RESULTS OF TEST DRILLING FOR GROUND WATER IN THE SOUTHEASTERN UINTA BASIN, UTAH AND COLORADO

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[Plates are in pocket]

TABLES

CONVERSION FACTORS

Values in this report are given in inch-pound units. Multiply inch-pound units by the conversion factors given below to obtain their metric equivalents.

Inch-pound Unit	Inch-pound Abbreviation	Conversion factors	Metric Unit	Metric Abbreviation
Acre		0.4047	Square hectometer	hm^2
		0.004047	Square kilometer	km^2
Cubic foot per day per foot	$(ft^3/d)/ft$	0.0920	Cubic meter per day per meter	$(m^3/d)/m$
Foot	ft	0.3048	Meter	m
Foot squared per day	ft^2/d	0.0929	Meter squared per day	m^2/d
Gallon	gal	3.785	Liter	L
		0.003785	Cubic meter	m^3
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 mile	mi^2	2.590	Square kilometer	km^2
Pound-force per square inch	lbf/in^2	6.895	Kilopascal	kPa

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); 1 mg/L is equivalent to 1,000 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. For concentrations less than 7,000 mg/L, the numerical value is about the same as values in parts per million.

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

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ABSTRACT

During 1974, the U.S. Geological Survey began a comprehensive hydrologic study of the oil-shale area in the southeastern Uinta Basin of Utah and Colorado. From 1976 to 1978, six deep test holes were drilled principally to obtain information about aquifers in the Green River Formation of Tertiary age. Information obtained from the drilling project includes description of lithologic samples from core and drill cuttings, temperature and geophysical logs, drilling logs, packer tests, aquifer (pumping and recovery) tests, and analyses of water samples.

Logs and analyses of water samples indicate the occurrence of two major aquifers. The "bird's-nest" aquifer was penetrated in two of the test holes and is apparently a major aquifer in the central part of the study area. This aquifer occurs about 400 feet above the Mahogany zone, an oil-shale bed in the Parachute Creek Member of the Green River Formation. A water sample collected during drilling indicated a dissolved-solids concentration of 9,870 milligrams per liter.

The Douglas Creek Member of the Green River Formation is a major freshwater aquifer in most of the study area, and it was penetrated in all six test holes. Water samples collected from this aquifer generally had dissolved-solids concentrations of less than 1,000 milligrams per liter. Values of transmissivity calculated for the Douglas Creek aquifer from hydrologic tests ranged from 16 to 170 feet squared per day. Estimates of storage coefficients ranged from about 2.5×10^{-4} to 7×10^{-4}.

INTRODUCTION

Proposed oil-shale mining in the Uinta Basin of northeastern Utah (fig. 1) will require large quantities of water for industrial and related needs. The mining and possible development of water supplies in the area could have a major impact on the hydrologic system. During 1974, therefore, the U.S. Geological Survey began a hydrologic study of the southeastern Uinta Basin. The study included a test-drilling program which would provide data necessary for an understanding of the ground-water resources of the area.

The purpose of this report is to present a compilation and interpretation of the data collected during the test-drilling program. Six deep test holes were drilled during 1976-78 to obtain information about aquifers in the Green River Formation of Tertiary age. Data collected and presented in this report include: description of lithologic samples; geophysical logs; packer-testing

Figure 1

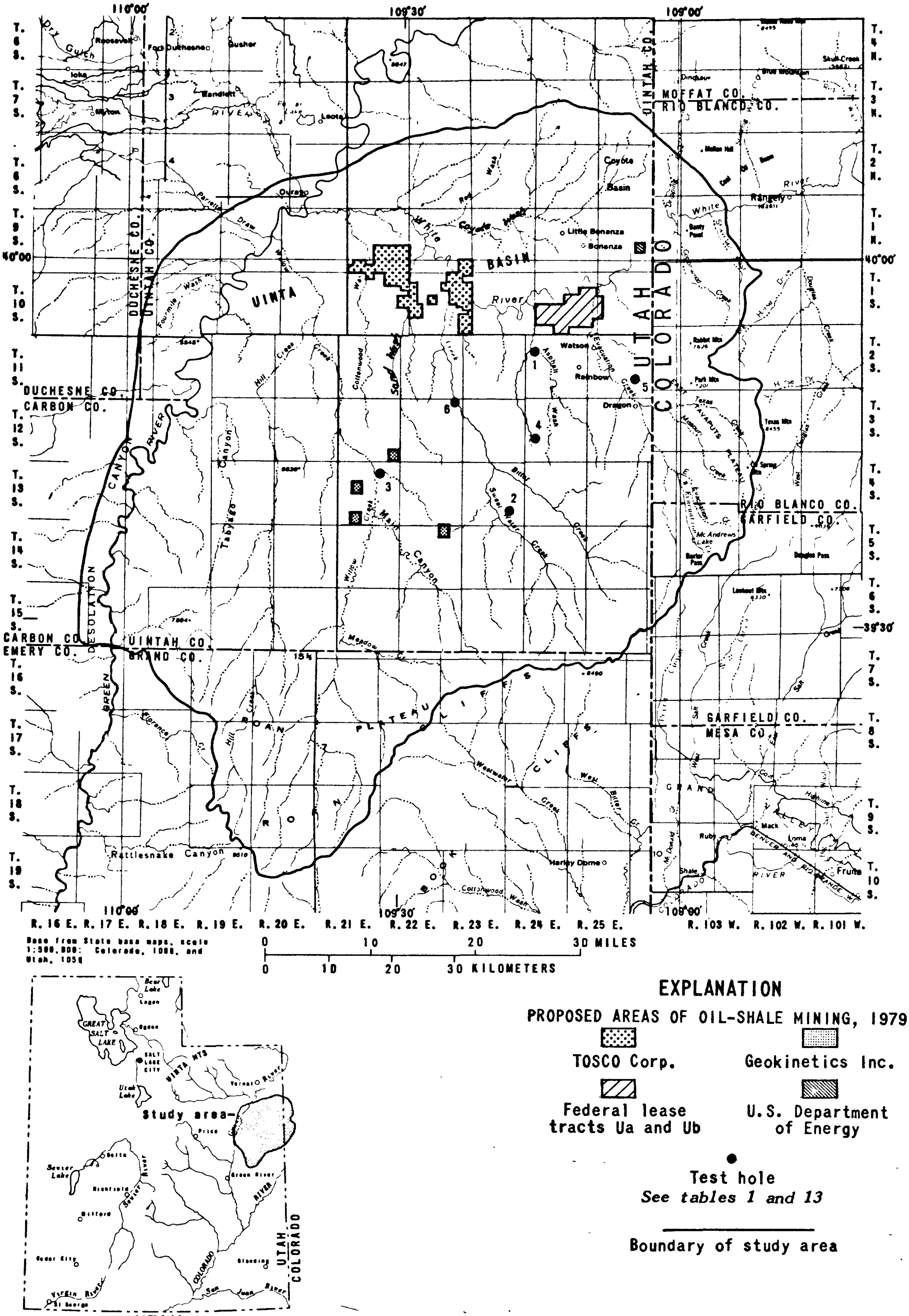

Figure 1.--Location of study area, proposed areas of oil-shale mining (1979), and test holes.

results; measurements of discharge, specific conductance, and water temperature during drilling; chemical analysis of water samples; and results of hydrologic testing. These data are used to identify aquifers and to evaluate their hydraulic and water-quality characteristics.

WELL- AND SPRING-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 acres;[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 tract; the letter "S" preceding the serial number denotes a spring. If a well or spring cannot be located within a 10-acre tract, one or two location letters are used and the serial number is omitted. Thus well (D-11-24)7acd-1 designates the first well constructed or visited in the SE¼SW¼NE¼ sec. 7, T. 11 S., R. 24 E., and (D-11-24)7a-S1 designates a spring known only to be in the northeast quarter of the same section. Other sites where hydrologic data were collected are numbered in the same manner, but three letters are used after the section number and no serial number is used. The numbering system is illustrated in figure 2.

GEOLOGIC AND HYDROLOGIC SETTING

The southeastern Uinta Basin is part of a large synclinal trough formed by the deformation of Tertiary and older rocks. The main axis of the Uinta Basin syncline trends eastward and lies just north of the northern boundary of the study area.

The geologic formations exposed in the southeastern Uinta Basin include the Mesaverde Formation of Upper Cretaceous age, the Wasatch, Green River, Uinta, and Duchesne River Formations of Tertiary age, and alluvial deposits of Quaternary age. The Green River Formation, which is of predominant hydrologic importance, has been divided into three members--the Douglas Creek, Garden

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[1]Although the basic land unit, the section, is theoretically 1 mi^2, many sections are irregular. Such sections are subdivided into 10-acre 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

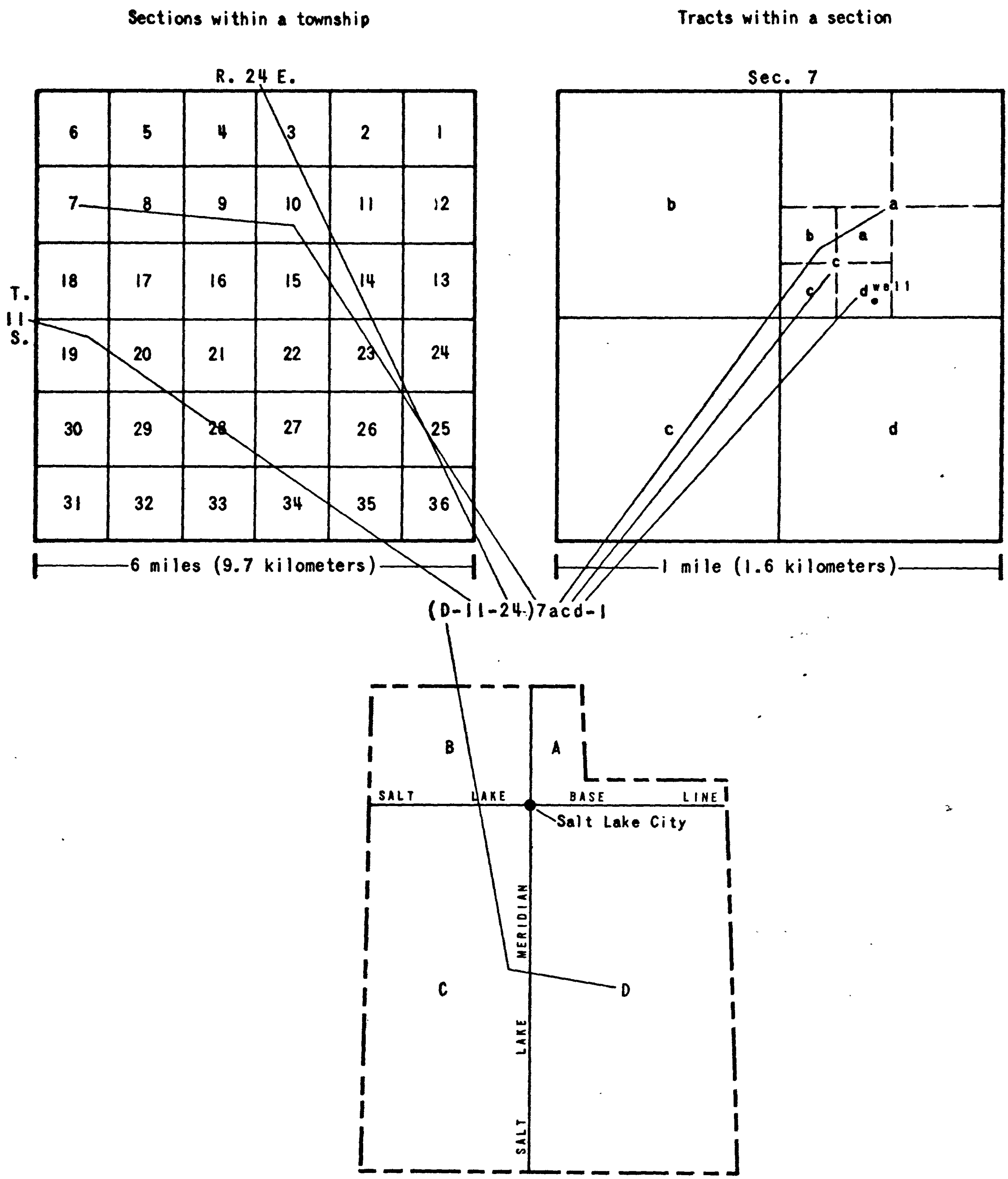

Figure 2.--Well- and spring-numbering system used in Utah.

Gulch, and Parachute Creek Members. The Garden Gulch Member is restricted to a small outcrop along the eastern edge of the study area and will not be discussed further in this report. Cashion (1967, p. 10) describes six tongues of the Douglas Creek Member. Due to the complex intertonguing of this member with the Wasatch Formation, and the great difficulty of differentiating these tongues in drill holes, the Douglas Creek Member is treated as one unit in this report.

A diagrammatic sketch across the southeastern Uinta Basin showing relations between the Green River Formation and the upper part of the Wasatch Formation is shown in figure 3. The general lithologic character and water-bearing properties of these formations are given in Price and Miller (1975) and Hood (1976).

The White River flows west from Colorado across the northern part of the study area to its confluence with the Green River near Ouray, Utah. The major drainageways in the study area are Evacuation Creek, Asphalt Wash, Sand Wash, Coyote Wash, and Bitter Creek--tributaries of the White River--and Hill and Willow Creeks--tributaries of the Green River.

Figure 3

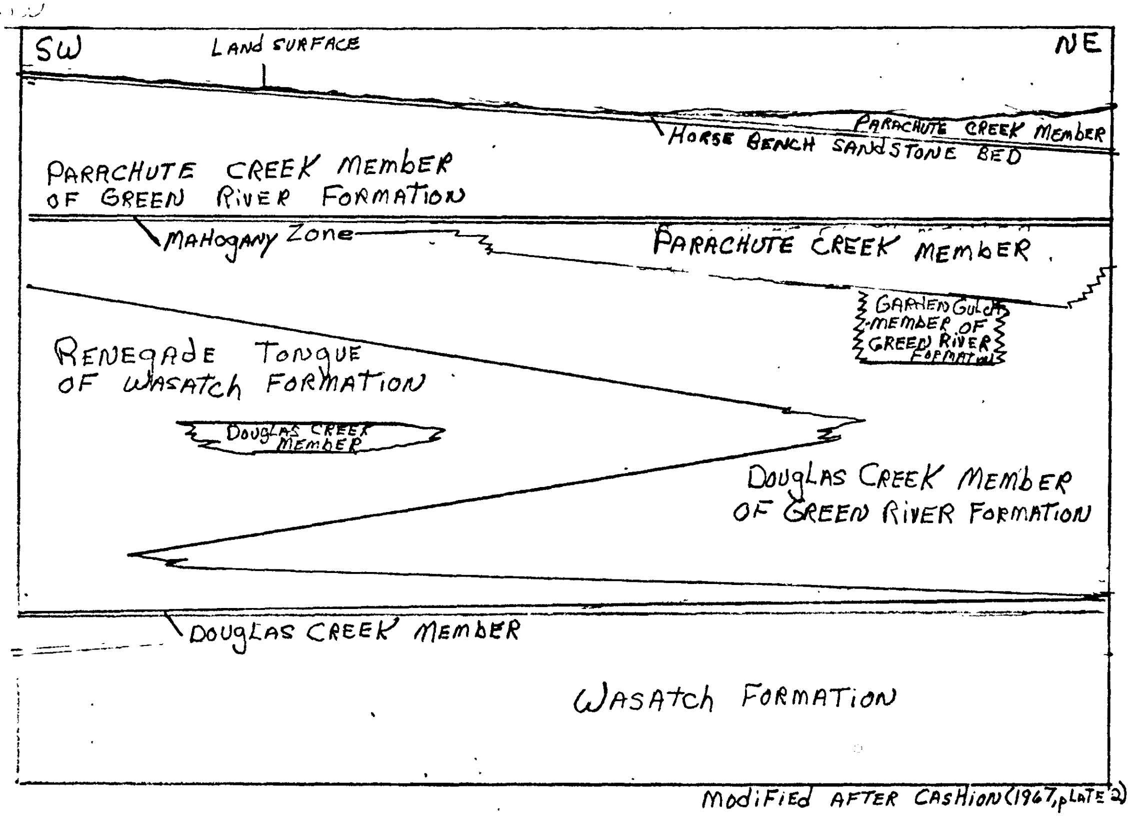

Figure 3.--Diagrammatic sketch across the southeastern Uinta Basin showing relations between the Green River Formation and the upper part of the Wasatch Formation.

The principal area of ground-water recharge is in the topographically high southern part of the study area, and movement is generally downdip toward the northwest. Water discharges from springs at high altitudes where streams have dissected the principal water-bearing zones in the Green River Formation and the Renegade Tongue in the upper part of the Wasatch Formation. Other discharge areas are along canyon bottoms where water-bearing zones are exposed at the surface. Production of water from wells is limited to the central part of the study area where artesian heads are above land surface. Discharge from these wells is normally less than 50 gal/min, and the water is used primarily for livestock.

METHODS OF INVESTIGATION

Six deep test holes were drilled by the rotary method with air, except where loss of circulation or caving in the hole required use of water-based commercial mud. A drilling log was maintained by Geological Survey personnel to record changes in drilling conditions, and measurements of discharge, specific conductance, and water temperature. Some description of rock cuttings also were recorded in the drilling log.

Samples of drill cuttings were collected approximately at 10-foot intervals in the six holes, and more than 1,000 feet of core were collected from test hole 1. Lithologic and drilling logs for test holes 1 and 2 are given in tables 3, 4, 7, and 8. Drill cuttings from test holes 3-6 were not analyzed, but entries in the drilling logs in tables 9-12 for some samples give an indication of the lithology.

Test hole 1 was drilled to the base of the Green River Formation at a depth of 2,650 feet. Information learned during drilling of the first test hole served as a guide for later drilling, and test holes 2-6 were drilled to depths ranging from 789 to 1,496 feet.

Water-temperature and geophysical logs were run in each test hole. Commercial logging services were used in test holes 1 and 2, and Geological Survey logging services were used in test holes 3-6. A variety of logs were run, including caliper, radiation, electric, and water-temperature. A spinner log also was run in test hole 1, but the data were inconclusive and are not presented in this report.

In addition to on-site measurements of discharge, specific conductance, and water temperature during drilling, water samples were collected for chemical analysis. The samples were collected by air jetting during drilling, by pumping after completion of a test hole, or from water flowing from a test hole.

In test hole 1, results of geophysical logs, drilling reports, and on-site measurements were used to determine intervals to be tested with hydraulically inflatable straddle packers. Values of transmissivity, storage coefficient, discharge, and hydraulic head were obtained for the isolated open interval between the packers. Packer tests were not conducted in test holes 2-6.

After drilling and testing, the test holes were cased using a variety of casing sizes. Attempts were made to seal off any zones containing saline water, leaving only the freshwater zones open for testing. In this report the following is used to classify water according to dissolved-solids concentrations:

Classification	Dissolved-solids concentrations (mg/L)
Fresh	0-1,000
Slightly saline	1,000-3,000
Moderately saline	3,000-10,000
Very saline	10,000-35,000
Briny	More than 35,000

After the test holes were cased and in some instances perforated, aquifer (pumping) tests were conducted at test holes 1, 2, and 5, and aquifer (recovery) tests were made at test holes 1 and 6. An attempted 30-day aquifer test at test hole 1, using nearby abandoned and producing gas wells as observation wells, gave unsatisfactory results. The main problems were the flow of gas from the producing wells and the lengthy intervals of uncemented casing open to production zones in both the producing and abandoned wells.

TEST HOLE 1

Test hole 1, (D-11-24)7acd-1, was drilled during the summer of 1976 in Asphalt Wash (fig. 1). The site was selected for three reasons: (1) The Green River Formation was known to yield water to abandoned and producing gas wells in the area, and the gas wells could be used as observation wells if an aquifer test were made at the test hole; (2) the site was close to Federal oil-shale tracts Ua and Ub, where early mining of oil shale might be anticipated; and (3) the site would provide an observation point that was necessary to define the potentiometric surface of the freshwater zones in the Douglas Creek Member of the Green River Formation.

