | Thickness shown is amount of saturated sandstone. |
| (D-29-4)25dcb-1 | do. | U | 60 | B | 6 | .05 | 1,300 | 115 | 11 | Thickness shown is amount of saturated sandstone. Well is in area of severe structural distortions. |
| 26dac-1 | do. | U | 50 | B | 50 | .05 | 10,000 | 180 | 60 | Thickness shown is amount of saturated sandstone. Estimate of specific capacity is minimum based on indefinite reported pumping level. However, well is in area of severe structural distortion and it probably produces from strongly fractured rock. |
| (D-31-7)36dad-1S | do. | C | 161 | O | 1.4 | .006 | 400 | 560 | .7 | Thickness shown is zone of cemented casing perforated by oil-field type of gun perforations. |
| (D-29-5)32bad-1 | 237SNBD | C | 35 | B | 1 | .0001 | 270 | 25 | 10 | Thickness shown is that of both the limestone and the perforated zone. Water probably is from cavernous zones or fractures. |
| (D-29-16)28cbc-1 | 310CTLR | U | 5 | B | .02 | .0001 | <14 | 200 | <.07 | Thickness shown is amount of perforated interval. Water may have been from fractured zone, 2,740 to 2,750 ft, where driller reported lost circulation when drilling. |

[1]The storage coefficient (S) of an aquifer is the volume of water it releases from or takes into storage per unit surface area of the aquifer per unit is a dimensionless number. Under confined conditions, S is typically small, generally between 0.00001 and 0.001. Under unconfined conditions, S is much larger, typically from 0.05 to 0.30.

[2]Transmissivity (T) is the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient. The units for T are cubic feet per day per foot [$(ft^3/d)/ft$], which reduces to $ft^2/d$. The term transmissivity replaces the term coefficient of transmissibility, which was formerly used by the U.S. Geological Survey and which was reported in units of gallons per day per foot. To convert a value for coefficient of transmissibility to the equivalent value of transmissivity, divide by 7.48; to convert from transmissivity to coefficient of transmissibility, multiply by 7.48.

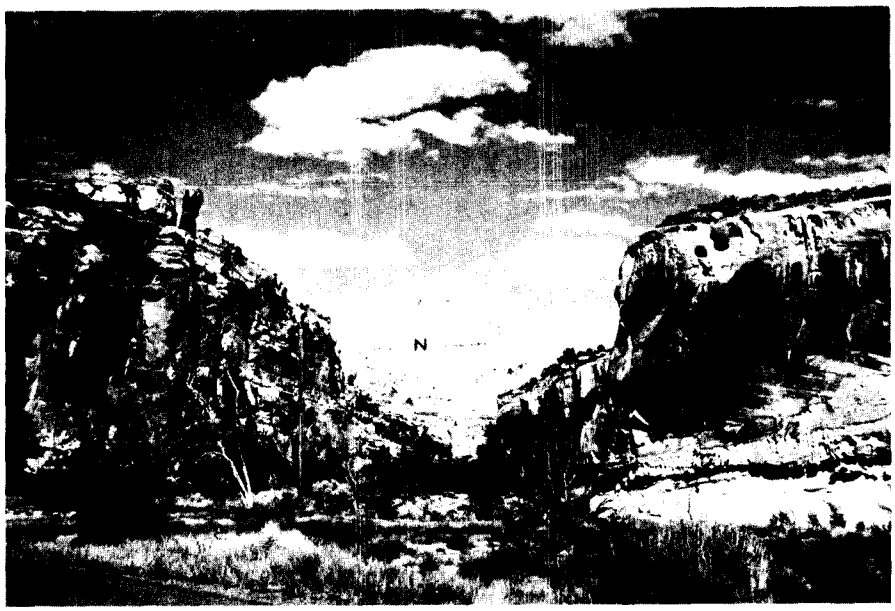



Figure 6.—View down Fremont River canyon from State Highway 24 near Fruita showing the massive Wingate Sandstone (W); because the formation has a very low hydraulic conductivity and crops out mainly in vertical bluffs, it receives little recharge from precipitation here. The light-colored Navajo Sandstone (N) here has a "beehive" erosion form common to the upper part of the formation in the Waterpocket Fold area. Steep slopes of this type rapidly shed water from thunderstorms and snowmelt because of the very low hydraulic conductivity of the sandstone.

3.) East of the structural basin, the Navajo slopes gently upward toward the canyons of the Dirty Devil and Green Rivers where it crops out at altitudes of about 4,000 to 5,000 ft (1,220 to 1,520 m). Superimposed on these large folds are numerous smaller features such as the Teasdale anticline and the series of anticlines and synclines between Thousand Lake Mountain and the San Rafael Swell (pl. 2). Associated with the folding is fracturing (figs. 8 and 9) of competent beds; the intensity of fracturing depends largely on the amount of folding.

In such folds as the Caineville anticline, the locally loose sand on the top of the Navajo Sandstone may be due to differential movement and shearing of the Navajo with respect to the overlying Carmel Formation during folding. (See log of (D-28-8)29dcb-1 in Hood and Danielson, 1979, table 9.)

Faulting may, in part, also affect permeability of several formations. Only the major faults in the area are shown on plate 2; in most places, smaller sympathetic fractures are associated with the major faults. Generally, faults include a zone of low permeability because of fault gouge and other products of compression and friction. However, some of the faults south of the San Rafael Swell, and possibly elsewhere around the swell, appear to be tension faults of relatively small throw; these faults probably are sufficiently permeable to allow some interformational movement of ground water.

Figure 7.—View southeast, approximately 1 mile (1.6 km) downstream from spring (D-31-13)9bcd-S1 in Poison Spring Canyon, showing strongly jointed or fractured Wingate Sandstone (W) underlying siltstone and sandstone of the Kayenta Formation (K).

In addition, the fracturing that accompanies essentially all faults, such as those in the San Rafael Swell, undoubtedly enhances recharge to some formations. Faults between the Dirty Devil and Green Rivers enhance ground-water drainage to the rivers.

Some faults in the area inhibit or restrict ground-water circulation by throwing aquifers partly or completely against less permeable formations. A specific example is the fault that trends northwestward through Cottonwood Spring, (D-24-14)32adb-S1, where the Navajo Sandstone is thrown 100 to 200 ft (30 to 61 m) up against the Carmel Formation and basal Entrada Sandstone; the Navajo section in direct hydraulic connection across the fault is reduced by 20 to 40 percent. Another example is an inferred fault that lies between test hole (D-27-11)34ddb-1D and petroleum-test well (D-28-11)5cdb-1. Mapping by Hunt (1953, pl. 1) shows only one fault passing between the two sites, and that fault with the downthrown block on the northeast side. Logs of the two holes, however, show that the top of the Navajo, after correction for regional dip, is about 400 ft (122 m) lower in the petroleum-test well. The amount of Navajo in direct hydraulic connection across the fault zone is estimated to be reduced about 60 percent.

Intrusive igneous rocks occur mainly in two parts of the study area--in the Henry Mountains and at the southwestern end of the San Rafael Swell. Generally, igneous intrusion introduces rocks of very low permeability that inhibit recharge and ground-water movement. Locally, however, the process of intrusion has created fractured areas that probably allow substantial interformational movement of water.

Figure 8.—View northward from road in Burr Canyon in the SE¼NE¼SE¼ sec. 16, T. 34 S., R. 8 E. Steeply dipping fractured Navajo Sandstone (N) overlies red siltstone of Kayenta Formation (K). Arrow shows site of sample 76UT23 (fig. 5 and table 11). Length of arrow is about 10 feet (3 m).

In the Henry Mountains, the massive intrusion of diorite porphyry in stocks, laccoliths, and other related forms domed up the consolidated rocks, interrupting the regional dip, and permeating the sedimentary rocks with a complex of subsidiary dikes and sills (Hunt, 1953). In the northern part of the mountains, around Mount Ellen, the rocks so affected are mainly the San Rafael Group and younger. Other than at the Mount Ellen stock, the Navajo Sandstone and the older rocks pass beneath the domed area with relatively little disturbance. Progressively greater deformation of the Navajo and older rocks occurs southward. (See Hunt, 1953, pls. 8, 11, and 13.) That the intrusion has affected older rocks is indicated by the sills found in the Chinle Formation in petroleum-test well (D-31-9)22bbd-1 and between the Hermosa and Molas Formations in petroleum-test well (D-31-11)20ddb-1. (See table 8.)

Figure 9.—South wall of Burr Canyon, approximately one-fourth of a mile east of site shown in figure 8. Fractures in Navajo Sandstone, near bottom of picture, are rounded and the Sandstone is stained (arrow) where water has circulated through the fractures. Height of wall is about 15 feet (4.6 m).

In contrast to the lowering of permeabilities of the aquifers by intrusion, the emplacement of the igneous rock also enhances the permeability by local fracturing, probably as a result of subsidence due to loading and to the literal thrusting aside of part of the sedimentary rocks. During the drilling of petroleum-test well (D-31-11)27ddd-1 (table 8), most or all the drilling fluid was lost repeatedly into a zone in the Navajo Sandstone, and repetitive cementing work was required to regain circulation. At times the drilling fluid contained 30 percent material used to seal fractures. Such an occurrence in the granular Navajo indicates that the formation at the site contained large open fractures. No record is available to indicate that the Navajo at this location contained water, but it may be inferred that the fracturing crosses formational contacts and permits local recharge to move down through the overlying Entrada Sandstone and Carmel Formation and into the Navajo.

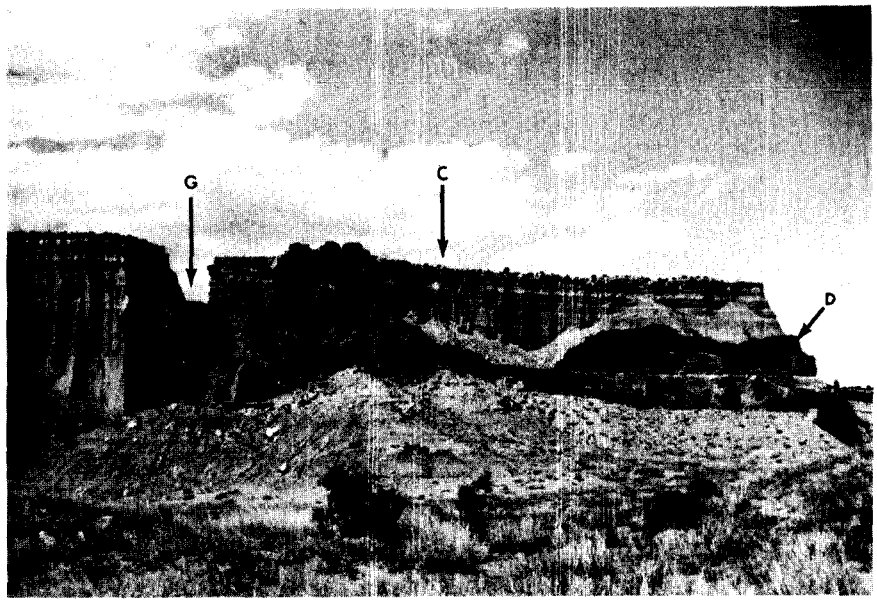



Figure 10.—View east-northeastward from SW¼SE¼ sec. 36, T. 25 S., R. 5 E., showing igneous dike (D) which strikes generally northward and cuts Entrada Sandstone (E). Curtis Formation (C) caps the Entrada. Part of the dark-colored rock is Entrada baked on the surface of the dike. Dike and baked sandstone are harder than the unaltered sandstone which has been eroded away from the dike, leaving the dike standing free in gap (G) through the butte. Dikes such as this and the one shown in figure 11 interfere with ground-water circulation.

At the southwestern side of the San Rafael Swell, a swarm of igneous dikes (pl. 2 and fig. 10) and related sills intrude rocks ranging from the Chinle Formation to the Summerville Formation. A single dike was also found east of the San Rafael Swell, in the southwestern corner of T. 26 S., R. 14 E., where igneous rock has intruded the fault mapped by Williams and Hackman (1971). (See fig. 11.) Detailed mapping east of the swell might reveal similar concealed intrusives.

The observed dikes range from less than 2 to at least 10 ft (0.6-3 m) thick; the sills are as much as 100 ft (30 m) thick. Based on field inspection of the sills, the unweathered parts and adjacent baked sedimentary rocks may have low permeability and thus impede vertical percolation of ground water through the intruded sedimentary rocks; similarly, unweathered parts of the associated dikes may impede lateral movement of ground water locally.

Solution of rock materials also has significant effect on the permeability of certain geologic formations. Three examples of the effect of solution or transport of gypsum and the solution of limestone are cited in table 1 under characteristics of the Carmel Formation. In addition to these, collapse structures are found locally in parts of the San Rafael Swell. (See Hawley and others, 1968, fig. 7.) These rubble-filled pipelike structures

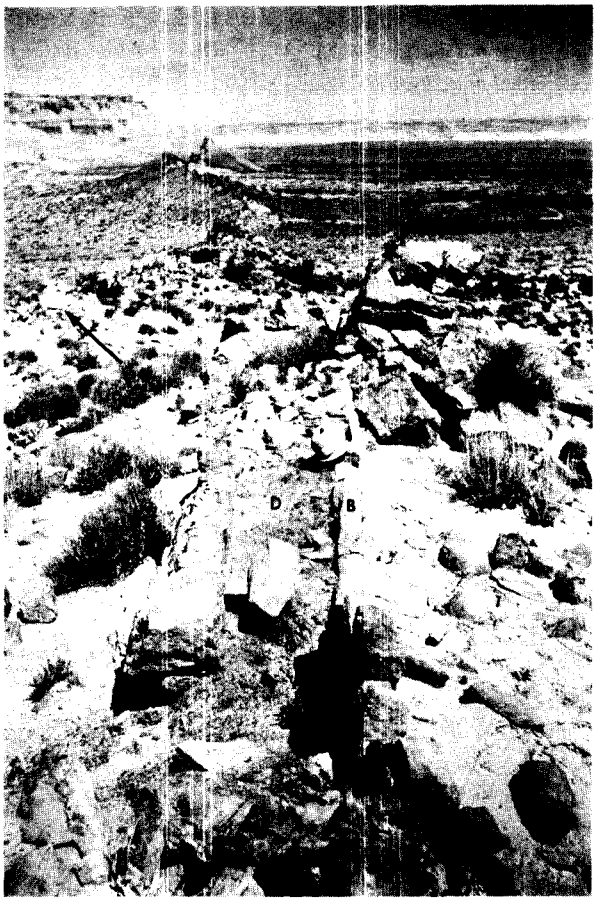



Figure 11.—View northwestward from near southwest corner of T. 26 S., R. 14 E., showing igneous dike (D) cutting Entrada Sandstone and trending several miles toward San Rafael Swell (background) past north side of Big Flat Top. Dike intruded fault zone. Sandstone is baked (B) by the dike and is harder than the weathered dike. Another strand of dike indicated by arrow.

penetrate at least into the Coconino Sandstone. It is inferred that the collapse is due to the removal of limestone in the underlying Elephant Canyon(?) Formation of Baars (1962), and Hermosa Formation or perhaps the Mississippian limestones. The result of multiformational penetration by such collapse is local interformational movement of water, which probably occurs in the strongly faulted area of the San Rafael Swell.

## HYDROLOGY

### Summary statement

Water available to the lower Dirty Devil River basin area is derived from precipitation on the basin, surface-water inflow from the upper Fremont River valley and upper Muddy Creek basin, and from subsurface ground-water

inflow. Discharge from the area is principally by surface-water outflow in the Dirty Devil River, by evapotranspiration from the area, and by subsurface ground-water outflow. Table 3 lists the estimated gross quantities of inflow and outflow.

Table 3.--Summary of hydrologic estimates

| Total hydrologic system | Long-term average (acre-feet per year) |
|---|---|
| Inflow | |
| Precipitation (p. 25) | 1,550,000 |
| Fremont River near Bicknell (p. 27) | 65,060 |
| Muddy Creek below I-70 (p. 27) | 10,720 |
| Ground-water inflow, minimum (from below) | 300 |
| Total (rounded) | 1,600,000 |
| Outflow | |
| Dirty Devil River (p. 28) | 68,760 |
| Ground-water outflow, minimum (from below) | 1,500 |
| Discharge by wells, probable maximum (p. 36) | 1,000 |
| Evapotranspiration | |
| Consumption of ground water (p. 45) | 30,000 |
| Consumption of precipitation and streamflow | [1]1,520,000 |
| Total (rounded) | 1,600,000 |
| **Ground-water system[2]** | **Acre feet** |
| Storage in three major consolidated aquifers | |
| Total (rounded) (p. 36) | 550,000,000 |
| Recoverable fresh to moderately saline water | [3]210,000,000 |
| Navajo Sandstone[4] | |
| Recharge | Acre-feet per year |
| From precipitation and streamflow | 4,700 |
| Ground-water inflow | 300 |
| Total | 5,000 |
| Discharge (p. 37-43) | |
| To Dirty Devil River and (?) Green River | 2,100 |
| Caine Springs and minor seeps | 1,400 |
| Ground-water outflow down Henry Mountain basin | 1,500 |
| Total | 5,000 |

[1]Amount calculated by difference between other individual items of inflow and outflow.

[2]No budget developed for total ground-water system because of unknowns.

[3]Assumes complete drainage of Navajo, Wingate, and Coconino Sandstones.

[4]Amount for each item as used in steady-state digital model for best fit of potentiometric surface west of Muddy Creek and Dirty Devil River.

## Precipitation

The average annual volume of precipitation on the lower Dirty Devil River basin during the period 1931-60 is estimated to be 1.55 million acre-ft (1,910 $hm^3$) as shown in table 4. The average for the 3,200-$mi^2$ (8,290-$km^2$) area is 9.1 in. (231 mm). Nearly all precipitation on the area is consumed within the area. The precipitation generally contains less than 20 mg/L of dissolved solids, as indicated by the analyses given in Feth, Rogers, and Roberson (1964, p. J14-J15).

## Surface water

The Dirty Devil River drains an area of about 4,360 $mi^2$ (11,290 $km^2$) of which about 3,200 $mi^2$ (8,290 $km^2$) is in the study area. The river receives the discharge of the Fremont River and Muddy Creek. Streams that drain to the San Rafael River northeast of Hanksville are ephemeral. The records for gaging stations through 1970 are illustrated by Covington and Williams (1972b), and the gaging-station sites (pl. 1) are given in the following table, together with the station numbers, names, and the periods of record. (See also U.S. Geological Survey, 1954, 1964, 1970, 1971-77, 1973.) Both the Fremont River and Muddy Creek derive their flow mainly from snowmelt and spring discharge in the mountains west and northwest of the area shown on plate 1.

| Station number | Station name | Period of record |
|---|---|---|
| 3300 | Fremont River near Bicknell (Thurber) | 1909-12, 1937-58, 1976-78 |
| 3302.1 | Pleasant Creek near Caineville | 1969-72 |
| 3302.3 | Fremont River near Caineville | 1967-78 |
| 3321 | Muddy Creek below Interstate Highway I-70, near Emery[1] | 1973-78 |
| 3325 | Muddy Creek below Ivie Creek, near Emery | 1950-61 |
| 3327 | Muddy Creek at Delta Mine, near Hanksville | 1975-78 |
| 3328 | Muddy Creek at mouth, near Hanksville | 1975-78 |
| 3330 | Dirty Devil River near Hanksville | 1945-48 |
| 3335 | Dirty Devil River above Poison Spring Wash, near Hanksville | 1964-78 |
| | Dirty Devil River near Hite[2] | 1948-64 |

[1]See prior record for nearby station 3325 which is not shown on plate 1.
[2]Station near Hite was moved 28 miles upstream to site above Poison Spring Wash on July 15, 1964, when first site was inundated by rising reservoir water. Record for Dirty Devil River considered poor because of shifting sand bed.

Within the study area important perennial streams include Oak, Pleasant, and Sulphur Creeks--all tributary to the Fremont River. Much of the flow from these smaller streams is diverted for irrigation and consumed. Several small

**Table 4.—Estimated average annual volumes of precipitation and ground-water recharge from precipitation (1931-60)**

Area: From planimeter survey of isohyetal map by Covington and Williams (1972a).
Estimated ground-water recharge: Based on method of Hood and Waddell (1968, p. 22-23).

| Precipitation zone (inches) | Area (acres) | Estimated average precipitation | | Estimated ground-water recharge | |
|---|---|---|---|---|---|
| | | Feet | Acre-feet | Percent of precipitation | Acre-feet |
| Less than 6 | 34,200 | 0.46 | 15,700 | 0 | 0 |
| 6-8 | 1,065,300 | .58 | 618,000 | 0 | 0 |
| More than 8 (less than 10) | 24,500 | .68 | 16,700 | 0 | 0 |
| 8-10 | 420,900 | .72 | 303,000 | 0 | 0 |
| More than 10 (less than 12) | 8,500 | .84 | 7,100 | 0 | 0 |
| 10-12 | 188,000 | .88 | 165,000 | .5 | 830 |
| More than 12 (less than 16) | 5,400 | 1.02 | 5,500 | .5 | 30 |
| 12-16 | 172,300 | 1.12 | 193,000 | 1 | 1,930 |
| 16-20 | 63,300 | 1.46 | 92,400 | 5 | 4,620 |
| 20-25 | 26,800 | 1.79 | 48,000 | 15 | 7,200 |
| 25-30 | 22,300 | 2.19 | 48,800 | 20 | 9,800 |
| More than 30 | 15,400 | 2.54 | 39,100 | 25 | 9,800 |
| Totals (rounded) | 2,050,000 or 3,203 $mi^2$ | | 1,550,000 | | 34,000 or 47 $ft^3/s$ |

streams in the Henry Mountains are perennial in their upper reaches (Goode and Olson, 1977, p. 27) but are intermittent or ephemeral in their lower reaches. All minor streams at lower altitudes are ephemeral except lower Salt Wash, which receives perennial flow from Caine Springs.

## Fremont River

The Fremont River heads in the mountains west of the area shown on plate 1. Upstream from the study area, the stream is regulated and much of the water is diverted to irrigated lands. (See Bjorklund, 1969, p. 16-18.) Unused streamflow, irrigation return flow, and the discharge from seeps and some large springs flow from the upper valley past Bicknell into the study area. This inflow is gaged at gaging station 3300, and averaged 65,060 acre-ft (80 $hm^3$) per year for 22 years of record (U.S. Geol. Survey, 1977, p. 202).

Sulphur Creek heads on Thousand Lake Mountain northwest of Fruita, where average annual precipitation exceeds 30 in. (762 mm). The stream is ungaged, but at Fruita, downstream from several diversions, the flow (into the Fremont River) is estimated to average about 4,000 acre-ft (4.9 $hm^3$) per year.

Pleasant and Oak Creeks head on Boulder Mountain southwest of Fruita, where precipitation exceeds 30 in. (762 mm) per year. Discharge of these streams is relatively consistent due to permeable soils and good vegetative cover in the watershed. Oak Creek generally contributes little directly to the flow of the Fremont River because most of its flow is diverted for irrigation where that stream joins Sandy Creek. An alloted 6.3 $ft^3/s$ (0.18 $m^3/s$) of water is diverted from Pleasant Creek for irrigation at Notom. Flows in excess of this allotment enter the Fremont River just below station 3302.1. During water years 1970-72, the average at station 3302.1 was 2,300 acre-ft (2.8 $hm^3$) per year.

## Muddy Creek

Muddy Creek heads on the Wasatch Plateau northwest of Emery (fig. 1), and enters the study area at station 3321 (pl. 1). Upstream from station 3321, water is diverted from Muddy Creek for irrigation, and much of the time the flow at the station (which replaced station 3325) is return from irrigation; this flow is periodically combined with ephemeral flows (chiefly stream runoff) that can be large. During the 15 years of records between 1950-76, the annual discharge at station 3321 averaged 10,720 acre-ft (13 $hm^3$). (See U.S. Geological Survey, 1977, p. 207.)

The only perennial tributary to Muddy Creek in the study area is Salt Wash, the flow of which heads at Caine Springs. Based on a few miscellaneous measurements (table 5), the average discharge from the springs is only about 2 $ft^3/s$ (0.057 $m^3/s$) or about 1,400 acre-ft (1.7 $hm^3$) per year. The flow in Salt Wash apparently varies with the fluctuation of springflow as noted on page 37.

Muddy Creek between stations 3321 and 3328 at the mouth loses a substantial but unknown amount of water to evapotranspiration and possibly to localized seepage loss. At times the creek goes dry between Salt Wash and the mouth indicating a minimum loss (chiefly to evapotranspiration) of at least 2 $ft^3/s$ (0.057 $m^3/s$). Because of these losses, it is estimated that the normal

discharge at short-term station 3328 would be no more than about 20 $ft^3/s$ (0.57 $m^3/s$), but considering that the creek has a drainage area of 1,552 $mi^2$ (4,020 $km^2$) and that there are periodic large cloudburst floods, the long-term average discharge may be larger.

### Dirty Devil River

Formed by the union of the Fremont River and Muddy Creek, the Dirty Devil River flows generally southward to the Colorado River (pl. 1). The Dirty Devil River near Hanksville flows most of the year, but it frequently is dry, or nearly so, during summer when irrigation diversions and evapotranspiration consume the water that would otherwise enter this lower reach. Evapotranspiration within this reach during summer removes still more of the flow.

The Dirty Devil River receives little perennial inflow downstream from Hanksville. Only a few small springs, such as Angel Cove Spring (table 7), flow directly into the river. Springflow from Beaver Wash in the summer of 1977 was estimated by D. J. Williamson (oral commun., 1977) to be about 0.5 $ft^3/s$ (0.014 $m^3/s$). Sets of miscellaneous measurements at sites 25 and 26 (pl. 1 and table 5), where the stream crosses the outcrop of the Navajo Sandstone, also indicate little, if any, ground-water seepage to the river from the formation.

Surface outflow from the Dirty Devil River basin is measured at station 3335 (pl. 1). During the 29 years of record, the annual discharge averaged 68,760 acre-ft (84.8 $hm^3$). (See U.S. Geological Survey, 1977, p. 217.) As noted on the table on page 25, the record for the station is poor because of streambed conditions. The record, moreover, represents flow at two different sites which are 28 mi (45 km) apart. The record for 1948-64 is for the station location near the mouth and the record includes a period of about 10 years of drought. The record for 1964-76 is for the upstream site and includes a period that was mainly wet.

Figure 12 shows the relation of streamflow at the two sites for station 3335 to precipitation in and near the drainage basin. The graph indicates that the flow in the 28-mile (45-km) reach may be supplemented by effluent ground water. The slope of the double-mass curve in figure 12 shows that the lower site has a larger discharge for a given amount of precipitation in the drainage basin than the upper site. Moreover, despite the large annual discharges that may have been due to thunderstorm activity, the discharge at the lower site was generally larger than can be accounted for by considering the small drainage area between the two locations--a drainage area of low precipitation and high rates of evaporation.

### Relation of runoff to precipitation

The long-term runoff generated by precipitation on the lower Dirty Devil River basin is lost almost entirely to evapotranspiration and infiltration within the basin. Although substantial quantities of water are discharged from the lower basin during wet periods, all the precipitation on the study area and part of the inflow in Muddy Creek and the Fremont River are lost before reaching the mouth of the Dirty Devil River during dry periods; consequently, long-term net outflow is negligible.

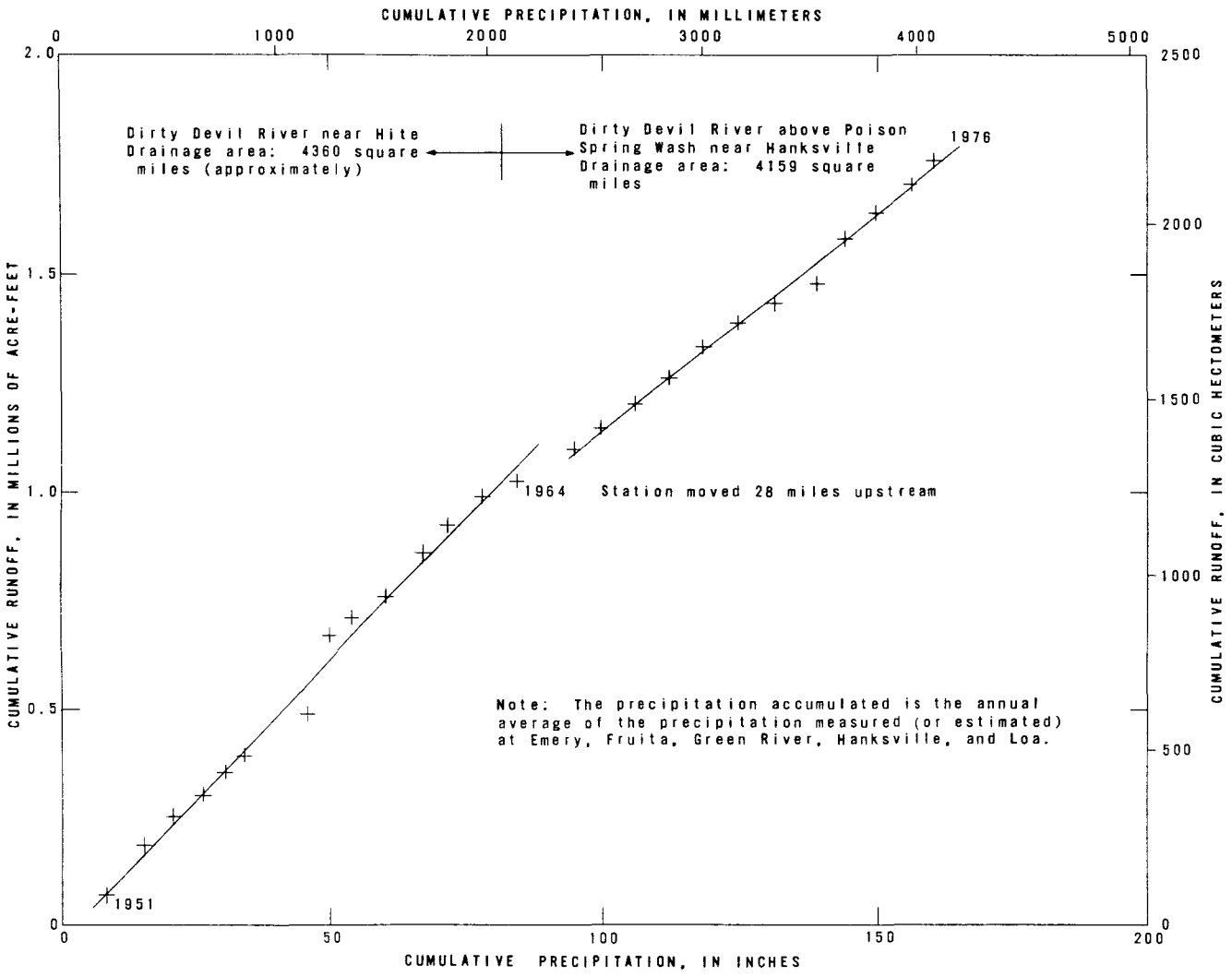



Figure 12.— Runoff at station 3335 versus precipitation in and near the Dirty Devil River basin.

That net long-term runoff from precipitation within the lower Dirty Devil River basin is negligible can be demonstrated in two ways. First, and simplest, is subtraction of the average inflow at stations 3300 and 3321 (or 3325) from the outflow at station 3335 (table 3); a net loss of about 7,000 acre-ft (8.6 $hm^3$) is obtained. This loss is less than 0.5 percent of the 1.55 million acre-ft (1,911 $hm^3$) for the 1931-60 average annual precipitation on the study area. Second is by examining the records of precipitation and streamflow for the period 1951-57, inclusive, for which the records for stations 3300, 3325, and 3335 are directly comparable. The net average annual runoff from the lower Dirty Devil River basin during this 7-year period was about 13,600 acre-ft (16.8 $hm^3$), or a gain amounting to about 0.9 percent of the average annual precipitation. Further confirmation of the relationship of runoff to precipitation has been obtained by relating the net annual runoff to the measured annual precipitation (1951-57) at weather stations that bracket the area. Two moderate-altitude stations, Loa (or Emery) and Fruita, and two low-altitude stations, Green River and Hanksville, were used; the annual precipitation at the four stations was averaged for each of the 7 years and related to the net runoff in the lower Dirty Devil River basin for that year. (See fig. 13.) The relation for the 7-year period shows that runoff from the lower basin will occur only when the four-station annual average precipitation exceeds about 6 in. (152 mm). The relation probably represents the long-term runoff because the 1931-60 average annual precipitation at the four stations was 6.28 in. (160 mm) and the 1951-57 average, coincidentally, was 6.29 in. (160 mm).

## Chemical quality of surface water

The chemical quality of surface water in the Dirty Devil River basin has been described by Mundorff (1979). Water in the Fremont River near Bicknell is fresh and mainly of the calcium bicarbonate type. Below the junction of the Fremont River and Sulphur Creek, the river water is also fresh, but it acquires additional dissolved solids in which the sulfate ion increases the most. Downstream, the mineral content varies seasonally depending on the rate of streamflow, but at the larger rates of flow--on the order of 100 $ft^3/s$ (2.8 $m^3/s$)--the river water generally is fresh to slightly saline, despite saline inflow from tributaries.

Muddy Creek at station 3321, where the stream enters the study area, is a slightly to moderately saline water of a mixed type in which the dominant anion is sulfate. The water passing this site has been degraded in quality by the effects of irrigation upstream from the site. Downstream, the chemical quality of Muddy Creek degrades because of evapotranspiration, solution of minerals from the fluvial sediment generated from such formations as the Moenkopi Formation, and inflow of mineralized ground water, the principal source of which is Caine Springs. Within the San Rafael Swell, the streamflow is a moderately saline water, in which sodium and sulfate are the dominant ions. This type of water persists to the mouth where Muddy Creek joins the Fremont River.

Water in streams tributary to the Fremont River mainly is fresh in headwater areas (Mundorff, 1979, table 1; Goode and Olson, 1977, tables 5 and 7), but where such streams as Pleasant Creek pass through lower areas before joining the Fremont River, the water gains in mineral content mainly because of evapotranspiration and solution of mineral constituents from fluvial

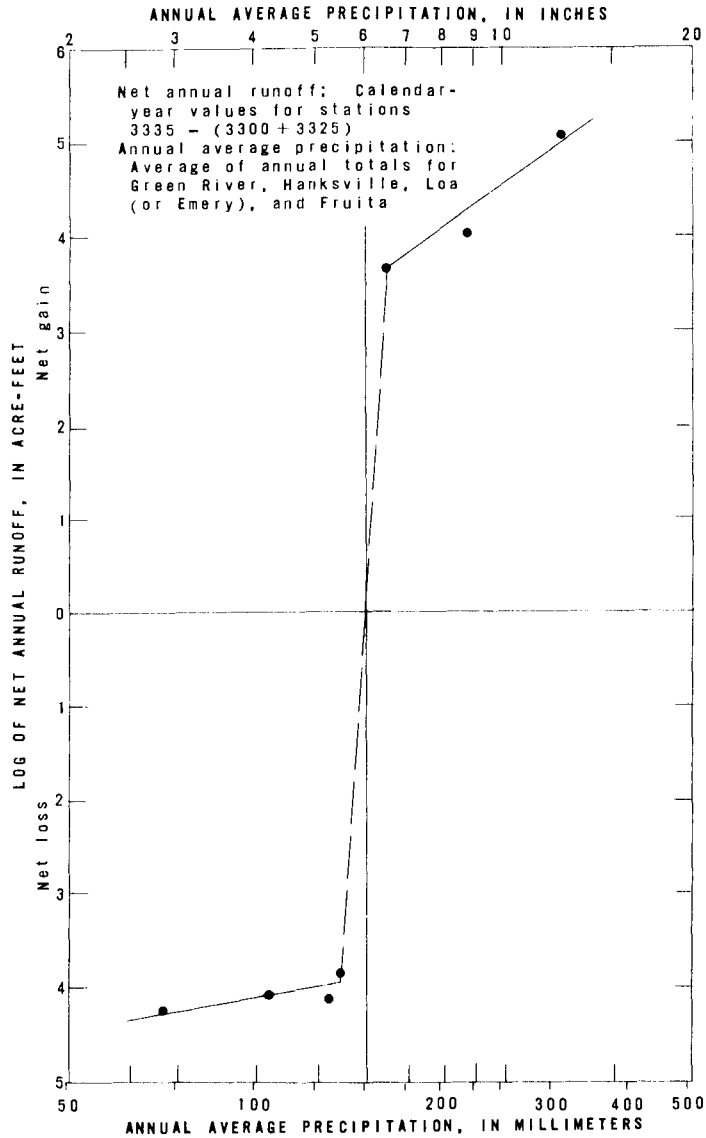



Figure 13.— Relation of net runoff to precipitation, 1951-57.

sediment. Some intermittent and ephemeral streams, such as Caineville Wash, contain accumulations of salt in their channels deposited by previous flows or evaporating ground water. Those streams contribute relatively small quantities of water, but most frequently when thunderstorm runoff occurs, the water is saline because of the re-solution of accumulated salts in the streambeds.

The chemical quality of streamflow leaving the study area is indicated by the record for station 3335 on the Dirty Devil River. Although the dissolved-solids concentration at this station ranges widely during the year, the water generally is slightly saline.

The chemical quality of water in the fall of 1975 at sites where Muddy Creek and the Fremont River enter the study area and the Dirty Devil River leaves the area is shown in plate 4 for comparison with the chemical quality of water in the Navajo Sandstone. (See discussion on p. 45.)

## Ground water

### Recharge

Ground-water recharge in the study area is principally from precipitation that falls within the area. A small but unknown amount of recharge results from stream inflow to the area. Also, relatively small quantities of recharge may occur where ground water flows into the area, principally along the strike of fractured beds in the western San Rafael Swell and west of the swell. Streamflow is a source of recharge where streams, principally the perennial tributaries of the Fremont River, cross outcrops of permeable rock where the ground-water level is below the streambed. Recharge is induced from the lower Muddy Creek and the Fremont River where locally dense stands of phreatophytes grow and consume the induced recharge.

The gross volume of recharge from precipitation in the lower Dirty Devil River basin area (pl. 1) is estimated to be 34,000 acre-ft (42 $hm^3$) per year. (See table 4.) This figure is based on the method of Hood and Waddell (1968, p. 22-23), which assumes that a fixed percentage of the average annual precipitation becomes ground-water recharge, taking into account such factors as local geology and physiography and the volume, time, and area of distribution of precipitation. The volume estimated includes not only direct recharge from precipitation but recharge from streamflow originating within the area.

Most recharge occurs during the snowmelt season of spring, and some recharge may occur during winter in the lower areas where the ground is not frozen. Some recharge occurs in summer along the Fremont River, possibly along upper Muddy Creek, along Pleasant and Oak Creeks, and the small perennial streams, such as Bull Creek on the flanks of the Henry Mountains.

Most of the ground-water recharge enters the system in the mountains where direct precipitation is greatest and where the mantle of colluvium and streambed alluvium maintains a saturated zone in contact with the underlying bedrock aquifers. Relatively little recharge occurs in the lower part of the area mainly because the rate of evapotranspiration exceeds the lower rates of precipitation and recharge to the bedrock aquifers which are poorly exposed or are steeply sloping (fig. 6). However, in such areas as the San Rafael Desert, where the precipitation is only about 6 in. (152 mm) per year, a small amount of recharge may occur when summer thunderstorms pass over areas covered with dune sand; otherwise, thunderstorms are not effective sources of recharge water because the duration of the storms is short and runoff is rapid.

The Navajo Sandstone receives more of the 34,000 acre-ft (42 $hm^3$) per year of recharge than any other bedrock formation in the study area. The estimated maximum direct recharge to the sandstone aquifer in the study area is 7,000 acre-ft (8.6 $hm^3$) per year, or an average rate of about 9.7 $ft^3/s$ (0.27 $m^3/s$). This figure does not include possible recharge by interformational leakage, such as in local fractured areas on the west flank

of the San Rafael Swell and in Waterpocket Fold, where the basal Carmel Formation probably contributes calcium sulfate laden water (p. 46), and in the Red Desert, where some upward leakage may occur along the Caineville anticline (Hood and Danielson, 1979, p. 34). The figure does include recharge directly from precipitation in the main area of outcrop (pl. 2) and the area of Thousand Lake Mountain, and recharge from perennial streams that cross outcrops of Navajo. Recharge from ephemeral stream channels on the Navajo (fig. 14) is estimated to be little more than that from direct precipitation on the channels.

In the deeply incised canyon of the Fremont River that cuts through the Waterpocket Fold, the Navajo Sandstone discharges some water to and receives recharge from the Fremont River. Miscellaneous streamflow measurements at sites 3, 4, and 5 (pl. 1) near the lower, middle, and upper parts of the sandstone outcrop traversed by the stream were made to define the stream-aquifer relationship. Analysis of the measurements and consideration of the characteristics of the sandstone aquifer indicate a probable net loss from the river to the aquifer of about 1 $ft^3/s$ (0.028 $m^3/s$) during the 2 years of measurements. The loss is a net loss because the water level for test well (D-29-7)15dbd-1 indicates that in the approximate lower third of the reach of the river across the sandstone, the river must be gaining from the aquifer.

The writers believe the present rate of recharge is less than that maximum rate (7,000 acre-ft or 8.6 $hm^3$ per year) cited above. Considering the data given for the Navajo Sandstone in the section on ground-water discharge (p. 37), the average annual recharge during modern time probably has totaled only about 5,000 acre-ft (6.2 $hm^3$). This conclusion is in part confirmed by isotope studies that indicate most of the ground water in the Navajo entered the aquifer 15,000 to 20,000 years ago during Pleistocene time. For the 198 million acre-ft (240,000 $hm^3$) stored in the formation (p. 36), this age indicates that an average annual rate of recharge of 9,900 to 13,200 acre-ft (12-16 $hm^3$) would be required to move the older water to the sampling points. Because more recharge water was available during the Pleistocene Epoch, the present rate should be less than the maximum 7,000 acre-ft (8.6 $hm^3$) per year cited above.

## Occurrence and movement

Ground water in the study area occurs under confined, perched, and unconfined conditions; each of these conditions has special significance in several areas. Ground water in the consolidated rocks is unconfined in and near outcrop areas along the Dirty Devil and Green Rivers, in and near the San Rafael Swell, and in and near the Henry Mountains and the mountains along the western edge of the study area. Downgradient from these outcrop areas, the water level intersects the bottoms of overlying confining beds, and beyond, the ground water becomes confined. The largest confining artesian pressure found in the study area is in the Navajo Sandstone at well (D-28-8)33cdd-1S (table 6), in which the static water level was 183.5 ft (55.9 m) above land surface.

Water in several aquifers differs in occurrence at any given site due to differences in recharge and permeability. For example, the Navajo Sandstone is drained or is partly saturated over a broad area between the Dirty Devil and Green Rivers because of its relatively higher permeability and because

Figure 14.—View of south wall of Fremont River canyon at about NE¼NW¼ sec. 20, T. 29 S., R. 7 E., showing ephemeral flow from side canyon developed along joint in Navajo Sandstone. Flow occurred immediately after a thunderstorm. The storm water on outcrop of very low permeability provided little, if any, recharge, but concentrated flow in the canyon may have provided some recharge. Waterfall is approximately 30 feet (9 m) high.

recharge to the Navajo there occurs mainly as small amounts of downward leakage from the overlying rocks. In the same area, ground water in the overlying Carmel Formation and Entrada Sandstone is perched and yields water to springs and shallow wells.

Perched conditions also occur locally in the Salt Wash Sandstone Member of the Morrison Formation, which yields flowing artesian water to (D-28-7)36bbb-1; the water is perched with respect to that in the Navajo Sandstone. (See Hood and Danielson, 1979, p 34.)

Most ground water in the unconsolidated rocks is unconfined. Confined conditions occur only along parts of the flood plain of the lower Fremont River where fine-grained alluvium overlies deeper coarse-grained alluvium.

Ground water moves downgradient from recharge areas to discharge areas chiefly along paths of greatest transmissivity. The direction of movement is generally depicted by maps of the potentiometric surface. For most of the formations listed in table 1, there are insufficient data to construct potentiometric-surface maps. The study area, however, is a part of the regional study by Hanshaw and Hill (1969, p. 267-280), who used petroleum-test data to show the gross features of the potentiometric surfaces in Paleozoic aquifers. The maps they constructed (Hanshaw and Hill, 1969, figs. 2 and 6-8) indicate that ground water west of the Green River moves generally southward from areas north and northwest of the San Rafael Swell, past the swell and Henry Mountains, whence Permian and Upper Pennsylvanian rocks apparently discharge the water southeastward to the Colorado River south of the area described in this report. Ground water in the Mississippian rocks, for the most part, moves from the Henry Mountains area southwestward parallel to the Colorado River and toward distant areas of discharge.

Of the younger aquifers, a potentiometric-surface map is provided only for the Navajo Sandstone as shown on plate 4 of this report; however, it can be assumed that the potentiometric surface for the Wingate Sandstone is similar because the two formations share common areas of general outcrop and similar structural distortion.

The potentiometric-surface map for the Navajo Sandstone (pl. 4) shows that ground water moves from the Thousand Lake Mountain-Waterpocket Fold area both eastward toward the canyon of the Dirty Devil River and southward along the axis of the Henry Mountain structural basin. Based largely on widely scattered, reported data and on the inference of little or no recharge to the sandstone aquifer along the San Rafael Swell, it can be inferred that some water entering the aquifer ultimately moves east-northeastward to the Green River.

Fragmentary water-level data for aquifers younger than the Navajo Sandstone show that ground-water movement in them is largely from their local outcrops to the nearest lower drainage that is cut into them. Water levels in the Entrada Sandstone near Hanksville have been changed by the long period of small withdrawals from the several domestic wells in the area. Based on the few water levels for wells in the Entrada, it can be inferred that in most of the area where the Entrada underlies the pediments north and east of the Dirty Devil River, ground water moves downdip to the nearest incised drainage. At Hanksville, however, the occurrence of freshwater in the Entrada is an areal anomaly which indicates direction of movement. At this location, the Entrada dips westward from outcrops along the Dirty Devil River canyon and is interrupted by faults north of the town. Water in the formation is freshest near the center and eastern part of the town and becomes more saline westward. The relation of water-level altitude, chemical quality of water, and formation dip lead to the conclusion that freshwater is moving to the Hanksville area from the south and probably from the southeast, thus indicating that recharge to the sandstone aquifer is from (1) the accumulation of a small amount of recharge from the dune-covered area on the higher land east and southeast of town, or (2) infiltration of streamflow in and downstream from the Henry

Mountains with subsequent movement along the formation strike, or (3) upward leakage of freshwater from the Navajo at or south of the town site. The latter is least probable; the occurrence is probably a combination of the first two. The freshwater moves from the Hanksville area toward the Dirty Devil River which has incised the Entrada northeast of the town.

## Storage

Estimates of ground-water storage are made only for the Navajo Sandstone, the Wingate Sandstone, and the Coconino Sandstone, including its lateral facies equivalents. The estimates for the Wingate and Coconino are based on their thicknesses (from data in table 8) as approximate percentages of the thickness of the Navajo on an areawide basis. The estimates for all three geologic units are as follows:

| Formation | Average thickness (feet) | Area (square miles) | Estimated effective porosity (percent) | Volume of ground water in transient storage (millions of acre-feet) | Assumed specific yield (percent) | Recoverable water in transient storage, assuming complete drainage (millions of acre-feet) |
|---|---|---|---|---|---|---|
| Navajo Sandstone | 800 | 2,580 | 20 | 198[1] | 9 | 89 |
| Wingate Sandstone | 400 | 2,200 | 20 | 110 | 5 | 28 |
| Coconino Sandstone | 700 | 2,700 | 20 | 240 | 8 | 98 |
| Totals (rounded) | | | | 550 | | 210 |

[1] An estimated 75 percent of the sandstone within the area is saturated.

The three sandstone aquifers, thus, contain about 200 million acre-ft (246,600 $hm^3$) of water that could be recovered if the aquifers could be completely drained. This figure is an upper limit to development of the aquifers because complete drainage could never be achieved.

The volume of water stored in the Emery, Ferron, and Sandstone Members, Salt Wash, Entrada Sandstone, and rocks of Mississippian age cannot be estimated from the available data, but it is probable that the total volume is considerably less than that stored in the Navajo, Wingate, and Coconino Sandstones.

The ground-water system in the lower Dirty Devil River basin area is almost unaffected by development. Other than the concentration of small domestic wells in Hanksville that withdraw water from the Entrada Sandstone and well (D-31-7)36dad-1S, a single irrigation well (table 6) in the Navajo Sandstone, withdrawals from wells are limited to a few widely scattered low-yield stock and domestic wells each finished in at least one of six aquifers. The estimated pumpage from the entire ground-water system in 1977 probably did not exceed 1,000 acre-ft (1.2 $hm^3$), and the withdrawal therefore, for practical purposes, did not change the volume of ground water in storage.

Most of the water-level changes in wells in the study area are due to small natural changes in storage. Figures 15 and 16 show the fluctuations of water levels in selected observation wells and figure 15 shows the cumulative

departures from average annual precipitation at the three weather stations in the study area, together with brief explanations of the causes of fluctuations. Water-level records from all observation wells in the study area are given in table 9.

Indirect information on water-level change also is provided by the fluctuation of discharge (fig. 17) from the Caine Springs. The perennial spring area (fig. 18 and table 7) rises along fractures in the crest of an anticline (pl. 2); although the surface source is the Carmel Formation, chemical quality of the springflow and the potentiometric surface in the general area indicate that at least part of the spring water is derived from the Navajo Sandstone by upward leakage.

## Discharge

Ground-water discharge in the study area equals the estimated ground-water recharge for that area (table 4). The discharge consists of discharge to streams, outflow in bedrock aquifers, evapotranspiration, and the small amount of pumpage noted in the section on storage. None of the means of discharge can be precisely quantified, but evapotranspiration is the largest.

### Navajo Sandstone

Discharge from the Navajo Sandstone occurs principally in two areas--to the surface in the Dirty Devil River and by subsurface outflow down the Henry Mountains structural basin (pl. 2) as shown by the potentiometric-surface contours on plate 4. A small amount of water may move northeastward toward the Green River. Discharge by upward leakage is assumed only at Caine Springs.

Two estimates of discharge were made based on values for hydraulic conductivity (K) derived from study of the Navajo Sandstone near Caineville--0.5 ft/d (0.15 m/d) and 1.7 ft/d (0.52 m/d). For the area at the Dirty Devil River canyon the flow of water across the 4,400-ft (1,340-m) potentiometric-surface contour was calculated using estimated slopes of the potentiometric surface, values for transmissivity (T) derived from the assumed values for K, and the saturated thickness of the sandstone as estimated from data in figures 3, 4, and 6. For calculations of the flow through the Henry Mountain structural basin, the same values of K and means of deriving values for T were used. A potentiometric slope of 30 ft/mi (5.7 m/km) was used, based on a few water levels in wells 15-20 mi (24-32 km) southeast of the study-area boundary. The width of the section in the structural basin is about 14 mi (22.5 km). The sum of these two values were then compared with the flow across the 5,000-ft (1,524-m) potentiometric-surface contour (pl. 4), again using the same values for K and means of deriving T. The results are summarized in the following table.

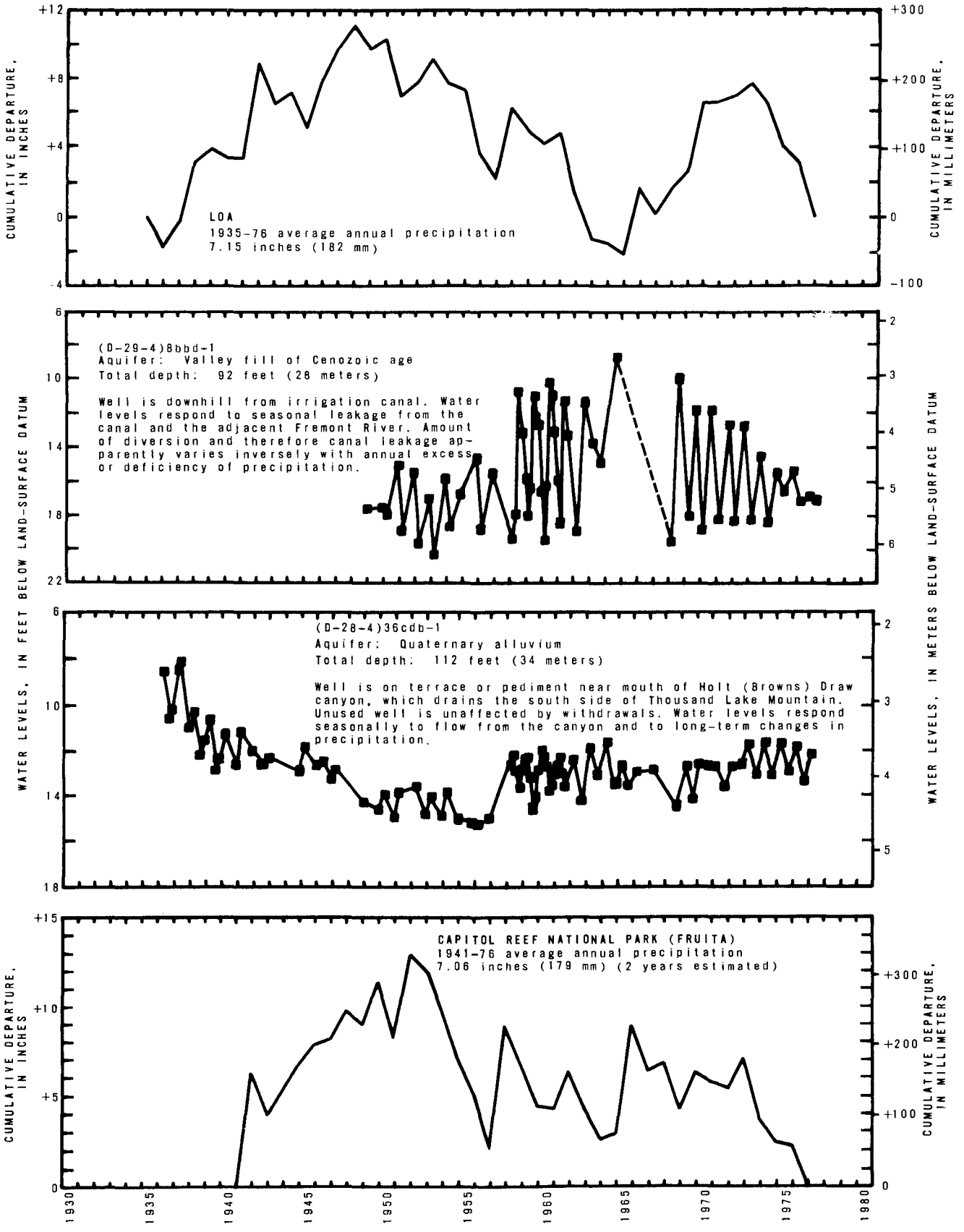



Figure 15.— Water levels in selected observation wells and cumulative departure from average annual precipitation at Loa, Capitol Reef National Park, and Hanksville.

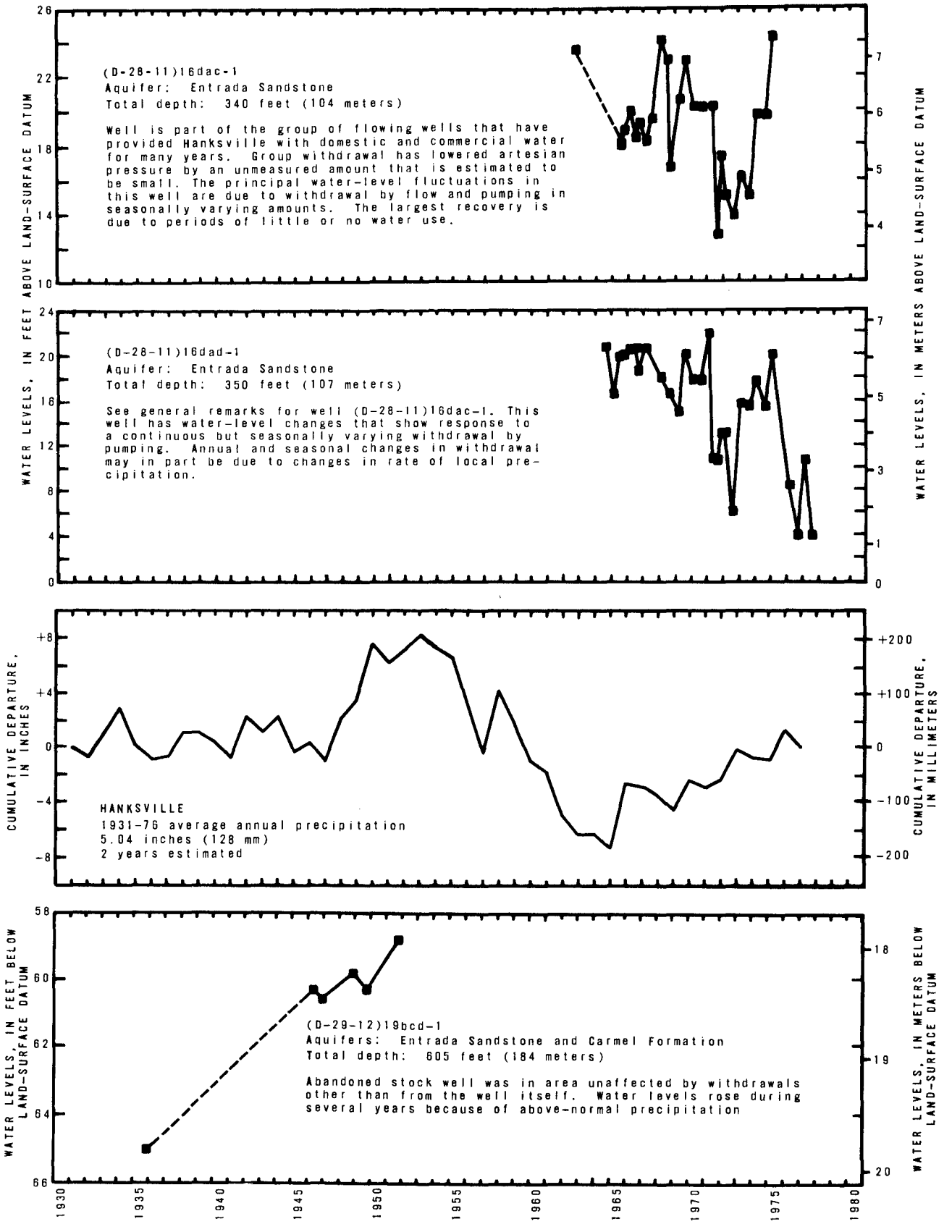



Figure 15.— Continued.

