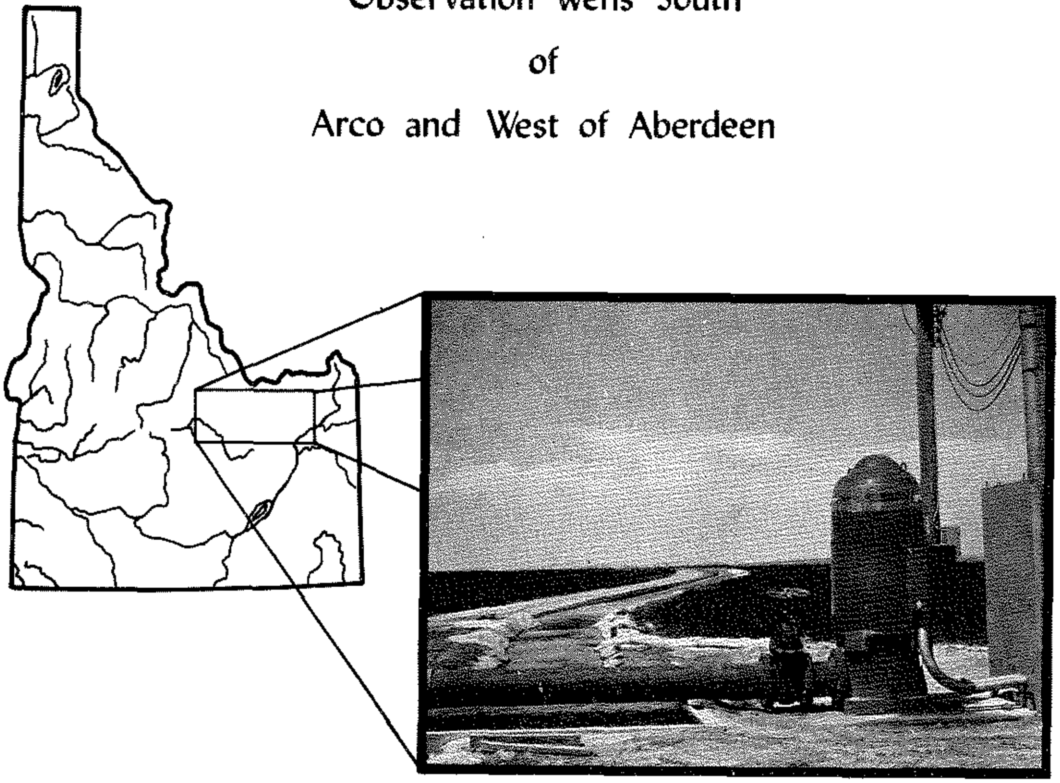
A PROGRESS REPORT ON RESULTS OF TEST-DRILLING AND GROUND-WATER INVESTIGATIONS OF THE SNAKE PLAIN AQUIFER, SOUTHEASTERN IDAHO

PART 1

Mud Lake Region, 1969-70

PART 2

Observation Wells South
of
Arco and West of Aberdeen



IDAHO DEPARTMENT OF WATER ADMINISTRATION

WATER INFORMATION BULLETIN NO. 32

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RESULTS OF TEST–DRILLING AND GROUND–WATER INVESTIGATIONS OF THE SNAKE PLAIN AQUIFER, SOUTHEASTERN IDAHO

Part 1
Mud Lake Region, 1969-70

and

Part 2
Observation Wells South of Arco and West of Aberdeen

By

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Prepared by the United States Geological Survey

in cooperation with

Idaho Department of Water Administration

Published by

Idaho Department of Water Administration

R. Keith Higginson

Director

October 1973

PART 1

MUD LAKE REGION, 1969-70

PREFACE

The Snake Plain aquifer, as defined by Mundorff, Crosthwaite, and Kilburn (1964, p. 142), is a series of basalt flows and intercalated pyroclastic and sedimentary materials that underlies the Snake River Plain east of Bliss (fig. 1). The aquifer is about 9,500 square miles in areal extent and yielded about a million acre-feet of water to wells in 1969. Approximately 6½-million acre-feet of water is recharged annually to this aquifer by seepage loss from the Snake River and its tributaries, by underflow from tributary valleys, by the downward percolation of water applied for irrigation, and by precipitation on the Plain. Water is discharged from the aquifer through springs and by pumping for irrigation, municipal, industrial, stock, and domestic use. Although the aquifer has been extensively studied and its general extent and properties are known, it is so large and thick that data on the distribution of basalt flows and interbedded sedimentary deposits that control the movement of ground water have not been obtained at several places of great current importance. Also, there are large areas where the position of the water table and the potential yield of the aquifer are not known.

The objectives of this investigation are to obtain (1) information descriptive of elevations and fluctuations of the water table, water-table gradients, and the distribution of transmissivity, in areas of the Snake Plain aquifer where data are lacking; (2) details of stratigraphic and hydrologic properties at localities selected as being suitable for pumping large quantities of ground water in exchange for surface water[1]; (3) hydrologic details in the eastern part of this aquifer, where the greatest amount of recharge occurs, so as to interpret better the distribution of recharge to spring discharge areas; and (4) water-level and stratigraphic data in the area of the Mud Lake-Market Lake barrier so as to better define recharge relations and large water-level differentials occurring in and around this barrier. In addition, it is anticipated that all the data collected will be integrated into an existing analog model of the Snake Plain aquifer so that the long-term effects of development of the aquifer can be better predicted.

The Idaho Department of Water Administration has the responsibility of administering the water resources of Idaho, and for this reason it is vitally interested in basic data descriptive of the water resources of the Snake River Plain. Because the U. S. Bureau of Reclamation is actively developing the water resources available in various parts of the Plain, it needs basic data which will be useful in selecting areas suitable for development and in evaluating effects of development. The U. S. Geological Survey has a responsibility for collecting basic data and for appraising the water resources of Idaho. Because of their common interests, and in recognition of the need for information about the water resources of the Snake Plain aquifer, these three agencies entered into a cooperative agreement whereby the U. S. Geological Survey and the U. S. Bureau of Reclamation would initiate, in

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[1] The U. S. Bureau of Reclamation is investigating the feasibility of diverting surface water from presently irrigated land to areas of inadequate surface-water supply or areas of no surface-water supply and replacing the diverted surface water with ground water.

July 1969, a 4-year project whose goal is to satisfy the objectives described above.

To provide for timely release of the data collected during this 4-year project, it is planned that a series of progress reports describing the work accomplished during each phase of the project will be prepared. This report, which describes the work accomplished in the Mud Lake region in the northeastern part of the Snake River Plain during the period July 1969 to July 1970, is the first report of this series.

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A PROGRESS REPORT ON
RESULTS OF TEST–DRILLING AND GROUND–WATER INVESTIGATIONS
OF THE SNAKE PLAIN AQUIFER, SOUTHEASTERN IDAHO

Part 1

Mud Lake Region, 1969-70

By E. G. Crosthwaite

ABSTRACT

The results of drilling test holes to depths of approximately 1,000 feet in the Mud Lake region show that a large part of the region is underlain by both sedimentary deposits and basalt flows. At some locations, predominantly sedimentary deposits were penetrated; at others, basalt flows predominated. The so-called Mud Lake-Market Lake barrier denotes a change in geology. From the vicinity of the barrier area, as described by Stearns, Crandall, and Steward (1938, p. 111), up the water-table gradient for at least a few tens of miles, the saturated geologic section consists predominantly of beds of sediments that are intercalated with numerous basalt flows. Downgradient from the barrier, sedimentary deposits are not common and practically all the water-bearing formations are basalt, at least to the depths explored so far. Thus, the barrier is a transition zone from a sedimentary-basaltic sequence to a basaltic sequence. The sedimentary-basaltic sequence forms a complex hydrologic system in which water occurs under water-table conditions in the upper few tens of feet of saturated material and under artesian conditions in the deeper material in the southwest part of the region. The well data indicate that southwest of the barrier, artesian pressures are not significant. Southwest of the barrier, few sedimentary deposits occur in the basalt section and, as described by Mundorff, Crosthwaite, and Kilburn (1964), ground water occurs in a manner typical of the Snake Plain aquifer. In several wells, artesian pressures are higher in the deeper formations than in the shallower ones, but the reverse was found in a few wells. The available data are not adequate to describe the water-bearing characteristics of the artesian aquifer nor the effects that pumping in one zone would have on adjacent zones. The water-table aquifer yields large quantities of water to irrigation wells.

Although the Mud Lake region is within the Snake River Plain, the geology and hydrology of the region differs significantly from that of most of the Plain, and for this reason the aquifers in the region should be considered as separate hydrologic units. Geologic sections and a fence diagram show that sediments dominate in the region of the Mud Lake-Market Lake barrier whereas basalts are most common in adjoining areas. Tentative correlations of hydrologic units are shown in the cross sections and fence diagram.

As an aid to continued development of needed ground-water supplies in the Mud Lake region, the water-bearing characteristics of the deep artesian aquifers should be tested and exploration of aquifers occurring at depths greater than those penetrated to date should be undertaken.

INTRODUCTION

Purpose and Scope

Water in the Mud Lake region (fig. 1) serves two important functions. Not only is it used for the irrigation of extensive farmlands in the region, but it has been postulated to be an important source of recharge to the Snake Plain aquifer. Movement of recharge to the Snake Plain aquifer is, however, complicated by the fact that in the vicinity of Mud Lake and Market Lake there is a hydrologic barrier to the movement of ground water. This barrier occurs along a northwest-trending line that extends through Market and Mud Lakes. The presence of this barrier is indicated by a change in slope of the water table. Northeast of the barrier the water table is at a relatively shallow depth (a few feet to a few tens of feet) and is very flat (it has a gradient of about 2 feet per mile). Southwest of the barrier the water table is at a considerably greater depth (several hundred feet) and the water table is again relatively flat (the gradient is about 5-10 feet per mile). At the barrier, in the area extending from northwest of Mud Lake to southeast of Market Lake, the water-table gradient is quite steep, about 30-60 feet per mile, and a considerable range occurs in the elevation of water levels in wells screened or perforated at different depths.

Previous investigators (Mundorff and others, 1964, pl. 4) have indicated that about 2.2 million acre-feet of ground water flows across the barrier annually as recharge to the Snake Plain aquifer. Later investigators (Norvitch and others, 1969, p. 39) had difficulty, however, in logically assigning aquifer transmissivity values large enough to transmit this quantity of water through the barrier. This difficulty made apparent the need for additional data descriptive of the geologic and hydrologic characteristics of the barrier.

The purposes of this report are, therefore, to (1) present the data obtained during the period 1969-70 from test wells drilled in and around the barrier and from adjacent areas; (2) describe water-level and stratigraphic relations in and near the Mud Lake-Market Lake barrier as indicated by these data; (3) relate the data to existing hydrologic concepts of the barrier and, where necessary, to revise those concepts; (4) evaluate the adequacy of the data collected to describe existent hydrologic relations; and (5) delineate areas where additional hydrologic data are needed.

Location and General Features

The Mud Lake region is in the northeastern part of the Snake River Plain in eastern Idaho (fig. 1). The Mud Lake basin encompasses a broad, shallow, closed depression about

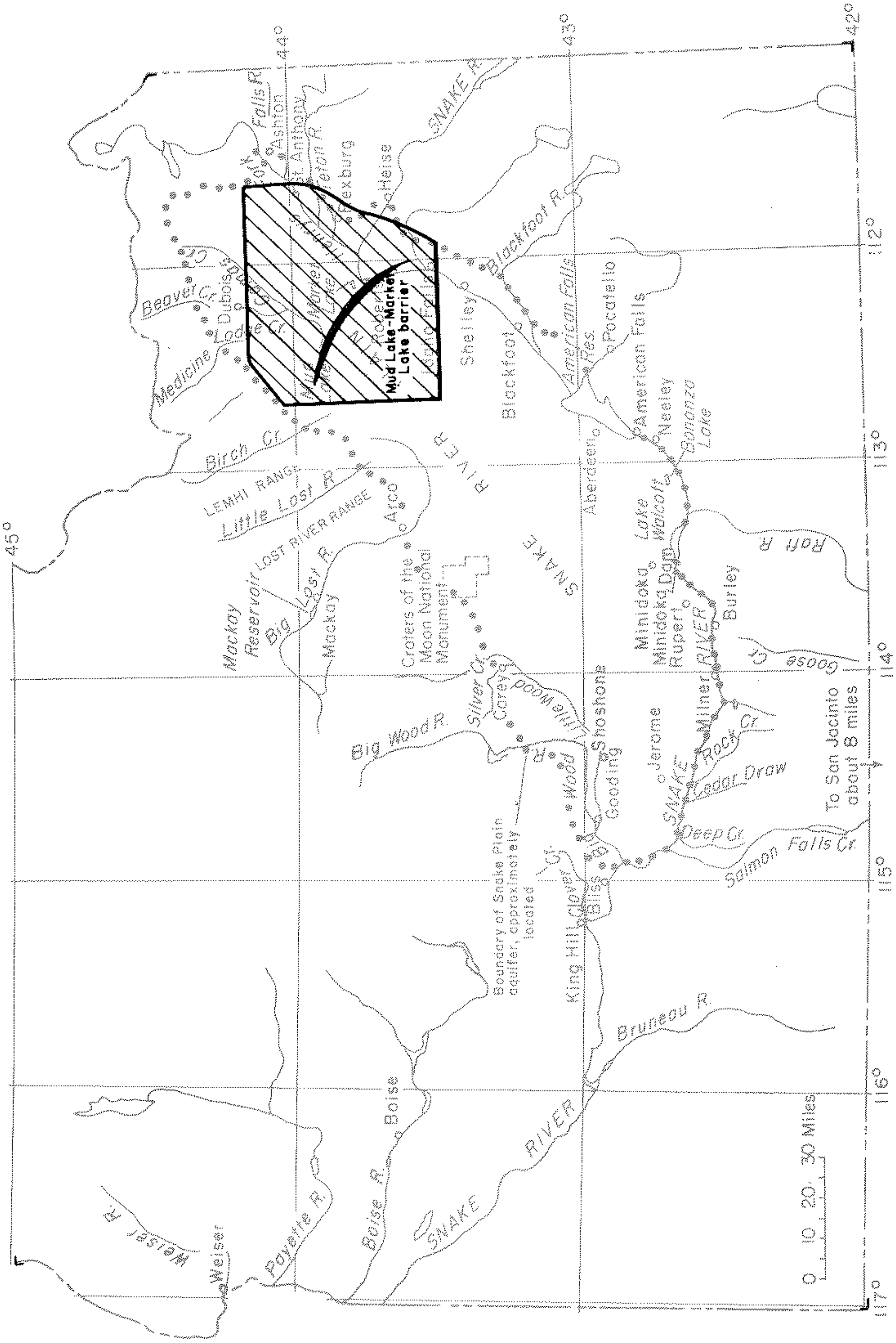

FIGURE 1. Map of southern Idaho showing the Snake River Plain and area covered by this report.

20 miles wide. Mud Lake is in the lowest part of this depression. The Market Lake basin is a much smaller depression that also contains a lake. Market Lake basin is open to the Snake River on the southeast and is separated from the Mud Lake basin by a topographic divide that is a few tens of feet in height. Mud Lake covers about 12 square miles when the lake is full, whereas Market Lake covers only several tens of acres. The principal area of study includes the basins containing the lakes and the area immediately adjacent to the basins. However, to assure that the geology and hydrology of these basins as presented in this report are in harmony with that in adjoining areas, pertinent data from outside these basins are utilized in the following discussions. For the purpose of this report, the study area shown in figure 1 is here designated the Mud Lake region. This is in accord with usage in the first comprehensive report on the area (Stearns and others, 1939).

Previous Work

Stearns, Crandall, and Steward (1938, p. 111) stated that a definite ground-water cascade, caused by a ground-water barrier, exists between the mouth of Birch Creek and Idaho Falls along a curved line that passes through the south side of Mud Lake and the west side of Market Lake. Stearns, Bryan, and Crandall (1939, p. 50-57, 59-60) described a perched water table and a main water table in the vicinity of Mud Lake and the Mud Lake basin. They also described the lakebeds which directly underlie both the Mud Lake and Market Lake basins and the basalt flows which encroach into the basin (Stearns and others, 1939, p. 37-38). Mundorff, Crosthwaite, and Kilburn (1964, p. 132-136) discussed the barrier and ground-water conditions in the Mud Lake area.

Well-Numbering System

The well-numbering system used by the U. S. Geological Survey in Idaho indicates the location of wells within the official rectangular subdivision of the public lands, with reference to the Boise base line and meridian. The first two segments of the number designate the township and range. The third segment gives the section number, followed by three letters and a numeral, which indicate the quarter section, the 40-acre tract, the 10-acre tract, and the serial number of the well within the tract, respectively. Quarter sections are lettered a, b, c, and d in counterclockwise order, from the northeast quarter of each section (fig. 2). Within the quarter sections, 40-acre and 10-acre tracts are lettered in the same manner. Well 4N-35E-14aaa1 is in the NE¼NE¼NE¼ sec. 14, T. 4 N., R. 35 E., and is the first well visited in that tract.

Several wells in the report area are equipped with piezometers and each piezometer has been assigned a well number. The shallowest piezometer in the well has the lowest serial number and the next deeper piezometer has the next higher serial number.

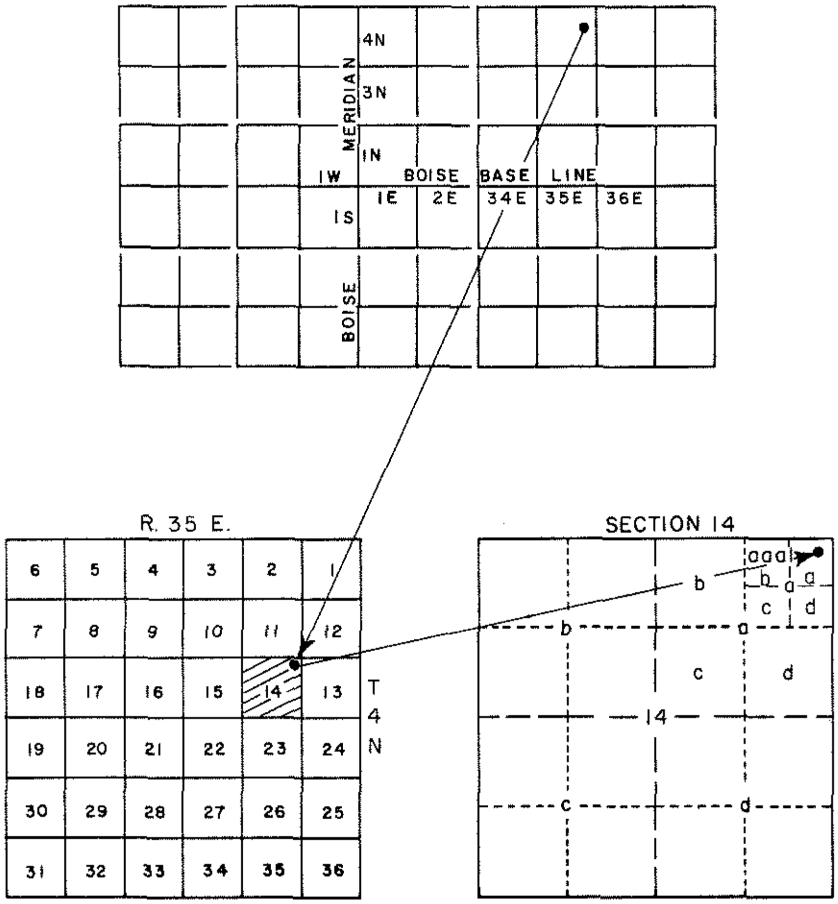

FIGURE 2. Diagram showing well-numbering system. (Using well 4N-35E-14aaa1.)

Acknowledgments

The U. S. Bureau of Reclamation supplied well data including drillers' logs, core samples, and water-level measurements for the seven wells drilled or deepened as part of this study and for other wells constructed during previous test drilling in the Bureau of Reclamation's Lower Teton Basin Project area.

GEOHYDRAULIC RELATIONS OF THE MUD LAKE–MARKET LAKE BARRIER

Previous Concepts of the Mud Lake-Market Lake Barrier

Stearns, Crandall, and Steward (1938, p. 111) state: *The contour lines show that a definite ground-water cascade exists between the mouth of Birch Creek and Idaho Falls, along a curved line passing through the south side of Mud Lake and the west side of Market Lake. Some large faults pass into the region of this cascade from the adjacent mountains and became buried by Pleistocene flows. Faults may cause this ground-water cascade by the downward displacement of the impermeable basement in this area, but it is more probably caused by the ending of clay beds or other perching formations.*

Stearns, Bryan, and Crandall (1939, p. 50) state that *Mud Lake and the water found in shallow wells in the vicinity of the lake form a perched body of water that lies a few hundred feet above the water table of a deeper body of ground water.* They also say that at Market Lake the hydrology and geology are somewhat similar to those at Mud Lake (Stearns and others, 1939, p. 59-60).

In general, previous investigators have noted that northeast and southwest of the Mud Lake-Market Lake barrier where water-table gradients are low (5-10 feet per mile), a very permeable basalt is the principal water-bearing formation, whereas at the barrier, where gradients are steep (30-60 feet per mile), the principal water-bearing formations are less permeable clay, silt, sand, and some gravel. Also, they believed that the ground water occurs principally under perched and water-table conditions, although weak artesian pressures were recognized in shallow wells on the east side of Market Lake (well data in files of U. S. Geological Survey) and in a narrow strip extending from Hamer to the site of former Spring Lake northwest of Mud Lake (Stearns and others, 1939, pl. 13). See figure 3. Using this information, they deduced that the barrier acts as a leaky dam. That is, as water moves laterally through the barrier it also percolates downward through the sedimentary beds. For this reason, the shallow beds contain progressively less water and depths to water increase toward the southwestern edge of the barrier. Soon after irrigation began in the Mud Lake-Market Lake area in the early 1900's, percolation of irrigation water caused an expansion of the perched water table in the sediments (mostly on the south and west sides of the barrier), thereby increasing the volume of saturated sediments. The area of perched water was again increased significantly in recent years, particularly south and west of Mud Lake, because large amounts of ground water pumped in the area north of Mud Lake were conveyed by canals to irrigated tracts west and southwest of the lake.

For convenience in the following discussion, the term *barrier* will be retained, but, as will be pointed out later, the concept of the barrier is changed by the data collected during this study.

Results of Test Drilling

Five wells were drilled to depths of 1,000 feet or more and two pre-existing wells were deepened in the general vicinity of the barrier in the summer and autumn of 1969 by the U. S. Bureau of Reclamation. In 1967 and 1968, prior to the beginning of this study, the Bureau drilled several deep test holes near and northeast of Market Lake. Data from these wells, a few private wells, and from municipal wells several hundred feet deep, provide most of the basis for the interpretations made in this report. Some of these data are summarized in table 1. Drillers' logs and other additional data are presented in the appendix, and well locations are given in figure 5. Pertinent water levels obtained in other wells were also used in this study. However, most of these other wells extend only a few tens to a few hundreds of feet below water level, and drillers' logs for these wells are not presented because they do not indicate geologic and hydrologic conditions to any significant depth.

The five wells constructed for this study were drilled, using air-rotary or cable-tool equipment, to depths of approximately 500 feet and then were core-drilled to approximately 1,000 feet. Deepening of the two pre-existing wells was accomplished by core drilling. Six of these seven wells contain two to five piezometers each. (See Appendix for well-construction diagrams and logs.) The one well in which piezometers were not installed was equipped with a continuous water-level recorder. Although each piezometer is a separate and distinct well that was constructed for the purpose of monitoring water levels, in the interest of conserving space and for ease of presentation, the maps and the geologic sections show only one well at each piezometer cluster.

Geophysical and drillers' logs of wells in the area of the barrier show that upgradient from the barrier a considerable number of sand, silt, and clay beds are interbedded with basalt flows; for example, 610 feet of the log of well 8N-34E-17ccc6 shows sediments and 390 feet basalt (fig. 4, section B-B'). The sediments consist of beds of clay that resemble varved glacial clay at some places, silt, and fine-to-coarse sands that range in thickness from a few inches to more than 50 feet. At some places, the clays and sands contain fine-to-coarse gravel.

Well logs show that both the essentially flat-lying sediments and the basalt extend several miles north and east of the barrier, although the areal extent of individual sedimentary beds and basalt flows cannot be determined with any degree of confidence. Southwest of the barrier, except in the area near the mouth of Birch Creek where thick deposits of sediments were found in wells, basalt is the predominant rock type and the sedimentary beds are sparse and thin.