Drilling and sampling

Test hole 1 was drilled to a depth of 2,650 feet, and it penetrated the entire thickness of the Green River Formation. Unconsolidated valley fill was penetrated to a depth of 40 feet. Consolidated geologic units penetrated and the approximate depths to their tops are as follows: Parachute Creek Member of the Green River Formation at 40 feet, Mahogany zone at 580 feet, Douglas Creek Member of the Green River Formation at 700 feet, Renegade Tongue of the Wasatch Formation at 2,600 feet, Douglas Creek Member at 2,610 feet, and the main body of the Wasatch Formation at 2,650 feet.

Core samples were collected between 307 and 1,364 feet and between 2,007 and 2,087 feet. The lithologic log in table 3 shows oil-shale beds dominant from 307 to about 700 feet. From 700 to about 950 feet the rocks consist primarily of sandstone, marlstone, oil shale, and thin beds of tuff. The marlstone beds contain many large vertical fractures. From about 950 to 1,364 feet the rocks consist primarily of limestone and sandstone beds. The drilling log in table 4 indicates sandstone at 1,432 and 1,525 feet. The core samples collected from 2,007 to 2,080 feet (table 3) consist primarily of mudstone and marlstone, and it is likely that fine-grained deposits continue to a depth of 2,650 feet.

Measurements of discharge, specific conductance, and water temperature obtained during the drilling of test hole 1 are shown in the drilling log and also are plotted against depth in figures 4 and 5. Although measurements were not obtained during the first 600 feet of drilling, the geophysical logs (pl. 1) show that an aquifer was penetrated at about 200 feet. This aquifer corresponds to the "bird's-nest zone" described by Cashion (1967, p. 17), and for the purposes of this report, is called the "bird's-nest" aquifer. This aquifer is characterized by large vugs caused by the removal of evaporite deposits, mainly nahcolite ($NaHCO_3$), through solution by water. The drilling log shows that water was encountered at 307 feet (table 4) in the "bird's-nest" aquifer, and some water may have been encountered above 307 feet.

Between 617 and 658 feet the discharge averaged about 19 gal/min, with a specific conductance of 3,500 µmho/cm (micromhos per centimeter) at 25° Celsius and an average temperature of about 19°C. At 659 feet discharge increased, reached a maximum of about 100 gal/min, and washed out the flume used to measure discharge. This large increase was of short duration, and at 664 feet discharge was about the same as previous measurements. At 669 feet the specific conductance was measured at about 45,000 µmho/cm. The lithologic log (table 3) indicates horizontal and vertical fractures between 644 and 675 feet. At about 900 feet the specific conductance decreased to about 3,800 µmho/cm.

At a depth of about 1,100 feet, discharge began to increase and by 1,550 feet had exceeded 200 gal/min. The increase in discharge was accompanied by a decrease in specific conductance and an increase in temperature. At a depth of 1,334 feet, specific conductance was measured at 1,500 µmho/cm and the water temperature at 23.5°C. Discharge increased gradually, but specific conductance remained relatively constant throughout the remainder of drilling. Water temperature gradually increased to a maximum of 25.5°C at 1,525 feet, and the temperature of the discharge water remained constant throughout the remainder of the drilling.

Water-temperature and geophysical logging

A water-temperature log and five geophysical logs were run in test hole 1 (pl. 1). The geophysical logs were electric, caliper, gamma-ray, neutron, and density. The water-temperature log, run while water was flowing from the test hole, does not indicate any changes in gradient caused by the "bird's-nest" aquifer between 200 and 330 feet. It is possible that the potentiometric head

Figure 4

is much lower in this zone than in deeper zones, and thus the "bird's-nest" aquifer may have been receiving flow from the lower part of the hole. The log shows a stepped increase at 700 feet and numerous stepped increases between 1,100 and 1,700 feet. These increases probably were the result of influx to the well bore. The temperature change at about 700 feet probably was due to the cooling effect of gas entering and moving up the hole at this point. Several small changes in gradient occurred below 1,700 feet, but on-site measurements indicated little additional flow from this part of the hole.

The electric log is erratic in the first 1,000 feet. This is due to the variation of organic content in the numerous but thin oil-shale beds. The conductivity log (inverse of the deep induction log) has an averaging effect in thin beds and thus shows the resistivity of the overall formation. The low conductivity indicates possible freshwater zones between 200 and 330 feet, 700 and 750 feet, and 1,100 and 1,770 feet. The shallow resistivity (averaged laterolog) gives a better indication of the resistivity of the thin beds. As shown in plate 1, the zone between 1,100 and 1,770 feet contains many individual, high

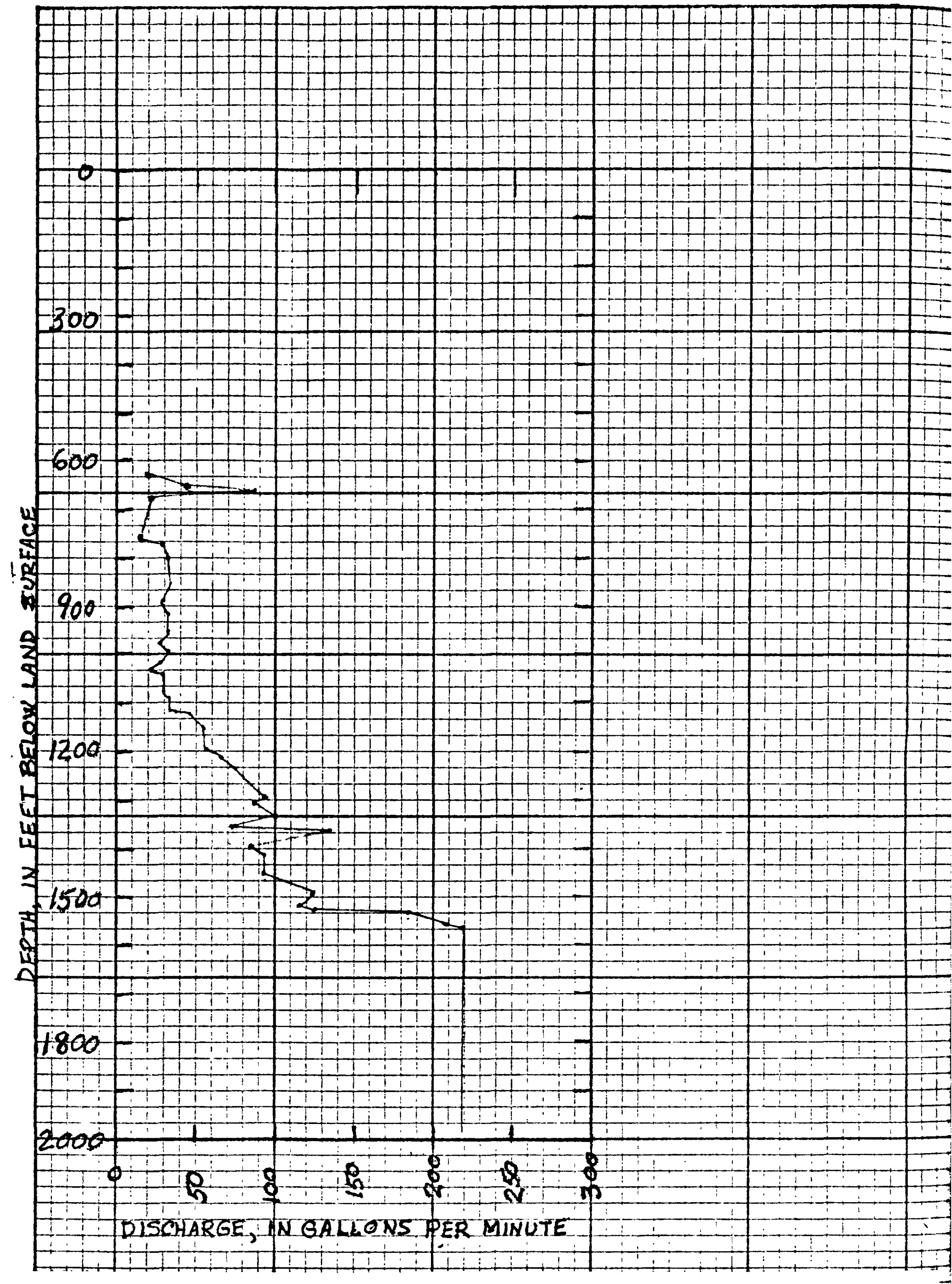

Figure 4.--Water discharged during the drilling of test hole 1.

Figure 5

resistivity beds. The spontaneous-potential log shows a large deflection at about 720 feet. This was due to gas production, as shown by the neutron and density porosity logs. The spontaneous-potential log reverses gradient at about 1,900 feet, and the formation conductivity increases. These reponses indicate a deterioration in water quality below this point.

The caliper log shows variations in the diameter of the hole, thus it is an indication of the hardness of formations. Large inflows of water or gas may

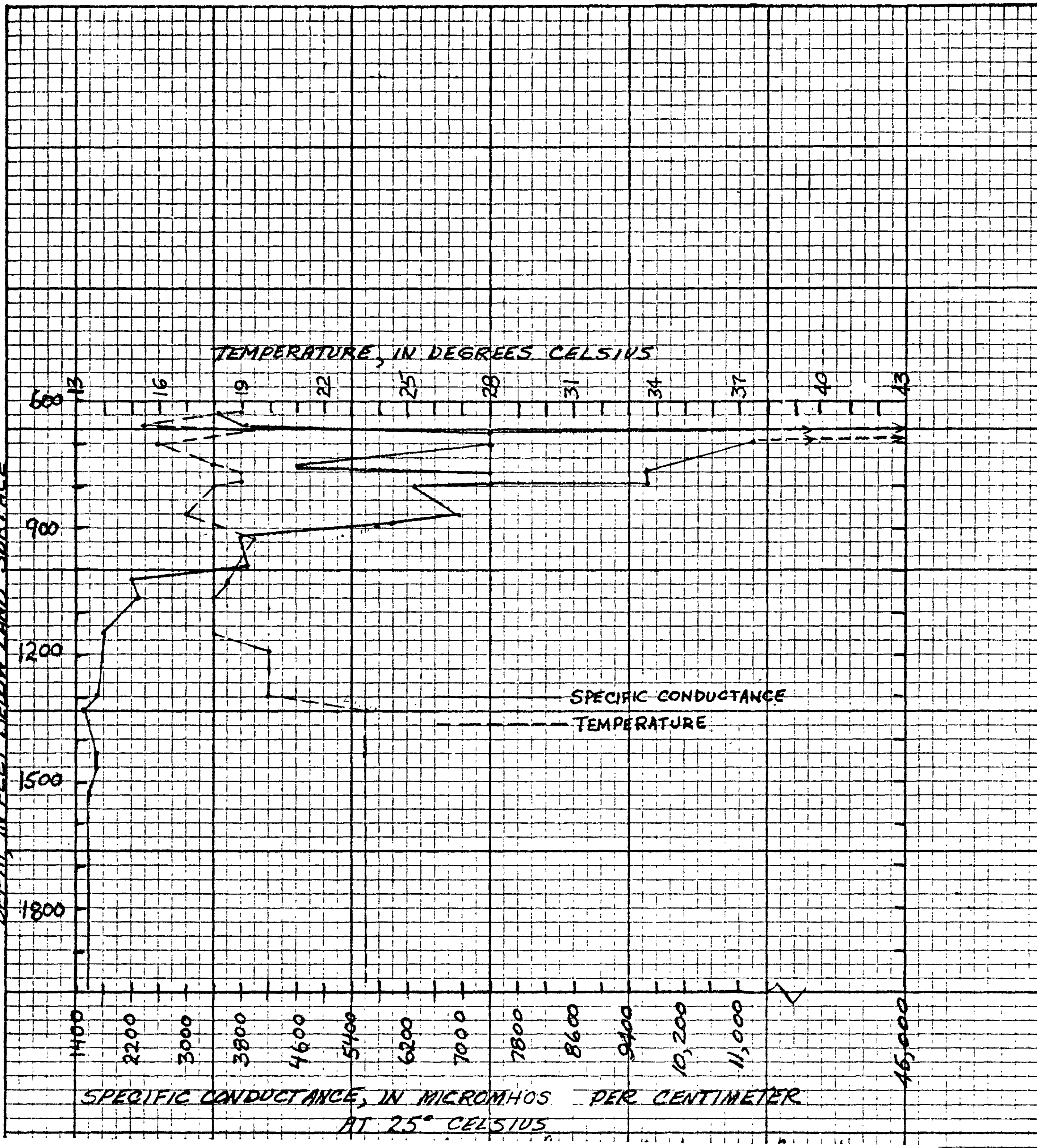

Figure 5.--Temperature and specific conductance of water discharged during the drilling of test hole 1.

have a washing effect which causes cavities that show up on the caliper log. The log in plate 2 shows a zone of increased diameter at aobut 700 feet. As previously mentioned, this zone was producing gas and possibly some water which washed away some of the formation. Small deflections in the caliper log below 1,900 feet probably were due to washing out of thin sand layers.

The gamma-ray log shows relatively large radiation responses in oil-shale beds for the first 1,000 feet. Below 1,000 feet, the log shows sharp small-radiation responses corresponding to high-resistivity responses on the electric log. These responses correlate with limestone beds noted in the lithologic log. Sandstone beds show responses in a range between the limestone and shale beds. The sandstone beds generally are interbedded with fine material and sometimes contain limy streaks, which accounts for the variable responses on the gamma-ray log.

The neutron and density porosity logs show large porosity in oil-shale beds above 700 feet. Neutron probes respond positively to all water in a formation, including water in relatively impermeable shale. For this reason, effective porosity is much less than indicated by the neutron log. Measurements of porosity using the density log also are complicated by the variable density of shales. At a depth of about 700 feet the neutron and density porosity logs cross, which is an indication of gas saturation (probably methane). As mentioned above, the neutron probe responds to all water or, more specifically, all hydrogen atoms. Because of the small number of hydrogen atoms in methane gas compared to the same volume of water, the neutron log indicates small porosity or little water content. The density log, on the other hand, responds to the less dense gas as an indication of large porosity. Large departures between density porosity and neutron porosity occur in limestone, whereas sandstone shows similar values for density porosity and neutron porosity. The interval below about 1,900 feet shows relatively large porosities. This probably was due to water in the shales and other fine-grained sediments, the presence of which are indicated in the lithologic and gamma-ray logs; thus, the effective porosity would be much smaller.

Open-hole packer tests

Packer testing in the open hole was designed to test hydrologic characteristics--including transmisssivity, hydraulic head distribution, and water quality--of individual zones. After examination of the drilling log, core analyses, and geophysical logs, four packer tests were conducted. Pressure recording devices placed above, between, and below packers were used during testing, and they did not indicate any leakage around the packers. A summary of the test results is shown in table 5.

Completion of test hole 1

Casing, cementing, and perforation information for test hole 1 are summarized in table 1. Surface casing was set to a depth of 176 feet and cemented to the land surface. Based on information obtained from the drilling log, core

Table 1.—Summary of drilling and completion information for test holes

Test hole: See locations in figure I.
Location: See description of numbering system.
Altitude: In feet above National Geodetic Vertical Datum of 1929 interpolated from U.S. Geological Survey topographic maps.
Depth: Total depth drilled.
Cemented interval: The part of the casing that has been cemented to the formation.
Production interval: The part of the test hole that is open to the formation and can contribute flow through one of the following methods: A, gun perforated through casing and cement; B, open hole behind uncemented casing; C, uncased open hole.

Test hole	Location	Altitude (ft)	Diameter (in.)	Depth (ft)	Casing: Nominal diameter (in.)	Casing: Depth (ft)	Casing: Cemented interval (ft)	Production interval (ft)
1	(D-11-24)7acd-1	5,245	12	176	10	176	0-176	1,092-1,112, 1,148-1,158, 1,204-1,214, 1,250-1,260, 1,304-1,314, 1,355-1,365, 1,392-1,402, 1,464-1,474, 1,516-1,526, 1,566-1,576, 1,755-1,765 A
			9 7/8	2,650	7	1,900[1]	0-1,900	
2	(D-13-23)26bdc-1	6,340	12	40	10	40	0-40	40-1,290 B
			8 3/4	1,290	6	1,290[2]		
3	(D-13-21)10ada-1	5,535	10 5/8	150	8	150	0-150	250-1,092 C
			6 1/8	250	5	250	0-250	
			4 3/4	1,092	—	—	—	
4	(D-12-24)19dbc-1	6,250	8 3/4	100	7	100	0-100	800-1,402 C
			6 1/8	800	4	800	400-800	
			3 7/8	1,402	—	—	—	
5	(D-11-25)26aab-1	5,790	10 1/2	117	8	117	0-117	117-798 B
			7 7/8	798	5	798	—	
6	(D-12-22)1bbb-1	5,410	10 1/2	138	8	138	0-138	138-860 B
			7 7/8	1,000	5	1,000	860-1,000	1,000,1,496 C
			4 1/2	1,497	—	—	—	

[1] Plug placed inside casing at 1,900 ft.
[2] Casing damaged below 600 ft.

analyses, geophysical logs, and open-hole packer tests, it was determined that the major freshwater zone is between about 1,100 and 1,750 feet. This freshwater zone, which is in the Douglas Creek Member of the Green River Formation, in this report is referred to as the Douglas Creek aquifer. Casing was installed to about 1,900 feet and cemented to the land surface. A 20-foot plug of cement was left inside the casing at 1,900 feet to stop any upward flow of water. Eleven zones were perforated using commercial gun-perforating tools.

Cased-hole packer tests

Two isolation packer tests were conducted in the cased hole using mechanical packers set with 2 7/8-inch standard tubing. In the first test, packers were set at 1,180 and 1,200 feet. Two perforated zones were at 1,092 to 1,112 feet and 1,148 to 1,158 feet. In the second test, packers were set at 1,230 and 1,274 feet to test the perforated zone from 1,250 to 1,260 feet. The packer tests were conducted to obtain water samples for chemical analyses.

Additional packer testing in the cased hole was designed to evaluate the flow from each perforated zone. A single mechanical packer was installed, using 2 7/8-inch standard tubing, just above the lowest perforated zone. Pressure was measured at land surface prior to opening a valve, and a flow measurement was made using a 6-gallon bucket and a stopwatch after the flow had stabilized. The packer was then moved up the casing and installed just above the second perforated zone, and the measurements were repeated. A flow for the second zone was calculated by subtracting the flow of the first zone from the combined flow of the first and second zones. An estimate of the flow from each zone was obtained by repeating this process while moving the packer up the casing. These flow estimates may be somewhat in error because of differences in hydraulic head between zones. Measurements of shut-in pressure at each packer setting do not represent pressures in individual zones but represent the combined pressure of all perforated zones below the setting.

The discharge from each zone, the combined shut-in pressure and the percentage of the total flow from each zone are shown in table 6. Eighty-five percent of the flow occurred between 1,092 and 1,314 feet. The perforated zone between 1,092 and 1,112 feet contributed 34 percent, the largest percentage of the total flow. The perforated interval from 1,755 to 1,765 feet did not produce water, thus indicating that the saline water observed during the open-hole packer tests below 1,900 feet is isolated from the Douglas Creek aquifer. Combined shut-in pressures ranged from 139 to 191 feet above land surface. The small combined pressure between 1,250 and 1,260 and 1,304 and 1,314 feet may have been due to instrument error, or possibly because the readings were made too early.

Water sampling during packer tests

Water samples were collected at the end of each open-hole packer test and during the two cased-hole isolation packer tests. A swabbing unit was used in the open-hole packer test from 1,888 to 2,650 feet because discharge was only

1 gal/min, and the time necessary to insure an uncontaminated sample at this rate of discharge was prohibitive. The remaining samples were collected from the artesian flow at the discharge line after the specific conductance and water temperature had stabilized.