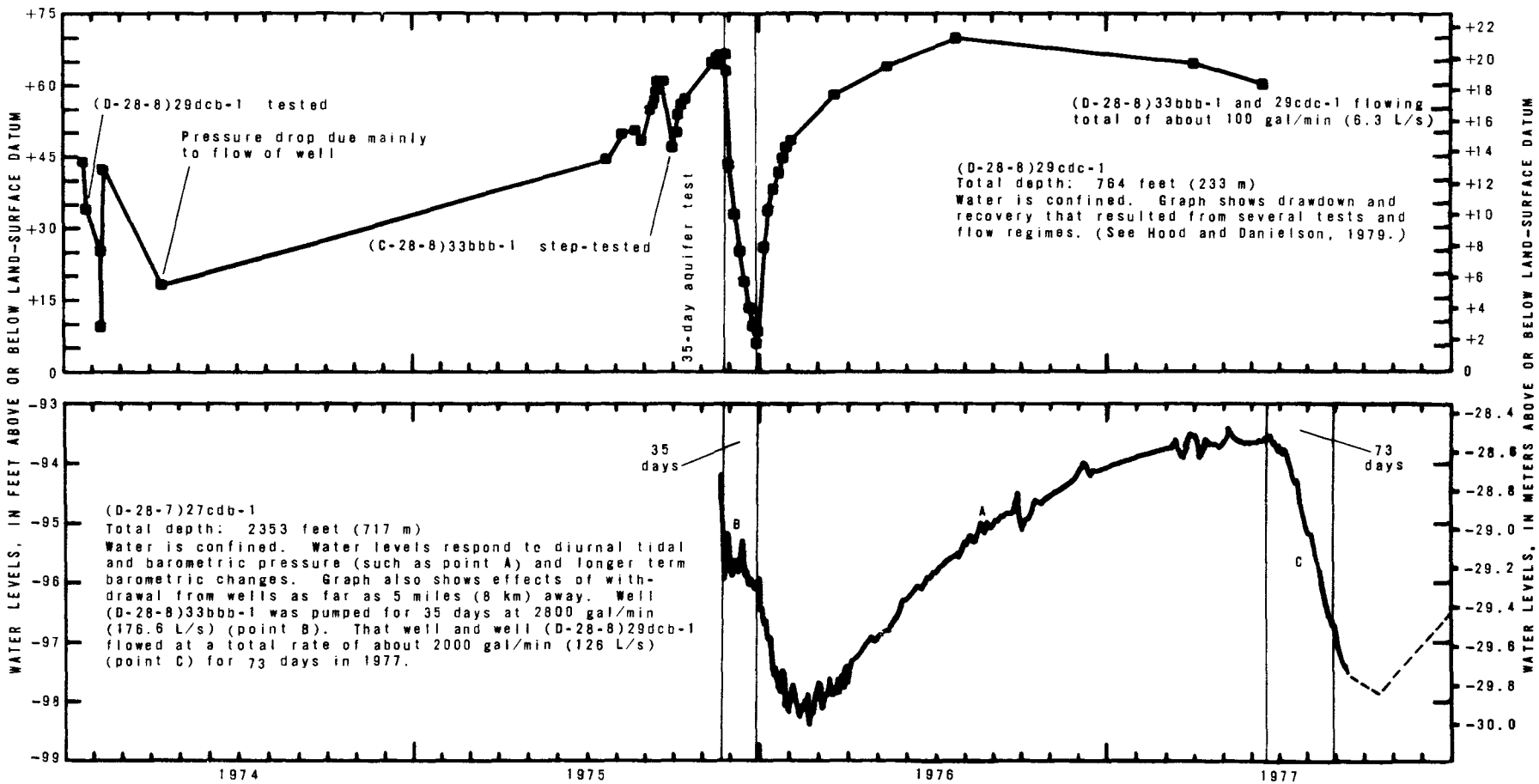



Figure 16.— Water levels in two wells finished in the Navajo Sandstone near Caineville, 1974-77.

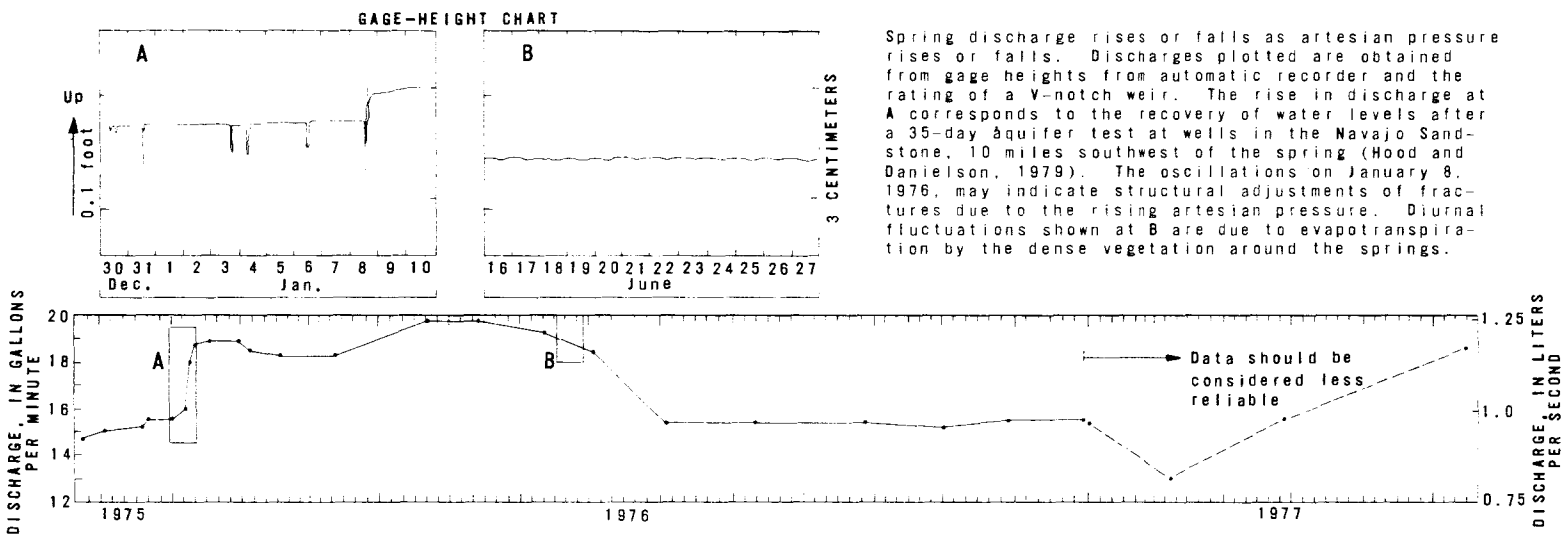


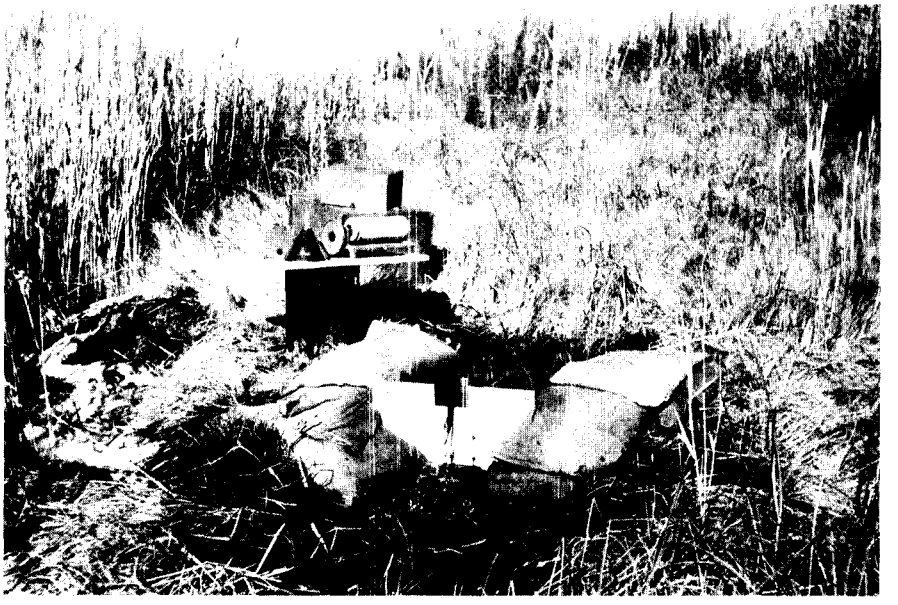

Figure 17.—Discharge of spring (D-27-8)12cca-S1, one of the Caine Springs.

A. Aerial view westward of the Caine Springs in the northeastern part of T. 27 S., R. 8 E., shows barren, dissected slopes of the Carmel Formation (C) and terrace deposits (T) along Salt Wash. The only dense vegetation is where springflow provides water. The springs are the head of perennial flow in Salt Wash, and they discharge about 2 $ft^3/s$ (0.057 $m^3/s$). Arrow indicates approximate location of gage for recording discharge of spring (D-27-8)12cca-S1.

Figure 18.—Photographs

| Area | Assumed hydraulic conductivity (ft/d) 0.5 | | 1.7 | |
|---|---|---|---|---|
| | ($ft^3/s$) | (acre-ft/yr) | ($ft^3/s$) | (acre-ft/yr) |
| Outflow: | | | | |
| Dirty Devil River canyon | 2.6 | 1,900 | 9.2 | 6,600 |
| Henry Mountain basin | 2.3 | 1,700 | 7.9 | 5,700 |
| Totals (rounded) | 4.7 | 3,600 | 17.0 | 12,300 |
| Flow across 5,000-ft potentiometric-surface contour | 4.8 | 3,500 | 16.0 | 11,600 |

The data in the table above raise the question of which value for K is most nearly correct. This can be partly evaluated from the gaged streamflow in the Dirty Devil River canyon at sites 25 and 26. (See table 5.) The reach of the river between the two sites is about 7.1 river miles (11.4 km) and amounts to the lower 70 percent of the 9.8 mi (15.8 km) of the channel that



B. Gage for recording gage height of pond behind V-notch weir below spring (D-27-8)12cca-S1. Dense grasses and hydrophytes grow in boglike peaty deposits in spring area. Discharge of spring was 17 gal/min (1.1 L/s) on November 21, 1975. (See fig. 17 and table 13.)

of the Caine Springs area.

crosses the outcrop of the Navajo Sandstone. Miscellaneous pairs of measurements in 2 consecutive years (table 5) show no significant gain in river flow across the outcrop. The larger calculated value for ground-water discharge to Dirty Devil River canyon, 9.2 $ft^3/s$ (0.26 $m^3/s$), is about 50 percent of the river flow measured on September 21, 1976. If that amount actually entered the Dirty Devil River, it would have been readily apparent in the September 21 measurement. After deducting the known springflow to the river in the reach, the smaller value of about 2 $ft^3/s$ (0.057 $m^3/s$) is near the probable gaging error. After allowing for some evaporation on the outcrop and from the river, it is probable that the smaller value for discharge from the Navajo, thus, went undetected.

Utilizing the digital model, the best fit to measured potentiometric-surface data for the area west of Muddy Creek and the Dirty Devil River was obtained by using the value K = 1 ft/d (0.3 m/d) and a flux of 7.2 $ft^3/s$ (0.2 $m^3/s$), including the smaller discharge noted in the table above, plus approximately 0.5 $ft^3/s$ (0.014 $m^3/s$) to the Green River near the mouth of the San Rafael River and 2 $ft^3/s$ (0.057 $m^3/s$) at Caine Springs. Thus, the discharge from the Navajo Sandstone in the lower Dirty Devil River basin area is estimated to be about 5,000 acre-ft (6.2 $hm^3$) per year.

## Other consolidated rocks

Discharge of ground water from the other consolidated rocks could not be calculated. However, the rocks younger than the Entrada Sandstone discharge mainly in the study area; a part of the water in the Ferron Sandstone Member of the Mancos Shale probably flows out of the area and down the Henry Mountain structural basin. Ground water in the Entrada and Carmel Formations discharges locally within the study area and in the same principal discharge areas as those described for the Navajo Sandstone. Rocks from the Kayenta Formation down to the Cedar Mesa Sandstone Member of the Cutler Formation also discharge to the canyon of the Dirty Devil River and down the Henry Mountain structural basin. Circulation in the latter area is confirmed by the occurrence of fresh to slightly saline water in petroleum-test wells in the structural basin as far south as 15-20 mi (24-32 km) from the southern border of the study area.

## Evapotranspiration

Evapotranspiration consumes an estimated minimum 30,000 acre-ft (37 $hm^3$) of ground water annually. Most of the evapotranspiration occurs in the bottom lands of the Fremont River and Muddy Creek, and the lower reaches of the larger north flowing tributaries from Dry Valley Wash on the east to Sandy Creek on the west along the Waterpocket Fold. These areas are classified as a greasewood community by Hackman (1973) and are in an area where the growing season ranges from about 140 to more than 180 days per year (Covington, 1972). The area of greasewood (*Sarcobatus vermiculatus*) as shown by Hackman includes about 52,000 acres (21,000 $hm^2$). The area also contains saltcedar (*Tamarix gallica*) and cottonwood (*Populus fremontii*), as well as areas of smaller phreatophytes. Saltcedar grows in sparse to locally dense stands at the edges of perennial channels and in cutoff meanders; cottonwood and greasewood generally grow on the adjacent terraces. At well (D-28-10)22abc-1, scattered healthy greasewood, 3 to 5 ft (0.9 to 1.5 m) high, cover the terrace above the Fremont River, where the minimum depth to water is about 12 ft (3.7 m); evapotranspiration lowers the water level in the well about 1 ft (0.3 m) during the growing season. (See table 9.) In these low areas along the Fremont River and Muddy Creek, the rate of evapotranspiration exceeds the equivalent annual consumptive use of alfalfa (*Medicago sativa*) as calculated from data in Criddle, Harris, and Willardson (1962, p. 12, 41) and may be, at maximum, 5 ft (1.5 m).

In addition to the areas along the streams, there are numerous but small areas (not mapped by Hackman) ranging in size from a few square yards as at Willow Seep, (D-28-8)5abd-S1, to several acres as at Caine Springs. (See fig. 18.) Characteristically, such areas as Willow Seep exhibit a patch of bright green wiregrass (*Juncus* sp.), a dense growth of saltcedar, or perhaps a single cottonwood, with only moist saline soil during the summer. With the first freeze of the year, the area then begins to discharge a small amount of water. These small areas aggregate an estimated 8,000 acres (3,200 $hm^2$), and combined with the area mapped by Hackman give a total area of about 60,000 acres (24,300 $hm^2$) in which the ground-water component of consumptive use is estimated to average about 0.5 ft (0.15 m) per year--that is, 30,000 acre-ft (37 $hm^3$) per year.

The bulk of the lower area consists of barren lands (fig. 19) or those covered with a generally sparse growth of xerophytes (fig. 20). At higher altitudes, vegetation type changes and density increases (figs. 21 and 22), owing to increased precipitation and decreased temperatures. Although there are numerous springs in the mountains, most of the precipitation falling there is consumed at or near the point of fall; most of the springflow ultimately is consumed downstream.

## Chemical quality of ground water

The chemical quality of ground water in the lower Dirty Devil River basin area ranges from fresh to briny. Tables 13 and 14 give chemical analyses of water samples from formations ranging from Devonian to Holocene in age. Table 1 includes brief descriptions of the chemical characteristics of water from several of the formations.

The dissolved-solids concentration of ground water is controlled by a number of factors, including the depth of burial of the aquifer, the distance of the water from the recharge area, the permeability of the rocks, and the amount of easily dissolved minerals in the rocks. Thus, mountain springs,

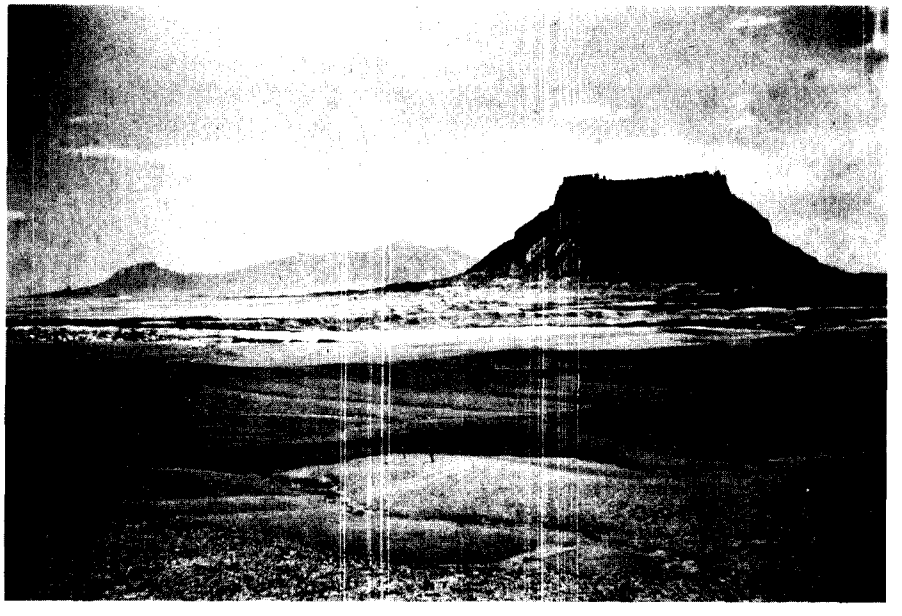


Figure 19.—View southward from near center of sec. 26, T. 26 S., R. 9 E., showing Factory Butte with Henry Mountains in background. The Emery Sandstone Member (E) of the Mancos Shale caps the butte. The Blue Gate Member (BG) and the Tununk Member (foreground) of the Mancos Shale have such low permeability that they reject almost all available water; the shales support no vegetation and their weathered surfaces contribute significantly to the sediment loads of streams.

such as (D-27-4)36cbb-S1, have low dissolved-solids concentrations because they discharge from shallow rocks near or in recharge areas that have been leached and contain mostly minerals of low solubility; conversely, some petroleum-test wells, such as (D-29-15)20add-1, that tap deeply buried aquifers, produce brine or very saline water because of slow circulation over long distances from recharge areas.

The Navajo Sandstone contains water that ranges from fresh to briny and varies in chemical type. Plate 4 shows selected analyses, by means of patterns, which indicate the types of water found in the sandstone aquifer, together with the chemical quality of the inflow and outflow in streams. The figure, when compared to the potentiometric surface (pl. 4), indicates that part of water stored in the northwestern part of the study area is a brine of the sodium chloride type, and that with mixing as the water moves downgradient, the brine is diluted. The brine may be the result of upward leakage, but it is equally possible that it comes from downward leakage from the Carmel Formation. (See description on Carmel Formation, table 1, and the remarks for petroleum-test well (D-25-5)14dbb-2, table 8.) Elsewhere, water in the Navajo, such as at well (D-26-8)6abb-1 and spring (D-29-7)18bdd-S1, is of the calcium sulfate type and probably indicates that small quantities of water leak down from the overlying Carmel Formation, which is rich in gypsum. These occurrences emphasize the fact that some natural interformational leakage must take place, if only in small quantities, because the sandstone aquifer in or near recharge areas contains freshwater. For example, samples

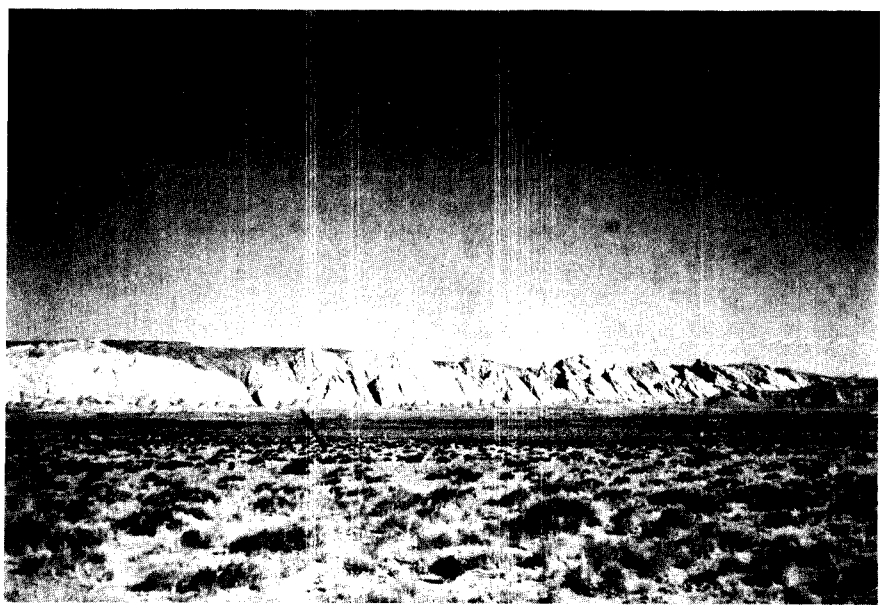


Figure 20.—View west-northwestward from about the SW¼SW¼ sec. 27, T. 25 S., R. 12 E., showing a part of the San Rafael Desert and the southeast side of the San Rafael Swell. Foreground shows stabilized windblown sand with a moderate growth of xerophytes. In the swell, light-colored Navajo Sandstone dips steeply eastward beneath Carmel Formation, the base of which is marked by dark-colored flatirons (arrow).

from well (D-31-7)36dad-1S and spring (D-29-15)14dbb-S1 were fresh and of the calcium magnesium bicarbonate type--a type that would be expected of a formation that contains little readily soluble material and generally has a silica cement.

Water in the Navajo Sandstone seems chemically unrelated to water entering the study area in Muddy Creek, but it may be related to that in the Fremont River. For example, the analysis of the sample from U.S. Geological Survey test hole 4, (D-29-7)15dbd-1, indicates that water in the Navajo there probably is a mixture of the sampled water that discharges at spring (D-29-7)18bdd-S1 and water sampled from the Fremont River at Fruita.

Sampled springs in the canyon of the Dirty Devil River yield calcium bicarbonate type rather than water of the sodium chloride type that moves through the Navajo toward the river north of Hanksville (pl. 4). The water in the river at station 3335 is of the calcium sulfate type and includes ground water discharged from formations that both overlie and underlie the Navajo. From these data, it can be inferred that discharge of water of the sodium chloride type from the Navajo is only localized and small in quantity.

Analyses of water from the Navajo Sandstone were run through the computer program, WATEQ (Truesdell and Jones, 1974), which calculates the equilibrium distribution of inorganic aqueous species of major and important minor elements. For the data available, the calculations show that most of the water in the Navajo Sandstone contains carbonate species, such as calcite

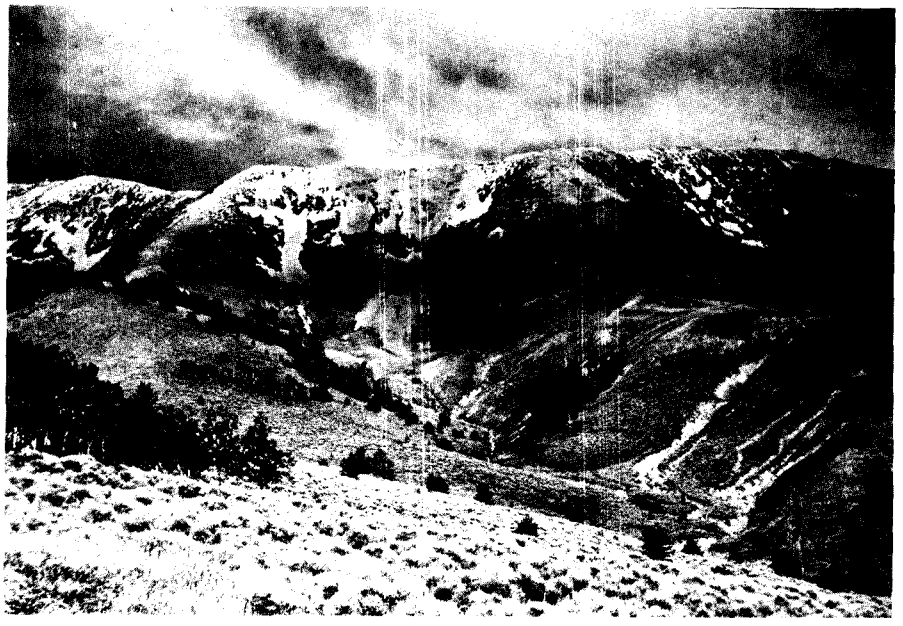


Figure 21.—View of the west flank of Mount Ellen in the Henry Mountains. Talus slopes (T) along flanks of intrusive igneous rock provide good area for local recharge from precipitation, but igneous rock and shale that underlie the area inhibit deep percolation of recharge and promote surface runoff. Vegetative cover is mainly mountain brush.

Figure 22.—View west-northwestward from location NW¼ sec. 25, T. 27 S., R. 7 E., showing Cathedral Valley in the Middle Desert with Thousand Lake Mountain in background. Sparse xerophytic vegetation (dense shadow) on the mountain. The earthy facies of the Entrada Sandstone (E) is preserved where the Summerville Formation (S) has been removed, but a cap of Curtis Formation (C) remains.

and aragonite, and silica at equilibrium; in some samples, sulfate species, such as gypsum, is at or near equilibrium. From this equilibrium condition, it can be inferred that abrupt pressure drops, assuming little or no change in temperature, could cause precipitation of carbonate species, thus reducing aquifer permeability of fractured areas and zones near well faces when large withdrawals are made from wells over a period of years.

## EFFECTS OF LARGE-SCALE WITHDRAWAL OF GROUND WATER

In 1975, the Intermountain Power Project planned to install a coal-fired electric powerplant near Caine Springs. Water for cooling and other purposes was to be obtained from the Fremont River and from the Navajo Sandstone in about equal amounts. Estimated needs ranged from 40,000 to 50,000 acre-ft (49 to 62 $hm^3$) per year; the ground-water component therefore ranged from 20,000 to 25,000 acre-ft (25 to 31 $hm^3$) per year. In 1977, a decision was made to locate the plant outside the study area. However, because there again could be a need for large-scale ground-water withdrawals from the Navajo Sandstone in the same area, a simplified example of pumping effects on the hydrologic system is evaluated below. Calculations were made manually, using the time-drawdown relation described by the Theis non-equilibrium formula (Brown, 1953).

## Basic assumptions

It is assumed that six wells are spaced evenly, 10,000 ft (3,048 m) apart along the crest of the Caineville anticline (pl. 2), and that each well is pumped at 2,000 gal/min (126.2 L/s) for 13,000 days (35.6 years). It is further assumed that interformational leakage is nil, and that the effects of known boundaries at the Waterpocket Fold and San Rafael Swell will be offset by a partial transition from artesian to water-table conditions. For a worst-case example, the assumed hydraulic conductivity is 1.67 ft/d (0.51 m/d); the average areal thickness of the sandstone aquifer is 800 ft (244 m), with an average transmissivity of 1,340 $ft^2/d$ (124 $m^2/d$). The assumed storage coefficient is 0.001.

## Effect on the potentiometric surface and natural discharge

Based on the foregoing assumptions, by the end of the theoretical 35.6-year pumping period, the potentiometric surface would decline over a large area and natural ground-water discharge would be reduced accordingly. The decline would be at least 1,100 ft (335 m) in the center of the well field, and water in the Navajo Sandstone in that area would become unconfined. The decline would be at least 450 ft (137 m) beneath the channel of the Fremont River in Capitol Reef National Park, and that reach would become entirely a losing stream. The decline would be at least 150 ft (46 m) beneath the drainage divide that crosses the Henry Mountain structural basin, thus reducing the southward gradient by at least 30 percent. At Hanksville, the decline would be about 150 ft (46 m), thus reducing the water-level gradient toward the river by about 50 percent. Caine Springs and other smaller seeps would cease flowing because of a decline in the potentiometric surface there amounting to 200 ft (61 m) or more. At test hole (D-27-7)bcc-2, northwest of the hypothetical well field, the decline would amount to at least 250 ft (76 m), and saline water stored in the Navajo in that area would flow toward the well field.

## Change in ground-water storage

The ground water pumped under the assumed regimen would come from (1) storage, (2) induced additional recharge, and (3) the reduction in natural discharge, as follows:

| Item | Probable rate, in cubic feet per second (rounded) | |
|---|---|---|
| | Minimum | Maximum |
| Pumpage (12,000 gal/min) | 27 | 27 |
| Induced additional recharge from Fremont River | -1 | -5 |
| Reduced spring discharge | -3 | -3 |
| Reduced outflow to Dirty Devil River | -1 | -5 |
| Reduced outflow down Henry Mountain structural basin | -1 | -4 |
| Induced interformational leakage from overlying and underlying formations | Unknown | Unknown |
| Change in storage | -21 | -10 |

The figures show that storage changes probably would be in the range of 7,200 to 15,200 acre-ft (8.9 to 18.7 $hm^3$) per year or 256,000 to 541,000 acre-ft (316 to 667 $hm^3$) for the assumed 35.6-year pumping period. The total calculated storage change, thus, amounts to an estimated 0.3 to 0.7 percent of the estimated 89 million acre-ft (110,000 $hm^3$) of recoverable water stored in the Navajo Sandstone.

### Effect on the Colorado River

The effects of pumping under the assumed worst-case regimen would reduce the flow from the Dirty Devil River basin by 5 to 13 $ft^3/s$ (0.14 to 0.37 $m^3/s$) annually or 6 to 14 percent of the long-term average discharge at station 3335. This reduction would be less than 0.1 percent of the average annual flow of the Colorado River as recorded at Hite, Utah (now inundated by Lake Powell). (See station 09335000, in U.S. Geolological Survey, 1964, p. 362.) The reduction in discharge down the Henry Mountain structural basin is not counted, because the most probable discharge point on the Colorado River is at the end of Waterpocket Fold, slightly more than 60 mi (96 km) from the assumed center of pumping. Effects of the assumed pumping would be small at that distance and would not reach the Colorado River (Lake Powell) for many years after the 35.6-year pumping period ended. The effect on Lake Powell or outflow from the Lower Colorado River Basin would be too small to measure.

## FURTHER STUDIES NEEDED

In 1978, the amount of ground-water data available on the Navajo Sandstone in the study area was small, even though detailed information was available in a small area near Caineville. Even less information was available on the other aquifers thought to be important. If large-scale ground-water development should be planned in the area in the future, the following studies, together with additional supporting data, are considered necessary to planning the operation of well fields.

1. The flow system in the Navajo Sandstone and other aquifers must be better defined. In support of this study, more information on the potentiometric surface is needed for the Navajo Sandstone and other aquifers. Data are needed most in the area along the southeast side of the San Rafael Swell, in the Henry Mountain structural basin, and around the base of the Henry Mountains.

2. Pressure relations among the several aquifers should be defined, because of the potential for increased or induced interformational movement of ground water. Although these data are needed throughout the area, they are especially important along the Dirty Devil River south of Hanksville and around the Henry Mountains where recharge to bedrock aquifers possibly occurs by interformational leakage from the surface.

3. From the data acquired under items 1 and 2, a reliable calibrated digital model of the Navajo Sandstone aquifer should be constructed for predictive purposes.

4. The chemical quality of available ground water areally and with depth must be better known. For example, the areal extent of brine in the Navajo Sandstone around test hole (D-27-7)7bcc-2 must be more clearly defined and, if possible, the source of the brine identified, because brine movement during large-scale withdrawal would cause a progressive deterioration of the ground-water supply in the sandstone aquifer.

With a better data base, further study of geochemical relations of ground-water quality to regional flow in the Navajo Sandstone should be made. For example, ground water from the sandstone aquifer in some areas contains a substantial amount of dissolved iron, as a test hole (D-29-7)15dbd-1 (table 13), where the sandstone generally does not contain iron coloration. To the east of the Dirty Devil River, however, parts of the sandstone show such coloration. A study similar to that of Schluger and Roberson (1975) may aid in better defining current and paleohydrologic conditions.

Although the data needed for further study probably should be obtained by an organized effort when planning future withdrawals, some of the data could be accumulated through the cooperation of companies exploring for petroleum and other mineral resources at little or no added cost to those companies.

## SUMMARY AND CONCLUSIONS

Rocks that crop out or underlie the lower Dirty Devil River basin area range from Precambrian to Holocene in age. All the geologic units contain some water, but only five are considered to be major aquifers--the Entrada, Navajo, and Wingate Sandstones, the Coconino Sandstone including its equivalents in the Cutler Formation, and rocks of Mississippian age. Several other lithologic units--older alluvium and terrace deposits, the Emery and Ferron Sandstone Members of the Mancos Shale, the Salt Wash Sandstone Member of the Morrison Formation, and the Carmel Formation--are locally important.

The circulation of ground water in the consolidated aquifers is affected by folding, faulting, and igneous intrusion which locally enhance ground-water movement by fracturing or impede the movement by offsetting permeable beds or sealing zones with rock of lower permeability. At least locally, fracturing also enhances interformational leakage of ground water.

The total hydrologic system in the lower Dirty Devil River basin has an estimated long-term average annual inflow and outflow of about 1.6 million acre-ft (1,970 $hm^3$), of which about 1.55 million acre-ft (1,910 $hm^3$) is derived from precipitation on the area, and the remainder is mainly inflow in the Fremont River and Muddy Creek. An estimated 96 percent of the water available to the area is discharged by evapotranspiration and about 4 percent leaves the area as surface flow. Subsurface outflow and withdrawal by wells are essentially nil.

The estimated long-term average annual ground-water recharge derived from precipitation is 34,000 acre-ft (42 $hm^3$); a relatively small part of this amount recharges the consolidated rocks. Most of the water is consumed by evapotranspiration within the basin.

The total amount of ground water in storage cannot be calculated; however, the Navajo, Wingate, and Coconino Sandstones contain an estimated 210 million acre-ft (259,000 $hm^3$) of recoverable fresh to moderately saline water.

The estimated average annual rate of recharge to and discharge from the Navajo Sandstone in the lower Dirty Devil River basin area is about 5,000 acre-ft (6.2 $hm^3$). This is only 0.006 percent of the recoverable water in the sandstone aquifer.

On the basis of available data and several basic assumptions, calculations show that withdrawal of approximately 20,000 acre-ft (25 $hm^3$) per year for 35.6 years from a hypothetical well field northwest of Caineville would reduce the amount of recoverable ground water in the Navajo Sandstone by 0.3 to 0.7 percent. By the end of the 35.6 years, the flow of the Dirty Devil River near its mouth would be reduced by 5 to 13 $ft^3/s$ (0.14 to 0.37 $m^3/s$); this is less than 0.1 percent of the average annual flow of the Colorado River into Lake Powell.

Large yields--2,800 to 3,000 gal/min (177-189 L/s)--to individual wells from the Navajo Sandstone have been demonstrated near Caineville but, owing to the low permeability of the sandstone aquifer, the large yields are accompanied by large drawdowns. In the simplified example cited above, the 35.6 years of pumping would cause about 1,000 ft (305 m) of drawdown of the potentiometric surface at a well in the well field.

Maximum well yields from the Wingate Sandstone would be less than from the Navajo Sandstone--probably on the order of 1,000 gal/min (63 L/s) per well in fractured areas under artesian pressure--and those yields also would be accompanied by large drawdowns. At greater depths, the Coconino Sandstone and its equivalents probably could sustain yields similar to that for the Navajo. The effects of pumping on other aquifers cannot be estimated.

Ground water in much of the consolidated rock in the lower Dirty Devil River basin area is saline. The occurrence of freshwater in the area generally is limited mainly to unconsolidated rocks in and near upland areas, such as the Fremont River valley above Fruita, and to consolidated rocks in their outcrop areas. The Navajo Sandstone, however, contains freshwater in a broad area, but water in the Navajo is degraded locally by interformational leakage of water ranging from slightly saline to briny.

From the information obtained for the lower Dirty Devil River basin area, it can be concluded that:

1. Bedrock aquifers in the study area, the thick sandstone aquifers in particular, can yield additional supplies from stored fresh to slightly saline water for small-scale development (up to about 5,000 acre-ft [6 $hm^3$] per year) with relatively little effect on the ground-water system.

2. Large-scale development (as much as about 20,000 acre-ft [25 $hm^3$] per year) of the bedrock aquifers, the Navajo Sandstone in particular, is feasible. Such large-scale development, however, would have to operate under the constraints of low permeability and the probability of the degradation of the chemical quality of water.

3. Large-scale development would have measurable side effects, including measurable lessening of streamflow in the lower Dirty Devil River and cessation of some spring flow. However, the effect on the flow of the Colorado River would be too small to measure.

## REFERENCES CITED


Barrs, D. L., 1962, Permian system of the Colorado Plateau: American Association of Petroleum Geologists Bulletin, v. 46, no. 2, p. 149-218.

Baker, A. A., 1946, Geology of the Green River Desert-Cataract Canyon region, Emery, Wayne, and Garfield Counties, Utah: U.S. Geological Survey Bulletin 951.

Bentall, Ray (compiler), 1963, Methods of determining permeability, transmissibility, and drawdown: U.S. Geological Survey Water-Supply Paper 1536-I.

Bjorklund, L. J., 1969, Reconnaissance of the ground-water resources of the upper Fremont River valley, Wayne County, Utah: Utah Department of Natural Resources Technical Publication 22.

Brown, R. H., 1953, Selected procedures for analyzing aquifer tests: Journal of the American Waterworks Association, v. 45, no. 8, p. 894-866.

Cooper, J. C., 1955, Cambrian, Devonian, and Mississippian rocks of the Four Corners Area: Four Corners Geological Society Guidebook, First Field Conference, p. 59-65.

Covington, H. R., 1972, Map showing length of freeze-free season in the Salina Quadrangle, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-591-E.

Covington, H. R., and Williams, P. L., 1972a, Map showing normal annual and monthly precipitation in the Salina Quadrangle, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-591-D.

_____1972b, Surface-water map of the Salina Quadrangle, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-591-F.

Criddle, W. D., Harris, Karl, and Willardson, L. S., 1962, Consumptive use and water requirements for Utah: Utah State Engineer Technical Publication 8 (revised).

Feltis, R. D., 1966, Water from bedrock in the Colorado Plateau of Utah: Utah State Engineer Technical Publication 15.

Feth, J. H., Rogers, S. M., and Roberson, C. E., 1964, Chemical composition of snow in the northern Sierra Nevada and other areas: U.S. Geological Survey Water-Supply Paper 1535-J.

Gilluly, James, 1929, Geology and oil and gas prospects in part of the San Rafael Swell, Utah: U.S. Geological Survey Bulletin 806, p. 69-130.

Gilluly, James, and Reeside, J. B., 1928, Sedimentary rocks of the San Rafael Swell and some adjacent areas in Utah: U.S. Geological Survey Professional Paper 150-D.

Goode, H. D., and Olson, Eric, 1977, Reconnaissance appraisal of the water resources of the Henry Mountain coal field, Wayne and Garfield Counties, Utah, 1975-77: University of Utah Research Report. Prepared for the U.S. Department of Interior, July 1977.

Hackman, R. J., 1973, Vegetation map of the Salina Quadrangle, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-591-P.

Hanshaw, B. B., and Hill, G. A., 1969, Geochemistry and hydrodynamics of the Paradox Basin region, Utah, Colorado, and New Mexico: Chemical Geology, no. 4, 1969, p. 263-294. Amsterdam, Elsevier Publishing Company.

Hawley, C. C., Robeck, R. C., and Dyer, H. B., 1968, Geology altered rocks, and ore deposits of the San Rafael Swell, Emery County, Utah: U.S. Geological Survey Bulletin 1239.

Hood, J. W. and Danielson, T. W., 1979, Aquifer tests of the Navajo Sandstone near Caineville, Utah: Utah Department of Natural Resources Technical Publication 66.

Hood, J. W., and Waddell, K. M., 1968, Hydrologic reconnaissance of Skull Valley, Tooele County, Utah: Utah State Engineer Technical Publication 18.

Hunt, C. B., *assisted by Paul Averett and R. L. Miller*, 1953, Geology and geography of the Henry Mountain region, Utah: U.S. Geological Survey Professional Paper 228.

Iorns, W. V., Hembree, C. H., and Oakland, G. L., 1965, Water resources of the Upper Colorado River Basin--Technical report: U.S. Geological Survey Professional Paper 441.

Iorns, W. V., Hembree, C. H., Phoenix, D. A., and Oakland, G. L., 1964, Water resources of the Upper Colorado River Basin--Basic data: U.S. Geological Survey Professional Paper 442.

Kelley, V. C., 1955, Monoclines of the Colorado Plateau: Geological Society of America Bulletin, v. 66, no. 7, p. 789-803.

Marine, I. W., 1962, Water-supply possibilities at Capitol Reef National Monument, Utah: U.S. Geological Survey Water-Supply Paper 1475-G.

Mundorff, J. C., 1971, Nonthermal springs of Utah: Utah Geological and Mineral Survey Water-Resources Bulletin 16.

_____1979, Reconnaissance of the chemical quality and fluvial sediment in the Dirty Devil River basin, Utah: Utah Department of Natural Resources Technical Publication 65.

Newman, W. L., 1962, Distribution of elements in sedimentary rocks of the Colorado Plateau--a preliminary report; Contributions to the geology of uranium: U.S. Geological Survey Bulletin 1107-F.

Price, Don, and Arnow, Ted, 1974, Summary appraisals of the nation's ground-water resources--Upper Colorado Region: U.S. Geological Survey Professional Paper 813-C.

Price, Don, and Waddell, K. M., 1973, Selected hydrologic data in the Upper Colorado River Basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-477.

Rowley, P. D., Anderson, J. J., and Williams, P. L., 1975, A summary of Tertiary volcanic strata in the southwestern High Plateaus and adjacent Great Basin, Utah: U.S. Geological Survey Bulletin 1405-B.

Schluger, P. R., and Roberson, H. E., 1975, Mineralogy and chemistry of the Patapsco Formation, Maryland, related to the ground-water chemistry and flow system; A contribution to the origin of red beds: Geological Society of America Bulletin, v. 86, no. 2, p. 153-158.

Smith, J. F., Jr., Huff, L. C., Hinrichs, E. N., and Luedke, R. G., 1963, Geology of the Capitol Reef area, Wayne and Garfield Counties, Utah: U.S. Geological Survey Professional Paper 363.

Stewart, J. H., Poole, F. G., and Wilson, R. F., 1972, Stratigraphy and origin of the Chinle Formation and related Upper Triassic strata in the Colorado Plateau region: U.S. Geological Survey Professional Paper 690.

Stokes, W. L. (ed.), 1964, Geologic map of Utah: University of Utah, scale 1:250,000.

Trescott, P. C., Pinder, G. F., and Larson, S. P., 1976, Finite-difference model for aquifer simulation in two dimensions with results of numerical experiments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 7, Chapter C1.

Truesdell, A. H., and Jones, B. F., 1974, WATEQ, a computer program for calculating chemical equilibria of natural waters: U.S. Geological Survey Journal of Research, v. 2, no. 2, p. 233-248.

U.S. Geological Survey, 1954, Compilation of records of surface waters of the United States through September 1950, Part 9, Colorado River basin: U.S. Geological Survey Water-Supply Paper 1313.

_____1964, Compilation of records of surface waters of the United States, October 1950 to September 1960, Part 9, Colorado River basin: U.S. Geological Survey Water-Supply Paper 1733.

_____1970, Surface-water supply of the United States, 1961-65, Part 9, Colorado River basin, Volume 2.: U.S. Geological Survey Water-Supply Paper 1925.

U.S. Geological Survey, 1973, Surface-water supply of the United States, 1966-70, Part 9, Colorado River basin, Volume 2: U.S. Geological Survey Water-Supply Paper 2125.

_____1971-77, Water resources data for Utah: Water Resources Division. Published annually.

Utah Division of Water Resources, 1975, Fremont River study Utah : Utah Department of Natural Resources, April 1975.

Waddell, K. M., Contratto, P. K., Sumsion, C. T., and Butler, J. R., 1980, Hydrologic reconnaissance of the Wasatch Plateau-Book Cliffs coal-fields area, Utah: U.S. Geological Survey Water-Supply Paper 2068.

Waddell, K. M., Vickers, H. L., Upton, R. T., and Contratto, P. K., 1978, Selected hydrologic data, 1931-77, Wasatch Plateau-Book Cliffs coal-fields area, Utah: U.S. Geological Survey Open-File Report 78-121 (also duplicated as Utah Basic-Data Release 31).

Wengerd, S. A., and Matheny, M. L., 1958, Pennsylvanian System of Four Corners Region: American Association of Petroleum Geologists Bulletin, v. 42, no. 9,p. 2048-2106.

Wengerd, S. A., and Strickland, J. W., 1954, Pennsylvanian stratigraphy of the Paradox Salt Basin, Four Corners Region, Colorado and Utah: American Association of Petroleum Geologists Bulletin, v. 38, no. 10, p. 2157-2199.

Williams, P. L., and Hackman, J. Jl, 1971, Geology, structure, and uranium deposits of the Salina Quadrangle, Utah: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-591.

Table 5.--Stream-discharge measurements in the study area

Site No.: Identifies site on plate 2.
Discharge: Measurements are good (5-percent error, or less), except a, fair (8-percent error) and b, poor (more than 8-percent error).
Specific conductance: In micromhos per centimeter at 25°C.

| Site No. | Measuring site | Date | Time | Discharge ($ft^3/s$) | Temperature (°C) | Specific conductance | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | Fremont River 50 feet above Fish Creek, near Torrey | 5- 4-77 | 0810 | 30.3 | 8.0 | 650 | |
| | | 5- 5-77 | 0815 | 30.4 | - | - | |
| 2 | Fremont River above park diversion, at Fruita | 5- 4-77 | 1155 | b 28.8 | - | - | |
| | | 5- 5-77 | 1510 | b 29.0 | - | - | |
| 3 | Fremont River 1.55 miles above Grand Wash, near Fruita | 8-22-75 | 1000 | 40.7 | - | - | Near Navajo-Kayenta (lower) contact. |
| | | 9- 3-75 | 0600 | 26.3 | 14.0 | 640 | pH 8.2. |
| | | 10-30-75 | 1300 | 81.6 | - | - | |
| | | 12-17-75 | 1340 | a 90.3 | - | - | Some floating ice. |
| | | 12-30-75 | 1250 | 106 | 10.0 | 460 | |
| | | 3-25-76 | 1040 | 88.3 | - | - | |
| | | 5-11-76 | 1410 | 53.4 | - | - | |
| | | 10- 6-76 | 1006 | 49.5 | - | - | Water nearly clear after being silty yesterday. |
| | | 5- 4-77 | 1350 | 29.5 | - | - | |
| | | 5- 5-77 | 0935 | 30.6 | - | - | |
| 4 | Fremont River 0.4 mile downstream from Grand Wash, near Fruita | 9- 3-75 | 0800 | 29.0 | 13.5 | 710 | Near middle of Navajo outcrop. |
| | | 10-30-75 | 1330 | 78.1 | - | - | |
| | | 12-30-75 | 1355 | 102 | - | - | |
| | | 5-11-76 | 1510 | 50.4 | - | - | |
| | | 10- 6-76 | 1133 | 52.3 | 11.0 | - | |
| | | 5- 4-77 | 1600 | 32.4 | - | - | |
| | | 5- 5-77 | 1130 | 29.6 | - | - | |
| 5 | Fremont River 2.75 mile below Grand Wash, near Fruita | 8-22-75 | 1100 | 42.0 | - | - | Near Navajo-Carmel (upper) contact. |
| | | 9- 3-75 | 0700 | 28.1 | 13.4 | 695 | pH 8.2. |
| | | 10-30-75 | 1520 | 85.7 | 7.0 | 690 | |
| | | 12-17-75 | 1550 | 103 | - | - | Some floating ice. |
| | | 12-30-75 | 1505 | 104 | - | - | |
| | | 3-25-76 | 1240 | 87.4 | - | - | |
| | | 5-11-76 | 1625 | 50.6 | 20.0 | 900 | |
| | | 10- 6-76 | 1250 | 49.4 | - | - | |
| | | 5- 4-77 | 1815 | 29.3 | 17.0 | 670 | |
| | | 5- 5-77 | 1330 | 27.7 | - | - | |
| 6 | Oak Creek 0.75 mile below South Fork, near Sandy Ranch | 10-28-76 | 1335 | 3.27 | 4.5 | 340 | Some thin ice seen downstream. |
| 7 | Oak Creek 2.6 miles below South Fork, near Sandy Ranch | 10-28-76 | 1445 | 3.00 | 7.5 | 340 | 0.1 mile below fault through Chinle-Wingate contact. |
| 8 | Oak Creek 3.6 miles below South Fork, near Sandy Ranch | 9- 3-75 | 1540 | 5.30 | 24.5 | 220 | Near Navajo-Kayenta (lower) contact. |
| | | 10-28-76 | 1555 | 2.90 | - | - | |
| 9 | Oak Creek 300 feet above diversion dam, near Sandy Ranch | 9- 3-75 | 1435 | 4.35 | 24.0 | 230 | On Navajo Sandstone. |
| 10 | Pleasant Creek at Pleasant Creek Ranch, near Fruita | 10- 9-75 | 1400 | 6.61 | 11.0 | 275 | |
| 11 | Pleasant Creek 0.8 mile below Pleasant Creek Ranch, near Fruita | 10- 9-75 | 1510 | 6.62 | 13.0 | 275 | |
| 12 | Pleasant Creek 1.6 miles below Pleasant Creek Ranch, near Fruita | 8-21-75 | 1330 | 7.33 | - | - | 0.25 mile downstream from Navajo-Kayenta (lower) contact. |
| | | 10- 9-75 | 1620 | 6.52 | 14.0 | 275 | |
| 13 | Pleasant Creek approximately 3.1 miles below Pleasant Creek Ranch, near Notom | 8-21-75 | 1500 | 6.77 | - | - | Approximately 0.2 miles upstream from Navajo-Carmel (upper) contact. |
| 14 | Pleasant Creek 4 miles below Pleasant Creek Ranch, near Notom | 8-21-75 | 1650 | 5.57 | - | - | 160 feet above park boundary fence. |
| | | 10- 9-75 | 1750 | 5.24 | 12.0 | 275 | |
| 15 | Muddy Creek 150 feet above Lone Tree Crossing, near Emery | 10- 6-75 | 1515 | 2.89 | 20.0 | 4,000 | |
| 16 | Muddy Creek 300 feet below South Salt Wash, near Emery | 10- 6-75 | 1340 | 2.69 | 19.0 | 4,000 | No flow from mouth of wash, but water seen in South Salt Wash upstream. |
| 17 | Muddy Creek at Tomsich Butte, near Hanksville | 9-24-75 | 1200 | 1.55 | 19.0 | 5,000 | |
| | | 10- 7-75 | 1050 | 2.30 | 12.0 | 5,000 | |
| 18 | Muddy Creek 100 feet below Delta Mine, near Hanksville | 10- 7-75 | 1600 | .26 | - | 6,000 | Site approximately 0.25 mile below gaging station 3327. |
| 19 | Muddy Creek approximately 1 mile above Salt Wash, near Hanksville | 9-23-75 | 1600 | .24 | 20.0 | 4,500 | Site approximately 300 feet upstream from Navajo-Carmel (upper) contact. |
| 20 | Muddy Creek 900 feet above Salt Wash, near Hanksville | 9-23-75 | 1430 | .33 | 27.5 | 5,000 | |
| 21 | Salt Wash at road crossing below Caine Springs, near Hanksville | 8- 5-75 | -- | b 1.94 | 27.5 | ~8,000 | All of flow is discharge from Caine Springs. |
| | | 2- 3-76 | 1600 | 2.34 | 7.0 | ~8,000 | |
| 22 | Salt Wash 150 feet above Muddy Creek, near Hanksville | 9-23-75 | 1405 | 1.86 | 26.0 | ~9,000 | |
| 23 | Muddy Creek at road crossing approximately 1 mile below Salt Wash, near Hanksville | 10- 8-75 | 1730 | 2.36 | 15.5 | ~8,000 | Recession of floodwater. |
| | | 5-12-76 | 1645 | 13.5 | 24.0 | 6,000 | |
| 24 | Muddy Creek 50 feet below Well Draw, near Hanksville | 5-13-76 | 0915 | 11.0 | 12.0 | 6,200 | Do. |
| 25 | Dirty Devil River 8.4 miles below Muddy Creek, near Hanksville | 9-20-76 | 1805 | 23.5 | - | - | Site is approximately 1.5 miles downstream from Navajo-Carmel (upper) contact. |
| | | 9-21-76 | 0935 | 17.7 | 14.5 | 1,500 | |
| | | | 1102 | 19.2 | - | - | |
| | | 10-14-77 | 0910 | 61.1 | - | - | |
| | | | 1015 | 63.6 | - | - | |
| 26 | Dirty Devil River 300 feet above Robbers Roost Canyon, near Hanksville | 9-21-76 | 1510 | 17.7 | 16.5 | 1,550 | Site is approximately 0.25 mile upstream from Navajo-Kayenta (lower) contact. |
| | | | 1538 | 17.5 | - | - | No flow from Robbers Roost Canyon. |
| | | 10-14-77 | 1500 | 62.3 | - | - | |

Table 6.--Records of
[See table 8 for water data

Location: See text for description of well- and spring-numbering system. D, well deepened; S, well plugged back in year shown as year constructed.
Owner: Owner at time well was visited by U.S. Geological Survey personnel or listed by driller in State Well Driller's Report or given in other State or Federal records.
Depth: All depths are reported, except for test holes drilled by the U.S. Geological Survey.
Finish: O, open-ended pipe with no perforations; P, pipe perforated, generally with acetylene torch; X, open hole below unperforated casing.
Principal aquifer: See table 1 for explanation of code and description of lithology.
Altitude: Altitude of land surface at well, above mean sea level. Altitudes to nearest foot are interpolated from topographic maps, except S, determined by surveying altimeter; those given in tenths or hundreths are surveyed altitudes.
Water level: Below or above(+) land-surface datum at well. Accuracy - G, measured with pressure gage; H, calibrated pressure gage; M, mercury manometer; R, reported; S, measured with steel tape; T, electric tape. Site status (second column) - F, flowing, but head not measured; R, pumped or flowed recently.
Type of lift: P, piston, generally windmill or pump jack and cylinder pump; S, submersible pump (electric); T, turbine pump. Some flowing wells are not equipped.
Discharge: B, bailer measurement by driller; E, estimated; F, discharge is for natural flow; P, pipe orifice; R, reported; V, volumetric, generally with bucket or stopwatch.
Use of water: C, commercial; F, fire protection; H, domestic; I, irrigation; N, industrial; P, public supply; R, recreation; S, stock; U, unused.
Data available: In files of U.S. Geological Survey. Chemical analyses (see tables 13 and 14 for selected analyses) - B, commonly determined constituents; C, commonly determined constituents plus one or more trace elements. Logs (see table 10 for selected drillers' or other lithologic logs) - A, drilling time; D, driller's; E, electric (resistivity and spontaneous potential); F, fluid conductivity; G, geologist's description of drill cuttings, or formation contacts; J, gamma-ray; T, temperature; Z, other, see remarks. Water level (see table 9 for water levels in observation wells and figures 15 and 16 for selected hydrographs) - I, intermittent, no regular schedule throughout period of record; O, original, single measurement or report; Z, other, see remarks.

| Location | Owner | Year constructed | Depth of well (ft) | Casing diameter (in.) | Depth cased (ft) | Depth to first opening (ft) | Finish | Principal aquifer | Depth to aquifer (ft) | Altitude (ft) | Water level (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-23-10)12ddd-1 | U.S. Bureau of Land Management | 1936 | 196 | - | - | - | - | 230MNKP | 40 | 6,850 | 25.6T |
| (D-24-9)7dab-1S | do. | 1961 | 195 | 8.63 | 170 | 170 | X | 230MNKP | - | 5,635 | - |
| (D-24-13)11adb-1S | do. | 1974 | 1,400 | 8.63 | 169 | 169 | X | 200MSZC | - | - | - |
| (D-25-5)14dda-1 | Elliot Crane | 1974 | 275 | 8 | 134 | 50 | P | 112ALVM | 0 | 5,945 | 55R |
| (D-25-12)14ccc-1 | J. Marsing | 1962 | 90 | 6 | - | - | - | 221CRML | - | 4,985 | - |
| 34cdb-1 | U.S. Bureau of Land Management | 1953 | 290 | 6 | 290 | 230 | P | 221ENRD | 6 | 5,150 | - |
| (D-25-15)23bdb-1 | do. | 1935 | 350 | 8.25 | 330 | 330 | X | 220NVJO | 193 | 4,795 | 290R |
| 32cac-1 | State of Utah | 1956 | 720 | 7 | 720 | 680 | P | 220NVJO | 255 | 5,080 | 650R |
| (D-26-8)6aab-1 | U.S. Bureau of Land Management | 1969 | 767 | 6.63 | 767 | 715 | P | 220NVJO | 220 | 5,960 | 686R |
| (D-26-9)24dbc-1 | do. | 1950 | 440 | 4 | 400 | 400 | X | 221SLWS | 400 | 4,550 | +22R F |
| (D-26-13)19cdb-1 | do. | 1913 | 400 | 8 | - | - | - | 221ENRD | 0 | 5,264 | 310R |
| 25cab-1 | do. | 1949 | 355 | 13.38 | - | - | - | 221ENRD | 0 | 5,385 | 312S |
| 25cbd-1 | do. | 1949 | 855 | 6 | 855 | - | - | 220NVJO | - | 5,240 | - |
| (D-27-7)7bcc-1 | do. | 1976 | 785 | 6 | 13 | 13 | X | 221CRML | 73 | 5,520 | 105T |
| 7bcc-2 | do. | 1977 | 950 | 6 | - | - | X | 220NVJO | 711 | 5,520 | 395T |
| (D-27-11)34dca-1 | Federal Aviation Administration | 1946 | 638 | 6.25 | 638 | 618 | P | 221CRML | 349 | 4,425 | +49HR +50.1HR |

selected water wells
from petroleum-test wells]

| Date measured | Type of lift | Date discharge measured | Discharge (gal/min) | Draw-down (ft) | Use of water | Tem-pera-ture (°C) | Data available: Chemical analysis | Data available: Log | Data available: Water levels | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 7-15-61 | - | - | - | - | S,R | - | - | D | O | Known both as Sinbad well and Georges Draw well. One of eight wells reportedly drilled by Standard Oil Co. of California for supply of drilling and domestic water. Drilled to 217 feet. Depth and water level shown measured by R. F. Hadley in 1961. Specific conductance more than 8,000 µmho/cm. Water has odor of hydrogen sulfide. |
| - | - | 7- 4-61 | 20R | - | U | - | - | - | - | Converted from petroleum-test well by plugging from 195 to 315 feet. Reported freshwater zone 184-188 feet. Casing sealed and left with a standard marker. |
| - | - | - | - | - | - | - | - | - | - | Converted from petroleum-test well by plugging back to 1,400 feet. Open hole exposes section from Entrada Sandstone to middle part of Wingate Sandstone. Water in Navajo and Wingate Sandstones reported to be fresh. Well assigned to U.S. Bureau of Land Management. |
| 10-18-74 | - | 10-18-74 | 30B | 5 | S | - | - | D | O | Casing perforated with Mills knife at 50-60 and 120-134 feet, open hole below 134 feet. Most water probably comes from shallowest perforations. |
| - | S | - | - | - | U | 16.5 | B | - | - | Formerly domestic supply. Unused and no power in 1977. Now in right-of-way of State Highway 24. |
| - | - | 3-25-53 | 11V | - | S | 14.5 | B | D | - | Known as Gilson Butte well. Drilled to supply petroleum-test well and then assigned to U.S. Government. |
| 9- 3-35 | P | 10- 1-35 | 8R | - | S | - | - | D | O | UERA well 93. Known as Saucer Basin well. Water level may be in error. Water reported at 170 feet, cased off(?). Water reported as "good." |
| 6-29-56 | - | 6-29-56 | 30B | 50 | S | - | B | - | - | Known as Moonshine well. Drilled to supply petroleum-test well and then turned over to the State. |
| 6-25-69 | P | 6-25-69 | 11B | 40 | S | 18.0 | C | D | O | Known as Last Chance well. Machine-cut perforations 717-767 feet. Well site in midst of a swarm of igneous dikes and on or near a fault. Sampled for isotope analysis. |
| 2-10-50 | - | 2-10-50 | 15RF | - | - | - | - | - | - | In grove of saltcedar and spring area north of old Hunt ranch house. Casing is used drill stem. |
| 8-29-75 | | 8-29-75 | 5EF | - | S | 17.0 | B | - | - | |
| 11- -44 | P | - | 10R | - | S | 17.0 | C | - | O | Known as Jeffrey well. Drilled to supply nearby petroleum-test well. Water level, discharge, and pump setting reported by U.S. Bureau of Land Management. Cylinder pump set at 318 feet. Sampled for isotope analysis. |
| 4- 1-77 | P | - | - | - | S | 17.0 | A | - | O | This may be well known as Flat Top well. Well is south of trend of diorite dike (pl. 1), which may affect water levels in area. Specific conductance of water in recently pumped tank of stock water was 3,000 µmho/cm on August 5, 1975. |
| - | P | 3- 1-49 | 4R | - | U | - | - | - | - | Drilled to supply nearby petroleum-test well. Found filled or plugged to near surface on April 1, 1977. |
| 8-23-76 | - | 8-13-76 | 4E | 7 | U | 18.5 | B | A,G | I | USGS test hole 1. See composite log (table 10) for measurements of water level, temperature, and specific conductance. Water level progressively deeper as hole deepened in Carmel Formation. Top of Navajo Sandstone was estimated to be 710 feet, based on drilling time. Extreme difficulty encountered in maintaining circulation of drilling fluid. Formation continually caved after passing depth of 500 feet. Briny formation water caused breakdown of fluid. Abandoned September 24, 1976, after plugging with cement at surface. |
| 9- 2-77 | - | 9- 2-77 | 6V | - | U | 18.5 | C | A,G, J | O | USGS test hole 1A. Site picked 50 feet southeast of test well 1 because original hole could not be reentered. Drilled to 950 feet, stopped because of insufficient air pressure to drill further. See composite log (table 10). Top of Navajo Sandstone at 711 feet; set packer on drill stem at 735-738 feet and pumped with air for 3 hours. Brine in Navajo. Water level in Navajo was 279 feet deeper than that in Carmel Formation after 1 hour of recovery. Abandoned September 3, 1976, after plugging with cement at 735 feet and at surface. |
| 7-29-75 | - | 6-18-46 | 167V | - | F,H | 18.0 | B | D | I | First well drilled at navigation-air facility. Used only for fire protection and sanitary purposes. Water stains porcelain with heavy iron deposits. Lowermost section of well may be in Navajo Sandstone. Casing 6-inch 0-393 feet, 4½-inch 360-638 feet, perforated 618-638 feet. |