The geologic map (fig. 6) shows the surficial geology in the Mud Lake region. Informal names used by Stearns, Bryan, and Crandall (1939, pl. 3) were assigned to the geologic units for convenience. These units are also shown on the geologic sections and fence diagram (figs. 4 and 5). The basalt and interbedded sedimentary deposits shown are a part of the Snake River Group of Pleistocene and Holocene age. These rocks and the more recent alluvium are the principal water-bearing formations explored by drilling. The silicic volcanic rocks shown on the geologic map were encountered in four wells (figs. 4 and 5). These rocks also contain ground water, although they are generally not as permeable as the basalt.

Test-drilling data and other well data showed that north and northeast of the barrier water in the upper zone of saturation occurs under water-table conditions. However, at the barrier area and for an unknown distance to the northeast, the water in the deeper aquifers is under artesian pressure. Northwest and west of Mud Lake and southwest of Terreton and Monteview, perched ground water occurs at shallow depth.

Wells 8N-34E-17ccc3-6 were completed so that water levels in four different water-bearing zones could be monitored at this location. Another well a few feet to the west (8N-34E-17ccc7) monitors the shallowest water level. Although the water level for each zone is different, those in the second and third shallowest zones are not greatly different. The following are the water levels and the water-bearing zones monitored at this site.

Well No.	Piezometer or Casing Size	Depth Monitored (feet)	Depth to Water (feet) (12-13-69)	Aquifer
8N-34E-				
17ccc7	6-in. casing	35 to 47	30±	Sand
17ccc3	8-in. casing	340 to 350	46.7	Sand
17ccc4	1-in. pipe C	460 to 545	45.0	Sand & gravel
17ccc5	3/4-in. pipe B	566 to 888	170.1	Basalt
17ccc6	3/4-in. pipe A	912 to 1,006	223.9	Basalt

As indicated above, water levels at this site are not consistent. The water level in the 6-inch well is about 15 feet higher than that in the next zone. The water level in the 1-inch pipe is 1.7 feet higher than in the 8-inch casing. At deeper depths, the water levels are lower. A more typical example of water levels at different depths below land surface is illustrated by wells 6N-36E-11aba1-4 in the following table.

Well No.	Piezometer or Casing Size	Depth Monitored (feet)	Depth to Water (feet) (12-13-69)	Aquifer
6N-36E-				
11aba1	10-in. casing	14 to 245	70.7	Basalt
11aba2	3/4-in. pipe C	258 to 615	35.1	Basalt
11aba3	3/4-in. pipe B	628 to 915	34.8	Basalt & sand
11aba4	3/4-in. pipe A	925 to 990	18.1	Basalt

At this site, the water table is about 70 feet below land surface and the deeper water-bearing zones are under artesian pressure, with the deeper zones having the higher heads. These two examples demonstrate the variety of ground-water occurrences in the area. The approximate positions of the water levels in piezometers and the water-bearing formation monitored by the piezometers are shown in the geologic sections (fig. 4).

Geophysical Studies

In 1961, 1963, and 1964, several gravity surveys were made by the U. S. Geological Survey in the eastern Snake River Plain which included a part of the Mud Lake-Market Lake region. Additional gravity observations were made in 1970 in the study area to determine if this geophysical method could be used to interpret the geology of the region and thus further the understanding of geologic-hydrologic relations. The resulting gravity map did not show any apparent relationship of the variations in gravity to the geology of the barrier. Therefore, the gravity data are not included in this report.

Interpretation of Data

The geologic data from the test drilling show that much of the Mud Lake region is underlain by both basalt flows and sedimentary deposits to a depth of at least 1,000 feet. Southwest of the Mud Lake-Market Lake barrier, wells in excess of 1,000 feet in depth have found mostly basalt, and the thick interbedded sediments found at and northeast of the barrier are not present.

The well logs on the geologic sections (fig. 4) show the basalt flows and the interbedded sedimentary deposits. The alluvium which is at the surface east of Henrys Fork is overlain by basalt of Little Grassy Butte and underlain by early basalt west of the river (geologic section A-A'). The alluvium pinches out near Market Lake. West of Market Lake, the lakebeds of Terreton occur at the surface and a thick lens of sediments occurs at a depth of about 600 feet. The only other significant sedimentary deposits are far to the west at the mouth of the Birch Creek basin and in the vicinity of the Big Lost River playa beyond the area of study. Geologic section B-B' shows that north of Terreton sedimentary deposits predominate in the geologic section, but south of Terreton, sediments are not significant. Geologic section C-C', about 15 miles east of section B-B', illustrates the same relationship as shown in B-B', but the well data are more numerous and more detail can be shown. The correlation of units between wells is tentative, but it serves to illustrate the general geologic conditions of the region as revealed by the test drilling and other well data.

In order to show the geologic conditions in a perspective not possible with geologic sections, a fence diagram was constructed (fig. 5). The fence diagram shows a thick sequence of sediments in the Market Lake-Idaho Falls-Rexburg area and northwest of Mud Lake. Several basalt flows are intercalated in sediments. There are sedimentary deposits in the subsurface between these two parts of the region, but they are thinner and the basalt units are more numerous and thicker. Northeast of a line between Dubois and St. Anthony, sparse data imply that the sediments become subordinate or even insignificant. Apparently, the streams were eroding and not depositing sediments in this part of the area. In the southwestern part of the region, basalt predominates and sedimentary beds are sparse and thin. It should be noted that geologic conditions below the depths drilled are unknown.

The water-level contour map (fig. 3) was constructed on the water table in the sedimentary aquifer except in that part of the area where perched water is known to occur. The hydrologic data show that, in general, upstream from the barrier, ground water occurs under water-table conditions in the uppermost saturated zone, although there are local areas with weak or low artesian pressures as described previously. However, in the deeper zones, ground water is under artesian pressure and contours for the artesian pressure surface are not shown. Data are not adequate to determine the northeasterly extent of the artesian aquifers from Mud Lake, but the artesian aquifers may pinch out north and east of Dubois, where the water-table steepens sharply at about the 4,800-foot contour. Water-level data from the test wells show that artesian pressures begin to develop about halfway between Rexburg and Market Lake and become progressively greater in the direction of the barrier (fig. 4, geologic section A-A'). Artesian pressures are found in both basalt and sediments. In general, the artesian pressures cause the water levels to rise above the water table and the deeper the well the higher the artesian pressure. For example, in wells 6N-36E-11aba1-4, described above, the elevation of the water table is at about 4,747 feet above mean sea level; the water level in the first artesian zone is about 4,783 feet, in the second zone at about 4,783 feet also, and in the third zone at 4,801 feet or 250 feet higher than the 4,570-foot contour 8 miles to the southwest (fig. 3). This implies a hydraulic gradient of something more than 30 feet per mile. In this and other test wells, the elevations of the artesian pressures range from about 1 to 53 feet above the elevation of the water table at the well site. Two private wells, 5N-35E-4bda2 and 4N-36E-1dac1, reportedly had artesian heads 200 feet higher than the elevation of the water table. (See fig. 4).

There are exceptions to this zonation of artesian pressure. In the wells north of Monteview that were described previously (8N-34E-17ccc3-6), the shallow water is perched and the deeper zones are under artesian pressure. The deeper water levels in this well are significantly lower than in a private well (6N-34E-7ba1), which is about 10.5 miles to the south. The reason for this is not clear, but the barrier probably does not extend from Mud Lake to Birch Creek valley as was described in previous reports. Instead, it may trend north or even northeast of Mud Lake.

Downstream from the barrier, the only artesian pressures are local occurrences that are common in basalt of the Snake River Group and are on the order of a few tenths of a foot to a few feet higher than the water table. This is caused by the interfingering of lava flows and the generally low vertical permeability of the basalts. Mundorff, Crosthwaite, and Kilburn (1964, p. 143) describe this factor in causing slight but significant differences in water levels in successive permeable zones in the basalt. Morris and others (1964, p. 40-42) describe the upward and downward flow of water from one permeable zone to another in bore holes on the National Reactor Testing Station and this phenomenon has been observed elsewhere in the Snake River Plain.

Upstream from the barrier, ground water in the non-artesian aquifer moves downgradient, or about normal to the water-level contours, southwestward and westward toward the barrier. In the downgradient part of the barrier, the water has a large downward component of movement as it percolates through the basalt and sediments to join the main body of water in the Snake Plain aquifer.

The water in the artesian aquifers appears to move in approximately the same direction as the non-artesian water except in the area northwest of Mud Lake. The reason for artesian pressures lower than the water table in well 8N-34E-17ccc6 is not apparent from the data. Either lithologic changes or some structural feature (or both) could cause this condition. For example, Stearns, Bryan, and Crandall (1939, p. 43) and Mundorff, Crosthwaite, and Kilburn (1964, p. 133) suggest that there is a fault along the north side of Mud Lake, but Malde (1971) found no evidence of faulting.

In general, in the area where the hydraulic heads in the artesian aquifer are above the water levels in the water-table aquifers, upward leakage recharges the water-table aquifer. The data are not adequate to evaluate the amount of upward leakage, but it may be a significant amount in the Mud Lake part of the region.

The artesian pressures found in the test and other wells indicate that the net hydraulic gradient is steeper than was previously known. Although the hydraulic properties of the artesian aquifers are not known, the data suggest that much of the ground water in the region moves through the artesian aquifers before discharging to the Snake Plain aquifer southwest of the barrier. This study has significantly modified the concept of the barrier. Previous descriptions imply that the barrier is more or less a linear phenomena with a restricted areal extent. Actually, the barrier denotes a change in geology. From the vicinity of the barrier area, as described by Stearns, Crandall, and Steward (1938, p. 111), up the water-table gradient for at least a few tens of miles, the saturated geologic section consists predominantly of beds of sediments that are intercalated with numerous basalt flows. Downgradient from the barrier, sedimentary deposits are not common and practically all the water-bearing formations are basalt, at least to the depths explored so far. Thus, the barrier is a transition zone from a sedimentary-basaltic sequence to a basaltic sequence.

The Mud Lake region lies close to high mountain ranges which shed large amounts of sediments during the Pleistocene and Holocene Epochs, particularly during times of glaciation and high precipitation. These sediments were deposited in streams and lakes in low areas. Basalt flows of local origin were erupted at infrequent intervals during deposition of the sediments. Eruptions of basalt on the Snake River Plain south and west of the Mud Lake region impeded the spread of sediments in those directions. The complex interbedding of basalt and sediments produced a hydrologic system different from the Snake Plain aquifer system and thus the Mud Lake region should be excluded from the Snake Plain aquifer.

This study did not develop new data to either support or change the estimate by Mundorff, Crosthwaite, and Kilburn (1964, p. 136) of the quantity of ground-water flow in the Mud Lake part of the region. It should be noted that the direction of ground-water flow as shown on their plate 4 applies only to the water table and not to the water in the artesian aquifers. Irrigation on the Egin Bench has undoubtedly influenced the water table and artesian pressures in the Mud Lake area, but an assessment of this effect is not possible at this time. Perhaps modification and stressing of the analog model might shed some light on this problem, and an analysis using this model will be attempted later in the project.

ADDITIONAL STUDY NEEDS

In the area of Mud Lake, a few hundred irrigation wells pump water from the water-table aquifer and Mud Lake receives much of its inflow from ground water. Surface-water use for irrigation is of minor importance. In the area of Market Lake and the Henrys Fork drainage, the reverse is true. Surface water is the major irrigation supply and ground-water use is minor. If the past is a clue to the future, development of ground water in the Mud Lake basin will continue and, because the water users have expressed concern about the present stage of development of the water-table aquifer, attempts will be made to utilize the artesian aquifers. In the Market Lake and Henrys Fork areas, ground-water development is being planned and additional developments are being considered. It would be desirable to assess the effects that planned and potential development will have on the ground-water regimen and to provide information for optimum management.

The test drilling has indicated in a general way the hydrologic and geologic conditions in the barrier and upgradient from the barrier area. However, only the upper 1,000 feet of the geologic section has been explored. There are no reliable data on the thickness of the water-bearing formations in the barrier area and only a little is known about the areal extent of the artesian aquifers. Also, the available data are not adequate to describe even generally the water-bearing characteristics of the artesian aquifer nor the effects that pumping in one zone would have on adjacent zones. Thus, more data are needed to define the areal extent and water-producing potential of the artesian aquifers and to evaluate the permeability of the perching beds above the artesian aquifers. Production test wells, deeper exploratory holes, and resistivity geophysical soundings could be used to obtain these data.

A production test well in the artesian aquifer could be drilled almost anywhere in the general area encompassed by a line from Roberts to Camas to Monteview to Roberts. One suggested location would be at the site of well 7N-35E-13aad1, where an observation well was drilled for the present investigation. Pumping the proposed production well for a sufficient period of time would provide information on the effects of deep pumping on the shallower water-table aquifer. The results of this test could then be evaluated for additional deep testing in other parts of the region.

Deeper exploratory holes should be drilled in the same general area outlined in the preceding paragraph to determine more about the thickness and character of the aquifers below a depth of 1,000 feet. Deeper exploratory holes would determine the possibility of drilling deeper production wells. To resolve the problem of the areal extent of the artesian aquifers, exploratory holes about 2,000 feet deep should be drilled in the basalt plain that occurs several miles northeast of Mud Lake, principally in Clark and Fremont Counties.

To minimize the number of exploratory holes needed, direct-current resistivity soundings could be used to correlate the major geologic units between widely spaced exploratory wells. However, the only method of determining the yield of any aquifers below the depths explored to date will require deep production wells.

This study revealed anomalous artesian pressures in wells 8N-34E-17ccc3-6 northeast of Monteview. Additional drilling and geophysical studies are needed to explain this condition and the effects of local development on the entire aquifer systems.

The present project study was not structured to answer the above problems.

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APPENDIX

APPENDIX

Well logs and well construction details of the wells constructed by the U. S. Bureau of Reclamation and used in this report are presented in the following pages.

TABLE 1

WELL DATA FROM EXPLORATORY AND OBSERVATION WELLS DRILLED FOR THIS STUDY AND FOR THE LOWER TETON DIVISION, TETON PROJECT, U.S.B.R.

(* - Well drilled or deepened for this study; A, B, C, and D, 3/4- or 1-inch piezometer.)

		Piezometer		
Well No.	Depth (feet)	Number or Casing Size[a]	Interval Open to Formation (feet)	Depth to Water[b] (feet)
9N-39E- 4aa1	885	5½-inch	845 - 885	844.3
9N-40E- 5dd1	747	5½-inch	705 - 747	705.4
8N-34E-17ccc3*	1,006.5	6-inch	340 - 350	40.5
17ccc4*		C	460 - 545	40.9
17ccc5*		B	566 - 888	165.8
17ccc6*		A	912 - 1,006.5	222.4
17ccc7		6-inch	47 - 48	29.0
8N-40E- 1cad1	376	5½-inch	330 - 376	303.7
21ddd1	450	C	15 - 80	Dry
21ddd2		B	192 - 382	136.3
21ddd3		A	423 - 450	136.6
7N-35E-13aad1*	1,000.7	14-inch	14 - 515	[c]3.8
13aad2*		C	590 - 760	[c]3.4
13aad3*		B	792 - 827	[c]+1.4
13aad4*		A	838 - 1,000.7	[c]+1.4
7N-38E-23dba3	632.5	8-inch	181 - 200	41.6
23dba4		C	313 - 426	47.7
23dba5		B	451 - 595	47.1
23dba6		A	613 - 632.5	47.1
7N-39E- 1ccc1	122	6-inch	84 - 122	80.7
1ccc2	55	6-inch	19 - 55	Dry
16acc1	444	8-inch	215 - 444	59.2
16acc2	107	8-inch	96 - 107	35.0
16acc3	38	8-inch	28 - 38	14.0
16acc4	503	22-inch	255.6 - 503	58.8
34ccb1	26	8-inch	14 - 26	6.0
34ccb2	342	8-inch	161.5 - 342	15.8
34ccb3	410	24-inch	156.7 - 410	15.9
7N-40E-19add1	394.7	24-inch	198.5 - 394.7	34.6
19add2	355.0	6-inch	144 - 355	33.7

TABLE 1 (Cont'd.)

WELL DATA FROM EXPLORATORY AND OBSERVATION WELLS DRILLED FOR THIS STUDY AND FOR THE LOWER TETON DIVISION, TETON PROJECT, U.S.B.R.

		Piezometer		
Well No.	Depth (feet)	Number or Casing Size[a]	Interval Open to Formation (feet)	Depth to Water[b] (feet)
7N-40E-19add3	40.5	8-inch	31.3 - 40.5	20.9
19add4	20.5	8-inch	10.7 - 20.5	9.3
20cdc1	399.6	C	63 - 189	46.0
20cdc2		B	220 - 356	52.4
20cdc3		A	378 - 399.6	53.7
6N-36E-11aba1*	1,002.2	10-inch	14 - 245	70.8
11aba2*		C	258 - 615	35.3
11aba3*		B	628 - 915	35.1
11aba4*		A	925 - 990	20.2
6N-37E-29aca1	573	16-inch	21 - 62	43.6
29aca2		12-inch	151 - 175	47.4
29aca3		10-inch	404 - 440	38.8
29aca4		6-inch	505 - 573	38.9
6N-38E-25acb1	685	24-inch	450.6 - 685	17.7
25acb2	681	8-inch	483.3 - 681	19.2
25acb3	243.7	8-inch	236.7 - 241.7	21.0
25acc4	50	8-inch	43 - 48	18.9
30bad2	638	6-inch	260 - 270	90.4
30bad3		B	430 - 543.5	85.6
30bad4		A	575 - 638	85.7
6N-39E-10bbb1	636.8	6-inch	168 - 260	21.7
10bbb2		C	290 - 317	21.7
10bbb3		B	339 - 545	21.7
10bbb4		A	570 - 636.8	19.1
23aac1	25	8-inch	20 - 25	7.0
23aac2	465	8-inch	257 - 435	29.7
23aac3	438	24-inch	245 - 426	30.1
6N-39E-30adc1	699.7	6-inch	263.6 - 385	5.7
30adc2		B	406 - 620	7.8
30adc3		A	638 - 699.7	7.0
5N-33E-13dbc1*	1,006.5	8-inch	276 - 290	263.2
			300 - 317	

TABLE 1 (Cont'd.)

WELL DATA FROM EXPLORATORY AND OBSERVATION WELLS DRILLED FOR THIS STUDY AND FOR THE LOWER TETON DIVISION, TETON PROJECT, U.S.B.R.

		Piezometer		
Well No.	Depth (feet)	Number or Casing Size[a]	Interval Open to Formation (feet)	Depth to Water[b] (feet)
5N-33E-13dbc2*		B	357 - 493	261.3
13dbc3*		A	540 - 1,006.5	254.3
5N-36E- 2bda1	995	16-inch	18 - 405	42.1
2bda2		12-inch	838 - 923	+7.3
2bda3		8-inch	985 - 995	8.3
5N-39E-18cac1	336	6-inch	300 - 336	1.1
4N-35E-14aaa1 *	1,000	6-inch	430 - 1,000	406.7
4N-38E-12bbb1*	1,026.0	10-inch	190 - 275	25.8
12bbb2*		D	475 - 490	46.5
4N-38E-12bbb3*		C	538 - 705	46.1
12bbb4*		B	726 - 842	47.1
12bbb5*		A	850 - 1,026	107.8
2N-35E- 2bbc1*	1,302	10-inch	110 - 800	577.6
2bbc2*		B	883 - 982	577.8
2bbc3*		A	1,038 - 1,147	578.0

[a] Some wells have 3/4-inch and 1-inch diameter piezometers that are designated by letters A, B, C, and D. At other places, three or four wells of various depths have been drilled within a few feet of each other.

[b] April 1969.

[c] Water-level measurements on 6-2-70.

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 1

LOG OF WELL

Project Lower Teton Division Rehab. Feature Observation Well (Rehabilitated) State Idaho

Well No. 9N/39E-4aa1 (Well B) Location NE¼, Section 4, T. 9 N., R. 39 E.

Total Depth 884.6 ft. Begun ____ Completed Prior to 1939 Drilling Method ____

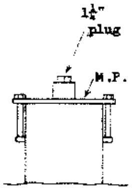
Static Water Level 844.6 ft. {above/below} Meas Pt. Original Ground Date 10-23-67

Elevation (ground) 5668.2 W. L. Meas. Pt 5669.68 (Top of csg. plate) ____

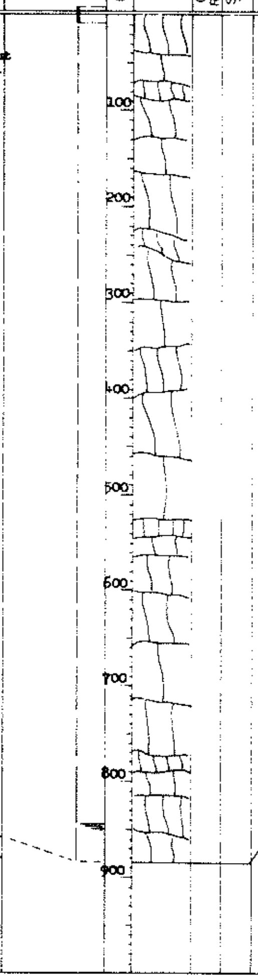
Yield ____ Drawdown ____ Other Data Owner - State of Idaho, Stearns No. 532

Logged By ____ Geophysical Log Caliper, Gamma, and Gamma Gamma by H.R.T.S./U.S.G.S. Drilled By ____

Drilling Data Pump Tests Water Samples	Description of Well Completion	Well Diagram	Depth	Log	Core Recov	Samp Type	Classification and Physical Condition
Unused stock well rehabilitated under Specs. 100C-934(SF) in August, 1967. Contract work consisted of removing well house and pump, cleaning and deepening well from 870 ft. and adding casing cap. Contractor - Commons Drilling Co.	5½ in (±) I.D. csg. + 1.5 to unknown depth but probably not exceeding 10 ft.						0.0 to 884.6 BASALT with numerous sedimentary interflow zones



El. R.P. - 5668.70 chiseled on conc. step 12 ft. NE. of well. Elevations by U.S.B.R. - 1967



884.6
Bottom of 5½ in. (±) hole

Total Depth - 884.6

Note: Lithologic log (classification) based on interpretation of geophysical logs.

SAMPLE TYPE
CR = Core
CT = Cuttings
D Drillers Log

▨ BASALT

PROJECT Lower Teton Division WELL NO 9N/39E 4aa1 Rehab.Well B

BUREAU OF RECLAMATION - REGION 1

SHEET 1 OF 1

LOG OF WELL

Project Lower Teton Division Rehab. Feature Observation Well (Rehabilitated) State Idaho

Well No 9N/40E-5dd1 (Well C) Location SE¼, Section 5, T. 9 N., R. 40 E.

Total Depth 747.6 Begun ______ Completed Prior to 1939 Drilling Method ______

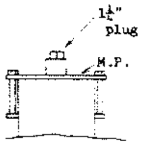
Static Water Level 705.2 (above/below) Meas Pt Original ground Date 9-21-67

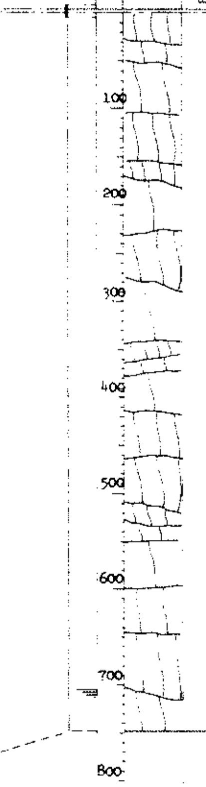
Elevation (ground) 5535.4 W L Meas Pt 5535.95 (Top of csg. plate) ______

Yield ______ Drawdown ______ Other Data Owner State of Idaho

Logged By ______ Geophysical Log Caliper, Gamma, and Gamma Gamma by N.R.T.S., U.S.G.S. Drilled By ______

Drilling Data Pump Tests Water Samples	Description of Well Completion	Classification and Physical Condition
Unused stock well rehabilitated under Specs. 100C-934(SF) in August, 1967. Contract work consisted of removing pump, cleaning, and deepening well from 730 ft. and adding casing cap. Contractor - Commons Drilling Co.	5½ in. (±) I.D. csg. + 0.5 to unknown depth but probably not exceeding 5 ft.	0.0 to 747.6 BASALT with numerous sedimentary interflow zones
El. R.P.-5535.48 chiseled on NE. corner conc. base. Elevations by U.S.B.R. - 1967	—— 747.6 —— Bottom of 5½ in. (±) hole	Total Depth - 747.6 Note: Lithologic log (Classification) based on interpretation of geophysical logs.