The results of the chemical analyses of samples collected during packer testing are given in table 13. The analyses of the samples collected during the open-hole packer tests in the intervals from 750 to 950 feet, 1,080 to 1,285 feet, and 1,507 to 1,622 feet were almost identical. The dissolved-solids concentration (residue) ranged from 1,260 to 1,340 mg/L. The only major differences in the analyses were the concentrations of sulfate, sulfide, boron, and some trace metals. The water from the interval between 750 and 950 feet was less concentrated in sulfate and more concentrated in sulfide. This may be an indication of sulfate reduction in this interval. Boron also was more concentrated in the 750- to 950-foot interval. The water from the three intervals was a sodium bicarbonate sulfate type[1] and would be classified as slightly saline.

The sample collected during open-hole packer tests in the interval from 1,888 to 2,650 feet had a dissolved-solids concentration (residue) of 6,110 mg/L, which would be classified as moderately saline. The water was a sodium chloride type, thus differing from the water in the upper part of the formation. The larger dissolved-solids concentration in the water in the lower part of the formation probably was due to longer contact with the formation caused by slower circulation due to less permeability.

The analyses of the two samples collected during the cased-hole packer tests were similar, and the samples contained less dissolved solids than the samples collected during the open-hole packer tests. The dissolved-solids concentration (sum) of the sample collected from the perforated interval from 1,250

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[1]In order to compare and contrast the chemical character of water, an arbitrary scheme of nomenclature has been used to define water types (Davis and DeWiest, 1966, p. 119). Major ions present in less than 20 percent of the total milliequivalents per liter (cations or anions) are not used in the type name. Ions present in greater than 20 percent, but less than 60 percent, are used in the name in the order of their abundance. If any ion is present as more than 60 percent of the anions or cations, it is used alone to represent the dominant ion type. As examples, a sample from test hole (D-13-23)26bdc-1 contained 18 percent calcium, 25 percent magnesium, and 57 percent sodium plus potassium for the cations and 28 percent bicarbonate plus carbonate, 70 percent sulfate, and 2 percent chloride for the anions. This would be a sodium magnesium sulfate type water. Test hole (D-12-22)1bbb-1 yielded a sample with 0.2 percent calcium, 15 percent magnesium, and 84 percent sodium plus potassium for the cations and 39 percent bicarbonate plus carbonate, 56 percent sulfate, and 5 percent chloride for the anions. In this sample carbonate is greater than 50 percent of bicarbonate plus carbonate, thus this would be a sodium sulfate carbonate type water.

to 1,260 feet was 974 mg/L, and the dissolved-solids concentration in the perforated interval from 1,092 to 1,158 feet was 965 mg/L. Both samples would be classified as fresh and were a sodium bicarbonate sulfate type. The larger dissolved-solids concentrations in samples obtained during the open-hole packer tests probably were due to the invasion of saline water from below 1,900 feet during the drilling operation. The cased-hole packer tests were conducted after the well was allowed to flow for several days, thus the samples were probably more representative of the actual water in the formation.

Aquifer (pumping and recovery) tests

An attempted 30-day pumping test at test hole 1 was unsuccessful because of the manner in which the observation wells were completed. These wells were abandoned or producing-gas wells which were completed so that large intervals of the Green River Formation, including the "bird's-nest" aquifer and possibly some intervals of the Wasatch Formation, were open to production. Test hole 1, however, was completed only in the Douglas Creek aquifer. The data collected during the pumping test therefore could not be used as an indication of the hydrologic characteristics of the Douglas Creek aquifer.

A recovery test was conducted in test hole 1 to estimate transmissivity. The hole had been flowing for a considerable amount of time, and the discharge was measured at 10 gal/min. The hole was shut in and pressure-recovery measurements were made during 4 hours. The results of the test are shown in table 2. The transmissivity was calculated as 41 ft^2/d, which is greater than the total of 17 ft^2/d calculated from the open-hole packer tests. This probably was caused by developing the well and allowing it to flow for about 2 years before the recovery test was conducted. The shut-in pressure at the end of the test was about 140 feet above land surface. This compares favorably with pressures measured during open-hole and cased-hole packer tests. Storage coefficient could not be determined using the test data, but it was estimated on the basis of the thickness of the aquifer using a method described by Lohman (1972, p. 53). Using a thickness of 650 feet, the storage coefficient was estimated to be 6.5×10^{-4}.

Summary

Test hole 1 was drilled through the entire thickness of the Green River Formation. Two major water-bearing zones were penetrated--the "bird's-nest" aquifer at a depth of about 200 feet and the Douglas Creek aquifer at a depth of about 1,100 feet. Water from the Douglas Creek aquifer was fresh with a dissolved-solids concentration of about 970 mg/L. A recovery test indicated a transmissivity of 41 ft^2/d, and the storage coefficient was estimated to be about 6.5×10^{-4}.

TEST HOLE 2

Test hole 2, (D-13-23)26bdc-1, was drilled during the summer of 1977. The site (fig. 1) was selected for four reasons: (1) Its proximity to the suspected

Table 2.--Summary of aquifer (pumping and recovery) tests using test holes completed in the Douglas Creek aquifer

Test hole: See locations in figure 1.
Location: See description of numbering system.
Estimated transmissivity: A, based on recovery for constant-discharge method described by Lohman (1972, p. 19); B, based on drawdown for constant-discharge method described by Lohman (1972, p. 19).

Test hole	Location	Date tested	Average discharge (gal/min)	Estimated transmissivity (ft^2/d)
1	(D-11-24)7acd-1	7-19-78	10.0	41A
2	(D-13-23)26bdc-1	7- 6-78	11.4	57B
5	(D-11-25)26aab-1	5-22-78	12.0	16B
		5-23-78	12.0	20A
6	(D-12-22)1bbb-1	4-18-78	51.0	170A

recharge area for the Douglas Creek aquifer; (2) the Douglas Creek aquifer would be penetrated at a relatively shallow depth, as indicated by geophysical logs from a nearby gas well; (3) the site would provide a needed observation point to define the potentiometric surface of the aquifer; and (4) the site is near the properties of Geokinetics, Inc., a private in-situ oil-shale development.

Drilling and sampling

Test hole 2 was drilled to a depth of 1,290 feet and penetrated most of the Douglas Creek aquifer. Consolidated geologic units penetrated and the depths to their tops are as follows: Parachute Creek Member of the Green River Formation at the surface, Douglas Creek Member of the Green River Formation at 50 feet, unidentified tongue of the Wasatch Formation at 500 feet, Douglas Creek Member at 510 feet, Renegade Tongue of the Wasatch Formation at 680 feet, and the Douglas Creek Member at 720 feet.

Drill cuttings, which were collected at 10-foot intervals whenever possible, are described in table 7. Oil-shale beds dominate to a depth of 40 feet. From 40 to 80 feet the rocks consist of oil shale, bituminous sandstone, limestone and shale. From 80 to 190 feet green shale is predominant, although some beds of sandstone were penetrated. From 190 to 490 feet the rocks consist of shale, sandstone, siltstone, and oolitic limestone. From 490 to 1,290 feet sandstone is the dominant rock type.

Discharge, specific-conductance, and water-temperature measurements obtained during drilling are shown in table 8 and also are plotted against depth in figures 6 and 7. Less than 1 gal/min was produced from 0 to 40 feet. At a depth of 400 feet, a small amount of additional water was produced. Measurements of discharge, specific conductance, and temperature made about the depth of 740 feet are not completely reliable because of the small discharge and the masking effect of the injection water, which was obtained from Bitter Creek and had a specific conductance of about 6,100 μmho/cm. Water was produced at a depth of 740 feet in the Douglas Creek aquifer. Water discharge began increasing and at 1,080 feet discharge was measured at 120 gal/min with a specific conductance of 2,900 μmho/cm and a temperature of 18°C. From 1,080 to 1,290 feet, discharge increased to more than 200 gal/min, the specific conductance decreased to 1,900 μmho/cm, and the temperature increased to 19.5 °C.

Water-temperature and geophysical logging

A water-temperature log and five geophysical logs were run in test hole 2 (pl. 2). The geophysical logs were electric, caliper, gamma-ray, neutron, and density.

The water-temperature log shows a consistent gradient from about 400 feet to a depth of 780 feet where the gradient increases sharply for about 30 feet. This response generally corresponds to an increase in discharge at 810 feet as shown in the drilling log (table 8) and also figure 6. Small changes in gradient below 780 feet probably represent additional water-producing zones.

Figure 6

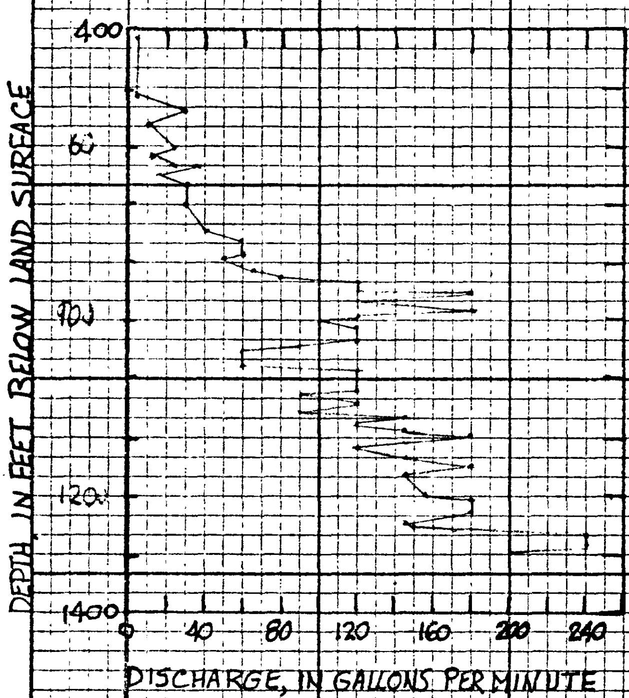


Figure 6.--Water discharged during the drilling of test hole 2.

Figure 7

The responses in the electric log between 460 and 790 feet do not reflect any large water-producing zones. At a depth of about 790 feet and continuing to a depth of 850 feet, a water-producing zone is indicated by the low resistivity of the deep induction log as compared with the resistivity of the medium and shallow induction logs. This response indicates a permeable zone containing water of poor quality compared to the water in the borehole. From 895 to 920 feet the response is reversed, probably representing water of better quality, or a response to the oolitic limestone and sandstone in the interval (table 7). The interval from 920 to 1,290 feet indicates possible water production from 990 to 1,050, 1,080 to 1,130, and 1,170 to 1,280 feet.

The caliper log shows an increase in the diameter of the hole from 630 to 650, 800 to 830, and 1,150 to 1,160 feet. These zones generally correspond to sandstone beds shown in table 7.

The gamma-ray log is erratic to a depth of about 400 feet with some low radiation counts corresponding to limestones in the lithologic log. Comparison of the gamma-ray log with the lithologic log below 400 feet indicates that fine-grained siltstones and shales give high radiation counts, sandstone beds give medium to low radiation counts, and limestone beds give low to very low counts.

USGS No. 2 TEST HOLE

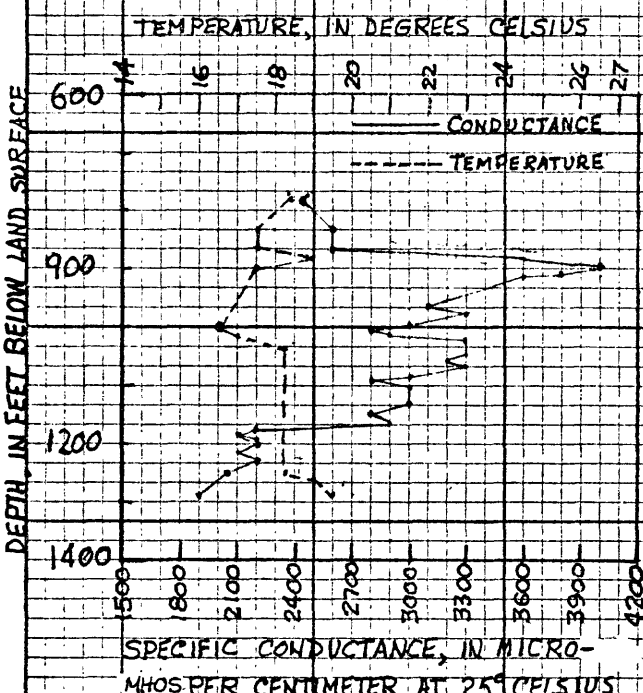


Figure 7.--Temperature and specific conductance of water during the drilling of test hole 2.

The neutron and density logs indicate large porosity from 630 to 650, 795 to 830, 900 to 930, 1,060 to 1,090, 1,150 to 1,160, and 1,270 to 1,290 feet. These large porosity values probably are representative of sandstones.

Completion of test hole 2

Casing, cementing, and production information for test hole 2 are summarized in table 1. The drilling, lithologic, and geophysical logs gave no indication of brackish water or gas production in the hole below 40 feet. Based on this information, casing was set to 1,290 feet and no attempt was made to cement the casing. Water enters the open hole behind uncemented casing and then moves through perforations in the lower 200 feet.

Aquifer (pumping) test

After completion of the test hole, the water level was about 383 feet below land surface, and a submersible pump was set at 509 feet. Pumping for 16 hours at an average rate of 11.4 gal/min produced a total drawdown of about 24 feet. The transmissivity was estimated to be 57 ft^2/d (table 2).

Storage coefficient could not be determined by using the test data, but it was estimated on the basis of the thickness of the aquifer (Lohman, 1972, p. 53). Using a thickness of 550 feet, the storage coefficient was estimated to 5.5×10^{-4}.

Water sampling

Two water samples were collected from test hole 2 (table 13). The first sample was collected at a depth of 40 feet prior to casing and cementing the surface pipe, and it represents perched water seeping from oil-shale beds above 40 feet. The second sample was collected at the end of the aquifer test, and it represents water from the interval open to production between 40 and 1,290 feet.

The water seeping from the oil-shale beds had a dissolved-solids concentration of 4,920 mg/L. The water was moderately saline and of the sodium bicarbonate chloride type. Dissolved sodium had a concentration of 2,300 mg/L and represented 99 percent of the cations present. The water had an anomolously large fluoride concentration of 110 mg/L, and the boron concentration also was large at 70 mg/L.

The water sample collected at the end of the aquifer test is representative of the water in the Douglas Creek aquifer in the area. The dissolved-solids concentration was 906 mg/L, and the water was fresh and of the sodium magnesium sulfate type.

Summary

Test hole 2 was drilled to a depth of 1,290 feet. Less than 1 gal/min was produced from oil-shale beds between 0 and 40 feet. Water, which was produced from the Douglas Creek aquifer at 740 feet, was fresh with a dissolved-solids concentration of 906 mg/L. An aquifer test indicated a transmissivity of 57 ft^2/d, and the storage coefficient was estimated to be 5.5×10^{-4}. The water level in the completed well was 383 feet below land surface.

TEST HOLE 3

Test hole 3, (D-13-21)10ada-1, was drilled during March 1978. The site (fig. 1) was selected for two reasons: (1) Its close proximity to the recharge area of the Douglas Creek aquifer, and (2) the site would provide a needed observation point to define the potentiometric surface of the aquifer.

Drilling and sampling

Test hole 3 was drilled to a depth of 1,092 feet and completely penetrated the Douglas Creek aquifer. Unconsolidated valley fill consisting of alternating beds of clay, sand, and gravel were penetrated to a depth of 190 feet. Consolidated geologic units penetrated and the approximate depths to their tops are as follows: Douglas Creek Member of the Green River Formation at 190 feet, Renegade Tongue of the Wasatch Formation at 720 feet, and the Douglas Creek Member at 780 feet. The drilling log (table 9) indicates that the rocks consist mainly of white, gray, or red sandstone with thin beds of siltstone, limestone, and bituminous sandstone.

Discharge, specific-conductance, and water-temperature measurements obtained during drilling are shown in table 9 and are also plotted against depth in figures 8 and 9. Water was encountered in the unconsolidated valley fill to a depth of 190 feet. Discharge exceeded 200 gal/min and caused considerable caving in the hole, eventually making it necessary to drill with mud. Measurements of discharge prior to the use of mud indicated that the water had a specific conductance of about 3,400 μmho/cm and a temperature of about 13°C. An intermediate string of casing was set about 250 feet and cemented to the surface to eliminate caving.

The first water produced from the consolidated rocks of the Douglas Creek Member was at about 300 feet. Discharge to a depth of about 450 feet averaged about 25 gal/min with a specific conductance of approximately 1,500 μmho/cm and an average temperature of 12.5°C. At 490 feet discharge increased substantially and at 550 feet discharge was about 190 gal/min with a specific conductance of 960 μmho/cm and a temperature of 16°C. Although the discharge fluctuated appreciably, only small fluctuations occurred in specific conductance and temperature throughout the remainder of the drilling.

Water-temperature and geophysical logging

A water-temperature log and four geophysical logs were run in test hole 3 (pl. 3). The geophysical logs were electric, gamma-ray, gamma-gamma (density), and neutron. The logs are not corrected for borehole effects and the electric log has relative scales.

Figure 8

The water-temperature log shows inflow of water at about 305, 650, and 960 feet as indicated by a break in gradient at these points. The zone at 305 feet corresponds to an increase in discharge during drilling. Changes in temperature gradient above 250 feet are due to the effects of cementing.

The electric log shows a higher resistivity in the long normal (deep penetrating) curve below about 400 feet when compared with the short normal (shallow penetrating) curve. This response is due to formation water that is fresher than the borehole fluid. The spontaneous-potential log shows a change at about 400 feet, which also reflects this change in the quality of the formation water. Measurements of the discharge between 440 and 460 feet show that the specific conductance decreased from 1,600 to 1,000 μmho/cm.

The low count rate in the gamma-ray log shows that sandstone beds probably dominate the lithology in most of the hole. Thin shale beds probably cause the high radiation counts at 510 and 650 feet and at several greater depths.

The gamma-gamma log shows large fluctuations. The high radiation counts are generally due to increased porosity and probably represent sandstones. The low neutron responses generally indicate large hydrogen-ion concentrations, probably corresponding to water-saturated sandstones. The high neutron responses generally correspond to shale or marlstone beds (identified by the gamma-ray log), which evidently lack a significant amount of water.

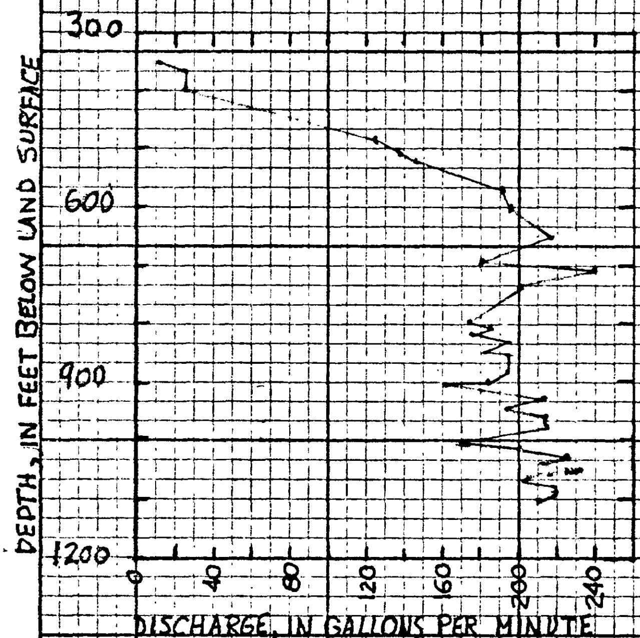


Figure 8.--Water discharged during drilling of test hole 3.

Figure 9

Completion of test hole 3

The casing, cementing, and production information for test hole 3 are summarized in table 1. It was necessary to set an intermediate string of casing to 250 feet due to drilling problems in the upper 200 feet. The hole was not cased below 250 feet due to restrictions in hole size caused by the intermediate string of casing; therefore, the completed hole is open from 250 to 1,092 feet. Hydrologic testing was not conducted at this site, but the hole is available for future testing. The water level after completion of the hole was 11 feet below land surface.