Table 6.--Records of selected

| Location | Owner | Year constructed | Depth of well (ft) | Casing diameter (in.) | Depth cased (ft) | Depth to first opening (ft) | Finish | Principal aquifer | Depth to aquifer (ft) | Altitude (ft) | Water level (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-27-11)34ddb-1 | Federal Aviation Administration | 1952 | 602 | 8 | 498 | 498 | X | 221CRML | 295 | 4,425 | F |
| 34ddb-1D | Utah Division of Aeronautics | 1976 | 750 | 8 | 498 | 498 | X | 220NVJO | 610 | 4,425 | 83H |
| (D-27-12)4ccc-1 | U.S. Bureau of Land Management | 1912 | 350 | - | - | - | P | 221ENRD(?) | - | 4,985 | 330R |
| (D-27-13)8dbc-1 | do. | 1935 | 795 | 6.30 | 465 | 465 | X | 220NVJO | 425 | 5,285 | 720R |
| (D-27-14)5acc-1S | do. | 1927 | 650 | 6.25 | 620 | 620 | P,X | 221CRML | 610 | 5,684 | 580R |
| (D-27-15)21aad-1 | do. | 1946 | 632 | 6 | 682 | - | P | 220NVJO | 143 | 5,381 | 582R |
| (D-27-16)1caa-1S | do. | 1970 | 2,650 | 9.63 | 2,683 | - | - | 310WTRM | 2,148 | 5,340 | - |
| (D-28-4)36cdb-1 | V. A. Lee | 1935 | 112 | 6 | 112 | 112 | O | 112ALVM | - | 6,860 | 8.53S |
| (D-28-7)27cdb-1 | Intermountain Power Project | 1975 | 2,353 | 5.63 | 1,990 | 1,990 | X | 220NVJO | 1,989 | 5,161.8 | 93.42S |
| 36bbb-1* | Emmett Clark and others | 1966 | 800 | 8 | 726 | 726 | X | 221SLWS | 530 | 5,100 | +30R<br>+17.8HR<br>+18.4HR |
| (D-28-8)29cdc-1 | U.S. Bureau of Land Management | 1955 | 764 | 13.38 | 720 | 720 | X | 220NVJO | 720 | 4,940 | +69.9H |
| 29dcb-1 | Garkane Power Association | 1973 | 761 | 16 | 679 | 679 | X | 220NVJO | 668 | 4,896.5 | +108H |
| 33bbb-1 | Intermountain Power Project | 1975 | 1,250 | 20 | 704 | 704 | X | 220NVJO | 709 | 4,883.6 | +121.6H |
| 33cdd-1S | do. | 1975 | 1,350 | 13.63 | 1,400 | 1,286 | P | 220NVJO | 745 | 4,823.5 | +183.5H |
| 35cbd-1 | O. L. Jeffs | 1960 | 117 | 4 | 117 | 105 | P | 112ALVM | 105 | 4,600 | 60R |
| 35dbb-1 | P. L. Jackson | 1964 | 62 | 6 | 61 | 31 | P | 112ALVM | 20 | 4,580 | 22R |
| (D-28-9)28bbb-1 | D. Brian | 1964 | 92 | 10 | 92 | - | O | 112ALVM | 25 | 4,540 | - |
| 29bdb-1 | Doyle Jackson | 1964 | 54 | 6 | 54 | 37 | P | 112ALVM | 27 | 4,555 | 21R |
| 30acc-1 | J. M. Regan | 1968 | 45 | 6 | 45 | - | O | 112ALVM | 10 | 4,560 | 14R |
| 30dad-1 | Thomas Hopkins | 1964 | 63 | 6 | 63 | 36 | P | 112ALVM | 30 | 4,560 | 17.5R |
| (D-28-10)16ccb-1 | D. B. Hatch | 1962 | 325 | 10 | 75 | 75 | Z | - | - | 4,420 | 10R |
| 22abc-1 | H. R. Phillips | 1951 | 75 | 12 | 75 | 30 | P | 112ALVM | 13 | 4,370 | 13.17S |
| (D-28-11)2ccc-1 | Andrew Hunt | 1950 | 180 | 7 | 10 | 10 | X | 221ENRD | 10 | 4,260 | F |

| Date measured | Type of lift | Date discharge measured | Discharge (gal/min) | Draw-down (ft) | Use of water | Tem-pera-ture | Data available: Chemical analysis | Data available: Log | Data available: Water levels | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 6-22-52 | - | 6-22-52 | 33FV | - | U | - | B | D | O | Second well. Drilled in former housing near cattle guard. Well reported never used; reports indicate that well was plugged about 1963. Casing 8-inch 0-37 feet, 6¼-inch 0-498 feet. When cleaned out in 1976, casing was found pinched shut at 347-351 feet and filled below about 300 feet. Hole found offset at 498 feet. Driller reported water in Entrada Sandstone was unfit for domestic use; same was true for water in Carmel Formation. |
| 8- 6-76 | - | 8- 5-76 | 200E<br>50EF<br>34VF | - | U | 18.0 | C | E,G,<br>J | O | Well (D-27-11)34ddb-1 deepened as USGS test hole 2. Produced 10 gal/min from zone of pinched casing while drilling with air. Bottom of existing hole at approximately 600 feet. Yield by airlift increased with depth to estimated 200 gal/min. Drilling stopped because of insufficient air-lift. Well had open flow estimated to be 50 gal/min. Set packer on drill stem at 600-605 feet and sampled after flow through drill stem at 34 gal/min measured recovery for 80 minutes after sampling. Artesian pressure required pressure plugging with 95 sacks of cement on August 8, 1976. Sampled for isotope analysis. |
| 2-20-36 | - | 2-20-36 | 2R | - | U | - | - | - | O | Known as Muller well. Old petroleum-test well cleaned out and reconditioned as UERA well 109 in February 1936. Water quality reported as "fair." |
| 11-19-35 | - | 11-19-35 | 20B | - | U | - | B | D | O | UERA well 91. Formerly used for stock. Measured dry and filled to 480 feet in 1976. Reported to contain dropped drilling tools and pipe. |
| 6-20-33 | P | 7-20-33 | 10V | 25 | S,H | - | B | D | O | Known as Texas well. Formerly Texas Production Co. petroleum-test well. Drilled to 2,875 feet, then plugged back and perforated 580-607 feet, open hole 620-650 feet. Casing inaccessible in 1975. Well drilled in or near fault zone on structure known as Flattop anticline and also as Nequia Arch. |
| 3-30-46 | - | 3-30-46 | 12B | 68 | S | - | - | D | O | Driller reported that drilling water was lost when upper Navajo Sandstone was penetrated. |
| - | - | 6- 70 | 175R | - | U | - | - | - | - | Petroleum-test well plugged back into base of casing and left for water well. Casing was not perforated and was capped. Well was drilled with air. Yield was 0.6 gal/min of fresh-water from Wingate Sandstone and 140-175 gal/min while drilling in White Rim Sandstone Member of Cutler Formation. Neither formation flows. |
| 4-21-36 | - | - | - | - | U | - | - | - | I | Observation well. Unused well that shows effects of recharge from flow in adjacent canyon. |
| 5- 5-77 | - | 11-20-75 | 300E | - | U | 16.0 | B | A,G,<br>Z | I | IPP test well QW-1A. Z, suite of geophysical logs. See Hood and Danielson (1979) for description of tests and detailed data. |
| 7-14-66<br>4-21-75<br>4-14-77 | -<br>-<br>- | 7-14-66<br>7-17-75<br>4-14-77 | 4VF<br>186VF<br>200VF | -<br>-<br>- | S | -<br>14.5<br>14.0 | B | D | I | See records in Hood and Danielson (1979). Leaks around surface casing. |
| 7-22-76 | - | 8- 7-55<br>8-28-75 | 100R<br>55VF | - | S | 17.0 | C | D | I | Known as Stanolind well or as Red Desert well. Flows to small pond. Leaks around surface casing. Water has odor of hydrogen sulfide. See records in Hood and Danielson (1979). |
| 11-24-75 | - | 2- 9-74<br>7-17-75 | 3,110P<br>400EF | 250<br>- | U<br>- | 16.5<br>- | C<br>- | G,J<br>- | I<br>- | Aquifer test well known as ICPA well. See records in Hood and Danielson (1979). |
| 7-22-76 | - | 9-22-75<br>12-29-75 | 770EF<br>2,800P | -<br>512 | U | 17.5 | C | E,G,<br>S,T | I | Test well 1. Pumped well in 35-day aquifer test. See records in Hood and Danielson (1979). |
| 7-22-75 | - | 8-21-75 | 200E | - | U | 17.5 | C | V | I | Known as Colt well. Petroleum-test well converted to observation well for aquifer test. See records in Hood and Danielson (1979). |
| 1-15-60 | - | - | - | - | H,S | - | - | D | O | Well in Fremont River valley flood plain at Caineville. This and the four wells listed immediately below are reported to yield water unfit for drinking. Casing perforated 105-117 feet with ¼-inch by 10-inch slots. |
| 2- 8-64 | - | - | - | - | H | - | - | D | O | Casing perforated 31-61 feet with 1/8-inch by 24-inch slots. |
| - | - | - | - | - | S | 10.0 | - | D | - | |
| 2-15-64 | - | 2-15-64 | 50B | 3 | H | - | - | D | O | Casing perforated 37-54 feet with 1/8-inch by 14-inch slots. |
| 10-27-68 | - | 10-27-68 | 8B | 26 | H | - | - | D | O | |
| 1- 3-64 | - | 1-25-64 | 60VR | 4 | H | 14.5 | - | D | O | Casing perforated 26-58 feet with 1/8-inch by 16-inch slots. |
| 12- 1-62 | - | 12- 1-62 | 2B | 60 | U | - | - | D | O | Casing perforated 20-75 feet with 1/8-inch by 3-inch slots. Well penetrates to Cedar Mountain(?) Formation. Most of the small yield probably came from the shallow deposits. Well was a test for irrigation supply. |
| 9-23-76 | T | 4-10-51 | 600 | 19 | U | - | - | D | I | Well intended for irrigation. Turbine pump has no power. Land has not been tilled for many years, if at all. Water levels respond to river stage(?) and to evapotranspiration of saltcedar and large greasewood on terrace above river. |
| 5-29-63 | - | 6-14-50 | 20B | - | U | 17.0 | - | D | - | See log for remarks on water while drilling. Driller reports water was "good" until drilling passed 140 feet, then quality was not good. Odor of hydrogen sulfide. Well reportedly filled with mud. Hole found flowing in 1963. |

Table 6.--Records of selected

| Location | Owner | Year constructed | Depth of well (ft) | Casing diameter (in.) | Depth cased (ft) | Depth to first opening (ft) | Finish | Principal aquifer | Depth to aquifer (ft) | Altitude (ft) | Water level (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-28-11)10dac-1 | M. M. Brown | 1968 | 170 | 8 | - | - | - | 221ENRD | - | 4,270 | - |
| 15bdc-1 | Jim-N-Ells Corp. | 1973 | 290 | 4 | 265 | 265 | P | 221ENRD | 40 | 4,340 | +40GR |
| 15bdc-2 | Andrew Ekker | 1950 | 290 | 2 | 290 | 250 | X | 221ENRD | 27 | 4,305 | +22R |
| 15bdd-1 | Alvin Robinson | 1970 | 215 | 2 | 215 | 195 | P | 221ENRD | 10 | 4,310 | +13R |
| 15cba-1 | Morrison Refining Co. | 1975 | 337 | 6 | 337 | 297 | P | 221ENRD | 90 | 4,310 | +5R |
| 15acc-1 | Utah Department of Transportation | 1961 | 362 | 5.50 | 362 | 342 | P | 221ENRD | 52 | 4,305 | +20R |
| 16bdd-1 | R. U. Hunt | 1965 | 392 | 4 | 392 | 362 | P | 221ENRD | 106 | 4,305 | - |
| 16cba-1 | O. E. Bullard | 1968 | 407 | 6 | 402 | 402 | X | 221ENRD | 387 | 4,316 | +20GR |
| 16cca-1 | Heber Reese | 1950 | 430 | 8 | 300 | 300 | X | 221ENRD | 4 | 4,335 | +18R |
| 16dac-1 | Stagecoach Motel | 1954 | 340 | 9.63 | 335 | 305 | X | 221ENRD | 95 | 4,310 | +23.6M |
| 16dad-1 | Federal Aviation Administration | 1963 | 350 | 8.63 | 350 | 327 | P | 221ENRD | 68 | 4,305 | +20.7M<br>+3.93H |
| 16dad-2 | Church of Jesus Christ of Latter-day Saints | 1977 | 320 | 6 | 180 | 180 | X | 221ENRD | 97 | 4,307 | +10R |
| 16dca-1 | U.S. Grazing Service | 1938 | 340 | 6.25 | 195 | - | - | 221ENRD | 30 | 4,318 | +19.9M |
| 16ddb-1 | Hanksville Canal Co. | 1934 | 332 | 6.63 | 332 | 292 | X | 221ENRD | 25 | 4,315 | +40R |
| 16ddb-2 | do. | 1952 | 330 | 2 | 300 | 280 | X | 221ENRD | 48 | 4,315 | +18R |
| 17adb-1 | Earl Jackson | 1964 | 503 | 2 | 503 | 488 | P | 221ENRD | 488 | 4,320 | F |
| 21abd-1 | U.S. Bureau of Land Management | 1966 | 363 | 6 | 363 | 353 | P | 221ENRD | 30 | 4,320 | F |
| 28aad-1 | Donald L. Hanni | 1977 | 370 | 6 | 112 | 112 | X | 221ENRD | 10 | 4,360 | 6R |
| 28bdd-2 | Lilly Denny | 1951 | 512 | 7 | 435 | - | X | 221ENRD | 19 | 4,380 | 20R |
| (D-29-4)2ddd-1 | Community of Torrey | 1935 | 500 | 8 | - | - | - | 230MNKP | - | 6,930 | 53.11S |
| 6ccb-1 | Ernest Brinkerhoff | - | 365 | 4 | - | - | O | 100VLFL | - | 6,935 | 19.4S |
| 7bdc-1 | Royal Harward | - | - | 4 | - | - | - | 100VLFL | - | 6,920 | F |
| 8bbd-1 | Reed Maxfield | - | 92 | 6 | 92 | 92 | O | 100VLFL | - | 6,880 | 17.6S |
| 25dcb-1 | G. H. Love | 1976 | 150 | 10 | 35 | 35 | X | 220NVJO | 35 | 7,070 | 35R |
| 26dac-1 | George Paletsas | 1974 | 275 | 10 | 28 | 28 | X | 220NVJO | 24 | 7,190 | 95R |
| (D-29-5)19cba-1 | S. and H. Parker | 1974 | 140 | 6 | 140 | 30 | P | 237SNBD | 78 | 6,740 | 30R |
| 32bad-1 | A. A. Morrill | 1975 | 100 | 6 | 100 | 75 | P | 237SNBD | 75 | 6,880 | 30R |

| Date measured | Type of lift | Date discharge measured | Discharge (gal/min) | Draw-down (ft) | Use of water | Tem-pera-ture (°C) | Data available: Chemical analysis | Data available: Log | Data available: Water levels | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| - | S | - | - | - | H,C, I | 17.0 | C | - | - | Supplies trailer park northeast of Hanksville. |
| 5-15-73 | S | 12- 1-74 | 60VR | 48 | H,C, I | - | B | D | O | Supplies trailer park, drive-in, automatic laundry, and restaurant at east edge of Hanksville. Casing 8-inch to 50 feet, 4-inch 0-290 feet, perforated 265-290 feet with 3/8-inch by 12-inch slots. Flow sealed in with packer. Flow resumes when pump is shut off. |
| 5-10-50 | - | 5-10-50 | 3R | - | H,S, I | - | - | D | O | Artesian flow sealed in by placing baffle on 2-inch pipe and setting baffle 40 feet off of bottom; hole backfilled above baffle. |
| 11- -70 | - | 11- -70 | 6R | - | H,S, I | - | - | D | O | Casing perforated 195-215 feet with ½-inch drilled holes. Artesian pressure sealed in with cement grout to 195 feet. |
| 3-18-75 | - | 3-18-75 | 6VF | - | H | - | - | D | O | Casing 6-inch to 100 feet, 4-inch plastic pipe 0-337 feet, perforated 297-337 feet with 3/8-inch drilled holes. |
| 2- 6-61 | - | 2- 6-61 | 3RF | - | H,N | - | - | D | O | Supplies highway maintenance yard. Casing 5½-inch to 60 feet, 2-inch 0-362 feet, perforated 342-362 feet with 1/8-inch by 8-inch torch-cut slots. Artesian pressure sealed in with neoprene packer and cement plug. Water level in shallow deposits 30 feet below land surface on February 4, 1961. |
| - | - | 6-27-65 | 20B | <1 | H | 10.0 | C | D | - | Casing perforated 362-392 feet with 1/8-inch by 10-inch slots. |
| 9- 5-68 | S | 9- 5-68 | 16VR | 214 | C,H | 17.0 | C | D | O | Supplies cafe, trailer park, and service station at west side of Hanksville. Reportedly flows if not pumped for awhile. |
| 4-20-50 | - | 4-20-50 | 4RF | - | S,H | - | - | D | O | Casing 8-inch, set in bedrock to 5 feet, 2-inch to 300 feet with baffle. Backfilled above baffle to seal in artesian pressure. Water level in hole outside of 2-inch pipe was 50 feet below land surface. |
| 10-11-62 | - | 5-29-62 | 13R | - | H,C | 15.5 | C | D | I | Supplies cafe, motel, and (?)machine shop when facilities are open. Casing 9 5/8-inch to 98 feet, 1½-inch pipe to 335 feet with baffle 60 feet above bottom of hole. Formerly used as observation well. |
| 10- 8-64<br>9-13-77 | - | 7-13-63 | 32B | 150 | H | 15.0 | C | D | I | Casing 8 5/8-inch to 112 feet, 6 5/8-inch 3-350 feet; perforated 327-346 feet with ½-inch by 6-inch torch-cut slots. Also used as observation well. |
| 10-20-77 | - | 10-20-77 | 4RF | - | H,I | - | - | D | O | Casing 6-inch to 180 feet, cemented, with open hole below. Brackish water reported in sand and gravel above 97 feet. |
| 5-10-46 | - | 12- -38 | 4RF | - | U | - | B | D | I | Known as Camp well. First used to supply CCC Camp and later Grazing Service (now U.S. Bureau of Land Management) work camp. Later used to supplement Hanksville town supply. Unused in 1977. Casing record reportedly incomplete. Shallow water reported as "bad" 30-250 feet. |
| 8- 7-34 | - | 8- 7-34 | 5RF<br>27B | -<br>64 | P | - | B | D | O | Southeastern of two public-supply wells. Multiple casing installation with 2-inch pipe sealed to formation at 292 feet (see log for record of bailing tests). Sample of 1962 is mixture of water from both wells mixed in storage tank. Water has odor of hydrogen sulfide. |
| 4-14-52 | - | 4-14-52 | 3RF | - | P | - | - | D | O | Northwestern of two public-supply wells. In 1962 flowed to common storage tank (see above). Casing 8½-inch to 48 feet 2-inch 0-300 feet with welded baffle at 280 feet. Hole backfilled above baffle to seal in artesian pressure. |
| 10- 5-76 | - | 10- 5-64 | 4RF | - | H,S | - | C | D | - | Casing perforated 488-503 feet with 1/8-inch by 6-inch torch-cut slots. Artesian pressure sealed in by packer above perforations--10 feet of cement and backfilled with sand. |
| 11-19-66 | - | 11-19-66 | .8RF<br>19B | 130 | H | - | B | D | O | Supplies camp. Casing perforated 353-363 feet with ½-inch by 10-inch torch-cut slots. |
| 11- 4-77 | - | 11- 4-77 | 30R | - | H,S, I | - | - | D | O | "Brackish" water at 65 feet. Water-bearing zone in sandstone encountered at 330 feet. Cased to 112 feet, cemented in place. |
| 10-17-51 | - | 10-17-51 | 15B | 35 | H,I, S | - | - | D | O | Cased off loose sand at 406-435 feet. |
| 4-21-36 | - | - | - | - | U | - | - | - | I | Intended for public supply but never(?) used. See table 9 for water-level response to filling of adjacent surface-water reservoir. |
| 8-11-66 | P | 8-22-58 | 20E | - | H,N | - | - | - | I | Formerly supplied dairy. Also used as observation well. |
| 8-12-66 | - | - | - | - | S,H | 8.5 | B | - | - | |
| 12-11-48 | J | 8-22-58 | 10E | - | U | - | - | - | I | Former domestic well. Used as observation well. |
| 5- 6-76 | - | 4- 6-76 | 60B | 10 | H,S, I | - | - | D | O | |
| 7-14-74 | - | 7-14-75 | 50B | <1 | H,S, I | - | - | D | O | Shallow deposits sealed off with casing and slurry. |
| 12-29-74 | S | 12-29-74 | 1B | 110 | H,I | - | - | D | O | Casing perforated 30-140 feet with ½-inch by 3-inch torch-cut slots. Bailed well dry at 1 gal/min for 8 hours. |
| 1- 5-76 | S | 1- 5-76 | 35B | 36 | H,S, I | - | - | D | O | Casing perforated 75-100 feet with ½-inch by 2-inch slots with Mills knife. Water in overlying alluvium bailed at 7 gal/min, water level 3 feet below land surface. |

Table 6.--Records of selected

| Location | Owner | Year constructed | Depth of well (ft) | Casing diameter (in.) | Depth cased (ft) | Depth to first opening (ft) | Finish | Principal aquifer | Depth to aquifer (ft) | Altitude (ft) | Water level (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-29-5)32cad-1 | C. and H. Morgan | 1974 | 240 | 6 | 240 | 200 | P | 220NVJO | 0 | 7,050 | 13R |
| 34ddb-1 | Allan Dietlien | 1974 | 71 | 6 | 71 | 25 | F | 112GLCL | 21 | 7,020 | 22R |
| (D-29-6)14ccb-1 | Capitol Reef Lodge | 1954 | 138 | 4 | 21 | 21 | X | 112ALVM | 0 | 5,420 | 19S |
| (D-29-7)15dbd-1 | U.S. National Park Service | 1977 | 460 | 6 | 246 | 246 | X | 220NVJO | 240 | 5,045 | +42.6H |
| (D-29-11)1bbc-1 | Utah Department of Transportation | 1951 | 320 | 8 | 20 | 20 | X | 221ENRD | 18 | 4,460 | - |
| 36daa-10 | Energy Fuels, Ltd. | 1970 | 500 | 6 | 458 | 312 | P | 221ENRD | 0 | 4,795 | 169R<br>180.62S |
| 36dcd-1 | do. | 1976 | 400 | - | - | - | - | 221ENRD | 10 | 4,840 | - |
| (D-29-12)19bcd-1 | U.S. Bureau of Land Management | 1935 | 605 | 5 | 131 | 131 | X | 221CRML | 348 | 4,930 | 60.3S |
| 33acd-2 | do. | 1976 | 510 | - | - | - | X | 220NVJO | 210 | 4,616 | 140.9T |
| (D-29-13)1aab-1S | do. | 1959 | 1,200 | 10.75 | 1,200 | 1,194 | P | 231WNGT | 908 | 5,250 | - |
| (D-29-16)28cbc-1 | U.S. National Park Service | 1973 | 2,750 | 10 | 2,750 | 2,550 | P | 310CTLR | 2,215 | 6,570 | 2,492R |
| (D-30-5)10abb-1 | Carl Hansen | 1976 | 130 | 8 | 130 | 117 | P | 112GLCL | 118 | 7,180 | 17R |
| (D-30-11)5adb-1 | Ralph D. Pace | 1977 | 40 | 6 | 40 | 25 | P | 110PTOD | 0 | 5,010 | 15R |
| (D-30-14)23bbb-1 | U.S. Bureau of Land Management | 1973 | 860 | 5.5 | 860 | 740 | P | 231WNST | 600 | 5,440 | 600R |
| (D-30-15)13cbd-1 | Tenneco Oil Co. | 1966 | 760 | 4.75 | 15 | 15 | X | 310WTRM | - | 4,949 | 720R |
| 23dbc-1 | U.S. Bureau of Land Management | 1966 | 1,618 | 7 | 1,615 | 716 | P | 310WTRM | 700 | 4,821 | 750R |
| (D-31-7)36dad-1 | Robert Weaver | 1970 | 2,305 | 10.75 | 2,305 | 580 | P | 220NVJO | 580 | 5,361 | 305R |
| (D-31-8)19aad-1 | Christensen Ranch | 1956 | - | - | - | - | - | 111ALVM | - | 5,275 | - |
| (D-31-9)32ddd-1 | King Ranch | 1949 | 404 | 8 | 404 | 364 | P | 211EMRY | 350 | 5,925 | 350R |
| (D-31-12)4bab-1 | U.S. Bureau of Land Management | - | 450 | - | - | - | X | 220NVJO | 320 | 4,900 | - |

| Date measured | Type of lift | Date discharge measured | Discharge (gal/min) | Draw-down (ft) | Use of water | Tem-pera-ture (°C) | Data available: Chemical analysis | Data available: Log | Data available: Water levels | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 8- 1-74 | - | - | - | - | H | - | - | D | O | Casing perforated 200-240 feet with 3/8-inch by 5-inch torch-cut slots. |
| 7- 5-74 | - | 7- 5-74 | 6B | 49 | H,S, I | - | - | D | O | Casing perforated 25-50 feet with ½-inch by 3-inch torch-cut slots. Well graveled 0-60 feet. Bailed well dry at 6 gal/min for 2 hours. |
| 9- 7-77 | - | - | - | - | U | - | - | - | O | Test well. Never used because water was assumed to be poor quality. Gravel and sand to top of Chinle Formation at about 40 feet. |
| 9-15-77 | - | 9-14-77 | 38VF | - | U | 14.0 | C | A,E, F,G, J,T | I | USGS test hole 4. Completed as observation well. Casing 6-inch surface casing to 37 feet, 1½-inch pipe to 238 feet with Lynes packer set at 238-246 feet. Discharge listed is for unrestricted flow from 1½-inch pipe; hole produced an estimated 200 gal/min by airlift while drilling. Well flows 12 gal/min through ½-inch faucet. |
| - | - | 6- 4-51 | 15B | 10 | U | - | - | D | - | Driller reported water at 130-180 feet. Could be bailed dry, but well would fill overnight. Yield listed is for zone 200-320 feet. Well now buried under State Highway 95. |
| 4- 3-70 | T | 6-30-51 | 15B | 12 | U | 14.0 | B | D | I | Drilled to 315 feet in 1951 with 8-inch casing to 12 feet. Zone 195-250 feet yielded only two bailers full after recovery overnight. Deepened to 500 feet in 1970; all reported in sandstone. Casing 6-inch 0-458 feet, perforated with 1/8-inch by 6-inch torch-cut slots. Driller reported water at 300 feet was "gyppy" but improved with depth and quantity increased. Unused turbine pump pulled in September 1976. |
| - | - | - | - | - | - | - | C | - | - | Test hole for water supply at ore-buying station. |
| 5-10-46 | P | 1935 | 2VR | - | U | - | - | D | I | UERA well 99. Water reported by driller as "good." Grazier reported later that water was unfit for stock. Found filled in 1952. Formerly used as observation well. |
| 8-10-76 | - | 8-10-76 | 200E | - | U | 16.5 | C | G | O | USGS test hole 3. No water in Carmel Formation. Yields estimated during air-drilling ranged from an initial 5 gal/min to 200 gal/min at 510 feet. Water level measured after 17 hours of recovery. Sampled from air-drilling discharge after hole completed. Sampled for isotope analysis. |
| - | P | 9- -59 | 125R | - | U | - | - | G | - | Petroleum-test well drilled to 2,649 feet and abandoned because of junk in hole, plugged back and completed as water well. Casing 10 3/4-inch to 1,200 feet, gun-perforated in Wingate Sandstone 1,037-1,039, 1,066-1,078, 1,089-1,096, and 1,194-1,195 feet. Set cylinder pump at about 1,115 feet. Drilling crew drank the water. Well and pump turned over to U.S. Bureau of Land Management on completion of adjacent replacement petroleum-test well. |
| 11- -73 | - | 11- 5-73 | 5B | 200 | H | 14.5 | C | D | O | Near Hans Flat Ranger Station. Casing 10-inch to 2,015 feet, 8 5/8-inch to 2,750 feet, perforated 2,550-2,750 feet. Small amount of water in Wingate Sandstone. Cutler Formation fractured; lost circulation at 2,740 feet. Water sampled after 8 hours of bailing. |
| 1-12-76 | - | 1-12-70 | 35B | 20 | H,S, I | - | - | D | O | Casing perforated 117-127 feet with Mills knife slots ½-inch by 2-inch. |
| 10- 1-77 | - | 10- 1-77 | 25R | 20 | H,I | - | - | D | O | Casing perforated 25-35 feet with 1/8-inch by 8-inch torch-cut slots. |
| 1- 8-73 | P | 2- -73 | 40R | - | - | - | - | D | O | Drilled to supply petroleum-test well. Casing perforated 740-860 feet with ½-inch by 12-inch slots. Cylinder pump was set at 850 feet. Water reported as "good." |
| 6-29-66 | - | - | - | - | U | - | B | - | O | Corehole. Water in White Rim Sandstone Member of Cutler Formation. Sample bailed; water was black with strong odor of hydrogen sulfide. |
| 6-29-66 | - | - | - | - | N,S | - | B | - | O | Probably corehole converted to petroleum-test well supply. Casing perforated 716-1,615 feet with slots. |
| 11-12-70 | T | 7- -70<br>11-13-70 | 55B<br>161P | <1(?)<br>115 | I,H, S | 17.5 | C | - | O | Petroleum-test well converted to irrigation supply. Existing casing has been plugged at 2,305 feet. Mud bailed from hole and 200 gun-perforations made in zone 580-1,140 feet. Production test for 10 hours in November 1970. Well supplies water through pipeline to field on terrace to north. Sampled for isotope analysis. |
| - | - | - | - | - | H,S, I | - | C | - | - | No driller's record. Site is on alluvium over Entrada Sandstone. Analysis indicates water similar to that expected from Carmel Formation upstream. Concluded that alluvium is source and contains debris from Carmel Formation. |
| 6-14-49 | - | 6-14-49 | 15B | - | - | - | - | D | O | Casing 8-inch 0-59 feet, 6-inch 54(?)-404 feet, perforated 364(?)-404 feet with torch-cut slots. |
| - | P | 4- 7-61 | 12R | - | S | - | C | - | - | Known as Poison Wash well. Drilled to supply petroleum-test well. Later assigned to U.S. Bureau of Land Management. Incomplete driller's record. Cylinder pump was set at bottom of hole. Pumps into pipeline to troughs in Burr Desert. Water sample from faucet at (D-30-12)34abc on Dell Seeps road. |

Table 7.--Records of selected springs

Location: See text for description of well- and spring-numbering system.
Name or owner: Name given on maps of U.S. Geological Survey or U.S. Bureau of Land Management, name used or assigned by Goode and Olsen (1977), or name used by local residents; otherwise, landowner is given. Alternative name, if any, is given in remarks.
Altitude: Altitude of land surface at spring orifice(s) above mean sea level, interpolated from topographic maps.
Aquifer: See table 1 for explanation of code and description of geologic unit.
Discharge: Method of measurement - C, current meter; E, estimated; R, reported; V, volumetric (method unspecified but generally with bucket and stopwatch).
Chemical analysis available: A, physical data; B, commonly determined constituents; C, commonly determined constituents plus some trace elements. See table 13 for selected chemical analyses and table 14 for selected analyses of trace elements.

| Location | Name or owner | Altitude (feet) | Aquifer | Discharge: Gallons per minute | Discharge: Date measured | Water quality: Temperature (°C) | Water quality: Specific conductance (µmho/cm at 25°C) | Water quality: Date measured | Chemical analysis available | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| (D-24-5)13bcd-S1 | Willow Springs | 6,210 | 211FRRN | 15E | 9-29-76 | 17.0 | 1,250 | 9-29-76 | B | |
| (D-24-8)25dcd-S1 | Secret Springs | 5,200 | 230MNKP | 3E | 10- 7-75 | 15.0 | 4,500 | 10- 7-75 | B | Sampled 500 feet below spring orifice. |
| (D-24-10)3bba-S1 | Tan Seep | 6,700 | 230MNKP | 5E | 10-27-44 | 18.0 | - | 10-27-44 | B | Developed spring for stock. May flow from fault zone. |
| (D-24-13)20cca-S1 | Lost Spring | 4,790 | 221CRML | 2E | 10-28-58 | 16.5 | - | 10-28-58 | B | Also called Red Rock Spring. Developed for stock. Sampled from pipe below cribbed rock wall. |
| 24dcd-S1 | Crows Nest Spring | 4,520 | 220NVJO | - | - | - | - | - | - | Rises in stream channel at or near fault that throws Navajo Sandstone up against Entrada Sandstone. |
| (D-24-14)32adb-S1 | Cottonwood Spring | 4,375 | 220NVJO | - | - | - | - | - | - | Rises in stream channel at or near fault that throws Navajo Sandstone up against Entrada Sandstone. Only seepage when visited in 1976. |
| (D-25-12)4aac-S1 | Swazy Seep | 5,020 | 221CRML | - | 7- -77 | | - | - | - | Issues from base of Carmel Formation. D. Williamson of U.S. Bureau of Land Management found site dry in midsummer 1977. |
| (D-25-13)2cab-S1 | Seep | 4,525 | 220NVJO | - | - | - | - | - | - | In channel of Cottonwood Wash where wash is cut into top of Navajo Sandstone. |
| (D-26-9)16bbb-S1 | U.S. Bureau of Land Management | 4,630 | 231WNGT | .5E | 10- 7-75 | 15.0 | 520 | 10- 7-75 | C | Flows from fractured rock in right bank of Muddy Creek Canyon. |
| 21aac-S1 | do. | 4,640 | 220NVJO | - | - | 16.5 | 3,000 | 10- 8-75 | C | Flows from fault zone in right bank of canyon of Muddy Creek. Fault displacement 50 feet. |
| 24dbc-S1 | Hunt Ranch Spring | 4,550 | - | 50E | 8-29-75 | 16.5 | 1,550 | 8-29-75 | B | Most, if not all, flow is uncontrolled flow from old artesian well. |
| (D-27-4)36cbb-S1 | U.S. Forest Service | 9,160 | 111CLVM | <5E | 8- 4-76 | 16.0 | 500 | 8- 4-76 | B | Flows from colluvium consisting mainly of igneous debris that lies on Navajo Sandstone. |
| (D-27-6)23cba-S1 | Ackland Spring | 5,995 | 221SLWS | 1E | 5-22-75 | - | - | - | C | |
| (D-27-7)17bdb-S1 | Campers Spring | 5,420 | 111ALVM | 2E | 10- 3-75 | - | - | - | C | Discharge estimated by IPP. Flows from bank of sand near southeast edge of thicket of saltcedar, where channel deposits thin across outcrop of bedrock. |
| 23acd-S1 | U.S. Bureau of Land Management | 5,210 | 111ALVM | 5E | 10- 4-75 | - | - | - | C | Discharge estimated by IPP. Flows from channel deposits where they thin across bedrock outcrop. |
| (D-27-8)6bad-S1 | Seep | 5,030 | 220NVJO | 0 | 9-26-75 | - | - | - | C | Sampled by IPP. Area marked by moist alluvium and saltcedars. Sampled from pit dug in sand next to outcrop of uppermost Navajo Sandstone. |
| 11dac-S1 | Caine Springs | 4,820 | 221CRML | - | 1972 | - | - | - | C | Westernmost of many springs in main group called Caine Springs. The spring group is scattered more than 0.25 mile along north bank of Salt Wash, rising in small basins in the terrace above creek level and at base of terrace at creek level. In terrace, alluvium, and boglike deposits that overlie the Carmel Formation at the crest of an anticline. The Carmel Formation is distorted both by anticlinal folding and by collapse where gypsum has been dissolved away. Individual springs discharge from less than 1 to 75 gal/min each. Total outflow is approximately 2 $ft^3/s$. |
| 11dca-S1 | do. | 4,790 | 221CRML | <1E | 9- 4-75 | 16.0 | 4,400 | 9- 4-75 | A | Seepage from cut bank on Salt Wash about 0.25 mile west of main springs group. |
| 11dca-S2 | do. | 4,790 | 221CRML | <1E | 9- 4-75 | 16.0 | 5,500 | 9- 4-75 | A | Do. |
| 12cbd-S1 | do. | 4,820 | 221CRML | - | - | - | - | - | C | Sampled by Utah Division of Water Resources. |
| 12cca-S1 | do. | 4,815 | 221CRML | 16V | 11-23-75 | 14.5 | 7,500 | 11-23-75 | B | Rises in small isolated basin. Equipped with gage-height recorder and weir (see figs. 15 and 16B). |
| (D-27-16)20bdc-S1 | Water Canyon Spring | 4,750 | 220KYNT | 3E | 11-12-69 | 15.5 | - | 11-12-69 | C | |
| (D-28-7)11cdb-S1 | Rock Water Spring | 5,430 | 221SLWS | - | - | 15.5 | 2,960 | 7-17-75 | B | In bluff on south side of Hartnet Draw. |
| (D-28-8)5abd-S1 | Willow Seep | 5,050 | 111ALVM | .5E | 9-28-75 | - | - | - | C | Discharge estimated by IPP. Site dry in hottest weather, but flows when evapotranspiration diminishes. Rises in distance of about 100 feet along south bank of Caineville Wash where alluvium thins over Morrison Formation. Site marked by moderate growth of grass and brush. |
| 35bca-S1 | Seep | 4,600 | 111ALVM | 1E | 3-25-76 | 11.0 | 6,500 | 3-25-76 | A | Dry most of time. Seepage rises where alluvium in stream channel thins over Mancos Shale. |
| (D-28-12)27add-S1 | Upper Sand Slide Spring | 4,160 | 220NVJO | 1E | 9-20-76 | 11.0 | 700 | 9-20-76 | B | Seepage area discharges into single channel to right bank of Dirty Devil River. |
| (D-28-14)22cad-S1 | Robbers Roost Spring | 5,200 | 221CRML | 1E | 5- -57 | 11.0 | - | 5- -57 | C | Piped to stock troughs. Discharge reported variable. Discharges from base of Carmel Formation. |
| (D-28-15)21dbb-S1 | Blue John Spring | 5,780 | 221CRML | 1E | 5-21-57 | 12.0 | - | 5-21-57 | B,C | Piped to stock tank. |
| 29ddd-S1 | Granary Spring | 5,870 | 221ENRD | <1 | 11- 1-44 | - | - | - | B | Discharge reported to be a "trickle." |
| (D-29-3)14bcb-S1 | Pine Creek Spring | 6,920 | 120TRTR | 7,900C | 10-11-66 | 10.0 | - | 10-11-66 | B | Developed spring supplies fish hatchery and irrigation downstream. Discharge from jointed basalt flow. This and related springs account for much of the Fremont River flow (Bjorkland, 1969, p. 26). |
| (D-29-6)23bbb-S1 | Dewey Gifford Spring | 5,455 | 230MNKP | 10E | 9-25-58 | - | - | - | B | Described by Marine (1962). |

Table 7.--Records of selected springs--Continued

| Location | Name or owner | Altitude (feet) | Aquifer | Discharge: Gallons per minute | Discharge: Date measured | Water quality: Temperature (°C) | Water quality: Specific conductance (µmho/cm at 25°C) | Water quality: Date measured | Chemical analysis available | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| (D-29-7)18bdd-S1 | Chimney Rock Spring | 5,250 | 220NVJO | 5E | 5-13-76 | 10.0 | 1,200 | 5-13-76 | B | Discharge from bed of Chimney Rock Canyon at base of cliff of Navajo Sandstone. Canyon is dry upstream and has perennial flow below spring. |
| (D-29-10)22ccb-S1 | Bert Avery Seeps | 4,840 | 211FRRN | 1E | 7-25-75 | 20.0 | 535 | 6-15-77 | B | Discharges as seepage at base of sandstone in two east-facing alcoves below edge of Blue Mesa. Land surface above alcoves is a pediment cut on the Ferron Sandstone Member of Mancos Shale, where direct local recharge to the sandstone accounts for the freshwater at the spring. Part of the seepage is intercepted by a buried pipe and conveyed to stock trough where sample was taken. Total discharge may be several times that measured. |
| (D-29-12)33ca to (D-30-12)4ca | Pool Spring area | 4,630-4,640 | - | 0 | 1975-1977 | - | - | - | - | Site marked by saltcedar thickets along dry stream channels. No flow observed for several years. Site is covered with sand dunes and gravelly surface that overlies contact between Entrada Sandstone and Carmel Formation. |
| (D-29-12)35aaa-S1 | Beaver Wash Spring | 4,360 | 220NVJO | 200R | 7- -77 | - | - | - | - | D. Williamson of U.S. Bureau of Land Management reported perennial flow in Beaver Wash heads at this spring. Water flows through area of beaver dams and vegetation, disappears downstream, and reappears (probably at base of Navajo Sandstone). Flow reported is estimated net outflow. |
| (D-29-13)7abc-S1 | Angel Cove Spring | 4,150 | 220NVJO | 1E | 9-21-76 | 16.5 | 625 | 9-21-76 | B | Discharge at base of Navajo Sandstone above Fremont River level. Broad area of seepage. Area in and near overhang of cliff is covered with fern and algae. Total discharge may be larger than observed. |
| (D-29-15)14dbb-S1 | Trail Spring | 5,760 | 220NVJO | .5V | 5-22-57 | 9.0 | - | 5-22-57 | B | Developed for stock water. Measured at pipe to trough. |
| (D-30-8)31abc-S1 | Cottonwood Spring | 5,150 | 111ALVM | 0 | 8-23-75 | - | - | - | - | No water found, but site marked by small grove of cottonwoods. Bedrock consists of contorted beds of Carmel Formation. |
| (D-30-10)13bcb-S1 | Dugout Bench Spring | 5,560 | 110PTOD | 1E | 7-27-75 | 18.0 | 630 | 7-27-75 | C | Discharges from pediment gravel that probably overlies Tununk Member of Mancos Shale. |
| 20aca-S1 | Lower Lost Spring | 5,780 | 111CLVM | 9V<br>3V<br>5.5V | 7-27-75<br>10- 6-76<br>7- 3-77 | 12.0<br>12.5<br>12.0 | 780<br>610<br>780 | 7- 3-77<br>10- 6-76<br>7- 3-77 | C | Developed for stock. Discharges from colluvium and(or) terrace deposits that overlie the Ferron Sandstone Member of Mancos Shale. |
| 23cbb-S1 | Jet Basin Spring | 6,040 | 200MNCS | 14V | 8-28-76 | 13.5 | 680 | 8-28-76 | C | |
| 25bba-S1 | McClellan Wash | 6,140 | 110PTOD | 23V | 8-27-76 | 12.0<br>20.0 | 770<br>680 | 8-27-76<br>7- 2-77 | C | Sampled and discharge measured about 100 feet below main orifice. |
| 25bcb-S1 | Birch Spring | 6,320 | 110PTOD | 13V<br>8V | 8-27-76<br>7- 2-77 | 15.0<br>- | 620<br>680 | 8-27-76<br>7- 2-77 | C | Water disappears downstream. |
| 33cdb-S1 | Oak Spring (South) | 7,320 | 200MNCS | 150E | 7-26-75 | 8.0 | 320 | 7-26-75 | C | Discharges from sandstone over shale. |
| (D-30-11)5dbc-S1 | Cow Wash Spring | 5,080 | 110PTOD | 100V | 8- 3-76 | 23.0 | 680 | 8- 3-76 | C | Spring flow only after irrigation of fields on flat above. Owner reported no flow occurred in 1975. |
| (D-30-13)30cad-S1 | Dell Seeps | 5,140 | 221ENRD | 5E | 7-28-75 | 27.0 | 255 | 7-28-75 | C | Discharges at contact of Carmel Formation with overlying Entrada Sandstone. |
| (D-30-16)3aab-S1 | French Spring | 6,520 | 111ALVM | .7V | 9- 3-69 | 15.0 | - | 9- 3-69 | C | Developed for stock. Measured at discharge pipe. Water is perched on thin red siltstone in Navajo Sandstone. The sandstone in this area is mostly drained. |
| (D-31-7)1bcb-S1 | False Spring | 5,240 | - | 0 | 8-23-75 | 16.0 | 235 | 8-23-75 | - | Spring called "False" by Goode and Olsen (1977) because no evidence to show the pool is anything but a pothole or plunge pool partly filled with alluvium and rainwater. No discharge. Also noted on some maps as Five Mile Spring. |
| (D-31-8)7ada-S1 | Bank Spring | 5,120 | 111ALVM | 5E | 8-23-75 | 14.0 | 2,700 | 8-23-75 | - | Discharges from sandy alluvium over Entrada Sandstone in west bank of Sandy Creek. Alluvium derived mostly from Carmel Formation. |
| 24caa-S1 | Dripping Rock Spring | 5,030 | 211EMRY | 5E | 8-22-75 | 15.0 | 1,500 | 8-22-75 | C | Water discharges from buff sandstone over gray sandstone. |
| 27dab-S1 | Blind Trail Spring | 5,450 | 211EMRY | .1E | 8-22-75 | 19.0 | 2,500 | 8-22-75 | C | Discharges principally from thin bed (3-4 feet) of sandstone below massive sandstone caprock. In 1976 and 1977 visible discharge amounted to only a few drops per minute. Site marked by cottonwoods in canyon. |
| (D-31-9)18adc-S1 | Dead Cow Spring | 5,700 | 200MNCS | 10E | 7-31-75 | 19.0 | 1,300 | 7-31-75 | C | Specific conductance measured at spring. Water sample taken from spring stream near its confluence with Dugout Creek. |
| (D-31-10)14bdc-S1 | Lonesome Beaver Spring | 8,150 | 200MNCS | - | - | 19.0 | 410 | 7-29-75 | C | Developed for campground supply. Sampled at campground faucet. |
| 20bbd-S1 | Pistol Spring | 8,620 | 111CLVM | 67V<br>50V<br><1E | 7-30-75<br>7-17-76<br>7- 4-77 | 5.5<br>7.0<br>6.5 | 340<br>305<br>320 | 7-30-75<br>7-17-76<br>7- 4-77 | C | Discharge measured with tarpaulin in bed of spring stream using bucket and stopwatch. Estimated accuracy ±10 percent. Source is probably colluvium over shale. |
| 29bdb-S1 | Corral Point Spring | 8,320 | 111CLVM | 32V<br>31V<br>15V | 7-17-76<br>7-29-76<br>7- 3-77 | 8.0<br>7.5<br>9.0 | 350<br>350<br>350 | 7-17-76<br>7-29-76<br>7- 3-77 | C | Discharges from colluvium over Tununk Member of Mancos Shale |
| 30aaa-S1 | Aspen Hole Spring | 8,080 | 111CLVM | -<br>50V | -<br>7-29-76 | 6.5<br>8.0 | -<br>340 | 7-17-76<br>7-29-76 | C | Colluvium consists of igneous debris. Discharge measured 450 feet below orifice. Water rises in aspen grove but can be heard upslope above orifice. |
| 30ada-S1 | Beaver Dam Spring | 8,080 | 211FRRN | 50V | 7-29-76 | 8.0 | 460 | 7-29-76 | C | Discharges in aspen grove. Beaver dam blocks flow. Tufa deposits. |
| 31abb-S1 | McMillan Spring | 8,340 | 211FRRN | - | - | 9.0 | 750 | 7-30-75 | C | Also called McClellan Spring. Water piped to campground. Discharges at contact of Ferron Sandstone and Blue Gate Members of Mancos Shale. One water sample taken at campground. |

Table 7.--Records of selected springs--Continued

| Location | Name or owner | Altitude (feet) | Aquifer | Discharge: Gallons per minute | Discharge: Date measured | Water quality: Temperature (°C) | Water quality: Specific conductance (umho/cm at 25°C) | Water quality: Date measured | Chemical analysis available | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| (D-31-10)31ada-S1 | Willow Spring | 8,500 | 200MNCS | 110V | 7-30-75 | 8.0 | 740 | 7-30-75 | C | Discharge measured at road below spring orifices. Area contains willows in a swale near creek. |
| | | | | 110V | 7-16-76 | 7.0 | 680 | 7-16-76 | | |
| | | | | 23V | 7- 3-77 | 9.5 | 660 | 7- 3-77 | | |
| 32bcb-S1 | East Willow Spring | 8,530 | 200MNCS | 5E | 7-30-75 | 7.0 | 1,050 | 7-30-75 | C | Issues beside creek bottom. |
| | | | | <1E | 7- 3-77 | | | | | |
| (D-31-11)1bdc-S1 | Poison Spring | 5,230 | 221MRSN | 3E | 8- 1-75 | 24.5 | 1,025 | 8- 1-75 | C | Discharges from sandstone over shale. |
| (D-31-13)9bcd-S1 | Hunts Cabin Spring | 4,300 | 231UNGT | 3V | 6-20-57 | 17.5 | - | 6-20-57 | C | Developed for domestic supply at cabin (unused in 1976). Discharges from joints and bedding planes in overhang about 30 feet west of cabin and in north wall of canyon. Overhang is walled in, and water discharges through pipe. Much seepage and vegetation in area. |
| | | | | 4V | 7-26-76 | 19.0 | 550 | 7-26-76 | | |
| (D-32-8)21dba-S1 | Spring Canyon Spring | 5,500 | 211EMRY | 2E | 9- 1-76 | 20.0 | 2,975 | 9- 1-76 | C | Discharges in stream channel upstream from hogbacks of Emery Sandstone Member of Mancos Shale. Discharge may occur at contact with Masuk Member of Mancos Shale. Site marked by saltcedar and tall grasses. |
| (D-32-10)4bcd-S1 | South Fork Spring | 9,200 | 120TRTR | <.5E | 7-16-76 | 10.0 | 410 | 7-16-76 | | |
| | | | | <1E | 9-11-76 | | | | | |
| 8bdc-S1 | Igneous Spring | 8,160 | 111CLVM | 3V | 8-14-75 | 23.0 | 440 | 8-14-75 | C | Measured about 0.3 mile below spring. Temperature of water affected by low rate of discharge and distance from orifice. |
| | | | | | | 23.0 | 420 | 7-15-76 | | |
| | | | | <1E | 7- 4-77 | 14.0 | 460 | 7- 4-77 | | |
| 8cdb-S1 | Six Gallon Spring | 7,880 | 111CLVM | 6V | 8-14-75 | 13.0 | 1,250 | 8-14-75 | C | Discharges from colluvium over shale. |
| 18cba-S1 | U.S. Bureau of Land Management | 6,880 | 200MNCS | 5E | 8-14-75 | 15.5 | 6,500 | 8-14-75 | C | Discharges from thin bed of sandstone in Mancos Shale. |
| (D-33-8)2ccd-S1 | Divide Canyon Spring | 6,100 | 211MVRD | 10E | 8-13-75 | 14.5 | 1,500 | 8-13-75 | C | Discharges from buff sandstone over gray sandstone near bottom of steep canyon about 300 feet below rim of Tarantula Mesa. |

Table 8.--Records of selected petroleum-test wells and core holes

[The term, freshwater, as reported by petroleum companies does not necessarily agree with the definition given in the introduction to this report. As reported by the petroleum companies, freshwater may include slightly to moderately saline water; the reported term, salt water, may include moderately saline water to brine.]