SAMPLE TYPE
CR = Core
CT = Cuttings
D = Drillers' Log

▦ BASALT

PROJECT Lower Teton Division

WELL NO 9N/40E-5dd1 Rehab.Well C

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 2

LOG OF WELL

Project Lower Teton Division Feature Exploratory Drill Hole (Monteview Area) State Idaho
Well No 8N/34E - 17 ccc3 (Site 12) Location SWSW Section 17, T8N, R34E Approx. 270' north, 575' east of section corner Jefferson County
Total Depth 1006.5 Begun 8/6/69 Completed 11/17/69 Drilling Method Cable Tool to 509' Diamond Core to 1006.5'
Static Water Level see below (above)(below) Meas. Pt. see below Date —
Elevation (ground) 4809.64 W. L. Meas. Pt — ( )
Yield — Drawdown — Other Data Driller, Inspector and Geologists Reports
Logged By G. I. Haskett Geophysical Log Electric, caliper, temperature, conductivity, gamma Drilled By Cope Drilling & Pump Co. and Justice Core Drilling

Drilling Data / Pump Tests / Water Samples

Churn drill to 509'; wireline diamond core to 1006.5' under Specs. 100C-1060

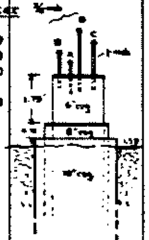
Top of 6" csg. is 4811.07

PIEZOMETERS
MP 12/13/69

No. Elev.	Depth, water
A 4812.61	223.90
B 4812.91	170.10
C 4813.07	45.00
"D" (6" csg.) 4811.07	46.70

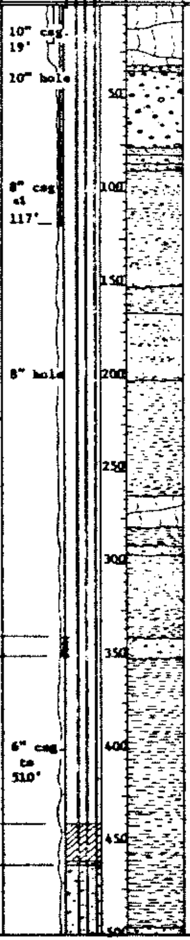
Description of Well Completion

Pipes are black iron. 5' of perforations begin 2-1/2' above bottom of each pipe.



"D"
Perforations in 6" csg.
340'
350'

PIEZOMETER C
1" pipe
440± Grout
468' Gravel



Samp Type	Classification and Physical Condition
D	0-32 BASALT, gray, broken.
	32-35 CLAY, brown.
CT, D	35-76 SAND and GRAVEL, subangular to subrounded, predominately rhyolite.
	76-80 CLAY, yellow-tan, ashy, disintegrates in water.
	80-85 SAND, coarse, with fine gravel.
	85-89 As above with yellow-tan ashy clay.
	90-151 CLAY, tan, ashy, silty to sandy with gravelly zones.
	151-165 CLAY, gray, ashy, slightly sandy.
	165-201 SAND, medium to coarse, subrounded, clayey, predominately rhyolite and quartz, trace basaltic grains.
	201-210 CLAY, tan.
	210-263 CLAY, gray; 1-foot zone coarse sand, fine gravel at 256'.
	263-280 BASALT, gray, very fine grained, trace feldspar needles, finely vesicular; vesicles near base filled with yellow-tan clay.
	280-290 CLAY, yellow-green, silty to sandy, slakes in water.
	290-295 SAND, coarse, to fine gravel of rhyolite, quartz, obsidian, subangular to subrounded.
	295-335 CLAY, tan with thin zones fine to coarse sand.
	335-340 CLAY, tan with trace sand grains.
	340-351 SAND, coarse with fine gravel of subangular rhyolite, quartz, trace basalt.
	351-495 CLAY, gray to tan, silty.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

CLAY
SILT
SAND
GRAVEL
BASALT

SITE 12

BUREAU OF RECLAMATION - REGION 1 SHEET 2 OF 2

LOG OF WELL

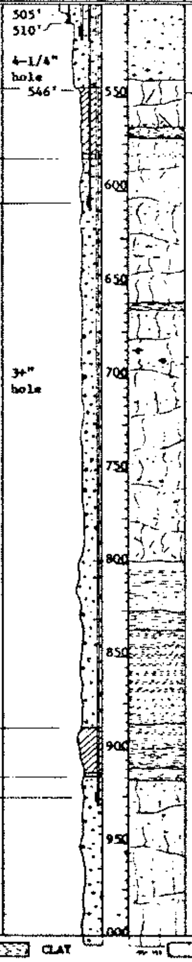
Project Lower Teton Division Feature Exploratory Drill Hole (Monteview Area) State Idaho
Well No 8N/34E - 17 ccc3 (Site 12) Location SWSW Section 17, T8N, R34E Approx. 270' north, 575' east of section corner Jefferson County
Total Depth 1006.5 Begun 8/6/69 Completed 11/17/69 Drilling Method Cable Tool to 509' Diamond Core to 1006.5'
Static Water Level See below (above)(below) Meas. Pt. See below Date —
Elevation (ground) 4809.64 W. L. Meas. Pt — ( )
Yield — Drawdown — Other Data Driller, Inspector and Geologists Reports
Logged By G. I. Haskett Geophysical Log Electric, caliper, temperature, conductivity, Gamma Drilled By Cope Drilling & Pump Co. and Justice Core Drilling

Description of Well Completion

514 ℄ perfs.

PIEZOMETER B
3/4" pipe
545' Grout
562' Gravel
405' ℄ perfs.

PIEZOMETER A
3/4" pipe
888' Grout
914' Gravel
925' ℄ perfs.



Samp Type	Classification and Physical Condition
CT D	495-540 SAND, coarse with fine gravel, subangular to subrounded rhyolite, quartz, obsidian, trace basalt.
CR	540-566.4 BASALT, gray, numerous fine feldspar needles; moderately, finely vesicular; 60° joints at 548, 565.5'; broken 565.9-566.4.
	566.4-571.0 CLAY, tan to brick red, silty, basalt fragments below 570.0.
	571.0-606.8 BASALT, gray, numerous feldspar needles; vesicular to 575.5, dense to 577.7, very vesicular to 581.2, dense to finely vesicular to 600.3; banded, broken to 601.5; scattered vugs with zeolite crystals to 606.8.
	606.8-659.8 BASALT, numerous, fine feldspar needles, zeolite crystals in some vesicles, occasional clay-filled joint; red-gray, vesicular to 613.4; brown, moderately vesicular to 628.8; red-gray, slightly altered to 632.2'; gray to red to 648.3; green-gray, dense to 659.8'.
	659.8-663.5 ASH, gray to red-brown, silty to sandy, occasional basalt fragment to 2".
	663.5-799.0 BASALT, brown-gray vesicular to 667.8; alternating gray-green to brown, dense to very vesicular to 690.1, feldspar rosettes to 1/4", 682.6-690.1; brick red, vesicular to 692.5 with zeolite crystals; banded green-gray to brown with occasional red zone, dense to vesicular to 784.1; gray, broken to 799.0.
	799.0-825.0 SAND with CLAY, tan, partly silty, firm, slightly calcareous, bedding horizontal.
	825.0-835.4 CLAY, tan, firm, slightly calcareous.
	835.4-886.0 VARVED CLAY, horizontal banded 1/16-1/4" varves of bright green plastic clay grades to light gray silt, varving more crude toward base.
	886.0-909.3 CLAY, crudely varved, 1-1/2±" layers green clay with slightly contorted laminations of gray silt, dip 0-5°.
	909.3-916.0 SILT, gray, indistinct bedding, trace carbonaceous material, fragments of basalt to 1-1/2" below 914.8.
	916.0-1006.5 BASALT, gray to red-brown, trace of fine feldspar needles, vesicular to 953.4; dense to 964.7; vesicular to 984.0; dense to 1006.5, gray color-banded below 999.9.
	1006.5 TOTAL DEPTH

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

CLAY
SILT
SAND
GRAVEL
BASALT

SITE 12

BUREAU OF RECLAMATION REGION ______ SHEET 1 OF 1

LOG OF WELL

Project **Lower Teton Division** Feature **Observation Well (Rehabilitated)** State **Idaho**

Well No **8N/40E-1 cal (Rehab. Well A)** Location **Approx. 2000 ft. East and 1870 ft. North of SW Corner Section 1, T. 8 N., R. 40 E.**

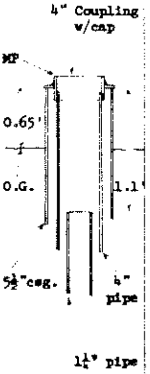
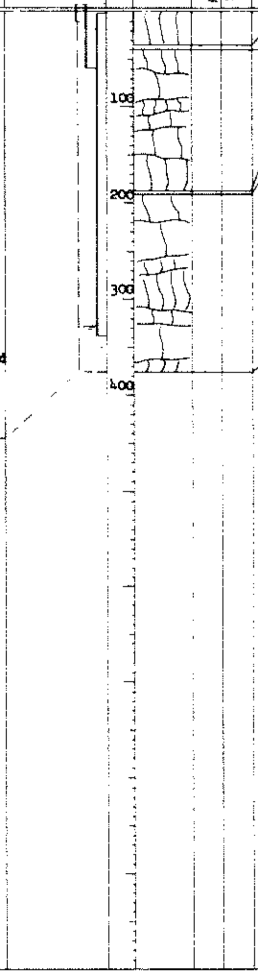
Total Depth **376 ft.** Begun ______ Completed **Prior to 1921** Drilling Method ______

Static Water Level **330.4** (above/below) Meas Pt **Original ground** Date **9-20-67**

Elevation (ground) **5161.0** W L Meas Pt **5161.65** (**Top of 4" Coupling**) ______

Yield ______ Drawdown ______ Other Data **Owner - State of Idaho, Stearns No. 397**

Logged By ______ Geophysical Log **Caliper, Gamma, and Gamma - Gamma by N.R.T.S./U.S.G.S.** Drilled By **C.E. Gunning; Deepened by Commons Drilling Co.**

Drilling Data Pump Tests Water Samples	Description of Well Completion	Well Diagram	Depth	Log	Core Recov	Samp Type	Classification and Physical Condition
Unused stock well rehabilitated under Specs.100C-934(SF) in August 1967. Contract work consisted of removing bridge near surface, cleaning, deepening from 355 ft. and adding casing cap. Contractor - Commons Drilling Co. **Hole bridged at 43 ft. 3/68 - 8/68. Bridge cleared by U.S.B.R. forces 8/1/68. Installed 4" coupled pipe and 1¼" BI pipe. Hole found to be filled back to 338'.** **Near Surface Detail** 	**5½" I.D. csg. + [illegible]5 to unknown d[illegible]th but probably not exceeding 20 ft.** **4" (10' joints) coupled steel pipe +0.65 to 60.0(-)** **1¼" B.I. pipe 1.1 to 338. Perforated lower end and capped. 338 to 376 - filled by bridge material.** 376.0 **Bottom of 5½" drilled hole.**						**0.0 to 35 (±) BASALT** **35 (±) to 40 (±) SEDIMENTARY INTERFLOW MATERIAL.** **35 (±) to 188 (±) BASALT** **188 (±) to 191 (±) SEDIMENTARY INTERFLOW MATERIAL** **191 (±) to 376 (±) BASALT** **T.D. - 376** **Note: Lithologic log (classification) based on interpretation of geophysical logs.**

SAMPLE TYPE
CR = Core
CT = Cuttings
D Drillers Log

▥ **BASALT**

PROJECT **Lower Teton Division** WELL NO **8N/40E-1 cal Rehab. Well A**

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 1

LOG OF WELL

Project Lower Teton Division Feature Exploratory Hole and Piezometer Bank State Idaho

Well No. 8N/40E-21dd1 (Site 6) Location Approx. 80 ft. North and 100 ft. West of SE Corner Section 21, T. 8 N., R. 40 E., B.M.

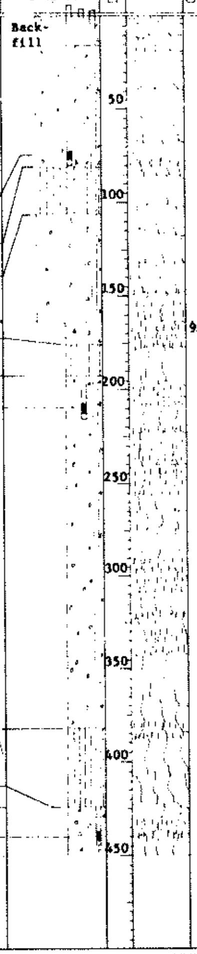
Total Depth 450' Begun 6/26/67 Completed 8/10/67 Drilling Method Wireline diamond core drill and air rotary

Static Water Level 132 ft. (general) (~~above~~) (below) Meas. Pt. Original ground Date 8/67

Elevation (ground) 4963.7' W L. Meas. Pt. See below ( )

Yield Drawdown Other Data See geologic log book, driller's and inspector's reports and geophysical logs.

Logged By H. Ham Geophysical Log Gamma & Gamma-Gamma by N.R.T.S./U.S.G.S. Drilled By Cope Drilling Co. Justice Core Drilling Co.

Drilling Data Pump Tests Water Samples	Description of Well Completion	Well Diagram	Depth	Log	Core Recov	Samp Type	Classification and Physical Condition
Air rotary hole to 163.5. Wire-line diamond drill hole 163.5 - 450.0. Specs. 100C-920 Water-surface elevations 8/28/67 Piezo A 4830.98 B 4831.27 C None Water sample taken by bailer 7/6/67 pH - 7.78 E.C. - 246×10^6 SAR - 0.63 Piezo  4" concrete slab	Three - 3/4" B.I. Piezometer pipes installed in 6" and Nx hole Elevations Top of pipe Piezo A 4964.57 B 4964.71 C 4964.93 R.P. (conc.) 4963.65 ℄ Perforations Piezometer C 75 80 Gravel 105 Grout Temp. 6", 4", Nx 163.5 Csg. 175 Gravel 192 Grout ℄ Perforations 210 Piezometer B 382 Gravel 423 Grout ℄ Perforations Piezometer A 440 450 Gravel Bottom of Nx hole				92%	D CR	0.0 - 3.0 - TOPSOIL 3.0 - 18.0 - BASALT; gray 18.0 - 27.0 - SAND and CLAY; red. 27.0 - 163.5 - BASALT; gray and brown 163.5 - 450.0 - BASALT; gray, red, and purple. Aphanitic; massive to highly jointed and brecciated. Dense to highly vesicular and scoriaceous. Generally olivine bearing. Fresh to moderately decomposed. Scoriaceous, cindery, and highly vesicular zones shown by vertical ticks on log. Total depth - 450 ft.

SAMPLE TYPE
CR = Core
CT = Cuttings
D Drillers Log

▭ CLAY ▨ BASALT
▭ SAND

PROJECT Lower Teton Division - Teton Basin Project WELL NO 8N/40E-21dd1 (Site 6)

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 2

LOG OF WELL

Game Farm Area

Project Lower Teton Division Feature Exploratory Drill Hole (Piezometers) State Idaho
Well No. 7N/35E-13aa1 (Site 13) Location (Approx. 980' south, 475' west, sec. corner) SE NE NE Sec. 13, T7N, R35E, Jefferson County
Total Depth 1000.7 Begun 9/1/69 Completed 10/4/69 Drilling Method Cable tool to 501' diamond core to 1000.7
Static Water Level See below (above) (below) Meas. Pt. Date --
Elevation (ground) 4789.50 W. L. Meas. Pt. ( ) --
Yield -- Drawdown -- Other Data Driller, Inspector, and Geologist reports
Logged By G. I. Haskett Geophysical Log Gamma Drilled By Cope Drilling and Pump Co. Justice Core Drilling Co.

Drilling Data Pump Tests Water Samples

Under Specs. No. 100C-1060

Cable tool to 501', wireline diamond drill core, 501-1000.7'.

MP, top 14" csg. 4791.67

Piezo.	Elev. top of pipe
A(3/4")	4790.64
B(3/4")	4790.72
C(3/4")	4790.81
"D"(1")	4791.07

Depth to water 10/22/69

Piezo.	
A	0.39'
B	0.59'
C	1.35
"D"	0.92

Description of Well Completion

Top gravel, 3'

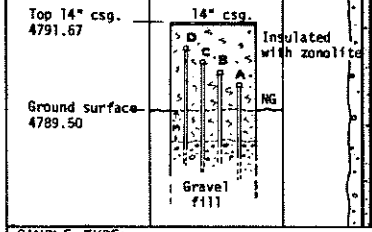
Piezo. pipes--5' of perforations starting 2½' above bottom of pipe

Pipe "D"

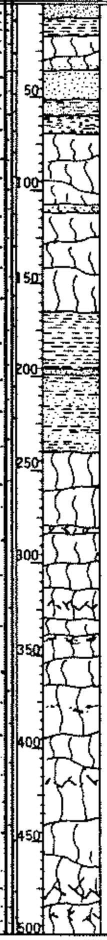
(for water level in upper hole)

325' ℄ perfs.

Surface Detail



Well Diagram / Depth / Log



Samp. Type	Classification and Physical Condition	
D	0-7	SAND, brown
	7-16	CLAY, brown
	16-35	BASALT, black, broken, cinders at base
	35-51	SAND, brown, fine
	51-60	CLAY and SAND, brown
	60-69	CLAY, brown, with gravel
	69-107	BASALT, gray
	107-111	CINDERS, black
	111-141	BASALT, gray
	141-165	BASALT, green-gray, hard
	165-195	CLAY, gray to brown
	195-199	SAND, brown
	199-240	CLAY, gray, blue, brown, with sand
	240-279	BASALT, gray
	279-284	BASALT, red-gray, broken
	284-310	BASALT, gray
	310-314	BASALT, red-gray, fractured
	314-330	BASALT, gray, badly fractured 318-326; (lost drilling mud, 320-326)
	330-338	BASALT, green-gray, very hard
	338-366	BASALT, gray, fractured, trace green clay, 338-344.
	366-375	BASALT, gray, very hard
	375-380	BASALT, broken, with cinders and green clay
	380-422	BASALT, gray, hard; fractured 416-422
	422-436	BASALT, gray, soft, porous
	436-500.9	BASALT, gray to green-gray; broken 470-484; broken zones, 484-500.9

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▤ CLAY ▨ GRAVEL ☐
▒ SAND ▦ BASALT ☐

SITE 13

PROJECT Lower Teton Division - Teton Basin Project WELL NO. 7N/35E-13aa1

BUREAU OF RECLAMATION - REGION 1 SHEET 2 OF 2

LOG OF WELL

Game Farm Area

Project Lower Teton Division Feature Exploratory Drill Hole (Piezometers) State Idaho
Well No. 7N/35E-13aa1 (Site 13) Location (Approx. 980' south, 475' west, sec. corner) SE NE NE Sec. 13, T7N, R35E, Jefferson County
Total Depth 1000.7 Begun 9/1/69 Completed 10/4/69 Drilling Method Cable tool to 501' diamond core to 1000.7
Static Water Level -- (above) (below) Meas. Pt. -- Date --
Elevation (ground) 4789.50 W. L. Meas. Pt. ( ) --
Yield -- Drawdown -- Other Data Driller, Inspector, and Geologist reports
Logged By G. I. Haskett Geophysical Log Gamma Drilled By Cope Drilling and Pump Co. Justice Core Drilling Co.

Description of Well Completion

PIEZOMETER C

515' Grout

592' Gravel

640' ℄ perfs.

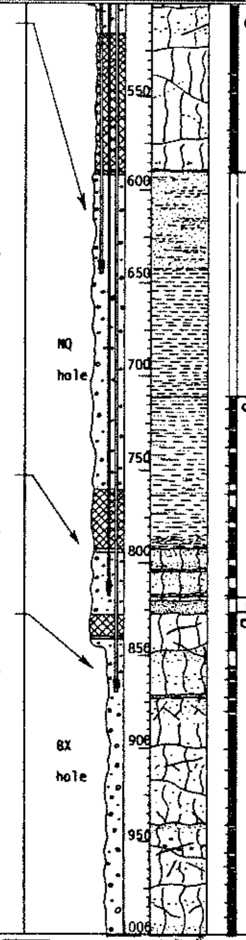
PIEZOMETER B

760' Grout
794' Gravel
812' ℄ perfs.

PIEZOMETER A

827' Grout
840' Gravel
865' ℄ perfs.

Well Diagram / Depth / Log / Core Recov.



Samp. Type	Classification and Physical Condition	
CR	500.9-512.6	BASALT, med. gray, moderately vesicular, numerous fine feldspar crystals.
	512.6-515.5	BASALT, red-gray, vesicular; 20° joint filled with clay at 515.0'.
	515.5-590.0	BASALT, gray to green-gray, irregular color zoning, dense with occasional stream of vesicles, numerous fine feldspar needles, glassy at base.
D	590.0-644.0	SAND, with sticky clay
	644.0-711.0	CLAY, gray
	711.0-791.6	CLAY, gray to gray-tan, finely silty, crumbly, massive to faintly bedded, dip 3-5°. 785.1-787.0 clay is brownish, contains carbonaceous trash and wormy pattern of plastic green clay inclusions. (glacial rock flour?)
CR	791.6-820.0	BASALT, gray to red-gray, with scoriateous zones, palagonite filling, flow banding of ½-4" zones blue-gray basalt below 804.1. 803.9-804.1 SAND, red, silty 816.8-817.0 CLAY, tan
	820.0-827.0	SAND
	827.0-871.7	BASALT, gray to red-gray, dense to moderately vesicular, occasional joint, some calcite healed, others clay filled.
D	871.7-872.0	SAND, red-brown, dirty, silty with basalt fragments to ½".
CR	872.0-941.2	BASALT, gray, numerous fine feldspar needles, becomes coarser-sugary in center, vesicular to 881.5, dense to 928.0, moderately vesicular to 941.2; broken 872-890, 909-910.6.
	941.2-997.0	BASALT, red-gray to 953.4, gray below; vesicular to 945.5, dense with zones moderately vesicular to 997.0; numerous fine feldspar needles; calcite or yellow clay in occasional joints, zeolite crystals in vugs, 945.5-953.4; base of flow is chilled, glassy.
	997.0-1000.7	BASALT, red-brown to red-gray, numerous feldspar needles, vesicular to moderately vesicular, some filled with yellow clay.
	1000.7	Total Depth

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▤ CLAY ▒ SAND ▦ VESICULAR BASALT
▤ SILT ▦ BASALT ☐

SITE 13

PROJECT Lower Teton Division - Teton Basin Project WELL NO. 7N/35E-13aa1

SHEET 1 OF 2

LOG OF WELL

Project Lower Teton Division Feature Exploratory Hole & Piezometer Bank State Idaho

Well No. 7N/38E-23d83 (Site 4) Location Approx. 1,440 ft. West and 730 ft. South of E¼ Corner section 23, T. 7 N., R. 38 E., B.M.

Total Depth 632.5 ft. Begun 6/10/67 Completed 6/26/67 Drilling Method Wireline diamond core drill & churn drill

Static Water Level 40 ft. (general) ~~(above)~~ (below) Meas. Pt. Original ground Date 8/67

Elevation (ground) 4859.9 W. L. Meas. Pt. See below ( )

Yield Drawdown Other Data See geologic log book, driller's and inspector's reports, and geophysical logs

Logged By H. Ham Geophysical Log Gamma & Gamma-Gamma by N.R.T.S./U.S.G.S. Drilled By Justice Core Drilling Co.