Water sampling

A water sample was collected at the completion of drilling by jetting with air until the discharge was clear of sediment and the specific conductance and temperature had stabilized. The dissolved-solids concentration was 651 mg/L, and the water was fresh and of the sodium sulfate bicarbonate type (table 3).

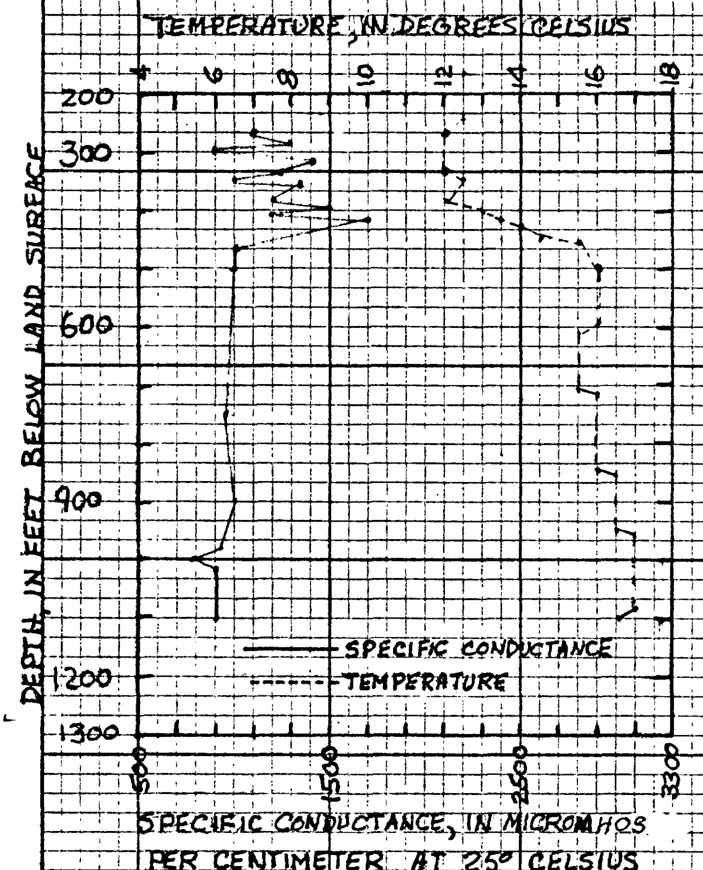


Figure 9.--Temperature and specific conductance of water discharged during the drilling of test hole 3.

Summary

Test hole 3 was drilled to a depth of 1,092 feet. Water was encountered in unconsolidated valley fill to a depth of 190 feet. Water was produced from consolidated rocks of the Douglas Creek Member of the Green River Formation at about 300 feet. A water sample collected during drilling had a dissolved-solids concentration of 651 mg/L and was fresh. The water level after completion of the hole was 11 feet below land surface.

TEST HOLE 4

Test hole 4, (D-12-24)19dbc-1, was drilled during March 1978 southwest of Rainbow (fig. 1). The site was selected because an existing core hole, drilled by the Energy Resources Development Administration to a depth of about 600 feet, was available for deepening.

Drilling and sampling

Test hole 4 was drilled through thick sequences of oil-shale beds in the Parachute Creek Member of the Green River Formation. The Douglas Creek Member of the Green River Formation was penetrated in the existing core hole at about 580 feet, and test hole 4 continued in the Douglas Creek Member to a total depth of 1,402 feet. Tongues of the Wasatch Formation were not evident during drilling except possibly for a thin bed at 1,300 feet.

The drilling log (table 10) indicates that the rocks below 600 feet consist of gray sandstone with some limestone and blue to black shale or siltstone. Above 600 feet the rocks are dominated by oil-shale beds and bituminous sandstone.

Discharge, specific-conductance, and water-temperature measurements obtained during drilling are shown in table 10 and also plotted against depth in figures 10 and 11. A maximum discharge of 10 gal/min was produced from between 600 and 800 feet. The specific conductance ranged from 3,200 to 6,500 µmho/cm, and the temperature was about 10°C. Water was produced again after setting and cementing casing at about 830 feet. At a depth of 1,100 feet the discharge was 10 gal/min, and the specific conductance was 5,550 µmho/cm with a temperature of 13°C. At 1,110 feet discharge began increasing, the specific conductance decreased and the temperature increased. At a depth of 1,340 feet discharge was 25 gal/min, and the specific conductance was 2,520 µmho/cm with a temperature of 19.5°C. At 1,360 feet the discharge increased to 36 gal/min, the specific conductance decreased to 2,150 µmho/cm, and the temperature increased to 21°C. Discharge at 1,402 feet was 42 gal/min, and the specific conductance was 1,300 µmho/cm with a temperature of 22°C. Due to the small discharge, the measurements of specific conductance and temperature were masked by the drilling water, which had a specific conductance of 4,500 µmho/cm. The actual specific conductance of the formation water is probably much less than indicated in table 10.

Figure 10

Water-temperature and geophysical logging

A water-temperature log and four geophysical logs were run in test hole 4 (pl. 4). The geophysical logs were electric, gamma-ray, gamma-gamma, and neutron. The water-temperature log does not indicate any major zones of inflow to the hole.

Some saline water enters the hole above 1,000 feet, but the exact location of inflow cannot be determined from the electric log. The spontaneous-potential log shows a change at about 1,000 feet, which probably indicates a change in the quality of the formation water. The resistivity log indicates small zones of freshwater inflow between 930 and 1,020 feet and between 1,375 and 1,385 feet.

USGS No. 4 TEST HOLE (D-12-24)17dbc-1

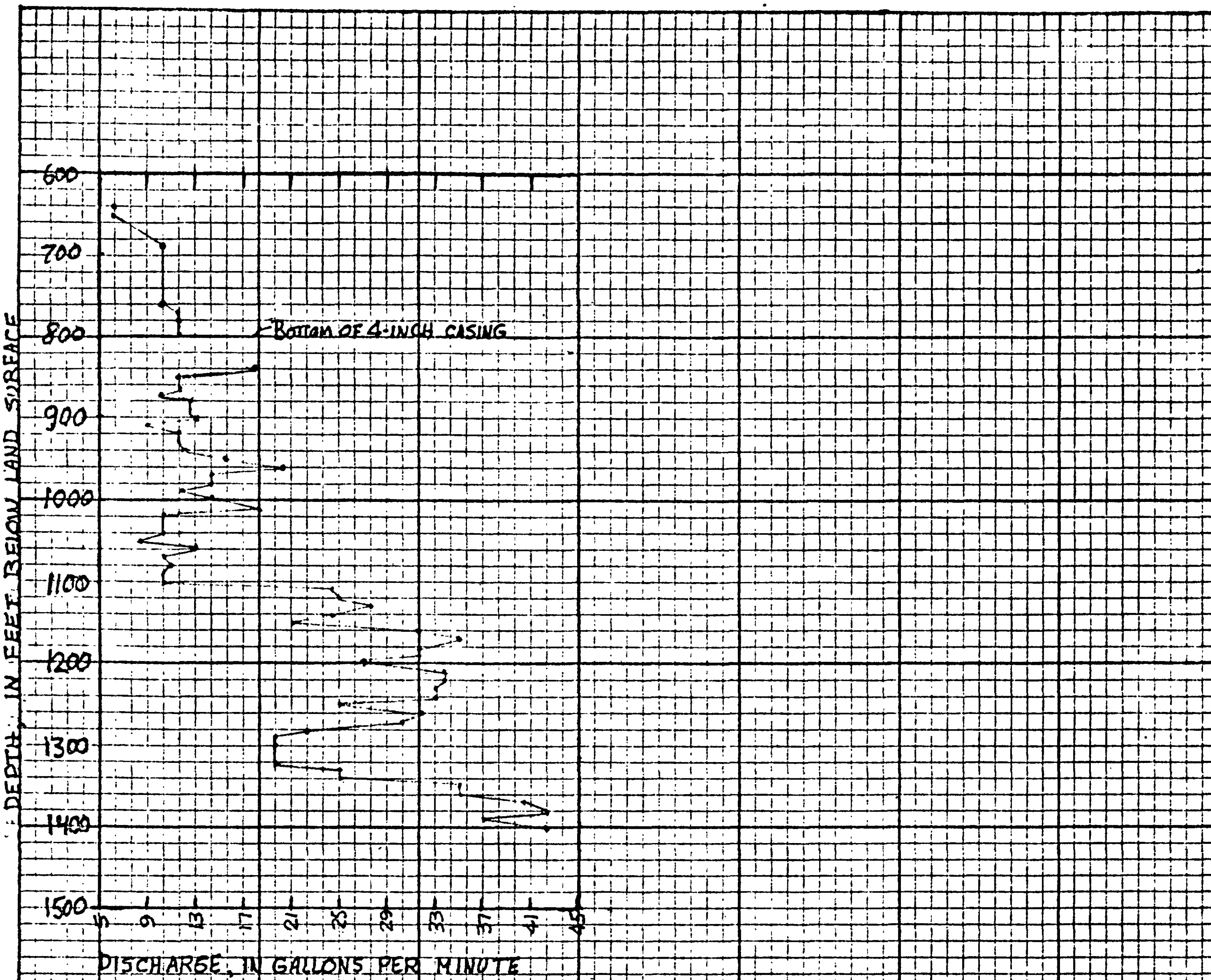


Figure 10.--Water discharged during drilling of test hole 4.

Figure 11

The high radiation counts on the gamma-ray log reflect mostly shale above 600 feet. Below 600 feet the log indicates a few thin beds of limestone, such as those at a depth of 950, 990, and 1,040 feet. (See Remarks in table 10 for depth of 1,050 feet.) Many thin shale beds exist below 900 feet as indicated by high radiation counts at 1,050, 1,080, and 1,140 feet. The remainder of the responses that show intermediate radiation counts are probably sandstone with some shale and limestone intermixed.

The gamma-gamma log above 800 feet is affected by the casing and cement used to complete the hole. The sharp low radiation responses between 250 and 550 feet show the location of dense casing collars. The low radiation interval from 600 to 800 feet indicates cement behind the casing. High radiation counts reflecting greater porosity below 800 feet correspond to sandstone. Some low radiation responses showing high density may be caused by limestone.

For depths above 800 feet, the neutron log also is affected by casing and cement used to complete the hole. Responses below 800 feet generally show fewer

USGS No. 4 TEST HOLE (D-12-24)19dbc-1

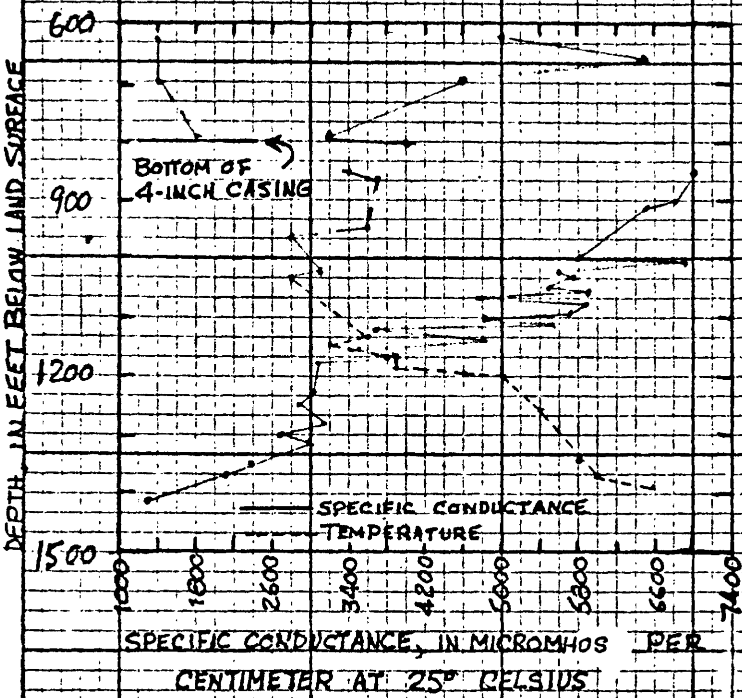


Figure 11.--Temperature and specific conductance of water discharged during the drilling of test hole 4.

count rates, indicating larger porosity that corresponds to sandstone. Some high count rates indicate small porosity, and corresponding low gamma-ray counts, such as at 905 feet, indicate the presence of limestone.

Completion of test hole 4

Casing, cementing, and production information for test hole 4 are summarized in table 1. Casing was set to a depth of 800 feet, the interval below 800 feet was not cased, and the hole is open from 800 to 1,402 feet. Hydrologic testing was not conducted at the site, but the hole is available for future testing. The water level after completion of the hole was 554 feet below land surface.

Water sampling

A water sample was collected prior to setting the casing at 800 feet, and a second sample was collected after the drilling was completed at 1,402 feet. The samples were collected by jetting with air until the discharge was clear of soap and sediment. The first sample had a dissolved-solids concentration of 2,350 mg/L, whereas the second sample had a dissolved-solids concentration of 948 mg/L. The water in the upper part of the hole was slightly saline and of the sodium bicarbonate sulfate type, whereas the water below 800 feet was fresh and of the sodium sulfate bicarbonate type. Concentrations of calcium, magnesium, bicarbonate, and boron were proportionally much larger in the upper part of the hole. Iron was the only ion in the lower part of the hole that exceeded the concentration in the upper part of the hole.

Summary

Test hole 4 was drilled to a depth of 1,402 feet. Water was encountered in consolidated rock at 600 feet. Water samples collected during drilling and at the completion of drilling indicate water above a depth of 800 feet has a dissolved-solids concentration of 2,350 mg/L and is slightly saline, whereas water below 800 feet has a dissolved-solids concentration of 948 mg/L and is fresh. The water level after completion of the hole was 554 feet below land surface.

TEST HOLE 5

Test hole 5, (D-11-25)26aab-1, was drilled during April 1978. The site (fig. 1) was selected because of its close proximity to the suspected recharge area and the shallow depth of the Douglas Creek aquifer.

Drilling and sampling

Test hole 5 was drilled through thick beds of sandstone in the Douglas Creek Member of the Green River Formation and tongues of the Wasatch Formation to a total depth of 798 feet. It is possible that the drilling penetrated the main body of the Wasatch Formation but data obtained during drilling and geophysical logging is not adequate to evaluate this possibility.

Discharge, specific-conductance, and water-temperature measurements obtained during drilling are shown in table 11 and also plotted against depth in figures 12 and 13. Water was first produced at about 120 feet. Discharge was erratic but averaged about 20 gal/min to a depth of 340 feet. Specific conductance increased from 2,200 to 3,100 μmho/cm at 290 feet and water temperatures decreased from 16.0° to 14°C. The decrease in temperature probably was due to a decrease in the temperature of the drilling water and to the cooling effect of the air being used for drilling during the night and early morning. An increase in discharge occurred at a depth of 340 feet and again at about 390 feet. Discharge below 390 feet ranged from 21 to 60 gal/min. The variation of specific conductance below 380 feet may have been due to equipment problems.

Geophysical logging

Three geophysical logs were run in test hole 5--gamma-ray, gamma-gamma, and neutron (pl. 5). The gamma-ray log shows that most of the sandstone beds are between 100 and 400 feet. When the sandstone beds at 125 and 400 feet were penetrated during drilling, the discharge increased.

Figure 12

USGS No. 5 Test Hole (D-11-25)26aab-1

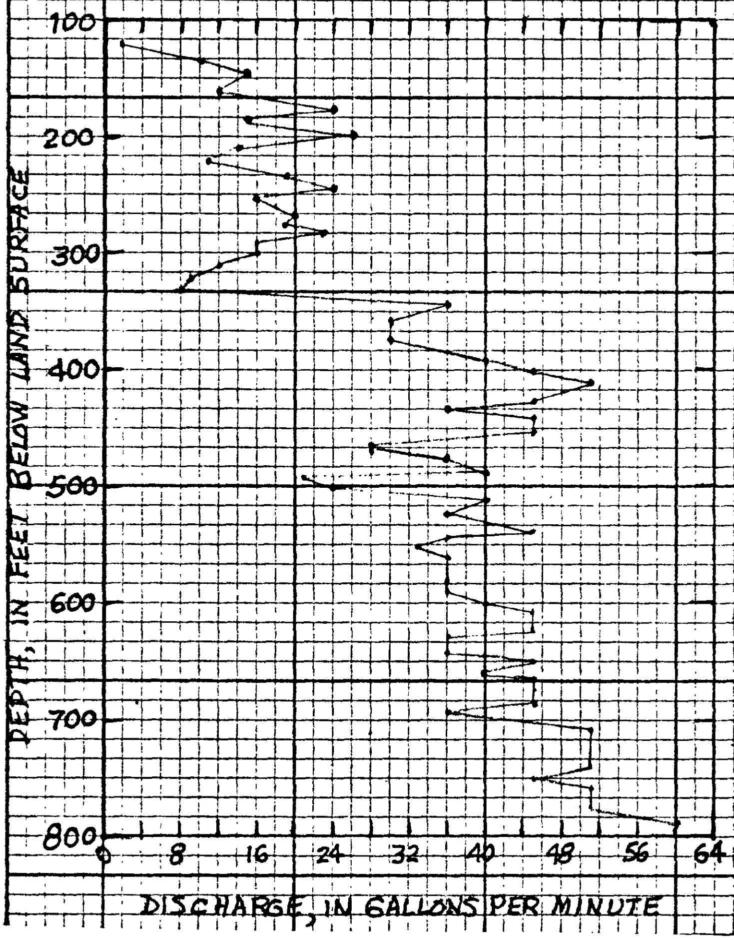


Figure 12.--Water discharged during the drilling of test hole 5.

The high radiation counts on the gamma-gamma log indicate larger porosity and generally correspond to sandstone beds between 100 to 400 feet. A decrease in the average count rate corresponding to a decrease in porosity is apparent at 415 feet. Deflections in the log above 120 feet were caused by casing and cement used in the completion of the hole.

The neutron log responses above 120 feet also were affected by casing and cement used in the completion of the hole. Below 120 feet the neutron log does not indicate any large porous zones.

Completion of test hole 5

Casing, cementing, and production information for the test hole are summarized in table 1. The hole was cased to its total depth of 798 feet and no

Figure 13

USGS No. 5 Test Hole (D-11-25) 26aab-1

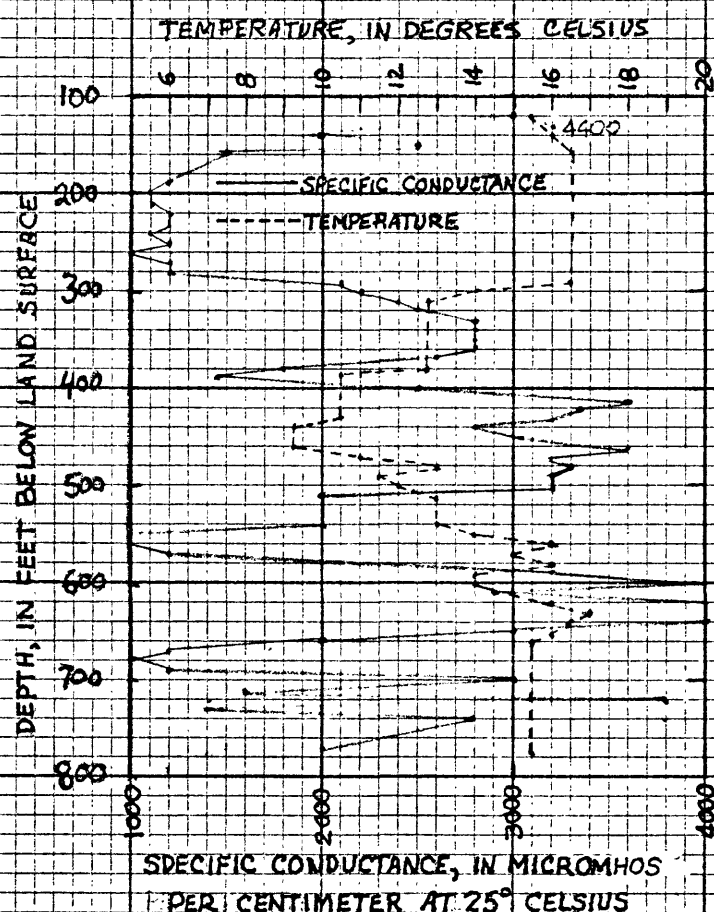


Figure 13.--Temperature and specific conductance of water discharged during the drilling of test hole 5.

attempt was made to cement the casing. Sections of the casing were perforated to allow water to enter, but the interval open to production is from behind uncemented casing from 117 to 798 feet. The water level after completion of the hole was 123 feet below land surface.