Location: See text for description of well- and spring-numbering system. D, well deepened, or S, well plugged back in year shown as year constructed; W, test well converted to water well (see table 6).
Name: Shows company that drilled well, followed by the number of well drilled in individual lease area, followed by landowner or other lease holder.
Altitude: Altitude of land surface at well, above mean sea level. Many altitudes are those reported by company drilling well, but all have been checked against topographic maps and have been modified where reported value seems seriously in error. S, altitude verified by surveying altimeter.
Selected geologic data: Formation code - See table 1 for explanation of code and description of lithology. Depths - All have been adjusted, where possible, to depth below land surface. Some are below company's reference datum, but difference is generally less than 15 feet.
Interval tested: Except as noted in the remarks, interval was isolated with packers and sampled through the drill stem. Depths have been adjusted, where possible, as noted under selected geologic data.
Other data available: Chemical analysis in table 13 and analyses of trace elements in table 14 - B, commonly determined constituents; C, commonly determined constituents plus some trace elements. DR, log in table 10.
Remarks: DST, drill-stem test.

| Location | Name | Year constructed | Altitude (feet) | Depth drilled (feet) | Selected geologic data: Formation code | Selected geologic data: Depth to top (feet) | Selected geologic data: Depth to bottom (feet) | Interval tested: Depth to top (feet) | Interval tested: Depth to bottom (feet) | Other data available | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-23-9)17cbd-1 | Amerada No. 1 Federal | 1962 | 7,046 | 3,665 | 220NVJO | 0 | 587 | - | - | - | Yield reported to be 4-6 gal/min at 1,248 feet. |
| | | | | | 231WNGT | 914 | 1,219 | - | - | | |
| | | | | | 310CCNN | 2,322 | - | - | - | | |
| (D-23-10)24dcc-1 | Pan American No. 1 Anderson | 1958 | 6,840 | 2,000 | 310CCNN | 320 | - | - | - | - | |
| | | | | | 330MSSP | 1,600 | - | - | - | | |
| 28dbb-1 | Amerada No. 1-354 Federal | 1961 | 6,818 | 3,144 | 330MSSP | - | - | - | 2,197 | C | |
| | | | | | | | | | 2,265 | | |
| (D-23-11)22ccc-1 | Standard Oil California No. 1 Federal | 1936 | 6,710 | 2,285 | 310KIBB | 0 | - | - | - | - | Tested Hermosa Formation. See composite log of lithology for this well and (D-23-11)27bbd-1 in Baker (1946, p. 117-120). |
| 27bbd-1 | Standard Oil California No. 2 Federal | 1936 | 6,690 | 4,900 | 310CCNN | 0 | - | - | - | - | See composite log of lithology for this well and (D-23-11)22ccc-1 in Baker (1946, p. 117-120). |
| | | | | | 400PCMB | 4,885 | - | - | - | | |
| (D-23-13)7dcc-1 | Kerr-McGee No. 1 Texas Pacific | 1957 | 6,520 | 2,218 | 310CCNN | 0 | - | - | - | - | Water reported at approximately 900 feet. Fault at 1,000(?) feet. DST(S) in massive Mississippian rocks yielded no water. |
| | | | | | 320PSLV | 763 | - | - | - | | |
| | | | | | 330MSSP | 1,012 | 1,680 | - | - | | |
| | | | | | 370CMBR | 1,965 | - | - | - | | |
| (D-23-14)19ddb-1 | Monsanto No. 1 Federal | 1958 | 4,378 | 6,060 | 221ENRD | 0 | - | - | - | - | |
| | | | | | 220NVJO | - | 1,018 | - | - | | |
| | | | | | 231WNGT | 1,246 | 1,610 | - | - | | |
| | | | | | 310CCNN | 2,665 | - | - | - | | |
| | | | | | 330MSSP | 5,898 | - | - | - | | |
| (D-23-15)21bab-1 | Shell No. 1 Federal | 1959 | 4,679 | 7,702 | 221ENRD | 370 | 385 | - | - | B | |
| | | | | | 220NVJO | 1,190 | 1,640 | - | - | | |
| | | | | | 231WNGT | 1,913 | 2,234 | - | - | | |
| | | | | | 310CCNN | 3,260 | 3,711 | - | - | | |
| | | | | | 330MSSP | 7,452 | - | 7,500 | 7,702 | | DST 1 recovered 3,240 feet of salt water. Well drilled using salty mud, but water is same in wells nearby. |
| (D-23-16)3bca-1 | Mobil No. 12-3 Federal | 1961 | 4,038 | 9,450 | 221SLWS | 0 | - | - | - | B | |
| | | | | | 220NVJO | - | 1,280 | - | - | | |
| | | | | | 231WNGT | 1,497 | 1,900 | - | - | | |
| | | | | | 310WTRM | 2,805 | 3,228 | - | - | | |
| | | | | | 330MSSP | - | - | 8,530 | 8,715 | | DST recovered 1,150 feet of mud-cut salt water and 2,000 feet of salt water. |
| 15dca-1 | Mobil No. 34-15 Federal | 1961 | 4,050 | 8,440 | 221ENRD | 0 | 363 | - | - | B | Well yielded slight flow at 800 feet. Yield 3.3 gal/min at 2,530-2,570 feet, 150 gal/min at 3,115 feet, and 146 gal/min at 3,240 feet. |
| | | | | | 220NVJO | 539 | 948 | - | - | | |
| | | | | | 231WNGT | 1,210 | 1,521 | - | - | | |
| | | | | | 310WTRM | 2,540 | 2,860 | - | 2,510 | | |
| | | | | | 319ELPC | 3,113 | 3,803 | - | - | | |
| | | | | | 330MSSP | 8,028 | - | 8,210 | 8,440 | | DST 1 recovered 651 feet of mud and 6,929 feet of salt water. |

Table 8.--Records of selected petroleum-test wells and core holes--Continued

| Location | Name | Year constructed | Altitude (feet) | Depth drilled (feet) | Selected geologic data: Formation code | Selected geologic data: Depth to top (feet) | Selected geologic data: Depth to bottom (feet) | Interval tested: Depth to top (feet) | Interval tested: Depth to bottom (feet) | Other data available | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-24-7)16daa-1 | True No. 43-16 State | 1975 | 5,560 | 3,583 | 310KIBB | 3,534 | - | - | - | - | |
| (D-24-9)7dab-1W | Amerada No. 1-362 Armstrong | 1961 | 5,635 | 1,835 | 230MNKP | 0 | 524 | - | - | - | Freshwater zone at 184-188 feet left for water well. Water also found at 1,242 feet in Pennsylvanian and Permian rocks. Mississippian rocks described as eroded. |
| | | | | | 310CCNN | 551 | - | - | - | | |
| | | | | | 330MSSP | 1,296 | 1,832 | - | - | | |
| | | | | | 341OURY | 1,832 | - | - | - | | |
| (D-24-13)2cab-1 | Superior No. 23-2 Stancal | 1958 | 4,529 | 5,326 | 231WNGT | - | 1,263 | - | - | B | Pumped 12,260 gallons of water and small amount of oil from perforations. |
| | | | | | 230MNKP | 1,562 | 2,200 | 1,800 | 1,885 | | |
| | | | | | 237SNBD | 2,038 | - | 2,041 | 2,065 | | DST 5 recovered 95 feet of mud and 1,225 feet of black sulfur water. |
| | | | | | 310CCNN | 2,200 | 2,830 | - | - | | |
| | | | | | 330MSSP | 3,775 | - | - | - | | |
| | | | | | 371LYNC | 5,170 | - | - | - | | |
| 2ccd-1 | Iron Wash Oil No. 1 State | 1950 | 4,760 | 2,381 | 221ENRD | 0 | - | - | - | - | |
| | | | | | 220NVJO | 333 | 860 | - | - | | |
| | | | | | 231WNGT | 1,060 | 1,340 | - | - | | |
| | | | | | 310CCNN | 2,329 | - | - | - | | |
| 3dbb-1 | Security No. 1 Federal | 1970 | 4,510 | 3,800 | 220NVJO | 88 | 500 | - | - | - | |
| | | | | | 231WNGT | 680 | 1,080 | - | - | | |
| | | | | | 310CCNN | 2,070 | 2,721 | - | - | | |
| | | | | | 330MSSP | 3,600 | - | - | - | | |
| 11adb-1W | Texas Gas Exploration No. 1 Federal | 1974 | 4,740 | 4,224 | 221ENRD | 0 | 218 | - | - | - | Plugged back to 1,400 feet and left as water well. |
| | | | | | 220NVJO | 480 | 922 | - | - | | |
| | | | | | 231WNGT | 1,232 | 1,525 | - | - | | |
| | | | | | 324HRMS | 3,567 | - | 3,814 | 3,868 | | DST recovered 2,825 feet of water. |
| 32bbd-1 | Union No. 1 State | 1967 | 4,844 | 2,355 | 221ENRD | 10 | - | - | - | - | |
| | | | | | 220NVJO | 177 | 797 | - | - | | |
| | | | | | 231WNGT | 998 | 1,325 | - | - | | |
| | | | | | 310CCNN | 2,265 | - | - | - | | |
| (D-24-14)10aac-1 | Union Texas Petroleum No. 1 Federal | 1972 | 4,308 | 7,284 | 221ENRD | 0 | - | - | - | C | |
| | | | | | 220NVJO | 280 | - | - | - | | |
| | | | | | 231WNGT | - | 1,373 | - | - | | |
| | | | | | 310CCNN | 2,341 | - | - | - | | |
| | | | | | 330MSSP | 6,102 | 6,912? | 6,120 | 6,353 | | DST recovered 1,530 feet of slightly mud-cut salt water and 21,753 feet of salt water. |
| 21dab-1 | Carter No. 1 Federal | 1958 | 4,321 | 7,655 | 221ENRD | 0 | - | - | - | - | |
| | | | | | 220NVJO | 220 | - | - | - | | |
| | | | | | 231WNGT | - | 1,325 | 2,114 | 2,340 | | DST recovered 180 feet of mud, 630 feet of mud-cut water, and 740 feet of brackish water. |
| | | | | | 230MNKP | 1,688 | 2,295 | 2,160 | 2,175 | | DST recovered 176 feet of mud-cut water and 1,356 feet of black sulfur water. |
| | | | | | 310CCNN | 2,295 | 2,990 | - | - | | |
| | | | | | 330MSSP | 7,144 | - | 7,200 | 7,350 | | DST recovered 105 feet of water-cut mud, 1,600 feet of muddy water, and 5,190 feet of brackish water. |
| (D-24-15)5caa-1 | General Petroleum No. 45-5-G Federal | 1950 | 4,260 | 7,161 | 221ENRD | 0 | 215 | - | - | - | |
| | | | | | 220NVJO | 360 | 880 | - | - | | |
| | | | | | 231WNGT | 1,090 | 1,410 | - | - | | |
| | | | | | 310CCNN | 2,470 | 3,030 | - | - | | |
| | | | | | 324HRMS | 3,220 | 6,681 | 3,618 | 3,712 | | DST recovered 1,800 feet of sulfur water. |
| | | | | | 330LDVL | 6,832 | - | - | - | | |
| 6caa-1 | P. B. English No. 1 Moore | 1954 | 4,110 | 2,370 | 221ENRD | 0 | - | - | - | | |
| | | | | | 220NVJO | 230 | 740 | - | - | | |
| | | | | | 231WNGT | 950 | 1,320 | - | - | | |
| (D-24-16)15acd-1 | Pledger No. 1 Federal | 1964 | 4,272 | 5,370 | 220NVJO | - | 440 | - | - | B | Casing 9 5/8 in. to 158 feet, cemented; 5 1/2 in. to 4,596 feet, cemented with 255 sacks of cement. On June 19, 1966, water discharge was reported at 2 gal/min from annulus between the two casings. |
| | | | | | 231WNGT | 766 | 1,050 | 158 | <4,596 | | |
| | | | | | 310CCNN | 2,047 | - | - | - | | |
| | | | | | 324HRMS | 2,698 | - | - | - | | |
| 19bda-1 | Shell No. 1 Federal | 1958 | 4,758 | 8,677 | 221ENRD | 10 | - | - | - | B | |
| | | | | | 220NVJO | 488 | - | - | - | | |
| | | | | | 231WNGT | - | 1,548 | - | - | | |
| | | | | | 310CCNN | 2,552 | 2,946 | - | - | | |
| | | | | | 310CTLR | 2,946 | 3,309 | - | - | | |
| | | | | | 330RDLL | 7,570 | 8,263? | 7,968 | 8,067 | | DST recovered 6,900 feet of salt water with strong odor of hydrogen sulfide. |
| (D-25-5)13cca-1 | American Liberty No. 1 Federal | 1948 | 5,927 | 4,493 | 221ENRD | 0 | 215 | - | - | - | |
| | | | | | 220NVJO | 610 | 2,217 | - | - | | |
| | | | | | 231WNGT | 2,355 | 2,723 | - | - | | |
| | | | | | 310CCNN | 4,315 | - | - | - | | |
| 14dbb-2 | Mountain Fuel No. 1A Federal | 1966 | 5,971 | 4,590 | 221ENRD | 0 | 332 | - | - | - | First hole abandoned. Drilled with air. Driller reported salt water encountered at 602 feet, in Carmel, formation was pumped at estimated 126 gal/min (180 barrels per hour). |
| | | | | | 220NVJO | 1,466 | 2,415 | - | - | | |
| | | | | | 231WNGT | 2,610 | 2,945 | - | - | | |
| | | | | | 230MNKP | 3,180 | 4,400 | 3,990 | 4,090 | | DST recovered 3,000 feet of muddy water |
| | | | | | 310CCNN | 4,562 | - | - | - | | |
| (D-25-9)27bba-1 | Amax No. 1 Federal | 1959 | 5,920 | 3,382 | 310CCNN | - | 830 | - | - | - | |
| | | | | | 330LDVL | 1,850 | 2,455? | - | - | | |
| (D-25-12)1dcc-1 | Union No. 019-1 Federal | 1967 | 4,880 | 2,355 | 221ENRD | 10 | - | - | - | - | |
| | | | | | 220NVJO | 177 | 797 | - | - | | |
| | | | | | 231WNGT | 998 | 1,325 | - | - | | |
| | | | | | 310CCNN | 2,265 | - | - | - | | |

Table 8.--Records of selected petroleum-test wells and core holes--Continued

| Location | Name | Year constructed | Altitude (feet) | Depth drilled (feet) | Selected geologic data: Formation code | Selected geologic data: Depth to top (feet) | Selected geologic data: Depth to bottom (feet) | Interval tested: Depth to top (feet) | Interval tested: Depth to bottom (feet) | Other data available | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-25-12)24bbb-1 | Pan American No. 1 American Petrofina | 1958 | 5,025 | 5,929 | 221ENRD | 10 | - | - | - | - | |
| | | | | | 220NVJO | 319 | 926 | - | - | | |
| | | | | | 231WNGT | 1,110 | 1,462 | - | - | | |
| | | | | | 310CCNN | 2,395 | 3,355 | - | - | | |
| | | | | | 324HRMS | 3,896 | 4,990 | 4,430 | 4,492 | | DST recovered 90 feet of mud-cut water and 1,230 feet of fresh(?) water. |
| | | | | | 330LDVL | 5,140 | 5,238 | - | - | | |
| | | | | | 330MDSN | 5,238 | - | 5,530 | 5,600 | | DST recovered 350 feet of mud and 4,500 feet of slightly(?) salty water. |
| 34ccc-1 | Delhi No. 1 Russell | 1953 | 5,157 | 6,008 | 221ENRD | 0 | 298 | - | - | - | |
| | | | | | 220NVJO | 694 | 1,145 | - | - | | |
| | | | | | 231WNGT | 1,420 | 1,745 | - | - | | |
| | | | | | 310CCNN | 2,680 | 3,350? | - | - | | |
| | | | | | 324PRDX | 4,755 | 5,185 | 4,785 | 4,988 | | DST recovered 300 feet of mud and 3,350 feet of water-cut mud with carbon dioxide. |
| | | | | | 330MSSP | 5,590 | 5,790 | - | - | | |
| | | | | | 340DVNN | 5,790 | - | 5,789 | 6,008 | | DST recovered 3,060 feet of water. |
| (D-25-13)11bbb-1 | Union No. 1(998-A) Federal | 1967 | 4,743 | 5,175 | 220NVJO | 85 | 563 | - | - | B | Sampled May 3, 1976, by bailing. Water level reported at 450 feet. Water mainly from Navajo and Wingate Sandstones. |
| | | | | | 231WNGT | 784 | 1,107 | - | - | | |
| | | | | | 310CCNN | 1,971 | 2,670 | | | | |
| | | | | | 324HRMS | 3,320 | 3,494 | 3,740 | 3,750 | | Tested three zones by perforation, acidizing, and swabbing. Recovered only water. No thorough test of water yield. |
| | | | | | 330RDLL | 3,492 | 4,644 | 3,495 | 3,520 | | |
| | | | | | | | | 4,160 | 4,180 | | |
| 14bbc-1 | Texaco No. 1 Federal | 1959 | 4,900 | 7,314 | 221ENRD | 10 | - | - | - | - | |
| | | | | | 231WNGT | - | 1,250 | - | - | | |
| | | | | | 230MNKP | 1,592 | 2,176 | 1,550 | 1,649 | | DST recovered 550 feet of water-cut mud with globules of black oil and 540 feet of sulfur water with oil specks. |
| | | | | | 310CCNN | 2,176 | - | 2,174 | 2,224 | | DST recovered 180 feet of mud and 1,365 feet of sulfur water. |
| | | | | | 330LDVL | 3,622 | 4,554 | - | - | | |
| | | | | | 400PCMB | 6,260 | - | - | - | | |
| (D-25-14)21bdb-1 | Reynolds and Carver No. 1 Federal | 1969 | 4,750 | 5,144 | 220NVJO | 90 | - | - | - | - | |
| | | | | | 310CCNN | 2,158 | - | - | - | | |
| 22cdd-1 | Texaco No. 2 Federal | 1960 | 4,770 | 7,010 | 231WNGT | - | 1,114 | - | - | - | |
| | | | | | 230MNKP | 1,474 | 2,042 | 1,855 | 1,860 | | Swabbed perforations; yielded 7 gal/min of water for 14 hours. |
| | | | | | 310CCNN | 2,042 | - | - | - | | |
| | | | | | 330MSSP | 4,392 | 5,232 | - | - | | |
| | | | | | 341ELBR | 5,303 | 5,672? | 5,340 | 5,841 | | DST recovered 4,400 feet of brackish water. |
| | | | | | 400PCMB | 6,856 | - | - | - | | |
| (D-25-15)15abd-1 | Superior No. 31-15 Federal | 1963 | 4,960 | 6,470 | 220NVJO | 353 | 764 | - | - | C | |
| | | | | | 231WNGT | 986 | 1,416 | - | - | | |
| | | | | | 310CCNN | 2,471 | - | - | - | | |
| | | | | | 324PRDX | - | - | 4,819 | 4,855 | | DST recovered 290 feet of water. |
| | | | | | 330MSSP | 6,212 | - | 6,230 | 6,470 | | DST recovered 5,560 feet of salt water. |
| 22aca-1 | Conoco No. 2 Federal | 1953 | 4,840 | 6,396 | 221ENRD | 0 | 185 | - | - | B | |
| | | | | | 220NVJO | 320 | 840 | - | - | | |
| | | | | | 231WNGT | 1,105 | 1,393 | - | - | | |
| | | | | | 310CCNN | 2,445 | 2,822 | - | - | | |
| | | | | | 324HRMS | 3,283 | - | 4,345 | 4,376 | | DST 6 in upper Hermosa Formation recovered 3,570 feet of salt water. |
| | | | | | 324PRDX | 4,955 | - | 4,950 | 5,062 | | DST 2 recovered 60 feet of mud-cut water and 750 feet of gas-cut sulfur water. |
| | | | | | 330MSSP | 5,916 | - | 6,085 | 6,220 | | DST 5 recovered 5,460 feet of sulfur water. |
| 32cad-1 | Standard Oil California No. 1 State | 1956 | 5,075 | 5,843 | 220NVJO | 250 | 810 | - | - | | |
| | | | | | 231WNGT | 1,042 | 1,330 | - | - | | |
| | | | | | 310CCNN | 2,294 | 2,743 | - | - | | |
| | | | | | 310CTLR | 2,743 | 3,190 | - | - | | |
| | | | | | 330MSSP | 5,594 | - | 5,631 | 5,843 | | DST recovered 825 feet of watery drilling fluid and 3,870 feet of dark muddy sulfur water. |
| (D-25-16)10bac-1 | Shell No. 2 Federal | 1959 | 4,738 | 7,370 | 220NVJO | 40 | 484 | - | - | B | |
| | | | | | 231WNGT | 778 | 1,072 | - | - | | |
| | | | | | 310CCNN | 2,160 | 2,377 | - | - | | |
| | | | | | 310CTLR | 2,377 | 2,710 | - | - | | |
| | | | | | 330RDLL | 6,707 | - | 6,898 | 7,092 | | DST 1 recovered 1,470 feet of muddy salt water and 4,395 feet of salt water. |
| 29cdb-1 | Standard Oil California No. 1 Federal | 1957 | 4,853 | 6,701 | 220NVJO | 117 | 610 | - | - | B | |
| | | | | | 231WNGT | 842 | 1,235 | - | - | | |
| | | | | | 310CCNN | 2,319 | 2,625 | - | - | | |
| | | | | | 310CTLR | 2,625 | - | - | - | | |
| | | | | | 330MSSP | 6,359 | - | 6,480 | 6,594 | | DST 3 recovered 180 feet of watery mud, 900 feet of muddy water, and 4,550 feet of black sulfur water. |
| (D-26-4)15bdd-1 | Mountain Fuel No. 1 Federal | 1966 | 8,181 | 6,485 | 221ENRD | 910 | 1,680 | - | - | DR | |
| | | | | | 220NVJO | 3,455 | - | 4,080 | 4,115 | | DST recovered 1,734 feet of water. |
| | | | | | 231WNGT | - | 4,975 | - | - | | |
| | | | | | 310KIBB | 6,465 | - | 6,468 | 6,485 | | DST recovered 200 feet of brackish water. |
| (D-26-6)11aad-1 | Energetics 41X-11 Federal | 1973 | 5,861 | 3,405 | 220NVJO | 425 | 1,475 | - | - | - | Water reported to be in Navajo Sandstone. |
| | | | | | 231WNGT | 1,675 | - | - | - | | |

Table 8.--Records of selected petroleum-test wells and core holes--Continued

| Location | Name | Year constructed | Altitude (feet) | Depth drilled (feet) | Selected geologic data: Formation code | Selected geologic data: Depth to top (feet) | Selected geologic data: Depth to bottom (feet) | Interval tested: Depth to top (feet) | Interval tested: Depth to bottom (feet) | Other data available | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-26-7)7cad-1 | Colorado Energetics No. 23-X Federal | 1973 | 6,017 | 3,230 | 220NVJO | 214 | - | - | - | - | |
| 17bca-1W | Mountain Fuel No. 1 Federal | 1946 | 6,125 | 3,845 | 220NVJO | 204 | 1,270 | - | - | - | Plugged back to 1,134 feet and left for freshwater supply. |
| | | | | | 231WNGT | 1,500 | 1,707 | - | - | | |
| | | | | | 310CCNN | 3,038 | 3,458 | - | - | | |
| 17bdb-1 | Mountain Fuel No. 1-A Federal | 1947 | 6,124 | 8,518 | 220NVJO | 204 | 1,250 | - | - | - | |
| | | | | | 231WNGT | 1,387 | 1,730 | - | - | | |
| | | | | | 310CCNN | 3,075 | 4,035 | - | - | | |
| | | | | | 330MSSP | 4,630 | - | - | - | | |
| 17cba-1 | Ramsey No. 1 Senior | 1934 | 6,122 | 3,168 | 220NVJO | 215 | 1,195 | - | 1,100 | - | Well produced (bailed?) 7 gal/min when well was 963 feet deep. Water in Navajo Sandstone "stood" at 900 feet, which seemed to be its level when well was 1,100 feet deep. Water level was about 740 feet below land surface when well was 1,745 feet deep. Well produced natural gas from Moenkopi Formation. |
| | | | | | 231WNGT | 1,270 | 1,689 | - | 1,745 | | |
| | | | | | 310CCNN | 3,002 | - | - | - | | |
| 17cda-1 | Byrd-Frost No. 1 English | 1952 | 6,118 | 2,753 | 220NVJO | 220 | 1,240 | - | - | - | Water reported in Sinbad Limestone Member of Moenkopi Formation. |
| | | | | | 231WNGT | 1,310 | 1,710 | - | - | | |
| | | | | | 237SNBD | 2,738 | - | - | - | | |
| 18aab-1 | Coleman 1A English | 1951 | 6,084 | 2,875 | 220NVJO | 230 | 1,309 | - | - | - | Well reported to produce 1½ gal/min at 852-855 feet, 3½ gal/min at 860-870 feet, and an unmeasured increase at 946-968 feet. |
| | | | | | 231WNGT | 1,416 | 1,734 | - | - | | |
| 19bbd-1 | Shell No. 1 Federal | 1960 | 5,955 | 6,704 | 220NVJO | 390 | 1,384 | - | - | C | |
| | | | | | 231WNGT | 1,527 | 1,909 | - | - | | |
| | | | | | 310CCNN | 3,342 | 3,502 | - | - | | |
| | | | | | 300PLZC | 3,502 | 4,304? | 3,706 | 3,921 | | Rocks equivalent to Supai Formation. DST recovered 2,218 feet of mud-cut sulfur water. |
| | | | | | 330RDLL | 5,002 | 5,906? | 5,420 | 5,530 | | DST recovered 3,890 feet of mud-cut water and sulfur water. |
| | | | | | 341ELBR | 6,220 | 6,672? | 6,300 | 6,704 | | DST recovered 4,540 feet of mud-cut water. |
| 20dab-1 | Shumway Mining No. 1 Parker | 1957 | 5,200 | 2,620 | 220NVJO | 38 | 1,050 | 603 | 650 | B | |
| | | | | | 231WNGT | 1,137 | 1,537 | - | 1,450 | | |
| | | | | | 231CHNL | 1,537 | 1,745 | 1,655 | 1,660 | | |
| (D-26-8)14bdb-1 | Texaco No. 1 Federal | 1967 | 6,480 | 4,415 | 220NVJO | 0 | - | - | - | - | Drill-stem test produced no water. |
| | | | | | 310CCNN | 2,620 | - | - | - | | |
| | | | | | 330MSSP | 4,330 | - | - | - | | |
| (D-26-13)17cdb-1 | Larue No. 1 Kerr-McGee | 1962 | 5,262 | 5,780 | 221ENRD | 10 | - | - | - | - | |
| | | | | | 220NVJO | - | 1,150 | - | - | | |
| | | | | | 231WNGT | 1,380 | 1,675 | - | - | | |
| | | | | | 310CCNN | 2,625 | - | - | - | | |
| | | | | | 330MSSP | 5,565 | - | - | - | | |
| 25cbd-2D | Pan American No. 9 Humble | 1949 | 5,402 | 6,380 | 221ENRD | 0 | 300 | - | - | - | |
| | | | | | 220NVJO | 540 | 1,000 | - | - | | |
| | | | | | 231WNGT | 1,350 | 1,630 | - | - | | |
| | | | | | 310WTRM | 2,572 | 3,225 | - | - | | |
| | | | | | 324HRMS | 4,186 | 5,394 | 5,035 | 5,135 | | DST recovered 960 feet of water-cut mud, 775 feet of mud-cut water, and 1,920 feet of fresh(?) water. |
| | | | | | | | | 5,147 | 5,220 | | DST recovered 300 feet of mud-cut water and 3,618 feet of water with odor of hydrogen sulfide. |
| | | | | | 330MSSP | 5,464 | 6,144 | 5,540 | 5,641 | | DST recovered 465 feet of slightly water-cut mud, 651 feet of mud-cut salt water, and 2,718 feet of slightly mud-cut salty sulfur water. |
| 32aaa-1 | Callahan No. 1 State | 1946 | 5,390 | 2,638 | 221ENRD | 10 | - | - | - | - | |
| | | | | | 310CCNN | 2,605 | - | - | - | | |
| 35aca-1 | Pan American No. 10 Humble | 1964 | 5,652 | 6,040 | 221ENRD | 0 | 566 | - | - | - | |
| | | | | | 220NVJO | 740 | 1,238 | - | - | | |
| | | | | | 310CCNN | 2,813 | - | - | - | | |
| | | | | | 330MSSP | 5,923 | - | 5,940 | 6,040 | | DST recovered 860 feet of slightly mud-cut water and 2,954 feet of sulfur water. |
| (D-26-14)7bbc-1 | Odessa No. 1 Shannon | 1959 | 5,155 | 5,750 | 221ENRD | 0 | - | - | - | B | |
| | | | | | 220NVJO | 490 | - | - | - | | |
| | | | | | 231WNGT | 1,197 | - | - | - | | |
| | | | | | 310CCNN | 2,247 | - | - | - | | |
| | | | | | 331MDSN | 5,617 | - | 5,619 | 5,750 | | DST recovered 180 feet of mud-cut sulfur water and 2,595 feet of sulfur water. |
| 26ddc-1 | Carter No. 1 Federal | 1958 | 5,680 | 6,700 | 221ENRD | 10 | - | - | - | - | |
| | | | | | 231WNGT | - | 1,806 | - | - | | |
| | | | | | 310WTRM | 2,747 | 3,353 | - | - | | |
| | | | | | 330MSSP | 6,436 | - | 6,500 | 6,700 | | DST recovered 810 feet of muddy salt water and 4,240 feet of slightly salty sulfur water. |
| 30cdb-1 | Humble No. 7 Federal | 1961 | 5,330 | 6,007 | 221ENRD | 10 | - | - | - | C | |
| | | | | | 220NVJO | 557 | - | - | - | | |
| | | | | | 310CCNN | 2,614 | - | - | - | | |
| | | | | | 330MSSP | 5,812 | - | 5,860 | 6,007 | | DST 3 recovered 3,628 feet of slightly mud-cut water. |
| (D-26-16)31ccd-1 | Hunt Oil No. 1 Federal | 1972 | 5,210 | 5,000 | 220NVJO | - | 630 | - | - | - | Drilled with air. Well producing an estimated 18 gal/min of freshwater by air lift. Producing an estimated 100 gal/min of slightly brackish water by air lift. |
| | | | | | 231WNGT | 790 | 1,170 | 965 | - | | |
| | | | | | 310WTRM | 2,198 | 2,720 | 2,280 | 2,550 | | |

Table 8.--Records of selected petroleum-test wells and core holes--Continued

| Location | Name | Year constructed | Altitude (feet) | Depth drilled (feet) | Selected geologic data: Formation code | Selected geologic data: Depth to top (feet) | Selected geologic data: Depth to bottom (feet) | Interval tested: Depth to top (feet) | Interval tested: Depth to bottom (feet) | Other data available | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-26-17)5ccc-1 | Superior No. 14-5 Federal | 1961 | 5,041 | 6,498 | 220NVJO | 0 | - | - | - | C | Reported "massive porosity" at 6,262 feet. |
| | | | | | 310CCNN | 1,935 | 2,227 | - | - | | |
| | | | | | 330MSSP | 6,001 | - | 6,350 | 6,410 | | DST 3 sampled from recovered 450 feet of water after well flowed by gas lift and blew gas and water spray. |
| | | | | | | | | 6,410 | 6,466 | | DST 5 sampled from bottom of fluid column. Recovered 2,340 feet of sulfur water after flow due to gas lift. |
| (D-27-4)23bbc-1 | Shumway Uranium No. 1 Federal | 1957 | 10,050 | 1,917 | 221ENRD | 170 | 340 | - | - | - | |
| | | | | | 220NVJO | 1,110 | - | - | - | | |
| (D-27-8)13aad-1 | Amax No. 1 Federal | 1959 | 4,990 | 6,235 | 220NVJO | 435 | 1,317 | - | - | - | |
| | | | | | 231WNGT | 1,556 | 1,843 | - | - | | |
| | | | | | 310CCNN | 3,063 | 3,725 | - | - | | |
| | | | | | 330LDVL | 5,824 | - | - | - | | |
| (D-27-12)9aac-1 | Carter No. 1 Federal | 1958 | 5,035 | 6,430 | 221ENRD | 0 | - | - | - | B | |
| | | | | | 220NVJO | - | 1,300 | - | - | | |
| | | | | | 231WNGT | 1,510 | 1,814 | - | - | | |
| | | | | | 310WTRM | 2,698 | 3,150 | - | - | | |
| | | | | | 330MSSP | 6,000 | - | 6,210 | 6,430 | | DST 3 recovered 540 feet of water-cut mud and 4,920 feet of slightly brackish water. |
| (D-27-13)30abc-1 | Superior No. 31-30 Federal | 1962 | 5,029 | 7,664 | 221ENRD | 10 | - | - | - | C | Reported "massive porosity" at 6,684 feet. |
| | | | | | 220NVJO | 183 | - | - | - | | |
| | | | | | 231WNGT | 1,060 | 1,375 | - | - | | |
| | | | | | 310CCNN | 2,258 | - | - | - | | |
| | | | | | 330MSSP | 6,390 | - | 6,549 | 6,685 | | DST 2 recovered 550 feet of mud and mud-cut water and 5,000 feet of brackish water. |
| 36cdc-1 | Conoco No. 1 State | 1958 | 5,220 | 6,820 | 221ENRD | 10 | - | - | - | B | |
| | | | | | 220NVJO | - | 930 | - | - | | |
| | | | | | 324PRDX | 5,180 | - | 5,176 | 5,335 | | DST recovered 360 feet of water-cut mud and 1,350 feet of muddy brackish water. |
| | | | | | 330MSSP | 6,645 | - | 6,712 | 6,820 | | DST recovered 5,600 feet of salty sulfur water. |
| | | | | | | | | 6,712 | 6,720 | | DST recovered 5,510 feet of salty sulfur water. |
| (D-27-14)5bca-1 | Carter Oil No. 1 Federal | 1955 | 5,682 | 5,940 | 221ENRD | - | 440 | - | - | B | Water reported in Glen Canyon Group. |
| | | | | | 220NVJO | 550 | - | - | - | | |
| | | | | | 231MBCK | 2,165 | - | 2,142 | 2,256 | | DST 1 recovered 510 feet of mud-cut water. |
| | | | | | 310CCNN | 2,760 | 3,350 | - | - | | |
| | | | | | 310CTLR | 3,350 | 3,605 | - | - | | |
| | | | | | 330MSSP | 5,380 | 5,820 | - | - | | |
| 13ddc-1 | Arco No. 1 Murphy-Federal | 1962 | 5,608 | 5,700 | 221ENRD | 10 | - | - | - | | |
| | | | | | 231WNGT | - | 1,607 | - | - | | |
| | | | | | 310CCNN | 2,517 | - | - | - | | |
| 17ccb-1 | Amerada No. 5 Federal | 1959 | 5,560 | 6,523 | 221ENRD | 10 | 483 | - | - | C | |
| | | | | | 220NVJO | 596 | 1,156 | - | - | | |
| | | | | | 231WNGT | 1,483 | 1,768 | - | - | | |
| | | | | | 310WTRM | 2,695 | 3,320 | 2,731 | 2,826 | | DST 2 recovered 1,355 feet of muddy freshwater. |
| 31dbc-1 | British-American No. 1 Federal | 1964 | 5,231 | 5,993 | 221ENRD | 0 | - | - | - | | |
| | | | | | 231WNGT | - | 1,495 | - | - | | |
| | | | | | 310CCNN | 2,300 | 3,008 | - | - | | |
| (D-27-15)32adb-1 | Texaco No. 6 State | 1960 | 5,615 | 8,096 | 221ENRD | 10 | - | - | - | B | |
| | | | | | 231WNGT | - | 1,421 | - | - | | |
| | | | | | 310WTRM | 2,352 | - | 2,330 | 2,366 | | DST 2 recovered 650 feet of muddy freshwater. |
| | | | | | 330MSSP | 5,845 | 6,378? | 5,900 | 5,990 | | DST 4 recovered 100 feet of mud and 4,500 feet of brackish water. |
| | | | | | 341ELBR | 6,508 | - | 6,510 | 6,776 | | DST recovered 720 feet of mud-cut water and 3,810 feet of brackish water. |
| | | | | | 374TNTC | 7,985 | - | - | - | | |
| 35bcc-1 | Carter No. 2 Federal | 1956 | 5,516 | 5,534 | 220NVJO | 40 | - | - | - | C | |
| | | | | | 310CCNN | 2,010 | 2,500 | - | - | | |
| | | | | | 310CTLR | 2,500 | 2,900 | - | - | | Lost circulation of drilling mud at 2,683 feet. |
| | | | | | 330MSSP | 5,170 | - | 5,170 | 5,410 | | DST 9 recovered 720 feet of drilling fluid and 3,085 feet of brackish water. Odor of hydrogen sulfide in bottom 290 feet. |
| (D-27-16)1caa-1W | Quintana No. 1 Federal | 1970 | 5,340 | 6,791 | 220NVJO | 50 | 572 | - | - | - | Plugged back and left as water well. Assigned to U.S. Bureau of Land Management July 15, 1970. (See table 6.) |
| | | | | | 231WNGT | 682 | 1,140 | - | - | | |
| | | | | | 310CCNN | 2,148 | 2,456 | - | - | | |
| | | | | | 310CTLR | 2,450 | - | - | - | | |
| | | | | | 330LDVL | 6,612 | - | - | - | | |
| 33abc-1 | Superior No. 32-33 Federal | 1961 | 5,719 | 6,867 | 221SRFL | 0 | - | - | - | C | |
| | | | | | 231WNGT | - | 1,225 | - | - | | |
| | | | | | 310CCNN | 2,173 | - | - | - | | |
| | | | | | 330MSSP | 5,779 | 6,435? | 5,894 | 5,994 | | DST 6 recovered 580 feet of brackish muddy water and 3,653 feet of brackish water. |
| | | | | | 370CMBR | 6,828 | - | - | - | | |
| (D-28-4)11bcb-1 | Texaco No. 1 Federal | 1959 | 9,370 | - | 220NVJO | 10 | 1,042 | - | - | - | |
| | | | | | 231WNGT | 1,300 | 1,716 | - | - | | |
| | | | | | 310CCNN | 3,353 | 3,450? | 3,341 | 3,369 | | DST recovered no water. |
| | | | | | 330MSSP | 5,250 | - | - | - | | |
| | | | | | 370CMBR | 6,742 | - | - | - | | |
| 25bac-1 | Texaco No. 2 Federal | 1960 | 7,915 | 5,478 | 231WNGT | 0 | 247 | - | - | - | |
| | | | | | 310CCNN | 1,898 | 3,007? | - | - | | |
| | | | | | 330RDLL | 3,744 | - | - | - | | |

Table 8.--Records of selected petroleum-test wells and core holes--Continued

| Location | Name | Year constructed | Altitude (feet) | Depth drilled (feet) | Selected geologic data: Formation code | Selected geologic data: Depth to top (feet) | Selected geologic data: Depth to bottom (feet) | Interval tested: Depth to top (feet) | Interval tested: Depth to bottom (feet) | Other data available | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-28-5)13dba-1 | Phillips No. 1 Federal | 1960 | 7,079 | 6,105 | 231WNGT | 0 | 470 | - | - | - | |
| | | | | | 310CCNN | 2,510 | - | 2,950 | 3,015 | | DST recovered 420 feet of fresh water-cut mud. |
| | | | | | 321HKTL | 3,238 | - | 3,260 | 3,374 | | DST recovered 605 feet of mud-cut freshwater. |
| | | | | | 330MSSP | 4,895 | 5,890 | 4,934 | 5,059 | | DST recovered 420 feet of mud and 2,480 feet of mud-cut freshwater. |
| (D-28-8)29cdc-2 | Stanolind No. 1 Federal | 1955 | 4,936 | 7,160 | 221ENRD | 0 | 306 | - | - | - | Pennsylvanian rocks from 4,705 to 6,330 feet also reported as important water-bearing zone. |
| | | | | | 220NVJO | 698 | 1,668 | - | - | | |
| | | | | | 231WNGT | 1,802 | 2,323 | - | - | | |
| | | | | | 310CCNN | 3,562 | 4,705 | 3,636 | 3,669 | | DST recovered 400 feet of water-cut mud and 800 feet of freshwater. |
| | | | | | 330MSSP | 6,550 | - | 6,550 | 6,618 | | DST recovered 6,125 feet of freshwater. |
| 32acb-1 | Ohio Oil Co. No. 1 State | 1921 | 4,990 | 3,650 | 220NVJO | 715 | 1,520 | - | - | - | This well provided the first indication of large supplies of artesian water in the Navajo Sandstone in the Caineville-Red Desert area. Salt water reported in sand from 2,636 to 2,750 feet. |
| 33cdd-1W | Colt Oil No. 1-33 Federal | 1975 | 4,823S | 3,700 | 221ENRD | 0 | 327 | - | - | - | |
| | | | | | 220NVJO | 745 | 1,670 | - | - | | |
| | | | | | 310KIBB | 3,469 | 3,600 | 3,493 | 3,530 | | DST 2 recovered 677 feet of water. Specific conductance 5,000 micromhos. |
| | | | | | 310WTRM | 3,600 | - | 3,595 | 3,700 | | DST 1 recovered 3,191 feet of muddy water. Specific conductance 4,040 micromhos. |
| (D-28-11)5cdb-1 | Tennessee Gas Transmission No. 1 Federal | 1960 | 4,618 | 7,301 | 221ENRD | 510 | 940 | - | - | C | Well is on southwest side of fault zone that has a net throw of 400 feet down to southwest as measured by offset of Navajo Sandstone in this well and well (D-27-11)34ddb-10. |
| | | | | | 220NVJO | 1,270 | 1,870 | - | - | | |
| | | | | | 231WNGT | 2,105 | 2,634 | - | - | | |
| | | | | | 310CCNN | 3,520 | - | - | - | | |
| | | | | | 330MSSP | 7,078 | - | 7,100 | 7,301 | | DST 1 recovered 5,200 feet of brackish water. |
| (D-28-12)32dad-1 | Kimbark No. 1 State | 1969 | 4,570 | 2,524 | 221ENRD | 10 | - | - | - | - | |
| | | | | | 220NVJO | 357 | 926 | - | - | | |
| | | | | | 231WNGT | 1,278 | 1,609 | - | - | | |
| | | | | | 310KIBB | 2,328 | 2,443 | 2,329 | 2,439 | | DST recovered 1,989 feet of mud-cut water. |
| | | | | | 310WTRM | 2,443 | - | 2,443 | 2,474 | | DST recovered 1,772 feet of sulfur water. |
| (D-28-14)14ccd-1 | Murphy No. 4 Federal | 1959 | 5,644 | 6,975 | 221ENRD | 10 | - | - | - | - | |
| | | | | | 231WNGT | 1,125 | 1,432 | - | - | | |
| | | | | | 310CCNN | 2,323 | - | - | - | | |
| | | | | | 330MSSP | 6,768 | - | 6,798 | 6,974 | | DST recovered 1,762 feet of muddy salt water. |
| (D-28-17)27bbd-1 | Placid No. DU-1 Tulley | 1970 | 4,352 | 5,075 | 310WTRM | 80 | 500 | - | - | - | |
| | | | | | 310CTLR | 500 | 1,090 | - | - | | |
| | | | | | 330MSSP | 4,562 | - | - | - | | |
| (D-29-5)30dbc-1 | Argo No. 1 Pan American Federal | 1958 | 7,280 | 3,768 | 310KIBB | 436 | 610 | - | - | - | |
| | | | | | 310CCNN | 610 | - | - | - | | |
| | | | | | 330RDLL | 2,700 | - | - | - | | |
| (D-29-10)8ccb-1 | Amerada No. 1 Stein-Federal | 1958 | 4,830 | 8,174 | 211FRRN | 0 | - | - | - | B | |
| | | | | | 221ENRD | 1,553 | 2,170 | - | - | | |
| | | | | | 220NVJO | 2,501 | 3,303 | - | - | | |
| | | | | | 231WNGT | 3,638 | 3,928 | - | - | | |
| | | | | | 237SNBD | 4,746 | - | 4,750 | 4,790 | | DST 1 recovered 1,100 feet of sulfur water. |
| | | | | | 310KIBB | 4,823 | 4,865 | 4,840 | 4,868 | | DST 2 recovered 465 feet of clear sulfur water. |
| | | | | | 310OGRK | 5,107 | 5,351 | 5,107 | 5,159 | | DST 3 recovered 828 feet of water-cut mud, 1,380 feet of slightly mud-cut water, and 2,128 feet of water. |
| | | | | | 310HLGT | 5,810 | 6,105 | 6,035 | 6,060 | | DST 4 recovered 450 feet of slightly mud-cut water. |
| | | | | | 324PRDX | 6,742 | 7,586 | 7,390 | 7,470 | | DST 7 recovered 6,310 feet of slightly muddy water. |
| | | | | | 331LDVL | 7,792 | - | 7,920 | 7,953 | | DST 8 recovered 90 feet of mud and 6,808 feet of water. |
| (D-29-11)2aac-1 | Amerada No. 1 State | 1958 | 4,490 | 2,847 | 221ENRD | 0 | 386 | - | - | B | |
| | | | | | 220NVJO | 643 | 1,246 | - | - | | |
| | | | | | 231WNGT | 1,610 | 1,952 | - | - | | |
| | | | | | 310KIBB | 2,751 | 2,785 | 2,695 | 2,783 | | DST 1 recovered 540 feet of water-cut mud and 1,771 feet of black sulfur water. |
| | | | | | 310WTRM | 2,785 | - | 2,787 | 2,847 | | DST 4 recovered 300 feet of water-cut mud and 2,071 feet of clear sulfur water. |
| (D-29-12)29bcb-1 | Skyline No. 2 Gulf | 1975 | 4,790 | 2,735 | 221ENRD | 0 | - | - | - | | |
| | | | | | 220NVJO | 630 | 1,210 | - | - | | |
| | | | | | 231WNGT | 1,570 | 1,920 | - | - | | |
| | | | | | 310WTRM | 2,718 | - | - | - | | |
| 30abb-1 | Kimbark No. 1 Federal | 1969 | 4,714 | 2,800 | 221ENRD | 0 | - | - | - | | DST in White Rim Sandstone Member yielded no water. |
| | | | | | 231WNGT | 1,543 | 1,908 | - | - | | |
| | | | | | 310WTRM | 2,698 | - | - | - | | |
| 33acd-1 | Tennessee Gas Transmission No. 1 Federal | 1958 | 4,616 | 6,584 | 220NVJO | 194 | 840 | - | - | C | |
| | | | | | 231WNGT | 1,141 | 1,478 | - | - | | |
| | | | | | 230MNKP | 1,770 | 2,260 | 2,162 | 2,178 | | Swabbed samples from perforated test zone. |
| | | | | | 310WTRM | 2,260 | - | - | - | | |
| | | | | | 330MSSP | 5,699 | 6,443? | - | - | | |

Table 8.--Records of selected petroleum-test wells and core holes--Continued

| Location | Name | Year constructed | Altitude (feet) | Depth drilled (feet) | Selected geologic data: Formation code | Selected geologic data: Depth to top (feet) | Selected geologic data: Depth to bottom (feet) | Interval tested: Depth to top (feet) | Interval tested: Depth to bottom (feet) | Other data available | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-29-12)33acd-1S | Gulf Energy No. 1 Federal | 1971 | 4,616 | 6,584 | 230MNKP | - | - | 2,161 | 2,190 | B | Well plugged back to 2,245 feet in 1976(?); produced 10 barrels of oil and 16 barrels of water on 1-21-71. Water was produced from perforations while producing oil. |
| | | | | | 310WTRM | 2,260 | - | 2,262 | 2,320 | | Second test of formation prior to plugging back. Head (above formation) reported to be 1,200 feet. |
| (D-29-13)1aab-1W | Phillips No. 1758 Paradox-Brown | 1959 | 5,250 | 2,649 | 220NVJO | 30 | 656 | - | - | - | Abandoned as petroleum-test well because of tools lost in hole. Cased, plugged back and converted to water well to supply nearby petroleum-test well. Water from Wingate Sandstone. Assigned to Bureau of Land Management. |
| | | | | | 231KYNT | 656 | 908 | - | - | | |
| | | | | | 231WNGT | 908 | 1,205 | - | - | | |
| 1aab-2 | Phillips No. 1758A Paradox-Brown | 1959 | 5,250 | 6,404 | 220NVJO | 30 | 650 | - | - | DR | |
| | | | | | 231WNGT | 910 | 1,210 | - | - | | Tested zone producing water in nearby water well; test produced no water. |
| | | | | | 310CTLR | 2,032 | - | - | - | | |
| | | | | | 330MSSP | 6,180 | - | 6,230 | 6,404 | | DST recovered 300 feet of mud and 4,800 feet of sulfur water. |
| (D-29-14)23bdd-1 | Whitney No. 1 Federal | 1969 | 5,807 | 5,038 | 220NVJO | - | 642 | - | - | - | |
| | | | | | 231WNGT | 896 | 1,173 | - | - | | |
| | | | | | 310WTRM | 2,053 | 2,460 | - | - | | |
| (D-29-15)20add-1 | Conoco No. 1 Hoover | 1957 | 6,235 | 6,886 | 221ENRD | 0 | - | - | - | B | |
| | | | | | 231WNGT | 1,013 | 1,312 | - | - | | |
| | | | | | 310CCNN | 2,205 | 2,635 | - | - | | |
| | | | | | 310CTLR | 2,635 | 3,655 | - | - | | |
| | | | | | 330MSSP | 6,606 | - | 6,685 | 6,846 | | DST 4 recovered 900 feet of muddy water and 680 feet of black sulfur water. |
| (D-30-12)19bbb-1 | Amerada No. 1 Federal | 1967 | 4,880 | 6,026 | 221ENRD | 0 | 597 | - | - | B | |
| | | | | | 220NVJO | 808 | 1,501 | - | - | | |
| | | | | | 231WNGT | - | 2,122 | - | - | | |
| | | | | | 310WTRM | 2,914 | 3,390 | 2,900 | 2,933 | | DST recovered 1,650 feet of brackish water. |
| | | | | | 310OGRK | 3,390 | 3,600 | 3,571 | 3,615 | | DST recovered 1,725 feet of slightly muddy water. |
| | | | | | 330MSSP | 5,794 | - | 5,918 | 6,026 | | DST recovered 94 feet of mud, 470 feet of slightly brackish water, and 376 feet of brackish water. |
| (D-30-13)4dcb-1 | Mountain Fuel No. 1 Federal | 1971 | 5,293 | 6,128 | 220NVJO | - | 825 | - | - | B | |
| | | | | | 231WNGT | 1,032 | 1,371 | - | - | | |
| | | | | | 310WTRM | 2,200 | 2,768 | 2,192 | 2,240 | | DST 3 recovered 282 feet of mud and 648 feet of water. |
| | | | | | 327PKRT | 5,340 | 5,712? | 5,540 | 5,610 | | DST 6 recovered 300 feet of mud and 3,728 feet of water. |
| | | | | | 330RDLL | 5,860 | - | 6,043 | 6,129 | | DST 9 recovered 180 feet of mud, 910 feet of mud-cut water, and 3,680 feet of water. |
| 4dcc-1 | Skyline No. 2 Mountain Fuel | 1972 | 5,291 | 1,848 | 220NVJO | 60 | - | - | - | - | |
| 26dbd-1 | Richfield No. 1 Paradox-Brown | 1958 | 5,552 | 4,202 | 220NVJO | 10 | 760 | - | - | - | |
| | | | | | 231WNGT | 870 | 1,205 | - | - | | |
| | | | | | 310WTRM | 2,065 | 2,510 | - | - | | |
| 27caa-1 | Paradox Production No. 2 Federal | 1957 | 5,390 | 4,122 | 220NVJO | 0 | 596 | - | - | - | |
| | | | | | 231WNGT | 876 | 1,211 | - | - | | |
| | | | | | 310WTRM | 2,060 | 2,506 | - | - | | |
| 34aba-1 | Paradox Production No. 1 Federal | 1957 | 5,466 | 6,301 | 220NVJO | 10 | 613 | - | - | - | |
| | | | | | 231WNGT | 890 | 1,224 | - | - | | |
| | | | | | 310WTRM | 2,073 | 2,498 | - | - | | |
| 35ddc-1 | Paradox Production No. 3X Federal | 1960 | 5,100 | 3,557 | 220NVJO | 0 | - | - | - | - | |
| | | | | | 231WNGT | 300 | 650 | - | - | | |
| | | | | | 310WTRM | 1,500 | 1,980 | - | - | | |
| (D-30-14)15ddc-1 | Mountain Fuel No. 4 Federal | 1973 | 5,465 | 4,494 | 220NVJO | 0 | - | - | - | - | Water produced from Wingate Sandstone in nearby supply well in sec. 23 (see table 6). |
| | | | | | 310WTRM | 1,670 | 2,310 | - | - | | |
| (D-30-16)6bbd-1 | Skyline No. 6-11 American Petrofina | 1965 | 6,410 | 2,156 | 220NVJO | 0 | 365 | - | - | - | |
| | | | | | 231WNGT | 650 | 1,015 | - | - | | |
| | | | | | 310WTRM | 1,964 | 2,364 | - | - | | Core of White Rim Sandstone Member of Cutler Formation described as white, fine- to medium-grained, well-sorted, and crossbedded poor to well-cemented. |
| (D-31-7)36dad-1W | Mountain Fuel No. 1 State | 1969 | 5,361 | 6,648 | 221ENRD | 0 | 285 | - | - | B | Test well was converted to irrigation well (table 6). Drilled with air and started producing water when hole was 600 feet deep. Produced about 70 gal/min at 1,200 feet, about 140 gal/min at 1,600 feet, and about 245 gal/min at 2,436 feet. Water sample from section including Navajo Sandstone through Wingate Sandstone. |
| | | | | | 220NVJO | 580 | 1,610 | - | - | | |
| | | | | | 231WNGT | 1,950 | 2,280 | 600 | 2,446 | | |
| | | | | | 310KIBB | 3,390 | 3,450 | 3,414 | 3,417 | | |
| | | | | | 310CCNN | 3,450 | - | - | - | | |
| | | | | | 324HRMS | 4,922 | 6,130 | 5,127 | 5,182 | | DST recovered 186 feet of mud, 465 feet of mud-cut water, and 1,035 feet of water. |
| | | | | | 330RDLL | 6,334 | - | 6,518 | 6,648 | | DST recovered 460 feet of mud and 5,340 feet of water. |
| (D-31-9)22bbd-1 | Webb Resources No. 22-4 Federal | 1970 | 6,221 | 6,805 | 211FRRN | 1,432 | - | - | - | - | An igneous sill was penetrated in the Chinle Formation at 5,824-6,034 feet. The sill is an outlying part of the Henry Mountain intrusive complex. |
| | | | | | 221ENRD | 3,520 | - | - | - | | |
| | | | | | 220NVJO | 4,100? | 5,000 | - | - | | |
| | | | | | 231WNGT | 5,060 | 5,550 | - | - | | |
| | | | | | 310WTRM | 6,750 | - | - | - | | |

Table 8.--Records of selected petroleum-test wells and core holes--Continued

| Location | Name | Year constructed | Altitude (feet) | Depth drilled (feet) | Selected geologic data: Formation code | Selected geologic data: Depth to top (feet) | Selected geologic data: Depth to bottom (feet) | Interval tested: Depth to top (feet) | Interval tested: Depth to bottom (feet) | Other data available | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-31-11)20ddb-1 | Belco No. 1 Kern County Land Co. | 1963 | 6,643 | 6,220 | 220NVJO | 300 | 960 | - | - | - | Igneous sill penetrated at 5,700-5,750 feet between Hermosa and Molas Formations. |
| | | | | | 231WNGT | 1,310 | 1,590 | - | - | | |
| | | | | | 310WTRM | 2,480 | 2,860 | - | - | | |
| | | | | | 330MSSP | 5,954 | - | 6,054 | 6,220 | | DST recovered only 847 feet of water-cut mud. |
| 27ddd-1 | Kern County Land No. 1X Federal | 1961 | 5,840 | 6,683 | 220NVJO | 947 | 1,630 | - | - | B | Navajo Sandstone apparently is strongly fractured at this site. Drilling-fluid circulation was first lost at 1,011-1,071 feet. Fluid loss persisted despite attempts to cement the losing zone and required large volumes of mud that at times included 30 percent loss inhibitors (including large amounts of broken up juniper branches). |
| | | | | | 231WNGT | 1,980 | 2,259 | - | - | | |
| | | | | | 310WTRM | 3,070 | 3,414 | - | - | | |
| | | | | | 330MSSP | 6,508 | - | 6,600 | 6,683 | | DST 1 recovered 2,430 feet of water. |
| (D-31-12)4aad-1 | Tennessee Gas Transmission No. 2 Federal | 1959 | 4,883 | 5,358 | 221ENRD | 0 | 77 | - | - | - | |
| | | | | | 220NVJO | 231 | 868 | - | - | | |
| | | | | | 231WNGT | 1,154 | 1,462 | - | - | | |
| | | | | | 310CCNN | 2,252 | 2,668 | - | - | | |
| 4abb-1 | Tennessee Gas Transmission No. 1 Federal | 1958 | 4,890 | 6,491 | 221ENRD | 0 | 137 | - | - | - | |
| | | | | | 220NVJO | 305 | 938 | - | - | | |
| | | | | | 231WNGT | 1,238 | 1,531 | 1,455 | 1,490 | | DST recovered 530 feet of freshwater. |
| | | | | | 310CCNN | 2,274 | 2,725 | - | - | | |
| | | | | | 324PRDX | 4,899 | 5,130 | 4,922 | 4,973 | | DST recovered 3,125 feet of slightly gas-cut sulfur water. |
| | | | | | 330MSSP | 5,510 | 5,517 | - | - | | |
| 5aaa-1 | Great Western No. 1 Riepe | 1960 | 4,950 | 5,427 | 221ENRD | 0 | 218 | - | - | - | |
| | | | | | 220NVJO | 385 | 1,122 | - | - | | |
| | | | | | 231WNGT | 1,483 | 1,728 | - | - | | |
| | | | | | 310CCNN | 2,450 | 3,110 | 2,448 | 2,490 | | DST recovered 230 feet of gas-cut mud, 90 feet of watery mud, and 1,170 feet of brackish sulfur water. |

## Table 9.--Water levels in observation wells

Local number: See text for description of well- and spring-numbering system (SR). Summary of record presented here; for more detail see hydrographs in Hood and Danielson (1979, figures 10 and 12), and figure 21.

Altitudes of land-surface datum (LSD) given to nearest foot are interpolated from topographic maps, except S, determined by surveying altimeter; those given to tenths or hundredths are surveyed altitudes. MSL, mean sea level.

Water level: In feet below or above (+) land-surface datum. A, well being pumped; B, well pumped or flowed recently; C, nearby well being pumped or flowing; D, nearby well pumped or flowed recently; E, estimated (recorder); F, dry; G, measurement by Intermountain Power Project; H, tape measurement (recorder); N, no measurement (recorder); O, discontinued; Q, flowing but unmeasured; Z, see note in heading for individual well.