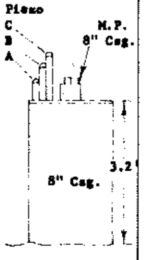
Drilling Data / Pump Tests / Water Samples

Churn drill hole to 201.5.
Drilled 1958.
Specs. 100C-329
Obs. Well 12B
Diamond drill
Rx wireline cored hole
201.5 to 632.5
Specs. 100C-920

Water-surface elevations
8/28/67
8" Csg. 4819.64
Piezo A 4816.06
B 4815.93
C 4815.51

Water sample taken from adjacent well
23db1 - 6/22/67
pH - 7.68
E.C. 249×10^{6}
SAR - 0.68

Surface details



concrete slab

Description of Well Completion

Three - 3/4" I.D.
B.I. Piezometer pipes installed in Rx hole and existing 8" well
Elevations:
Top of 1¼" coupling - 4860.32
Top of pipe
Piezo A - 4860.33
B 4860.48
C 4860.67

RP in concrete - 4856.89

10" Hole
181 8" Csg.
Temp. 4" Csg.
201.5 8" Hole

230 Grout

293 Gravel

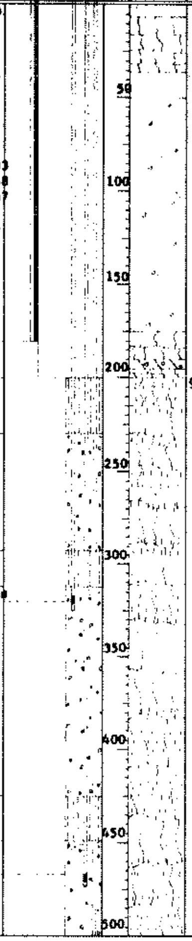
313 Grout
℄ Perforations
320
Piezometer C

395.0 Temp. Nx Csg.

426 Gravel

451 Grout
℄ Perforations
470
Piezometer B

Well Diagram / Depth / Log



Core Recov	Samp. Type	Classification and Physical Condition
	D	0.0 - 6.5 - SAND
		6.5 - 36.0 - BASALT
		36.0 - 50.0 - SAND
		50.0 - 175.0 - SAND and GRAVEL.
		175.0 - 190.0 - BASALT
		190.0 - 195.0 - SAND and GRAVEL (?); silty.
91%	CR	195.0 - 201.5 - BASALT, CINDERS, GRAVEL.
		201.5 - 632.5 - BASALT; gray, brown, purple, and red. Aphanitic to porphyritic. Massive to highly jointed and brecciated. Dense to highly vesicular and scoriaceous. Generally olivine-bearing. Fresh to decomposed
		Scoriaceous, cindery, and highly vesicular zones shown by vertical ticks on log.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

☐	SAND	▨	SILT
⛶	SAND & GRAVEL	▦	BASALT

PROJECT Lower Teton Division - Teton Basin Project

WELL NO. 7N/38E-23db3 (Site 4)

SHEET 2 OF 2

LOG OF WELL

Project Lower Teton Division Feature Exploratory Hole & Piezometer Bank State Idaho

Well No. 7N/38E-23d83 (Site 4) Location Approx. 1,440 ft. West and 730 ft. South of E¼ Corner, section 23, T. 7 N., R. 38 E., B.M.

Total Depth 632.5 ft. Begun 6/10/67 Completed 6/26/67 Drilling Method Wireline diamond core drill & churn drill

Static Water Level 40 ft. (general) ~~(above)~~ (below) Meas. Pt. Original ground Date 8/67

Elevation (ground) 4859.9 W. L. Meas. Pt. See below ( )

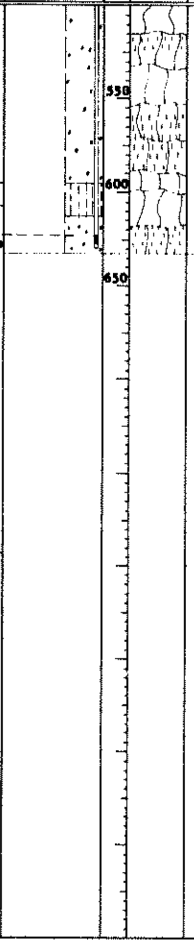
Yield Drawdown Other Data See geologic log book, driller's and inspector's reports, and geophysical logs

Logged By H. Ham Geophysical Log Gamma & Gamma-Gamma by N.R.T.S./U.S.G.S. Drilled By Justice Core Drilling Co.

Description of Well Completion

595 Gravel
613 Grout
℄ Perforations
625 Piezometer A
Bottom of Rx Hole

Well Diagram / Depth / Log



Classification and Physical Condition

Total depth - 632.5 ft.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

☐	SAND	▨	SILT
⛶	SAND & GRAVEL	▦	BASALT

PROJECT Lower Teton Division - Teton Basin Project

WELL NO. 7N/38-23db3 (Site 4)

BUREAU OF RECLAMATION - REGION 1

SHEET 1 OF 1

LOG OF WELL

Project **Lower Teton Division** Feature **Observation Wells** State **Idaho**

Well No. **7/39-1cc1 (Well A)
7/39-1cc2 (Well B) Site 5** Location **Approx. 600 ft. East and 141 (Well A) and 151 (Well B) ft. North of SW¼ Corner section 1, T. 7 N., R. 39 E., B.M.**

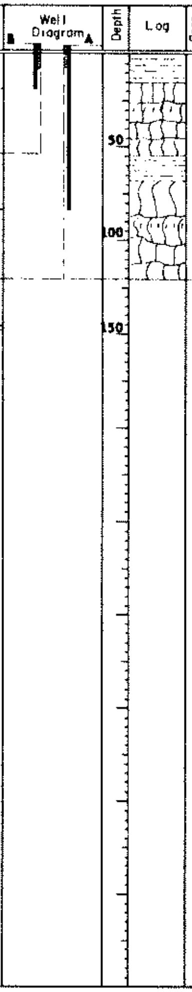
Total Depth **Well A - 122 ft. B - 55 ft.** Begun **6/29/67** Completed **7/5/67** Drilling Method **Air rotary**

Static Water Level **Well A - 72.5 ft. B - 39.0 ft.** (above) (below) Meas. Pt. **Original ground** Date **8/67**

Elevation (ground) **4904.3** W. L. Meas. Pt. **See below** ( )

Yield ______ Drawdown ______ Other Data **See driller's and inspector's reports**

Logged By **Driller** Geophysical Log ______ Drilled By **Cope Drilling Co. Justice Core Drilling Co.**



Drilling Data Pump Tests Water Samples	Description of Well Completion	Core Recov.	Samp. Type	Classification and Physical Condition
Drilled under Specs. 100C-920	**Puddled surface seal**		**D**	**0.0 - 16.0 - TOPSOIL and SAND.**
	19 6" I.D. Csg.			**16.0 - 55.0 - BASALT and CINDERS; red and gray.**
Water-surface elevations 8/28/67	**55 8" Hole**			**55.0' - 68.0' - CLAY; soft.**
Well A - 4831.9 **B - 4875.3**	**84.3 6" I.D. Csg. w/shoe**			**68.0' - 122.0' - BASALT and CINDERS; gray.**
	122 8" hole			**Total depth - 122 ft.**
	Elevations **Well A - Top of Csg. - 4904.86** **Well B - Top of Csg. - 4905.41**			**Cinder zones shown by vertical ticks on log.**

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

☐	**SAND**
▤	**CLAY**
▦	**BASALT & CINDERS**

PROJECT **Lower Teton Division - Teton Basin Project**

WELL NO. **7N/39E-1cc1 & (Site 5)**

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 1

LOG OF WELL

Project Lower Teton Division Feature Test Well State Idaho

Well No 7N/40E-19ad1 (Test Well 2) Location Approx. 415 ft. North and 200 ft. West of the E¼ Corner Section 19, T. 7 N., R. 40 E., B.M.

Total Depth 394.7 Begun 5/9/68 Completed 8/2/68 Drilling Method Cable tool

Static Water Level 30.83 ft. (above) (below) Meas. Pt. Top of casing, S. side Date 7/31/68

Elevation (ground) 4857.0 W. L. Meas. Pt. 4858.01 ( )

Yield See below Drawdown See below Other Data See driller's and inspector's reports and geologic field log.

Logged By H. Ham Geophysical Log Drilled By Ralph C. Denton Drilling Co.

Drilling Data Pump Tests Water Samples

Drilled under Specs. 100C-958 Developed by surging with test pump for 10 hrs. at 5000 gpm max.

Step drawdown test 7/30/68.

Disch.	Dd.
1000 gpm	0.69 ft.
2000	1.26
3000	2.31
4000	3.83
5000	5.76

Continuous test 90 min. per step Constant yield test 7/31/68 - 8/2/68.

Transmissibility - 1.6 X 10^3 to 2.7 X 10^3 ft.^{2}/min. (1.7 to 2.9 X 10^7 gpd./ft.) Coefficient of storage - less than 1.0 X 10^{-5}

Quality sample 8/1/68
pH - 7.96
Spec. Cond.-290 X 10^{-6} mho
B - 0.06 ppm
HCO_3 - 2.89 me./l.
Residual $N_a CO_3$ - 0.12 me./l.
SAR - 0.34
Sediment after pumping C.Y. for 48 hrs. - less than 0.01 ml.

Description of Well Completion

34 in. hole 0.0 to 40, 34 in. csg. 2 to 40, cement grout 2 to 42

40

30 in. hole 40 to 124, 30 in. temp. csg 0 to 124, 27 in. hole 124 to 160.

24 in. O.D.,500 in. wall csg. +2 to 160, Cement grout 154-160, factory shoe at 160.

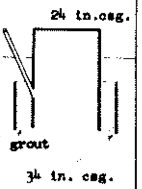
160

23 in. hole 160 to 198.5
20 in. O.D.,.312 wall liner 145 to 198.5

198.5

Near surface details

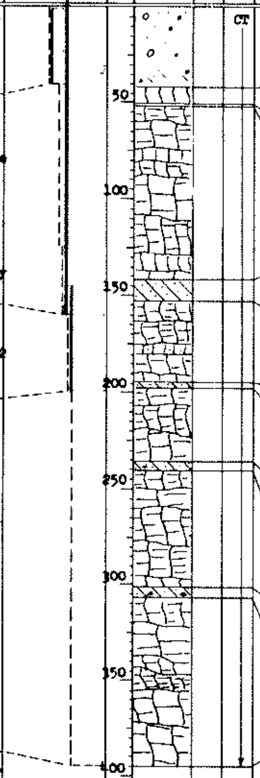
1¼ in. pipe



394.7

Bottom of 19 in. hole.

Well Diagram | **Depth** | **Log** | **Core Recov** | **Samp Type**



Classification and Physical Condition

0.0 to 42 SAND, GRAVEL AND COBBLES, rounded to subangular basalt, quartzite and silicic volcanics up to 150mm., basalt and quartz sand increasing with depth, silty 30-42.

42 to 51, BASALT, light gray, aphanitic, mostly dense, olivine - bearing

51 to 52 SAND AND GRAVEL, similar to that at 0-42.

52 to 142 BASALT, gray, brown, reddish, aphanitic, dense to highly vesicular, olivine - bearing. Driller reports sand 120-123

142 to 153 SILTY SAND, reddish brown, fine to coarse grained, principally subrounded to subangular quartz and silicic volcanic rocks

153 to 194 BASALT, similar to 52 to 142. Thin zone of SILTY SAND near 175-180

194 to 197 SILTY SAND, reddish-brown, fine-grained, principally quartz.

197 to 236 BASALT, gray, lathy with few phenocrysts grading to aphanitic, dense to scoriaceous, olivine-bearing

236 to 241 SANDY SILT, reddish-brown, fine of coarse grained quartz and basalt sand, numerous fragments of basalt and alteration material.

241 to 302 BASALT, gray, aphanitic, dense to vesicular olivine-bearing,

302 to 307 SANDY SILT, dark brown, fine grained quartz and basalt sand, numerous basalt fragments and alteration material.

307 to 394.7 BASALT, gray, reddish, aphanitic, dense to scoriaceous, olivine-bearing, much alteration material at 394

394.7 - Total Depth

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▨	CLAY	⬚	SAND	▦	BASALT
▧	SILT	⁘	GRAVEL	☐	

PROJECT Lower Teton Division

WELL NO. 7N/40E-19ad1 (Test Well 2)

BUREAU OF RECLAMATION ~~R~~EGION 1 SHEET 1 OF 1

LOG OF WELL

Project Lower Teton Division Feature Observation Wells at Test Well Site 2 State Idaho

Well No. (Obs. Wells 2A, 2B & 2C) 7N/40E-19 ad2, ad3 & ad4 Location Approx. 415 ft. North and 230 ft. West of the E. ¼ Corner Section 19, T. 7 N., R. 40 E., B.M.

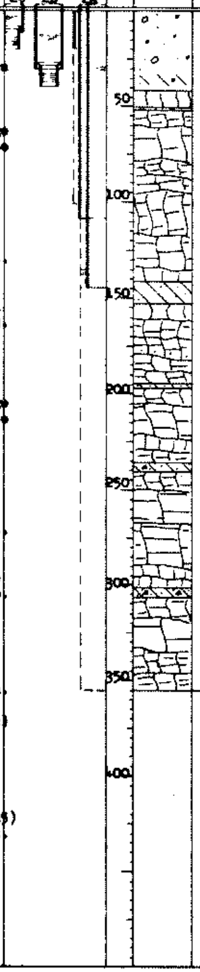
Total Depth 2A-355.0 2B-40.5 2C-20.5 Begun 3/28/68 Completed 5/7/68 Drilling Method Cable tool

Static Water Level See below (above) (below) Meas. Pt See below Date

Elevation (ground) Average 4856.7 W. L. Meas. Pt. See below ( )

Yield Drawdown Other Data

Logged By Taken from log of Test Well 2 Geophysical Log Drilled By Ralph C. Denton Drilling Co.

Drilling Data Pump Tests Water Samples	Description of Well Completion	Well Diagram 2C 2B 2A	Depth	Log	Core Recov	Samp Type	Classification and Physical Condition
Drilled under Specs. 100C-958 Developed by surging with bailer.	**Well 2C** 8 in., .277 wall csg. +0.9 to 10.7, 4 in. screen assembly 9.0 - 20.5. #12 slot screen 13.5 to 18.5, lead swedge seal, steel plate bottom. El. O.G.-4857.1 El. top of csg.- 4858.02, s.w.l. 7/31/68, 3.11 (El. 4854.91). Radius - 31.8 ft. **Well 2B** 8 in., .277 wall csg. 0.9 to 31.3, 4 in. screen assembly 29.0 to 40.5. #12 slot screen 33.5 to 38.5, lead swedge seal, steel plate bottom. El.O.G.-4856.4 El. top of csg.- 4857.29, s.w.l. 7/31/68, 13.72 (El. 4843.55) Radius - 29.4 ft. **Well 2A** 10 in. hole 0 to 102, 10 in. temp. csg. 0 to 41 (0-18.8 remaining), 8 in. 277 csg. + 0.7 to 107, 8 in. hole 102 to 355, 6 in. csg. + 0.9 to 144, grout 135(±) to 144 El. O.G.-4856.3 El. top of 6 in. csg. - 4857.17, s.w.l. 7/31/68, 28.82 (El.4828.35) Radius - 31.0 ft.					CT	Refer to log of Well 7N/40E-19ad1 (Test Well 2) for approximate classification and physical condition. Graphic log at left taken from Well 7N/39E-19ad1.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▨	CLAY	⬚	SAND	▦	BASALT
▨	SILT	⁘	GRAVEL	☐	

PROJECT Lower Teton Division WELL NO. 7N/40-19ad2, ad3 & ad4 Obs.Wells 2A,2B

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 1

LOG OF WELL

Project **Lower Teton Division** Feature **Exploratory Hole and Piezometer Bank** State **Idaho**

Well No **7N/40E-20cd1 (Site 8)** Location **Approx. 842' West and 78' North of S. ¼ Corner**

Total Depth **399.6 ft.** Begun **8/2/67** Completed **8/22/67** Drilling Method **Churn & Rotary Drill**

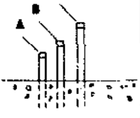
Static Water Level **36 ft.** ~~(above)~~ (below) Meas. Pt **Original ground** Date **8/67**

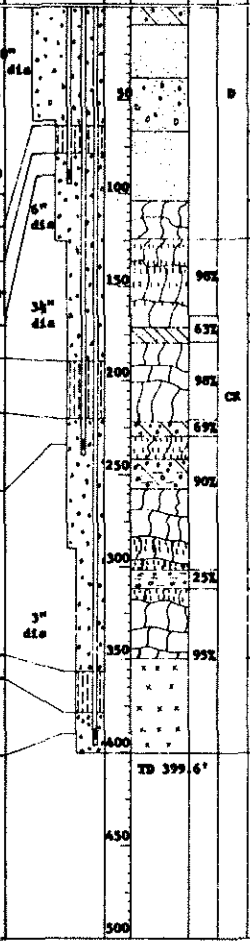
Elevation (ground) **4875.6 ft.** W. L. Meas. Pt **Top of 3/4" pipes** ( )

Yield **No test** Drawdown Other Data **Geologist detail log book, driller's and inspector's reports, and geophysical logs**

Logged By **L. Hampton** Geophysical Log **Gamma & Gamma-Gamma by W.R.T.S./U.S.G.S.** Drilled By **Justice Core Drilling Co.**

Drilling Data Pump Tests Water Samples	Description of Well Completion	Classification and Physical Condition
Churn drill hole 0.0' - 125.5'. Wireline diamond drill core hole 125.5' - 399.6' under Specs. 100C-920	Three 3/4" I.D. B.I. Piezometer pipes installed as shown. Elevation top of 3/4" piezometers Piezo A 4875.30 B 4875.40 C 4875.40 R.P. in concrete base 4875.92	0.0' - 8.0' - SILTY SAND AND GRAVEL. 8.0' - 37.0' - SAND. 37.0' - 66.0' - SANDY GRAVEL
Water-surface elevations 9/5/67 Piezo A 4830.10 B 4831.28 C 4840.84	63' Grout 78' Gravel	66.0' - 103.0' - SAND. 103.0' - 124.3' - BASALT; medium gray.
Water sample @ 125.5' Temp. 53°F. Cond. 182 Ex10⁶	Piezometer C ℄ of 5' perforations 90.0' 189' Grout	124.3' - 171.0' - BASALT; grayish red-purple to gray, aphanitic, scoriaceous to dense, jointed and massive. 171.0' - 177.8' - SANDY SILT; light brown. 177.8' - 222.0' - BASALT; medium gray, equigranular (1 mm), moderately vesicular to dense; jointed to massive.
Piezometer	220' Gravel 235.0' Piezometer B ℄ of 5' perforations	222.0' - 228.0' - SILTY GRAVEL; moderate pink, basaltic. 228.0' - 242.0' - BASALT; grayish red-purple to gray, equigranular, highly vesicular to slightly vesicular, jointed to massive. 242.0' - 257.8' - CLAYEY, SILTY GRAVEL; brown to gray, basaltic. 257.8' - 302.8' - BASALT; grayish red-purple to gray, equigranular (1 mm), scoriaceous, and highly to moderately jointed. 302.8' - 312.0' - CLAYEY GRAVEL.
concrete slab	356' Grout 378' Gravel Piezometer A ℄ of 5' perforations 391.5'	312.0' - 349.0' - BASALT; grayish red-purple to gray, porphyritic, plagioclase crystals to 10 mm, scoriaceous to vesicular, highly to slightly jointed. 349.0' - 399.6' - RHYOLITIC ROCKS; reddish-orange to light gray, welded tuff or rhyolite porphyry with quartz and plagioclase phenocrysts to 3 mm; badly altered 349.0' - 355.7'; grades to fresh rock 371.0'.





Note: Scoriaceous, cindery, and highly vesicular zones shown by vertical ticks on log.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▨	GRAVEL
▨	SAND
▨	SILT
▨	CLAY
▨	BASALT
▨	RHYOLITIC ROCKS

PROJECT **Lower Teton Division - Teton Basin Project** WELL NO. **7N/40E-20cd1 (Site 8)**

BUREAU OF RECLAMATION - REGION 1

SHEET 1 OF 2

LOG OF WELL

Project Lower Teton Division Feature Exploratory Drill Hole State Idaho

Well No. 6N/36E - 11 abl (Site 11) Location NW NE Section 11, T6N,R36E (Monteview Area)

Total Depth 1002.2 Begun 7/10/69 Completed 9/29/69 Drilling Method Cable tool 0-500' Core Rig 500-1002.2'

Static Water Level see below (above/below) Meas. Pt. see below Date —

Elevation (ground) 4817.90 W. L. Meas. Pt. — ( )

Yield — Drawdown — Other Data Driller, inspector reports; and Geologists Well Report

Logged By G. I. Haskett Geophysical Log Electric, caliper, neutron, gamma gamma-gamma, temperature Drilled By Cope Drilling & Pump Co. and Justice Core Drilling

Drilling Data / Pump Tests / Water Samples

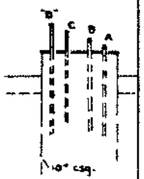
Churn drill to 501.7'; wireline diamond core to 1002.2', under Specs. 100C-1060

Top of 10" csg. is 4819.25 (high pt).

PIEZOMETERS

	MP Elev.	12/13/69 Depth, water
A	4819.52	19.76'
B	4819.60	36.55'
C	4819.78	36.95'
"D"	4819.90	72.73'

Original hole lost below 710'; sidetracked hole drilled to 990'.



Description of Well Completion

Pipes are 3/4" threaded-welded coupling, black iron.

"D" 3/4" surface pipe

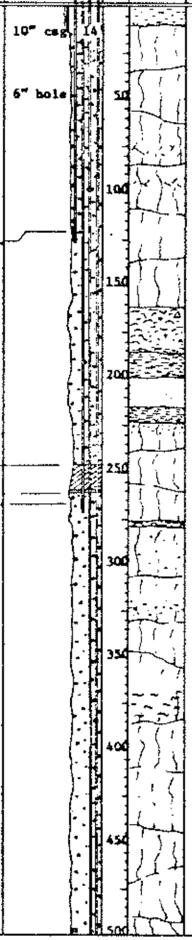
121' ℄ perfs.

Piezometer C

245' Grout

260' Gravel

267' ℄ perfs.



Classification and Physical Condition

Samp Type	
D	0-10 SILT, sandy
	10-161 BASALT, brown-gray, fine grained-sugary, scattered to numerous fine feldspar laths; broken 74-81, 92-96 feet.
D CT	161-186 ASH, orange-red, with fragments of red scoria, trace of clayey sand near base.
	186-200 CLAY, tan, ashy, falls apart in water, with inclusions of basaltic glass and rhyolite grains.
	200-215 SAND, coarse, predominately quartz with rhyolite and basaltic glass.
	215-223 CLAY, yellow-tan, ashy, sticky, plastic.
	223-276 BASALT, gray, fine grained, scoriateous with clay in some vesicles 223-229.
	276-279 SCORIA, orange-red, glassy, trace red ash.
	279-305 BASALT, red-gray, very fine grained, vesicular.
	305-318 BASALT, brown-gray, fine grained, finely vesicular.
	318-327 BASALT, dark gray, very fine grained, vesicular to scoriateous, with porous-red SCORIA.
	327-370 BASALT, brown-gray, fine grained-slightly sugary, trace of white clay below 340.
	370-385 BASALT, red, fine grained, very vesicular, some filled with white clay, abundant yellow-orange ash.
	385-440 BASALT, brown-gray, very fine grained, trace of feldspar laths to 2 mm.
	440-501.2 BASALT, brown-red, finely vesicular, trace of feldspar.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▨ CLAY
▨ SILT
▭ SAND
▨ BASALT
▨ ASH
▨ VESICULAR BASALT

SITE 11

PROJECT Lower Teton Division WELL NO. 6N/36E - 11 abl

BUREAU OF RECLAMATION - REGION 1

SHEET 2 OF 2

LOG OF WELL

Project Lower Teton Division Feature Exploratory Drill Hole State Idaho

Well No. 6N/36E - 11 abl (Site 11) Location NW NE Section 11, T6N,R36E (Monteview Area)

Total Depth 1002.2 Begun 7/10/69 Completed 9/29/69 Drilling Method Cable Tool 0-500' Core Rig 500-1002.2'

Static Water Level ~~see below~~ (above/below) Meas. Pt. ~~see below~~ Date —

Elevation (ground) 4817.90 W. L. Meas. Pt. — ( )

Yield — Drawdown — Other Data Driller, inspector reports; and Geologists Well Report

Logged By G. I. Haskett Geophysical Log Electric, caliper, neutron, gamma gamma-gamma, temperature Drilled By Cope Drilling & Pump Co. and Justice Core Drilling

Description of Well Completion

6" csg left in hole 496-710'

Piezometer B

615' Grout

630' Gravel

656' ℄ perfs.

710' start of side tracked hole

3" csg. lost in old hole, 705-777'

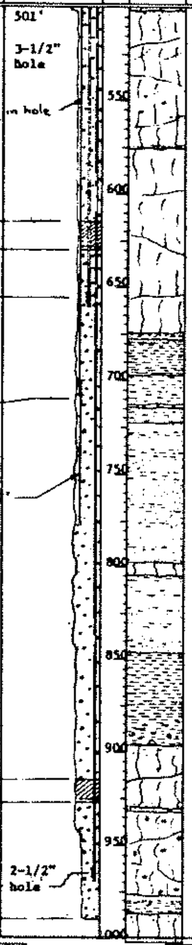
Piezometer A

915' Grout

927' Gravel

963' ℄ perfs.