Aquifer (pumping) test

After completion of the hole, a submersible pump was set at 373 feet. An average pumping rate of 12 gal/min was maintained for 24 hours with a total drawdown of 140 feet. The transmissivity was estimated to be 16 ft^2/d (table 2). Recovery was measured for about 20 hours, and the transmissivity estimated on that basis was 20 ft^2/d, which agrees closely with the transmissivity calculated for the drawdown test.

Storage coefficient could not be determined by using the test data, but it was estimated on the basis of the thickness of the aquifer (Lohman, 1972, p. 53). Using a thickness of 250 feet, the storage coefficient was estimated to be 2.5 $\times 10^{-4}$.

Water sampling

A water sample was collected at the completion of the aquifer test. The sample had a dissolved-solids concentration of 3,030 mg/L (table 13) and is classified as moderately saline and of the sodium sulfate type. The interval open to production during sampling was 117 to 798 feet.

Summary

Test hole 5 was drilled to a depth of 798 feet. Water was produced in consolidated rocks at a depth of about 120 feet. A water sample collected during an aquifer test was moderately saline with a dissolved-solids concentration of 3,030 mg/L. An aquifer test indicated a transmissivity of 16 ft^2d, and the storage coefficient was estimated to be 2.5 $\times 10^{-4}$. The water level after completion of the hole was 123 feet below land surface.

TEST HOLE 6

Test hole 6, (D-12-22)1bbb-1, was drilled during April 1978. The site was selected because it was centrally located between proposed areas of oil-shale development (fig. 1) and because of the need for ground-water information in that part of the basin.

Drilling and sampling

Test hole 6 was drilled to a total depth of 1,497 feet. Unconsolidated valley fill, which was penetrated to 110 feet, was saturated; and it was necessary to drill with commercial mud. Consolidated geologic units penetrated and the approximate depths to their tops are as follows: Parachute Creek

Member of the Green River Formation at 110 feet, Douglas Creek Member of the Green River Formation at 650 feet, Renegade Tongue of the Wasatch Formation at 1,360 feet, and the Douglas Creek Member of the Green River Formation at 1,440 feet.

The drilling log (table 12) indicates that oil shale is the dominant rock unit to a depth of about 650 feet. Below 650 feet the rocks consist mainly of fine-grained gray sandstone with a few beds of shale and limestone.

Discharge, specific-conductance, and water-temperature measurements are shown in table 12 and also are plotted against depth in figures 14 and 15. The oil-shale beds between 180 and 720 feet generally discharged less than 20 gal/min. Specific-conductance measurements averaged about 28,000 μmho/cm, and the average water temperature was about 14.0°C. The water-temperature measurements may have been less than the actual temperature because the small amount

Figure 14

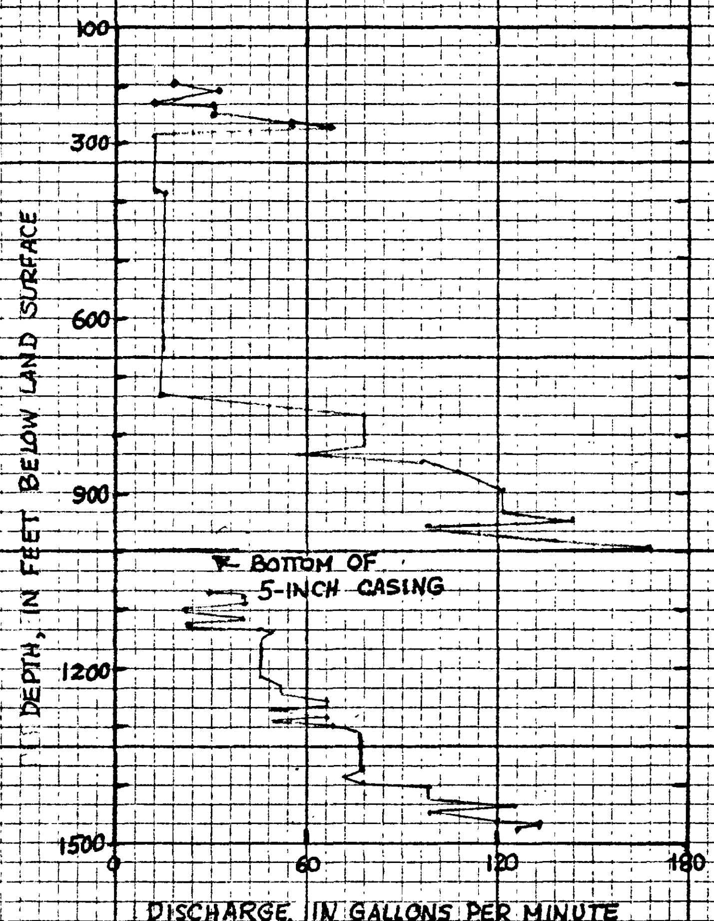
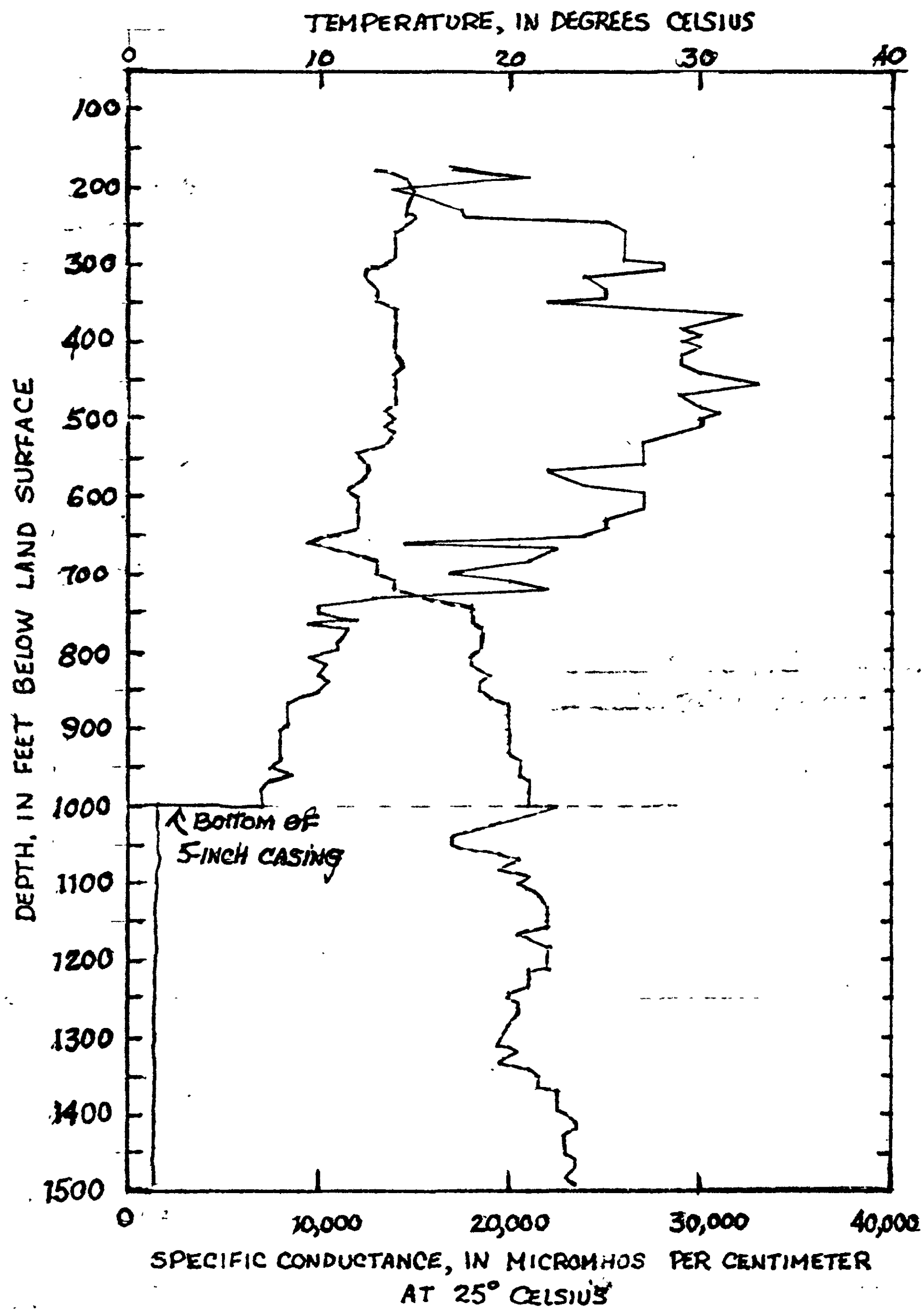


Figure 14.--Water discharged during drilling of test hole 6.

Figure 15

of discharge may have been affected by the cool air injected into the hole during the early morning. Discharge increased from 16 gal/min at 720 feet to



Depth (Ft)

Figure 15.--Temperature and specific conductance of water discharged during the drilling of test hole 6.

76 gal/min at 750 feet. Specific conductance decreased from 22,000 to 10,000 µmho/cm, and water temperatures increased from 14.0° to 18.0°C. Discharge increased again at 860 feet. At 920 feet the discharge was measured at 121 gal/min with a specific conductance of 8,000 µmho/cm and a temperature of 20°C.

When casing was set at 1,000 feet, the hole began to flow. The casing was cemented from 860 to 1,000 feet, and the hole continued to flow through the annular space. About 19 hours after drilling was stopped at 1,000 feet, the flow was 22.5 gal/min, and the water had a specific conductance of 1,400 µmho/cm and a temperature of 22.5°C. The Douglas Creek aquifer was penetrated at 720 feet. The specific conductance of the water in the aquifer probably was about 1,400 µmho/cm; but until the well was allowed to flow and thus flush the saline water from the upper part of the hole, measurements of specific conductance indicated more saline water.

Drilling continued below 1,000 feet, and water again was produced at 1,040 feet. At 1,080 feet the discharge was 40 gal/min with a specific conductance of 1,430 µmho/cm and a temperature of 19.5°C. Discharge gradually increased, and at 1,490 feet it was measured at 125 gal/min with a specific conductance of 1,370 µmho/cm and a temperature of 23.5°C.

Water-temperature and geophysical logging

A water-temperature log and four geophysical logs were run in test hole 6 (pl. 6). The geophysical logs were electric, gamma-ray, gamma-gamma, and neutron. The water-temperature log indicates flow into the hole at depths of 1,060, 1,120, 1,190, and 1,400 feet. The temperature log was not run inside the casing above 1,000 feet.

The electric log indicates freshwater from 1,000 to 1,400 feet. The high resistivity at 1,080 feet probably is caused by limestone, whereas the high resistivity at 1,405 feet is caused by oil shale. (See Remarks for entries at 1,090 and 1,410 feet in table 12.) The electric log does not indicate any freshwater below 1,400 feet. The spontaneous-potential log shows a change below 1,380 feet, but this probably is due to saline water in fine-grained sediments below this depth.

The gamma-ray log indicates fine-grained sediments above 790 feet. Thick sandstone beds apparently occur below this point at depths of from 790 to 810, 840 to 855, 905 to 915, 930 to 940, 1,020 to 1,040, and 1,035 to 1,050 feet. Many thin beds of sandstone are apparent between 1,050 and 1,260 feet. Below 1,260 feet the gamma-ray log indicates mostly fine-grained sediments.

The gamma-gamma log is partly affected by casing and cement used in the completion of the well. A high radiation response between 210 and 260 feet corresponds to zones of increased discharge noted during drilling. Lithologic samples from this interval include a white crystalline mineral identified as nahcolite, indicating that this interval is probably the "birds-nest" aquifer.

The log shows high radiation counts between 680 and 750 feet and between 1,000 and 1,400 feet. Comparing these responses with responses on the gamma-ray log indicates that the two zones consist primarily of sandstone.

The neutron log indicates large porosity above 650 feet. The response is due partly to water in shale and hydrogen ions in oil-shale beds; thus the effective porosity would be much smaller than is indicated by the log. The responses below 650 feet, which indicate large porosity, generally agree with responses from the gamma-ray and gamma-gamma logs, thus indicating sandstone beds. Responses at about 1,400 feet show high resistivity, low density, and small porosity; and examination of lithologic samples from this zone indicates a limestone or a limy shale.

Completion of test hole 6

Casing, cementing, and production information for test hole 6 are summarized in table 1. Casing was installed to 1,000 feet to prevent inflow of saline water. The completed test hole is open to production from 1,000 to 1,496 feet through the main casing. The casing was cemented only from 860 to 1,000 feet, therefore, the annular space also is open to production from 138 to about 860 feet. The water level after completion of the test hole was 109 feet above land surface.

Aquifer (recovery) test

After test hole 6 was allowed to flow for about 30 days it was shut in and recovery measurements were made using a pressure gage. The transmissivity was calculated to be 170 ft^2/d (table 2), the largest transmissivity estimated for all the test holes. Test hole 6 penetrated the greatest thickness of aquifer, and it is possible that the sandstones were more sorted and contained less fine-grained material than those penetrated in the other holes.

Storage coefficient could not be determined by using the test data, but it was estimated on the basis of the thickness of the aquifer (Lohman, 1972, p. 53). Using a thickness of 700 feet the storage coefficient was estimated to be 7×10^{-4}.

Water sampling

Three water samples were collected from test hole 6. The first sample, which was collected while drilling at 764 feet, was probably a mixture of freshwater from the Douglas Creek aquifer penetrated at about 720 feet and the saline water occurring in the "bird's-nest" aquifer at about 220 feet. The water had a dissolved-solids concentration of 9,870 mg/L (table 3), and it was moderately saline and of the sodium sulfate carbonate type. Because this sample represented a mixture of freshwater from the Douglas Creek aquifer and saline water from the "bird's-nest" aquifer, it can be assumed that water in the "bird's-nest" aquifer had a dissolved-solids concentration greater than 9,870 mg/L. The second sample was collected at 1,497 feet by air jetting, and it represented discharge from 1,000 to 1,497 feet. The water had a dissolved-solids concentration of 959 mg/L, and it was fresh and of the sodium bicarbonate type. The third sample was collected after completion of the test hole where it was possible to sample the interval from 135 to about 860 feet through the annular space between the casing and the hole. The water had a dissolved-solids concentration of 921 mg/L, and it was fresh and of the sodium bicarbonate type. The third sample was more representative of water in the Douglas Creek aquifer between 720 and about 860 feet, whereas the first sample was more representative of water in the "bird's-nest" aquifer.

Summary

Test hole 6 was drilled to a depth of 1,497 feet. Water was first produced in oil-shale beds at 180 feet. The "bird's-nest" aquifer was probably penetrated at 210 feet, and the Douglas Creek aquifer was penetrated at 720 feet. Water samples collected during drilling indicate that the dissolved-solid concentrations of water in the "bird's-nest" aquifer was greater than 9,870 mg/L, whereas water in the Douglas Creek aquifer had a dissolved-solids concentration of about 950 mg/L. An aquifer (recovery) test at the site indicated a transmissivity of 170 ft^2/d, and the storage coefficient was estimated to be 7×10^{-4}. The water level after completion of the test hole was 109 feet above land surface.

CONCLUSIONS

Two major aquifers in the Green River Formation were identified by test drilling in the southeastern Uinta Basin. One of the aquifers, the "bird's-nest" aquifer, was penetrated in only two of six test holes and is apparently limited to the central part of the study area. The second aquifer, the Douglas Creek aquifer, was penetrated in all test holes and has a much larger areal extent.

A water sample collected from the "bird's-nest" aquifer had a dissolved-solids concentration of about 10,000 mg/L. Samples from the Douglas Creek aquifer had dissolved-solids concentrations of about 1,000 mg/L.

Hydrologic testing of the Douglas Creek aquifer indicated transmissivities ranging from 16 to 170 ft^2/d. Based on an average transmissivity of 50 ft^2/d and an estimated storage coefficient of 5×10^{-4}, maximum discharge from individual wells would generally not exceed 200 gal/min.

Future studies need to include a simplified ground-water model of the study area using data from the test-drilling program. The model could help define recharge and discharge areas, direction of ground-water flow, and the potentiometric surfaces of the two aquifers. The model could serve as a guide to future ground-water development in the area.

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Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1

Interval (ft)	Description
0 - 307.0	No data
307.0- 311.2	Oil shale, brown, with some dark-brown, and numerous crystals
311.2- 314.4	Oil shale, with abundant individual crystals
314.4- 314.7	Oil shale, brown, and tuffaceous zone with white crystals (calcite?); large vugs
314.7- 322.2	Oil shale, brown and dark-brown, fewer individual crystals; carbonaceous mineral at 319.6 feet
322.3- 322.8	Oil shale, brown and dark-brown
322.8- 323.2	Oil shale, dark-brown to black
323.2- 335.1	Oil shale, brown and dark-brown, pyrite stringers
335.1- 336.3	Oil shale, dark-brown with some black; tuffs at 335.2, 335.3, 335.7-335.8, 336.0 and 336.1 feet
336.3- 337.0	No data
337.0- 338.9	Oil shale, dark-brown, fine-grained; wavy, brown tuff at 337.15-337.2 feet and gray tuff at 337.05 feet
338.9- 340.3	Oil shale, medium-brown, some stringers of pyrite(?)
340.3- 362.8	Oil shale, brown, dark-brown to black; tuffs with variable pyritic stringers at 344.2, 345.5 and 348.2 feet
362.8- 363.1	Oil shale, variegated and varved
363.1- 364.5	Oil shale, dark-brown
364.5- 366.7	Oil shale, dark-brown, vertical fractures at 350.4-351.6 and 362.5-363.1 feet
366.7- 366.8	Oil shale, black
366.8- 367.5	Oil shale, brown
367.5- 367.9	Oil shale, black
367.9- 372.9	Oil shale, brown; tuff stringer at 369.9-370.0 feet
372.9-373.3	Oil shale, black

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
373.3- 375.3	Oil shale, brown, with stringers (probably pyrite)
375.3- 375.9	Oil shale, black
375.9- 379.0	Oil shale, brown; tuff stringers at 377.3 and 377.9 feet
379.0- 380.3	Oil shale, dark-brown
380.3- 381.2	Oil shale, dark-brown and black
381.2- 382.9	Oil shale, brown
382.9- 383.9	Oil shale, dark-brown
383.9- 385.8	Oil shale, dark-brown to black
385.8- 387.6	Oil shale, dark-brown
387.6- 387.7	Tuff
387.7- 389.4	Oil shale, brown, mixed with some black
389.4- 389.9	Oil shale, dark-brown and some black
389.9- 391.3	Oil shale, black, mixed with some dark-brown
391.3- 392.9	Oil shale, dark-brown, with laminations; tuff at 392.6 feet, pyrite inclusions
392.9- 398.6	Oil shale, brown; tuff with pyrite stringers at 397.4 feet, tuff bleeding oil at 398.3 feet
398.6-399.2	Oil shale, dark-brown, laminated
399.2- 402.6	Oil shale, brown; tuff at 402.6 feet
402.6- 403.8	Oil shale, brown and dark-brown, laminated
403.8- 406.9	Oil shale, brown, some pyrite
406.9- 407.0	No data
407.0- 407.1	Oil shale, black
407.1- 407.4	Oil shale, black, banded with dark-brown
407.4- 408.9	Oil shale, brown to dark-brown