LOCAL NUMBER (D-28-4)36CDB-1. NO STATE CLAIM. V.A.LEE. DRILLED UNUSED WATER-TABLE WELL IN ALLUVIUM. DIAM 6 IN (15 CM), DEPTH 112 FT (34 M), CASED TO 112 FT (34 M), UNPERFORATED, WITH OPEN END.MP TOP OF COUPLING AT LSD. WATER LEVELS BELOW LSD.
LSD 6860 FT ABOVE MSL.
HIGHEST WATER LEVEL 8.14 BELOW LSD, JUNE 8, 1937,
LOWEST WATER LEVEL 15.27 BELOW LSD, MAR. 20, 1956.
RECORDS AVAILABLE: 1936-42, 1944-56, 1958-77.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| APR. 21, 1936 | 8.53 | DEC. 17, 1946 | 13.27 | MAY 1, 1959 | 12.27 | MAR. 18, 1965 | 12.65 |
| SEP. 29 | 10.54 | MAR. 26, 1947 | 12.81 | JULY 1 | 13.16 | SEP. 13 | 13.57 |
| NOV. 27 | 10.17 | DEC. 11, 1948 | 14.27 | SEP. 2 | 14.63 | MAR. 10, 1966 | 12.95 |
| APR. 9, 1937 | 8.40 | DEC. 10, 1949 | 14.59 | NOV. 3 | 14.06 | MAR. 22, 1967 | 12.85 |
| JUNE 8 | 8.14 | MAR. 29, 1950 | 13.93 | JAN. 6, 1960 | 12.89 | SEP. 13, 1968 | 14.50 |
| DEC. 8 | 10.95 | DEC. 9 | 14.96 | MAR. 24 | 12.07 | APR. 22, 1969 | 12.73 |
| APR. 11, 1938 | 10.32 | MAR. 26, 1951 | 13.84 | MAY 11 | 12.27 | OCT. 8 | 14.16 |
| AUG. 24 | 12.18 | APR. 6, 1952 | 13.61 | JULY 12 | 12.69 | MAR. 3, 1970 | 12.60 |
| DEC. 20 | 11.52 | DEC. 7 | 14.84 | SEP. 16 | 13.79 | SEP. 3 | 12.65 |
| APR. 18, 1939 | 10.62 | MAR. 16, 1953 | 14.08 | NOV. 2 | 13.57 | MAR. 15, 1971 | 12.69 |
| AUG. 21 | 12.83 | DEC. 15 | 14.91 | JAN. 6, 1961 | 13.02 | OCT. 19 | 13.59 |
| DEC. 6 | 12.35 | MAR. 25, 1954 | 13.85 | MAR. 20 | 12.67 | MAR. 2, 1972 | 12.71 |
| MAR. 25, 1940 | 11.21 | DEC. 1 | 15.02 | MAY 25 | 12.30 | OCT. 11 | 12.59 |
| DEC. 6 | 12.60 | DEC. 5, 1955 | 15.20 | JULY 7 | 12.98 | MAR. 7, 1973 | 11.73 |
| MAR. 20, 1941 | 11.14 | MAR. 20, 1956 | 15.27 | SEP. 12 | 13.60 | OCT. 2 | 13.06 |
| DEC. 4 | 11.99 | DEC. 5 | 15.00 | APR. 4, 1962 | 12.39 | MAR. 21, 1974 | 11.67 |
| AUG. 9, 1942 | 12.62 | MAR. 11, 1958 | 12.58 | SEP. 26 | 14.19 | SEP. 30 | 13.08 |
| DEC. 18 | 12.33 | MAY 9 | 12.18 | APR. 4, 1963 | 11.88 | MAR. 24, 1975 | 11.68 |
| DEC. 5, 1944 | 12.91 | JULY 8 | 12.88 | SEP. 27 | 13.08 | OCT. 7 | 12.91 |
| MAR. 2, 1945 | 11.88 | NOV. 7 | 13.66 | MAR. 31, 1964 | 11.62 | MAR. 23, 1976 | 11.83 |
| DEC. 7 | 12.65 | JAN. 5, 1959 | 12.88 | SEP. 25 | 13.51 | OCT. 7 | 13.35 |
| MAY 9, 1946 | 12.50 | MAR. 3 | 12.36 | DEC. 8 | 13.43 | MAR. 8, 1977 | 12.16 |

(SR) LOCAL NUMBER (D-28-7)27CDB-1. TEST HOLE. US BUR LAND MANAGEMENT. DRILLED BY INTERMOUNTAIN POWER PROJECT. ARTESIAN OBSERVATION WELL IN NAVAJO SANDSTONE. DIAM 6 IN (15 CM), DEPTH 2353 FT (717 M). CASED TO 1900 FT (579 M). MP IS TOP OF RECORDER PLATFORM, 3.95 FT (1.2 M) ABOVE LSD. BAROM.EFF. APPROXIMATELY 60 PERCENT. WATER LEVELS BELOW LSD. VALUES ARE DAILY NOON MEASUREMENTS FROM RECORDER CHARTS EXCEPT (H).
LSD 5161.81 FT ABOVE MSL.
HIGHEST WATER LEVEL 93.42 BELOW LSD, MAY 5, 1977,
LOWEST WATER LEVEL 98.22 BELOW LSD, FEB. 25, 1976.
RECORDS AVAILABLE: 1975-78.

| DAY | JAN. | FEB. | MAR. | APR. | MAY | JUNE | JULY | AUG. | SEPT. | OCT. | NOV. | DEC. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1975 | | | | | | |
| 5 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 95.66C |
| 10 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 95.75C |
| 15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 95.92C |
| 20 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 94.19H | 96.06C |
| 25 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 95.77C | 96.07C |
| EOM | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 95.83C | 95.95H |
| | | | | | | 1976 | | | | | | |
| 5 | 96.66H | . N | 98.13 | 97.33 | 96.84 | 96.22 | 95.72 | 95.23 | 94.93 | 94.97H | . N | 94.01 |
| 10 | 96.99H | . N | 97.77 | 97.28 | 96.83 | 96.10 | . N | 95.33 | . N | 94.82 | . N | 94.17 |
| 15 | 97.52H | 98.10H | 97.91 | . N | 96.69 | 96.13E | . N | 95.05 | . N | 94.65 | . N | 94.13 |
| 20 | 97.86H | 98.06 | 97.89 | . N | 96.54 | 95.93 | . N | 95.19 | 94.85 | 94.70 | . N | . N |
| 25 | 97.67H | 98.22 | 97.55E | 96.98 | 96.33 | 95.87 | 95.58 | 95.10 | 94.55 | . N | . N | . N |
| EOM | 98.18H | 97.75 | 97.66 | 96.97 | . N | 95.82 | 95.38 | 95.03 | 95.15B | . N | 94.21H | . N |
| | | | | | | 1977 | | | | | | |
| 5 | ..... | ..... | . N | 93.92C | 93.42C | . N | 93.81 | 95.28 | 97.21 | ..... | ..... | ..... |
| 10 | ..... | ..... | 93.62C | 93.60C | 93.57C | . N | . N | 95.60 | 97.45 | ..... | ..... | ..... |
| 15 | ..... | ..... | 93.89C | 93.69C | 93.59C | 93.63H | 94.29 | . N | . N | ..... | ..... | ..... |
| 20 | ..... | ..... | 93.73C | 93.68C | 93.63C | 93.52 | 94.44 | . N | . N | ..... | ..... | ..... |
| 25 | ..... | ..... | 93.51C | 93.74C | . N | 93.67 | 94.82 | . N | . N | ..... | ..... | ..... |
| EOM | ..... | . N | 93.53H | 93.69C | . N | 93.73 | 95.16 | 96.81 | . N | ..... | ..... | 96.45 |

LOCAL NUMBER (D-28-7)36BBB-1. WATER-USER CLAIM 95-427. EMMETT CLARK AND OTHERS. DRILLED ARTESIAN STOCK WELL IN THE SALT WASH SS. MEMBER OF THE MORRISON FMN. DIAM 8 IN (20 CM), DEPTH 800 FT (244 M), CASED TO 726 FT(221 M). MP IS LSD AT STOCK TROUGH EAST OF WELL, 1.0 FT (0.3 M) ABOVE LSD AT WELL. LEAKS AROUND CASING. FLOWS CONTINOUSLY. WATER LEVELS ABOVE LSD.
LSD 5100 FT ABOVE MSL.
HIGHEST WATER LEVEL 30.00 ABOVE LSD, JULY 14, 1966,
LOWEST WATER LEVEL 16.30 ABOVE LSD, DEC. 3, 1975.
RECORDS AVAILABLE: 1966, 1975-77.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| JULY 14, 1966 + | 30. | NOV. 18, 1975 + | 18.2 B | NOV. 24, 1975 + | 17.8 B | MAR. 16, 1976 + | 17.2 B |
| AUG. 21, 1975 + | 17.8 B | NOV. 21 + | 18.1 B | DEC. 1 + | 18.1 B | APR. 14, 1977 + | 18.4 B |
| NOV. 15 + | 18.9 B | NOV. 23 + | 18.1 B | DEC. 3 + | 16.3 B | | |

(SR) LOCAL NUMBER (D-28-8)29CDC-1. STATE APPLICATIONS 27143,31003. US BUR. LAND MANAGEMENT. DRILLED BY STANOLIND OIL CO. TO SUPPLY OIL TEST. ARTESIAN STOCK WELL IN NAVAJO SS. DIAM 7 IN (18 CM), DEPTH 764 FT (233 M), CASED TO 720 FT (219 M). MP TOP OF BOLTED PLATE ABOVE DISCHARGE PIPE, 2.8 FT (0.9 M) ABOVE SURFACE CASING AT LSD. FLOWS CONTINUOUSLY TO SMALL DIRT TANK. WATER LEVELS ABOVE LSD.
LSD 4940 FT ABOVE MSL.
HIGHEST WATER LEVEL 69.90 ABOVE LSD, JULY 22, 1976,
LOWEST WATER LEVEL 5.60 ABOVE LSD, DEC. 29, 1975.
RECORDS AVAILABLE: 1974-77.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| JAN. 22, 1974 | + 44.2 D | SEP. 10, 1975 | + 57. G | NOV. 17, 1975 | + 64.2 | JAN. 5, 1976 | + 25.8 D |
| JAN. 25 | + 34.0 C | SEP. 12 | + 59. G | NOV. 20 | + 66.2 | JAN. 10 | + 33.7 D |
| FEB. 8 | + 25.3 C | SEP. 14 | + 61. G | NOV. 22 | + 66.2 | JAN. 15 | + 38.1 D |
| FEB. 9 | + 9.1 C | SEP. 16 | + 60. G | NOV. 24 | + 66.5 | JAN. 20 | + 41.7 D |
| FEB. 10 | + 25.3 C | SEP. 18 | + 61. G | NOV. 25 | + 63.2 C | JAN. 25 | + 45.1 D |
| FEB. 12 | + 42.6 D | SEP. 30 | + 47. D | NOV. 30 | + 43.4 C | JAN. 30 | + 47.4 D |
| APR. 13 | + 18.3 C | OCT. 2 | + 50. D | DEC. 5 | + 32.9 C | FEB. 2 | + 48.6 D |
| JULY 22, 1975 | + 44.5 C | OCT. 5 | + 54. G | DEC. 10 | + 25.1 C | MAR. 17 | + 58.1 |
| AUG. 7 | + 49.9 C | OCT. 8 | + 56. G | DEC. 15 | + 18.6 C | MAY 10 | + 64.0 |
| AUG. 21 | + 50.6 C | OCT. 11 | + 57. G | DEC. 20 | + 13.3 C | JULY 22 | + 69.9 B |
| AUG. 28 | + 48.4 C | NOV. 11 | + 64.5 | DEC. 25 | + 9.1 C | MAR. 31, 1977 | + 64.6 C |
| SEP. 6 | + 55. D | NOV. 13 | + 65.0 | DEC. 29 | + 5.6 C | JUNE 15 | + 60.2 C |
| SEP. 8 | + 56. G | NOV. 15 | + 65.7 | DEC. 30 | + 8.2 D | | |

(SR) LOCAL NUMBER (D-28-8)29DCB-1. WATER-USER CLAIM 95-697. ICPA WELL 39.GARKANE POWER ASSOC. DRILLED ARTESIAN TEST WELL IN NAVAJO SS. DIAM 16 IN (41 CM), DEPTH 761 FT (232 M), CASED TO 679 FT (207 M). LOOSE SAND FILLS WELL TO 727 FT (222 M). MP TOP OF 20-IN (51-CM) SURFACE CASING. USED AS AQUIFER TEST AND OBSERVATION WELL. WATER LEVELS ABOVE LSD.
LSD 4896.50 FT ABOVE MSL.
HIGHEST WATER LEVEL 110.00 ABOVE LSD, SEP. 18, 1975,
LOWEST WATER LEVEL 38.60 ABOVE LSD, DEC. 29, 1975.
RECORDS AVAILABLE: 1974-76.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| FEB. 12, 1974 | + 67. D | SEP. 16, 1975 | + 109. G | NOV. 17, 1975 | + 108. | DEC. 25, 1975 | + 41.5 C |
| APR. 13 | + 67. A | SEP. 18 | + 110. G | NOV. 20 | + 108. | DEC. 29 | + 38.6 C |
| JULY 17, 1975 | + 83.0 B | SEP. 30 | + 91. D | NOV. 22 | + 108.2 | DEC. 30 | + 44.6 D |
| AUG. 7 | + 103. C | OCT. 2 | + 95. D | NOV. 24 | + 108.0 | JAN. 5, 1976 | + 65.7 D |
| AUG. 21 | + 101.5 C | OCT. 5 | + 101. G | NOV. 25 | + 101. C | JAN. 10 | + 74.8 D |
| AUG. 28 | + 98.0 C | OCT. 8 | + 104. G | NOV. 30 | + 78.1 C | JAN. 15 | + 79.5 D |
| SEP. 6 | + 104. D | OCT. 11 | + 105. G | DEC. 5 | + 66.5 C | JAN. 20 | + 83.3 D |
| SEP. 8 | + 105. G | NOV. 11 | + 106.5 | DEC. 10 | + 58.5 C | JAN. 25 | + 85.8 D |
| SEP. 10 | + 108. G | NOV. 13 | + 107. | DEC. 15 | + 52.0 C | JAN. 30 | + 89.5 D |
| SEP. 12 | + 108. G | NOV. 15 | + 107.5 | DEC. 20 | + 46.0 C | FEB. 2 | + 90.0 D |
| SEP. 14 | + 109. G | | | | | | |

(SR) LOCAL NUMBER (D-28-8)33BBB-1. TEST WELL. INTERMOUNTAIN POWER PROJECT. DRILLED ARTESIAN TEST WELL IN NAVAJO SS. DIAM 20 IN (51 CM), DEPTH 1250 FT (381 M), CASED TO 704 FT (215 M). MP IS TOP OF STEEL PLATE BOLTED TO TOP OF CASING TEE ABOVE 12-IN (30 CM) DISCHARGE PIPE, 2.6 FT(0.8 M) ABOVE LSD. WATER LEVELS 1975-MAY 1976 AFFECTED BY FLOW AND TESTING. NON-PUMPING WATER LEVELS ABOVE LSD.
LSD 4883.60 FT ABOVE MSL.
HIGHEST WATER LEVEL FLOWING, MAR. 31, 1977, JUNE 15, 1977,
LOWEST WATER LEVEL 28.20 ABOVE LSD, DEC. 30, 1975.
RECORDS AVAILABLE: 1975-77.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| SEP. 6, 1975 | + 107. B | OCT. 11, 1975 | + 113. G | NOV. 30, 1975 | 353.5 A | JAN. 15, 1976 | + 84.6 B |
| SEP. 8 | + 111. B | NOV. 8 | + 117. G | DEC. 5 | 366.6 A | JAN. 20 | + 89.3 B |
| SEP. 10 | + 113. B | NOV. 11 | + 114.5 | DEC. 10 | 377.8 A | JAN. 25 | + 92.5 B |
| SEP. 12 | + 114. B | NOV. 13 | + 116.5 | DEC. 15 | 379.4 A | JAN. 30 | + 95.8 B |
| SEP. 14 | + 115. G | NOV. 15 | + 117.1 | DEC. 20 | 385.3 A | FEB. 2 | + 97.1 B |
| SEP. 16 | + 116. G | NOV. 17 | + 117.1 | DEC. 25 | 389.8 A | MAR. 17 | + 107.0 |
| SEP. 18 | + 116. G | NOV. 20 | + 117.1 | DEC. 29 | 393.7 A | MAY 10 | + 114.1 |
| SEP. 30 | + 48. B | NOV. 22 | + 117.0 | DEC. 30 | + 28.2 B | JULY 22 | + 121.6 |
| OCT. 2 | + 94. B | NOV. 24 | + 117.8 | JAN. 5, 1976 | + 68.5 B | MAR. 31, 1977 | Q |
| OCT. 5 | + 105. | NOV. 25 | 314.9 A | JAN. 10 | + 79.1 B | JUNE 15 | Q |
| OCT. 8 | + 109. B | | | | | | |

(SR) LOCAL NUMBER (D-28-8)33CDD-1S. NO CLAIM. US BUR LAND MANAGEMENT. OIL TEST DRILLED BY COLT OIL CO. TO 3700 FT(1128 M) IN MAY 1975: PLUGGED BACK TO 1350 FT (411 M) BY IPP IN AUGUST 1975 AND CONVERTED TO ARTESIAN OBSERVATION WELL IN NAVAJO SANDSTONE. DIAM 8 IN (20 CM), CASED TO 1400 FT. FINAL GUN PERFORATIONS 756-1296 FT(230-395 M). MP TOP OF VALVE FLANGE, 1.0 FT (0.30 M) ABOVE TOP OF CASING AT LSD. WATER LEVELS ABOVE LSD.
LSD 4823 FT ABOVE MSL.
HIGHEST WATER LEVEL 186.00 ABOVE LSD, SEP. 12, 1975, SEP. 14, 1975, SEP. 16, 1975, SEP. 18, 1975,
LOWEST WATER LEVEL 118.80 ABOVE LSD, DEC. 29, 1975.
RECORDS AVAILABLE: 1975-77.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| AUG. 21, 1975 | + 179. C | OCT. 3, 1975 | + 171. D | DEC. 10, 1975 | + 139.0 C | JAN. 20, 1976 | + 153.8 D |
| AUG. 27 | + 170. C | OCT. 8 | + 172. D | DEC. 15 | + 132.5 C | JAN. 25 | + 156.9 D |
| SEP. 8 | + 184. G | OCT. 11 | + 174. G | DEC. 20 | + 126.6 C | JAN. 30 | + 159.6 D |
| SEP. 10 | + 184. G | NOV. 11 | + 177.8 | DEC. 25 | + 121.8 C | FEB. 2 | + 159.6 D |
| SEP. 12 | + 186. G | NOV. 16 | + 178.8 | DEC. 29 | + 118.8 C | MAR. 17 | + 170. |
| SEP. 14 | + 186. G | NOV. 20 | + 178.6 | DEC. 30 | + 120.4 D | MAY 10 | + 176.7 |
| SEP. 16 | + 186. G | NOV. 24 | + 178.4 | JAN. 5, 1976 | + 136.5 D | JULY 22 | + 183.5 |
| SEP. 18 | + 186. G | NOV. 30 | + 159.8 C | JAN. 10 | + 144.6 D | MAR. 31, 1977 | + 147.5 C |
| SEP. 30 | + 167. D | DEC. 5 | + 146.8 C | JAN. 15 | + 148.8 D | | |

LOCAL NUMBER (D-28-10)22ABC-1. STATE APPLICATION 22469. H.R.PHILLIPS(1951). DRILLED UNUSED WELL IN FREMONT VALLEY ALLUVIUM. DIAM 12 IN (30 CM), DEPTH 75 FT (23 M), CASED TO BOTTOM, PERFORATED 30-75 FT (9-23 M). UNUSED FOR YEARS. MP IS BOTTOM OF TURBINE DISCHARGE FLANGE, 1.4 FT(0.4 M) ABOVE LSD. WATER LEVELS BELOW LSD.
LSD 4370 FT ABOVE MSL.
HIGHEST WATER LEVEL 12.04 BELOW LSD, APR. 1, 1977,
LOWEST WATER LEVEL 13.62 BELOW LSD, SEP. 6, 1977.
RECORDS AVAILABLE: 1976-78.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| JULY 22, 1976 | 13.22 | APR. 1, 1977 | 12.04 | SEP. 6, 1977 | 13.62 | DEC. 28, 1977 | 12.21 |
| SEP. 23 | 13.17 | JUNE 15 | 12.83 | | | | |

LOCAL NUMBER (D-28-11)16DAC-1. WATER-USER CLAIM 95-380. STAGECOACH MOTEL (FORMERLY E.E.STONE). DRILLED DOMESTIC AND COMMERCIAL ARTESIAN WELL IN THE ENTRADA SS. DIAM 1.5 IN (3.8 CM), DEPTH 340 FT (104 M). PRODUCTION PIPE TO 335 FT(102 M) IN 5.5-IN HOLE; PRESSURE SEAL IS STEEL BAFFLE AT 275 FT, HOLE ABOVE BACKFILLED WITH MUD. MP IS TOP OF CASING IN PIT BENEATH WELL HOUSE, 3.4 FT (1.0 M) BELOW LSD. WATER LEVELS ABOVE LSD.
LSD 4310 FT ABOVE MSL.
HIGHEST WATER LEVEL 24.30 ABOVE LSD, MAR. 12, 1975,
LOWEST WATER LEVEL 12.80 ABOVE LSD, SEP. 22, 1971.
RECORDS AVAILABLE: 1962, 1965-75.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| OCT. 11, 1962 | + 23.6 | JULY 19, 1967 | + 19.5 | OCT. 6, 1970 | + 20.2 | MAR. 8, 1973 | + 16.2 |
| AUG. 14, 1965 | + 18.0 | MAR. 19, 1968 | + 24.1 | JUNE 9, 1971 | + 20.2 | SEP. 13 | + 15.1 |
| OCT. 26 | + 18.8 | JULY 15 | + 22.9 | SEP. 22 | + 12.8 | FEB. 27, 1974 | + 19.7 |
| MAR. 21, 1966 | + 20.0 | SEP. 17 | + 16.7 | DEC. 15 | + 17.4 | SEP. 24 | + 19.7 |
| JULY 21 | + 18.5 | APR. 22, 1969 | + 20.6 | MAR. 15, 1972 | + 15.1 | MAR. 12, 1975 | + 24.3 |
| OCT. 18 | + 19.3 | SEP. 8 | + 22.9 | SEP. 13 | + 13.9 | SEP. | 0 |
| MAR. 22, 1967 | + 18.2 | MAR. 9, 1970 | + 20.2 | | | | |

Table 9.--Water levels in observation wells--Continued

LOCAL NUMBER (D-28-11)16DAD-1. WATER-USER CLAIM 95-460. US FED. AVIATION ADM. DRILLED ARTESIAN DOMESTIC WELL IN THE ENTRADA SS. DIAM 6 IN (15 CM), DEPTH 350 FT (106.7 M). CASED TO 350 FT(106.7M), PERFORATED 327-346 FT (99-105 M). MP TOP OF CASING IN PIT, 3.0 FT (0.91 M) BELOW LSD. WATER LEVELS ABOVE LSD.
LSD 4305 FT ABOVE MSL.
HIGHEST WATER LEVEL 21.90 ABOVE LSD, MAR. 12, 1971,
LOWEST WATER LEVEL 3.93 ABOVE LSD, SEP. 23, 1976, SEP. 13, 1977.
RECORDS AVAILABLE: 1964-77.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| OCT. 8, 1964 | + 20.70 | MAR. 19, 1968 | + 18.00 | JUNE 9, 1971 | + 10.90 | FEB. 27, 1974 | + 17.80 |
| MAR. 18, 1965 | + 16.60 | SEP. 17 | + 16.60 | SEP. 23 | + 10.90 | SEP. 24 | + 15.50 |
| AUG. 4 | + 19.90 | APR. 22, 1969 | + 15.00 | DEC. 15 | + 13.20 | MAR. 12, 1975 | + 20.00 |
| OCT. 26 | + 20.00 | SEP. 8 | + 20.10 | MAR. 15, 1972 | + 13.20 | MAR. 10, 1976 | + 8.60 |
| MAR. 21, 1966 | + 20.50 | MAR. 9, 1970 | + 17.80 | SEP. 13 | + 6.20 | SEP. 23 | + 3.93 |
| JULY 21 | + 20.60 | OCT. 6 | + 17.80 | MAR. 8, 1973 | + 15.80 | MAR. 15, 1977 | + 10.90 |
| OCT. 18 | + 18.60 | MAR. 12, 1971 | + 21.90 | SEP. 13 | + 15.50 | SEP. 13 | + 3.93 |
| MAR. 22, 1967 | + 20.60 | | | | | | |

(D-29-4)6CCB-1. APPLICATION 18863. ERNEST BRINKERHOFF. DRILLED DOMESTIC AND STOCK ARTESIAN WELL. DIAM 6 IN, DEPTH 365 FT. MP TOP OF CASING 0.8 FT. ABOVE LSD. WATER LEVEL BELOW LSD.
LSD 6980 FT ABOVE MSL.
HIGHEST WATER LEVEL 17.09 BELOW LSD, NOV. 2, 1960,
LOWEST WATER LEVEL 21.00 BELOW LSD, MAR. 24, 1960.
RECORDS AVAILABLE: 1958-76.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| MAR. 11, 1958 | 19.31 | NOV. 2, 1960 | 17.09 | MAR. 10, 1966 | 18.92 | OCT. 8, 1969 | 19.63 |
| MAY 9 | 19.80 | JAN. 6, 1961 | 19.65 | APR. 6 | 19.22 | MAR. 5, 1970 | 19.83 |
| JULY 8 | 18.10 | MAR. 20 | 20.20 | MAY 17 | 19.18 | SEP. 3 | 19.95 |
| NOV. 7 | 17.93 | MAY 25 | 20.06 | JUNE 14 | 18.91 | MAR. 16, 1971 | 19.44 |
| JAN. 5, 1959 | 18.80 | JULY 7 | 19.77 | JULY 13 | 18.43 | OCT. 19 | 19.56 |
| MAR. 3 | 19.08 | SEP. 12 | 18.90 | AUG. 11 | 19.32 | MAR. 2, 1972 | 19.51 |
| MAY 1 | 19.42 | APR. 4, 1962 | 19.97 | SEP. 9 | 18.80 | OCT. 10 | 19.35 |
| JULY 1 | 19.49 | SEP. 26 | 18.69 | OCT. 4 | 18.55 | MAR. 6, 1973 | 19.47 |
| SEP. 2 | 18.94 | APR. 10, 1963 | 19.52 | NOV. 2 | 18.39 | OCT. 3 | 19.29 |
| NOV. 3 | 19.17 | SEP. 27 | 18.83 | DEC. 13 | 18.72 | MAR. 21, 1974 | 19.56 |
| JAN. 1, 1960 | 19.98 | MAR. 31, 1964 | 20.23 | JAN. 9, 1967 | 18.98 | SEP. 30 | 18.42 |
| MAR. 24 | 21.00 | SEP. 25 | 18.79 | MAR. 22 | 19.60 | MAR. 17, 1975 | 18.87 |
| MAY 11 | 19.24 | DEC. 8 | 19.00 | MAR. 14, 1968 | 19.22 | OCT. 7 | 18.44 |
| JULY 12 | 18.18 | MAR. 18, 1965 | 19.75 | SEP. 18 | 18.10 | MAR. 22, 1976 | 18.81 |
| SEP. 16 | 19.42 | SEP. 13 | 17.89 | APR. 22, 1969 | 19.40 | OCT. 7 | 17.28 |

LOCAL NUMBER (D-29-4)2DDD-1. NO STATE CLAIM. TORREY COMMUNITY. FORMERLY PUBLIC SUPPLY. DRILLED WELL IN THE MOENKOPI FORMATION. DIAM 8 IN (20 CM),DEPTH 500 FT (152 M). MP TOP OF CASING AT LSD. WATER LEVELS BELOW LSD. WHEN ADJACENT SURFACE RESERVOIR WAS COMPLETED IN 1937, WATER LEVEL ROSE (NOTE Z); WATER LEVEL IN TERRACE GRAVEL OUTSIDE OF CASING WAS 0.3 FT (0.09 M) ON DEC. 8, 1977.
LSD 6930 FT ABOVE MSL.
HIGHEST WATER LEVEL 8.20 BELOW LSD, APR. 9, 1937,
LOWEST WATER LEVEL 53.11 BELOW LSD, APR. 21, 1936.
RECORDS AVAILABLE: 1936-37.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| APR. 21, 1936 | 53.11 | SEP. 29, 1936 | 35.71 | FEB. 8, 1937 | 33.72 | JUNE 8, 1937 | 13.54 |
| AUG. 5 | 34.9 | NOV. 27 | 36.36 | APR. 9 | 8.20 | DEC. 8 | 12.36 |

Table 9.--Water levels in observation wells--Continued

LOCAL NUMBER (D-29-4)8BBD-1. STATE APPLICATION 19179. REED MAXFIELD. DRILLED ARTESIAN DOMESTIC WELL IN ALLUVIUM. DIAM 6 IN (15 CM), DEPTH 92 FT (28 M). CASED TO 92 FT (28 M); UNPERFORATED, WITH OPEN END. MP TOP OF CASING IN PIT, 8.0 FT (2.4 M) BELOW LSD. WATER LEVELS BELOW LSD.
LSD 6880 FT ABOVE MSL.
HIGHEST WATER LEVEL 8.72 BELOW LSD, SEP. 25, 1964,
LOWEST WATER LEVEL 20.33 BELOW LSD, MAR. 16, 1953.
RECORDS AVAILABLE: 1948-56, 1958-64, 1968-77.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| DEC. 11, 1948 | 17.57 | MAR. 11, 1958 | 19.38 | NOV. 2, 1960 | 13.08 | MAR. 5, 1970 | 18.83 |
| DEC. 10, 1949 | 17.48 | MAY 9 | 17.92 | JAN. 6, 1961 | 15.93 | SEP. 3 | 11.83 |
| MAR. 29, 1950 | 17.82 | JULY 8 | 10.80 | MAR. 20 | 18.41 | MAR. 15, 1971 | 18.15 |
| DEC. 9 | 15.07 | NOV. 7 | 13.12 | MAY 25 | 11.32 | OCT. 19 | 12.70 |
| MAR. 26, 1951 | 18.87 | JAN. 5, 1959 | 15.83 | JULY 7 | 11.32 | MAR. 2, 1972 | 18.30 |
| DEC. 10 | 15.47 | MAR. 3 | 17.97 | SEP. 12 | 13.30 | OCT. 10 | 12.70 |
| APR. 6, 1952 | 19.68 | MAY 1 | 16.43 | APR. 4, 1962 | 18.90 | MAR. 7, 1973 | 18.22 |
| DEC. 7 | 16.97 | JULY 1 | 11.08 | SEP. 26 | 11.34 | OCT. 3 | 14.58 |
| MAR. 16, 1953 | 20.33 | SEP. 2 | 12.23 | APR. 10, 1963 | 13.70 | MAR. 21, 1974 | 18.40 |
| DEC. 15 | 15.80 | NOV. 3 | 12.67 | SEP. 27 | 14.89 | SEP. 30 | 15.44 |
| MAR. 25, 1954 | 18.62 | JAN. 6, 1960 | 16.50 | SEP. 25, 1964 | 8.72 | MAR. 17, 1975 | 16.56 |
| DEC. 1 | 16.68 | MAR. 24 | 19.46 | MAR. 14, 1968 | 19.51 | OCT. 7 | 15.47 |
| DEC. 5, 1955 | 14.60 | MAY 11 | 16.27 | SEP. 18 | 9.98 | MAR. 23, 1976 | 17.16 |
| MAR. 20, 1956 | 18.81 | JULY 12 | 10.22 | APR. 22, 1969 | 18.00 | OCT. 7 | 16.88 |
| DEC. 5 | 15.49 | SEP. 16 | 10.97 | OCT. 8 | 11.90 | MAR. 8, 1977 | 17.07 |

LOCAL NUMBER (D-29-7)15DBD-1. NO STATE CLAIM USGS TEST HOLE 4(1977). US NATL PARK SERVICE. DRILLED ARTESIAN TEST HOLE IN NAVAJO SS. DEPTH 460 FT (140 M), CONTAINS 6 IN (15 CM) SURFACE CASING TO 37 FT (11 M) AND 1.5 in (3.8 CM) PIPE TO 238 FT WITH LYNES PACKER SET AT 238 TO 246 FT (72.5 TO 75.0 M) WITH OPEN HOLE BELOW. MP IS TOP OF CONCRETE BOX, 0.5 FT (0.15 M) ABOVE LSD. WATER LEVELS ABOVE LSD.
LSD 5045 FT ABOVE MSL.
HIGHEST WATER LEVEL 42.60 ABOVE LSD, SEP. 15, 1977,
LOWEST WATER LEVEL 40.60 ABOVE LSD, SEP. 14, 1977.
RECORDS AVAILABLE: 1978-77.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| SEP. 14, 1977 | + 40.60B | OCT. 13, 1977 | + 42.50 | NOV 5, 1977 | + 41.4 | DEC. 28, 1977 | + 42.3 |
| SEP 15 | + 42.60B | OCT. 23 | + 41.90 | | | | |

LOCAL NUMBER (D-29-12)19BCD-1. UERA WELL 99. US BUR LAND MANAGEMENT. DRILLED ARTESIAN STOCK WELL IN THE ENTRADA SS AND CARMEL FMN. DIAM 5 IN (13 CM), DEPTH 605 FT (184 M). MP TOP OF CASING,4.5 FT BELOW LSD. CASING FOUND FILLED IN JULY 1952. WATER LEVEL BELOW LSD.
LSD 4930 FT ABOVE MSL.
HIGHEST WATER LEVEL 58.78 BELOW LSD, OCT. 16, 1951,
DRY, WATER LEVEL NOT MEASUREABLE, JULY 9, 1952.
RECORDS AVAILABLE: 1935, 1946, 1948-49, 1951-52.

| DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL | DATE | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| DEC. , 1935 | 65. | DEC. 17, 1946 | 60.56 | OCT. 31, 1949 | 60.3 | JULY 9, 1952 | F |
| MAY 10, 1946 | 60.30 | DEC. 11, 1948 | 59.8 | OCT. 16, 1951 | 58.78 | | |

Table 10.--Selected logs of wells and test holes
[See also the logs in Hood and Danielson, 1979, table 9]

See data-site numbering systems in text.
Altitude of land surface at well in feet above mean sea level.
Thickness of unit, in feet.
Depth to base of unit, in feet below land surface.

| Material | Thickness | Depth |
|---|---|---|
| (D-23-10)12ddd-1. Log reported by C. A. McKinnon of the U.S. Grazing Service. Alt. 6,850. | | |
| Alluvium | | |
| Soil, red | 40 | 40 |
| Moenkopi Formation | | |
| Limestone and red shale; small amount of water | 25 | 65 |
| Shale, gray, limy | 25 | 90 |
| Shale, brown, limy | 10 | 100 |
| Shale, gray, limy | 75 | 175 |
| Shale, brown | 20 | 195 |
| Sand, fine, gray; water | 19 | 214 |
| Shale, gray | 3 | 217 |
| (D-25-5)14dda-1. Log by Scott Stephenson. Alt. 5,945. | | |
| Alluvium (older) | 65 | 65 |
| Entrada Sandstone | | |
| shale, red | 60 | 125 |
| Carmel(?) Formation | | |
| Shale, white | 3 | 128 |
| Shale, red | 9 | 137 |
| Shale, very hard | 3 | 140 |
| Shale, variegated | 135 | 275 |
| Well cased to 134 ft. | | |
| (D-25-12)34cdb-1. Log by Delhi Oil Corp. Alt. 5,150. | | |
| Sand, dune | 6 | 6 |
| Entrada Sandstone | | |
| Shale, sandy | 19 | 25 |
| Shale, sandy, red | 162 | 187 |
| Sand | 40 | 227 |
| Sand, soft | 63 | 290 |
| (D-25-15)23bdb-1. Log by O. R. Anderson. Alt. 4,795. | | |
| Soil, sandy | 4 | 4 |
| Entrada Sandstone | | |
| Sandstone, red | 66 | 70 |
| Sandstone, white | 20 | 90 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-25-15)23bdb-1.--Continued | | |
| Carmel(?) Formation | | |
| Shale, red, sandy | 15 | 105 |
| Sandstone | 45 | 150 |
| Shale, sandy, red | 14 | 164 |
| Shale, blue | 6 | 170 |
| Shale, hard, blue | 12 | 182 |
| Shale, hard, red | 11 | 193 |
| Navajo Sandstone | | |
| Sandstone, soft; water at 295 ft | 157 | 350 |
| (D-26-4)15bdd-1. Condensed from partial sample log by Mountain Fuel Supply Co. Alt. 8,181. | | |
| No record | 570 | 570 |
| Sandstone, white, very fine to medium-grained, subangular to subrounded; unconsolidated in upper part | 150 | 720 |
| Sandstone, white to red, very fine grained, subrounded; trace of red shale 750-820 ft | 100 | 820 |
| Shale, soft, red; some gypsum; sandstone as above | 50 | 870 |
| Sandstone, as above, with trace of soft red shale | 150 | 1,020 |
| Shale, soft to firm, red | 30 | 1,050 |
| Sandstone, as above; trace of shale | 30 | 1,080 |
| Shale, red, with some gypsum, sandstone and red siltstone | 180 | 1,260 |
| Silstone, red, firm to unconsolidated, red shale and green to gray limestone | 360 | 1,620 |
| Siltstone, red, white, shale, gypsum, and green siltstone | 90 | 1,710 |
| Siltstone, firm to friable, green calcareous; some silty green calcareous shale, sandstone, and white gypsum | 240 | 1,950 |
| No record | 10 | 1,960 |
| Shale, silty, green, calcareous, siltstone, trace of white sandstone, and trace of white gypsum; trace of hard buff limestone at 2,050-2,070 ft | 110 | 2,070 |
| Shale and siltstone, green, as above; every other sample missing | 290 | 2,360 |
| Siltstone and shale, green, traces of gypsum and red chert; traces of brown sandstone at 2,725-2,750 ft, soft red shale and brown siltstone at 2,820-2,940 ft | 580 | 2,940 |
| Shale and siltstone, green; traces of sandstone and red chert | 10 | 2,950 |
| Shale and siltstone, green; light-gray and light-green fine-grained sandstone; traces of brown limestone, red chert, and reddish-brown siltstone; abundance in gypsum | 190 | 3,140 |
| Limestone, hard, brown, microcrystalline; medium hard brown shale; green siltstone and shale as above | 120 | 3,260 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-26-4)15bdd-1.--Continued | | |
| Shale, soft, gray, calcareous and light-green, soft, calcareous, partly micaceous; traces of brown shale, white limestone, and white sandstone..... | 50 | 3,310 |
| Limestone, hard, light-brown and very hard white to light-tan, dolomitic..... | 50 | 3,360 |
| Shale and siltstone, soft, light-green to light-gray, calcareous; some sandstone, limestone and an abundance of chert..... | 30 | 3,390 |
| Limestone, very hard, tan to brown; very hard calcareous partly conglomeritic sandstone; some dolomite, siltstone, chert, and dark-brown shale near bottom; part of limestone is oolitic..... | 67 | 3,457 |
| Shale, soft, gray to green; some siltstone, limestone, and white sandstone..... | 13 | 3,470 |
| Company reported top of Navajo Sandstone at 3,455 ft. Well was drilled to 3,573 ft with air; large amount of water was encountered at 3,467 ft. | | |
| Sandstone, light-brown to clear, very fine grained, fairly well sorted, very porous; water; some gray to green siltstone and shale..... | 10 | 3,480 |
| Shale, gray to green; sandstone and siltstone as noted above; traces of other rock types noted above..... | 30 | 3,510 |
| Sandstone, light-brown, very fine grained, poorly cemented..... | 63 | 3,573 |
| Shale and siltstone, soft, light-green calcareous; some light-tan sandstone..... | 47 | 3,620 |

Sample description continues to 6,485 ft. It should be noted that much of the green shale and siltstone sampled in the Navajo section probably are cavings from the overlying section of Carmel Formation, particularly after drilling.

Fluid was changed from air to mud; similar sample contamination due to shale hydration was noted at test hole (D-27-7)7bcc-1 and in test wells drilled by the Intermountain Power Project. (See Hood and Danielson, 1979, tables 9 and 10.)

(D-26-7)17cba-1. Log by Ramsey Petroleum Co.
Alt. 6,122.

| | | |
|---|---|---|
| Carmel Formation | | |
| Limestone, broken..... | 10 | 10 |
| Limestone, hard..... | 45 | 55 |
| Rock, red..... | 10 | 65 |
| Limestone, hard..... | 18 | 83 |
| Gypsum..... | 7 | 90 |
| Limestone, hard..... | 7 | 97 |
| Shale, blue..... | 10 | 107 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-26-7)17cba-1.--Continued | | |
| Carmel Formation--Continued | | |
| Sand, soft | 7 | 114 |
| Limestone, hard, sandy | 26 | 140 |
| Shale, red | 5 | 145 |
| Limestone, hard, red | 15 | 160 |
| Sand, red | 15 | 175 |
| Sandstone and shale, interbedded | 25 | 200 |
| Sandstone, hard, red | 15 | 215 |
| Navajo Sandstone | | |
| Sand, soft | 135 | 350 |
| Sand, harder | 42 | 392 |
| Sandstone; water; at 963 ft, bailed 7 gal/min of fresh soft water; water level 900 ft below land surface | 803 | 1,195 |
| Kayenta Formation | | |
| Shale, blue | 10 | 1,205 |
| Sandstone, hard | 65 | 1,270 |
| Sandstone, hard, red | 5 | 1,275 |
| Shale, red | 5 | 1,280 |
| Sandstone, hard, red, limy | 35 | 1,315 |
| Wingate Sandstone | | |
| Sandstone, hard, white | 10 | 1,325 |
| Sandstone, hard, red | 33 | 1,358 |
| Sandstone, soft, light | 36 | 1,394 |
| Limestone(?), hard, sandy | 59 | 1,453 |
| Limestone(?), sandy | 49 | 1,502 |
| Sandstone, red | 187 | 1,689 |
| Chinle(?) Formation | | |
| Limestone, hard, white | 11 | 1,700 |
| Limestone, hard, black | 16 | 1,716 |
| Limestone, white | 9 | 1,725 |
| Shale, red and blue | 15 | 1,740 |
| Sandstone; hole filled with 1,000 ft of water | 5 | 1,745 |
| No record | 11 | 1,756 |
| Limestone, sandy | 4 | 1,760 |
| Shale, green | 10 | 1,770 |
| Limestone, red | 15 | 1,785 |
| Shale, red | 15 | 1,800 |
| Shale, red; hard thin interbeds | 35 | 1,835 |
| Record illegible | 65 | 1,900 |
| Moenkopi(?) Formation | | |
| Shale, red | 35 | 1,935 |
| Shale, red; hard thin interbeds | 45 | 1,980 |
| Shale, red | 20 | 2,000 |
| Shale, blue | 65 | 2,065 |
| Limestone, sandy | 7 | 2,072 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-26-7)17cba-1.--Continued | | |
| Moenkopi(?) Formation--Continued | | |
| Shale, red | 13 | 2,085 |
| Limestone, red | 8 | 2,093 |
| Shale, red | 30 | 2,123 |
| Limestone, sandy, red, thin-bedded | 37 | 2,160 |
| Limestone with some shale | 85 | 2,245 |
| Limestone with thin interbeds | 285 | 2,530 |
| Sandstone; natural gas | 4 | 2,534 |
| Limestone with thin interbeds | 66 | 2,600 |
| Limestone, sandy, with thin interbeds | 20 | 2,620 |
| Shale, sandy | 70 | 2,690 |
| Limestone, sandy; natural gas | 5 | 2,695 |
| Shale, brown | 2 | 2,697 |
| Limestone, red | 8 | 2,705 |
| Limestone, hard | 19 | 2,724 |
| Limestone, gray; natural gas | 91 | 2,815 |
| Limestone, red and gray, interbedded | 35 | 2,850 |
| Limestone and sandstone; natural gas | 13 | 2,863 |
| Limestone, red and gray | 22 | 2,885 |
| Shale, sandy, light | 35 | 2,920 |
| Kaibab Limestone | | |
| Limestone, hard, gray | 3 | 2,923 |
| Limestone, sandy, gray | 17 | 2,940 |
| Sandstone, sharp; odor of oil | 8 | 2,948 |
| Limestone, sandy, gray | 10 | 2,958 |
| Limestone, hard, gray | 12 | 2,970 |
| Limestone, sandy | 20 | 2,990 |
| Limestone | 12 | 3,002 |
| Coconino Sandstone | | |
| Sandstone, hard | 73 | 3,075 |
| Sandstone, soft; tarlike oil | 2 | 3,077 |
| Sandstone, medium to hard | 43 | 3,120 |
| Sandstone, soft, white; caved | 48 | 3,168 |
| (D-26-8)6aab-1. Log by C. A. Stephenson. Alt. 5,960. | | |
| Carmel Formation | | |
| Limestone, gray | 220 | 220 |
| Navajo Sandstone | | |
| Sandstone, tan | 547 | 767 |
| Well bottomed on very hard limestone at 767 ft. | | |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-27-4)23bbc-1. Log by Shumway Uranium Mining Corp. Alt. 10,050. | | |
| Colluvium(?) | | |
| Conglomerate, volcanic | 170 | 170 |
| Entrada Sandstone | | |
| Shale, limy, red | 80 | 250 |
| Silt, red | 60 | 310 |
| Conglomerate | 30 | 340 |
| Carmel(?) Formation | | |
| Siltstone, green to gray, silty to shaly | 60 | 400 |
| Shale, black to gray | 50 | 450 |
| Shale, black to gray, silty, white and orange chert, and anhydrite | 190 | 640 |
| Anhydrite interbedded with black to gray shale | 60 | 700 |
| Siltstone, gray to green, with some carbonate | 90 | 790 |
| Limestone, silty, brown | 110 | 900 |
| Siltstone, gray to green, and silty gray chloritic shale | 85 | 985 |
| Sandstone, light-gray, very calcareous | 65 | 1,050 |
| Shale, black to gray, silty | 50 | 1,100 |
| Limestone, tan to light-brown | 10 | 1,110 |
| Navajo Sandstone | | |
| Sandstone, well-rounded | 807 | 1,917 |
| (D-27-7)7bcc-2. USGS test hole 1A. Composite field log by J. W. Hood. Alt. 5,520. | | |
| Soil | 5 | 5 |
| Carmel Formation | | |
| Clay, red | 12 | 17 |
| Shale, greenish-gray, silty | 14 | 31 |
| Shale, white, and gypsum with streak of red shale at 32 ft | 8 | 39 |
| Sand, reddish-tan and clay | 2 | 41 |
| Shale, red | 2 | 43 |
| Shale, gray, and gypsum(?) | 1 | 44 |
| Shale, red-brown; thin interbedded types | 12 | 56 |
| Shale, gray to white and gypsum(?) | 6 | 62 |
| Shale, red to tan and dark gray; rough drill action | 10 | 72 |
| Limestone, yellow, crystalline; limonite | 1 | 73 |
| Shale, gray, limy; drill action very rough at 76 ft; water at 110 ft | 57 | 130 |
| Silt, tan, with gray shale near bottom | 20 | 150 |
| Shale, gray; occasional hard layer; greenish shale and gypsum at about 220 ft | 110 | 260 |
| Shale, dark-gray, limy, and crystalline gypsum | 45 | 305 |
| Gypsum, crystalline, with gray shaly limestone at bottom | 30 | 335 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-27-7)7bcc-2.--Continued | | |
| Carmel Formation--Continued | | |
| Limestone, gray, shaly; water has been increasing in volume in small increments | 15 | 350 |
| Shale, gray, and red shale near 380 ft; shaly limestone | 60 | 410 |
| Water at 395 ft; specific conductance 22,000 micromhos. | | |
| Gypsum, crystalline, and gray shale | 40 | 450 |
| Limestone, gray, shale and gypsum | 30 | 480 |
| Limestone, dark-gray; rough drill action at 530 ft; cuttings fine 530-560 ft; at depth of 605 ft water level 116 ft below land surface | 95 | 575 |
| Shale, dark, and gray shaly limestone | 60 | 635 |
| Limestone, gray, shaly, with crystalline gypsum and bright green shale; some brown sand at 680 ft | 45 | 680 |
| Specific conductance of water at 680 ft 7,000 micromhos. | | |
| Limestone, gray, and red sandstone | 15 | 695 |
| Navajo Sandstone | | |
| Sandstone, brown | 15 | 710 |
| Sandstone, white, with fragments of red shale | 75 | 785 |
| Sandstone, hard, and red shale | 15 | 800 |
| Shale, red | 15 | 815 |
| Sandstone and red shale | 15 | 830 |
| Sandstone | 30 | 860 |
| Sandstone, brown, with gray and red shale; some fragments of limestone | 15 | 875 |
| Sandstone, yellow; some coarse brown sand and shale fragments | 30 | 905 |
| Sandstone | 45 | 950 |

Test hole drilled with air. Water level in open hole after completion was 115 ft below land surface. Gamma-ray log was run to 853 ft inside drill stem, because logging sonde would not pass tight zones at 399 and 700 ft. Resistivity log run to 901 ft where sonde would not pass. Set Lynes Packer at 735 ft and pumped by air lift at about 6 gal/min for 205 minutes. Water level inside drill stem, measured by electric tape, was steady at 395 ft below land surface, 1 hour after pumping stopped. Cement plug pumped down through drill stem to top of Navajo at 711 ft. Detailed sample descriptions by Stacie Kruer available in files of U.S. Geological Survey.

(D-27-11)34ddb-1. Hanksville Airport well 2.
Log by H. R. Phillips. Alt. 4,425.

| | | |
|---|---|---|
| Terrace deposits | | |
| Sand and gravel | 34 | 34 |
| Entrada Sandstone | | |
| Shale, red | 92 | 126 |
| Shale, sandy, gray | 10 | 136 |
| Shale, red | 37 | 173 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-27-11)34ddb-1.--Continued | | |
| Entrada Sandstone--Continued | | |
| Sand; water unfit for domestic use | 5 | 178 |
| Shale, red | 14 | 192 |
| Shale, sandy, red | 16 | 208 |
| Shale, red | 28 | 236 |
| Shale, sandy, red | 26 | 262 |
| Sand, hard | 12 | 274 |
| Shale, sandy, red | 8 | 282 |
| Shale, sandy, gray | 28 | 310 |
| Shale, hard, red | 34 | 344 |
| Shale, red | 18 | 362 |
| Carmel(?) Formation | | |
| Shale, sandy, gray | 54 | 416 |
| Shale, blue, and gypsum | 53 | 469 |
| Limestone, white | 27 | 496 |
| Note: Well cased to this point; subsequent investigation showed hole offset by 496 ft. | | |
| Shale, red | 16 | 512 |
| Shale, hard, red | 7 | 519 |
| Shale, hard, gray | 21 | 540 |
| Shale, hard, red | 18 | 558 |
| Shale, red | 34 | 592 |
| Sand; water flowed 3.3 gal/min | 10 | 602 |
| Record of deepening follows | | |
| (D-27-11)34ddb-1D. USGS test hole 2. Deepening of well 2 at Hanksville Airport. Composite sample log by Stacie Kruer and field log by J. W. Hood. Alt. 4,425. | | |
| Carmel Formation | | |
| Shale, red-brown, silty, muscovite, calcareous; abundant bits of magnetic material that appear igneous in origin; magnetite, zeolites, calcite coating; sandstone, grayish-white, medium-to fine-grained, subangular to rounded; carbonate cement, friable | 8 | 610 |
| Navajo Sandstone | | |
| Sandstone, grayish-tan, medium- to fine-grained, subrounded to rounded, carbonate cement, fairly friable; shale, red-brown, silty, muscovite, gypsum, laminated, calcareous; some bits of the igneous material, magnetite, zeolites, calcite coating | 10 | 620 |
| Sandstone, grayish-white, medium- to very fine grained, subrounded to rounded, carbonate cement, friable; shale, red-brown, silty, muscovite, gypsum, laminated, calcareous; bits of igneous material, magnetite, zeolites, calcite coating | 10 | 630 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-27-11)34ddb-1D.--Continued | | |
| Navajo Sandstone--Continued | | |
| Sandstone, grayish-white, medium to fine-grained, subangular to rounded, carbonate cement, friable; shale, red-brown, silty, muscovite, calcareous; some small bits of the igneous appear; material contains zeolites | 10 | 640 |
| Sandstone, grayish-white, medium- to fine-grained, angular to subrounded; gypsum, carbonate cement; few bits of shale, red-brown, sandy, calcareous | 10 | 650 |
| Sandstone, grayish-white, medium- to fine-grained, angular to subrounded, gypsum, magnetite, carbonate cement; shale, red-brown, silty, muscovite, gypsum, calcareous; some of the igneous-appearing material containing zeolites, magnetite, and calcite | 10 | 660 |
| Sandstone, grayish-white, medium- to very fine grained, subangular to rounded, carbonate cement, friable; shale, red-brown, as above; igneous material, as above; possible contamination from above | 10 | 670 |
| Sandstone, white, fine-grained, subangular to sub-rounded; some magnetite; carbonate cement | 10 | 680 |
| Sandstone, white, fine-grained, angular to sub-rounded, friable | 10 | 690 |
| Sandstone, grayish-white, fine-grained, subangular to rounded, friable, carbonate cement(?); shale, red-brown, muscovite, calcareous | 10 | 700 |
| Sandstone, white, fine-grained, subangular to rounded, magnetite, friable | 10 | 710 |
| Sandstone, white, fine-grained, subangular to rounded, magnetite, friable; some shale, red-brown, silty, muscovite, calcareous | 10 | 720 |
| Sandstone, white, medium- to fine-grained, sub-angular to rounded, magnetite, carbonate cement | 10 | 730 |
| Sandstone, grayish-white, fine-grained, subangular to rounded, carbonate cement, friable; some shale, red-brown, silty, muscovite, calcareous | 10 | 740 |
| Sandstone, tan to brown (while wet), and some small fragments of green sandstone and red shale | 10 | 750 |

Deepened with air-rotary drilling. Found casing collapsed and broken at 349 to 351 ft. This zone had a water level of about 10 ft below land surface and produced about 10 gal/min by airlift. Well was filled below 351 ft. Gamma-ray log indicates basal sandstone in Carmel Formation at 591-599 ft, and basal red shale marker at 599-606 ft. Red shales noted in samples below 610 ft are thin interbeds in upper Navajo Sandstone and are generally 2 to 6 ft thick. Geophysical logs were obtained by setting open-ended drill stem past offset in hole to 520 ft. Final yield was approximately 200 gal/min, by airlift; natural flow after drilling stopped was approximately 50 gal/min. Set Lynes packer at 660.5-605 ft. Flowed 34 gal/min through 1-in. hose. Final shut-in pressure was 78.3 ft above land surface; recovery curve extrapolated to non-pumping level of 83 ft above land surface. Well plugged with 95 sacks of cement.

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-27-13)8dbc-1. Log by O. R. Anderson. Alt. 5,285. | | |
| Soil, sandy (dune sand in area) | 20 | 20 |
| Entrada Sandstone | | |
| Sandstone, red | 10 | 30 |
| Shale, red | 55 | 85 |
| Sandstone, red | 165 | 250 |
| Carmel Formation | | |
| Sandstone, white, and red shale | 12 | 262 |
| Limestone | 7 | 269 |
| Gypsum and shale, interbedded | 101 | 370 |
| Shale, interbedded, red and blue | 45 | 415 |
| Sandstone, hard, red | 5 | 420 |
| Shale, red | 5 | 425 |
| Navajo Sandstone | | |
| Sandstone, interbedded, red and white | 370 | 795 |
| Water level is in the Navajo Sandstone. Sandstone tends to cave, as shown by the need to clean out the uncased water-producing zone. Well abandoned because tools and pipe were lost in the open hole. | | |
| (D-27-14)5acc-1S. Log by Texas Production Co. Alt. 5,684. | | |
| Summerville and Curtis Formations and Entrada Sandstone | | |
| Rock, red | 240 | 240 |
| Sand, red | 90 | 330 |
| Sandstone, red | 40 | 370 |
| Sand, red | 10 | 380 |
| Rock, red, and white sand | 20 | 400 |
| Sand, red | 40 | 440 |
| Rock, red | 20 | 460 |
| Sand, white | 45 | 505 |
| Rock, red, and white sand | 35 | 540 |
| Rock, red | 70 | 610 |
| Carmel Formation | | |
| Shale, red and white, soft; five bailers of water per hour at 610 ft | 5 | 615 |
| Shale, red | 15 | 630 |
| Rock, red | 10 | 640 |
| Conglomerate | 20 | 660 |
| Sand, soft, white | 5 | 665 |
| Conglomerate | 35 | 700 |
| Rock, hard, red | 70 | 770 |
| Navajo Sandstone | | |
| Sand, soft, white | 310 | 1,080 |
| Sand, soft, red | 40 | 1,120 |
| Sand, white | 80 | 1,200 |
| Sand, red; water | 85 | 1,285 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-27-14)5acc-1S.--Continued | | |
| Kayenta Formation | | |
| Shale, red | 10 | 1,295 |
| Thin hard bed | 5 | 1,300 |
| Sand, red; 300 ft of water in hole | 15 | 1,315 |
| Shale, red | 5 | 1,320 |
| Sandstone, hard, red | 80 | 1,400 |
| Rock, red, red sand, and red shale | 25 | 1,425 |
| Wingate Sandstone | | |
| Sand and red rock | 50 | 1,475 |
| Sand, white | 80 | 1,555 |
| Shale, red | 5 | 1,560 |
| Sand, gray | 60 | 1,620 |
| Sand, red | 20 | 1,640 |
| Sand, brown; 600 ft of water in hole at 1,700 ft | 190 | 1,830 |
| Chinle Formation | | |
| Shale, red; 900 ft of water in hole at 1,845-1,855 ft | 70 | 1,900 |
| Limestone | 20 | 1,920 |
| Rock, red | 80 | 2,000 |
| Sand, hard, white | 10 | 2,010 |
| Conglomerate | 20 | 2,030 |
| Sand, hard, white | 10 | 2,040 |
| Shale, red | 10 | 2,050 |
| Conglomerate, variegated | 35 | 2,085 |
| Shale, red | 35 | 2,120 |
| Conglomerate, variegated | 48 | 2,168 |
| Shinarump Member of Chinle Formation | | |
| Sand, gray; show of oil | 2 | 2,170 |
| Sand, gray; heavy residual oil | 25 | 2,195 |
| Moenkopi Formation | | |
| Shale, red | 5 | 2,200 |
| Conglomerate, variegated | 15 | 2,215 |
| Shale, green | 20 | 2,235 |
| Shale, gray | 95 | 2,330 |
| Shale, grayish-green | 35 | 2,365 |
| Limestone, hard, blue | 25 | 2,390 |
| Shale, grayish-green | 35 | 2,425 |
| Limestone and sand, brown | 30 | 2,455 |
| Limestone, sandy, gray | 35 | 2,490 |
| Limestone, brown and white | 25 | 2,515 |
| Limestone, sandy, gray | 70 | 2,585 |
| Limestone, sandy, brown | 20 | 2,605 |
| Limestone, gray | 70 | 2,675 |
| Limestone, hard, sandy, gray | 55 | 2,730 |
| White Rim Sandstone Member of Cutler Formation | | |
| Sand, brown; water at 2,740 ft, rose to 1,575 ft | 20 | 2,750 |
| Sandstone, white; more water at 2,780 ft and at 2,830 ft | 125 | 2,875 |

Note: Baker (1946, p. 115-116) interprets parts of this log differently. The interpretation given above is based on water-level relations and logs in other wells in this area and on local structure.