990' bottom of side tracked hole



Classification and Physical Condition

Samp Type	
CR	501.2-501.8 BASALT, red, vesicular to scoriateous.
	501.8-575.7 BASALT, gray to red-brown, fine to very fine grained, slight to vesicular, numerous fine feldspar laths; slightly altered and rusty, soft green clay in vesicles below 575.2.
	575.7-674.0 BASALT, gray to red-gray, slightly vesicular to vesicular, numerous fine feldspar crystals, to 6 mm. (594-605).
	675.0-677.7 CLAY, yellow-tan, silty, faint bedding.
	677.7-678.1 SAND, brown-gray, very fine grained, subangular grains of quartz, biotite, dirty, slightly porous.
	679.1-697.0 CLAY, gray, silty, faint horizontal bedding, inclusions of black cinders, 679.0-679.6.
	697.0-712.9 SILT, gray, micaceous, clayey; 0.9 ft. slightly porous sand at base, bleached at contact.
	712.9-713.4 BASALT SILL, black, dense, chilled top and bottom.
D	713.4-723.0 SILT, brown-gray, clayey, baked at top.
	723.0-798.0 SAND and SILT, alternating layers of gray silt and fine grained, slightly porous brown-gray sand.
CR	798.0-804.5 BASALT SILL(?), gray, dense, numerous fine feldspar laths, chilled top and base.
	804.5-845.5 SILT to very fine SAND, brown to gray-brown banded.
	845.5-895.5 CLAYSTONE, brown-gray, massive, scattered fine carbonaceous inclusions; at 885.6 is a 0.4' silt, with sand laminations containing fragments of glassy scoria; inclusions of vesicular basalt below 887.0.
	895.5-929.7 BASALT, gray, vesicular at top and bottom, pyrite in vesicles, occasional old fracture healed with green clay.
	929.7-930.5 SAND, dull red, dirty, tight.
	930.5-976.3 PORPHYRITIC BASALT, gray, feldspar laths to 25 mm., scattered large vesicles, some with zeolite crystals.
	976.3-986.9 INTERFLOW ZONE: 3.2' fine sand, 1.4' silt; 0.6' claystone, 5.4' silt with trace carbonaceous fragments.
	986.9-1002.2 BASALT, gray, vesicular-decreas. w/ depth, many filled w/ clear to tan zeolite crystals
	1002.2 TOTAL DEPTH

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▨ CLAY
▨ SILT
▭ SAND
▨ BASALT
▨ VESICULAR BASALT
▨ FELDSPAR CRYSTALS

SITE 11

PROJECT Lower Teton Division WELL NO. 6N/36E - 11 abl

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 2

LOG OF WELL

Project Lower Teton Division Feature Exploratory Drill Hole State Idaho

Well No. 6N/37E-29acl (Expl. Hole 9) Location Approx. 1550 ft. South and 250 ft. East of the N½ corner Sec. 29, T. 6 N., R. 37 E. (U.S. land)

Total Depth 573 ft. Begun 9/5/68 Completed 12/17/68 Drilling Method Cable Tool

Static Water Level See below (above/below) Meas. Pt. Date

Elevation (ground) 4823.4 W. L. Meas. Pt. ( )

Yield Drawdown Other Data See driller's and inspector's reports and geologic field log

Logged By H. Hem Geophysical Log Caliper, Gamma and Gamma-Gamma by H.R.T.S./U.S.G.S. Drilled By Commons Drilling Co.

Drilling Data Pump Tests Water Samples

Drilled under Specs. 100C-1003

Undisturbed drive samples taken by double tube sampler attached to drill stem.

Lab. analysis by U.S.G.S. Denver Hydrologic Lab. - Spec. grav., spec. ret., porosity, spec. yield, vert. perm. and m.e.

Struck first water at 53 to 65 ft.

W.S. depths (below O.G.) and elevations 1/10/69

6 in. csg.
Depth - 39.6
El. - 4783.8

10 in. csg.
Depth - 39.6
El. - 4783.8

12 in. csg.
Depth - 47.7
El. - 4775.7

16 in. csg.
Depth - 43.9
El. - 4779.5

Description of Well Completion

20 in. hole 0.0 to 21.0 ft.

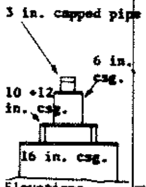
16 in. O.D., .250 wall csg. + 0.8 to 21.0 ft. - builtup shoe. Puddled clay surface seal.
15 in. hole 21 to 90 ft. Clay seal 62 to 90 ft.

12 in. I.D. .250 wall csg. + 1.2 to 151.5 ft. - factory shoe
12 in. hole 90 to 175 ft.

10 in. I.D. .250 wall csg. + 1.2 to 404 ft. - factory shoe
10 in. hole 175 to 440 ft.

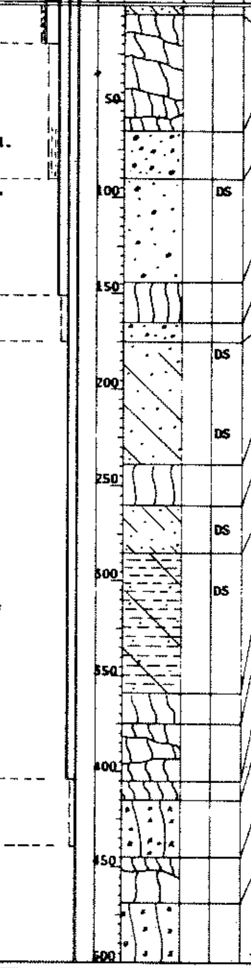
6 in. I.D. .250 wall csg. + 1.9 to 505 ft. - factory shoe
6 in. hole 440 to 573 ft.

Well Head Detail



Elevations
Top of:
3" pipe - 4825.52
6" csg. - 4825.32
10" csg.- 4824.62
12" csg.- 4824.62
16" csg.- 4824.22
O.G. - 4823.42

Well Diagram | Depth | Log | Core Recov | Samp Type



Classification and Physical Condition

0.0 to 4 - SILTY SAND, tan, fine-grained.

4 to 65 - BASALT, gray and red, dense to vesicular.

65 to 90 - SAND & GRAVEL, reddish-orange, quartz sand and basalt, obsidian, silicic volcanic and quartzite gravels up to 25mm.

90 to 144 - SAND, grayish tan, fine-grained quartz with numerous gravels, becomes silty and gray with depth.

144 to 165 - BASALT, dark gray, vesicular.

165 to 175 - SAND & GRAVEL, gray, quartz sand and basalt, obsidian and silicic volcanic gravels up to 25mm.

175 to 238 - SAND, gray, fine-to-medium grained, mostly quartz and basalt, becomes tan, fine-grained and silty at 180 (+).

238 to 260 - BASALT, dark gray, dense.

260 to 285 - SAND, gray, fine-grained, silty, coarser and cleaner 275 to 280 and very silty 280 - 285.

285 to 358 - SILTY CLAY, gray, firm, becomes sandy at 300, sandy and silty at 310.

358 to 375 - BASALT, dark gray, dense.

375 to 405 - BASALT, reddish-gray, highly vesicular to scoriaceous, lost all cuttings 380 - 405.

405 to 415 - BASALT, light gray, dense.

415 to 445 - VOLCANIC BRECCIA, reddish gray, basaltic, apparently vesicular basalt and scoria fragments in granular mud-like matrix.

445 to 469 - BASALT, reddish-gray, dense to scoriaceous, lost all cuttings 445 to 450, 455 to 469.

469 to 513 - VOLCANIC EJECTA, red, brown, gray, basaltic, loose cinders, scoria and obsidian, lost most of cuttings.

SAMPLE TYPE:
CR = Core DS = Drive Sample
CT = Cuttings
D Drillers Log

▤ CLAY
▨ SILT
░ SAND
▒ GRAVEL
▥ BASALT
▦ CINDERS, SCORIA, ETC.

PROJECT Lower Teton Division WELL NO. 6N/37E-29 acl
Expl. Hole 9

BUREAU OF RECLAMATION REGION 1 SHEET 2 OF 2

LOG OF WELL

Project Lower Teton Division Feature Exploratory Drill Hole State Idaho

Well No. 6N/37E-29acl (Expl. Hole 9) Location Approx. 1550 ft. South and 250 ft. East of the N½ corner Sec. 29, T. 6 N., R. 37 E. (U.S. Land)

Total Depth 573 ft. Begun 9/5/68 Completed 12/17/68 Drilling Method Cable Tool

Static Water Level See below (above/below) Meas. Pt. Date

Elevation (ground) 4823.4 W. L. Meas. Pt. ( )

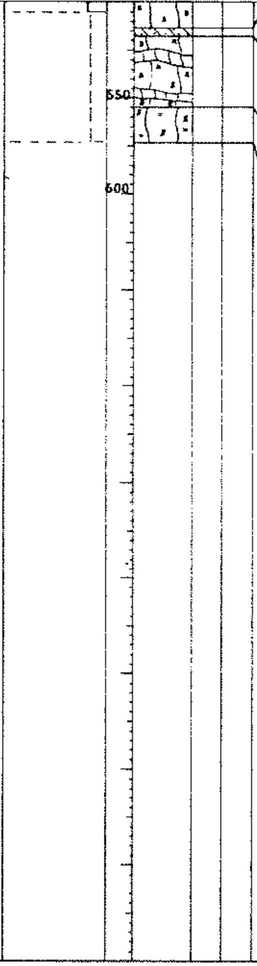
Yield Drawdown Other Data See driller's and inspector's reports and geologic field log

Logged By H. Hem Geophysical Log Caliper, Gamma and Gamma-Gamma by H.R.T.S./U.S.G.S. Drilled By Commons Drilling Co.

Drilling Data Pump Tests Water Samples

Description of Well Completion

Well Diagram | Depth | Log | Core Recov | Samp Type



Classification and Physical Condition

513 to 517 - SILT, orange, sandy, lightly indurated, underlain by SAND, tan, fine-grained quartz.

517 to 555 - BASALT, gray, vesicular interbedded with VOLCANIC EJECTA, red and gray, apparently cinders and scoria, lost most of cuttings.

555 - 573 - VOLCANIC BRECCIA, reddish, basaltic, apparently vesicular basalt and scoria in granular, mud-like matrix, cinders near bottom, lost many cuttings.

573 - TOTAL DEPTH

SAMPLE TYPE:
CR = Core DS = Drive Sample
CT = Cuttings
D Drillers Log

▤ CLAY
▨ SILT
░ SAND
▒ GRAVEL
▥ BASALT
▦ CINDERS, SCORIA, ETC.

PROJECT Lower Teton Division WELL NO. 6N/37E-29acl
Expl. Hole 9

BUREAU OF RECLAMATION REGION 1 SHEET 1 OF 2

LOG OF WELL

Project Lower Teton Division Feature Test Well State Idaho

Well No. 6N/38E-25acl (Test Well 1) Location Approx. 2180 ft. West and 1900 ft. South of the NE Corner Section 25, T. 6 N., R. 38 E.

Total Depth 685 Begun 1-10-68 Completed 6-18-68 Drilling Method See Below

Static Water Level 18.05 ft. (above) (below) Meas. Pt. Top of casing, SW side Date 6/16/68

Elevation (ground) 4825.4 W. L. Meas. Pt. 4826.41 ( )

Yield See Below Drawdown See Below Other Data See driller's and inspector's reports and geologic field log

Logged By H. Ham Geophysical Log Drilled By Ralph C. Denton Drilling Co Cope Drilling & Pump Co.

Drilling Data Pump Tests Water Samples

Drilled under Specs.100C-958 by Denton, sub. by Cope. Cable tool 0-40, reverse rotary 40-269, cable tool 269-685. Two previous holes .135 and 278 ft. deep, were abandoned.

Developed by surging with test pump for 2.5 hrs. Sediment reduced to 0.05 ml. at 5000 gpm. max.

Step drawdown test 6/15/68

Disch.	Dd.
1100 gpm	0.25 ft.
2050	0.70
3100	1.50
4150	2.55
5125	3.75

Continuous test -120 min. per step.

Constant yield test 6/16/68 - 6/18/68.

Transmissibility- 1.2 x 10^3 to 2.1 x 10^3 ft.^{2}/min. (1.3 to 2.3 x 10^7 gpd/ft.) Coefficient of storage - less the 1.0 x 10^{-5}.

Quality sample 6/17/68
pH - 7.72
Spec.Cond.-469 x 10^{-6} mho B - 0.06 ppm HCO_3 - 4.06 me./l. Residual $NaCO_3$ - (-) 0.56 me./l.
SAR - 0.45

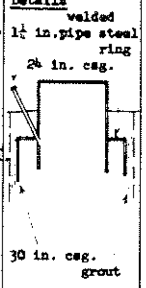
Description of Well Completion

40 in. hole 0.0 to 41, 40 in. temp. csg. 0.0 to 6.0, cement grout 1.0 to 30

— 40 —

39 in hole 41 to 269, 30 in. csg. 1.0 to 269.

Near-Surface Details

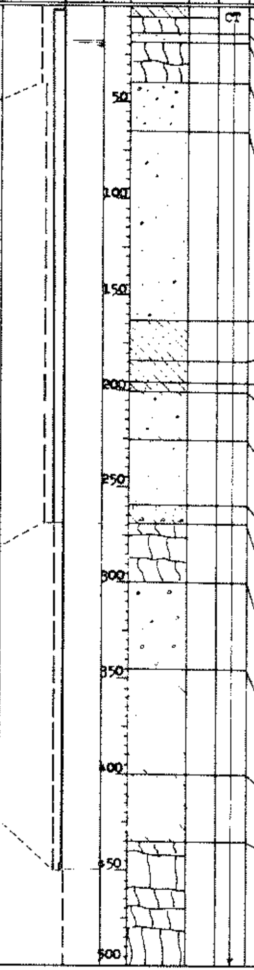


— 269 —

29 in. hole 269 to 450 24 in. O.D.., .500 in. wall csg. + 1.0 to 450.6 Factory shoe at 450.6 cement grout 437 to 450.6

— 450.6 —

Well Diagram / Depth / Log / Core Recov / Samp Type



Classification and Physical Condition

0.0 to 5 SILTY SAND; tan

5 to 13 BASALT; dark gray, aphanitic, dense to vesicular, olivine-bearing

13 to 18 SAND; gray, fine-grained, basalt and quartz with silicic volcanics, few gravels.

18 to 39 BASALT; dark gray, aphanitic, dense, olivine bearing,

39 to 65 SAND AND GRAVEL; sub-rounded to subangular obsidian porphyry with basalt and other silicic volcanics, decreasing obsidian and increasing quartz sand content with depth.

65 to 163 SAND; gray, fine to coarse grained, quartz and silicic volcanics with basalt, few gravels of similar composition

163 to 184 SILTY CLAY; tan, plastic, sticky,

184 to 195 SILTY CLAY; gray, plastic, sticky

195 to 201 SILTY SAND; tan, very fine-grained mostly quartz.

201 to 226 SAND; tan, medium to coarse grained, quartz with silicic volcanics, few gravels possibly partly cemented.

226 to 259 SAND; tan and gray, very fine to fine grained, micaceous quartz with silicic volcanics, silty top and bottom

259 to 269 SILTSTONE; tan, sandy, moderately indurated, distinct bedding planes upper part, contains angular fragments of dark gray, vesicular basalt 260-269

269 to 300 (±) BASALT; dark gray, aphanitic, dense to moderately vesicular, olivine bearing

300 (±) to 345 SAND AND SAND AND GRAVEL; tan; interbedded fine to coarse quartz sand, subrounded to sub-angular silicic volcanic gravel

345 to 400 (±) SILTY SAND; tan fine to medium grained quartz with basalt

400 (±) to 435 SANDY SILT; tan, contains very fine-grained quartz sand.

435 to 670 (±) BASALT; gray to brown to red, aphanitic, dense to scoriaceous, olivine bearing

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▭ CLAY ▨ SILT ▭ SAND ⁘ GRAVEL ▥ BASALT ▭

PROJECT Lower Teton Division WELL NO 6N/38E-25acl (Test Well 1)

BUREAU OF RECLAMATION - REGION 1 SHEET 2 OF 2

LOG OF WELL

Project Lower Teton Division Feature Test Well State Idaho

Well No. 6N/38E-25acl (Test Well 1) Location Approx. 2180 ft. West and 1900 ft. South of the NE Corner Section 25 T. 6 N., R. 38 E.

Total Depth 685 Begun 1-10-68 Completed 6-18-68 Drilling Method See Below

Static Water Level 18.05 ft. (above) (below) Meas. Pt. Top of casing, SW side Date 6/16/68

Elevation (ground) 4825.4 W. L. Meas. Pt. 4826.41 ( )

Yield See Below Drawdown See Below Other Data See driller's and inspector's reports and geologic field log

Logged By H. Ham Geophysical Log Drilled By Ralph C. Denton Drilling Co Cope Drilling & Pump Co.

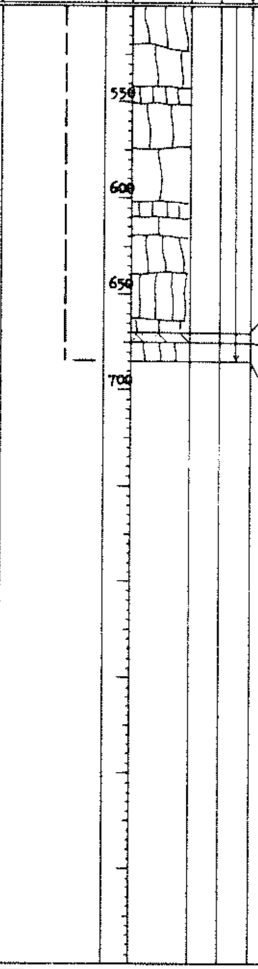
Drilling Data Pump Tests Water Samples

Description of Well Completion

— 685 —

Bottom of 23 in hole

Well Diagram / Depth / Log / Core Recov / Samp Type



Classification and Physical Condition

670 (±) to 675 (±) SILTY SAND; tan, fine grained quartz, clayey

675 to 685, BASALT; dark gray to black, lathy textured, scoriaceous to vesicular, olivine bearing, caving reported

Total Depth - 685 ft.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▨ CLAY ▨ SILT ▭ SAND ⁘ GRAVEL ▥ BASALT ▭

PROJECT Lower Teton Division WELL NO. 6N/38E-25acl (Test Well 1)

BUREAU OF RECLAMATION REGION 1 SHEET 1 OF 2

LOG OF WELL

Project Lower Teton Division Feature Observation Wells at Test Well Site 1 State Idaho
Well No. 6N/38E-25ac2, ac3 & ac4 (Observation Wells 1A, 1B & 1C) Location T. 6N., R. 38 E. Approx. 2180 ft. West and 1870 ft. South of the NE Corner Section 25,
Total Depth 1A - 681 ft.. 1B - 246.3 1C - 50.0 Begun 12-28-67 Completed 6-18-68 Drilling Method Cable Tool
Static Water Level See below (above) (below) Meas. Pt See below Date
Elevation (ground) Average - 4826.7 W. L. Meas. Pt See below ( )
Yield ------ Drawdown ------ Other Data See driller's and inspector's reports and geologic field log
Logged By Taken from log of Test Well No. 1 Geophysical Log Drilled By Ralph C. Denton Drilling Co

Drilling Data Pump Tests Water Samples

Drilled under Specs. 100C-958 Developed by surging with bailer.

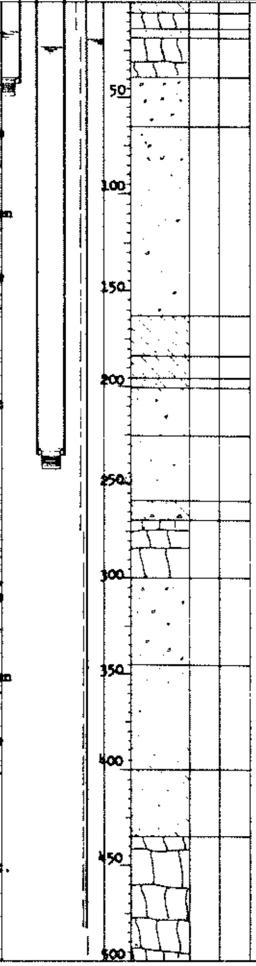
Description of Well Completion

Well 1C
8 in. I.D., .277 in. wall csg. + 0.5-42.5
41.0
2.0 ft.- 4 in. I.D. blank csg. with lead swedge seal
43.0
5.0 ft.-4 in. I.D. #12 slot wire wound screen
48.0
2.0 ft.-4 in. I.D. blank csg. with steel plate bottom
50.0
El.O.G.@ 4826.6 top of csg. - 4827.34 s.w.l. 6/16/68 16.28 (El.4811.06) Radius - 27.5 ft

Well 1B
8 in. I.D. .277 wall csg. + 1.0 to 237 csg. set in backfilled 3⅝ in. hole to 135
234.7
2.0 ft.-4 in. I.D. blank csg.. with lead swedge seal
236.7
5.0 ft.-4 in. I.D. #12 slot wire wound screen
241.7
2.0 ft.-4 in. I.D. blank csg. with steel plate bottom
243.7
El.O.G.-4826.7 top of csg. - 4827.48 s.w.l. 6/16/68 24.24 (El. 4803.24) Radius - 25.0 ft.

Well 1A
8 in. I.D. .277 in. wall csg. + 1.3 to 483.3

Well Diagram 1C 1B 1A | Depth | Log | Core Recov | Samp Type



Classification and Physical Condition

Refer to log of Well 6N/38E-25ac1 (Test Well No. 1) for approximate classification and physical condition. Graphic log at left taken from log of Well 6N/38E-25ac1.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▨ CLAY
▨ SILT
☐ SAND
⁘ GRAVEL
▥ BASALT
☐

PROJECT Lower Teton Division WELL NO. 6N/38E-25ac2 ac3 & ac4 Obs. Wells 1A, 1B & 1C

BUREAU OF RECLAMATION REGION 1 SHEET 2 OF 2

LOG OF WELL

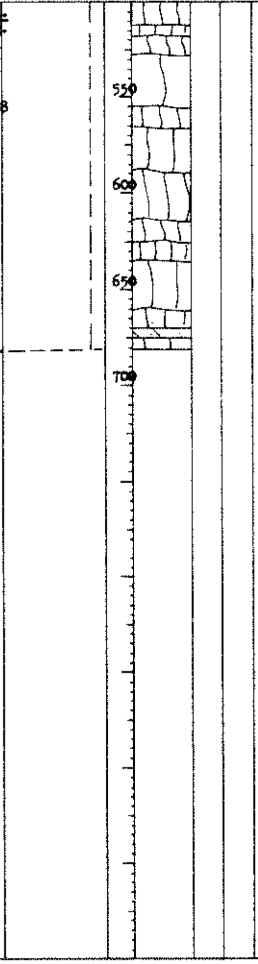
Project Lower Teton Division Feature Observation Wells at Test Well Site 1 State Idaho
Well No. 6N/38E-25ac2, ac3 & ac4 (Observation Wells 1A, 1B & 1C) Location T. 6N. R. 38 E. Approx. 2180 ft. West and 1870 ft. South of the NE Corner Section 25
Total Depth 1A - 681 ft. 1B - 246.3 1C - 50.0 Begun 12-28-67 Completed 6-18-68 Drilling Method Cable Tool
Static Water Level See below (above) (below) Meas. Pt. See below Date
Elevation (ground) Average - 4826.7 W. L. Meas. Pt. See below ( )
Yield ------- Drawdown -------- Other Data See driller's and inspector's reports and geologic field log c.
Logged By Taken from log of Test Well No. 1 Geophysical Log Drilled By Ralph C. Denton Drilling Co

Drilling Data Pump Tests Water Samples

Description of Well Completion

Well 1A Cont'd.
Temp. 14 in csg. to 6 ft. 12 in. to 27ft. 10 in. to 439 - all removed
El.O.G. - 4826.8 top of csg. - 4827.42 s.w.l. 6/16/68 18.98 (El. 4808.44) Radius - 39.5 ft.
483.3
Bottom of 8 in. csg. and grout
681.0
Bottom of 8 in. hole.