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
408.9- 409.0	Tuff, brown
409.0- 423.3	Oil shale, dark-brown to black; thin tuff layers common from 414.7 to 422.2 feet
423.3- 423.35	Tuff, grayish-brown
423.35-429.2	Oil shale, dark-brown to black
429.2- 430.6	Oil shale, brown and black, laminated and varved; thin tuff layer at 429.2 feet
430.6- 437.8	Oil shale, brown and dark-gray; thin tuff layers
437.8- 439.1	Oil shale, brown, dark-brown, and dark-gray; abundant small crystals
439.1- 440.2	Oil shale, brown
440.2- 441.1	Oil shale, dark-brown
441.1- 441.8	Oil shale, dark chocolate brown; dark-brown tuffs
441.8- 453.0	Oil shale, brown, dark-brown, and dark-gray; occasional thin tuff beds
453.0- 453.9	Oil shale, brown to dark-brown, interbedded
453.9- 459.7	Oil shale, brown, dark-brown, and grayish-brown with thin pyrite stringers; some thin gray tuffs, natural fractures 457.7-459.4 feet
459.7- 460.2	Oil shale, dark chocolate brown and dark-gray
460.2- 465.0	Oil shale, brown to dark grayish-brown
465.0- 465.6	Oil shale, dark chocolate brown and black
465.6- 466.9	Oil shale, brown, dark-brown, and dark-gray
466.9- 467.0	No data
467.0- 470.1	Oil shale, dark-brown to brown
470.1- 470.2	Tuff, bituminous stain
470.2- 471.3	Oil shale, dark-brown to black
471.3- 471.4	Tuff, bituminous

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
471.4- 476.9	Oil shale, dark to medium-brown; vertical fractures at 471.6-476 feet
476.9- 477.2	Tuff, bituminous stain
477.2- 477.9	Oil shale, dark-gray and brown
477.9- 478.2	Oil shale, medium- to dark-brown; interbedded tuff
478.2- 480.0	Oil shale, light-gray
480.0- 481.0	Oil shale, medium- to dark-brown; 0.15 foot interbedded tuff at base
481.0- 487.7	Oil shale, light-gray to light-brown
487.7- 487.8	Tuff, bituminous stain
487.8- 489.2	Oil shale, medium-gray, some pyrite blocks and stringers; tuff, bituminous stain, at 488.2-488.25 feet
489.2- 489.6	Oil shale, light-gray and brown, laminated
489.6- 489.7	No data
489.7- 490.4	Tuff, contorted at top; some interbedded oil shale; bituminous sand (tar sand)
490.4- 492.1	Oil shale, light-gray and light-brown, laminated at top
492.1- 492.4	Tuff, bituminous stain
492.4- 494.9	Oil shale, light-gray
494.9- 495.1	Tuff, bituminous stain
495.1- 496.0	Oil shale, medium-brown; natural vertical fractures
496.0- 496.5	Tuff, bituminous; vertical fractures
496.5- 503.1	Oil shale, light-brown and gray; scattered thin tuffs
503.1- 503.3	Tuff, light-brown, bituminous stain, breccia at top
503.3- 516.7	Oil shale, light-brown, with some laminar; thin interbedded tuffs at 505.65 and 508.75 to 508.9 feet
516.7- 517.3	Oil shale; tuff, wavy laminate

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
517.3- 518.4	No data
518.4- 521.5	Oil shale, light-gray
521.5- 521.9	No data
521.9- 526.4	Oil shale, brown and black, interbedded
526.4- 528.9	Oil shale, black
528.9- 529.5	Oil shale, brown and black, broken up
529.5- 530.9	Oil shale, brown and black, interbedded
530.9- 532.9	Oil shale, brown and black, interbedded; large stringers (pyrite?)
532.9- 535.1	Oil shale, brown and black, interbedded
535.1- 538.4	Oil shale, brown and some black; interbedded tuff at 536.8 and 537.3 feet
538.4- 540.0	Oil shale, wavy, laminated, dark-brown and black; tuff at 539.2 feet
540.0- 541.2	Oil shale (?), light-brown; minor faulting at 540.6 feet; some crystals
541.2- 542.0	Oil shale, black and brown, laminated or varved
542.0- 555.4	Oil shale, brown with black laminations; white mineral at 545.8 and 547.8 feet
555.4- 555.9	Oil shale, black and brown, wavy laminations; oil-soaked tuff at 555.55 feet
555.9- 556.6	Oil shale, brown; tuff
556.6- 556.7	Tuff, bituminous
556.7- 558.6	Oil shale, brown thick beds; tuff at 558.5 feet
558.6- 558.9	Oil shale and tuff, interbedded; bleeding oil
558.9- 560.6	Oil shale, wavy, brown and black, interbedded; tuffs at 559.5 to 559.7, and 560 feet (0.1 ft thick)
560.6- 561.8	Oil shale, brown and black; tuff beds at 560.8 feet

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
561.8- 562.8	Oil shale, dark-brown and black; tuff layers at 562.4 and 562.5 feet; tuffs bleeding oil; white crystals (salt?)
562.8- 569.4	Oil shale, brown; tuff at 562.9 and 563.2 feet; pyrite stringers
569.4- 569.8	Tuff; bleeding oil, includes clay stones
569.8- 573.3	Oil shale, light-brown; pyrite stringers; some black oil-shale layering; tuff at 573.2 feet
573.3- 574.2	Oil shale, black, with brown layers
574.2- 574.5	Oil shale, brown, with pyrite stringers
574.5- 578.8	Oil shale, dark-brown; wavy tuff at 578.5 feet; brown mineral at 578.8 feet, indentation on core, good one-directional cleavage, acrylate(?)
578.8- 580.0	Oil shale, brown and black, layered
580.0- 582.2	Oil shale, black and brown, wavy and laminated, Mahogany Bed(?)
582.2- 582.9	Oil shale, black, distorted
582.9- 584.3	Oil shale, black; discontinuous tuff layers
584.3- 585.6	Oil shale, dark-brown to black
585.6- 585.7	Tuff, brown
585.7- 585.8	Oil shale, dark-brown
585.8- 587.8	Tuff, thin, gray; interbedded dark-brown and black oil shale
587.8- 588.5	Oil shale, dark-brown and black, interbedded
588.5- 590.4	Oil shale, dark-brown to black
590.4- 591.7	Oil shale, dark-brown and black, interbedded
591.7- 592.6	Oil shale, dark-brown
592.6- 592.8	Oil shale, black
592.8- 595.9	Oil shale, dark-brown and black, interbedded

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
595.9- 597.5	Oil shale, black, dark-brown streaks and contorted beds at 597.1 feet
597.5- 607.4	Oil shale, dark-gray and dark-brown, interbedded
607.4- 611.3	Oil shale, dark-brown
611.3- 612.4	Oil shale, dark-brown and black, interbedded
612.4- 614.8	Oil shale, brown and gray, fine laminations
614.8- 616.0	No data
616.0- 616.5	Oil shale, gray, natural vertical fractures
616.5- 618.0	Oil shale, gray and some dark-gray
618.0- 618.9	Oil shale, dark-gray to black, varved
618.9- 620.2	Oil shale, gray and dark-gray, natural vertical fractures
620.2- 621.4	Oil shale, dark-gray, black and brown, thinly banded
621.4- 622.7	Oil shale, gray and dark-brown, badly fractured and crushed
622.7- 623.0	No data
623.0- 623.5	Oil shale, gray and some dark-gray
623.5- 624.3	Oil shale, brown, dark-brown, black, and some dark-gray, varved
624.3- 625.5	Oil shale, dark-gray and brown, some tan marlstone
625.5- 627.4	Oil shale, dark-gray, and tan marlstone
627.4- 627.9	Oil shale, dark-brown and tan, thin, varved
627.9- 628.0	Tuff, dark-gray, thin
628.0- 629.4	Tuff, sandy, dark-brown to brown, and dark-gray
629.4- 629.7	Oil shale, dark-brown and black, banded with tan marlstone
629.7- 629.9	Oil shale, dark-gray to black
629.9- 630.9	Oil shale and marlstone, gray, dark-gray, tan, and brown banded
630.9- 631.7	No data

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
631.7- 632.7	Oil shale and marlstone, gray, dark-gray, tan, and brown banded
632.7- 637.8	Oil shale and marlstone, light-gray, dark-gray, and dark-brown
637.8- 639.4	Oil shale; light-gray (marlstone?); crystals of pyrite
639.4- 639.5	Tuff; bleeding oil
639.5- 656.0	Oil shale, light-gray; pyrite stringers; tuff; bleeding oil at 642.3, 642.6, 642.7, 642.8, and 642.9-643.0 feet; natural vertical fractures at 643.8, and 645.0-645.5 feet, tuff-textured surface throughout
656.0- 660.0	Oil shale, light-gray, brown, and dark-gray, layered; tuff; large water flow at 658 feet
660.0- 660.9	Oil shale, dark-brown and black; tuff layers
660.9- 662.3	Oil shale, light-gray and light-brown; tuff at 661.1 feet
662.3- 664.4	Oil shale, light-gray and dark-gray, layered, laminated, horizontal fractures at 662.2, 662.9, 664.4, and 664.6 feet; dark-brown tuff
664.4- 664.6	No data
664.6- 675.0	Oil shale, light-gray, laminated dark-gray layers; tuff at 664.8, 666.4, 668.9, and 672.1 feet, probable horizontal fractures at 668.9 feet, vertical fractures at 668.8 and 669.5 feet
675.0- 676.0	Oil shale, dark-brown and gray; tuff at 675.6 feet
676.0- 681.9	Oil shale, light-gray
681.9- 682.2	No data
682.2- 683.6	Oil shale, light-brown; laminated tuff at 683.1 feet
683.6- 684.0	Tuff, medium-brown and medium-green, oil-stained
684.0- 684.4	Oil shale, black, laminated
684.4- 688.0	Oil shale, light-gray and brown, laminated; few spots of bleeding oil

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
688.0- 688.1	Tuff, medium-brown, contorted top
688.1- 690.6	Oil shale and marlstone, light-brown to gray, laminated
690.6- 692.9	Oil shale, dark-brown to black; laminated, little pods of tuff at 691 feet; tuff at 691.4 feet; contorted; bleeding oil
692.9- 694.6	Oil shale and marlstone, light-brown, laminated with thin layers and stringers of coarse-grained material
694.6- 695.3	Same as above, but with inclusions
695.3- 699.3	Oil shale, medium- to dark-brown, laminated; some interbedded tuffs
699.3- 700.5	Tuff
700.5- 701.2	Oil shale and marlstone, dark-gray, and brown, slight lamination
701.2- 701.7	Tuff, interbedded, dark-gray and light-brown oil shale, wavy, contorted
701.7- 701.9	Oil shale, gray
701.9- 702.3	Oil shale, gray and brown, laminated
702.3- 702.5	Tuff, interbedded with dark-gray sandstone; wavy to contorted oil shale
702.5- 703.2	Sandstone, dark-gray, medium-grained, interbedded gray layers
703.2- 704.2	Sandstone, brown, with gray layers
704.2- 706.4	Sandstone, gray and brown
706.4- 707.0	Sandstone, gray, and interbedded with shale
707.0- 707.7	Oil shale and marlstone, with some sandstone
707.7- 711.0	Sandstone, gray to dark-gray, with layers of oil shale(?)
711.0- 711.6	Sandstone, clayey, gray, with mica(?)
711.6- 714.0	Sandstone, gray
714.0- 723.0	Sandstone, brown, coarse-grained

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
723.0- 725.0	Sandstone, gray to brown; coarse-grained gray layers at 723 feet
725.0- 728.6	Sandstone, light-gray, coarse-grained, weakly cemented
728.6- 742.0	Sandstone, light-gray to gray, medium- to coarse-grained, appears massive with some dark-gray layering (mica?)
742.0- 743.5	Sandstone, light to medium-brown, fine- to medium-grained, massive, wavy bedding
743.5- 756.4	Mudstone and marlstone, medium- to light-gray
756.4- 758.8	Oil shale and marlstone, light-brown, laminated to bedded, slightly wavy
758.8- 759.0	Oil shale, black
759.0- 763.0	Oil shale, medium-brown to black, some lamination
763.0- 765.2	Oil shale and marlstone, light-brown to black at base, irregular lamination, interbedded thin tuffs
765.2- 767.9	Oil shale, dark-gray to black
767.9- 768.8	Oil shale, dark-brown to black, laminated
768.8- 769.0	Tuff, medium-grained, medium-brown, massive
769.0- 769.7	Oil shale and marlstone, light to medium-brown, thin and irregular bedding, bleeding oil
769.7- 770.0	Oil shale and marlstone, medium-brown, and breccia
770.0- 773.2	Oil shale and marlstone, medium-brown, dark-gray to black
773.2- 774.1	Marlstone and mudstone, light-gray and brown, thin bedded
774.1- 775.2	Mudstone(?), light-brown, laminated, oil-stained; vertical fractures from 774.1 to 775.5 feet
775.2- 775.6	Tuff(?), medium-brown, oil-stained
775.6- 776.3	Marlstone and oil shale, light-brown, irregularly bedded, splotchy
776.3- 786.6	Marlstone, light-gray, laminated to thin bedded, vertical fractures containing oil

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
786.6- 787.0	No data
787.0- 793.0	Marlstone, light-gray to light-brown, laminated to thin bedded, some discontinuous bedding
793.0- 794.3	Marlstone(?), medium-brown, badly fractured, laminated to contorted bedding
794.3- 812.0	Marlstone, light- to medium-gray, laminated to massive; vertical fractures 805-806.3 and 807.5-809.5 feet
812.0- 813.5	Tuff, bleeding oil, some interbedded layers of marlstone(?), slightly irregular, continuous with underlying marlstone
813.5- 817.5	Marlstone, light-gray, massive, some oil spots and bleeding; thin tuff at 815.1 feet, lower boundry gradational, irregularly bedded with underlying tuff
817.5- 819.5	Sandstone, light-brown to light-gray at base, transition zone, irregularly bedded with underlying sandstone
819.5- 834.7	Sandstone, light-gray, fine-grained, slightly contorted interbedded material, vertical fractures 834.2-839.2 feet
834.7- 847.1	Marlstone, light-gray, laminated to thin bedded, minor stringers and blebs of dark material
847.1- 849.4	Marlstone, light-gray to brown, laminated to thin bedded
849.4- 853.7	Oil shale, medium dark-gray to black
853.7- 856.9	Oil shale and marlstone, interbedded light-gray to light-brown; thin tuff at 854.9 feet, laminated to thin bedded
856.9- 873.9	Oil shale and marlstone, light- to medium-gray to black; minor stringers of pyrite(?)
873.9- 874.2	Tuff(?), medium-brown (slight oil-stain), medium-grained
874.2- 876.0	Marlstone, light-gray to light-brown, irregular to regular bedding, laminated
876.0- 880.7	Mudstone(?), light- to medium-gray; appears to be abundant stringers and grains of pyrite
880.7- 907.0	Mudstone, light-gray and some light-brown, bedded to irregularly thin bedded; scattered thin tuffs; some bleeding oil; oil shale with tuff at 886.4-886.5 feet

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)		Description
907.0-	909.0	Marlstone, light-gray and brown lamination, thin beds, and thin interbedded tuffs
909.0-	909.6	Marlstone, light-brown and gray, thin bedded
909.6-	910.7	Tuff, fragmented and irregularly bedded, light-brown, highly altered
910.7-	915.9	Marlstone, light-gray, thin bedded
915.9-	916.6	Tuff(?), irregularly bedded; porous, bleeding oil
916.6-	920.2	Marlstone, light-gray, thin bedded
920.2-	929.4	Marlstone, light-gray, massive to thin bedded, highly micaceous
929.4-	939.2	Marlstone, light- to dark-gray, thin bedded to laminated, highly contorted bedding at 934.2-934.5 feet
939.2-	942.2	Oil shale, light-brown, laminated
942.2-	943.2	Oil shale and interbedded light-brown tuffs; massive tuff at 942.7-943.2 feet
943.2-	944.8	Oil shale, dark-gray to brown, laminated
944.8-	946.2	Tuff, with minor interbedded oil shale; bleeding oil at 942.2 feet
946.2-	946.6	No data
946.6-	948.3	Oil shale, medium-brown, irregular, contorted, with interbedded brown tuff
948.3-	952.4	Oil shale, medium-brown bands; contorted from 951.5-953.2 feet
952.4-	952.9	Limestone(?), light-tan, fragmented
952.4-	954.2	Oil shale, medium-gray, irregular stringers of limy material
954.2-	956.3	Marlstone, intermixed with contorted to fragmented medium-gray to medium-tan limy material
956.3-	958.0	Oil shale, interbedded limy material, dark bands appear to be carbonaceous fossils(?)

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
958.0- 962.5	Oil shale, gray, fossil material as above, brown layers
962.5- 965.1	Tuff and interbedded shale
965.1- 970.3	Oil shale, gray and brown, stringers (pyrite or fossils)
970.3- 972.0	Tuff, light-brown, intermixed with shale
972.0- 976.8	Oil shale, gray, dark-gray stringers, brown oil shale intermixed; tuff at 975.0 feet
976.8- 978.1	Limestone (ostracoda?), brown, interbedded with shale at 978 feet
978.1- 979.3	Oil shale, gray, with stringers
979.3- 981.0	Limestone, light-brown, with some interbedded shale
981.0- 985.7	Oil shale, laminated, dark-gray to gray
985.7- 986.1	Tuff, brown
986.1- 989.2	Limestone, light-brown, interbedded tuff
989.2- 989.8	Oil shale and some limestone
989.8- 990.5	Limestone, shale, and tuff, interbedded
990.5- 998.6	Tuff, thin bedded or layered; marlstone, limestone, and shale
998.6- 999.5	Limestone, mixed with shale, light-brown
999.5-1,003.8	Shale and oil shale, gray, with stringers of limestone
1,003.8-1,004.9	Limestone, light-brown, with light-gray fossils
1,004.9-1,016.9	Shale, sandy, wavy layers of unlaminated blebs, especially wavy at 1,009.8-1,011.3 feet
1,016.9-1,018.0	Sandstone, shaly, especially at 1,017.5-1,017.8 feet; contains mica
1,018.0-1,018.7	Sandstone, fine-grained
1,018.7-1,020.5	Shale (oil shale?), light-gray
1,020.5-1,021.0	Sandstone, fine-grained

Table 3.--Lithologic log of test hole 1,(D-11-24)7acd-1 - Continued

Interval (ft)	Description
1,021.0-1,025.2	Mudstone, light-gray, wavy, laminated with light-gray stringers
1,025.2-1,026.0	Mudstone,gray
1,026.0-1,056.3	Mudstone, light-gray to gray, wavy, sandy or silty, contorted at 1,032.0 feet, brown at 1,035.0 feet, interbedded with brown shale (oil shale?) at 1,051.1-1,056.3
1,056.3-1,057.1	Limestone and marlstone, light-brown
1,057.1-1,058.2	Shale and limestone, interbedded; more limestone at beginning and shale at end
1,058.2-1,065.0	Oil shale, gray and dark-gray, interbedded with contorted light-brown marlstone and limestone, fragmented
1,065.0-1,066.0	Shale, gray, interbedded with brown limestone
1,066.0-1,072.8	Shale, gray, with convoluted limestone at 1,067.2 feet
1,072.8-1,074.0	Shale and marlstone, light-brown and light-gray interbedded
1,074.0-1,074.7	Oil shale, gray
1,074.7-1,075.1	Marlstone(?), light-brown
1,075.1-1,075.7	Oil shale, gray, light-brown stringers
1,075.7-1,076.5	Limestone, brown, contorted, and some shale
1,076.5-1,077.1	Oil shale, gray
1,077.1-1,078.0	Limestone
1,078.0-1,078.3	Oil shale, black
1,078.3-1,079.0	Oil shale, gray to light-brown
1,079.0-1,079.7	Limestone, brown and some interbedded shale
1,079.7-1,080.4	Limestone, brown and some shale
1,080.4-1,082.8	Oil shale, gray and dark-gray, with brown limestone layers at 1,082.0, 1,082.2, 1,082.4, and 1,082.7 feet
1,082.8-1,083.0	Limestone, brown