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-27-15)21aad-1. Log by Conway Bros. Alt. 5,381. | | |
| Alluvium | | |
| Sand and brown shale | 15 | 15 |
| Gravel | 12 | 27 |
| Entrada Sandstone | | |
| Sand, light-brown | 8 | 35 |
| Carmel Formation | | |
| Shale and sand | 50 | 85 |
| Sand, red, limy | 58 | 143 |
| Navajo Sandstone | | |
| Sand, brown; lost drilling water | 100 | 243 |
| Sand; water at 592 ft | 352 | 595 |
| Sand, white | 10 | 605 |
| Sand | 63 | 668 |
| Kayenta Formation | | |
| Shale, sandy | 14 | 682 |
| (D-28-8)32acb-1. Log by Ohio Oil Co. Alt. 4,990. | | |
| Terrace deposits | | |
| Sand, red, and gravel | 32 | 32 |
| Entrada Sandstone | | |
| Shale, red | 288 | 320 |
| Carmel Formation | | |
| Shale, green | 65 | 385 |
| Shale, hard, sandy | 3 | 388 |
| Shale, blue | 107 | 495 |
| Limestone, white, thin-bedded | 10 | 505 |
| Gypsum | 5 | 510 |
| Limestone, bluish-green | 40 | 550 |
| Shale, hard, sandy, red | 25 | 575 |
| Limestone, thin, blue | 20 | 595 |
| Sand; water at 590 to 597 ft | 5 | 600 |
| Limestone, blue and gray; water at 614-695 ft | 110 | 710 |
| Shale, gray | 5 | 715 |
| Water found in the zone 705-2,300 ft. | | |
| Navajo Sandstone | | |
| Sand, white | 195 | 910 |
| Sand, yellow | 225 | 1,135 |
| Sand, white | 45 | 1,180 |
| Sand, yellow | 150 | 1,330 |
| Sand, white | 55 | 1,385 |
| Sand, red | 25 | 1,410 |
| Sand, white | 110 | 1,520 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-28-8)32acb-1.--Continued | | |
| Kayenta Formation | | |
| Sand, hard, red | 205 | 1,725 |
| Shale, hard, red | 25 | 1,750 |
| Wingate Sandstone | | |
| Sand, red | 581 | 2,331 |
| Sand, hard, red | 37 | 2,368 |
| Chinle Formation | | |
| Shale, sandy, red | 30 | 2,398 |
| Shale, hard, red | 5 | 2,403 |
| Shale, red | 37 | 2,440 |
| Hard layer, thin, gray | 10 | 2,450 |
| Shale, gray | 10 | 2,460 |
| Shale, red | 100 | 2,560 |
| Shale, dark-brown | 20 | 2,580 |
| Shale, red | 150 | 2,730 |
| Sand; salt water at 2,636-2,754 ft | 15 | 2,745 |
| Sand, hard, red | 11 | 2,756 |
| Shale and conglomerate(?) | 6 | 2,762 |
| Moenkopi Formation | | |
| Shale, sandy, dark-red | 373 | 3,135 |
| Sand, red | 10 | 3,145 |
| Shale, sandy, red | 175 | 3,320 |
| Limestone, gray | 11 | 3,331 |
| Hard layer, thin, red | 14 | 3,345 |
| Kaibab Limestone | | |
| Limestone, gray | 48 | 3,393 |
| Shale, red | 74 | 3,467 |
| Coconino Sandstone | | |
| Sand, gray | 5 | 3,472 |
| Sand, white, sharp | 51 | 3,523 |
| Sand, gray | 3 | 3,526 |
| Shale, white | 4 | 3,530 |
| Sand, gray | 7 | 3,537 |
| Sand, white | 13 | 3,550 |
| Sand, gray | 8 | 3,558 |
| Sand, yellow | 92 | 3,650 |
| Drilled with steam-powered cable-tool (percussion) rig. | | |
| (D-28-8)35dbb-1. Log by Mac Exploration Co. Alt. 4,580. | | |
| Holocene alluvium | | |
| Silt and sand, red | 8 | 8 |
| Sand, blue | 6 | 14 |
| Clay, blue | 2 | 16 |
| Sand, red | 4 | 20 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-28-8)35dbb-1.--Continued | | |
| Pleistocene alluvium | | |
| Gravel, fine to medium | 7 | 27 |
| Gravel, coarse | 7 | 34 |
| Gravel and cobbles | 20 | 54 |
| Clay, gray | 3 | 57 |
| Gravel, medium | 11 | 68 |
| Mancos Shale | | |
| Shale, barren | 23 | 91 |
| (D-28-9)30dad-1. Log by Mac Exploration Co. Alt. 4,560. | | |
| Holocene alluvium | | |
| Clay and sand | 4 | 4 |
| Clay | 4 | 8 |
| Clay and silt | 8 | 16 |
| Sand | 6 | 22 |
| Clay | 8 | 30 |
| Pleistocene alluvium | | |
| Sand and gravel | 6 | 36 |
| Gravel and cobbles | 22 | 58 |
| Mancos Shale | | |
| Shale, gray | 14 | 72 |
| (D-28-10)16ccb-1. Log by L. P. Cromer. Alt. 4,420. | | |
| Alluvium and slope wash | | |
| Clay, blue-gray | 20 | 20 |
| Clay and gravel | 3 | 23 |
| Tununk Member of Mancos Shale | | |
| Clay, gray | 32 | 55 |
| Clay and sharp sandstone | 10 | 65 |
| Clay, blue | 20 | 85 |
| Dakota(?) Sandstone | | |
| Sandstone | 20 | 105 |
| Shale, blue, interbedded with sandstone | 80 | 185 |
| Cedar Mountain(?) Formation | | |
| Clay, gray | 35 | 220 |
| Limestone | 2 | 222 |
| Clay, gray | 13 | 235 |
| Sandstone | 30 | 265 |
| Clay, gray | 41 | 306 |
| Limestone and sandstone | 3 | 309 |
| Sandstone | 16 | 325 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-28-10)22abc-1. Log by H. R. Phillips. Alt. 4,370. | | |
| Alluvium | | |
| Soil | 13 | 13 |
| Sand, very fine | 12 | 25 |
| Sand and gravel | 50 | 75 |
| (D-28-11)2ccc-1. Log by H. R. Phillips. Alt. 4,260. | | |
| Surface | 10 | 10 |
| Entrada Sandstone | | |
| Shale, sandy, red | 17 | 27 |
| Shale, red | 5 | 32 |
| Sand; small amount of flowing water | 8 | 40 |
| Shale, sandy, light-red; at 63 ft water could be bailed down to 40 ft; water good | 54 | 94 |
| Shale, red | 8 | 102 |
| Shale, light-red | 4 | 106 |
| Sand; water good; at 130 ft bailed 20 gal/min with pumping level of 15 ft | 16 | 122 |
| Shale, red | 13 | 135 |
| Sand, hard; water not good | 3 | 138 |
| Shale, red | 2 | 140 |
| No record | 20 | 160 |
| Shale, red, with gypsum; water worse | 20 | 180 |
| (D-28-11)15bdc-1. Loman Exploration Co. Alt. 4,340. | | |
| Fill | 40 | 40 |
| Entrada Sandstone | | |
| Shale, red | 200 | 240 |
| Sand, red | 25 | 265 |
| Sand, white | 10 | 275 |
| Sand and silt, red | 15 | 290 |
| (D-28-11)15cba-1. Log by W. E. Hoggard. Alt. 4,310. | | |
| Alluvium | | |
| Clay | 4 | 4 |
| Sand; unusable water at 18 ft | 22 | 26 |
| Sand and gravel | 64 | 90 |
| Entrada Sandstone | | |
| Sandstone, red; some water | 180 | 270 |
| Sandstone, light-brown; a lot of water | 67 | 337 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-28-11)16bdd-1. Log by H. E. Beeman. Alt. 4,305. | | |
| Alluvium | | |
| Sand | 20 | 20 |
| Gravel | 86 | 106 |
| Entrada Sandstone | | |
| Sandstone, red | 246 | 352 |
| Sand, white; water | 40 | 392 |
| (D-28-11)16cca-1. Log by H. R. Phillips. Alt. 4,335. | | |
| Surface deposits | 4 | 4 |
| Entrada Sandstone | | |
| Shale, red | 46 | 50 |
| Sand; water | 2 | 52 |
| Shale, red | 117 | 169 |
| Shale, sandy, light-red | 177 | 346 |
| Sand, hard | 4 | 350 |
| Shale, red | 18 | 368 |
| Sand, hard | 6 | 374 |
| Shale, red | 27 | 401 |
| Sand; water | 27 | 428 |
| Shale, red | 2 | 430 |
| (D-28-11)16dad-1. Log by J. L. Zimmerman. Alt. 4,305. | | |
| Alluvium | | |
| Soil | 2 | 2 |
| Sand, brown | 9 | 11 |
| Clay, brown | 20 | 31 |
| Sand and gravel; alkaline salty water | 37 | 68 |
| Sand, red; alkaline salty water | 11 | 79 |
| Clay, brown | 5 | 84 |
| Sand, brown | 7 | 91 |
| Sand and cobbles; salty water | 5 | 96 |
| Entrada Sandstone | | |
| Sand, red | 8 | 104 |
| Sandstone | 56 | 160 |
| Clay | 3 | 163 |
| Sandstone | 97 | 260 |
| Clay and sandstone | 31 | 291 |
| Sandstone; water | 57 | 348 |
| No record | 2 | 350 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-28-11)16ddb-1. Log by A. J. Denny. Alt. 4,315. | | |
| Alluvium | | |
| Sand, soft, light | 25 | 25 |
| Sand, light, and muddy blue shale | 10 | 35 |
| Sand, gray, coarse; bailed 3 gal/min of bad water | 13 | 48 |
| Shale, soft, blue, muddy | 2 | 50 |
| Shale, blue and red, with gravel | 10 | 60 |
| Shale, red | 5 | 65 |
| Gravel, coarse; increase in water | 9 | 74 |
| Entrada Sandstone | | |
| Sand and red shale | 4 | 78 |
| Shale, sandy red | 32 | 110 |
| Sand, light; 26 gal/min of good water at 130 ft, increasing to 30 gal/min at 140 ft | 55 | 165 |
| Sand, hard, brown | 10 | 175 |
| Shale, sandy, red | 13 | 188 |
| Sand, red, fine | 27 | 215 |
| Sand, red, sharp; bailed 50 gal/min with pumping level of 168 ft | 3 | 218 |
| Sand, hard, red, sharp | 12 | 230 |
| Sand, red, sharp | 10 | 240 |
| Sand, soft, light; water level 24 ft below land surface | 10 | 250 |
| Sand, soft, red | 42 | 292 |
| Sand, soft, white; water level 3 ft; bailed 4.6 gal/min of good water with drawdown of 60 ft | 12 | 304 |
| Sand, loose, white; at 316 ft bailed 4.6 gal/min; at 320 ft bailed 30 gal/min | 24 | 328 |
| Sand, hard, red; bailed 27 gal/min with pumping level of 24 ft; flowed 5 gal/min | 4 | 332 |
| (D-28-11)17adb-1. Log by H. E. Beeman. Alt. 4,320. | | |
| Alluvium | | |
| Sand | 10 | 10 |
| Entrada Sandstone | | |
| Clay, blue, and shale | 105 | 115 |
| Sandstone, red; water | 3 | 118 |
| Sandstone, red | 370 | 488 |
| Sandstone, white; water | 15 | 503 |
| (D-28-11)21abd-1. Log by Binning Drilling Co. Alt. 4,320. | | |
| Alluvium | | |
| Clay and silt, brown | 10 | 10 |
| Clay, brown, sand, and gravel | 10 | 20 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-28-11)21abd-1.--Continued | | |
| Entrada Sandstone | | |
| Clay, red, and sand | 10 | 30 |
| Sandstone and clay, red, interbedded | 56 | 86 |
| Sandstone and clay, tan, interbedded | 6 | 92 |
| Sandstone and clay, red, interbedded | 108 | 200 |
| Sandstone | 105 | 305 |
| Clay and sandstone, interbedded | 5 | 310 |
| Sandstone | 10 | 320 |
| Sandstone, light-red | 25 | 345 |
| Sandstone, red | 5 | 350 |
| Sandstone, tan | 10 | 360 |
| Sandstone, red | 3 | 363 |
| (D-28-11)28bdd-2. Log by H. R. Phillips. Alt. 4,380. | | |
| Alluvium | 19 | 19 |
| Entrada Sandstone | | |
| Shale, red | 41 | 60 |
| Shale, sandy red | 10 | 70 |
| Shale, red | 135 | 205 |
| Sand; water | 10 | 215 |
| Shale, sandy, red | 60 | 275 |
| Shale, red | 56 | 331 |
| Sand, hard | 4 | 335 |
| Shale, red | 50 | 385 |
| Sand, hard | 6 | 391 |
| Shale, red | 15 | 406 |
| Sand; water; sand at 406-435 ft was loose and ran into well | 49 | 455 |
| Sand, hard, fine | 20 | 475 |
| Sand; water | 29 | 504 |
| Shale, red | 8 | 512 |
| (D-29-4)25dcb-1. Log by Well Supply Co. Alt. 7,070. | | |
| Glacial outwash | | |
| Clay, gravel, and boulders | 34 | 34 |
| Navajo Sandstone | | |
| Sandstone, yellow; water at 35 ft | 116 | 150 |
| (D-29-5)19cba-1. Log by Well Supply Co. Alt. 6,740. | | |
| Glacial outwash | | |
| Gravel, cobbles and clay | 28 | 28 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-5)19cba-1.--Continued | | |
| Moenkopi Formation | | |
| Shale, red | 50 | 78 |
| Sinbad Limestone Member | | |
| Limestone, yellow; water 80-110 ft | 62 | 140 |
| (D-29-5)32bad-1. Log by Well Supply Co. Alt. 6,880. | | |
| Alluvium and glacial deposits | | |
| Clay, silt, gravel, cobbles, and boulders | 21 | 21 |
| Moenkopi Formation | | |
| Shale, gray | 54 | 75 |
| Sinbad Limestone Member | | |
| Limestone, fractured limonitic; poor cutting returns | 25 | 100 |
| Note: Water level declined while drilling well, from 3 ft in the shallow deposits to 30 ft at finished depth. | | |
| (D-29-7)15dbd-1.--USGS test hole 4. Composite field log by J. W. Hood. Alt. 5,045. | | |
| Fill, artificial, and brown silt, sand and gravel; larger gravel is bit-cut; one boulder; sand and gravel caved during reaming; water level approximately 12 ft below land surface | 17 | 17 |
| Siltstone, red to dark-brown, clayey, sand; wet material forms lumps around bit and drill stem | 23 | 40 |
| Shale, gray, silty, soft to firm limy chips; cuttings look wet | 10 | 50 |
| Mud, thick, tan; a little water | 5 | 55 |
| Limestone and limy shale, gray, hard, in thin flakes and chips; drill action is rough | 5 | 60 |
| Limestone, dark-gray, shaly; many flakes and chips; few flakes of red-brown shale at 90-100 ft; started producing much water at about 70 ft where formation is hard and drilling rough; slightly softer at 77-80 ft; produced more water at 90 ft | 60 | 120 |
| Shale and siltstone, brown, sandy, with limestone chips with solution pits at 125 ft; had to pull bit up to clear hole of cuttings | 10 | 130 |
| Limestone, dark-gray, shaly, hard; cuttings finer than above; some gypsum; iron stains in limestone | 10 | 140 |
| As above, with brown siltstone and thin flakes of tan to green limy shale; some red chert and thin veinlets of gypsum at 160-170 ft | 40 | 180 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-7)15dbd-1.--Continued | | |
| Gypsum; drilling fluid turned white; includes some gray limestone, flakes of green and red shale; some sand in cutting at about 199 ft | 20 | 200 |
| Shale, greenish-white with red mottled zones; gypsum | 10 | 210 |
| Limestone and gypsum, gray with dark- to light-brown siltstone and fine sand | 10 | 220 |
| Sandstone, tan, fine- to coarse-grained with red siltstone and minor amounts of limestone and gypsum | 10 | 230 |
| Siltstone, red and tan, red sandstone, and gray limestone | 10 | 240 |
| Sandstone, tan, red siltstone, and red sandstone | 10 | 250 |
| As above, with more sand | 10 | 260 |
| Water sample at 261 ft; specific conductance, 1,800 micromhos; pH, 6.8; estimated yield, 150 gal/min. | | |
| Sandstone, white to tan, very fine to fine-grained | 10 | 270 |
| As above, with cavings(?) of red siltstone and gray limestone | 10 | 280 |
| Sandstone, slightly yellowish, very fine to fine-grained; cavings(?) of reddish-tan shaly sandstone at 290-300 ft | 20 | 300 |
| Sandstone, tan, very fine to medium-grained; 5 percent dark reddish-brown silty sandstone at 320-330 ft | 50 | 350 |
| Water sample at 330 ft; specific conductance, 1,400 micromhos; temp., 14°C; pH, 6.8; estimated yield, 200 gal/min. | | |
| Sandstone, dirty, with dark-red sandstone and siltstone, tan siltstone, and dark-tan strongly cemented sandstone | 10 | 360 |
| Sandstone, tan, very fine to fine-grained; many small white fragments (vein fillings?) below 380 ft | 30 | 390 |
| As above, looks dirtier and darker tan; fragments of dirty sandstone | 30 | 420 |
| Sandstone, tan, very fine grained; few cavings with fine white fragments as above; slightly dirtier at 440-450 ft | 40 | 460 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-7)15dbd-1.--Continued | | |
| After final cleaning, hole open to total depth, with no cavings; maximum open-hole flow was 43 gal/min; packer set at 260 ft and failed to stop flow; final packer setting at 238-242 ft shut-off flow from Navajo Sandstone. Detailed description of samples, by Stacie Kruer, available in files of the U.S. Geological Survey. | | |
| (D-29-11)1bbc-1. Log by H. R. Phillips. Alt. 4,460. | | |
| Surface deposits | 18 | 18 |
| Entrada Sandstone | | |
| Shale, red; water at 130 ft | 162 | 180 |
| Sand and streaks of red shale; water | 140 | 320 |
| Red Shale at 320 ft. | | |
| (D-29-12)19bcd-1. Log by Charles Erb. Alt. 4,930. | | |
| Sand, windblown | 3 | 3 |
| Entrada Sandstone | | |
| Sandstone, red and white, interbedded | 100 | 103 |
| Shale, red | 37 | 140 |
| Sandstone, red | 208 | 348 |
| Carmel Formation | | |
| Shale, red and blue, interbedded | 84 | 432 |
| Gypsum | 13 | 445 |
| Shale, red | 10 | 455 |
| Flintrock(?) | 6 | 461 |
| Shale, red | 36 | 497 |
| Sandstone, hard, red | 21 | 518 |
| Shale, red; water | 87 | 605 |
| (D-29-12)33acd-2. Composite sample log by Stacie Kruer and field log by J. W. Hood. Alt. 4,616. | | |
| Shale, light-red, silty, micaceous, laminated, fissile, calcareous, with gypsum; shale, gray, micaceous, some small gypsum crystals, laminated, fissile, calcareous | 10 | 10 |
| Gypsum, white, massive; also some satin spar interlayered with shale, red-brown, silty, muscovite, calcareous | 10 | 20 |
| Shale, gray, silty, micaceous, calcareous, with gypsum; shale, red-brown, silty, calcareous | 10 | 30 |
| Shale, gray, muscovite, laminated, fissile, calcareous | 10 | 40 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-12)33acd-2.--Continued | | |
| Shale, gray, silty, micaceous, calcareous; some gypsum, white, massive; siltstone, reddish-gray, unidentifiable black grains, calcareous..... | 10 | 50 |
| Shale, gray, micaceous, gypsum, sulfides, laminated, calcareous..... | 10 | 60 |
| Shale, gray and red, muscovite, gypsum, laminated, calcareous; gypsum, white, massive..... | 10 | 70 |
| Shale, dard-gray, micaceous, laminated, fissile, calcareous; siltstone, reddish-gray, calcareous; gypsum, white, massive..... | 10 | 80 |
| Shale, red-brown, silty, muscovite, gypsum, laminated and calcareous; gypsum, grayish-white, massive..... | 10 | 90 |
| Gypsum, white, granular (looks like it has been ground up into small pieces)..... | 10 | 100 |
| Shale, dark-gray, biotite, laminated, calcareous; gypsum, white, massive..... | 10 | 110 |
| Gypsum, white, massive and granular..... | 10 | 120 |
| Gypsum, reddish-white, crystalline and massive and granular; siltstone, dark red-brown; biotite; gypsum, slightly calcareous..... | 10 | 130 |
| Siltstone, dark red-brown; biotite; gypsum, slightly calcareous; some gypsum, white, massive..... | 10 | 140 |
| Shale, greenish-gray, silty, muscovite, chlorite, biotite, laminated, extremely calcareous; shale, dark red-brown, muscovite, laminated, calcareous..... | 10 | 150 |
| Limestone, light-gray, shaly; some chlorite, and muscovite..... | 10 | 160 |
| Limestone, light-gray, shaly, some chlorite; siltstone, red-brown, biotite, calcareous..... | 10 | 170 |
| Shale, dark red-brown, silty, micaceous, calcareous..... | 10 | 180 |
| Limestone, light-red to red-brown, oolitic, some biotite flakes, some sulfides, oolites are spherical to eliptical; siltstone, red biotite, calcareous; seems to be interlayered with the oolitic limestone; the biotite in both the siltstone and limestone are fairly large flakes..... | 20 | 200 |
| Shale, dark red-brown, micaceous, calcareous; sandstone, grayish-white, very fine grained, subangular to subrounded, some magnetite, calcareous cement..... | 10 | 210 |
| Sandstone, pinkish-tan, fine- to very fine grained; subangular to rounded, some magnetite, carbonate cement; some shale, red-brown, silty, slightly calcareous..... | 10 | 220 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-12)33acd-2.--Continued | | |
| Sandstone, pinkish-white, fine-grained, subrounded to rounded; some magnetite, friable, carbonate cement. Test hole began producing estimated 5 gal/min at 225 ft by air lift | 10 | 230 |
| Sandstone, tan, very fine grained, subangular to rounded, friable | 10 | 240 |
| Sandstone, tan, very fine grained, subangular to rounded, friable, some magnetite. Test hole producing estimated 25 gal/min at 250 ft | 10 | 250 |
| Sandstone, tan, medium- to fine-grained, subrounded to rounded, friable; carbonate cement | 10 | 260 |
| Sandstone, tan, very fine grained, subangular to rounded, friable, clean | 10 | 270 |
| Sandstone, tan, medium- to fine-grained, subrounded to rounded, friable, clean | 10 | 280 |
| Sandstone, tan, medium-grained, subrounded to rounded; some magnetite, friable | 10 | 290 |
| Sandstone, pinkish-tan, medium- to very fine grained, angular to rounded, magnetite, friable, carbonate cement | 20 | 310 |
| Sandstone, tan, medium- to fine-grained, subangular to rounded, magnetite, friable | 10 | 320 |
| Sandstone, pinkish-tan, very fine grained, subrounded to rounded, magnetite, friable | 10 | 330 |
| Sandstone, tan, fine-grained, subrounded to rounded, some magnetite, friable, carbonate cement | 10 | 340 |
| Sandstone, tan, fine-grained, subrounded to rounded, some magnetite, friable | 10 | 350 |
| Sandstone, tan, medium- to fine-grained, subangular to rounded, magnetite, friable | 10 | 360 |
| Sandstone, tan, fine-grained, subangular to rounded, magnetite, some biotite, friable | 10 | 370 |
| Sandstone, tan, fine-grained, subangular to rounded, magnetite, friable. Test hole producing estimated 200 gal/min at 390 ft | 20 | 390 |
| Sandstone, tan, fine-grained, subangular to rounded, magnetite, friable, carbonate cement | 10 | 400 |
| Sandstone, tan, medium- to fine-grained, subangular to rounded, magnetite, friable, carbonate cement | 10 | 410 |
| Sandstone, tan, fine-grained, subrounded to rounded, magnetite, some pyrite, friable, carbonate cement; shale, red-brown, sandy, gypsum, biotite, calcareous | 10 | 420 |
| Sandstone, tan, fine-grained, subangular to rounded, magnetite, friable, carbonate cement | 10 | 430 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-12)33acd-2.--Continued | | |
| Sandstone, tan, fine-grained, subrounded to rounded, friable, carbonate cement | 10 | 440 |
| Sandstone, tan, fine-grained, subangular to rounded, magnetite, friable, carbonate cement | 30 | 470 |
| Sandstone, tan, fine to very fine grained, subrounded to rounded; sandstone, pinkish-white, silty, cemented with gypsum | 10 | 480 |
| Sandstone, tan, very fine grained, subangular to rounded, magnetite, friable, carbonate cement | 10 | 490 |
| Sandstone, tan, very fine grained, subangular to rounded, magnetite, some pyrite, friable, carbonate cement; sandstone, pinkish-white, silty, cemented with gypsum | 10 | 500 |

Hole drilled to 510 ft to assure full 500 ft of open hole. Carmel Formation was dry; no packer set to obtain water level and water sample. Sample taken from casing head after blowing hole free of cuttings and detergent. No geophysical log. Water level was 140.9 ft below land surface after 17 hours of recovery from air lift pumping.

(D-29-13)1aab-2. Log reported by Paradox Production Corp. Alt. 5,250.

| | | |
|---|---|---|
| Carmel Formation | | |
| Siltstone and shale, red, soft, very calcareous | 30 | 30 |
| Navajo Sandstone | | |
| Sandstone, white to light-orange, very fine to coarse-grained, slightly calcareous, friable | 70 | 100 |
| Sandstone, light-orange, medium-grained, slightly dolomitic, very friable | 45 | 145 |
| Siltstone, red, siliceous, dolomitic, hard | 25 | 170 |
| Sandstone, orange, very fine grained, silty, slightly calcareous | 40 | 210 |
| Sandstone, orange, fine- to medium-grained, friable, slightly calcareous | 60 | 270 |
| Sandstone, orange, very fine grained, silty, friable | 70 | 340 |
| Sandstone, white to orange, very fine grained, silty, friable | 70 | 410 |
| Sandstone, orange, fine- to medium-grained, friable | 50 | 460 |
| Sandstone, as above, silty | 70 | 530 |
| Sandstone, orange, very fine grained, friable, calcareous | 60 | 590 |
| Sandstone, as above, with stringers brown soft shale | 10 | 600 |
| Sandstone, white to orange, very fine grained, silty, friable | 50 | 650 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Kayenta Formation | | |
| Sandstone, white, very fine grained, silty, with stringers chocolate brown shale | 170 | 820 |
| Siltstone, chocolate brown, calcareous, with stringers chocolate brown shale | 10 | 830 |
| Sandstone, pink, very fine to fine-grained, slightly calcareous | 30 | 860 |
| Sandstone, orange, very fine to medium-grained, slightly calcareous, friable, abundant gypsum | 50 | 910 |
| Wingate Sandstone | | |
| Sandstone, white to light-orange, very fine grained, slightly calcareous, friable | 20 | 930 |
| Sandstone, light-orange, very fine grained, silty, friable | 60 | 990 |
| Sandstone, as above, saturated | 20 | 1,010 |
| Sandstone, white, very fine grained, very friable, slightly calcareous | 40 | 1,050 |
| Sandstone, light-orange, very fine grained, slightly calcareous, very friable | 10 | 1,060 |
| Sandstone, light-orange, silty, friable, slightly calcareous; trace of gypsum | 20 | 1,080 |
| Sandstone, white, very fine grained, slightly calcareous, friable | 60 | 1,140 |
| Sandstone, white, very fine grained, silty, calcareous, friable | 40 | 1,180 |
| Sandstone, light-orange, very fine grained, friable | 30 | 1,210 |
| Chinle Formation | | |
| Siltstone, red to brown, micaceous, calcareous | 40 | 1,250 |
| Siltstone, red, brown, purple, micaceous, calcareous, with some chocolate brown shale stringers | 75 | 1,325 |
| Limestone, gray and purple, hard, dense | 15 | 1,340 |
| Siltstone, red and brown, with trace of pink lime | 60 | 1,400 |
| Shale, purple, silty, trace of gray lime | 10 | 1,410 |
| Limestone, pink-gray, hard, dense, with above siltstone stringers | 40 | 1,450 |
| Shale, chocolate brown, calcareous | 40 | 1,490 |
| Shale, gray, soft, calcareous | 30 | 1,520 |
| Sandstone, very fine to medium-grained, white, very calcareous | 40 | 1,560 |
| Shale, chocolate brown, calcareous, hard, some gray-green shale | 50 | 1,610 |
| Sandstone, white, very fine grained, hard, tight | 10 | 1,620 |
| Shale, red, calcareous, with some gray-green shale | 50 | 1,670 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Chinle Formation--Continued | | |
| Shale, gray-green, pyritic, micaceous | 100 | 1,770 |
| Shale, as above, with white sandstone stringers | 60 | 1,830 |
| Siltstone, dolomitic | 60 | 1,890 |
| Shale, brown, gray, hard, dense | 10 | 1,900 |
| Siltstone, gray-white, dolomitic | 10 | 1,910 |
| Shale, gray, pyritic, micaceous, calcareous | 20 | 1,930 |
| Siltstone, gray-white | 40 | 1,970 |
| Shale, gray, pyritic, calcareous | 10 | 1,980 |
| Dolomite, white-gray, argillaceous; dead oil stain | 10 | 1,990 |
| Shale, gray-green, pyritic, calcareous | 50 | 2,040 |
| Coconino Sandstone | | |
| Sandstone, white, medium-grained, angular, light fluorescence and cut, calcareous | 10 | 2,050 |
| Sandstone, clear-white, medium- to coarse-grained, friable, subangular; asphaltic shows; abundant gypsum | 80 | 2,130 |
| Sandstone, clear-white, fine- to medium-grained, subangular; appears water bearing; trace of gypsum | 40 | 2,170 |
| Sandstone, white, fine-grained, subangular, frosted, widely sorted, friable; trace of gypsum | 10 | 2,180 |
| Sandstone, as above, more friable, poorly sorted, trace of coarse-grained conglomerate sandstone | 70 | 2,250 |
| Sandstone, white-tan, very fine to fine-grained, sub-rounded, frosted, poorly sorted, very friable, abundant gypsum | 60 | 2,310 |
| Sandstone, as above, except less friable, fine-grained, fairly sorted | 60 | 2,370 |
| Sandstone, white-tan, fine-grained, subrounded, frosted, poorly sorted, very friable; trace of gypsum; tract pyrite | 40 | 2,410 |
| Sandstone, white-light gray, very fine to fine-grained, fairly sorted, trace of gypsum | 30 | 2,440 |
| Sandstone, white, fine- to coarse-grained; some coarse-grained rounded frosted individual quartz grains, very friable; trace of pyrite; trace of gypsum | 30 | 2,470 |
| Sandstone, white-light gray, very fine to fine-grained, less friable, trace of gypsum; trace of pyrite | 90 | 2,560 |
| Sandstone, white-tan, fine-grained, subrounded, frosted, very friable; trace of gypsum | 10 | 2,570 |
| Sandstone, white-light gray, fine-grained, subangular, friable, trace of gypsum, trace of pyrite | 40 | 2,610 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Coconino Sandstone--Continued | | |
| Sandstone, white, medium-coarse grained, rounded, frosted, very friable; trace of gypsum | 20 | 2,630 |
| Sandstone, white, fine- to medium-grained, very friable, rounded, frosted; trace of gypsum; trace of pyrite | 20 | 2,650 |
| Sandstone, white to tan, fine to medium-grained, trace of gypsum | 550 | 3,200 |
| Sandstone, white-tan, very fine grained, silty, very friable, frosted, rounded | 60 | 3,260 |
| Sandstone, as above, with stringers red to brown siltstone | 10 | 3,270 |
| Sandstone, white, very fine to fine-grained, less friable, micaceous, calcareous, with trace of red to brown siltstone, trace of purple dolomite, fine crystalline | 10 | 3,280 |
| Sandstone, as above, with trace of light-gray, very micaceous, hard, siltstone, sandy, trace of purple dolomite | 10 | 3,290 |
| Siltstone, tan, micaceous, calcareous | 10 | 3,300 |
| Sandstone, white to tan, very fine to fine-grained, micaceous, calcareous, trace of gypsum | 10 | 3,310 |
| Dolomite, white to light-purple, fine crystalline; trace of dolomite, purple, sandy, very highly micaceous; very poor sample, lost circulation | 10 | 3,320 |
| Very poor sample; cavings | 10 | 3,330 |
| Dolomite, dark-purple, fine crystalline, hard; trace of purple chert | 10 | 3,340 |
| Very poor sample; cavings | 20 | 3,360 |
| Dolomite, light-purple, fine crystalline, with trace of white chert | 10 | 3,370 |
| No samples | 20 | 3,390 |
| Siltstone, purple, very micaceous, calcareous, with some red-brown siltstone, micaceous, sandy | 10 | 3,400 |
| As above, with trace of purple and white mottled limestone, fine crystalline, trace of purple dolomite | 10 | 3,410 |
| Sandstone, white, fine- to medium-grained, calcareous, with above siltstone | 5 | 3,415 |
| Sandstone, white, fine- to medium-grained, calcareous, with above siltstone | 15 | 3,430 |
| As above, trace of brown limestone, dense | 5 | 3,435 |
| Siltstone, red-brown, micaceous, calcareous, sandy | 5 | 3,440 |
| As above, with one piece of limestone, white to tan, very fine crystalline | 10 | 3,450 |
| Sandstone, light-purple, silty, micaceous, with trace of limestone, tan to light-gray, dense, slightly sucrosic | 10 | 3,460 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Hermosa Group of Wengerd and Matheny (1958) | | |
| Honaker Trail Formation of Wengerd and Matheny (1958) | | |
| Limestone, tan, cryptocrystalline | 5 | 3,465 |
| As above, with trace of light-gray fine crystalline limestone, trace of orange and tan chert | 5 | 3,470 |
| Limestone, lavender, very sandy, with stringers light-gray dense limestone, some lavender sandstone, micaceous, calcareous | 10 | 3,480 |
| Sandstone, lavender, fine- to medium-grained, subangular poorly sorted, very calcareous, micaceous | 10 | 3,490 |
| As above, with stringers of limestone, light-gray, with individual quartz grains dispersed throughout | 10 | 3,500 |
| Limestone, light-gray, fine crystalline, slightly sucrosic, with stringers of purple siltstone; poor sample; cavings | 20 | 3,520 |
| Limestone, gray, very dense, with stringers of brown dense dolomite, cryptocrystalline, with gray-brown chert | 10 | 3,530 |
| Limestone, light-gray, very dense, cherty, with abundant white and tan chert, trace of light-gray dolomite | 10 | 3,540 |
| Limestone, tan, very dense | 10 | 3,550 |
| Sandstone, white, fine-grained, rounded, fair porosity; no show | 10 | 3,560 |
| As above, becoming very fine grained with trace of red-brown shale | 20 | 3,580 |
| As above, with stringers of red to brown shale | 10 | 3,590 |
| As above, with trace of greenish-gray sandstone, very fine grained | 10 | 3,600 |
| Siltstone and shale, red to brown, calcareous, with stringers of dark-purple dolomite, fossiliferous, very fine crystalline | 10 | 3,610 |
| Dolomite, purple, very fine crystalline, cherty with stringers red to brown shale | 10 | 3,620 |
| Siltstone, red to brown to purple, calcareous | 10 | 3,630 |
| Limestone, light-gray, dense, cherty, dolomite with abundant white and tan chert | 10 | 3,640 |
| Limestone, light-gray, very dense, siliceous, considerable chert, amber, trace glauconite | 10 | 3,650 |
| Limestone, brown, very fossiliferous, slightly argillaceous, silty in part, siliceous, considerable amber, black and white chert | 10 | 3,660 |
| Sandstone, white, very fine to coarse-grained, calcareous, poorly sorted; larger grains are well rounded | 10 | 3,670 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Hermosa Group of Wengerd and Matheny (1958) | | |
| Honaker Trail Formation of Wengerd and Matheny (1958)--Continued | | |
| Sandstone, as above, mostly very fine grained, with silt stringers, shale, dark-gray to black, very calcareous, fossiliferous, hard..... | 10 | 3,680 |
| Sandstone, as above, considerable siltstone, gray, very calcareous..... | 10 | 3,690 |
| Limestone, light-gray to brown, very silty, considerable chert, buff..... | 10 | 3,700 |
| As above, stringers limestone, dark-gray, very argillaceous, fossiliferous..... | 10 | 3,710 |
| Limestone, dark-gray, fossiliferous, dolomitic, argillaceous, silty in part, chert, dark-gray..... | 10 | 3,720 |
| Sandstone, gray, very fine grained, soft, dolomitic, argillaceous..... | 10 | 3,730 |
| Conglomerate, with silty limestone matrix, sand as above, reworked sand, shale and limestone..... | 30 | 3,760 |
| Sandstone, gray to green, very fine grained, calcareous, glauconitic, micaceous, calcareous..... | 10 | 3,770 |
| Siltstone, gray, calcareous, micaceous; trace disseminated pyrite..... | 10 | 3,780 |
| Limestone, brown, dense, very fossiliferous; considerable brown chert nodules..... | 10 | 3,790 |
| Siltstone, gray, calcareous, micaceous..... | 10 | 3,800 |
| As above, stringers of black shale, stringers of gray, dense limestone..... | 10 | 3,810 |
| As above, trace of gypsum..... | 10 | 3,820 |
| Siltstone, gray to green, soft, glauconitic, stringers of fine, white sand, friable, trace of gypsum and white to pink chert..... | 20 | 3,840 |
| Siltstone, gray to green, as above..... | 10 | 3,850 |
| Sandstone, gray to green, very fine grained, very calcareous, micaceous, glauconitic in part..... | 10 | 3,860 |
| Sandstone, as above, stringers of shale, dark-gray to black, calcareous, stringers of limestone, gray, dense..... | 10 | 3,870 |
| Siltstone, gray, very calcareous, micaceous, stringers of gray, dense dolomite..... | 10 | 3,880 |
| Sandstone, white, fine-grained, very calcareous, subangular, poorly sorted; siltstone, green, calcareous, very micaceous, glauconitic..... | 10 | 3,890 |
| Siltstone, green, as above..... | 10 | 3,900 |
| Sandstone, white to green, very fine to fine-grained, subangular, very micaceous, glauconitic, dolomitic.... | 10 | 3,910 |
| Sandstone, as above, very fine siltstone, very dense, gray dolomite; considerable gummy gray shale..... | 10 | 3,920 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Hermosa Group of Wengerd and Matheny (1958) | | |
| Honaker Trail Formation of Wengerd and Matheny (1958)--Continued | | |
| Sandstone, as above, trace of gray to green, dense dolomite | 10 | 3,390 |
| Limestone, buff to pink, dense, slightly fossiliferous | 20 | 3,950 |
| Limestone, as above, considerable siltstone, gray to green, calcareous, very micaceous, glauconitic | 10 | 3,960 |
| Sandstone, white to green, fine-grained, micaceous, friable, glauconitic, loose, considerable gummy gray shale | 11 | 3,971 |
| 3,971.5-3,988 ft, recovered 16.5 ft, | Core No. 1 | |
| Shale, dark-gray to black fossiliferous, carbonaceous | .5 | 3,972 |
| Siltstone, gray to green, very argillaceous, very micaceous, calcareous, fossiliferous | 2.5 | 3,974.5 |
| Shale, gray, slightly calcareous, micaceous, very silty; numerous plant fossils; finely disseminated pyrite at top | 2.5 | 3,977 |
| As above, much less silt, less calcareous | 5 | 3,982 |
| As above, becoming very silty, more calcareous | 2 | 3,984 |
| Limestone, gray to brown, very dense, micro-oolitic(?), fossiliferous; shale inclusions; slightly silty and argillaceous | 1 | 3,985 |
| As above, non-oolitic | 1 | 3,986 |
| Anhydrite, gray to white, reworked at top | 2 | 3,988 |
| No record | 12 | 4,000 |
| Limestone, dark-gray to white, microcrystalline, fossiliferous, some anhydrite; some smoky chert | 65 | 4,065 |
| Sandstone, gray, very fine grained, friable, micaceous, calcareous; variable porosity | 20 | 4,085 |
| Shale, red and brown, soft | 10 | 4,095 |
| Sandstone, gray to white, very fine grained, micaceous, calcareous; fair to poor porosity | 15 | 4,110 |
| Limestone, gray to white, microcrystalline, anhydritic, few anhydrite inclusions | 15 | 4,125 |
| Sandstone, white, very fine grained, well cemented, with calcite, some gray, calcareous, hard shale | 30 | 4,155 |
| Limestone and dolomite, gray to white, micro-crystalline, anhydritic, argillaceous | 25 | 4,180 |
| Siltstone, white to gray, very fine grained, calcareous, hard | 60 | 4,240 |
| Limestone, gray, silty, argillaceous, interbedded with siltstone and shale, few feet of anhydrite at 4,290 | 60 | 4,300 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Hermosa Group of Wengerd and Matheny (1958) | | |
| Honaker Trail Foramtion of Wengerd and Matheny (1958)--Continued | | |
| Siltstone, gray, calcareous, interbedded with limestone, fine-grained, microcrystalline, silty | 80 | 4,380 |
| Limestone, gray, microcrystalline, slightly fossiliferous, some gray to black, calcareous shale | 45 | 4,425 |
| Siltstone, white, soft, considerable silty soft calcareous material, appearance similar to clay; possible fracture or fault zone. At 4,432-4,435 ft had 4-foot drilling break and lost pump pressure momentarily upon entering zone with bit | 10 | 4,435 |
| Limestone, dark-gray, microcrystalline, silty, calcareous, trace of siltstone | 15 | 4,450 |
| Limestone, dark-gray, microcrystalline, silty, calcareous, slightly fossiliferous; milky smoky gray chert | 20 | 4,470 |
| Limestone, gray, silty, slightly fossiliferous; considerable gray chert; trace of anhydrite | 10 | 4,480 |
| Siltstone, gray, very calcareous, trace of anhydrite | 20 | 4,500 |
| Siltstone, light-gray, very soft, argillaceous, calcareous | 10 | 4,510 |
| Limestone, gray to brown, dense, slightly fossiliferous | 10 | 4,520 |
| Limestone, as above, silty in part, trace of anhydrite | 10 | 4,530 |
| Limestone, as above, trace of black chert | 10 | 4,540 |
| Limestone, as above, becoming very silty | 10 | 4,550 |
| Siltstone, light-gray, soft, argillaceous, calcareous, gypsiferous | 10 | 4,560 |
| Siltstone, dark-brown, hard, very calcareous, fossiliferous; brown chert | 10 | 4,570 |
| Siltstone, as above, grading into very silty dark-brown limestone | 10 | 4,580 |
| Limestone, brown, dolomitic, argillaceous, silty | 30 | 4,610 |
| Siltstone, gray, very calcareous, anhydrite inclusions. Very poor sample at 4,620-4,630 ft | 20 | 4,630 |
| Shale, light-gray, soft, silty, calcareous | 10 | 4,640 |
| Siltstone, light-gray, soft, calcareous, argillaceous | 10 | 4,650 |
| Dolomite, light-gray to brown, silty, argillaceous, no visible porosity | 10 | 4,660 |
| Limestone, gray to brown, dense, silty, argillaceous; trace of white chert | 10 | 4,670 |
| As above, considerable anhydrite; trace of black chert | 10 | 4,680 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Hermosa Group of Wengerd and Matheny (1958) | | |
| Honaker Trail Formation of Wengerd and Matheny (1958)--Continued | | |
| Dolomite, light-gray to brown, very dense, anhydritic, trace of brown and white chert..... | 10 | 4,690 |
| Limestone, light-gray, dolomitic, dense, slightly silty, argillaceous, brown and and white chert..... | 10 | 4,700 |
| Limestone, as above, softer, more argillaceous, less chert..... | 10 | 4,710 |
| Limestone, as above, siltstone, gray, quartizitic, considerable chert, trace of gypsum..... | 10 | 4,720 |
| As above, stringers of limestone, black..... | 10 | 4,730 |
| As above, fossiliferous in part..... | 10 | 4,740 |
| Limestone, light-gray to brown, very dense, hard, slightly fossiliferous, stringers of light-brown dolomite, very argillaceous..... | 10 | 4,750 |
| Siltstone, light-gray to white, very soft, argillaceous, calcareous; considerable white chert..... | 10 | 4,760 |
| Siltstone, light-gray to white, very soft, argillaceous, calcareous; considerable white chert..... | 10 | 4,770 |
| As above, stringers of limestone, white, very dense, slightly silty, fusilinid..... | 20 | 4,790 |
| Limestone, light-gray to white, dense, very fossiliferous, oolitic in part, white chert..... | 10 | 4,800 |
| Limestone, as above, very silty in part..... | 10 | 4,810 |
| Shale, dark-gray to black, calcareous, stringers of dark-brown dolomite, fossiliferous, argillaceous, considerable anhydrite..... | 10 | 4,820 |
| Shale, as above, silty in part, anhydritic..... | 5 | 4,825 |
| Limestone, light-gray, dense, fossiliferous (algal?), silty in part, white chert..... | 5 | 4,830 |
| Siltstone, light-gray, calcareous, considerable white and gray chert..... | 5 | 4,835 |
| Siltstone and chert as above, gray shale and anhydrite..... | 10 | 4,845 |
| Limestone, light-gray to white, very fine, crystalline, soft, very fossiliferous, chalky in part, slightly anhydritic..... | 5 | 4,850 |
| Limestone, as above, gray and white, fossiliferous chert..... | 10 | 4,860 |
| Limestone, as above, becoming slightly silty, considerable gray chert..... | 10 | 4,870 |
| Limestone, light-gray to brown, very dense, very fossiliferous (crinoidal, fusilinid), silty in part, considerable light-gray and brown fossil chert..... | 10 | 4,880 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Hermosa Group of Wengerd and Matheny (1958) | | |
| Honaker Trail Formation of Wengerd and Matheny (1958)--Continued | | |
| As preceding 10-foot interval, stringers of dark-gray calcareous shale | 5 | 4,885 |
| Chert, light-brown, some limestone as above | 15 | 4,900 |
| Dolomite, gray, fine crystalline, abundant dark-gray chert, trace of green shale | 10 | 4,910 |
| Limestone, gray-brown, fine crystalline, dense, silty; abundant chert, scattered spicules in chert | 60 | 4,970 |
| Base of Honaker Trail Formation at 4,967. | | |
| Siltstone, gray, micaceous, argillaceous; carbonaceous streaks, trace of very fine grained sand | 20 | 4,990 |
| Sandstone, gray to white, with very fine grained, hard, tight, micaceous, scattered thin laminations of black carbonaceous shale | 10 | 5,000 |
| Anhydrite, white, crystallline, with soft siltstone inclusions | 15 | 5,015 |
| Siltstone and sandstone, gray with very fine grained, micaceous, anhydrite and shale inclusions | 10 | 5,025 |
| 5,025-5,042 ft, cut and recovered 17 ft. | Core No. 2 | |
| Limestone, dark-gray, very fine crystalline, slightly argillaceous, very hard, highly fossiliferous (fusilinid-crinoid), tight | 5 | 5,030 |
| Limestone, as above, with minute vertical and horizontal fractures | 1 | 5,031 |
| Dolomite, medium-gray, dense, microcrystalline, slightly micaceous, argillaceous, slightly anhydritic, very hard, tight | 3 | 5,034 |
| Limestone, medium- to dark-gray, fine crystalline, hard, anhydritic, dolomitic, hard, tight, with anhydrite inclusions at 5,034 ft | 3 | 5,037 |
| Dolomite, gray-tan, very fine to fine crystalline, hard, anhydrite; no visible porosity; salty taste in bottom 1 foot | 5 | 5,042 |
| Sandstone or siltstone, very fine grained, micaceous, anhydritic | 1 | 5,043 |
| Anhydrite, white, crystalline | 20 | 5,063 |
| Limestone, gray, fine crystalline, silty, micaceous, anhydrite inclusions, grading to sandstone, very fine grained, silty, micaceous, anhydritic and cherty | 27 | 5,090 |
| Limestone, medium-gray, fine crystalline, silty, with gray-black chert | 10 | 5,100 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Base of Honaker Trail Formation at 4,967--Continued | | |
| Siltstone, gray, micaceous, with trace of black carbonaceous, shale and inclusions and streaks of anhydrite | 33 | 5,133 |
| Anhydrite, white, crystalline | 11 | 5,144 |
| Siltstone, gray, micaceous, anhydritic, with trace of black shale | 21 | 5,165 |
| Salt | 35 | 5,200 |
| Siltstone, gray, calcareous | 5 | 5,205 |
| Dolomite, very fine crystalline, black; trace of limestone, microcrystalline; good pinpoint porosity | 10 | 5,215 |
| Siltstone, limestone and anhydrite, siltstone, gray, calcareous, limestone, gray, microcrystalline, anhydrite, gray to white | 31 | 5,246 |
| 5,246-5,262 ft; cut 16 ft, recovered 15 ft. | Core No. 3 | |
| Anhydrite, white to gray, microcrystalline, dolomitic | 1 | 5,247 |
| Lost, presumed to be salt | 1 | 5,248 |
| Salt, halite, microcrystalline, white | 10 | 5,258 |
| Anhydrite, gray, microcrystalline, dolomitic | 4 | 5,262 |
| Anhydrite, gray, microcrystalline, some gray, calcareous siltstone | 13 | 5,275 |
| Limestone, gray to black, argillaceous, microcrystalline, considerable anhydrite inclusions | 35 | 5,310 |
| Siltstone, gray, anhydrite, calcareous | 25 | 5,335 |
| Anhydrite, gray to white, microcrystalline | 25 | 5,360 |
| Siltstone, gray, calcareous, few stringers, gray microcrystalline anhydrite, and dark-gray microcrystalline dolomite, black, sooty, slightly calcareous shale | 50 | 5,410 |
| Gypsum (anhydrite), thin stringers of calcareous siltstone | 25 | 5,435 |
| Siltstone, gray, hard to soft, calcareous, few thin stringers anhydrite, limestone and black shale | 45 | 5,480 |
| Anhydrite, gray to black, microcrystalline, calcareous | 15 | 5,495 |
| Siltstone, gray, calcareous, dolomitic, few thin stringers anhydrite, limestone, and black shale | 55 | 5,545 |
| Gypsum (anhydrite) | 10 | 5,555 |
| Dolomite, limestone, and anhydrite (thin stringers) | 20 | 5,575 |
| Limestone, gray to black-tan, microcrystalline, trace of chert, silty to clean, few anhydrite inclusions, few thin stringers siltstone, very calcareous, gray, trace of tan and white chert, trace of brown and gray shale | 105 | 5,680 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Base of Honaker Trail Formation at 4,967--Continued | | |
| Limestone, dark-gray to gray, microcrystalline, silty, dense; trace of anhydrite | 10 | 5,690 |
| Siltstone, gray, calcareous | 10 | 5,700 |
| Limestone, dark-gray to brown, dense, very argillaceous, fossiliferous, trace of shale, dark-gray to black | 10 | 5,710 |
| Limestone, light-brown, dense, slightly fossiliferous, trace of anhydrite | 30 | 5,740 |
| Limestone, as above, considerable anhydrite, stringers of black shale | 20 | 5,760 |
| Limestone, light-brown, very dense, fossiliferous in part, dolomitic, anhydritic | 10 | 5,770 |
| Limestone, gray to brown, silty, dense, anhydrite inclusions | 40 | 5,810 |
| Limestone, brown, lithographic, fossiliferous, very dolomitic | 10 | 5,820 |
| Limestone, light-brown to white, very fine to microcrystalline, fossiliferous, chalky in part | 20 | 5,840 |
| Limestone, as above, becoming very fossiliferous, chalky | 20 | 5,860 |
| Limestone, as above, stringers of dolomite, dark-gray, argillaceous, fossiliferous | 30 | 5,890 |
| Limestone, dark-gray to brown, very dense, argillaceous, fossiliferous (fusilinid), stringers of black shale | 20 | 5,910 |
| Limestone, light-brown to white, very fine to microcrystalline, fossiliferous, chalky in part | 45 | 5,955 |
| Molas Formation | | |
| Limestone, as above, considerable gray, green, maroon, and purple shale | 5 | 5,960 |
| Shale, as above, trace of sand, pink, medium-grained, well rounded | 10 | 5,970 |
| Shale, as above, stringers of limestone, light-gray, very fine crystalline | 30 | 6,000 |
| Shale, maroon, very soft, silty, stringer of limestone, white, dense, fossiliferous (fusilinid) | 20 | 6,020 |
| Shale, as above, interbedded shale, gray to green, waxy | 30 | 6,050 |
| Shale, as above, numerous nodules of limestone, dark-gray, trace of anhydrite | 130 | 6,180 |
| Mississippian rocks, undivided | | |
| Limestone, white, lithographic, soft, chalky, fossiliferous in part | 20 | 6,200 |
| Limestone, light-gray, dense, fossiliferous, dolomitic in part | 40 | 6,240 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-29-13)1aab-2.--Continued | | |
| Mississippian rocks, undivided--Continued | | |
| Limestone, light-brown, very fine crystalline, very dolomitic, considerable chert, brown and gray | 10 | 6,250 |
| Limestone, as above, becoming silty in part, interbedded limestone, white, chalky | 25 | 6,275 |
| Dolomite, brown, fine crystalline, slightly argillaceous, scattered intercrystalline and pinpoint porosity | 8 | 6,283 |
| Very poor sample; mostly cavings from uphole | 35 | 6,318 |
| Limestone, white, fine crystalline, dolomitic, fossiliferous, in part, interbedded dolomite, brown, fine crystalline, with scattered intercrystalline porosity | 12 | 6,330 |
| Dolomite, brown, with interbedded white, chalky limestone | 21 | 6,351 |
| 6,351-6,401 ft, recovered 50 ft. | Core No. 4 | |
| Limestone, white, coarse crystalline, very fossiliferous, (corals, crinoid stems, algae, fusilinids), recrystallized; sulfur odor; slight salt taste, scattered fair intercrystalline porosity, good vugular porosity at 6,356, 6,358 and 6,359-6,630.5. Note: Best developed porosity has been completely dolomitized | 10 | 6,361 |
| Dolomite, brown, fine crystalline, dense, anhydritic | 3 | 6,364 |
| Same as at 6,351-6361 ft. Porosity fair to poor, very scattered | 24 | 6,388 |
| Limestone, gray to white, fine crystalline (recrystallized), dense, very fossiliferous; no visible porosity | 13 | 6,401 |
| No record | 3 | 6,404 |
| (D-30-5)10abb-1. Log by Well Supply Co. Alt. 7,180. | | |
| Glacial deposits, undivided | | |
| Clay, gravel, and a boulder | 74 | 74 |
| Mud, gray | 44 | 118 |
| Silt, sand, gravel, and cobbles, pink | 12 | 130 |

Table 10.--Selected logs of wells and test holes--Continued

| Material | Thickness | Depth |
|---|---|---|
| (D-30-11)5adb-1. Log by Unzicker and Wells Co. Alt. 5,010. | | |
| Terrace deposits | | |
| Gravel and clay | 35 | 35 |
| Brushy Basin Member of Morrison Formation | | |
| Clay, bentonitic | 5 | 40 |
| (D-30-14)23bbb-1. Log by Loman Exploration Co. Alt. 5,440. | | |
| Navajo Sandstone | 335 | 335 |
| Kayenta Formation | | |
| Shale, with thin layers of sand | 265 | 600 |
| Wingate Sandstone; water | 260 | 860 |
| (D-31-9)32ddd-1. Log by H. R. Phillips. Alt. 5,925. | | |
| Terrace deposits | | |
| Boulders and sand | 55 | 55 |
| Masuk Member of Mancos Shale | | |
| Shale, blue | 59 | 114 |
| Shale, sandy, gray | 66 | 180 |
| Coal | 3 | 183 |
| Shale, sandy, gray | 167 | 350 |
| Emery Sandstone(?) Member of Mancos Shale | | |
| Sandstone; water | 46 | 396 |
| Shale, gray | 8 | 404 |

Table 11.--Descriptions of rock samples collected for analysis of hydrologic properties and grain-size distribution and of sampling sites

Location: See text for description of data-site numbering systems.

Samples of the Navajo Sandstone and one sample of the Wingate Sandstone were obtained, except as noted, by portable air coring equipment and submitted to the Hydrologic Laboratory of the U.S. Geological Survey. The descriptions of the sources and of thin sections, where applicable, follow. Hydraulic, physical, and statistical characteristics of the samples are given in table 12.

| Location | Laboratory number | Description |
|---|---|---|
| | | Eastern San Rafael Swell |
| (D-24-12)35bcd | TQUT5 | Bare slope of Navajo Sandstone where precipitation can drain from site. |
| | TQUT4 | Depression in Navajo Sandstone where precipitation can accumulate. |
| | TQUT9 | Do. |
| 35cbd | TQUT6 | Channel of Old Woman Wash where Navajo Sandstone is covered with alluvial sand. |
| | TQUT8 | Do. |
| | 76UT39 | Channel of Old Woman Wash where Navajo Sandstone is bare and exposed directly to streamflow. |
| | | Thousand Lake Mountain area |
| (D-27-4)36dca | TQUT1 | Shelf on south side of small hillock of Navajo Sandstone, which stands above adjacent drainage and on steep side of Thousand Lake Mountain. Surface around core hole is nearly flat and has small amount of loose sand. |
| | | Oak Creek area |
| (D-31-7)28dda | TQUT2 | Sloping outcrop of Navajo Sandstone above Oak Creek channel. |
| 28ddb | TQUT3 | In channel of Oak Creek. |
| | TQUT7 | Do. |
| | | Burr Canyon area |
| (D-34-8)16dad | 76UT23 | Navajo Sandstone. Outcrop specimen from fresh road cut near head of Burr Canyon. (See fig. 8.) Fractured sandstone immediately above contact with Kayenta Formation. Sandstone is weathered by water circulation in fractures; very fine grained, subrounded; color is dark yellowish orange and is due to cement. Calcium carbonate present in part of the sample, especially, in veins, and entirely replaces the ferruginous cement locally. Manganese oxide growths present through much of sample. In selecting a fraction of the specimen for carbonate analysis, a portion of the rock was selected that had approximate average distribution of cement and veins; other portions of the specimen, thus, could have greater or lesser amounts of calcium carbonate than indicated in table 12. |
| 16dca | 76UT22 | Wingate Sandstone. Outcrop specimen from road cut just west of head of Burr Canyon. Specimen slightly weathered. Very fine grained sandstone, particles subrounded, well bedded, with beds 1 mm to 3 cm thick; color varies from moderate reddish orange to light brown and is due to cement. |

Table 12.--Hydraulic, physical, and statistical characteristics of miscellaneous rock specimens
[See also Hood and Danielson, 1979, tables 1-5]

Location: See text for description of data-site numbering systems.
Water type: Water used for various tests in laboratory; D, distilled; T, Denver tap water.
Hydraulic conductivity (K): Determined in meters per day (m/d) at 60°F (15.5°C).
Ratio H/V: Ratio of horizontal to vertical hydraulic conductivity.
Porosity: Effective porosity is for voids having entrance diameters larger than 0.1 micron.
Grain-size diameter: Clay and silt sized by hydrometer where value is given for each; single value is by difference between weight of total sample and that for sand sizes; sand sizes determined by sieve analysis. See figure 5 for selected histograms of grain-size distribution.
Carbonate content: Calculated as $CaCO_3$ equivalent by $CO_2$ absorption method.
Median diameter: Median = $d_{50}$.
Sorting coefficient: Geometric quartile deviation, $\sqrt{Q_3/Q_1}$, taken from cumulative curves representing frequency data of sediments. $Q_3$ = 25 percent quartile, $Q_1$ = 75 percent quartile.
Skewness: $(Q_1 \cdot Q_3)/d_{50}$.
Kurtosis: $(Q_3-Q_1)/2(P_{90}-P_{10})$, taken from cumulative curves. $P_{90}$ = 90 percentile, $P_{10}$ = 10 percentile.
Uniformity coefficient: Uniformity coefficient sorting index = $d_{60}/d_{10}$.

| Location | Laboratory No. | Depth (ft) | Water type | Hydraulic conductivity (K) Horizontal m/d | Horizontal ft/d | Vertical m/d | Vertical ft/d | Ratio H/V | Porosity (N) (percent) Total | Effective | Grain-size diameter (millimeters) Percent by weight: Clay and silt <0.004 Clay | 0.004-0.0625 Silt | Sand 0.625-0.125 Very fine | 0.125-0.25 Fine | 0.25-0.5 Medium | 0.5-1.0 Coarse | 1.0-2.0 Very course | Carbonate content (percent by weight) | Statistical and physical data: Median diameter (mm) | Sorting coefficient | Skewness | Kurtosis | Uniformity coefficient | Specific gravity of solids (gm/cc) | Dry unit weight (gm/cc) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Eastern San Rafael Swell** | | | | | | | | | | | | | | | | | | | | | | | | | |
| (D-24-12)35bcd | TQUT5 | 0-1 | D | - | - | 0.50* | 1.5 | - | 24.3 | - | - | 4.5 | - | 80 | 0.49 | 15 | 0.30 | 0 | 0 | 0.093 | 1.2 | 1.0 | 0.081 | 1.5 | 2.67 | 2.02 |
| | TQUT4 | 0-1 | T | - | - | - | - | - | 20.9 | - | - | 3.8 | - | 18 | 43 | 35 | .24 | 0 | 0 | .20 | 1.5 | 1.0 | .26 | 2.9 | 2.73 | 2.16 |
| | TQUT9 | 3-4 | T | 0.16 | 0.52 | .015 | .049 | 10.6 | - | - | - | - | - | - | - | - | - | - | 0 | - | - | - | - | - | - | - |
| 35cbd | TQUT8 | 0-1 | T | - | - | - | - | - | 26.8 | - | - | 5.3 | - | 38.4 | 53.8 | 2.4 | .10 | .10 | 0 | .14 | 1.4 | .91 | .31 | 2.3 | 2.61 | 1.91 |
| | | | | - | - | .43* | 1.4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | TQUT6 | 3-4 | T | .019 | .062 | .024 | .079 | .31 | - | - | - | - | - | - | - | - | - | - | 0 | - | - | - | - | - | - | - |
| | 76UT39 | 0-0.1 | T | - | - | .40 | 1.3 | - | 25.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2.70 | 2.02 |
| | | 0.1-1 | T | .092 | .30 | .074 | .24 | 1.25 | 24.1 | 21.3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Thousand Lake Mountain area** | | | | | | | | | | | | | | | | | | | | | | | | | |
| (D-27-4)36dca | TQUT1 | 0-1 | D | - | - | - | - | - | 34.9 | - | - | 3.6 | - | 66 | 30 | 0.73 | 0 | 0 | 0 | 0.10 | 1.3 | 1.1 | 0.24 | 1.7 | 2.75 | 1.79 |
| **Oak Creek area** | | | | | | | | | | | | | | | | | | | | | | | | | |
| (D-31-7)28dda | TQUT2 | 1-2 | D | - | - | - | - | - | 33.8 | - | - | 1.4 | - | 5.5 | 63 | 30 | 0 | 0 | 0 | 0.20 | 1.4 | 1.1 | 0.24 | 1.7 | 2.60 | 1.72 |
| 28ddb | TQUT3 | 0-1 | T | - | - | 0.30* | 0.98 | - | 26.1 | - | - | 4.0 | - | 9.6 | 26 | 46 | 15 | 0 | 0 | .29 | 1.6 | .84 | .24 | 3.6 | 2.72 | 2.01 |
| | TQUT7 | 3-4 | T | 0.0020 | 0.0066 | .0059 | .019 | 0.35 | - | - | - | - | - | - | - | - | - | - | 0 | - | - | - | - | - | - | - |
| **Burr Canyon area** | | | | | | | | | | | | | | | | | | | | | | | | | |
| (D-34-8)16dc. | 76UT23 | Surface | T | 0.00063 | 0.0021 | 0.00025 | 0.00082 | 2.6 | 16.1 | 13.4 | 7.1 | - | 23.5 | 54.3 | 10.7 | 4.1 | 0.30 | 0 | 17.8 | 0.080 | 1.5 | 0.89 | 0.17 | 16.3 | 2.66 | - |
| 16dad | 76UT22 | do. | T | .013 | .043 | .0032 | .010 | 4.3 | 24.1 | 23.0 | 7.7 | - | 19.6 | 49.8 | 22 | .63 | .20 | 0 | 4.8 | .086 | 1.5 | .91 | .19 | 8.9 | 2.67 | - |

*Determination by Dr. R. H. Brooks, Corvallis, Oreg.