Well Diagram 1C 1B 1A | Depth | Log | Core Recov | Samp Type



Classification and Physical Condition

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▨ CLAY
▨ SILT
☐ SAND
⁘ GRAVEL
▥ BASALT
☐

PROJECT Lower Teton Division WELL NO. 6N/38E-25ac2 ac3 & ac4 Obs.Wells 1A, 1B &

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 2

LOG OF WELL

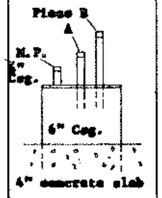
Project **Lower Teton Division** Feature **Exploratory Hole & Piezometer Bank** State **Idaho**
Well No. **6N/38E-30bad2 (Site 1)** Location **Approx. 230' West and 1120' South of N. ¼ Corner**
Total Depth **638'** Begun **6/12/67** Completed **8/11/67** Drilling Method **Churn & Rotary Drill**
Static Water Level **90' approx.** ~~(above)~~ (below) Meas. Pt. **Original ground** Date **7/67**
Elevation (ground) **4873.1'** W L. Meas. Pt. **See below** ( )
Yield **No test** Drawdown Other Data **Geologist detail log book, driller's and inspector's reports, and geophysical logs**
Logged By **L. Hampton** Geophysical Log **Gamma and Gamma-Gamma by N.R.T.S./U.S.G.S.** Drilled By **Justice Core Drilling Co.**

Drilling Data Pump Tests Water Samples

Churn drill hole 0.0' - 360.0'
Wireline diamond drill core hole 360.0' - 638.0'
under Spec. 100C-920

Water-surface elevations 9/5/67
Piezo. A 4803.48
B 4786.96
6" Csg. 4782.08

Packer test 7/26/67
Hole depth 484.9'
compression-type rubber packer @ 381.5'
Water level below packer 86.62'
above packer 90.75'



Description of Well Completion

Two 3/4" I.D. B.I. Piezometer pipes installed as shown

Elevation top of 3/4" pipes
Piezo A 4874.54
B 4874.86
3/4" coupling 4874.08
R.P. in concrete 4373.17

260.0' - 270.0' perforated 6" Csg.

308' Grout

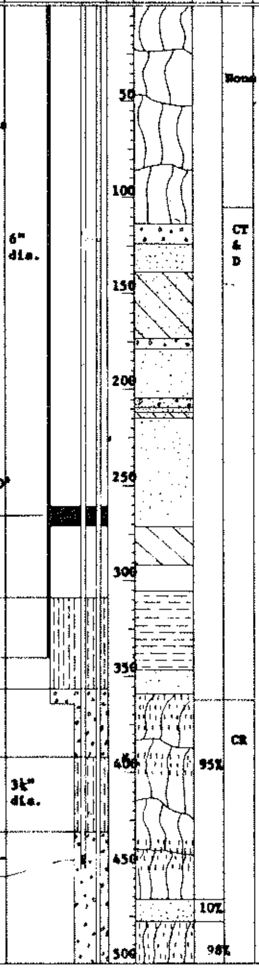
340' 6" Csg.

355' Gravel

392' Grout

430' Gravel

445' ℄ perforations Piezometer B



Classification and Physical Condition

0.0' - 113.0' - BASALT; no samples.

113.0' - 123.0' - GRAVEL; gray, cinders.
123.0' - 138.0' - SAND; brownish gray, basaltic, rhyolitic.
138.0' - 173.0' - SILTY SAND; gray, rhyolitic, basaltic.

173.0' - 178.0' - SAND and GRAVEL; gray, rhyolitic, basaltic.
178.0' - 204.0' - SAND; gray, basaltic, rhyolitic.
204.0' - 209.0' - SANDY GRAVEL; gray, rhyolitic, basaltic.
209.0' - 211.0' - SAND; gray, basaltic, rhyolitic.
211.0' - 214.0' - SILTY SAND; gray, rhyolitic, basaltic.
214.0' - 271.0' - SAND; gray, rhyolitic, basaltic, quartzose.

271.0' - 291.0' - SILTY SAND; gray, rhyolitic, basaltic, quartzose.
291.0' - 305.0' - SAND; gray, rhyolitic, quartzose.
305.0' - 346.0' - SANDY CLAY; gray.

346.0' - 359.0' - SAND; gray, basaltic.
359.0' - 466.0' - BASALT; grayish red purple to gray, aphanitic to equigranular, scoriaceous to dense, highly jointed to massive, fresh to decomposed.

466.0' - 477.0' - SAND; yellowish brown, quartzose.
477.0' - 533.6' - BASALT; grayish red purple to gray, aphanitic to equigranular, scoriaceous to dense, jointed to massive.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

⁘	GRAVEL	▨	SILT	▦	BASALT
░	SAND	▤	CLAY	☐	

PROJECT **Lower Teton Division - Teton Basin Project** WELL NO **6N/38E-30bad2 (Site 1)**

BUREAU OF RECLAMATION - REGION 1 SHEET 2 OF 2

LOG OF WELL

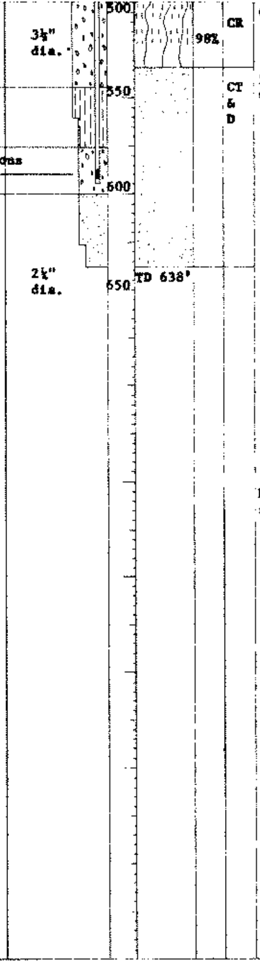
Project **Lower Teton Division** Feature **Exploratory Hole & Piezometer Bank** State **Idaho**
Well No **6N/38E-30bad2 (Site 1)** Location **Approx. 230' West and 1120' South of N. ¼ Corner**
Total Depth **638'** Begun Completed **8/11/67** Drilling Method **Churn & Rotary Drill**
Static Water Level **90' approx.** ~~(above)~~ (below) Meas. Pt **Original ground** Date **7/67**
Elevation (ground) **4873.1'** W. L. Meas. Pt. **See below** ( )
Yield **No test** Drawdown Other Data **Geologist detail log book, driller's and inspector's reports, and geophysical logs**
Logged By **L. Hampton** Geophysical Log **Gamma and Gamma-Gamma by N.R.T.S./U.S.G.S.** Drilled By **Justice Core Drilling Co.**

Drilling Data Pump Tests Water Samples

Description of Well Completion

543.5' Grout

575' Gravel
590' ℄ Perforations Piezometer A
600' Sand (caved)



Classification and Physical Condition

Continued from sheet 1.

533.6' - 638.0' - SAND; yellowish gray, arkosic medium to fine.

Note: Scoriaceous, cindery, and highly vesicular zones shown by vertical ticks on log.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

⁘	GRAVEL	▨	SILT	▦	BASALT
░	SAND	▤	CLAY	☐	

PROJECT **Lower Teton Division - Teton Basin Project** WELL NO **6N/38E-30bad2 (Site 1)**

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 2

LOG OF WELL

Project Lower Teton Division Feature Exploratory Hole and Piezometer Bank State Idaho

Well No. 6N/39E-10bb1 (Site 3) Location Approx. 500 ft. East and 120 ft. South of NW¼ Corner Section 10, T. 6 N., R. 39 E., B.M.

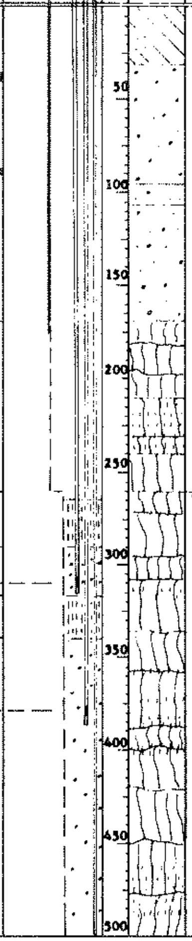
Total Depth 636.8 ft. Begun 5/26/67 Completed 6/8/67 Drilling Method Wireline diamond drill & churn drill

Static Water Level 17.5 ft. (general) ~~(above)~~ (below) Meas. Pt. Original ground Date 8/67

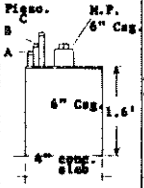
Elevation (ground) 4834.0 W. L. Meas. Pt. See below ( )

Yield No test Drawdown Other Data See geologic log book, driller's and inspector's reports and geophysical logs

Logged By H. Ness Geophysical Log Gamma and Gamma-Gamma by R.R.T.S./U.S.G.S. Drilled By Justice Core Drilling Co.



Drilling Data Pump Tests Water Samples	Description of Well Completion	Core Recov	Samp Type	Classification and Physical Condition
Churn drill hole to 260.0. Drilled 1962. Specs. 100C-577	Three 3/4" I.D. B.I. Piezometer pipes installed as shown in Nx hole and existing 6" well		D	0.0 to 30.0 - SILT and SAND.
Wireline diamond drill cored hole 260.0 to 636.8. Specs. 100C-920	Elevations: Top at 1¼" coupling - 4836.00			30.0 to 96.0 - SAND and GRAVEL, coarse.
Water-surface elevations - 8/28/67 6" Csg. - 4816.56 Piezo A - 4817.81 B - 4816.53 C - 4816.56	Top of 3/4" pipes Piezo A-4835.94 B-4836.22 C-4836.52			96.0 to 105.0 - SAND, small amount of gravel.
				105.0 to 168.0 - SAND and GRAVEL.
	R.P. in concrete 4834.23			
Surface details	168 6" Csg.			168.0 to 210.0 - BASALT, black,
				210.0 to 230.0 - CINDERS, black and red basalt.
				230.0 to 240.0 - BASALT & CINDERS,
	Temp. Nx Csg. Temp. 4" Csg. 260 6" hole			240.0 to 260.0 - BASALT, black, gray, and red,
	290 Grout	93%	CR	260.0 to 566.0 - BASALT, gray, brown, purple, and red. Aphanitic to porphyritic. Massive to highly jointed and brecciated. Dense to highly vesicular and scoriaceous. Generally olivine-bearing. Fresh to decomposed.
Attempted packer tests in open hole with compression-type rubber packer - generally unsuccessful due to bridging and hang-ups.	℄ Perforations Piezometer C 310 317 Gravel 339 Grout ℄ Perforations 379 Piezometer B			Scoriaceous, cindery, and highly vesicular zones shown by vertical ticks on log.



SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

SAND
SILT
MUDSTONE & BRECCIA
SANDSTONE & BRECCIA
BASALT
RHYOLITIC ROCKS

PROJECT Lower Teton Division - Teton Basin Project WELL NO. 6N/39E-10bb1 Site 3

BUREAU OF RECLAMATION - REGION 1 SHEET 2 OF 2

LOG OF WELL

Project Lower Teton Division Feature Exploratory Hole and Piezometer Bank State Idaho

Well No. 6N/39E-10bb1 (Site 3) Location Approx. 500 ft. East and 120 ft. South of NW¼ Corner Section 10, T. 6 N., R. 39 E., B.M.

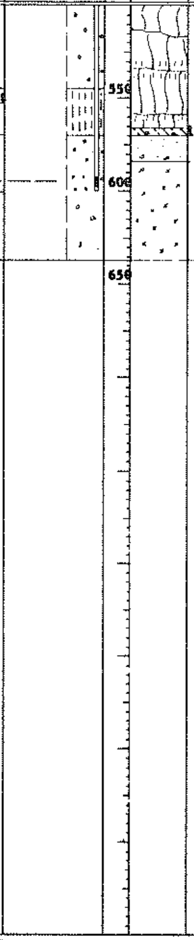
Total Depth 636.8 ft. Begun 5/28/67 Completed 6/8/67 Drilling Method Wireline diamond drill & churn drill

Static Water Level 17.5 ft. (general) ~~(above)~~ (below) Meas. Pt. Original ground Date 8/67

Elevation (ground) 4834.0 W. L. Meas. Pt. See below ( )

Yield No test Drawdown Other Data See geologic log book, driller's and inspector's reports, and geophysical logs

Logged By H. Ness Geophysical Log Gamma and Gamma-Gamma by R.R.T.S./U.S.G.S. Drilled By Justice Core Drilling Co.



Drilling Data Pump Tests Water Samples	Description of Well Completion	Core Recov	Samp Type	Classification and Physical Condition
	545 Gravel 552 Packer Test 570 Grout	100% 25%	CR CR	566.0 to 570.0 - MUDSTONE grading downward into BRECCIA. Reddish-brown. Some quartz and feldspar sand with fragments of rhyolitic rocks.
	℄ Perforations Piezometer A 595 560 Gravel	50%	CR	570.0 to 584.0 - SANDSTONE grading downward into sand and ROCK FRAGMENTS. Light brown to orange. Quartz and feldspar sand and fragments of rhyolitic rocks.
	Hole caved Bottom of Nx hole			584.0 to 636.8 - RHYOLITIC ROCKS including alternating layers of OBSIDIAN PORPHYRY And RHYO-DACITE PORPHYRY, gray and brown. Porphyritic. Massive to highly jointed. Dense. Phenocrysts of quartz and plagioclase and inclusions of pumice. Fresh to decomposed.
				636.8 - Total depth ft.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

SAND
SILT
MUDSTONE & BRECCIA
SANDSTONE & BRECCIA
BASALT
RHYOLITIC ROCKS

PROJECT Lower Teton Division - Teton Basin Project WELL NO. 6N/39E-10bb1 Site 3

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 2

LOG OF WELL

Project **Lower Teton Division** Feature **Exploratory Hole and Piezometer Bank** State **Idaho**
Well No. **6N/39E-**30adc1**(Site 7)** Location **Approx. 607' North & 1197' West of the E. ¼ Corner**
Total Depth **699.7'** Begun **7/10/67** Completed **7/25/67** **(See drilling data)** Drilling Method **Rotary**
Static Water Level **1.8** ~~(above)~~ (below) Meas. Pt. **Original ground** Date **9/5/67**
Elevation (ground) **4816.8** W. L. Meas. Pt **Top of pipe** ( )
Yield **No test** Drawdown Other Data **Geologist detail log book, driller's and inspector's reports, and geophysical logs**
Logged By **L. Hampton** Geophysical Log **Gamma and Gamma-Gamma by E.R.T.S/U.S.G.S.** Drilled By **Jack Alexander Justice Core Drilling Co.**

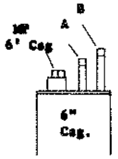
Drilling Data / Pump Tests / Water Samples:

Original private water well 295.0' deep drilled by J. Alexander 1962.

Wireline diamond drill core hole 295.0' - 699.7' by Justice under Specs. 100C-920

No pump test

Water-surface elevations 9/ 5/67
Piezo A 4816.26'
B 4815.42'
6" Csg. 4817.05'
Piezo



Water sample @ 699.7'
Temp. 52°F.
Cond. 516 Kx10^6

Attempted packer tests in open hole with compression type packer, generally unsuccessful.

Description of Well Completion:

Two 3/4" I.D. B.I. Piezometer pipes installed, as shown.

Elevation top of 3/4" pipes
Piezo A 4818.95'
B 4819.12'
Top of 1¼" coupling 4818.92'

263' 6" blank casing

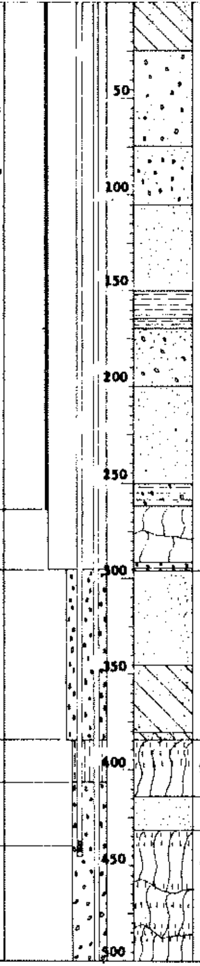
297' gravel

385' Grout

406' Gravel

Piezometer B 440' ℄ of 5' perforations

Well Diagram / Depth / Log:



Core Recov.	Samp Type	Classification and Physical Condition
		0.0' - 25.0' - SAND AND SILT.
	D	**25.0' - 75.0' - SAND AND GRAVEL.**
		75.0' - 105.0' - SAND AND PEA GRAVEL.
		105.0' - 150.0 - SAND.
		150.0' - 165.0' - CLAY; gray brown.
		165.0' - 170.0' - CLAY; gray blue. **170.0' - 200.0' - GRAVEL AND SAND; cemented.**
		200.0' - 250.0' - SAND; brown.
		250.0' - 262.0' - PEA GRAVEL AND SANDY YELLOW CLAY.
	CT & D	**262.0' - 292.0' - LAVA; gray.** **292.0' - 294.0' - GRAVEL; coarse.** **294.0' - 295.0' - LAVA.** **295.0' - 345.0' - SAND; light gray, rhyolitic, basaltic, quartzose.**
		345.0' - 381.0' - SILTY SAND; light gray, rhyolitic, basaltic, quartzose.
98%		**381.0' - 384.5' - SANDY SILT; yellowish brown.** **384.5' - 413.1' - BASALT; gray to grayish red purple, aphanitic, highly vesicular to dense, jointed to massive, olivine common.**
0%		**413.1 - 431.2' - SAND**
95%		**431.2' - 647.1' - BASALT; gray to grayish red purple, aphanitic to equigranular, scoriaceous to dense, jointed to massive.**

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

⁘	**GRAVEL**	▧	**SILT**	▤	**BASALT**
░	**SAND**	▤	**CLAY**	☐	

PROJECT **Lower Teton Division - Teton Basin Project** WELL NO. **6N/39E-30adc1** Site 7

BUREAU OF RECLAMATION - REGION 1 SHEET 2 OF 2

LOG OF WELL

Project **Lower Teton Division** Feature **Exploratory Hole and Piezometer Bank** State **Idaho**
Well No. **6N/39E-**30adc1**(Site 7)** Location **Approx. 607' North & 1197' West of the E. ¼ Corner**
Total Depth **699.7'** Begun **7/10/67** Completed **7/25/67** **(see drilling data)** Drilling Method **Rotary**
Static Water Level **1.8'** ~~(above)~~ (below) Meas. Pt. **Original ground** Date **9/5/67**
Elevation (ground) **4816.8'** W. L. Meas. Pt. **Top of pipe** ( )
Yield **No test** Drawdown Other Data **Geologist detail log book, driller's and inspector's reports, and geophysical logs**
Logged By **L. Hampton** Geophysical Log **Gamma and Gamma-Gamma by E.R.T.S/U.S.G.S.** Drilled By **Jack Alexander** ~~**Justice Core Drilling Co.**~~

Drilling Data / Pump Tests / Water Samples

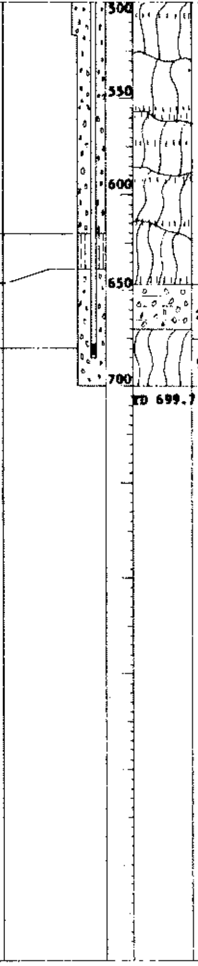
Description of Well Completion:

620' Grout

638' Gravel

Piezometer A 680' ℄ of 5' perforations

Well Diagram / Depth / Log:



Core Recov.	Samp Type	Classification and Physical Condition
	CR	**Continued from page 1.**
28%		**647.1' - 670.0' - GRAVEL; gray, porphyritic basalt, angular, clayey.**
98%		**670.0' - 699.7' - BASALT; grayish red to gray, porphyritic (plagioclase), moderately vesicular, moderately fractured.**

Note: Scoriaceous, cindery, and highly vesicular zones shown by vertical ticks on log.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

⁘	**GRAVEL**	▧	**SILT**	▤	**BASALT**
░	**SAND**	▤	**CLAY**	☐	

PROJECT **Lower Teton Division - Teton Basin Project** WELL NO. **6N/39E-30adc1** **(Site 7)**

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 2

LOG OF WELL

Project Snake Plain Recharge Feature Exploration Drill Hole - Deepen USGS #30 State Idaho
Well No. 5N 33E 13db (Site 17) Location NW¼SE¼ sec. 13, T. 5 N., R. 33 E., Jefferson County
Total Depth 1006.5' Begun 7/27/69 Completed 12/5/69 Drilling Method Core Drill
Static Water Level 266.05' (~~above~~) (below) Meas. Pt. Top of casing Date 12/5/69
Elevation (ground) 4794.58' W. L. Meas. Pt. 1.8 Feet (above) (~~below~~) Ground
Yield No test Drawdown — Other Data Geologist's detailed logbook, driller's logs, inspector's reports, and geophysical logs.
Logged By L. Hampton G. King Geophysical Log caliper, conductance, electric, temp, brine injection flowmeter, gamma, neutron, gamma gamma Drilled By Justice Core Drilling Co.

Drilling Data Pump Tests Water Samples

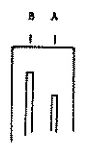
Well was drilled for the NRTS in April 1953 from 0.0' to 405.0'. Deepened by core drilling from 405.0' to 1006.5' under Specs. 100C-1060 by Justice Core Drilling Co.

Standing water level 266.05' below M. P. 12/5/69.
W.S. elev. 4530.3
Piezometer water level data 12/5/69

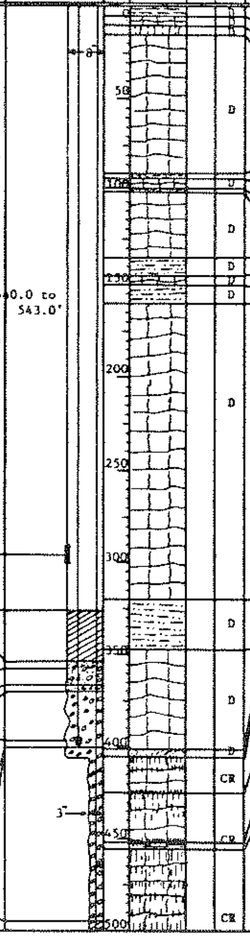
No.	Depth water	Elev.
A	256.97	4539.41
B	263.96	4532.42
8" csg.	266.05	4530.33

Description of Well Completion

Hole size
8" 0.0' - 405.0'
3" 405.0' - 1006.5'.
8" csg. 0.0' - 357.0'.
Piezometer MP Top 8" casing elev. 4796.38'.
Two B.I. piezometer pipes installed as shown below; 5.0' of perforations begin 2½' above bottom of each pipe.
A - 1" 0.0' to 540.0'. Packer 540.0 to 543.0'
1¼" 543.0' to 725.0'.
B - 3/4" 0.0' to 400.0'.



290' to 300' perforations
326.0' grout
353.0' sand, gravel, bentonite, grout
357.0' bottom 8" csg.
367.0' sand
370.0' gravel
Piezometer B
395.0' ℄ of 5.0' perforations
400.0' bottom of piezometer B
400.0' gravel
493.0' grout



Classification and Physical Condition

0.0' to 5.0' - CLAY.
5.0' to 10.0' - BASALT.
10.0' to 15.0' - ASH.
15.0' to 90.0' - BASALT
90.0' to 93.0' - SANDSTONE.
93.0' to 97.0' - BASALT.
97.0' to 100.0' - SANDSTONE.
100.0' to 135.0' - BASALT.
135.0' to 145.0' - SILT.
145.0' to 150.0' - BASALT.
150.0' to 160.0' - SILT.
160.0' to 320.0' - BASALT AND CINDERS.
320.0' to 347.0' - SILT.
347.0' to 402.0' - BASALT.
402.0' to 405.0' - SAND.
405.0' to 424.7' - BASALT; gray; aphanitic; quartz and olivine crystals; slightly to highly vesicular; highly to moderately jointed; scoriaceous in places.
424.7' to 452.6' - BASALT; gray; equigranular; plagioclase and olivine phenocrysts; highly vesicular to dense; slightly to highly jointed.
452.6' to 455.5' - CLAYEY SILT; brown; baked; angular basaltic gravel.
455.5' to 519.2' - BASALT; series of flows; gray; equigranular; few plagioclase crystals; highly vesicular to scoriaceous; moderately to highly jointed.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▤ CLAY	▨ SAND	▦ BASALT
▤ SILT	▨ GRAVEL	▦ CINDERS OR ASH

PROJECT Snake Plain Recharge WELL NO. 5N 33E 13db
Site #17

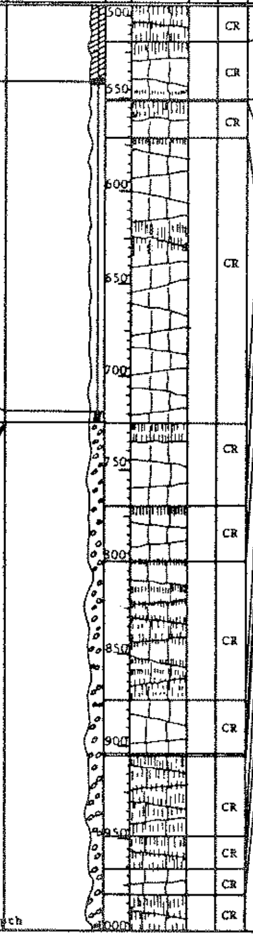
BUREAU OF RECLAMATION - REGION 1 SHEET 2 OF 2

LOG OF WELL

Project Snake Plain Recharge Feature Exploration Drill Hole - Deepen USGS #30 State Idaho
Well No. 5N 33E 13db (Site 17) Location NW¼SE¼ sec. 13, T. 5 N., R. 33 E., Jefferson County
Total Depth 1006.5' Begun 7/27/69 Completed 12/5/69 Drilling Method Core Drill
Static Water Level 266.05' (~~above~~) (below) Meas. Pt. Top of casing Date 12/5/69
Elevation (ground) 4794.58' W. L. Meas. Pt. 1.8 Feet (above) (~~below~~) Ground
Yield No test Drawdown — Other Data Geologist's detailed logbook, driller's logs, inspector's reports, and geophysical logs
Logged By L. Hampton G. King Geophysical Log caliper, conductance, electric, temp, brine injection flowmeter, gamma, neutron, gamma gamma Drilled By Justice Core Drilling Co.