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
1,083.0-1,083.4	Oil shale, gray, with light-brown layers
1,083.4-1,083.6	Limestone, brown
1,083.6-1,090.5	Oil shale, gray and dark-gray
1,090.5-1,093.6	Oil shale and limestone; marlstone layer at 1,090.5 feet
1,093.6-1,095.9	Limestone, dark-brown, interbedded, with shale
1,095.9-1,097.0	Oil shale and limestone, interlaminated or layered and contorted
1,097.0-1,102.8	Mudstone or marlstone and brown sandstone 1,098.0-1,099.2 feet
1,102.8-1,107.8	Sandstone or siltstone, fine-grained, gray
1,107.8-1,108.2	Sandstone, red-brown, medium-grained; probable water zone
1,108.2-1,108.6	Oil shale, laminated, wavy, light and dark-gray
1,108.6-1,116.8	Sandstone, medium-grained, some red to brown shale interbedded, dark-gray shale at 1,114.3 feet
1,116.8-1,118.5	Mudstone, light-gray
1,118.5-1,128.4	Siltstone and mudstone, contorted and interbedded
1,128.4-1,136.7	Mudstone, light-gray
1,136.7-1,139.1	No data
1,139.1-1,143.5	Mudstone, medium-gray, laminated to thin bedded, some medium-brown stripes
1,143.5-1,145.5	Limestone, fragmented to massive, light-brown to buff, medium- to coarse-grained, intermixed with oil shale at base
1,145.5-1,146.6	Oil shale, medium dark-brown
1,146.6-1,148.8	Mudstone, medium-gray to buff, wavy, interbedded limestone
1,148.8-1,155.7	Limestone, buff, light- to dark-gray
1,155.7-1,170.0	Limestone, light-gray, variable contorted zones
1,170.0-1,174.1	Sandstone, medium- to fine-grained, light-gray, micaceous

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
1,174.1-1,184.5	Limestone, light-gray, relatively massive, few wavy zones
1,184.5-1,184.6	Limestone (algal?), light-gray and buff
1,184.6-1,185.4	Mudstone, gray; limestone at 1,184.7 feet
1,185.4-1,201.8	Oil shale, gray, some light-brown stringers; dark-gray limestone at 1,194.8-1,195.7 feet
1,201.8-1,207.9	Limestone, light to dark-brown, porous
1,207.9-1,214.4	Limestone and shale; massive limestone to 1,208.4 feet
1,214.4-1,220.2	Oil shale; gray limestone at 1,214.9 and 1,216.3-1,216.6 feet
1,220.2-1,224.8	Sandstone, brown, fine-grained
1,224.8-1,233.4	Mudstone, gray
1,233.4-1,237.9	Sandstone and shale interlayered
1,237.9-1,245.0	Mudstone or marlstone, gray to light-gray; calcite stringers interlayered with contorted oil shale at 1,239.0-1,240.0 feet
1,245.0-1,247.4	Siltstone, medium-gray
1,247.4-1,248.2	Siltstone, light-gray, limy, with thin dark laminations
1,248.2-1,250.3	Siltstone, medium-gray
1,250.3-1,250.5	Oil shale(?), dark-gray, light contorted laminations
1,250.5-1,258.5	Limestone, coarse-grained, porous, and brownish-white
1,258.5-1,260.0	Sandstone, gray, fine-grained, limy
1,260.0-1,262.0	Same as above but with inclusions of shale fragments and other calcareous materials
1,262.0-1,262.4	Siltstone, dark-gray, medium-grained
1,262.4-1,265.5	Siltstone, light-gray, fine-grained
1,265.5-1,265.8	Siltstone, medium-gray, many laminations
1,265.8-1,266.6	Sandstone, medium-gray, limy, darker bands at 1,266.0 and 1,266.2 feet

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
1,266.6-1,267.2	Sandstone, medium-gray, limy, fine-grained
1,267.2-1,267.7	No data
1,267.7-1,272.0	Sandstone, light-gray, darker layers and dark wavy laminations
1,272.0-1,282.9	Sandstone, light-gray, uniformly fine-grained
1,282.9-1,286.5	Same as above, but with more dark wavy laminations
1,286.5-1,295.6	Sandstone, light-gray, dark laminations rare or absent
1,295.6-1,296.0	Sandstone, with dark contorted laminations
1,296.0-1,297.4	Sandstone, medium-gray
1,297.4-1,298.3	Sandstone, gray, limy, with many dark laminations
1,298.3-1,300.8	Limestone, whitish-gray, fine-grained
1,300.8-1,304.6	Sandstone, medium-gray, limy; dark band of calcareous fragments at 1,301.8 feet
1,304.6-1,305.8	Limestone, fossiliferous, brown- to light-brown; gray porous shale at 1,304.8 feet
1,305.8-1,307.9	Limestone, massive, light-brown; more porous at 1,308 feet; fossiliferous at 1,307.3 feet
1,307.9-1,309.3	Sandstone, fine-grained, brown to dark-gray; contains some mica at 1,308.2 feet
1,309.3-1,315.2	Mudstone, light-gray; black fossil at 1,310.1 feet; some wavy laminations
1,315.2-1,315.4	Siltstone, dark-gray
1,315.4-1,317.5	Mudstone (siltstone?) gray, sometimes wavy
1,317.5-1,320.0	Limestone, brown; appears massive
1,320.0-1,320.8	Sandstone, fine-grained, and siltstone, dark-gray, wavy laminations, white stringers
1,320.8-1,329.0	Mudstone, light-gray, wavy laminations, silty around 1,320.5 and 1,323.0 feet
1,329.0-1,332.6	Sandstone, fine-grained, gray to brown, grades to siltstone; large increase in water flow at 1,330-1,331 feet
1,332.6-1,334.7	Mudstone, gray, laminated

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
1,334.7-1,340.0	Siltstone, gray and brown, grades from mudstone to a fine-grained sandstone
1,340.0-1,343.7	Mudstone, purple-red; appears oil-bearing
1,343.7-1,345.9	Siltstone, gray and brown
1,345.9-1,363.9	Sandstone, gray and brown, fine- and medium-grained to coarse-grained toward the bottom of section, dark-gray stringers laminated at 1,351.0 feet
1,363.9-2,007.0	No data
2,007.0-2,015.2	Marlstone, medium- to dark-gray, scattered stringers of lighter gray material
2,015.2-2,016.9	Marlstone and sandstone intergrading, wavy irregular
2,016.9-2,023.4	Sandstone, light-brown to gray, fine-grained, some swirly texture
2,023.4-2,024.0	Mudstone, dark-gray; minor amount of sandstone at top
2,024.0-2,025.5	As above, fine- to very fine grained, and light-brown
2,025.5-2,033.0	Mudstone, dark-gray, with minor laminations
2,033.0-2,036.9	Mudstone, intermingled with fine-grained sandstone, dark-gray to light-gray
2,036.9-2,039.0	Mudstone, dark-gray
2,039.0-2,042.0	Mudstone, with some irregularly interbedded fine-grained sandstone, medium dark-gray mudstone, and light-gray to brown sandstone
2,042.0-2,044.0	Mudstone, dark-gray
2,044.0-2,046.5	Mudstone and sandstone, interbedded
2,046.5-2,049.0	Mudstone, dark-gray
2,049.0-2,052.5	Mudstone, dark-gray, sandstone increasing
2,052.5-2,056.8	Sandstone, fine-grained to medium-grained, swirly texture
2,056.7-2,057.3	Mudstone, dark-gray
2,057.3-2,058.6	Sandstone, limy, medium-gray, medium-gray, fine-grained
2,058.6-2,059.7	Sandstone, limy, grading to mudstone, irregularly interbedded

Table 3.--Lithologic log of test hole 1, (D-11-24)7acd-1 - Continued

Interval (ft)	Description
2,059.7-2,080.0	Mudstone, dark-gray, irregular sandstone and limestone inclusions, vertical fractures from 2,078-2,081.3 feet
2,080.0-2,650.0	No data

Table 4.--Drilling log of test hole 1, (D-11-24)7acd-1

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (C°)	Remarks
617	16.7	3,500	19.0	Injected 3.5 gal/min with a specific conductance of 1,500 μmhos/cm. Water encountered at 307 feet.
618	18.9			
638	21.2			
658	18.9			
659	45.9	3,860	15.5	
661				Discharge washed out flume. Peak discharge approximately 100 gal/min.
664	21.2			
669	21.2	45,000	19.5	Specific conductance estimated (exceeded scale of meter).
695		11,200	16.0	
750		4,700	18.0	
763	14.9	9,700	19.0	
780	28.8	9,700	19.0	
791	31.5			
800	31.5	6,300	18.0	
811	31.5			
831	31.5			
853	31.5			
860	31.5	6,980		
872	31.5	6,000	17.0	
892	28.8			
910	31.5			

Table 4.--Drilling log of test hole 1, (D-11-24)7acd-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (C°)	Remarks
918	28.8	3,800	19.5	
930	31.5			
950	31.5			
970	28.8			
990	31.5	3,900	16.0	
1,010	28.8			
1,021	23.8	2,200	18.5	
1,036	28.8			
1,049	28.8			
1,059	26.1			
1,066	28.8	2,300	18.0	
1,074	28.8			
1,083	31.5			
1,103	31.5			
1,110	36.9			
1,120	42.8			
1,139	45.9			
1,159	52.7	1,800	18.0	
1,165	55.6			
1,185	52.7			
1,197	55.6		20.0	
1,217	59.0			
1,227	69.3			

Table 4.--Drilling log of test hole 1, (D-11-24)7acd-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
1,270	95.9			
1,294	92.3	1,700	20.0	
1,312	88.2			
1,334	99.9	1,500	23.5	
1,353	72.9			
1,357	135			
1,400	84.2			
1,432	92.3	1,700	23.5	Mostly sandstone.
1,458	92.3	1,650		
1,492	126			
1,512	117			
1,525	126	1,600	25.5	Sandstone.
1,530	187			
1,550	208			
1,570	213			No additional readings recorded because the specific conductance or discharge did not change by greater than 10 percent.
2,650				Total depth.

Table 5.—Summary of open-hole packer testing data for test hole 1, (D-11-24)7acd-1

Estimated Transmissivity: Based on constant-drawdown method described by Lohman (1972, p. 23).
Remarks and other available data: C, chemical analysis in table 13.

Interval open during testing (ft)	Average discharge (gal/min)	Water temperature (°C)	pH	Specific conductance (mho/cm)	Estimated shut-in pressure (ft)	Estimated transmissivity (ft²/d)	Remarks and other available data
1,888-2,650	1.0	26.5	8.2	10,300	231	0.3	Discharge from fractures in fine-grained shale and mudstone. C.
1,507-1,622	3.3	26.0	8.8	2,070	143	3.2	Discharge from thick sandstone beds. C.
1,080-1,285	8.1	26.0	8.7	2,070	114	9.7	Discharge from sandstone and possibly limestone beds. Producing enough gas to sustain flame at end of discharge pipe. C.
750-950	6.0	25.0	8.6	1,970	([1])	—	Test was inconclusive due to the presence of large amounts of gas that probably entered the well bore through vertical fractures. C.

[1] Pressure measurements did not stabilize.

Table 6.--Percentage of flow and combined shut-in pressures from perforated zones measured at test hole 1, (D-11-24)7acd-1

Perforated zone (ft)	Average discharge (gal/min)	Combined shut-in pressure (ft above land surface)	Percentage of total flow
1,092-1,112	3.9	162	34
1,148-1,158	.5	155	4
1,204-1,214	.2	155	2
1,250-1,260	1.7	144	15
1,304-1,314	3.5	139	30
1,355-1,365	.2	157	2
1,392-1,402	.5	160	4
1,464-1,474	.3	152	2
1,516-1,526	.3	171	3
1,566-1,576	.5	191	4
1,755-1,765	0	0	0

Table 7.--Lithologic log of test hole 2, (D-13-23)26bdc-1

Interval (ft)	Description
0- 6	No data
6- 10	Oil shale
10- 20	Marlstone and oil shale, fine laminations
20- 30	Oil shale; abundant pyrite, small reaction to hydrochloric acid
30- 40	Sandstone, bituminous; marlstone and oil shale
40- 50	Limestone, white and sandy; oil shale
60- 70	Oil shale; some bituminous sandstone
70- 80	Shale (siltstone?), green and oil shale; bituminous sandstone
80- 90	Shale, green
90-100	Shale, green; some bituminous sandstone
110-120	Shale, green, and marlstone(?)
120-130	Shale, green, and white sandstone
130-140	Sandstone, bituminous, and green shale
140-150	Shale, light-green; black mineral (gilsonite?)
150-160	Shale, green, powdery, reacts strongly to hydrochloric acid
160-170	Shale, green
170-180	Sandstone, slightly bituminous,green shale and some white sandstone with pyrite
180-190	Shale, green and limestone(?)
190-200	Limestone, oolitic, slightly bituminous, and green shale
200-210	Shale, green, and slightly bituminous sandstone
210-220	Sandstone and green shale
220-230	Shale, green
230-240	Limestone, oolitic
240-250	Limestone, oolitic, and green shale

Table 7.--Lithologic log of test hole 2, (D-13-23)26bdc-1 - Continued

Interval (ft)	Description
250-260	Shale, green
260-270	Sandstone and green shale
270-280	Shale, green, and sandstone
280-290	Sandstone and green shale
290-300	Siltstone, light-green to brown
300-330	Shale, green
330-340	Shale, green, with some biotite
340-350	Shale, light-green to brown
350-360	No data
360-370	Sandstone, oolitic, fine-grained, and green shale; reacts slowly to hydrochloric acid
370-380	Shale, green, and fine-grained white sandstone
380-390	Shale, green
390-400	Siltstone, green, and some white siltstone
400-410	Siltstone, green to brown, well cemented(?) cuttings much larger than above
410-420	Siltstone, green-brown, limy; large cuttings as above,
420-430	Sandstone, white, calcareous, some feldspar, cuttings well cemented; limestone and oolitic limestone
430-440	Siltstone, green, and limy, sandy, light-orange,
440-450	Sandstone; fine-grained, green, siltstone; oolitic limestone
450-460	Sandstone, white, fine-grained, with accessory minerals; limy green siltstone and limestone
460-470	Siltstone, green and white, fine-grained, some limestone
470-480	Siltstone green; sandstone fragments
480-490	Siltstone, green; some oolitic limestone
490-500	Sandstone, gray to white, and green siltstone, sandstone contains abundant biotite, some muscovite, and a metallic mineral (zircon or rutile?)

Table 7.--Lithologic log of test hole 2, (D-13-23)26bdc-1 - Continued

Interval (ft)	Description
500-510	Sandstone, fine-grained; white-green accessory mineral; Large piece of red limy siltstone, (Renegade Tongue of the Wasatch Formation?)
510-520	Sandstone, green to white, fine-grained; biotite; brown and green siltstone
520-530	Siltstone, green and brown, white limestone; and some sandstone
530-550	Limestone and green siltstone
550-560	Sandstone, fine-grained; green siltstone
560-570	Siltstone, green, tan to white; some accessory minerals present; some oolitic sandstone and fine-grained, white sandstone
570-600	Siltstone, green, white, and some brown; some sandstone
600-610	Siltstone, green, brown, and white; limestone and fine-grained, white sandstone.
610-620	Siltstone, green, and silty limestone; fine-grained, slightly oolitic limestone
620-630	Limestone and fine-grained sandstone; white and green accessory minerals (biotite and chlorite?)
630-640	Sandstone and limestone
640-650	Sandstone, white, fine-grained, less friable than above, and black to green, sandy siltstone
650-660	Sandstone and green siltstone
660-680	Siltstone, green, and oolitic limestone
680-700	Siltstone, brown, sandy; white sandstone and green siltstone (Renegade Tongue of the Wasatch Formation?)
700-710	Siltstone, brown and black; green sandstone
710-720	Siltstone, brown, black, and white sandstone
720-730	Sandstone, white; black, and some green siltstone
730-740	Sandstone, white, fine-grained; some green siltstone
740-750	Siltstone, black, and white sandstone

Table 7.--Lithologic log of test hole 2, (D-13-23)26bdc-1 - Continued

Interval (ft)	Description
750- 760	Sandstone, white; black and brown siltstone
760- 770	Siltstone, red-brown; some sandstone
770- 780	No data
780- 790	Sandstone, green; green, and red-brown siltstone
790- 800	Sandstone, green, and green-black siltstone
800- 810	Sandstone, gray
810- 830	Sandstone, gray; some gray-black siltstone
830- 850	Siltstone, gray; limestone and oolitic limestone
850- 860	Sandstone, gray, fine-grained; some oolitic sandstone
860- 870	Sandstone, gray, fine-grained; some light-brown siltstone
870- 880	Siltstone, light-brown, some limestone
880- 890	No data
890- 900	Sandstone, fine-grained; gray siltstone and oolitic limestone
900- 910	No data
910- 920	Sandstone, gray, fine-grained; some black siltstone
920- 930	Same as above with large piece of red-brown siltstone
930- 940	Limestone, green to white; fine-grained sandstone; and red-brown siltstone
940- 960	Siltstone, red-brown; some green to white sandstone
960- 970	Sandstone, gray
970- 980	Sandstone, gray; red and gray siltstone
980-1,000	Sandstone, gray to white; some glauconite(?)
1,000-1,010	Same as above with gray siltstone
1,010-1,020	No data
1,020-1,030	Siltstone, yellow, gray, and light-brown; some white sandstone

Table 7.--Lithologic log of test hole 2, (D-13-23)26bdc-1 - Continued

Interval (ft)	Description
1,030-1,090	No data
1,090-1,110	Sandstone, gray to white; gray siltstone
1,110-1,130	No data
1,130-1,150	Siltstone, gray; gray to white sandstone
1,150-1,170	Sandstone, gray, and oolitic limestone
1,170-1,290	No data

Table 8.--Drilling log of test hole 2, (D-13-23)26bdc-1

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (C°)	Remarks
0				Started drilling surface hole.
15				Change from oil shale to limestone or shaly limestone.
40		9,000	15.0	Prior to setting surface casing, obtained three-bottle water sample. pH = 8.7.
41				Drilled with air.
140				Fine-gray sandstone at 135 feet.
150				Gilsonite pieces at 142 and 145 feet.
190				Limestone.
200				Do.
210				Intermittent green siltstone and green shale.
220				Sandstone and some tar sand.
230				Alternating green shale and white limestone.
240				Asphalt in sandstone with limestone layers (asphalt may have been diesel fuel).
280				Green shale.
290				Do.
390				May have penetrated water-yielding zone (definite decrease in dust).
391				Almost no dust.

Table 8.--Drilling log of test hole 2, (D-13-23)26bdc-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (C°)	Remarks
392				Enough water so that drilling was stopped to replace a rubber seal. No water at surface.
400				Drilled with mist. Injected water at a rate of about 4 gal/min with a specific conductance of 6,100 μmhos/cm. Total discharge from hole about 6 gal/min.
420	6			Not enough clear water to sample.
430	4			No return water or cutting at 432 feet.
440	1			Unable to obtain sample.
450	8			Shale and some sandstone.
460	4			Sandstone and shale (slightly limy).
470	7			Sandstone. Injection rate was 4.5 gal/min.
480	4			Sandstone and some shale.
490	8			
500	5			Sandstone and shale.
520	7			During shutdown, water level apparently came up in well. Injection rate increased to 9.5 gal/min.
530	30			Discharge increased.
540	11			Discharge sporadic.
550	12			Do.