Location: See text for description of well- and spring-numbering system. D, deepened; S, plugged back; W, petroleum-test well converted to water well after testing.
Discharge: E, estimated.
Geologic unit: See table 1 for explanation of code and description of lithology.
Dissolved solids, sum of constituents: Sum of determined constituents shown, plus trace elements, if any.
Analysis by: BM, U.S. Bureau of Mines; CG, Chemical and Geological Laboratories; CL, Core Laboratories, Inc.; CO, Continental Oil Co.; GS; U.S. Geological Survey; LA, Los Angeles Dept. of Water and Power; RM, Rocky Mountain Engineering, Inc.; SH, Shell Oil Co; SO, Superior Oil Co.; UC, Utah State Chemist; UH, Utah Division of Health.
Specific conductance: In micromhos per centimeter at 25°C.

| LOCATION | DATE OF SAMPLE | DISCHARGE (GAL/MIN) | TOTAL DEPTH OF WELL (FT) | DEPTH TO TOP OF SAMPLE INTERVAL (FT) | DEPTH TO BOTTOM OF SAMPLE INTERVAL (FT) | GEOLOGIC UNIT | TEMPERATURE (DEG C) | DISSOLVED SILICA (SIO2) (MG/L) | DISSOLVED IRON (FE) (UG/L) | DISSOLVED CALCIUM (CA) (MG/L) | DISSOLVED MAGNESIUM (MG) (MG/L) | DISSOLVED SODIUM (NA) (MG/L) | DISSOLVED SODIUM PLUS POTASSIUM (MG/L) | DISSOLVED POTASSIUM (K) (MG/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-23-10)28dbb-1 | July 1961 | -- | 3144 | -- | 2265 | 330MSSP | -- | -- | 0 | 160 | 196 | -- | 331 | -- |
| (D-24-5)13bcd-S1 | July 16, 1975 | -- | -- | -- | -- | 211FRRN | -- | 17 | -- | 220 | 120 | 120 | -- | 11 |
| | Sep. 29, 1976 | 15 | -- | -- | -- | | 17.0 | 19 | 470 | 110 | 65 | 99 | -- | 6.4 |
| (D-24-8)25dcd-S1 | Oct. 7, 1975 | E3 | -- | -- | -- | 230MNKP | 15.0 | 7.8 | 0 | 42 | 37 | 18 | -- | 3.9 |
| (D-24-10)3bba-S1 | Oct. 27, 1944 | E5 | -- | -- | -- | 230MNKP | -- | -- | -- | 232 | 216 | -- | 70 | -- |
| | Oct. 30, 1958 | <2 | -- | -- | -- | | 6.5 | 11 | -- | 257 | 224 | -- | 88 | -- |
| (D-24-13)2cab-1 | Sep. 1958 | -- | 5326 | 2041 | 2065 | 230MNKP | -- | -- | -- | 239 | 3.6 | -- | 5910 | -- |
| | Nov. 9, 1958 | -- | | 1800 | 1885 | 230MNKP | -- | -- | -- | 358 | 36 | -- | 5250 | -- |
| 20cca-S1 | Oct. 28, 1958 | E2 | -- | -- | -- | 221CRML | 16.5 | 9.8 | -- | 54 | 50 | -- | 35 | -- |
| (D-24-14)10aac-1 | Oct. 7, 1972 | -- | 7284 | 6120 | 6353 | 330MSSP | -- | -- | 4000 | 1540 | 292 | 43800 | -- | 951 |
| (D-24-16)15acd-1 | June 19, 1966 | E2 | 5370 | 158 | <4596 | | -- | 11 | -- | 473 | 114 | -- | 37 | -- |
| 19bda-1 | Nov. 12, 1958 | -- | 8677 | 7968 | 8067 | 330RDLL | -- | -- | -- | 1960 | 384 | -- | 54700 | -- |
| (D-25-12)14ccc-1 | Oct. 30, 1958 | -- | 90 | -- | -- | 221CRML | 16.5 | 13 | -- | 481 | 642 | -- | 339 | -- |
| 34cdb-1 | Oct. 30, 1958 | -- | 290 | -- | -- | 221ENRD | 14.5 | 9.6 | -- | 240 | 372 | -- | 105 | -- |
| | Sep. 24, 1964 | -- | | -- | -- | | -- | -- | -- | 255 | 373 | -- | 75 | -- |
| (D-25-13)11bbb-1 | May 23, 1967 | -- | 5175 | 80 | <2756 | 200MSZC | -- | 14 | -- | 463 | 72 | -- | 72 | -- |
| (D-25-15)15abd-1 | July 23, 1963 | -- | 6470 | 4819 | 4855 | 324PRDX | -- | -- | 0 | 9680 | 5640 | -- | 68700 | -- |
| 22aca-1 | June 1958 | -- | 6396 | 4345 | 4367 | 324HRMS | -- | -- | -- | 801 | 460 | -- | 7190 | -- |
| | June 10, 1958 | -- | | 6085 | 6220 | 330MSSP | -- | -- | -- | 1380 | 234 | -- | 9690 | -- |
| | June 27, 1958 | -- | | 4950 | 5062 | 324PRDX | -- | -- | -- | 876 | 444 | -- | 7180 | -- |
| (D-25-15)32cac-1 | July 11, 1956 | -- | 720 | -- | -- | 220NVJO | -- | -- | -- | 125 | 86 | -- | 28 | -- |
| (D-25-16)10bac-1 | Mar. 2, 1959 | -- | 7393 | 6898 | 7092 | 330RDLL | -- | -- | -- | 2230 | 750 | -- | 33200 | -- |
| 29cdb-1 | Oct. 21, 1957 | -- | 6701 | 6480 | 6594 | 330MSSP | -- | -- | -- | 1620 | 41 | -- | 13700 | -- |
| (D-26-7)19bbd-1 | Nov. 14, 1960 | -- | 6704 | 6300 | 6704 | 300PLZC | -- | -- | -- | 616 | 158 | -- | 1040 | -- |
| | Nov. 15, 1960 | -- | | 5420 | 5530 | 330RDLL | -- | -- | -- | 424 | 101 | -- | 1670 | -- |
| 20dab-1 | June 7, 1957 | -- | 2620 | 603 | 650 | 220NVJO | -- | -- | 3840 | -- | -- | -- | -- | -- |
| | June 8, 1957 | -- | | -- | 1450 | 231WNGT | -- | -- | 240 | -- | -- | -- | -- | -- |
| | June 9, 1957 | -- | | 1655 | 1660 | 231CHNL | -- | -- | 2560 | -- | -- | -- | -- | -- |
| (D-26-8)6aab-1 | June 26, 1969 | 10.7 | 767 | -- | -- | 220NVJO | -- | 8 | 120 | 417 | 146 | 128 | -- | 10 |
| | July 16, 1975 | -- | | -- | -- | | -- | 7.7 | -- | 470 | 150 | 140 | -- | 10 |
| | Sep. 27, 1976 | -- | -- | -- | -- | | 18.0 | 8.6 | 12000 | 420 | 160 | 140 | -- | 10 |
| (D-26-9)16bbb-S1 | Oct. 7, 1975 | E.5 | -- | -- | -- | 231WNGT | 15.0 | 10 | 20 | 500 | 330 | 220 | -- | 94 |
| 21aac-S1 | Oct. 8, 1975 | -- | -- | -- | -- | 220NVJO | 16.5 | 8.9 | 60 | 120 | 110 | 370 | -- | 10 |
| 24dbc-1 | Aug. 29, 1975 | E5 | -- | -- | -- | 221SLWS? | 17.0 | 9.5 | 50 | 110 | 81 | 140 | -- | 7.1 |
| 24dbc-S1 | Aug. 29, 1975 | E50 | -- | -- | -- | | -- | -- | -- | -- | -- | -- | -- | -- |
| (D-26-13)19cdb-1 | Nov. 1, 1944 | -- | 400 | -- | -- | 221ENRD | -- | -- | -- | 234 | 228 | -- | 53 | -- |
| | Oct. 30, 1958 | E5 | | -- | -- | | 15.0 | 9.3 | -- | 224 | 227 | -- | 69 | -- |
| | Sep. 24, 1964 | -- | | -- | -- | | -- | -- | -- | 236 | 230 | -- | 43 | -- |
| | Sep. 25, 1976 | -- | | -- | -- | | 15.5 | 9.9 | 110 | 260 | 240 | 43 | -- | 12 |
| (D-26-14)7bbc-1 | Nov. 22, 1959 | -- | 5750 | 5619 | 5750 | 331MDSN | -- | -- | -- | 1090 | 277 | -- | 3120 | -- |
| 30cdb-1 | Dec. 27, 1961 | -- | 6007 | 5860 | 6007 | 330MSSP | -- | -- | 0 | 160 | 923 | -- | 1170 | -- |
| (D-26-17)5ccc-1 | Jan. 12, 1962 | -- | 6498 | 6350 | 6410 | 330MSSP | -- | -- | 134000 | 160 | 2380 | -- | 4340 | -- |
| | Jan. 19, 1962 | -- | | 6410 | 6466 | 330MSSP | -- | -- | 0 | 320 | 1020 | -- | 3920 | -- |
| (D-27-4)36cbb-S1 | Aug. 4, 1976 | <5 | -- | -- | -- | 111CLVM | 16.0 | 33 | -- | 62 | 25 | 6.1 | -- | 3.2 |
| (D-27-6)23cba-S1 | May 22, 1975 | -- | -- | -- | -- | 221SLWS | -- | 13 | 10 | 60 | 28 | 290 | -- | 7 |
| (D-27-7)7bcc-1 | Aug. 13, 1976 | E10 | 100 | 73 | 100 | 221CRML | 18.5 | 9.1 | 40 | 540 | 180 | 550 | -- | 20 |
| | Aug. 13, 1976 | E20 | 260 | 73 | 260 | | 15.5 | -- | -- | -- | -- | -- | -- | -- |
| | Aug. 14, 1976 | E30 | 440 | 73 | 440 | | 15.0 | 6.8 | 60 | 610 | 280 | 4000 | -- | 20 |
| 7bcc-2 | Aug. 30, 1977 | -- | 380 | 110 | 380 | 221CRML | -- | -- | -- | -- | -- | -- | -- | -- |
| | Aug. 31, 1977 | -- | 690 | 110 | 690 | | -- | -- | -- | -- | -- | -- | -- | -- |

from water wells, springs, and petroleum-test wells

| BICAR-BONATE (HCO3) (MG/L) | CAR-BONATE (CO3) (MG/L) | DIS-SOLVED SUL-FATE (SO4) (MG/L) | DIS-SOLVED CHLO-RIDE (CL) (MG/L) | DIS-SOLVED FLUO-RIDE (F) (MG/L) | DIS-SOLVED NI-TRATE (NO3) (MG/L) | DIS-SOLVED NITRITE PLUS NITRATE (N) (MG/L) | PHOS-PHATE (PO4) (MG/L) | DIS-SOLVED ORTHO PHOS-PHATE (PO4) (MG/L) | DIS-SOLVED BORON (B) (UG/L) | DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L) | DIS-SOLVED SOLIDS SUM OF CONSTI-TUENTS (MG/L) | SPE-CIFIC CON-DUCT-ANCE (MICRO MHOS) | HARD-NESS (CA,MG) (MG/L) | NON-CAR-BONATE HARD-NESS (MG/L) | SODIUM AD-SORP-TION RATIO | PH (UNITS) | AGENCY ANA-LYZING SAMPLE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 586 | 0 | 1000 | 284 | -- | -- | -- | -- | -- | -- | -- | 2260 | 3910 | 470 | 0 | 6.7 | 7.0 | CL |
| 321 | -- | 950 | 28 | 0.4 | -- | 0.04 | -- | 0 | 200 | -- | 1630 | 2020 | 1000 | 780 | 1.6 | -- | GS |
| 388 | 0 | 360 | 18 | .3 | -- | .17 | -- | -- | 110 | -- | 872 | 1250 | 540 | 230 | 1.9 | 7.3 | GS |
| 192 | -- | 120 | 12 | .3 | -- | -- | -- | 0 | 50 | -- | 336 | 542 | 260 | 100 | .5 | -- | GS |
| 262 | -- | 1310 | 28 | -- | 1.5 | -- | -- | -- | -- | -- | 1990 | 2460 | 1470 | 1250 | -- | -- | GS |
| 286 | 10 | 1380 | 42 | 1.3 | .7 | -- | -- | -- | -- | 2340 | 2150 | 2500 | 1560 | 1310 | 1 | 8.4 | GS |
| 5450 | 0 | 325 | 6140 | -- | -- | -- | -- | -- | -- | -- | 15300 | 18300 | 611 | 0 | -- | 7.7 | SO |
| 4040 | 0 | 324 | 6080 | -- | -- | -- | -- | -- | -- | -- | 14000 | 22500 | 1040 | 0 | -- | 7.0 | SO |
| 336 | 13 | 94 | 14 | .2 | 2.1 | -- | -- | -- | -- | 428 | 437 | 700 | 340 | 43 | .8 | 8.5 | GS |
| 212 | 0 | 2630 | 73400 | -- | -- | -- | -- | -- | 3600 | -- | 123000 | -- | 5100 | 5000 | 268 | 7.7 | BM |
| 228 | 0 | 1420 | 45 | -- | 2.8 | -- | -- | -- | -- | 2320 | 2210 | 2430 | 1650 | 1460 | .4 | 7.7 | GS |
| 293 | 0 | 5130 | 85000 | -- | -- | -- | -- | -- | -- | 150000 | 147000 | 162000 | 2170 | 1900 | 296 | 7.1 | CG |
| 408 | 0 | 3900 | 105 | .2 | 41 | -- | -- | -- | -- | 6300 | -- | 5640 | 3840 | 3510 | 2.4 | 7.6 | GS |
| 255 | 0 | 1980 | 36 | 1.4 | 42 | -- | -- | -- | -- | -- | 3500 | 3160 | 2130 | 1930 | 1 | 7.8 | GS |
| -- | -- | 2050 | -- | -- | -- | -- | -- | -- | -- | 3280 | -- | 3150 | 2200 | -- | .7 | -- | GS |
| 52 | 0 | 1470 | 23 | -- | .4 | -- | -- | -- | -- | 2270 | 2140 | 2250 | 1450 | 1410 | .8 | 7.3 | GS |
| 536 | 0 | 120 | 125000 | -- | -- | -- | -- | -- | -- | -- | 210000 | 155000 | 47000 | 47000 | 137 | 7.0 | CL |
| 451 | 0 | 7840 | 7800 | -- | -- | -- | -- | -- | -- | 24600 | 24300 | 30600 | 3900 | 3500 | 50 | 7.6 | CG |
| 439 | 0 | 3810 | 15000 | -- | -- | -- | -- | -- | -- | 32000 | 30300 | 42300 | 4400 | 4100 | 64 | 7.6 | CG |
| 195 | 60 | 5880 | 9400 | -- | -- | -- | -- | -- | -- | 24400 | 23900 | 33300 | 4000 | 3800 | 49 | 8.6 | CG |
| 340 | -- | 394 | 26 | -- | -- | -- | -- | -- | -- | 944 | 827 | 1590 | 666 | 390 | -- | 7.5 | CG |
| 427 | 0 | 4250 | 54000 | -- | -- | -- | -- | -- | -- | 100000 | 94700 | 125000 | 8700 | 8300 | 156 | 6.9 | CG |
| 380 | 0 | 4020 | 21000 | -- | -- | -- | -- | -- | -- | 42300 | 40600 | 55000 | 4200 | 3900 | 92 | 7.6 | CG |
| 1340 | 0 | 2350 | 638 | -- | -- | -- | -- | -- | 1000 | 5300 | 5460 | 6260 | 2200 | 1100 | -- | 7.3 | SH |
| 1640 | 0 | 2930 | 518 | -- | -- | -- | -- | -- | 2000 | 5570 | 6450 | 6570 | 1480 | 140 | -- | 7.4 | SH |
| 286 | -- | 92 | 26 | -- | -- | -- | -- | -- | -- | 382 | -- | -- | -- | -- | -- | 8.4 | UH |
| 2290 | -- | 279 | 2150 | -- | -- | -- | -- | -- | -- | 5130 | -- | -- | -- | -- | -- | 12.1 | UH |
| 500 | -- | 1460 | 10500 | -- | -- | -- | -- | -- | -- | 30200 | -- | -- | -- | -- | -- | 7.5 | UH |
| 348 | 0 | 1410 | 100 | 1.2 | 1.1 | -- | -- | -- | 280 | 2640 | 2390 | 2840 | 1640 | 1350 | 1.4 | 7.8 | GS |
| 391 | -- | 1500 | 160 | .4 | -- | .01 | -- | .03 | 300 | -- | 2630 | -- | 1800 | 1500 | 1.4 | -- | GS |
| 405 | 0 | 1500 | 150 | .4 | -- | 0 | -- | 0 | 290 | -- | 2600 | 3050 | 1700 | 1400 | 1.5 | 6.7 | GS |
| 219 | -- | 2900 | 85 | .4 | -- | -- | -- | 0 | 860 | -- | 4250 | 4550 | 2600 | 2400 | 1.9 | -- | GS |
| 305 | -- | 390 | 650 | .4 | -- | -- | -- | 0 | 100 | -- | 1810 | 3040 | 750 | 500 | 5.9 | -- | GS |
| 181 | 0 | 700 | 19 | .3 | -- | .52 | 0.06 | -- | 160 | -- | 1160 | 1550 | 610 | 460 | 2.5 | 7.3 | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1550 | -- | -- | -- | -- | GS |
| 204 | 0 | 1390 | 12 | -- | 6.9 | -- | -- | -- | -- | -- | 2020 | 2400 | 1520 | 1350 | -- | -- | GS |
| 205 | 3 | 1390 | 12 | .9 | 6.4 | -- | -- | -- | -- | 2210 | 2250 | 2330 | 1500 | 1320 | .8 | 8.3 | GS |
| -- | -- | 1120 | -- | -- | -- | -- | -- | -- | -- | 2300 | -- | 2380 | 1540 | -- | .5 | -- | GS |
| 190 | 0 | 1500 | 10 | .8 | -- | 1.80 | -- | .03 | 270 | -- | 2180 | 2400 | 1600 | 1500 | .5 | 7.5 | GS |
| 488 | -- | 3000 | 5040 | -- | -- | -- | -- | -- | -- | 13300 | 12800 | 17700 | 3900 | 3500 | -- | 7.5 | CG |
| 732 | 0 | 120 | 4260 | -- | -- | -- | -- | -- | -- | -- | 6990 | 13500 | 4200 | 3600 | -- | 6.0 | CG |
| 390 | 0 | 400 | 13600 | -- | -- | -- | -- | -- | -- | -- | 21200 | 38500 | 10000 | 9900 | 19 | 6.0 | CI |
| 1710 | 0 | 680 | 8090 | -- | -- | -- | -- | -- | -- | -- | 14900 | 26300 | 5000 | 3600 | 24 | -- | CI |
| 311 | -- | 13 | 5.2 | .2 | -- | 0 | -- | .15 | 40 | -- | 301 | 500 | 260 | 3 | .2 | -- | GS |
| 400 | 0 | 483 | 38 | 1.3 | .1 | -- | 0 | -- | 200 | -- | 1132 | 1640 | 265 | 0 | 7.8 | 6.6 | UH |
| 64 | 0 | 3000 | 150 | .8 | -- | .06 | -- | .03 | 2600 | -- | 4480 | 4680 | 2100 | 2000 | 5.2 | 7.8 | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5000 | -- | -- | -- | -- | GS |
| 82 | 0 | 4300 | 5000 | 1 | -- | .04 | -- | .06 | 7800 | -- | 14300 | 16600 | 2700 | 2600 | 34 | 7.6 | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 22000 | -- | -- | -- | -- | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7000 | -- | -- | -- | -- | GS |

Table 13.--Selected chemical analyses of water samples from

| LOCATION | DATE OF SAMPLE | DISCHARGE (GAL/MIN) | TOTAL DEPTH OF WELL (FT) | DEPTH TO TOP OF SAMPLE INTER-VAL (FT) | DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT) | GEOLOGIC UNIT | TEMP-ERA-TURE (DEG C) | DIS-SOLVED SILICA (SIO2) (MG/L) | DIS-SOLVED IRON (FE) (UG/L) | DIS-SOLVED CAL-CIUM (CA) (MG/L) | DIS-SOLVED MAG-NE-SIUM (MG) (MG/L) | DIS-SOLVED SODIUM (NA) (MG/L) | DIS-SOLVED SODIUM PLUS POTAS-SIUM (MG/L) | DIS-SOLVED POTAS-SIUM (K) (MG/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-27-7)7bcc-2 | Sep. 2, 1977 | 6 | 950 | 735 | 950 | 220NVJO | 15.5 | 5.3 | 50 | 750 | 250 | 26000 | -- | 20 |
| 17bdb-S1 | Oct. 3, 1975 | -- | -- | -- | -- | 111ALVM | -- | 24 | -- | 552 | 122 | 560 | -- | 12 |
| 23acd-S1 | Oct. 4, 1975 | -- | -- | -- | -- | 111ALVM | -- | 24 | -- | 536 | 154 | 840 | -- | 18 |
| (D-27-8)6bad-S1 | Sep. 26, 1975 | -- | -- | -- | -- | 220NVJO | -- | 17 | -- | 552 | 54 | 310 | -- | 12 |
| 11dac-S1 | Apr. 19, 1972 | -- | -- | -- | -- | 221CRML | -- | 11 | 0 | 268 | 68 | 1275 | -- | 12 |
| 11dca-S1 | Sep. 4, 1975 | E.1 | -- | -- | -- | 221CRML | -- | -- | -- | -- | -- | -- | -- | -- |
| 11dca-S2 | Sep. 4, 1975 | E.1 | -- | -- | -- | 221CRML | -- | -- | -- | -- | -- | -- | -- | -- |
| 12cbd-S1 | Apr. 19, 1972 | -- | -- | -- | -- | 221CRML | -- | 11 | 0 | 342 | 74 | 1440 | -- | 12 |
| 12cca-S1 | Nov. 11, 1975 | -- | -- | -- | -- | 221CRML | 15.0 | 9.8 | 20 | 270 | 61 | 1300 | -- | 8.9 |
| | Nov. 21, 1975 | 17.1 | -- | -- | -- | | 14.5 | -- | -- | -- | -- | -- | -- | -- |
| | Nov. 23, 1975 | 16 | -- | -- | -- | | 14.5 | -- | -- | -- | -- | -- | -- | -- |
| | Dec. 2, 1975 | -- | -- | -- | -- | | 14.5 | -- | -- | -- | -- | -- | -- | -- |
| | Mar. 17, 1976 | 20 | -- | -- | -- | | 16.0 | -- | -- | -- | -- | -- | -- | -- |
| (D-27-11)34dca-1 | June 28, 1952 | -- | 638 | 393 | 638 | 221CRML | -- | 13 | -- | 130 | 5.3 | -- | 1160 | -- |
| | May 29, 1962 | -- | 638 | 393 | 638 | | 18.0 | -- | -- | -- | -- | -- | 1070 | -- |
| 34ddb-1 | June 28, 1952 | -- | 602 | -- | 602 | 221CRML | -- | 14 | 3000 | 101 | 7.1 | -- | 869 | -- |
| | Aug. 6, 1976 | 34 | 750 | 605 | 750 | 220NVJO | 18.0 | 10 | 420 | 130 | 53 | 920 | -- | 11 |
| (D-27-12)9aac-1 | Feb. 17, 1959 | -- | 6430 | 6210 | 6430 | 330MSSP | -- | -- | -- | 1140 | 337 | -- | 1630 | -- |
| (D-27-13)8dbc-1 | Nov. 1, 1944 | -- | 795 | -- | -- | 220NVJO | -- | -- | -- | 62 | 46 | -- | 17 | -- |
| (D-27-13)30abc-1 | May 1962 | -- | 7664 | 6549 | 6685 | 330MSSP | -- | -- | 0 | 400 | 535 | -- | 3070 | -- |
| 36cdc-1 | Dec. 20, 1958 | -- | 6820 | 6712 | 6820 | 330MSSP | -- | -- | 0 | 1200 | 512 | 4000 | -- | 130 |
| (D-27-14)5acc-1S | July 15, 1934 | -- | 650 | 580 | 650 | 221CRML | -- | -- | -- | 216 | 150 | -- | 16 | -- |
| 5bca-1 | Dec. 5, 1955 | -- | 5940 | 2142 | 2256 | 231MBCK | -- | -- | -- | 34 | 27 | -- | 1880 | -- |
| 17ccb-1 | Oct. 12, 1959 | -- | 6523 | 2731 | 2826 | 310WTRM | -- | -- | 0 | 496 | 272 | -- | 901 | -- |
| (D-27-15)32adb-1 | Oct. 8, 1960 | -- | 8096 | 2330 | 2366 | 310WTRM | -- | -- | -- | -- | 760 | -- | 108 | -- |
| | Dec. 23, 1960 | -- | 8096 | 5900 | 5990 | 330MSSP | -- | -- | -- | 1200 | 1760 | -- | 7380 | -- |
| 35bcc-1 | Oct. 18, 1956 | -- | 5534 | 5170 | 5410 | 330MSSP | -- | -- | 0 | 1920 | 0 | -- | 3130 | -- |
| (D-27-16)20bdc-S1 | Nov. 12, 1969 | E3 | -- | -- | -- | 231KYNT | 15.5 | 8.5 | 10 | 30 | 26 | 4.1 | -- | 3.7 |
| 33acb-1 | Nov. 7, 1961 | -- | 6867 | 5894 | 5994 | 330MSSP | -- | -- | 0 | 1200 | 438 | -- | 9110 | -- |
| (D-28-7)11cdb-S1 | July 17, 1975 | -- | -- | -- | -- | 221SLWS | -- | 21 | -- | 230 | 51 | 430 | -- | 7.3 |
| 27cdb-1 | Nov. 20, 1975 | E300 | 2353 | 1990 | 2353 | 220NVJO | 16.0 | 12 | 20 | 130 | 48 | 21 | -- | 4.2 |
| 36bbb-1 | July 17, 1975 | 1.9 | 800 | 726 | -- | 221SLWS | 14.5 | 8.3 | 40 | 11 | 4.1 | 450 | -- | 1.7 |
| (D-28-8)5abd-S1 | Sep. 28, 1975 | -- | -- | -- | -- | 111ALVM | -- | 21 | -- | 564 | 66 | 400 | -- | 11 |
| 29cdc-1 | Aug. 7, 1975 | 60 | 764 | 720 | 764 | 220NVJO | 17.0 | -- | -- | -- | -- | -- | -- | -- |
| | Aug. 28, 1975 | 55 | | | | | 17.0 | 10 | 1800 | 140 | 37 | 460 | -- | 4.2 |
| | June 15, 1977 | 80 | | | | | 17.0 | -- | -- | -- | -- | -- | -- | -- |
| 29dcb-1 | Nov. 26, 1973 | E1350 | 597 | 560 | 597 | 221CRML | -- | 17 | -- | 700 | 240 | 460 | -- | 6.3 |
| | Jan. 22, 1974 | 280 | 695 | 679 | 695 | 220NVJO | -- | 14 | -- | 420 | 120 | 530 | -- | 6.3 |
| | Feb. 9, 1974 | 3110 | 761 | 679 | 761 | | -- | 12 | -- | 300 | 96 | 480 | -- | 6.2 |
| | Oct. 4, 1974 | -- | | | | | 24.0 | 13 | 70 | 284 | 88 | 494 | -- | 4.4 |
| 33bbb-1 | Aug. 21, 1975 | E500 | 1250 | 700 | 1250 | 220NVJO | 17.5 | 9.6 | 630 | 94 | 71 | 780 | -- | 3.9 |
| | Dec. 29, 1975 | 2800 | | 750 | | | 17.5 | 8.8 | 690 | 80 | 26 | 810 | -- | 4.2 |
| 33cdd-1S | Aug. 21, 1975 | E200 | 1350 | 756 | 1296 | 220NVJO | 17.5 | 9.6 | 2700 | 110 | 52 | 130 | -- | 5.6 |
| (D-28-11)5cdb-1 | Feb. 15, 1961 | -- | 7301 | 7100 | 7301 | 330MSSP | -- | -- | 72000 | 600 | 416 | -- | 1170 | -- |
| 10dac-1 | Oct. 16, 1968 | -- | 170 | -- | -- | 221ENRD | -- | 10 | 0 | 24 | 8 | 120 | -- | 2 |
| 15bdc-1 | Dec. 6, 1975 | -- | 290 | -- | -- | 221ENRD | -- | 13 | -- | 11 | 5 | 120 | -- | 1.3 |
| 16bdd-1 | July 20, 1965 | -- | 392 | -- | -- | 221ENRD | -- | 14 | 140 | 80 | 25 | 237 | -- | 2.7 |
| 16cba-1 | May 28, 1969 | -- | 407 | 402 | 407 | 221ENRD | -- | 14 | 0 | 99 | 35 | 220 | -- | 3 |
| | July 26, 1976 | -- | | | | | -- | 12 | 1600 | 100 | 36 | 230 | -- | 3.3 |
| 16dac-1 | May 19, 1955 | -- | 340 | 305 | 340 | 221ENRD | -- | 7.5 | 0 | 21 | 0 | -- | 175 | -- |
| | May 29, 1962 | 13 | | | | | 11.0 | -- | -- | -- | -- | -- | 133 | -- |
| | Jan. 7, 1964 | -- | | | | | 11.0 | 14 | 50 | 15 | 8 | 130 | -- | 1.5 |
| | Mar. 10, 1976 | -- | | | | | 15.5 | -- | -- | -- | -- | -- | -- | -- |
| 16dad-1 | Jan. 31, 1964 | -- | 350 | 327 | 346 | 221ENRD | -- | 11 | 11 | 11 | 5 | 120 | -- | 1.7 |
| | Sep. 13, 1965 | -- | | | | | -- | -- | 270 | -- | -- | -- | -- | -- |
| | June 10, 1975 | -- | | | | | -- | 13 | -- | 19 | 5.3 | 120 | -- | 1.5 |
| 16dca-1 | Sep. 27, 1944 | -- | 340 | -- | -- | 221ENRD | -- | -- | -- | 22 | 4.6 | -- | 115 | -- |
| | Mar. 16, 1947 | -- | | | | | -- | -- | -- | 15 | 14 | -- | 115 | -- |
| 16ddb-1 | Mar. 16, 1947 | -- | 332 | -- | -- | 221ENRD | -- | -- | -- | 10 | 8.7 | -- | 122 | -- |
| | Dec. 11, 1951 | -- | | | | | -- | 16 | 0 | 18 | 0 | -- | 126 | -- |

water wells, springs, and petroleum-test wells--Continued

| BICAR-BONATE (HCO3) (MG/L) | CAR-BONATE (CO3) (MG/L) | DIS-SOLVED SUL-FATE (SO4) (MG/L) | DIS-SOLVED CHLO-RIDE (CL) (MG/L) | DIS-SOLVED FLUO-RIDE (F) (MG/L) | DIS-SOLVED NI-TRATE (NO3) (MG/L) | DIS-SOLVED NITRITE PLUS NITRATE (N) (MG/L) | PHOS-PHATE (PO4) (MG/L) | DIS-SOLVED ORTHO PHOS-PHATE (PO4) (MG/L) | DIS-SOLVED BORON (B) (UG/L) | DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L) | DIS-SOLVED SOLIDS SUM OF CONSTI-TUENTS (MG/L) | SPE-CIFIC CON-DUCT-ANCE (MICRO MHOS) | HARD-NESS (CA,MG) (MG/L) | NON-CAR-BONATE HARD-NESS (MG/L) | SODIUM AD-SORP-TION RATIO | PH (UNITS) | AGENCY ANA-LYZING SAMPLE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 79 | 0 | 3700 | 40000 | 0.1 | -- | -- | -- | 0 | 290 | -- | 70800 | 82000 | 2900 | 2800 | 210 | 7.0 | GS |
| -- | -- | 2280 | 373 | .6 | .5 | -- | -- | -- | 440 | 3910 | -- | 4840 | 1880 | -- | 5.6 | 8.1 | LA |
| -- | -- | 2810 | 512 | .7 | .5 | -- | -- | -- | 640 | 5300 | -- | 6080 | 1970 | -- | 8.2 | 8.2 | LA |
| -- | -- | 2050 | 37 | .2 | .4 | -- | -- | -- | 270 | 3390 | -- | 3740 | 1600 | -- | 3.4 | 7.2 | LA |
| 208 | 0 | 983 | 1850 | .5 | .6 | -- | .10 | -- | 350 | -- | 4810 | 7370 | 950 | 780 | 18 | 7.4 | UH |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4400 | -- | -- | -- | -- | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5500 | -- | -- | -- | -- | GS |
| 233 | 0 | 1208 | 2090 | .6 | .6 | -- | 0 | -- | 410 | -- | 5500 | 8080 | 1160 | 970 | 18 | 7.8 | UH |
| 221 | 0 | 1000 | 1900 | .5 | -- | 0 | -- | .18 | 310 | -- | 4660 | 7500 | 930 | 740 | 19 | 7.8 | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7500 | -- | -- | -- | -- | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7600 | -- | -- | -- | -- | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7090 | -- | -- | -- | -- | GS |
| 1182 | -- | 236 | 1750 | -- | -- | -- | -- | -- | -- | 3560 | -- | -- | 346 | 0 | -- | -- | UH |
| 178 | 0 | 249 | 1780 | -- | -- | -- | -- | -- | -- | 3520 | -- | 6200 | 590 | 444 | 19 | 8.0 | GS |
| 193 | -- | 281 | 1220 | -- | -- | -- | -- | -- | -- | 2730 | -- | -- | 282 | 120 | -- | -- | UH |
| 179 | 0 | 11 | 1700 | .3 | -- | .01 | -- | .03 | 180 | -- | 2930 | 5290 | 550 | 400 | 17 | 7.6 | GS |
| 1070 | -- | 2460 | 2940 | -- | -- | -- | -- | -- | -- | 9590 | 9030 | 12400 | 4200 | 3400 | -- | 7.0 | CG |
| 366 | -- | 65 | 9 | -- | 1 | -- | -- | -- | -- | -- | 380 | 670 | 344 | 44 | -- | -- | GS |
| 537 | 0 | 320 | 6460 | -- | -- | -- | -- | -- | -- | -- | 11000 | 20400 | 3200 | 2800 | -- | 6.0 | CL |
| 664 | 0 | 3100 | 7100 | -- | -- | -- | -- | -- | -- | 17400 | 16400 | 22700 | 5100 | 4600 | 24 | 7.4 | CO |
| 152 | -- | 995 | 16 | .7 | 6.2 | -- | -- | -- | -- | -- | 1460 | -- | 1160 | 1000 | -- | -- | GS |
| 1880 | 505 | 988 | 620 | -- | -- | -- | -- | -- | -- | 5970 | 4980 | 7330 | 200 | 0 | -- | 8.6 | CG |
| 1240 | 0 | 2900 | 199 | -- | -- | -- | -- | -- | -- | 6010 | 5380 | 8730 | 2400 | 1300 | -- | 6.0 | CL |
| 10 | 120 | 1780 | 600 | -- | -- | -- | -- | -- | -- | 3470 | -- | 4300 | -- | -- | -- | 10.5 | RM |
| 597 | 0 | 3840 | 15500 | -- | -- | -- | -- | -- | -- | 30500 | 30000 | -- | 10000 | 9800 | -- | 7.3 | CL |
| 627 | 0 | 3240 | 5510 | -- | -- | -- | -- | -- | -- | -- | 14100 | 14300 | 4800 | 4300 | 20 | 5.0 | CL |
| 196 | 0 | 14 | 6.2 | .4 | .3 | -- | -- | -- | 160 | 200 | 189 | 353 | 180 | 19 | .1 | 7.4 | GS |
| 853 | 0 | 2200 | 15300 | -- | -- | -- | -- | -- | -- | -- | 28700 | 44400 | 4800 | 4100 | 57 | 7.0 | CL |
| 278 | -- | 1300 | 71 | 1.6 | -- | -- | -- | .03 | 530 | -- | 2250 | 2960 | 780 | 560 | 6.7 | -- | GS |
| 279 | 0 | 320 | 9.7 | .2 | -- | 0 | -- | 0 | 50 | -- | 683 | 973 | 520 | 290 | .4 | 7.4 | GS |
| 174 | 0 | 770 | 54 | 1.1 | -- | .01 | -- | 0 | 250 | -- | 1390 | 2050 | 44 | 0 | 29 | 8.0 | GS |
| -- | -- | 2180 | 36 | .4 | .4 | -- | -- | -- | 250 | 3550 | -- | 3740 | 1680 | -- | 4.2 | 8.2 | LA |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3000 | -- | -- | -- | -- | GS |
| 300 | 0 | 640 | 460 | .4 | -- | .01 | -- | .03 | 250 | -- | 1900 | 2700 | 500 | 260 | 8.9 | 7.1 | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2550 | -- | -- | -- | -- | GS |
| 121 | 0 | 2000 | 1100 | .8 | -- | .04 | -- | .18 | 470 | -- | 4580 | 5460 | 2700 | 2600 | 3.8 | 7.3 | GS |
| 191 | 0 | 1300 | 860 | .6 | -- | .12 | -- | .03 | 480 | -- | 3350 | 4440 | 1500 | 1400 | 5.9 | 7.5 | GS |
| 231 | 0 | 1000 | 680 | .7 | -- | .03 | -- | .09 | 350 | -- | 2690 | 3920 | 1100 | 960 | 6.2 | 7.4 | GS |
| -- | -- | 1070 | 627 | .5 | .2 | -- | .03 | -- | 280 | 3746 | -- | 4200 | 1070 | -- | 6.6 | 7.8 | LA |
| 286 | 0 | 690 | 850 | .8 | -- | .02 | -- | 0 | 520 | -- | 2640 | 4000 | 530 | 290 | 15 | 7.3 | GS |
| 296 | 0 | 500 | 870 | .8 | -- | .02 | -- | .03 | 530 | -- | 2450 | 4380 | 310 | 66 | 20 | 7.1 | GS |
| 225 | 0 | 380 | 130 | .2 | -- | .01 | -- | 0 | 60 | -- | 933 | 1400 | 490 | 310 | 2.6 | 7.0 | GS |
| 1950 | 0 | 1200 | 2130 | -- | -- | -- | -- | -- | -- | -- | 7540 | 10500 | 3200 | 1600 | -- | 7.0 | CL |
| 227 | 1 | 173 | 12 | .4 | 0 | -- | .10 | -- | 240 | -- | 484 | 775 | 94 | 0 | 5.4 | 8.0 | UH |
| 236 | 0 | 110 | 2.7 | .4 | -- | .02 | -- | 0 | 230 | -- | 380 | -- | 48 | 0 | 7.5 | 7.3 | GS |
| 183 | 1 | 581 | 12 | .2 | 0 | -- | 0 | -- | 260 | -- | 1058 | 1390 | 301 | 150 | 5.9 | 7.8 | UH |
| 159 | 1 | 758 | 21 | .2 | 0 | -- | .70 | -- | 350 | -- | 1308 | 1980 | 390 | 260 | 4.8 | 8.0 | UH |
| 154 | 0 | 730 | 7.6 | .2 | -- | .43 | -- | .03 | 920 | -- | 1200 | 1550 | 400 | 270 | 5 | 7.4 | GS |
| 245 | -- | 165 | 6 | .4 | -- | -- | -- | -- | -- | 441 | -- | -- | 54 | 0 | -- | -- | UH |
| 242 | 0 | 146 | 4.5 | -- | -- | -- | -- | -- | -- | 424 | -- | 692 | 67 | 0 | 7.1 | 8.2 | GS |
| 235 | 2 | 133 | 9 | .4 | 0 | -- | 0 | -- | 190 | -- | 426 | 605 | 70 | 0 | 6.7 | 8.2 | UH |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 700 | -- | -- | -- | -- | GS |
| 236 | 3 | 109 | 7 | .4 | 50 | -- | .68 | -- | 170 | -- | 405 | 660 | 50 | 0 | 7.5 | 8.4 | UH |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 397 | 650 | -- | -- | -- | 8.3 | UH |
| 238 | -- | 130 | 3.5 | .4 | -- | .02 | -- | .03 | 150 | -- | 410 | 657 | 69 | 0 | 6.3 | -- | GS |
| 240 | -- | 119 | 3 | -- | .5 | -- | -- | -- | -- | -- | 382 | 619 | 74 | 0 | -- | -- | GS |
| 238 | -- | 130 | 8 | .7 | .1 | -- | -- | -- | -- | -- | -- | 617 | 95 | 0 | -- | -- | GS |
| 236 | -- | 119 | 4 | .7 | .5 | -- | -- | -- | -- | -- | 381 | 588 | 61 | 0 | -- | -- | GS |
| 243 | -- | 109 | 3 | 0 | .3 | -- | -- | -- | -- | 380 | -- | -- | 43 | 0 | -- | -- | UH |

Table 13.--Selected chemical analyses of water samples from

| LOCATION | DATE OF SAMPLE | DISCHARGE (GAL/MIN) | TOTAL DEPTH OF WELL (FT) | DEPTH TO TOP OF SAMPLE INTER-VAL (FT) | DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT) | GEOLOGIC UNIT | TEMP-ERA-TURE (DEG C) | DIS-SOLVED SILICA (SIO2) (MG/L) | DIS-SOLVED IRON (FE) (UG/L) | DIS-SOLVED CAL-CIUM (CA) (MG/L) | DIS-SOLVED MAG-NE-SIUM (MG) (MG/L) | DIS-SOLVED SODIUM (NA) (MG/L) | DIS-SOLVED SODIUM PLUS POTAS-SIUM (MG/L) | DIS-SOLVED POTAS-SIUM (K) (MG/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-28-11)16ddb-1 | May 29, 1962 | -- | | | | | -- | -- | -- | -- | -- | -- | 124 | -- |
| 17abd-1 | Mar. 13, 1965 | -- | 503 | -- | -- | 221ENRD | -- | 15 | 30 | 158 | 49 | 275 | -- | 4.5 |
| 21abd-1 | June 10, 1975 | -- | 363 | 353 | 363 | 221ENRD | -- | 12 | -- | 9.8 | 2.8 | 110 | -- | 1.2 |
| (D-28-12)27add-S1 | Sep. 20, 1976 | -- | -- | -- | -- | 220NVJO | -- | 7.3 | 30 | 36 | 36 | 61 | -- | 5.2 |
| (D-28-14)22cad-S1 | May 1957 | <1 | -- | -- | -- | 221CRML | 11.0 | 14 | 10 | 547 | 102 | 20 | -- | 4.4 |
| (D-28-15)21dbb-S1 | May 21, 1957 | -- | -- | -- | -- | 221CRML | 12.0 | 18 | 10 | 96 | 47 | 83 | -- | 5.2 |
| 29ddd-S1 | Nov. 1, 1944 | <1 | -- | -- | -- | 221ENRD | -- | -- | -- | 79 | 30 | -- | 33 | -- |
| (D-29-3)14bcb-S1 | May 2, 1962 | -- | -- | -- | -- | 120TRTR | 9.0 | 32 | -- | 22 | 7.8 | 5.1 | -- | 1.8 |
| | Sep. 27, 1962 | -- | -- | -- | -- | | 9.0 | 30 | -- | 28 | 7.3 | 6.5 | -- | -- |
| | Oct. 11, 1966 | -- | -- | -- | -- | | 10.0 | 28 | -- | 21 | 9.2 | -- | 5.4 | -- |
| | Oct. 29, 1976 | -- | -- | -- | -- | | 9.0 | 20 | 10 | 22 | 8.2 | 6 | -- | 1.9 |
| (D-29-4)7bdc-1 | Aug. 12, 1966 | -- | -- | -- | -- | 100VLFL | 8.5 | 14 | -- | 303 | 140 | -- | 861 | -- |
| (D-29-6)23bbb-S1 | Oct. 3, 1951 | E10 | -- | -- | -- | 230MNKP | -- | 43 | -- | 215 | 32 | -- | 70 | -- |
| (D-29-7)15dbd-1 | Sep. 12, 1977 | E150 | 261 | 37 | 261 | 200MSZC | -- | 26 | 150 | 330 | -- | 64 | -- | 5.5 |
| | Sep. 12, 1977 | E200 | 330 | | 330 | | 14.0 | -- | -- | -- | -- | -- | -- | -- |
| | Sep. 13, 1977 | 30 | 460 | | 460 | | 14.0 | -- | -- | -- | -- | -- | -- | -- |
| | Sep. 13, 1977 | 43 | | | | 220NVJO | -- | -- | -- | -- | -- | -- | -- | -- |
| | Sep. 14, 1977 | 38 | | | | 200MSZC | 14.0 | -- | -- | -- | -- | -- | -- | -- |
| | Sep. 14, 1977 | -- | | 240 | | 220NVJO | 14.0 | -- | -- | -- | -- | -- | -- | -- |
| | Sep. 15, 1977 | 12 | | | | | 14.0 | 11 | 5000 | 100 | 45 | 12 | -- | 4.4 |
| 18bdd-S1 | May 13, 1976 | -- | -- | -- | -- | 220NVJO | -- | 11 | 940 | 170 | 65 | 24 | -- | 10 |
| (D-29-10)8ccb-1 | July 16, 1958 | -- | -- | 4750 | 4790 | 327SNBD | -- | -- | -- | 50 | 19 | -- | 1510 | -- |
| | July 18, 1958 | -- | -- | 4840 | 4868 | 310KIBB | -- | -- | -- | 550 | 154 | -- | 467 | -- |
| | July 22, 1958 | -- | -- | 5107 | 5159 | 310OGRK | -- | -- | -- | 726 | 90 | -- | 669 | -- |
| | July 29, 1958 | -- | -- | 6035 | 6060 | 310HLGT | -- | -- | -- | 456 | 139 | -- | 895 | -- |
| | Aug. 28, 1958 | -- | -- | 7390 | 7470 | 324PRDX | -- | -- | -- | 375 | 108 | -- | 1260 | -- |
| | Sep. 8, 1958 | -- | -- | 7920 | 7953 | 331LDVL | -- | -- | -- | 1040 | 242 | -- | 1680 | -- |
| 22ccb-S1 | July 25, 1975 | E1 | -- | -- | -- | 221FRRN | -- | -- | -- | -- | -- | -- | -- | -- |
| | June 15, 1977 | 1 | -- | -- | -- | | 20.0 | 17 | 50 | 87 | 15 | 27 | -- | 1.3 |
| (D-29-11)2aac-1 | Dec. 22, 1958 | -- | 2847 | 2695 | 2783 | 310KIBB | -- | -- | -- | 99 | 31 | -- | 2130 | -- |
| | Dec. 23, 1958 | -- | -- | 2787 | 2847 | 310WTRM | -- | -- | -- | 102 | 38 | -- | 2060 | -- |
| 36daa-1D | Sep. 22, 1976 | E20 | 500 | 312 | 500 | 221ENRD | -- | 7.5 | 110 | 120 | 70 | 460 | -- | 7.6 |
| 36dcd-1 | Dec. 21, 1976 | -- | 4000 | -- | -- | 221ENRD | -- | 4 | 400 | 352 | 114 | 2020 | -- | 15 |
| (D-29-12)33acd-1S | Feb. 9, 1959 | 1.6 | 6584 | 2162 | 2178 | 230MNKP | -- | -- | 25000 | 896 | 439 | -- | 1590 | -- |
| | Dec. 1970 | -- | -- | 2262 | 2320 | 310WTRM | -- | -- | -- | -- | -- | -- | -- | -- |
| | Sep. 28, 1971 | -- | 2245 | 2161 | 2190 | 230MNKP | -- | -- | 0 | 284 | 185 | 1120 | -- | 180 |
| 33acd-2 | Aug. 9, 1976 | E200 | 510 | 180 | 510 | 220NVJO | 16.5 | 11 | 70 | 59 | 31 | 26 | -- | 7.5 |
| (D-29-13)7abc-S1 | Sep. 21, 1976 | -- | -- | -- | -- | 220NVJO | 16.5 | 9.3 | 290 | 35 | 47 | 41 | -- | 8.6 |
| (D-29-15)14dbb-S1 | May 22, 1957 | .5 | -- | -- | -- | 220NVJO | 9.0 | 8.6 | 10 | 28 | 22 | 4.8 | -- | 2.1 |
| 20add-1 | Oct. 4, 1958 | -- | 6886 | 6685 | 6846 | 330MSSP | -- | -- | 4000 | 2100 | 471 | 30000 | -- | 218 |
| (D-29-16)28cbc-1 | Nov. 5, 1973 | -- | 2750 | -- | -- | 310CTLR | 14.5 | 8.9 | 70 | 270 | 53 | 180 | -- | 52 |
| (D-30-10)13bcb-S1 | Oct. 7, 1976 | 2 | -- | -- | -- | 110PTOD | 14.0 | 22 | <0 | 80 | 16 | 24 | -- | .8 |
| 20aca-S1 | Oct. 6, 1976 | 3 | -- | -- | -- | 111CLVM | 12.5 | 27 | 20 | 110 | 23 | 45 | -- | .4 |
| 23cbb-S1 | Aug. 28, 1976 | -- | -- | -- | -- | 200MNCS | 13.5 | 15 | -- | 82 | 18 | 40 | -- | 1.5 |
| 25bba-S1 | Aug. 27, 1976 | -- | -- | -- | -- | 110PTOD | 17.0 | 20 | -- | 110 | 21 | 36 | -- | .6 |
| 25bcb-S1 | Aug. 27, 1976 | 13 | -- | -- | -- | 110PTOD | 15.0 | 17 | -- | 90 | 16 | 23 | -- | .5 |
| 33cdb-S1 | July 26, 1975 | E150 | -- | -- | -- | 200MNCS | 8.0 | 13 | -- | 52 | 5 | 6 | -- | .5 |
| (D-30-11)5dbc-S1 | Aug. 3, 1976 | -- | -- | -- | -- | 110PTOD | 23.0 | 21 | -- | 89 | 18 | 39 | -- | 1.1 |
| (D-30-13)4dcb-1 | Sep. 1, 1971 | -- | 6128 | 2192 | 2240 | 310WTRM | -- | -- | 0 | 720 | 188 | 637 | -- | 104 |
| | Sep. 2, 1971 | -- | | 5540 | 5610 | 327PKRT | -- | -- | 0 | 1940 | 723 | 41500 | -- | 420 |
| | Sep. 3, 1971 | -- | | 6043 | 6129 | 330RDLL | -- | -- | 0 | 1330 | 361 | 7340 | -- | 250 |
| 30cad-S1 | July 28, 1975 | -- | -- | -- | -- | 221ENRD | 27.0 | 14 | -- | 22 | 14 | 9.4 | -- | 3.6 |
| (D-30-15)13cbd-1 | June 29, 1966 | -- | 760 | 720 | 760 | 310WTRM | -- | 8.3 | -- | 40 | 35 | -- | 272 | -- |
| 23dbc-1 | June 29, 1966 | -- | 1618 | 750 | 1615 | 310WTRM | -- | 6.4 | -- | 80 | 88 | -- | 109 | -- |
| (D-30-16)3aab-S1 | May 1957 | 1 | -- | -- | -- | 111ALVM | 9.5 | 8.9 | 0 | 43 | 13 | 11 | -- | 1.5 |
| | Sep. 3, 1969 | .7 | -- | -- | -- | | 15.5 | 11 | 40 | 64 | 26 | 54 | -- | 2.1 |
| (D-31-7)36dad-S1 | Aug. 29, 1975 | -- | 2305 | 580 | 1140 | 220NVJO | 17.5 | 9.6 | 30 | 32 | 20 | 6.5 | -- | 2 |
| 36dad-1W | Dec. 23, 1968 | 243 | 6648 | 600 | 2446 | 200MSZC | -- | -- | 0 | 144 | 30 | 62 | -- | 4 |
| | Jan. 13, 1969 | -- | | 3414 | 3417 | 310KIBB | -- | -- | 0 | 93 | 20 | 46 | -- | 7 |
| (D-31-8)9aad-1 | Feb. 1969 | -- | -- | -- | -- | 111ALVM | -- | 20 | -- | 145 | 31 | 15 | -- | 4 |

water wells, springs, and petroleum-test wells--Continued

| BICAR-BONATE (HCO3) (MG/L) | CAR-BONATE (CO3) (MG/L) | DIS-SOLVED SUL-FATE (SO4) (MG/L) | DIS-SOLVED CHLO-RIDE (CL) (MG/L) | DIS-SOLVED FLUO-RIDE (F) (MG/L) | DIS-SOLVED NI-TRATE (NO3) (MG/L) | DIS-SOLVED NITRITE PLUS NITRATE (N) (MG/L) | PHOS-PHATE (PO4) (MG/L) | DIS-SOLVED ORTHO PHOS-PHATE (PO4) (MG/L) | DIS-SOLVED BORON (B) (UG/L) | DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L) | DIS-SOLVED SOLIDS SUM OF CONSTI-TUENTS (MG/L) | SPE-CIFIC CON-DUCT-ANCE (MICRO MHOS) | HARD-NESS (CA,MG) (MG/L) | NON-CAR-BONATE HARD-NESS (MG/L) | SODIUM AD-SORP-TION RATIO | PH (UNITS) | AGENCY ANA-LYZING SAMPLE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 214 | 11 | 112 | 3 | -- | -- | -- | -- | -- | -- | 372 | -- | 605 | 46 | 0 | 7.9 | 8.6 | GS |
| 136 | 0 | 1018 | 15 | .1 | .2 | -- | 0 | -- | 40 | -- | 1700 | 2140 | 596 | 480 | 4.9 | 7.2 | UH |
| 228 | -- | 90 | 2.6 | .3 | -- | .01 | -- | .03 | 110 | -- | 341 | 528 | 36 | 0 | 8 | -- | GS |
| 189 | -- | 58 | 100 | .2 | -- | .07 | -- | 0 | 60 | -- | 397 | 724 | 240 | 83 | 1.7 | -- | GS |
| 202 | 0 | 1580 | 19 | .3 | .2 | -- | -- | -- | 120 | 2560 | 2390 | 2470 | 1780 | 1620 | .2 | 6.8 | GS |
| 274 | 0 | 240 | 103 | .3 | 14 | -- | -- | -- | 70 | 783 | 742 | 1160 | 434 | 209 | 1.7 | 6.9 | GS |
| 203 | -- | 147 | 52 | -- | .2 | -- | -- | -- | -- | -- | 441 | 740 | 320 | 154 | -- | -- | GS |
| 114 | 0 | 2.1 | 2 | .1 | .1 | -- | -- | -- | 30 | 119 | 129 | 185 | 88 | 0 | .2 | 7.9 | GS |
| 125 | 0 | 3.9 | 4 | -- | 1.1 | -- | -- | -- | -- | 128 | 142 | 199 | 99 | 0 | .3 | 7.9 | GS |
| 117 | 0 | 1.9 | 2.2 | -- | .9 | -- | -- | -- | -- | 118 | 127 | 192 | 90 | 0 | .2 | 7.5 | GS |
| 110 | 0 | 3 | 1.7 | .3 | -- | .04 | -- | .09 | 20 | -- | 118 | 220 | 89 | 0 | .3 | 7.5 | GS |
| 130 | 0 | 1020 | 1440 | -- | 1.9 | -- | -- | -- | -- | 4190 | 3840 | 5960 | 1330 | 1220 | 10 | 7.7 | GS |
| 232 | 0 | 513 | 35 | .5 | 1.8 | -- | -- | -- | -- | 1050 | -- | 1275 | 680 | 490 | -- | 7.8 | UH |
| 140 | 0 | 1100 | 51 | .4 | -- | -- | -- | -- | 310 | -- | -- | 2045 | -- | -- | -- | 6.8 | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1400 | -- | -- | -- | 6.8 | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 970 | -- | -- | -- | -- | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 950 | -- | -- | -- | -- | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 980 | -- | -- | -- | -- | GS |
| 170 | 0 | 280 | 11 | .6 | -- | -- | -- | -- | 30 | -- | 553 | 765 | 440 | 300 | .3 | 6.8 | GS |
| 232 | 0 | 500 | 19 | .4 | -- | .04 | -- | 0 | 100 | -- | 916 | 1200 | 690 | 500 | .4 | 7.7 | GS |
| 586 | 168 | 1770 | 630 | -- | -- | -- | -- | -- | -- | 4580 | 4440 | 6290 | 200 | 0 | 46 | 8.5 | CG |
| 647 | 0 | 1800 | 440 | -- | -- | -- | -- | -- | -- | 4070 | 3730 | -- | 2000 | 1500 | 4.5 | 7.5 | CG |
| 1120 | 0 | 1990 | 460 | -- | -- | -- | -- | -- | -- | 4580 | 4490 | 4820 | 2200 | 1300 | 6.2 | 7.3 | CG |
| 1200 | 0 | 1980 | 440 | -- | -- | -- | -- | -- | -- | 4410 | 4500 | 5290 | 1700 | 730 | 9.4 | 7.3 | CG |
| 415 | 0 | 2690 | 700 | -- | -- | -- | -- | -- | -- | 5460 | 5340 | 6830 | 1400 | 1000 | 15 | 7.5 | CG |
| 1460 | 0 | 1840 | 2940 | -- | -- | -- | -- | -- | -- | 8490 | 8460 | 11580 | 3600 | 2400 | 12 | 7.9 | CG |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 610 | -- | -- | -- | -- | GS |
| 170 | 0 | 170 | 6.9 | .4 | -- | .06 | -- | 0 | 30 | -- | 409 | 535 | 280 | 140 | .7 | 6.4 | GS |
| 1660 | -- | 1910 | 1180 | -- | -- | -- | -- | -- | -- | 6030 | 6170 | 7300 | 380 | 0 | -- | 7.5 | CG |
| 1560 | -- | 1960 | 1120 | -- | -- | -- | -- | -- | -- | 6040 | 6040 | 7300 | 410 | 0 | -- | 7.7 | CG |
| 104 | 0 | 1400 | 19 | .2 | -- | .07 | -- | 0 | 240 | -- | 2140 | 2950 | 590 | 500 | 8.3 | 7.9 | GS |
| 76 | 0 | 4720 | 132 | .4 | 0 | -- | -- | 1.50 | 1060 | 7230 | 7420 | 7920 | 1350 | 1300 | 24 | 8.3 | UH |
| 1590 | 0 | 1500 | 3310 | -- | -- | -- | -- | -- | -- | 9350 | 8540 | 12400 | 4000 | 2700 | -- | 7.0 | CL |
| -- | -- | -- | 1210 | -- | -- | -- | -- | -- | -- | 6305 | -- | -- | -- | -- | -- | 7.0 | UC |
| 1840 | 0 | 337 | 1610 | -- | -- | -- | -- | -- | -- | 4620 | 4600 | 7300 | 1500 | 0 | 13 | 7.2 | CG |
| 239 | 0 | 110 | 15 | .2 | -- | .06 | -- | 0 | 40 | -- | 378 | 640 | 280 | 79 | .7 | 7.5 | GS |
| 332 | -- | 55 | 23 | .3 | -- | .09 | -- | 0 | 50 | -- | 384 | 640 | 280 | 9 | 1.1 | -- | GS |
| 174 | 0 | 15 | 10 | .1 | 2.6 | -- | -- | -- | 10 | 179 | 179 | 318 | 159 | 16 | .2 | 7.3 | GS |
| 586 | 0 | 5900 | 46500 | -- | -- | -- | -- | -- | -- | -- | 85500 | 118000 | 7200 | 6700 | 154 | 7.7 | CO |
| 304 | 0 | 960 | 45 | .2 | -- | .03 | -- | .09 | -- | -- | 1720 | 2330 | 890 | 640 | 2.6 | 7.7 | GS |
| 260 | 0 | 83 | 8.1 | .3 | -- | .01 | -- | .09 | 60 | -- | 363 | 546 | 270 | 52 | .6 | 7.5 | GS |
| 380 | 0 | 140 | 19 | .5 | -- | .03 | -- | .09 | 210 | -- | 553 | 783 | 370 | 58 | 1 | 7.0 | GS |
| 257 | 0 | 130 | 6.6 | .3 | -- | .17 | -- | .03 | 80 | 387 | 421 | 680 | 280 | 68 | 1 | 8.2 | GS |
| 244 | 0 | 160 | 14 | .5 | -- | .01 | -- | .03 | 210 | 471 | 483 | 770 | 360 | 160 | .8 | 8.2 | GS |
| 223 | 0 | 130 | 11 | .4 | -- | .01 | -- | 0 | 170 | 354 | 398 | 620 | 290 | 110 | .6 | 8.2 | GS |
| 155 | -- | 34 | 2.8 | .2 | 0 | .02 | -- | 0 | 30 | 204 | 190 | 320 | 150 | 23 | .2 | -- | GS |
| 210 | -- | 180 | 6.1 | .9 | -- | .01 | -- | 0 | 100 | 472 | 459 | 680 | 300 | 120 | 1 | -- | GS |
| 1320 | 0 | 1700 | 880 | -- | -- | -- | -- | -- | -- | -- | 4880 | 6000 | 2600 | 1500 | 5.5 | 7.5 | CG |
| 281 | 0 | 6370 | 65000 | -- | -- | -- | -- | -- | -- | -- | 116000 | 120000 | 7800 | 7600 | 204 | 7.3 | CG |
| 915 | 0 | 4420 | 11200 | -- | -- | -- | -- | -- | -- | -- | 25400 | 31500 | 4800 | 4100 | 46 | 8.0 | CG |
| 107 | -- | 30 | 7.4 | .3 | 6.2 | 1.40 | -- | .03 | 30 | 161 | 160 | 255 | 110 | 25 | .4 | -- | GS |
| 714 | 0 | 119 | 90 | -- | .4 | -- | -- | -- | -- | 946 | 916 | 1490 | 245 | 0 | 7.6 | 7.6 | GS |
| 320 | 0 | 432 | 60 | -- | .4 | -- | -- | -- | -- | 984 | 933 | 1410 | 560 | 298 | 2 | 7.7 | GS |
| 165 | 0 | 22 | 18 | .1 | 6.5 | -- | -- | -- | 10 | 214 | 205 | 362 | 161 | 26 | .4 | 7.1 | GS |
| 212 | 0 | 24 | 133 | .1 | 9 | -- | -- | -- | 0 | 504 | 427 | 790 | 268 | 94 | 1.4 | 7.9 | GS |
| 175 | 0 | 27 | 2.8 | .1 | -- | .27 | -- | .03 | 30 | -- | 188 | 350 | 160 | 19 | .2 | 7.1 | GS |
| 305 | 0 | 344 | 10 | -- | -- | -- | -- | -- | -- | -- | 744 | 902 | 480 | 230 | 1.2 | 7.6 | CG |
| 220 | 0 | 223 | 8 | -- | -- | -- | -- | -- | -- | -- | 505 | 660 | 320 | 130 | 1.1 | 7.[illegible] | CG |
| 198 | 1 | 330 | 14 | .2 | -- | -- | -- | -- | 250 | -- | 760 | 920 | 490 | 330 | .3 | 7.8 | UH |