Description of Well Completion

540.0' bottom packer
Piezometer A
720.0' ℄ of 5.0' perforations
725.0' bottom of piezometer A
750.0' gravel
1006.5' total depth



Classification and Physical Condition

(Continued from page 1)
519.2' to 551.0' - BASALT; greenish-black; equigranular; abundant calcite crystals; slightly to highly vesicular; scoriaceous; slightly to highly jointed.
551.0' to 551.6' - SANDY SILT; light red; medium to coarse basaltic sand; baked.
551.6' to 571.5' - BASALT; medium gray; 50% plagioclase crystals, olivine common; highly vesicular to scoriaceous; highly to moderately jointed.
571.5' to 724.5' - BASALT; gray; equigranular, with plagioclase phenocrysts increased in percent and size downward; highly vesicular to dense; slightly to moderately jointed.
724.5' to 770.1' - BASALT; gray; equigranular; few olivine crystals; highly vesicular to dense; highly to slightly jointed; some vesicles in lower 5 feet filled with calcite.
770.1' to 798.6' - BASALT; two flows; light gray; porphyritic plagioclase crystals; highly to slightly vesicular; slightly to moderately jointed; some vesicles filled with calcite; vesicular zones filled with clay.
798.6' to 874.5' - BASALT; possibly four, five, or more flows; gray; equigranular plagioclase crystals; some olivine; highly to moderately vesicular; highly jointed in more vesicular zones and slightly jointed elsewhere; vesicles lined with calcite.
874.5' to 903.0' - BASALT; light gray; equigranular; few olivine crystals; slightly vesicular except top and bottom which are moderately vesicular; slightly jointed calcite in some vesicles.
903.0' to 904.8' - CLAYEY SILT; reddish-brown; few angular basalt gravels; baked.
904.8' to 947.5' - BASALT; possibly several flows; grayish-red purple; moderately to highly vesicular; moderately to highly jointed; many vesicles filled with calcite; joints normally filled with clay; equigranular.
947.5' to 966.0' - BASALT; red-purple; equigranular; moderately to highly vesicular; moderately to slightly jointed; vesicles filled with calcite; clay in joints; heavy clay top & bottom; some banding.
966.0' to 979.0' - BASALT; gray; moderately to slightly vesicular; highly to slightly jointed; few vesicles filled with clay; joints normally filled with clay.
979.0' to 1006.5' - BASALT; red-purple; aphanitic to equigranular; few plagioclase crystals; moderately to highly vesicular; moderately to highly jointed; vesicles commonly filled with calcite; joints normally filled with clay; some banding.

Note: Scoriaceous, cindery, and highly vesicular zones shown by vertical ticks on log.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▤ CLAY	▨ SAND	▦ BASALT
▤ SILT	▨ GRAVEL	▦ CINDERS OR ASH

PROJECT Snake Plain Recharge WELL NO. 5N 33E 13db
Site #17

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 2

LOG OF WELL

Project Lower Teton Division Feature Exploratory Drill Hole Short section N and S State Idaho
Well No 5N/36E-2bda1 (Exploratory Hole 10) Location Approx. 400 ft. South and 400 ft. West of the N¼ corner Sec. 2 T. 5 N., R. 36 E. (U.S. land)
Total Depth 995 Begun 6/29/68 Completed 9/4/68 Drilling Method Cable Tool
Static Water Level See below (above / below) Meas Pt. Date
Elevation (ground) 4764.0 W. L. Meas. Pt. ( )
Yield Drawdown Other Data See driller's and inspector's reports and geologic field log.
Logged By P. Brooks Geophysical Log Caliper, Gamma & Gamma-Gamma by N.R.T.S./U.S.G.S. Drilled By Commons Drilling Co.

Drilling Data / Pump Tests / Water Samples

Drilled under Specs.100C-1003

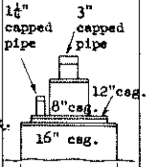
Undisturbed drive samples taken by double tube sampler attached to drill stem.
Lab. analysis by U.S.G.S. Denver Hydrologic Lab.- Spec. grav., spec. ret., porosity, spec. yield, vert. perm., and m.a.

Struck water at 70-75 ft. W.S. depths (below [illegible].G.) and elevations - 8/30/68.
8 in. csg.
Depth - 19.4 ft.
El. - 4744.6
12 in. csg.
Depth-est. + 6 ft. (flowing)
El. - 4770 (±)
16 in. csg.
Depth - 43.9
El. - 4721.1

Description of Well Completion

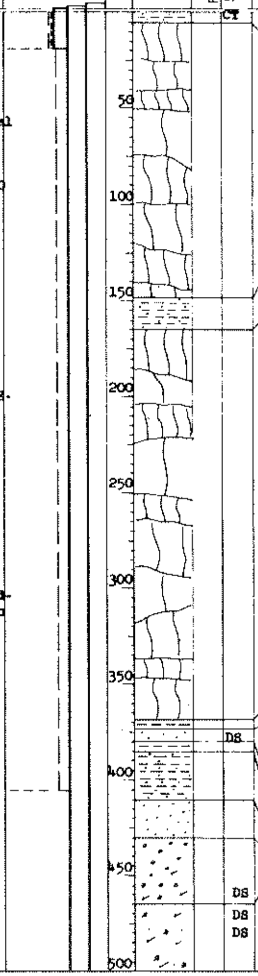
20 in. hole 0 to 18. 16 in. O.D. .250 in. wall csg. + 1.0 to 18. - with built-up shoe. Puddled clay seal at surface.
15 in. hole 18 to 405
12 in. I.D. .250 wall csg. + 1.1 to 838 - with factory shoe

Near Surface Detail



Elevations:
Top of 3" pipe cap - 4767.11
top of 8" csg. cover - 4766.65
top of 16" csg. cover - 4765.00
Note: 3/4" standpipe attached to 1¼" pipe for measuring artesian head - removed during cold weather.

Well Diagram / Depth / Log / Core Recov / Samp Type



Classification and Physical Condition

0.0 to 5 - SANDY CLAY, gray

5 to 148 (±)-BASALT, gray, brown, reddish, dense to scoriaceous.

148 (±) to 165 - CLAYEY SAND, yellowish brown becoming light gray,

165 to 368 - BASALT, gray, brown, reddish, dense to scoriaceous,

368 to 373 - CLAY, light gray

373 to 380 - SAND, light gray, medium grained, mostly quartz, reddish silicic volcanic with lesser basalt and obsidian gravels up to 10mm from 373-375.

380 to 385 - CLAY, tan

385-to 410 - SANDY CLAY, grayish tan, mostly quartz sand

410 to 430 - SAND, medium grained mostly quartz.

430 to 465 - GRAVEL, angular to subrounded, mostly basalt and cinders with tuff 445-465.

465 to 853 - VOLCANIC EJECTA, mostly basaltic cinders and fragments with lesser tuft, obsidian and silicic volcanic fragments, clay, and quartz sand.

SAMPLE TYPE
CR = Core
CT = Cuttings
D Drillers Log
DS= Drive Sample

▤ CLAY
▨ SILT
⁘ SAND
⁘ GRAVEL
▧ BASALT
⁘ CINDERS & TUFF

PROJECT Lower Teton Division WELL NO. 5N/36E-2bda1 ~~Expl. Hole 10~~

BUREAU OF RECLAMATION - REGION 1 SHEET 2 OF 2

LOG OF WELL

Project Lower Teton Division Feature Exploratory Drill Hole Short section N and S State Idaho
Well No. 5N/36E-2bda1 (Exploratory Hole 10) Location Approx. 400 ft. South and 400 ft. West of the N¼ corner Sec. 2 T. 5 N., R. 36 E. (U.S. land)
Total Depth 995 Begun 6/29/68 Completed 9/4/68 Drilling Method Cable Tool
Static Water Level See below (above / below) Meas. Pt. Date
Elevation (ground) 4764.0 W. L. Meas. Pt. ( )
Yield Drawdown Other Data See driller's and inspector's reports and geologic field log.
Logged By P. Brooks Geophysical Log Caliper, Gamma & Gamma-Gamma by N.R.T.S./U.S.G.S. Drilled By Commons Drilling Co.

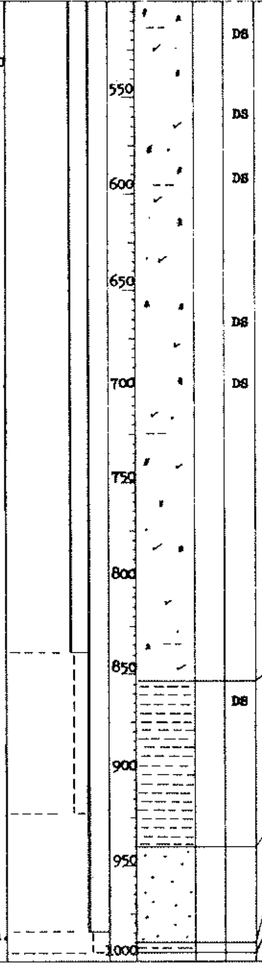
Description of Well Completion

12 in. hole 838 to 923.

8 in. I.D. .250 in csg. + 2.6 to 985 - with factory shoe

Bottom of 8 in. hole 995

Well Diagram / Depth / Log / Core Recov / Samp Type



Classification and Physical Condition

853 to 940 - CLAY, medium to dark gray

940 to 990 - SAND, medium to dark gray, fine to very fine grained, mostly basalt and obsidian with lesser quartz.

990 to 995 - CLAY, medium to dark gray

Total Depth - 995

SAMPLE TYPE
CR = Core
CT = Cuttings
D Drillers Log
DS= Drive Sample

▤ CLAY
▨ SILT
⁘ SAND
⁘ GRAVEL
▧ BASALT
⁘ CINDERS & TUFF

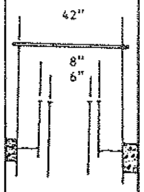
PROJECT Lower Teton Division WELL NO. 5N/36E-2bda1 Expl. Hole 10

BUREAU OF RECLAMATION - REGION 1 **SHEET 1 OF 2**

LOG OF WELL

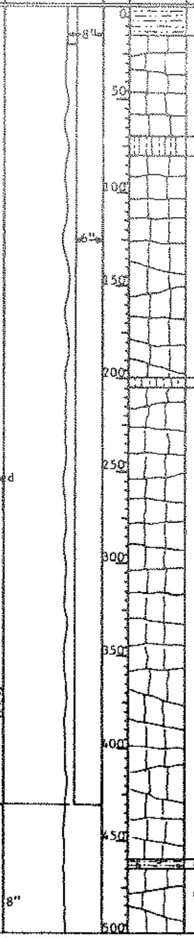
Project Snake Plain Recharge Feature Exploratory Drill Hole - West of Roberts State Idaho
Well No. 4N 35E 14aaa (Site 15) Location NE¼NE¼NE¼ sec. 14, T. 4 N., R. 35 E., Jefferson County
Total Depth 1000.0' Begun 7/29/69 Completed 11/1/69 Drilling Method Air Rotary Drill and Core Drill
Static Water Level 406.8' ~~(above)~~ (below) Meas. Pt. East Side - top of 6" casing Date 11/5/69
Elevation (ground) 4939.66' W. L. Meas. Pt. 0.60 Feet (above) ~~(below)~~ Ground
Yield No test Drawdown -- Other Data Geologist's detailed logbook, driller's logs, inspector's reports, and geophysical logs
Logged By G. King Geophysical Log Conductance, temperature, gamma, electric, caliper Drilled By Cope Drilling Co. Justice Core Drilling Co.

Drilling Data Pump Tests Water Samples	Description of Well Completion
Drilled under Specs. 100C-1060 Air Rotary drilled 0.0' to 500.0' by Cope Drilling Co. no samples. Core drilled 500.0' to 1000.0' by Justice Core Drilling Co. Struck water at 412.0' 7/31/69 Standing water level 406.8' below top of casing 11/5/69 Elevation 4533.5'	Hole size 8" 0.0' - 500.0' 3" 500.0' - 1000.0' 8" csg. 0.0' - 19.0' 6" csg 0.0' - 430.0' 6" csg hung and welded inside 8" csg to protect recorder wire and float. Open hole 430.0' to 1000.0'. Top of 8" csg elev. 4940.26' 42"x48" corrugated culvert-type pipe shelter cemented down and installed upon completion as shown below.



430.0' bottom of 6" csg

500.0' bottom of 8" hole



Core Recov.	Samp. Type	Classification and Physical Condition
0	D	0.0' to 15.0' - CLAY AND SILT; brown.
0	D	15.0' to 68.0' - BASALT; gray; 48.0' to 68.0' broken and fractured.
	D	68.0' to 80.0' - ASH; reddish-brown; semiwelded.
0	D	80.0' to 200.0' - BASALT; gray, reddish-gray; 122.0' to 134.0' fractured and broken; 183.0' to 197.0' broken lava.
0	D	200.0' to 204.0' - ASH.
0	D	204.0' to 460.0' - BASALT; 234.0' to 243.0' broken lava; 251.0' to 253.0' loose cinders; 280.0' to 282.0' broken lava; 374.0' to 384.0' fractured lava' 395.0' to 417.0' hard lava; 417.0' to 427.0' fractured lava.
0	D	460.0' to 465.0' - SEDIMENT (ASH); soft; stands open.
0	D	465.0' to 500.0' - BASALT; 483.0' to 492.0' broken lava.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▤ CLAY ▦ SAND ▭ BASALT
▤ SILT ▦ GRAVEL ▥ CINDERS OR ASH

PROJECT Snake Plain Recharge WELL NO. 4N 35E 14aaa Site #15

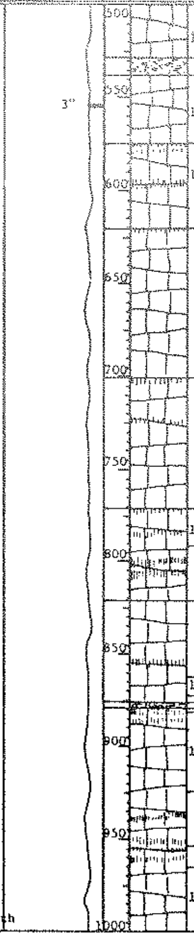
BUREAU OF RECLAMATION - REGION 1 **SHEET 2 OF 2**

LOG OF WELL

Project Snake Plain Recharge Feature Exploratory Drill Hole - West of Roberts State Idaho
Well No. 4N 35E 14aaa (Site 15) Location NE¼NE¼NE¼ sec. 14, T. 4 N., R. 35 E., Jefferson County
Total Depth 1000.0' Begun 7/29/69 Completed 11/1/69 Drilling Method Air Rotary Drill and Core Drill
Static Water Level 406.8' ~~(above)~~ (below) Meas. Pt. East Side - top of 6" casing Date 11/5/69
Elevation (ground) 4939.66' W. L. Meas. Pt. 0.60 Feet (above) ~~(below)~~ Ground
Yield No test Drawdown -- Other Data Geologist's detailed logbook, driller's logs, inspector's reports, and geophysical logs
Logged By G. King Geophysical Log Conductance, temperature, gamma, electric, caliper Drilled By Cope Drilling Co. Justice Core Drilling Co.

Drilling Data Pump Tests Water Samples | Description of Well Completion

1,000' total depth



Core Recov.	Samp. Type	Classification and Physical Condition
		(Continued from page 1)
100	CR	500.0' to 527.5' - BASALT; medium gray to dusky red; equigranular; plagioclase phenocrysts, few olivine; moderately to slightly vesicular; slightly jointed.
0	D	527.5' to 537.5' - SEDIMENT; no sample.
100	CR	537.5' to 574.8' - BASALT; generally medium gray; equigranular; plagioclase phenocrysts, few olivine; moderately to slightly vesicular; slightly jointed.
100 99	CR	574.8' to 620.1' - BASALT; grayish-red to medium gray; equigranular; plagioclase phenocrysts, little olivine; slightly to highly vesicular; moderately jointed.
99	CR	620.1' to 701.0' - BASALT; generally medium gray; equigranular; plagioclase phenocrysts, few olivine; highly to slightly vesicular; slightly jointed.
99	CR	701.0' to 772.2' - BASALT; medium dark gray to brownish-gray; equigranular; plagioclase phenocrysts, little olivine; highly vesicular to dense; slightly jointed.
100 95 40	CR	772.2' to 820.8' - BASALT; medium dark gray; equigranular; plagioclase phenocrysts, little olivine; highly vesicular to dense; slightly jointed.
99	CR	820.8' to 876.7' - BASALT; medium gray to dusky red; equigranular to aphanitic; plagioclase phenocrysts, little olivine; highly vesicular to dense; slightly jointed.
100 80		876.7' to 878.4' - SILT; moderate reddish-brown; silt or fine sand; baked.
100 99 90 100 80	CR	878.4' to 1000.0' - BASALT; dark gray to brownish-gray; equigranular to aphanitic; no easily identifiable minerals, possibly plagioclase phenocrysts; greenish cast probably due to olivine or amphibole; highly vesicular to dense; slightly to moderately jointed. Note: Scoriaceous, cindery, and highly vesicular zones shown by vertical ticks on log.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▤ CLAY ▦ SAND ▭ BASALT
▤ SILT ▦ GRAVEL ▥ CINDERS OR ASH

PROJECT Snake Plain Recharge WELL NO. 4N 35E 14aaa Site #15

BUREAU OF RECLAMATION - REGION 1 SHEET 1 OF 2

LOG OF WELL

Rigby Area

Project Lower Teton Division Feature Exploratory Drill Hole (Piezometers) State Idaho
Well No. 4N/38E - 12bb1 (Site 14) Location NWNW Section 12, T. 4 N., R. 38 E., Jefferson County
Total Depth 1026.0 Begun 8/15/69 Completed 12/9/69 Drilling Method Cable Tool to 510' Diamond Core to 1026'
Static Water Level See below (above) (below) Meas. Pt - Date -
Elevation (ground) 4829.55 W. L. Meas. Pt. - ( ) -
Yield - Drawdown - Other Data Driller, Inspector, and Geologist Reports
Logged By G. I. Haskett Geophysical Log Electric, Caliper, Temp., Conductivity Gamma, Gamma-Gamma, Neutron Drilled By Cope Drilling and Pump Co. Justice Core Drilling Co.

Drilling Data / Pump Tests / Water Samples

Under specs. 100c-1060

Churn drill to 510', wire line diamond drill core, 510-1026.0'

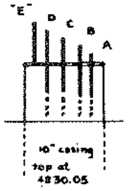
Attempted reverse circ. 0-45', 210-235', 475-510'.

MP Elevation
Piezo.

A	4830.36
B	4830.55
C	4830.60
D	4830.80
"E" 3/4" pipe in (10" csg.)	4830.97

Water surface, 1/19/70

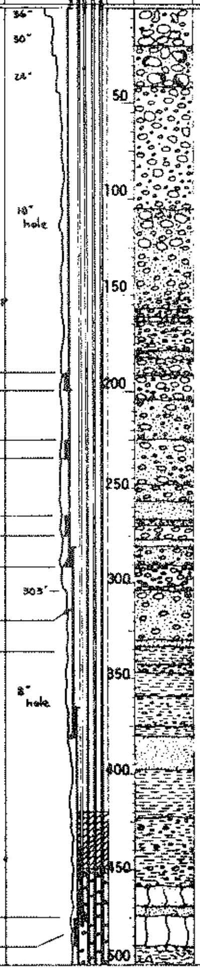
Piezo.	Elev.
A	4732.68
B	4790.35
C	4790.88
D	4790.56
"E"	4813.87



Description of Well Completion

"E" shallow water (3/4" pipe)
10" csg. perfs
190'
200'
225'
235'
265'
275'
10" csg. 291.8'
8" csg. 280.0-381.6'
6" liner 364-510'

PIEZOMETER D
(1" pipe)
420' grout
452' gravel
475' ℄ perfs.
475-490' perfs. 6" csg.



Samp Type: D

Classification and Physical Condition

0-20 BOULDERS
20-40.5 GRAVEL, with boulders
40.5-90 GRAVEL, medium to coarse
90-105 GRAVEL, fine to medium
105-157 GRAVEL, coarse, with sand; cobbles 106-115 and 120-125; gravel and sand mixed with mud 150-155.
157-161 GRAVEL, medium
161-163 GRAVEL, coarse, with few boulders
163-178 GRAVEL, clayey
178-181 GRAVEL, coarse, and sand
181-190 GRAVEL, coarse with sandy clay
190-204 GRAVEL, coarse, bailed 4-5" cobbles
204-225 GRAVEL, medium, with sand
225-248 GRAVEL, medium to coarse, with sand
248-256 GRAVEL, medium, with sand
256-266 SAND
266-269 GRAVEL, fine, sandy
269-276 GRAVEL, coarse, drills up fine
276-280 SAND
280-290 GRAVEL and SAND
290-303 GRAVEL, cemented
303-330 GRAVEL, coarse, with sand
330-333 SAND
333-342 CLAY, brown, sticky at top, sandy toward base
342-347 CLAY, gravelly
347-359 CLAY, brown, sandy
359-375 CLAY, with fine gravel
375-380 CLAY, sandy
380-397 SAND, firm with soft streaks
397-423 CLAY, brown, sticky
423-459 CLAY, with streaks of gravel
459-469 BASALT, black
469-474 SAND, gray (blow sand, driller)
474-490 BASALT, dark gray, with some scoria
490-500 CLAY, ASH, with some broken basalt

SAMPLE TYPE
CR - Core
CT - Cuttings
D Drillers Log

▨ CLAY
▨ SAND
▨ GRAVEL
▨ BOULDERS
▨ ASH
▨ BASALT

SITE 14

PROJECT Lower Teton Division - Teton Basin Project WELL NO. 4N/38E - 12bb1

BUREAU OF RECLAMATION - REGION 1 SHEET 2 OF 2

LOG OF WELL

Rigby Area

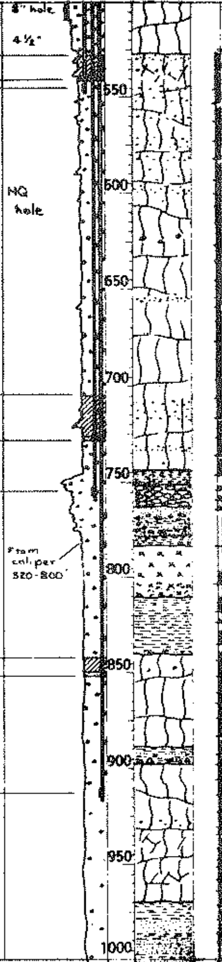
Project Lower Teton Division Feature Exploratory Drill Hole (Piezometers) State Idaho
Well No. 4N/38E - 12bb1 (Site 14) Location NWNW Section 12, T. 4 N., R. 38 E., Jefferson County
Total Depth 1026.0 Begun 8/15/69 Completed 12/9/69 Drilling Method Cable Tool to 510' Diamond Core to 1026'
Static Water Level - (above) (below) Meas. Pt. - Date -
Elevation (ground) 4829.55 W. L. Meas. Pt - ( ) -
Yield - Drawdown - Other Data Driller, Inspector, and Geologist Reports
Logged By G. I. Haskett Geophysical Log Electric, Caliper, Temp., Conductivity Gamma, Gamma-Gamma, Neutron Drilled By Cope Drilling and Pump Co. Justice Core Drilling Co.

Description of Well Completion

PIEZOMETER C
(3/4" pipe)
528' grout
540' gravel
545' ℄ perfs.

PIEZOMETER B
(3/4" pipe)
705' grout
728' gravel
755' ℄ perfs.