Table 8.--Drilling log of test hole 2, (D-13-23)26bdc-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (C°)	Remarks
560	10			Discharge sporadic, volume of drilling air increased.
570	15			
580	18			Sandstone, discharge estimated.
590	24			Sandstone.
600				Discharge increased when hole cleaned with air. Approximately 300 feet of water in hole.
607	13			
610	24			Shale and gray sandstone.
612	36			Discharge increased.
620				Too much air prevented discharge measurement.
630	24			
640	36			
650	17			
658				Discharge increased.
660	30			
670	28			Discharge increased.
680	20			Change to brown color.
690	20			Discharge increased.
700	28			Do.
710	36			Discharge increased sporadically.
720	36			Retaining pond discharged 45 gal/min.
730	30			

Table 8.--Drilling log of test hole 2, (D-13-23)26bdc-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (C°)	Remarks
740	40			Discharge increased.
750	60			Do.
760	60			
770	60	2,450	18.5	Specific-conductance and water-temperature measure obtained from retaining pond that discharged 14 gal/min. That discharge stopped when pipe changed.
780	48			Discharge fluctuated.
790	48			
800	60			Discharge from retaining pond was approximately 54 gal/min and increased.
810	66			Discharge erratic; water contained fine sand. Retaining pond discharged 70 gal/min.
815	80			Retaining pond discharged about 80 gal/min.
820	120			Fine gray sandstone. All subsequent discharge readings were obtained from the retaining pond because of inability to get accurate readings from discharge pipe.
830	120	2,600	17.5	
840	120			
850	180			
860	120	2,600	17.5	
870	150	2,600	17.5	
880	120	3,600	19.0	Discharge estimated.

Table 8.--Drilling log of test hole 2, (D-13-23)26bdc-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (C°)	Remarks
890	120	4,000	19.0	Discharge estimated.
900	102	3,800	17.5	Drilling rate increased, possibly a change in permeability.
910	120	3,600	17.0	
920	120	3,300	17.5	
930	120	3,300	17.0	
940	90	3,200	17.0	Brown-colored discharge.
950	60	3,200	17.5	Brown, fine cuttings, probably Renegade Tongue of Wasatch Formation.
960	60	3,100	17.5	Discharge estimated. Still reddish-brown.
970	60	3,300	17.5	Change in color to light-brown. Drilling rate rate increased, possibly a change in permeability.
980	120	3,000	17.0	Same color.
990	120	3,000	17.0	Small cutting sample. No change in color.
1,000	120	2,800	16.5	
1,010	120	2,900	17.0	
1,020	90	3,300	17.0	
1,030	120	3,300	18.5	Unable to obtain cuttings.
1,040	120	3,300	18.0	Deep brownish-red color.
1,050	103	3,200	18.0	
1,060	90	3,300	18.0	

Table 8.--Drilling log of test hole 2, (D-13-23)26bdc-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (C°)	Remarks
1,073		3,000	18.5	No discharge measured because of plugged pipe.
1,080	120	2,900	18.0	
1,085				Color change from red-brown to gray.
1,090	144	2,800	18.0	Gray.
1,100	180	3,000	18.5	
1,105				Soft brown material.
1,110	144	3,000	18.0	Color change to gray.
1,120	120	3,000	18.0	
1,130	144	3,000	18.0	
1,140	180	2,800	18.0	
1,150	144	2,900	18.0	
1,160	144	2,200	18.5	Increased air pressure required to clean out hole indicated a more permeable zone.
1,170	156	2,100	18.5	
1,180	144	2,200	18.5	
1,190	156	2,150	18.5	
1,200	180	2,200	18.0	
1,210	180	2,100	18.5	
1,220	180	2,150	18.6	
1,230	170	2,200	18.5	
1,240	144	2,150	18.0	
1,250	150	2,150	18.4	Color change from gray to brown.
1,260	240	2,050	19.0	Discharge estimated. Drilled fast from 1,260-1,268 feet.

Table 8.--Drilling log of test hole 2, (D-13-23)26bdc-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
1,270	240			Hard drilling from 1268-1270 feet.
1,290	200	1,900	19.5	Discharge estimated. Retaining pond washed out.

Table 9.--Drilling log of test hole 3, (D-13-21)10ada-1

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
0				Started drilling surface hole.
15				Slow drilling.
17				Fast drilling, some coarse particles.
20				Do.
92				Soft bed (probably clay).
110				Slow drilling.
133				Coarse sand caved in and filled 15 feet of hole; redrilled.
159				Shut down to set surface casing. Drilled cement out.
160	140	3,420	12.5	Discharge estimated.
175	120	3,400	13.0	Do.
183	200			Hole caved, stopped drilling. Water level at 40 feet below land surface, began drilling with mud.
190				Consolidated rock.
210				Blue shale.
220				Sandstone.
230				Light-gray siltstone at 235 feet.
240				White sandstone or limestone.
246				Set casing and cemented.
250		2,400	12.5	
260		1,100	12.0	Small amount of water.

Table 9.--Drilling log of test hole 3, (D-13-21)10ada-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
270		1,100	12.0	
280		1,300	12.0	
290		1,100	12.0	
300		900	12.0	Discharge increased (not enough to measure).
310		1,400	12.0	
320		1,250	12.0	
330		1,000	12.0	
340		1,350	12.5	
350	12	1,350	12.5	
360	14.4	1,300	12.5	
370	27.7	1,200	12.0	
380	27.7	1,500	13.0	
390	25.7	1,200	13.0	
400		1,700	13.5	
410		1,700	13.5	
420		1,700	14.0	
430		1,650	14.0	
440		1,600	14.5	
460		1,000	15.5	Sandstone, fast drilling.
470		1,000	16.0	Sandstone, discharge increased.
480		1,000	16.0	Sandstone.
490	126	1,000	16.0	
500	135	1,000	16.0	
510	139	900	15.5	

Table 9.--Drilling log of test hole 3, (D-13-21)10ada-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
520	162	950	16.0	
530	166	900	16.0	
540	171	970	16.0	Some iron pyrite.
550	189	960	16.0	
560	189	960	16.0	
570	189	960	16.0	
580		950	16.0	
590	198	950	16.0	
600	193	940	15.5	
610	189	950	15.5	
620	189	950	15.5	
630	189	960	15.5	
640	216	920	15.5	
650	211	920	15.5	
660		920	15.5	
670	216	920	15.5	
680		920	15.5	
690	180			
700	238	950	15.0	Flume overflowed. Discharge estimated.
710	240	920	15.5	Discharge estimated.
720		950	15.5	Red sandstone (Renegade Tongue of Wasatch Formation?)
730	200	950	16.0	
740		960	16.0	Trace of oil.
750		970	16.0	

Table 9.--Drilling log of test hole 3, (D-13-21)10ada-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (µmho/cm)	Water temperature (°C)	Remarks
770	175	1,000	16.0	Installed 6-inch flume.
780	175	990	16.0	Red sandstone.
790	171	1,000	16.0	Gray sandstone.
800	184	990	16.5	
810	175	990	16.5	
820	193	990	16.5	
830	193	990	16.5	
840	184	1,000	16.0	
850	193	1,000	16.5	
860	193	990	16.5	Possible tar sand.
870	184	990	16.5	
880	184	990	16.5	
890	184	980	16.5	
900	162	980	16.5	
910	193	990	16.5	
920	211	950	16.5	Discharge increased.
930	202	950	16.5	
940	193	950	16.5	
950	211	950	16.5	
960	211	920	17.0	
970		900	17.0	
980	171	950	16.5	
990	202	880	17.0	
1,000	202	790	16.5	
1,010	225	900	17.0	

Table 9.--Drilling log of test hole 3, (D-13-21)10ada-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
1,020	211	900	17.0	
1,030	211	900	17.0	
1,040	233	900	17.0	
1,050	216	920	17.0	
1,060	202	900	17.0	
1,070	216	920	17.0	
1,080	216	910	17.0	
1,090	211	940	17.0	
1,092	211	940	17.0	Circulated with air.
1,092		905	16.5	Water-quality sample collected, water clear.

Table 10.--Drilling log of test hole 4, (D-12-24)19dbc-1

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (C°)	Remarks
640	6	5,000	9.0	Sandstone.
650	6	6,500	9.0	
690	8	4,600	9.0	
720				Gray sandstone.
760	8			Fine-grained sandstone.
770	10			
780	10			Fine-grained, gray sandstone.
790	10	3,200	10.0	Fine-grained sandstone.
800	10	4,000	10.0	Temperature estimated. Stopped drilling, set casing and cemented.
810				Sandstone. Small amount of water.
830				Mostly black shale. Some water discharged. Injected 8-10 gal/min at 14.0°C and a specific conductance of 7,400 μmho/cm^2.
840	18	7,000	14.0	Medium-grained sandstone.
850	10	6,800	14.0	
860	10	6,700	15.0	
870	8	6,900	14.5	
880	12	6,800	15.0	
890	12	6,800	15.0	
900	13	6,800	14.5	
910	9	6,500	14.5	
920	12	6,500	14.0	
930	12	6,200	14.5	

Table 10.--Drilling log of test hole 4, (D-12-24)19dbc-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (C°)	Remarks
940	13	6,200	14.0	
950	16	6,200	14.0	
960	20	6,100	12.5	
970	15	6,100	13.5	
980	15	6,000	13.5	Discharge estimated.
990	12	5,800	13.5	Discharge surged to as much as 30 gal/min.
1,000	15	5,800	13.5	Discharge estimated.
1,010	18	6,900	13.0	
1,012		5,600	13.0	
1,020	10	5,750	13.0	Discharge estimated.
1,030	10	5,500	13.0	
1,040	10	5,900	12.5	
1,050	8	4,750	13.5	White limestone at 1,044 feet. Discharge estimated.
1,060	13	5,850	13.0	Discharge estimated.
1,070	10	5,550	13.0	Blue siltstone.
1,080	11	4,800	13.0	
1,090	10	4,750	13.0	
1,100	10	5,550	13.0	Fine-grained, gray sandstone at 1,098 feet.
1,110	24	3,700	13.5	Abrupt change at 1,102 feet to lighter color and more discharge.
1,120	25	4,000	14.5	
1,130	28	4,800	13.5	Gray sandstone.
1,140	24	3,500	15.0	

Table 10.--Drilling log of test hole 4, (D-12-24)19dbc-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (C°)	Remarks
1,150	21	3,600	15.0	
1,160	32	3,800	15.0	
1,170	36	3,600	15.0	
1,180	32	3,050	17.0	
1,190	32	3,200	17.0	
1,200	27	3,120	18.0	
1,210	34	3,050	17.5	
1,220	34	3,000	18.0	
1,230	33	3,000	18.5	
1,240	33	2,820	18.5	
1,250	25	2,960	19.0	
1,260	32	2,900	18.5	
1,270	30	3,100	19.5	
1,280	22	3,160	19.0	
1,284				Black mudstone, air pressure during drilling was more than 400 lbf/in^2.
1,290	20	2,550	19.5	Gray sandstone.
1,300	20	2,950	19.5	Color of discharge water turned from gray to brown.
1,310		2,860	19.5	
1,320	20	2,500	19.5	
1,330	25	2,640	19.5	
1,340	25	2,520	19.5	
1,360	36	2,150	20.5	Drilling fast at 1,355 feet.

Table 10.--Drilling log of test hole 4, (D-12-24)19dbc-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
1,370	36	1,900	21.5	
1,380	40	1,720	22.0	Injection water had specific conductance of 4,500 $\mu mhos/cm^2$ and a temperature of 17.0 °C.
1,400	37	1,780	22.0	Last 10 feet drilling was slower.
1,402	42	1,300	22.0	Collected water-quality sample after flushing 0.5 hour.

Table 11.--Drilling log of test hole 5, (D-11-25)26aab-1

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
120	4	4,400	15.5	
130	10			
140	15	3,000	16.0	Discharge estimated, dark gray in appearance.
150	8	3,500	16.0	
158	12	2,500	17.0	
170	5		16.0	
180	24		16.0	
190	15	2,200	16.5	
200	26	2,100	17.0	
210	14	2,100	17.0	
220	11	2,200	17.0	
230	19	2,200	17.0	
240	24	2,100	16.5	
250	16	2,200	16.5	
260	20	2,000	16.0	
270	19	2,200	16.0	
280	23	2,200	16.0	
290	16	3,100	14.0	
300	16	3,200	14.0	
310	12	3,400	13.0	
320	9	3,500	12.0	
330	8	3,800	12.5	
340	36	3,800	13.0	Discharge estimated.

Table 11.--Drilling log of test hole 5, (D-11-25)26aab-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
350	30	3,800	12.5	Discharge estimated.
360	33	3,800	12.5	Do.
370	30	3,600	12.5	Do.
380	30	2,800	12.5	Drilling additive may have affected specific conductance.
390	40	1,450	10.0	Discharge estimated.
400	45	2,500	11.0	Do.
410	51	3,600	10.0	Discharge estimated. Specific conductance meter malfunctioned.
420	45	3,350	10.0	Do.
430	36	3,200	10.0	Do.
440	45	2,800	9.0	
450	45	3,050	9.5	
460	28	3,600	9.5	
462		3,600	9.5	
470	36	3,200	11.0	
480	40	3,300	13.0	
490	21	3,200	11.5	
500	24	3,200	12.0	
510	40	2,000	13.0	
520	36	2,000	13.0	
530	45	2,000	13.0	
540	36	2,000	13.0	
550	33	1,000	14.0	

Table 11.--Drilling log of test hole 5, (D-11-25)26aab-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
560	36	1,000	16.0	
570	36	1,200	15.0	
580	36		16.0	
590	40	3,200	14.0	
600	45	4,000	14.0	
610	45	2,900	16.0	
620	36	4,000	16.0	
630	36	4,000	17.0	
640	45	4,000	16.5	
650	40	3,000	16.0	
660	45	2,000	15.5	
670	45	1,200	15.5	
680	45	1,000	15.0	
690	36	1,200	15.0	
700		3,000	15.0	
710	51	1,600	15.0	
720	51	3,800	16.0	
730	51	1,400	15.0	
740	45	2,800	16.0	
750	51		15.0	
760	51		15.0	
770	60	1,000	15.0	
798			15.0	Hole caved, was unable to lift cuttings. Circulation was with air only. Collected water-quality sample.

Table 12.--Drilling log of test hole 6, (D-12-22)1bbb-1

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
30				Hole caved, began drilling with mud.
50				Lost circulation, waited for mud.
51				Drilled with mud in unconsolidated alluvium, gravel and sand.
110				Hard, probably marlstone.
120				Hard oil shale.
130				Oil shale.
135				Set casing.
170				Hard shale. Drilled with air.
180	18	17,000	13.0	Discharge estimated.
190	33	21,000	14.5	Do.
200				Sandstone.
210	12	14,000	15.0	Shale, discharge estimated.
220	30			Do.
230	30	17,500	14.5	Discharge estimated.
240	30	17,500	15.0	Do.
250	54	25,000	14.5	Do.
260	65	26,500	14.0	
280	12	26,000	14.0	Discharge estimated.
290		26,000	14.0	
300		28,000	13.5	
310		28,000	12.5	

Table 12.--Drilling log of test hole 6, (D-12-22)1bbb-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (µmho/cm)	Water temperature (°C)	Remarks
320	13	24,000	12.5	
330	11	25,000	13.0	
340	11	25,000	13.0	Hole caved in.
350		22,000	13.0	
360		27,000	14.0	
370	11	32,000	14.0	
380	13	29,000	14.0	
390	16	30,000	14.0	
400	16	29,000	14.0	
410	16	30,000	14.0	
420	16	29,000	14.0	
430		29,000	14.5	
440		30,000	14.0	
450	18	30,000	14.0	
460	13	33,000	14.0	
470	18	29,000	14.0	
480	18	30,000	14.0	Fine-grained sandstone.
490	13	31,000	13.5	
500	16	30,000	14.0	
510	16	30,000	13.5	
520	13	29,000	14.0	
530	11	27,000	13.5	
540	11	27,000	12.0	
550	16	27,000	12.0	
560	11	27,000	12.5	

Table 12.--Drilling log of test hole 6, (D-12-22)1bbb-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
570	16	22,000	12.5	
580	18	24,000	12.0	
590	18	27,000	11.5	
600	18	27,000	12.0	
620	16	27,000	12.0	
630	16	25,000	12.0	
640		25,000	12.0	
650	13	24,000	10.5	
660	20	14,500	9.5	
670	11	22,500	11.0	
680	20	21,000	13.0	
690	20			
700	20	17,000	13.0	
710	9	20,000	14.0	
720	16	22,000	14.0	
730	43	13,000	16.0	
740	67	10,000	18.0	
750	76	10,000	18.0	
760		12,000		
764	76	9,600	18.0	Collected three-bottle water sample, water green.
770	76	11,500	18.5	
780	65	11,000	18.5	
790	72	11,000	18.5	
810	72	9,500	18.0	Coarse-grained sandstone.

Table 12.--Drilling log of test hole 6, (D-12-22)1bbb-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
820		10,550	18.0	
830	81	10,000	19.0	
840	76	10,500	18.5	
850	57	10,000	18.5	Fine-grained, gray sandstone.
860	98	9,000	19.0	Fine- and coarse-grained sandstone.
870	111	8,500	20.0	
880	116	8,500	20.0	
890	121	8,500	20.0	
900		8,000	20.0	
910		8,000	20.0	Coarse-grained sandstone.
920	121	8,000	20.0	
930	121	8,000	20.0	
940	145	8,000	20.5	
950	98	7,500	20.5	
960		8,500	20.0	Fine-grained, gray sandstone. Flume washed out; replaced with larger flume.
970		7,500	21.0	
980	170	7,000	21.0	
1,000	170	7,000	21.0	Stopped drilling to set casing.
1,000	22.5	1,400	22.5	After several hours, the hole began to flow from annular space. Saline water from upper part of hole was flushed and specific conductance decreased. Annular space was welded shut before drilling resumed.
1,001				Resumed drilling with air.

Table 12.--Drilling log of test hole 6, (D-12-22)1bbb-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
1,040		1,460	17.0	Oolitic limestone last few feet. Unable to measure discharge until flow stabilized.
1,050		1,460	17.0	
1,060	31	1,460	19.5	
1,070	40	1,520	20.5	
1,080	40	1,430	19.5	
1,090	22	1,430	21.0	Thin belt of limestone at approximately 1,085 feet.
1,100	40	1,400	20.5	
1,110	22	1,410	21.0	
1,120	49	1,400	21.5	
1,130		1,390	22.0	
1,140		1,400	22.0	Coarse-grained sandstone.
1,150	45	1,400	22.0	
1,160	45	1,400	22.0	
1,170	45	1,400	20.5	Fine-grained, gray sandstone.
1,180	40	1,400	22.0	
1,190		1,400	22.0	
1,200	54	1,400	22.0	
1,210	54	1,400	22.0	Fine-grained, tan sandstone, possibly limestone.
1,220	67	1,360	21.0	
1,230	67	1,360	21.0	
1,240	49	1,400	20.0	

Table 12.--Drilling log of test hole 6, (D-12-22)1bbb-1 - Continued

Depth (ft)	Discharge (gal/min)	Specific conductance (μmho/cm)	Water temperature (°C)	Remarks
1,250	49	1,390	20.0	
1,260	67	1,360	20.5	Tan sandstone or limestone.
1,270	72	1,360	20.5	Gray sandstone.
1,280	49	1,360	20.0	
1,310	72	1,320	19.5	
1,320	72	1,320	20.5	
1,330	81	1,340	19.5	
1,340	81	1,300	21.0	Slow drilling.
1,350	81	1,270	21.5	Dark-colored sandstone.
1,360	81	1,330	21.5	Dark-red sandstone.
1,370	72	1,320	22.5	Gray sandstone and shale.
1,380	72	1,420	22.5	Gray sandstone.
1,390	85	1,400	22.5	Fine-grained, light-gray sandstone.
1,400	99	1,350	23.0	Darker-colored sandstone.
1,410	99	1,410	22.5	Sandstone and some oil shale.
1,420	85	1,410	23.5	
1,430	112	1,400	23.0	Gray to light-brown sandstone.
1,440	125	1,340	23.0	Mostly light-brown, fine-grained sandstone.
1,450	99	1,370	23.0	
1,460	117	1,370	23.5	Coal(?) at 1,455 feet.
1,470	117	1,370	23.5	
1,480	130	1,370	23.0	
1,490	125	1,370	23.5	
1,497				Stopped drilling, flushed hole with air. Collected three-bottle water sample.