Table 13.--Selected chemical analyses of water samples from

| LOCATION | DATE OF SAMPLE | DISCHARGE (GAL/MIN) | TOTAL DEPTH OF WELL (FT) | DEPTH TO TOP OF SAMPLE INTER-VAL (FT) | DEPTH TO BOT-TOM OF SAMPLE INTER-VAL (FT) | GEOLOGIC UNIT | TEMP-ERA-TURE (DEG C) | DIS-SOLVED SILICA (SIO2) (MG/L) | DIS-SOLVED IRON (FE) (UG/L) | DIS-SOLVED CAL-CIUM (CA) (MG/L) | DIS-SOLVED MAG-NE-SIUM (MG) (MG/L) | DIS-SOLVED SODIUM (NA) (MG/L) | DIS-SOLVED SODIUM PLUS POTAS-SIUM (MG/L) | DIS-SOLVED POTAS-SIUM (K) (MG/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-31-8)24caa-S1 | Aug. 22, 1975 | -- | -- | -- | -- | 211EMRY | 15.0 | 8.9 | -- | 140 | 120 | 74 | -- | 4.3 |
| 27dab-S1 | July 22, 1975 | -- | -- | -- | -- | 211EMRY | -- | 9.8 | -- | 200 | 140 | 230 | -- | 7.1 |
| | Aug. 22, 1975 | <0.1 | -- | -- | -- | | 19.0 | 10 | -- | 160 | 160 | 240 | -- | 6.6 |
| (D-31-9)18adc-S1 | July 31, 1975 | -- | -- | -- | -- | 200MNCS | 25.0 | 19 | -- | 150 | 67 | 62 | -- | .8 |
| (D-31-10)14bdc-S1 | July 22, 1975 | -- | -- | -- | -- | 200MNCS | 5.0 | 12 | -- | 64 | 10 | 6.9 | -- | .5 |
| | July 29, 1975 | -- | -- | -- | -- | | 9.0 | 11 | -- | 67 | 11 | 6.7 | -- | .5 |
| | Aug. 29, 1975 | -- | -- | -- | -- | | -- | -- | -- | -- | -- | -- | -- | -- |
| 20bbd-S1 | July 30, 1975 | 67 | -- | -- | -- | 111CLVM | 5.5 | 13 | -- | 49 | 5 | 6.7 | -- | .3 |
| 29bdb-S1 | July 29, 1976 | -- | -- | -- | -- | 111CLVM | 7.5 | 11 | -- | 57 | 7.4 | 7.3 | -- | .5 |
| 30aaa-S1 | July 29, 1976 | -- | -- | -- | -- | 111CLVM | 8.0 | 11 | -- | 56 | 6.9 | 7.6 | -- | .5 |
| 30ada-S1 | July 29, 1976 | -- | -- | -- | -- | 221FRRN | 8.0 | 9.5 | -- | 72 | 16 | 8.2 | -- | .8 |
| 31abb-S1 | July 22, 1975 | -- | -- | -- | -- | 211FRRN | -- | 16 | -- | 110 | 30 | 17 | -- | 1.1 |
| | July 30, 1975 | -- | -- | -- | -- | | 9.0 | 15 | -- | 110 | 32 | 16 | -- | 1.2 |
| 31ada-S1 | July 22, 1975 | -- | -- | -- | -- | 200MNCS | -- | 15 | -- | 110 | 27 | 14 | 7 | 1.4 |
| | July 30, 1975 | 110 | -- | -- | -- | | 8.0 | 15 | -- | 100 | 28 | 14 | -- | .8 |
| 32bcb-S1 | July 30, 1975 | E5 | -- | -- | -- | 200MNCS | 7.0 | 14 | -- | 120 | 58 | 31 | -- | 2.5 |
| (D-31-11)1bdc-S1 | Aug. 1, 1975 | E3 | -- | -- | -- | 221MRSN | 24.5 | 12 | -- | 170 | 37 | 21 | -- | 2.9 |
| 27ddd-1 | Nov. 27, 1961 | -- | 6683 | 6600 | 6683 | 330MSSP | -- | -- | -- | 1180 | 227 | -- | 2250 | -- |
| (D-31-12)4bab-1 | July 28, 1975 | -- | 450 | -- | -- | 220NVJO | -- | 10 | -- | 26 | 43 | 18 | -- | 3.9 |
| (D-31-13)9bcd-S1 | June 20, 1957 | 3 | -- | -- | -- | 231WNGT | 17.5 | 9.1 | 0 | 25 | 28 | 46 | -- | 8.5 |
| | July 26, 1976 | 4.1 | -- | -- | -- | | 19.0 | 8.9 | 40 | 25 | 30 | 47 | -- | 9.4 |
| (D-32-8)21bda-S1 | Sep. 1, 1976 | -- | -- | -- | -- | 211EMRY | 20.0 | 13 | -- | 220 | 150 | 270 | -- | 8.5 |
| (D-32-10)8bdc-S1 | Aug. 14, 1975 | 3 | -- | -- | -- | 111CLVM | 23.0 | 20 | -- | 60 | 14 | 11 | -- | .2 |
| 8cbd-S1 | Aug. 14, 1975 | 6 | -- | -- | -- | 111CLVM | 13.0 | 21 | -- | 180 | 58 | 37 | -- | .3 |
| 18cba-S1 | Aug. 14, 1975 | <5 | -- | -- | -- | 200MNCS | 15.5 | 8.1 | -- | 430 | 460 | 1000 | -- | 26 |
| (D-33-8)2ccd-S1 | Aug. 13, 1975 | E10 | -- | -- | -- | 211MVRD | 14.5 | 7.8 | -- | 200 | 80 | 28 | -- | 4.3 |

| BICAR-BONATE (HCO3) (MG/L) | CAR-BONATE (CO3) (MG/L) | DIS-SOLVED SUL-FATE (SO4) (MG/L) | DIS-SOLVED CHLO-RIDE (CL) (MG/L) | DIS-SOLVED FLUO-RIDE (F) (MG/L) | DIS-SOLVED NI-TRATE (NO3) (MG/L) | DIS-SOLVED NITRITE PLUS NITRATE (N) (MG/L) | PHOS-PHATE (PO4) (MG/L) | DIS-SOLVED ORTHO PHOS-PHATE (PO4) (MG/L) | DIS-SOLVED BORON (B) (UG/L) | DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L) | DIS-SOLVED SOLIDS SUM OF CONSTI-TUENTS (MG/L) | SPE-CIFIC CON-DUCT-ANCE (MICRO MHOS) | HARD-NESS (CA,MG) (MG/L) | NON-CAR-BONATE HARD-NESS (MG/L) | SODIUM AD-SORP-TION RATIO | PH (UNITS) | AGENCY ANA-LYZING SAMPLE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 364 | -- | 630 | 11 | 0.2 | -- | 0.02 | -- | 0 | 110 | 1240 | 1170 | 1500 | 840 | 550 | 1.1 | -- | GS |
| 368 | -- | 1200 | 20 | .3 | -- | .05 | -- | .03 | 200 | -- | 1990 | 2580 | 1100 | 770 | 3.1 | -- | GS |
| 383 | -- | 1200 | 19 | .2 | -- | .02 | -- | 0 | 210 | 2220 | 1990 | 2500 | 1100 | 740 | 3.2 | -- | GS |
| 0 | -- | 520 | 29 | .5 | 0 | .01 | -- | .03 | 110 | 1050 | 971 | 1350 | 650 | 450 | 1.1 | -- | GS |
| 174 | -- | 61 | 3.1 | .2 | -- | .11 | -- | .03 | 50 | -- | 244 | 314 | 200 | 58 | .2 | -- | GS |
| 178 | -- | 66 | 2 | .2 | .2 | .06 | -- | 0 | 30 | 267 | 252 | 410 | 210 | 67 | .2 | -- | GS |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | GS |
| 150 | -- | 35 | 2.5 | .2 | 0 | .01 | -- | .03 | 30 | 189 | 186 | 340 | 140 | 20 | .2 | -- | GS |
| 149 | -- | 64 | 2.7 | .2 | .6 | .15 | -- | 0 | 30 | 220 | 224 | 350 | 170 | 51 | .2 | -- | GS |
| 147 | -- | 64 | 3 | .2 | 1.2 | .29 | -- | 0 | 30 | 216 | 223 | 340 | 170 | 48 | .3 | -- | GS |
| 205 | -- | 80 | 2.8 | .2 | .3 | .09 | -- | 0 | 30 | 245 | 291 | 460 | 250 | 78 | .2 | -- | GS |
| 267 | -- | 180 | 6 | .3 | -- | .21 | -- | .03 | 60 | -- | 493 | 781 | 400 | 180 | .4 | -- | GS |
| 275 | -- | 190 | 4.9 | .3 | 1.1 | .25 | -- | 0 | 50 | 542 | 506 | 750 | 410 | 180 | .3 | -- | GS |
| 239 | -- | 200 | 3.1 | .3 | -- | .52 | -- | .03 | 60 | -- | 491 | 730 | 390 | 190 | .3 | -- | GS |
| 233 | -- | 190 | 2.7 | .3 | 2.3 | .53 | -- | .03 | 20 | 499 | 468 | 740 | 370 | 170 | .3 | -- | GS |
| 309 | -- | 290 | 12 | .1 | .8 | .19 | -- | .03 | 70 | 723 | 681 | 1050 | 540 | 290 | .6 | -- | GS |
| 194 | -- | 420 | 10 | .3 | -- | 0 | -- | .03 | 70 | 814 | 769 | 1025 | 580 | 420 | .4 | -- | GS |
| 535 | 0 | 2240 | 4260 | -- | -- | -- | -- | -- | -- | 11500 | 10400 | 14500 | 3900 | 3400 | 16 | 7.8 | CG |
| 245 | -- | 67 | 7.6 | .2 | 0 | .01 | -- | .03 | 30 | 305 | 297 | 510 | 240 | 41 | .5 | -- | GS |
| 275 | 0 | 44 | 12 | .3 | 3.7 | -- | -- | -- | 60 | 305 | 312 | 528 | 176 | 0 | 1.5 | 7.4 | GS |
| 274 | 0 | 50 | 12 | .5 | -- | 1.20 | -- | 0 | 90 | -- | 323 | 550 | 190 | 0 | 1.5 | 7.6 | GS |
| 479 | 0 | 1400 | 22 | .4 | -- | .02 | -- | 0 | 270 | 2460 | 2320 | 2975 | 1200 | 770 | 3.4 | 7.1 | GS |
| 222 | -- | 39 | 4.8 | .3 | -- | .01 | -- | .06 | 210 | 265 | 259 | 440 | 210 | 25 | .3 | -- | GS |
| 270 | -- | 500 | 14 | .4 | -- | .01 | -- | .03 | 560 | 997 | 944 | 1250 | 690 | 470 | .6 | -- | GS |
| 423 | -- | 4600 | 40 | .3 | -- | .06 | -- | .03 | 410 | 7660 | 6780 | 6500 | 3000 | 2600 | 8 | -- | GS |
| 256 | -- | 620 | 15 | .9 | -- | .05 | -- | .03 | 120 | 1120 | 1080 | 1500 | 830 | 620 | .4 | -- | GS |

Table 14.--Selected analyses of

[See table 13 for analyses of major constituents and explanation

Specific conductance: In micromhos per centimeter at 25°C.

| LOCATION | DATE OF SAMPLE | GEOLOGIC UNIT | AGENCY ANALYZING SAMPLE | DISSOLVED SOLIDS (MG/L) (RESIDUE AT 180 C) | DISSOLVED SOLIDS (MG/L) SUM OF CONSTITUENTS | SPECIFIC CONDUCTANCE | ARSENIC (AS) | BARIUM (BA) |
|---|---|---|---|---|---|---|---|---|
| (D-23-10)28DBB- 1 | JULY 0,1961 | 330MSSP | CL | -- | 2260 | 3910 | -- | 0 |
| (D-24- 5)13BCD-S1 | SEP. 29,1976 | 211FRRN | GS | -- | 872 | 1250 | 1 | -- |
| (D-24- 8)25DCD-S1 | OCT. 7,1975 | 230MNKP | GS | -- | 336 | 542 | -- | -- |
| (D-24-14)10AAC- 1 | OCT. 7,1972 | 330MSSP | BM | -- | 123000 | -- | -- | 87000 |
| (D-25-15)15ABD- 1 | JULY 23,1963 | 324PRDX | CL | -- | 210000 | 155000 | -- | 0 |
| (D-26- 7)19BBD- 1 | NOV. 14,1960 | 300PLZC | CL | 5300 | 5460 | 6260 | -- | 0 |
| | NOV. 15 | 330RDLL | CL | 5570 | 6450 | 6570 | -- | 0 |
| (D-26- 8) 6AAB- 1 | JUNE 26,1969 | 220NVJO | GS | 2640 | 2390 | 2840 | 0 | -- |
| (D-26- 9)16BBB-S1 | OCT. 7,1975 | 231WNGT | GS | -- | 4250 | 4550 | -- | -- |
| 21AAC-S1 | OCT. 8 | 220NVJO | GS | -- | 1810 | 3040 | -- | -- |
| 24DBC- 1 | AUG. 29 | 221SLWS | GS | -- | 1160 | 1550 | -- | -- |
| (D-26-14)30CDB- 1 | DEC. 27,1961 | 330MSSP | CL | -- | 6990 | 13500 | -- | 0 |
| (D-26-17) 5CCC- 1 | JAN. 12,1962 | 330MSSP | CL | -- | 21200 | 38500 | -- | 0 |
| | JAN. 19 | 330MSSP | CL | -- | 14900 | 26300 | -- | 0 |
| (D-27- 6)23CBA-S1 | MAY 22,1975 | 221SLWS | UH | -- | 1132 | 1640 | 0 | 0 |
| (D-27- 7) 7BCC- 2 | SEP. 2,1977 | 220NVJO | GS | -- | 70800 | 82000 | 1 | 100 |
| 17BDB-S1 | OCT. 3,1975 | 111ALVM | LA | 3910 | -- | 4840 | -- | -- |
| 23ACD-S1 | OCT. 4 | 111ALVM | LA | 5300 | -- | 6080 | -- | -- |
| (D-27- 8) 6BAD-S1 | SEP. 26 | 220NVJO | LA | 3390 | -- | 3740 | -- | -- |
| 11DAC-S1 | APR. 19,1972 | 221CRML | UH | -- | 4810 | 7370 | 0 | 0 |
| 12CBD-S1 | APR. 19,1972 | 221CRML | UH | -- | 5500 | 8080 | 10 | 4000 |
| (D-27-11)34DDB- 1 | AUG. 6,1976 | 220NVJO | GS | -- | 2930 | 5290 | -- | 0 |
| (D-27-13)30ABC- 1 | MAY 0,1962 | 330MSSP | CL | -- | 11000 | 20400 | -- | 0 |
| (D-27-14)17CCB- 1 | OCT. 12,1959 | 310WTRM | CL | 6010 | 5380 | 8730 | -- | 0 |
| (D-27-15)35BCC- 1 | OCT. 18,1956 | 330MSSP | CL | -- | 14100 | 14300 | -- | 0 |
| (D-27-16)20BDC-S1 | NOV. 12,1969 | 231KYNT | GS | 200 | 189 | 353 | 10 | -- |
| 33ACB- 1 | NOV. 7,1961 | 330MSSP | CL | -- | 28700 | 44400 | -- | 0 |
| (D-28- 8) 5ABD-S1 | SEP. 28,1975 | 111ALVM | LA | 3550 | -- | 3740 | -- | -- |
| 29CDC- 1 | AUG. 28 | 220NVJO | GS | -- | 1900 | 2700 | -- | -- |
| 29DCB- 1 | OCT. 4,1974 | 220NVJO | LA | 3746 | -- | 4200 | -- | -- |
| | OCT. 30 | 220NVJO | LA | -- | -- | 3880 | -- | -- |
| 33BBB- 1 | AUG. 21,1975 | 220NVJO | GS | -- | 2640 | 4000 | -- | -- |
| | DEC. 29 | 220NVJO | GS | -- | 2450 | 4380 | -- | -- |
| 33CDD- 1S | AUG. 21 | 220NVJO | GS | -- | 933 | 1400 | -- | -- |
| (D-28-11) 5CDB-1 | FEB. 15,1961 | 330MSSP | CL | -- | 7540 | 10500 | -- | 0 |
| 10DAC- 1 | OCT. 16,1968 | 221ENRD | UH | -- | 484 | 775 | 0 | 0 |
| 16BDD- 1 | JULY 20,1965 | 221ENRD | UH | -- | 1058 | 1390 | 10 | 60 |
| 16CBA- 1 | MAY 28,1969 | 221ENRD | UH | -- | 1308 | 1980 | 10 | 0 |
| 16DAC- 1 | JAN. 7,1964 | 221ENRD | UH | -- | 426 | 605 | 0 | 60 |
| 16DAD- 1 | JAN. 31 | 221ENRD | UH | -- | 405 | 660 | 0 | 50 |

trace elements in water samples

of location, geologic unit, and agency analyzing sample.]

DISSOLVED TRACE ELEMENTS (MICROGRAMS/LITER)

| CAD-MIUM (CD) | CHRO-MIUM (CR) | COPPER (CU) | LEAD (PB) | LITH-IUM (LI) | MER-CURY (HG) | MAN-GANESE (MN) | MOLYB-DENUM (MO) | NICKEL (NI) | SELE-NIUM (SE) | STRON-TIUM (SR) | VANA-DIUM (V) | ZINC (ZN) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | 0 | -- | 0 | 50 | 0 | -- | -- | -- | 0 | 1400 | -- | 10 |
| -- | -- | 0 | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- |
| -- | -- | 430 | -- | 2000 | -- | 2000 | -- | -- | -- | 21000 | -- | 290 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | 20 | 0 | -- | -- | 50 | -- | -- | 0 | -- | -- | 10 |
| -- | -- | 1 | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- |
| -- | -- | 0 | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- |
| -- | -- | 2 | -- | -- | -- | -- | -- | -- | 56 | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 10 | 0 | 60 | 10 | -- | -- | 0 | -- | 10 | 0 | -- | -- | 50 |
| 1 | 0 | 5 | 5 | -- | 0 | 200 | 0 | 5 | 1 | 4900 | 170 | 390 |
| -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- | -- | -- | -- |
| 0 | -- | 0 | 0 | -- | -- | 0 | -- | -- | 0 | -- | -- | 20 |
| 0 | -- | 0 | 2 | -- | -- | 20 | -- | -- | 0 | -- | -- | 10 |
| -- | -- | 0 | 11 | -- | -- | 20 | -- | -- | 0 | 1900 | 7 | 110 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | 10 | -- | -- | -- | -- | -- | -- | 10 | -- | -- | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | 0 | -- | -- | -- | 60 | -- | -- | -- | -- | -- | -- |
| -- | -- | 18 | -- | -- | -- | 120 | -- | -- | -- | -- | -- | -- |
| -- | 7 | 9 | 20 | -- | -- | 120 | 5 | 10 | -- | 1800 | 80 | -- |
| -- | -- | 1 | -- | -- | -- | 50 | -- | -- | -- | 1500 | 4 | -- |
| -- | -- | -- | -- | -- | -- | 50 | -- | -- | 0 | 1300 | 3 | -- |
| -- | -- | 4 | -- | -- | -- | 130 | -- | -- | -- | 1400 | 1 | -- |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 0 | 0 | 0 | 0 | -- | -- | 0 | -- | -- | 0 | -- | -- | 70 |
| 0 | 0 | 0 | 0 | -- | -- | 0 | -- | -- | 0 | -- | -- | 120 |
| 0 | 0 | 0 | 0 | -- | -- | 0 | -- | -- | 0 | -- | -- | 160 |
| 0 | 0 | 0 | 0 | -- | -- | 0 | -- | -- | 0 | -- | -- | 30 |
| 0 | 0 | 0 | 0 | -- | -- | 10 | -- | -- | 0 | -- | -- | 40 |

Table 14.--Selected analyses of trace

| LOCATION | DATE OF SAMPLE | GEOLOGIC UNIT | AGENCY ANALYZING SAMPLE | DISSOLVED SOLIDS (MG/L) (RESIDUE AT 180 C) | DISSOLVED SOLIDS (MG/L) SUM OF CONSTITUENTS | SPECIFIC CONDUCTANCE | ARSENIC (AS) | BARIUM (BA) |
|---|---|---|---|---|---|---|---|---|
| (D-28-11)17ADB- 1 | MAR. 13,1965 | 221ENRD | UH | -- | 1700 | 2140 | 30 | 10 |
| (D-28-14)22CAD-S1 | MAY 0,1957 | 221CRML | GS | 2560 | 2390 | 2470 | -- | -- |
| (D-29- 7)15DBD- 1 | SEP. 12,1977 | 220NVJO | GS | -- | -- | 2045 | -- | 300 |
| | SEP. 15 | 220NVJO | GS | -- | 553 | 765 | 8 | 100 |
| (D-29-11)36DCD- 1 | DEC. 21,1976 | 221ENRD | UH | 7230 | 7420 | 7920 | 2 | 0 |
| (D-29-12)33ACD- 1 | FEB. 9,1959 | 230MNKP | CL | 9350 | 8540 | 12400 | -- | 0 |
| 33ACD- 2 | AUG. 9,1976 | 220NVJO | GS | -- | 378 | 640 | -- | 0 |
| (D-29-16)28CBC- 1 | NOV. 5,1973 | 310CTLR | GS | -- | 1720 | 2330 | 0 | -- |
| (D-30-10)13BCB-S1 | OCT. 7,1976 | 110PTOD | GS | -- | 363 | 546 | -- | 30 |
| 20ACA-S1 | OCT. 6 | 111CLVM | GS | -- | 553 | 783 | -- | 30 |
| 23CBB-S1 | AUG. 28 | 200MNCS | GS | 387 | 421 | 680 | 0 | -- |
| 25BBA-S1 | AUG. 27 | 110PTOD | GS | 471 | 483 | 770 | 0 | -- |
| 25BCB-S1 | AUG. 27 | 110PTOD | GS | 354 | 398 | 620 | 0 | -- |
| 33CDB-S1 | JULY 26,1975 | 200MNCS | GS | 204 | 190 | 320 | 0 | -- |
| (D-30-13)30CAD-S1 | JULY 28 | 221ENRD | GS | 161 | 160 | 255 | 15 | -- |
| (D-30-16) 3AAB-S1 | MAY 0,1957 | 111ALVM | GS | 214 | 205 | 362 | -- | -- |
| (D-31- 7)36DAD- 1S | AUG. 29,1975 | 220NVJO | GS | -- | 188 | 350 | -- | -- |
| (D-31- 8)19AAD- 1 | FEB. 0,1969 | 111ALVM | UH | -- | 760 | 920 | -- | -- |
| 24CAA-S1 | AUG. 22,1975 | 211EMRY | GS | 1240 | 1170 | 1500 | 0 | -- |
| 27DAB-S1 | AUG. 22 | 211EMRY | GS | 2220 | 1990 | 2500 | 0 | -- |
| (D-31- 9)18ADC-S1 | JULY 31 | 200MNCS | GS | 1050 | 971 | 1350 | 0 | -- |
| (D-31-10)14BDC-S1 | JULY 29 | 200MNCS | GS | 267 | 252 | 410 | 0 | -- |
| 20BBD-S1 | JULY 30 | 200MNCS | GS | 189 | 186 | 340 | 4 | -- |
| 29BDB-S1 | JULY 29,1976 | 111CLVM | GS | 220 | 224 | 350 | 0 | -- |
| 30AAA-S1 | JULY 29 | 111CLVM | GS | 216 | 223 | 340 | 0 | -- |
| 30ADA-S1 | JULY 29 | 211FRRN | GS | 245 | 291 | 460 | 0 | -- |
| 31ABB-S1 | JULY 30,1975 | 211FRRN | GS | 542 | 506 | 750 | 1 | -- |
| 31ADA-S1 | JULY 30 | 200MNCS | GS | 499 | 468 | 740 | 0 | -- |
| 32BCB-S1 | JULY 30 | 200MNCS | GS | 723 | 681 | 1050 | 0 | -- |
| (D-31-11) 1BDC-S1 | AUG. 1 | 221MRSN | GS | 814 | 769 | 1025 | 7 | -- |
| (D-31-12) 4BAB- 1 | JULY 28 | 220NVJO | GS | 305 | 297 | 510 | 0 | -- |
| (D-31-13) 9BCD-S1 | JUNE 20,1957 | 231WNGT | GS | 305 | 312 | 528 | -- | -- |
| (D-32- 8)21DBA-S1 | SEP. 1,1976 | 211EMRY | GS | 2460 | 2320 | 2975 | 2 | -- |
| (D-32-10) 8BDC-S1 | AUG. 14,1975 | 111CLVM | GS | 265 | 259 | 440 | 2 | -- |
| 8CBD-S1 | AUG. 14. | 111CLVM | GS | 997 | 944 | 1250 | 0 | -- |
| 18CBA-S1 | AUG. 14 | 200MNCS | GS | 7660 | 6780 | 6500 | 0 | -- |
| (D-33- 8) 2CCD-S1 | AUG. 13 | 211MVRD | GS | 1120 | 1080 | 1500 | 0 | -- |

elements in water samples--Continued

DISSOLVED TRACE ELEMENTS (MICROGRAMS/LITER)

| CAD-MIUM (CD) | CHRO-MIUM (CR) | COPPER (CU) | LEAD (PB) | LITH-IUM (LI) | MER-CURY (HG) | MAN-GANESE (MN) | MOLYB-DENUM (MO) | NICKEL (NI) | SELE-NIUM (SE) | STRON-TIUM (SR) | VANA-DIUM (V) | ZINC (ZN) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | -- | -- | 0 | -- | -- | 0 | -- | -- | 60 |
| -- | -- | 60 | 1 | -- | -- | -- | -- | -- | 30 | -- | -- | -- |
| -- | -- | 12 | -- | -- | -- | 20 | -- | -- | 0 | 6600 | 2 | 50 |
| -- | -- | 0 | -- | -- | -- | 330 | -- | -- | 0 | 180 | 0 | 20 |
| 0 | -- | 85 | 0 | -- | 0 | 160 | -- | 0 | 0 | -- | -- | 2500 |
| -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | 2 | 11 | -- | -- | 10 | -- | -- | 0 | 400 | 0 | 20 |
| -- | -- | 5 | -- | -- | -- | 230 | -- | -- | 2 | -- | -- | -- |
| 0 | 3 | 2 | 6 | 0 | -- | 20 | 3 | 3 | -- | 220 | 6 | 20 |
| 0 | 5 | 2 | 12 | 20 | -- | 5 | 15 | 5 | -- | 380 | 9 | 20 |
| -- | -- | -- | 0 | 30 | -- | -- | -- | -- | -- | -- | -- | 0 |
| -- | -- | -- | 3 | 10 | -- | -- | -- | -- | -- | -- | -- | 0 |
| -- | -- | -- | 4 | 10 | -- | -- | -- | -- | -- | -- | -- | 10 |
| -- | -- | -- | 2 | 0 | -- | -- | -- | -- | -- | -- | -- | 0 |
| -- | -- | -- | 4 | 0 | -- | -- | -- | -- | -- | -- | -- | 100 |
| -- | -- | 60 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | 3 | -- | -- | -- | 0 | -- | -- | 0 | -- | -- | -- |
| -- | -- | -- | 0 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| -- | -- | -- | 1 | 50 | -- | -- | -- | -- | -- | -- | -- | 10 |
| -- | -- | -- | 2 | 80 | -- | -- | -- | -- | -- | -- | -- | 350 |
| -- | -- | -- | 3 | 30 | -- | -- | -- | -- | -- | -- | -- | 0 |
| -- | -- | -- | 9 | 0 | -- | -- | -- | -- | -- | -- | -- | 20 |
| -- | -- | -- | 4 | 0 | -- | -- | -- | -- | -- | -- | -- | 10 |
| -- | -- | -- | 3 | 10 | -- | -- | -- | -- | -- | -- | -- | 10 |
| -- | -- | -- | 0 | 10 | -- | -- | -- | -- | -- | -- | -- | 0 |
| -- | -- | -- | 4 | 10 | -- | -- | -- | -- | -- | -- | -- | 10 |
| -- | -- | -- | 13 | 0 | -- | -- | -- | -- | -- | -- | -- | 10 |
| -- | -- | -- | 11 | 20 | -- | -- | -- | -- | -- | -- | -- | 0 |
| -- | -- | -- | 6 | 0 | -- | -- | -- | -- | -- | -- | -- | 0 |
| -- | -- | -- | 3 | 20 | -- | -- | -- | -- | -- | -- | -- | 10 |
| -- | -- | -- | 12 | 20 | -- | -- | -- | -- | -- | -- | -- | 560 |
| -- | -- | 40 | 1 | -- | -- | -- | -- | -- | 8 | -- | -- | -- |
| -- | -- | -- | 0 | 130 | -- | -- | -- | -- | -- | -- | -- | 10 |
| -- | -- | -- | 2 | 0 | -- | -- | -- | -- | -- | -- | -- | 0 |
| -- | -- | -- | 1 | 30 | -- | -- | -- | -- | -- | -- | -- | 0 |
| -- | -- | -- | 2 | 1300 | -- | -- | -- | -- | -- | -- | -- | 20 |
| -- | -- | -- | 1 | 130 | -- | -- | -- | -- | -- | -- | -- | 10 |

PUBLICATIONS OF THE UTAH DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF WATER RIGHTS

(*)-Out of Print

TECHNICAL PUBLICATIONS

*No. 1. Underground leakage from artesian wells in the Flowell area, near Fillmore, Utah, by Penn Livingston and G. B. Maxey, U.S. Geological Survey, 1944.

No. 2. The Ogden Valley artesian reservoir, Weber County, Utah, by H. E. Thomas, U.S. Geological Survey, 1945.

*No. 3. Ground water in Pavant Valley, Millard County, Utah, by P. E. Dennis, G. B. Maxey and H. E. Thomas, U.S. Geological Survey, 1946.

*No. 4. Ground water in Tooele Valley, Tooele County, Utah, by H. E. Thomas, U.S. Geological Survey, in Utah State Engineer 25th Biennial Report, p. 91-238, pls. 1-6, 1946.

*No. 5. Ground water in the East Shore area, Utah: Part I, Bountiful District, Davis County, Utah, by H. E. Thomas and W. B. Nelson, U.S. Geological Survey, in Utah State Engineer 26th Biennial Report, p. 53-206, pls. 1-2, 1948.

*No. 6. Ground water in the Escalante Valley, Beaver, Iron, and Washington Counties, Utah, by P. F. Fix, W. B. Nelson, B. E. Lofgren, and R. G. Butler, U.S. Geological Survey, in Utah State Engineer 27th Biennial Report, p. 107-210, pls. 1-10, 1950.

No. 7. Status of development of selected ground-water basins in Utah, by H. E. Thomas, W. B. Nelson, B. E. Lofgren, and R. G. Butler, U.S. Geological Survey, 1952.

*No. 8. Consumptive use of water and irrigation requirements of crops in Utah, by C. O. Roskelly and W. D. Criddle, Utah State Engineer's Office, 1952.

No. 8. (Revised) Consumptive use and water requirements for Utah, by W. D. Criddle, Karl Harris, and L. S. Willardson, Utah State Engineer's Office, 1962.

No. 9. Progress report on selected ground water basins in Utah, by H. A. Waite, W. B. Nelson, and others, U.S. Geological Survey, 1954.

*No. 10. A compilation of chemical quality data for ground and surface waters in Utah, by J. G. Connor, C. G. Mitchell, and others, U.S. Geological Survey, 1958.

*No. 11. Ground water in northern Utah Valley, Utah: A progress report for the period 1948-63, by R. M. Cordova and Seymour Subitzky, U.S. Geological Survey, 1965.

*No. 12. Reevaluation of the ground-water resources of Tooele Valley, Utah, by J. S. Gates, U.S. Geological Survey, 1965.

*No. 13. Ground-water resources of selected basins in southwestern Utah, by G. W. Sandberg, U.S. Geological Survey, 1966.

*No. 14. Water-resources appraisal of the Snake Valley area, Utah and Nevada, by J. W. Hood and F. E. Rush, U.S. Geological Survey, 1966.

*No. 15. Water from bedrock in the Colorado Plateau of Utah, by R. D. Feltis, U.S. Geological Survey, 1966.

*No. 16. Ground-water conditions in Cedar Valley, Utah County, Utah, by R. D. Feltis, U.S. Geological Survey, 1967.

*No. 17. Ground-water resources of northern Juab Valley, Utah, by L. J. Bjorklund, U.S. Geological Survey, 1968.

No. 18. Hydrologic reconnaissance of Skull Valley, Tooele County, Utah, by J. W. Hood and K. M. Waddell, U.S. Geological Survey, 1968.

No. 19. An appraisal of the quality of surface water in the Sevier Lake basin, Utah, by D. C. Hahl and J. C. Mundorff, U.S. Geological Survey, 1968.

No. 20. Extensions of streamflow records in Utah, by J. K. Reid, L. E. Carroon, and G. E. Pyper, U.S. Geological Survey, 1969.

No. 21. Summary of maximum discharges in Utah streams, by G. L. Whitaker, U.S. Geological Survey, 1969.

No. 22. Reconnaissance of the ground-water resources of the upper Fremont River valley, Wayne County, Utah, by L. J. Bjorklund, U.S. Geological Survey, 1969.

No. 23. Hydrologic reconnaissance of Rush Valley, Tooele County, Utah, by J. W. Hood, Don Price, and K. M. Waddell, U.S. Geological Survey, 1969.

No. 24. Hydrologic reconnaissance of Deep Creek valley, Tooele and Juab Counties, Utah, and Elko and White Pine Counties, Nevada, by J. W. Hood and K. M. Waddell, U.S. Geological Survey, 1969.

No. 25. Hydrologic reconnaissance of Curlew Valley, Utah and Idaho, by E. L. Bolke and Don Price, U.S. Geological Survey, 1969.

No. 26. Hydrologic reconnaissance of the Sink Valley area, Tooele and Box Elder Counties, Utah, by Don Price and E. L. Bolke, U.S. Geological Survey, 1969.

No. 27. Water resources of the Heber-Kamas-Park City area, north-central Utah, by C. H. Baker, Jr., U.S. Geological Survey, 1970.

No. 28. Ground-water conditions in southern Utah Valley and Goshen Valley, Utah, by R. M. Cordova, U.S. Geological Survey, 1970.

No. 29. Hydrologic reconnaissance of Grouse Creek valley, Box Elder County, Utah, by J. W. Hood and Don Price, U.S. Geological Survey, 1970.

No. 30. Hydrologic reconnaissance of the Park Valley area, Box Elder County, Utah, by J. W. Hood, U.S. Geological Survey, 1971.

No. 31. Water resources of Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Harr, U.S. Geological Survey, 1971.

No. 32. Geology and water resources of the Spanish Valley area, Grand and San Juan Counties, Utah, by C. T. Sumsion, U.S. Geological Survey, 1971.

No. 33. Hydrologic reconnaissance of Hansel Valley and northern Rozel Flat, Box Elder County, Utah, by J. W. Hood, U.S. Geological Survey, 1971.

No. 34. Summary of water resources of Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Harr, U.S. Geological Survey, 1971.

No. 35. Ground-water conditions in the East Shore area, Box Elder, Davis, and Weber Counties, Utah, 1960-69, by E. L. Bolke and K. M. Waddell, U.S. Geological Survey, 1972.

No. 36. Ground-water resources of Cache Valley, Utah and Idaho, by L. J. Bjorklund and L. J. McGreevy, U.S. Geological Survey, 1971.

No. 37. Hydrologic reconnaissance of the Blue Creek Valley area, Box Elder County, Utah, by E. L. Bolke and Don Price, U.S. Geological Survey, 1972.

No. 38. Hydrologic reconnaissance of the Promontory Mountains area, Box Elder County, Utah, by J. W. Hood, U.S. Geological Survey, 1972.

No. 39. Reconnaissance of chemical quality of surface water and fluvial sediment in the Price River Basin, Utah, by J. C. Mundorff, U.S. Geological Survey, 1972.

No. 40. Ground-water conditions in the central Virgin River basin, Utah, by R. M. Cordova, G. W. Sandberg, and Wilson McConkie, U.S. Geological Survey, 1972.

No. 41. Hydrologic reconnaissance of Pilot Valley, Utah and Nevada, by J. C. Stephens and J. W. Hood, U.S. Geological Survey, 1973.

No. 42. Hydrologic reconnaissance of the northern Great Salt Lake Desert and summary hydrologic reconnaissance of northwestern Utah, by J. C. Stephens, U.S. Geological Survey, 1973.

No. 43. Water resources of the Milford area, Utah, with emphasis on ground water, by R. W. Mower and R. M. Cordova, U.S. Geological Survey, 1974.

No. 44. Ground-water resources of the lower Bear River drainage basin, Box Elder County, Utah, by L. J. Bjorklund and L. J. McGreevy, U.S. Geological Survey, 1974.

No. 45. Water resources of the Curlew Valley drainage basin, Utah and Idaho, by C. H. Baker, Jr., U.S. Geological Survey, 1974.

No. 46. Water-quality reconnaissance of surface inflow to Utah Lake, by J. C. Mundorff, U.S. Geological Survey, 1974.

No. 47. Hydrologic reconnaissance of the Wah Wah Valley drainage basin, Millard and Beaver Counties, Utah, by J. C. Stephens, U.S. Geological Survey, 1974.

No. 48. Estimating mean streamflow in the Duchesne River basin, Utah, by R. W. Cruff, U.S. Geological Survey, 1974.

No. 49. Hydrologic reconnaissance of the southern Uinta Basin, Utah and Colorado, by Don Price and L. L. Miller, U.S. Geological Survey, 1975.

No. 50. Seepage study of the Rocky Point Canal and the Grey Mountain-Pleasant Valley Canal systems, Duchesne County, Utah, by R. W. Cruff and J. W. Hood, U.S. Geological Survey, 1976.

No. 51. Hydrologic reconnaissance of the Pine Valley drainage basin, Millard, Beaver, and Iron Counties, Utah, by J. C. Stephens, U.S. Geological Survey, 1976.

No. 52. Seepage study of canals in Beaver Valley, Beaver County, Utah, by R. W. Cruff and R. W. Mower, U.S. Geological Survey, 1976.

No. 53. Characteristics of aquifers in the northern Uinta Basin area, Utah and Colorado, by J. W. Hood, U.S. Geological Survey, 1976.

No. 54. Hydrologic evaluation of Ashley Valley, northern Uinta Basin area, Utah, by J. W. Hood, U.S. Geological Survey, 1977.

No. 55. Reconnaissance of water quality in the Duchesne River basin and some adjacent drainage areas, Utah, by J. C. Mundorff, U.S. Geological Survey, 1977.

No. 56. Hydrologic reconnaissance of the Tule Valley drainage basin, Juab and Millard Counties, Utah, by J. C. Stephens, U.S. Geological Survey, 1977.

No. 57. Hydrologic evaluation of the upper Duchesne River valley, northern Uinta Basin area, Utah, by J. W. Hood, U.S. Geological Survey, 1977.

No. 58. Seepage study of the Sevier Valley-Piute Canal, Sevier County, Utah, by R. W. Cruff, U.S. Geological Survey, 1977.

No. 59. Hydrologic reconnaissance of the Dugway Valley-Government Creek area, west-central Utah, by J. C. Stephens and C. T. Sumsion, U.S. Geological Survey, 1978.

No. 60. Ground-water resources of the Parowan-Cedar City drainage basin, Iron County, Utah, by L. J. Bjorklund, C. T. Sumsion, and G. W. Sandberg, U.S. Geological Survey, 1978.

No. 61. Ground-water conditions in the Navajo Sandstone in the central Virgin River basin, Utah, by R. M. Cordova, U.S. Geological Survey, 1978.

No. 62. Water resources of the northern Uinta Basin area, Utah and Colorado, with special emphasis on ground-water supply, by J. W. Hood and F. K. Fields, U.S. Geological Survey, 1978.

No. 63. Hydrology of the Beaver Valley area, Beaver County, Utah with emphasis on ground water, by R. W. Mower, U.S. Geological Survey, 1978.

No. 64. Hydrologic reconnaissance of the Fish Springs Flat area, Tooele, Juab, and Millard Counties, Utah, by E. L. Bolke and C. T. Sumsion, U.S. Geological Survey, 1978.

No. 65. Reconnaissance of chemical quality of surface water and fluvial sediment in the Dirty Devil River basin, Utah, by J. C. Mundorff, U.S. Geological Survey, 1978.

No. 66. Aquifer tests of the Navajo Sandstone near Caineville, Wayne County, Utah, by J. W. Hood and T. W. Danielson, U.S. Geological Survey, 1979.

No. 67. Seepage study of the West Side and West Canals, Box Elder County, by R. W. Cruff, U.S. Geological Survey, 1980.

## WATER CIRCULARS

No. 1. Ground water in the Jordan Valley, Salt Lake County, Utah, by Ted Arnow, U.S. Geological Survey, 1965.

No. 2. Ground water in Tooele Valley, Utah, by J. S. Gates and O. A. Keller, U.S. Geological Survey, 1970.

## BASIC-DATA REPORTS

*No. 1. Records and water-level measurements of selected wells and chemical analyses of ground water, East Shore area, Davis, Weber, and Box Elder Counties, Utah, by R. E. Smith, U.S. Geological Survey, 1961.

No. 2. Records of selected wells and springs, selected drillers' logs of wells, and chemical analyses of ground and surface waters, northern Utah Valley, Utah County, Utah, by Seymour Subitzky, U.S. Geological Survey, 1962.

No. 3. Ground-water data, central Sevier Valley, parts of Sanpete, Sevier, and Piute Counties, Utah, by C. H. Carpenter and R. A. Young, U.S. Geological Survey, 1963.

*No. 4. Selected hydrologic data, Jordan Valley, Salt Lake County, Utah, by I. W. Marine and Don Price, U.S. Geological Survey, 1963.

*No. 5. Selected hydrologic data, Pavant Valley, Millard County, Utah, by R. W. Mower, U.S. Geological Survey, 1963.

*No. 6. Ground-water data, parts of Washington, Iron, Beaver, and Millard Counties, Utah, by G. W. Sandberg, U.S. Geological Survey, 1963.

No. 7. Selected hydrologic data, Tooele Valley, Tooele County, Utah, by J. S. Gates, U.S. Geological Survey, 1963.

No. 8. Selected hydrologic data, upper Sevier River basin, Utah, by C. H. Carpenter, G. B. Robinson, Jr., and L. J. Bjorklund, U.S. Geological Survey, 1964.

*No. 9. Ground-water data, Sevier Desert, Utah, by R. W. Mower and R. D. Feltis, U.S. Geological Survey, 1964.

No. 10. Quality of surface water in the Sevier Lake basin, Utah, by D. C. Hahl and R. E. Cabell, U.S. Geological Survey, 1965.

*No. 11. Hydrologic and climatologic data, collected through 1964, Salt Lake County, Utah, by W. V. Iorns, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1966.

No. 12. Hydrologic and climatologic data, 1965, Salt Lake County, Utah, by W. V. Iorns, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1966.

No. 13. Hydrologic and climatologic data, 1966, Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1967.

No. 14. Selected hydrologic data, San Pitch River drainage basin, Utah, by G. B. Robinson, Jr., U.S. Geological Survey, 1968.

No. 15. Hydrologic and climatologic data, 1967, Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1968.

No. 16. Selected hydrologic data, southern Utah and Goshen Valleys, Utah, by R. M. Cordova, U.S. Geological Survey, 1969.

No. 17. Hydrologic and climatologic data, 1968, Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1969.

No. 18. Quality of surface water in the Bear River basin, Utah, Wyoming, and Idaho, by K. M. Waddell, U.S. Geological Survey, 1970.

No. 19. Daily water-temperature records for Utah streams, 1944-68, by G. L. Whitaker, U.S. Geological Survey, 1970.

No. 20. Water-quality data for the Flaming Gorge area, Utah and Wyoming, by R. J. Madison, U.S. Geological Survey, 1970.

No. 21. Selected hydrologic data, Cache Valley, Utah and Idaho, by L. J. McGreevy and L. J. Bjorklund, U.S. Geological Survey, 1970.

No. 22. Periodic water- and air-temperature records for Utah streams, 1966-70, by G. L. Whitaker, U.S. Geological Survey, 1971.

No. 23. Selected hydrologic data, lower Bear River drainage basin, Box Elder County, Utah, by L. J. Bjorklund and L. J. McGreevy, U.S. Geological Survey, 1973.

No. 24. Water-quality data for the Flaming Gorge Reservoir area, Utah and Wyoming, 1969-72, by E. L. Bolke and K. M. Waddell, U.S. Geological Survey, 1972.

No. 25. Streamflow characteristics in northeastern Utah and adjacent areas, by F. K. Fields, U.S. Geological Survey, 1975.

No. 26. Selected hydrologic data, Uinta Basin area, Utah and Colorado, by J. W. Hood, J. C. Mundorff, and Don Price, U.S. Geological Survey, 1976.

No. 27. Chemical and physical data for the Flaming Gorge Reservoir area, Utah and Wyoming, by E. L. Bolke, U.S. Geological Survey, 1976.

No. 28. Selected hydrologic data, Parowan Valley and Cedar City Valley drainage basins, Iron County, Utah, by L. J. Bjorklund, C. T. Sumsion, and G. W. Sandberg, U.S. Geological Survey, 1977.

No. 29. Climatologic and hydrologic data, southeastern Uinta Basin, Utah and Colorado, water years 1975 and 1976, by L. S. Conroy and F. K. Fields, U.S. Geological Survey, 1977.

No. 30. Selected ground-water data, Bonneville Salt Flats and Pilot Valley, western Utah, by. G. C. Lines, U.S. Geological Survey, 1977.

No. 31. Selected hydrologic data, Wasatch Plateau-Book Cliffs coal-fields area, Utah, by K. M. Waddell and others, U.S. Geological Survey, 1978.

No. 32. Selected coal-related ground-water data, Wasatch Plateau-Book Cliffs area, Utah, by C. T. Sumsion, U.S. Geological Survey, 1979.

No. 33. Hydrologic and climatologic data, southeastern Uinta Basin, Utah and Colorado, water year 1977, by L. S. Conroy, U.S. Geological Survey, 1979.

## INFORMATION BULLETINS

*No. 1. Plan of work for the Sevier River Basin (Sec. 6, P. L. 566), U.S. Department of Agriculture, 1960.

*No. 2. Water production from oil wells in Utah, by Jerry Tuttle, Utah State Engineer's Office, 1960.

*No. 3. Ground-water areas and well logs, central Sevier Valley, Utah, by R. A. Young, U.S. Geological Survey, 1960.

*No. 4. Ground-water investigations in Utah in 1960 and reports published by the U.S. Geological Survey or the Utah State Engineer prior to 1960, by H. D. Goode, U.S. Geological Survey, 1960.

*No. 5. Developing ground water in the central Sevier Valley, Utah, by R. A. Young and C. H. Carpenter, U.S. Geological Survey, 1961.

*No. 6. Work outline and report outline for Sevier River basin survey, (Sec. 6, P. L. 566), U.S. Department of Agriculture, 1961.

*No. 7. Relation of the deep and shallow artesian aquifers near Lynndyl, Utah, by R. W. Mower, U.S. Geological Survey, 1961.

*No. 8. Projected 1975 municipal water-use requirements, Davis County, Utah, by Utah State Engineer's Office, 1962.

No. 9. Projected 1975 municipal water-use requirements, Weber County, Utah, by Utah State Engineer's Office, 1962.

*No. 10. Effects on the shallow artesian aquifer of withdrawing water from the deep artesian aquifer near Sugarville, Millard County, Utah, by R. W. Mower, U.S. Geological Survey, 1963.

*No. 11. Amendments to plan of work and work outline for the Sevier River basin (Sec. 6, P. L. 566), U.S. Department of Agriculture, 1964.

*No. 12. Test drilling in the upper Sevier River drainage basin, Garfield and Piute Counties, Utah, by R. D. Feltis and G. B. Robinson, Jr., U.S. Geological Survey, 1963.

*No. 13. Water requirements of lower Jordan River, Utah, by Karl Harris, Irrigation Engineer, Agricultural Research Service, Phoenix, Arizona, prepared under informal cooperation approved by Mr. W. W. Donnan, Chief, Southwest Branch (Riverside, California) Soil and Water Conservation Research Division, Agricultural Research Service, U.S.D.A., and by W. D. Criddle, State Engineer, State of Utah, Salt Lake City, Utah, 1964.

*No. 14. Consumptive use of water by native vegetation and irrigated crops in the Virgin River area of Utah, by W. D. Criddle, J. M. Bagley, R. K. Higginson, and D. W. Hendricks, through cooperation of Utah Agricultural Experiment Station, Agricultural Research Service, Soil and Water Conservation Branch, Western Soil and Water Management Section, Utah Water and Power Board, and Utah State Engineer, Salt Lake City, Utah, 1964.

*No. 15. Ground-water conditions and related water-administration problems in Cedar City Valley, Iron County, Utah, February, 1966, by J. A. Barnett and F. T. Mayo, Utah State Engineer's Office.

*No. 16. Summary of water well drilling activities in Utah, 1960 through 1965, compiled by Utah State Engineer's Office, 1966.

*No. 17. Bibliography of U.S. Geological Survey water-resources reports for Utah, compiled by O. A. Keller, U.S. Geological Survey, 1966.

*No. 18. The effect of pumping large-discharge wells on the ground-water reservoir in southern Utah Valley, Utah County, Utah, by R. M. Cordova and R. W. Mower, U.S. Geological Survey, 1967.

No. 19. Ground-water hydrology of southern Cache Valley, Utah, by L. P. Beer, Utah State Engineer's Office, 1967.

*No. 20. Fluvial sediment in Utah, 1905-65, A data compilation by J. C. Mundorff, U.S. Geological Survey, 1968.

*No. 21. Hydrogeology of the eastern portion of the south slopes of the Uinta Mountains, Utah, by L. G. Moore and D. A. Barker, U.S. Bureau of Reclamation, and J. D. Maxwell and B. L. Bridges, Soil Conservation Service, 1971.

*No. 22. Bibliography of U.S. Geological Survey water-resources reports for Utah, compiled by B. A. LaPray, U.S. Geological Survey, 1972.

*No. 23. Bibliography of U.S. Geological Survey water-resources reports for Utah, compiled by B. A. LaPray, U.S. Geological Survey, 1975.

No. 24. A water-land use management model for the Sevier River Basin, Phase I and II, by V. A. Narasimham and Eugene K. Israelsen, Utah Water Research Laboratory, College of Engineering, Utah State University, 1975.

No. 25. A water-land use management model for the Sevier River Basin, Phase III, by Eugene K. Israelsen, Utah Water Research Laboratory, College of Engineering, Utah State University, 1976.

No. 26. Test drilling for fresh water in Tooele Valley, Utah, by K. H. Ryan, B. W. Nance, and A. C. Razem, Utah Department of Natural Resources, 1981.

No. 27. Bibliography of U.S. Geological Survey Water-Resources Reports for Utah, compiled by Barbara A. LaPray and Linda S. Hamblin, U.S. Geological Survey, 1980.