PIEZOMETER A
(3/4" pipe)
842' grout
852' gravel
913' ℄ perfs.



Samp Type: D, CR, D

Classification and Physical Condition

500-527 BASALT.
527-582.3 BASALT, medium gray, fine grained to 568.4, very fine below, numerous feldspar needles; slightly to moderately vesicular with very vesicular red-gray zones, 557.5-562.6, 571.5-571.8 573.6-576.2; broken, caving 530-540.
582.3-599.6 BASALT, grey, feldspathic, very vesicular to 583.0, moderately vesicular to 597.7, scoriateous to 599.6.
599.6-656.7 BASALT, gray to gray-green, dense, feldspathic, inclusions of red vesicular basalt, 645.0-653.5.
656.7-658.0 BASALT, red-brown, very vesicular, slightly altered.
658.0-744.1 BASALT, numerous fine feldspar needles
  676-686 green-gray
  709.3-717.2 red, vesicular to scoriateous
  732.9-733.4 red, scoriateous
744.1-751± CLAY, rusty red, silty, firm
751±-763 GRAVEL, medium (2½" recovered) subrdd pebbles of gray to pink quartzite and trace of green igneous (diorite?) pebbles.
763-778 SAND, brown with clay and gravel
778-784 CLAY, silty
784-811± RHYOLITE TUFF, light gray to 804, red-tan below (slightly altered to red-tan clay); with phenocrysts of quartz, sanadine(?), and trace magnetite, dip 7-8°.
811-840.0 CLAY, red-tan, firm to plastic, silty
840.0-889.5 BASALT, gray with zones green-gray, numerous feldspar needles, dense to moderately vesicular, trace zeolite crystals at 848.5.
889.5-898.0 CLAY, red-brown, silty to sandy, contains angular basalt fragments.
898.0-970.0 BASALT, gray to red-brown, abundant feldspar, dense to moderately vesicular, numerous broken zones below 936.5.
970.0-1026.0 CLAY, brown silty to green plastic, with thin hard layers of calcareous silt to sand, with zones of fine grained brown clayey sand, beds dip 8°±.

1026.0 Total depth

SAMPLE TYPE
CR - Core
CT - Cuttings
D Driller's Log

▨ CLAY
▨ SAND
▨ GRAVEL
▨ BASALT
▨ RHYOLITE TUFF
☐

SITE 14

PROJECT Lower Teton Division - Teton Basin Project WELL NO. 4N/38E-12bb1

BUREAU OF RECLAMATION - REGION 1

SHEET 1 OF 3

LOG OF WELL

Project Snake Plain Recharge Feature Exploration Drill Hole - Deepen Hwy. #1 State Idaho

Well No. 2N 35 E 2bb (Site #16) Location NW¼NW¼ sec. 2, T. 2 N., R. 35 E., Bonneville County

Total Depth 1302.0' Begun 7/1/69 Completed 7/25/69 Drilling Method Core Drill

Static Water Level 577.0' ~~(above)~~ (below) Meas. Pt. Top casing Date 7/16/69

Elevation (ground) 5089.83' W. L. Meas. Pt. 1.18 Feet (above) ~~(below)~~ Ground

Yield No test Drawdown — Other Data Geologist's detailed log book, driller's logs, inspector's reports, and geophysical logs

Logged By L. Hampton G. King Geophysical Log gamma gamma, electric, gamma, temp, caliper Drilled By Justice Core Drilling Co.

Drilling Data Pump Tests Water Samples

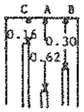
Well was drilled for the Idaho State Hwy. Dept. 0.0' to 679.0'. Deepened by core drilling from 679.0' to 1302.0' under Specs. 100C-1060 by Justice Core Drilling Co.

Standing water level 577.0' below land surface 7/16/69. W.S. elev. 4514.0' Piezometer water level data 7/23/69

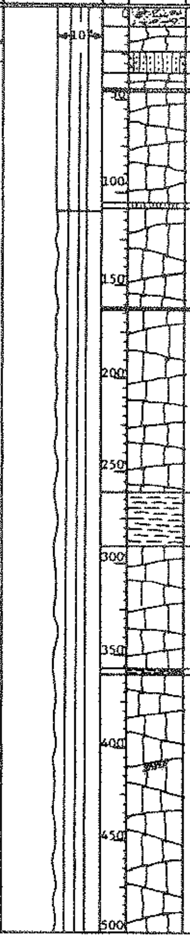
No.	Depth water	Elev.
A	581.75	4509.26
B	581.73	4509.28
C	582.35	4508.66

Description of Well Completion

Hole size 10" 0.0'-679.0'; 3" 679.0'-1302.0' (10" casing 0.0'-110.0') Piezometer MP top 10" casing elev. 5091.01'. Three 3/4" I.D. B.I. piezometer pipes installed as shown below; 5' of perforations begin 2½' above bottom of each pipe.



Piezometer bottomed at 1297.0'; broke off at 1173.0' during installation. That section of pipe left in drill hole.



Core Recov.	Samp. Type	Classification and Physical Condition
0	D	0.0' to 10.0' - SOIL.
0	D	10.0' to 24.0' - BASALT; gray.
0	D	24.0' to 34.0' - CINDERS; loose.
0	D	34.0' to 43.0' - BASALT; gray
	D	43.0' to 45.0' - CINDERS.
0	D	45.0' to 105.0' - BASALT; red to gray.
0	D	105.0' to 108.0' - CINDERS-ASH.
0	D	108.0' to 162.0' - BASALT; gray to black.
		162.0' - 163.0' - CINDERS-ASH; red.
0	D	163.0' - 261.0' - BASALT; gray to red; 168 to 184 with cinders.
0	D	261.0' to 290.0' - CLAY; yellow.
0	D	290.0' to 355.0' - BASALT; gray.
0	D	355.0' to 360.0' - CLAY.
0	D	360.0' to 679.0' - BASALT; gray, black, brown, and red. 480.0' to 509.0' - cinders 528.0' to 560.0' - cinders

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▤	CLAY	▨	SAND	⊞	BASALT
▤	SILT	▨	GRAVEL	▦	CINDERS AND ASH

PROJECT Snake Plain Recharge

WELL NO. 2N 35 E 2bb
Site #16

BUREAU OF RECLAMATION - REGION 1

SHEET 2 OF 3

LOG OF WELL

Project Snake Plain Recharge Feature Exploration Drill Hole - Deepen Hwy. #1 State Idaho

Well No. 2N 35 E 2bb (Site #16) Location NW¼NW¼ sec. 2, T. 2 N., R. 35 E., Bonneville County

Total Depth 1302.0' Begun 7/1/69 Completed 7/25/69 Drilling Method Core Drill

Static Water Level 577.0' ~~(above)~~ (below) Meas. Pt. Top casing Date 7/16/69

Elevation (ground) 5089.83' W. L. Meas. Pt. 1.18 Feet (above) ~~(below)~~ Ground

Yield No test Drawdown — Other Data Geologist's detailed log book, driller's logs, inspector's reports, and geophysical logs

Logged By L. Hampton G. King Geophysical Log gamma gamma, electric, gamma, temp. caliper Drilled By Justice Core Drilling Co.

Description of Well Completion

Piezometer C 646.0' ℄ of 5.0' perforations.

651.0' gravel
651.0' bottom piezometer C.

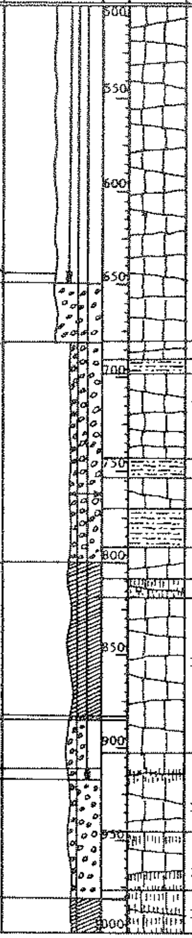
679.0' bottom of 10" hole.

800.0' grout

883.0' sand

885.0' gravel
Piezometer B 912.0' ℄ of 5.0' perforations.
917.0' bottom of piezometer B.

982.0' grout



Core Recov.	Samp. Type	Classification and Physical Condition
		(Continued from page 1)
93	CR	680.0' to 689.5' - BASALT; light gray; olivine and plagioclase phenocrysts; dense.
50	CR	689.5' to 697.5' - SILT; brown; quartz sand; baked.
100	CR	697.5' to 742.5' - BASALT; gray; olivine and plagioclase phenocrysts; vesicular.
40	CR	742.5' to 750.3' - SILT; brown; slightly sandy; baked.
100	CR	750.3' to 769.2' - BASALT; gray; equigranular, with olivine and plagioclase phenocrysts; vesicular.
0	CR	769.2' to 791.2' - SILT; brown; fine-to-medium sand composed of quartz and dark minerals and few fine basaltic gravels.
80	CR	791.2' to 808.9' - BASALT; gray; scoriaceous to dense; highly jointed; flow structure; banding; hard.
100	CR	808.9' to 818.0' - BASALT; grayish-red, scoriaceous; highly jointed.
100	CR	818.0' to 902.8' - BASALT; gray; fine equigranular; dense; highly jointed; flow structure; hard.
70 75 100	CR	902.8' to 945.3' - BASALT; medium-gray; aphanitic; slightly to highly vesicular; slightly to highly jointed; clay seams, and banding.
90 100	CR	945.3' to 976.5' - BASALT; medium dark gray; slightly to highly vesicular; moderately to highly jointed.
100	CR	976.5' to 1048.0' - BASALT; medium gray; equigranular to aphanitic; plagioclase and quartz phenocrysts; scoriaceous; highly to slightly vesicular; highly to slightly jointed.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▤	CLAY	▨	SAND	⊞	BASALT
▤	SILT	▨	GRAVEL	▦	CINDERS AND ASH

PROJECT Snake Plain Recharge

WELL NO. 2N 35 E 2bb
Site #16

BUREAU OF RECLAMATION - REGION 1 **SHEET** 3 **OF** 3

LOG OF WELL

Project Snake Plain Recharge **Feature** Exploration Drill Hole - Deepen Hwy. #1 **State** Idaho

Well No. 2N 35E 2bb (Site #16) **Location** NW¼NW¼ sec. 2, T. 2N., R. 35E., Bonneville County

Total Depth 1302.0' **Begun** 7/1/69 **Completed** 7/25/69 **Drilling Method** Core Drill

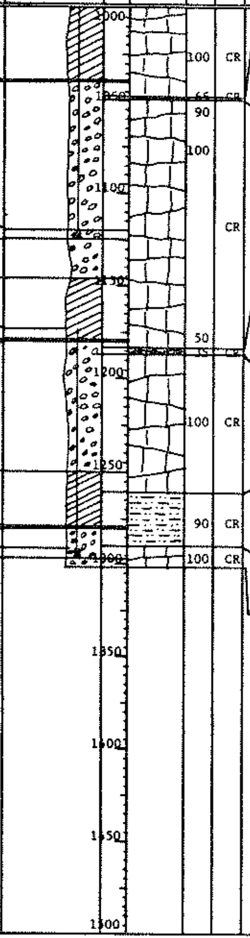
Static Water Level 577.0' ~~(above)~~ (below) **Meas. Pt.** Top casing **Date** 7/16/69

Elevation (ground) 5089.83' **W. L. Meas. Pt.** 1.18 **Feet** (above) ~~(below)~~ **Ground**

Yield No test **Drawdown** -- **Other Data** Geologist's detailed log book, driller's log, inspector's reports, and geophysical logs

Logged By L. Hampton G. King **Geophysical Log** gamma gamma, electric, gamma, ~~temp., caliper~~ **Drilled By** Justice Core Drilling Co.

Drilling Data Pump Tests Water Samples	Description of Well Completion	Well Diagram / Depth / Log / Core Recov. / Samp Type	Classification and Physical Condition
	1038.0' sand 1040.0' gravel		(Contined from page 2) 1048.0' to 1050.0' - GRAVELLY SILT; light red to pale brown; up to 30% angular basaltic gravel.
	Piezometer A 1120.0' ℄ of 5.0' perforations 1125.0' gravel Bottom piezometer A 1147.0' grout		1050.0' to 1183.0' - BASALT; medium gray; equigranular; plagioclase and olivine common; moderately to slightly vesicular; slightly jointed.
	1173.0' piezometer broken off 1178.0' sand 1180.0' gravel		1183.0' to 1187.0' - SANDY GRAVELLY SILT; reddish-orange; fine quartz sand, angular basaltic gravel.
	1250.0' grout		1187.0' to 1261.1' - BASALT; medium gray; equigranular; olivine phenocrysts; scoreaceous; slightly to moderately vesicular; moderately jointed.
	1278.0' sand 1280.0' gravel 1292.0' ℄ of 5.0' perforations		1261.1' to 1289.1' - CLAYEY SILT; brown; baked; caliche stringers; considerable clay; minor fine sand.
	1297.0' bottom piezometer that was broken off 1302.0' total depth		1289.1' to 1302.0' - BASALT; medium gray; equigranular; minor altered olivine; slightly to moderately vesicular; moderately to slightly jointed.



Note: Scoriaceous, cindery, and highly vesicular zones shown by vertical ticks on log.

SAMPLE TYPE:
CR = Core
CT = Cuttings
D Drillers Log

▤	CLAY	▨	SAND	▦	BASALT
▤	SILT	▨	GRAVEL	▥	CINDERS AND ASH

PROJECT Snake Plain Recharge **WELL NO.** 2N 35E 2bb Site 16

PART 2

OBSERVATION WELLS SOUTH OF ARCO AND WEST OF ABERDEEN

PREFACE

The Snake Plain aquifer, as defined by Mundorff, Crosthwaite, and Kilburn (1964, p. 142), is a series of basalt flows and intercalated pyroclastic and sedimentary materials that underlies the Snake River Plain east of Bliss (fig. 1). The aquifer is about 9,500 square miles in areal extent and is one of the largest-yielding aquifers in the United States. Approximately 6½-million acre-feet of water is recharged annually to this aquifer by seepage loss from the Snake River and its tributaries, by underflow from tributary valleys, by the downward percolation of water applied for irrigation, and by precipitation on the Plain. Water is discharged from the aquifer through springs and by pumping for irrigation, municipal, industrial, stock, and domestic use. Although the aquifer has been extensively studied and its general extent and properties are known, it is so large and thick that data on the distribution of the basalt flows and interbedded sedimentary deposits that control the movement of ground water have not been obtained at several places of great current importance. Also, there are large areas where the position of the water table and the potential yield of the aquifer are not known.

The objectives of this investigation are to obtain (1) information descriptive of elevations and fluctuations of the water table, water-table gradients, and the distribution of transmissivity, in areas of the Snake Plain aquifer where data are lacking; (2) details of stratigraphic and hydrologic properties at localities selected as being suitable for pumping large quantities of ground water in exchange for surface water[1]; (3) hydrologic details in the eastern part of this aquifer, where the greatest amount of recharge occurs, so as to interpret better the distribution of recharge to spring discharge areas; and (4) water-level and stratigraphic data in the area of the Mud Lake-Market Lake barrier so as to better define recharge relations and large water-level differentials occurring in and around this barrier. In addition, it is expected that all the data collected will be integrated into an existing analog model of the Snake Plain aquifer so that the long-term effects of development of the aquifer can be better predicted.

The Idaho Department of Water Administration has the responsibility of administering the water resources of Idaho, and for this reason it is vitally interested in basic data descriptive of the water resources of the Snake River Plain. Because the U. S. Bureau of Reclamation is actively developing the water resources available in various parts of the Plain, it needs basic data which will be useful in selecting areas suitable for development and in evaluating effects of development. The U. S. Geological Survey has a responsibility for collecting basic data and for appraising the water resources of Idaho. Because of their common interests, and in recognition of the need for information about the water resources of the Snake Plain aquifer, these three agencies entered into a cooperative agreement whereby the U. S. Geological Survey and the U. S. Bureau of Reclamation would initiate, in

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[1] The U. S. Bureau of Reclamation is investigating the feasibility of diverting surface water from presently irrigated land to areas of inadequate surface-water supply or areas of no surface-water supply and replacing the diverted surface water with ground water.

July 1969, a 4-year project whose goal is to satisfy the objectives described above.

To provide for timely release of the data collected during this 4-year project, it is planned that a series of reports describing the work accomplished during each phase of the project will be prepared. The Mud Lake region was discussed in part 1 of this report series. The present report (part 2) concentrates attention on an area farther southwest, where the hydrologic environment and problems are different. Part 2 presents (1) water-level and lithologic data obtained from drilling three observation wells (2N-26E-22dda1, 1S-27E-14dcc1, and 5S-28E-26bbd1) and deepening another well (3N-26E-22aba1) on the Snake River Plain south of Arco and west of Aberdeen and (2) a revision of a local part of the existing regional water-level contour map.

CONTENTS

ILLUSTRATIONS

A PROGRESS REPORT ON RESULTS OF TEST–DRILLING AND GROUND–WATER INVESTIGATIONS OF THE SNAKE PLAIN AQUIFER, SOUTHEASTERN IDAHO

Part 2

Observation Wells South of Arco and West of Aberdeen

By E. G. Crosthwaite

ABSTRACT

Three wells were drilled and another well deepened in a part of the Snake River Plain where geologic and hydrologic data are sparse. Most of the material drilled was basalt with a few thin interbedded fine-grained sedimentary deposits. The sediments increase in thickness and coarseness near the mouth of the Big Lost River basin. The water-level data obtained from the wells indicate that the water-table gradient is relatively steep between Arco and American Falls and that the gradient is relatively low southwest of the area of steep gradient. The new data generated in this study permit a significant revision of previous water-level contour maps.

The reason for the steep gradient is not clear, but the water table may be influenced by a rift zone which is visible more than three fourths of the way across the Plain from the Craters of the Moon National Monument; by a change in thickness of the aquifer caused by a ridge representing a buried north-south trending mountain range; by a significant thickening of basalt filling an erosional basin immediately downgradient from the steepened gradient; or by a fault in the underlying basalt whose trace has been obliterated by younger flows.

INTRODUCTION

Three wells drilled for this phase of the project are in line 5, 12, and 25 miles south of Arco; the fourth is 18 miles west of Aberdeen; all are in the north-central part of the Snake River Plain in southern Idaho (fig. 3). The Snake River Plain, a broad, rolling plain extending from Bliss eastward and northeastward to Ashton (fig. 1), is underlain chiefly by basaltic lava flows. Domes, craters, and cinder cones are scattered throughout the Plain and mark centers of past volcanic activity. The total thickness of the basaltic flows is unknown, but wells and geophysical data indicate that the basalt is more than 2,000 feet thick. From

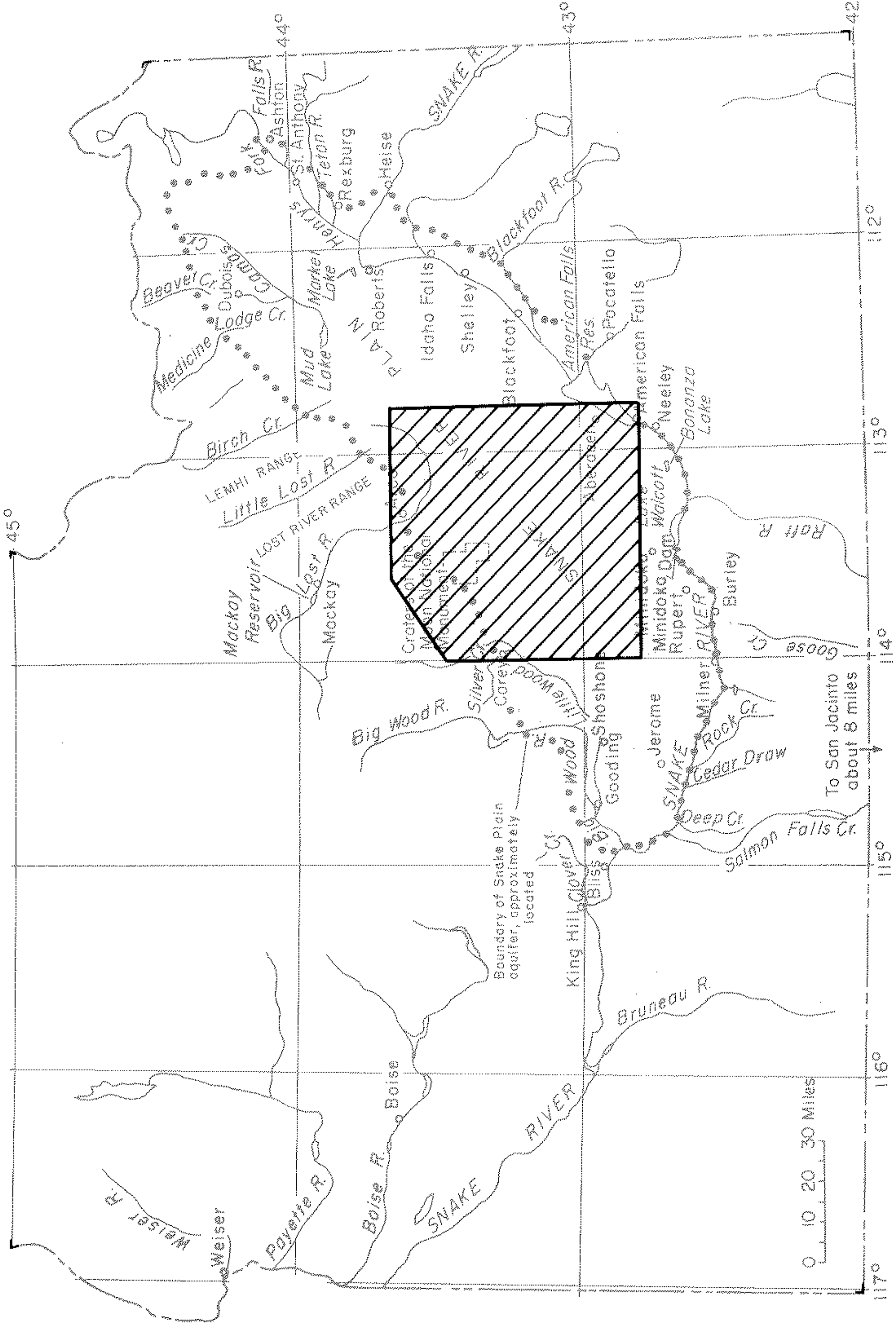

FIGURE 1. Map of southern Idaho showing the Snake River Plain and area covered by this report.

Arco southward toward Minidoka and southwestward toward Carey, wells are scarce and, therefore, even the approximate position of the water table in this area has been but poorly defined. The drilling described herein was accomplished to better define the position of the water table in this part of the Plain and to collect hydrologic information descriptive of hydrogeologic conditions at the margin of the Plain where a large mountain basin (Big Lost River basin) is tributary to the Plain.

Well-Numbering System

The well-numbering system used by the U. S. Geological Survey in Idaho indicates the location of wells within the official rectangular subdivision of the public lands, with reference to the Boise base line and meridian. The first two segments of the number designate the township and range. The third segment gives the section number, followed by three letters and a numeral, which indicate the quarter section, the 40-acre tract, the 10-acre tract, and the serial number of the well within the tract, respectively. Quarter sections are lettered a, b, c, and d in counterclockwise order from the northeast quarter of each section (fig. 2). Within the quarter sections, 40-acre and 10-acre tracts are lettered in the same manner. Well 2N-26E-22dda1 is in the NE¼SE¼SE¼ sec. 22, T. 2 N., R. 26 E., and was the first well inventoried in that tract.

RESULTS OF DRILLING

Well 3N-26E-22aba1

Well 3N-26E-22aba1 (fig. 3) was originally drilled to a depth of 819 feet and, when completed in 1966, had a perched water level of 585 feet below land surface. While this well was being constructed, the driller reported that perched water also occurred at depths of 275 and 445 feet. As a part of this project, the well was deepened to 1,075 feet in 1970 and a 4-inch casing was grouted at 970 feet leaving the bottom 105 feet of the well open to basalt, sand, and gravel. The water level in the deepened well was at 793 feet below land surface on September 17, 1970, and is representative of the water table in the Snake Plain aquifer at this location. As shown in figure 4, illustrating lithologic and geophysical logs, a total of eight zones of basalt, each separated by layers of clay, sand, and gravel, were penetrated in drilling the well.

Well 2N-26E-22dda1

Well 2N-26E-22dda1 (fig. 3) was drilled to a depth of 1,053 feet and cased with 6-inch casing to a depth of 728 feet. The well is uncased from 728 to 1,053 feet. Perched water was found in clean sand and gravel at a depth of 664 feet below land surface. The perching layer is a clay bed from 720 to 728 feet. The only other sediments found in drilling were a

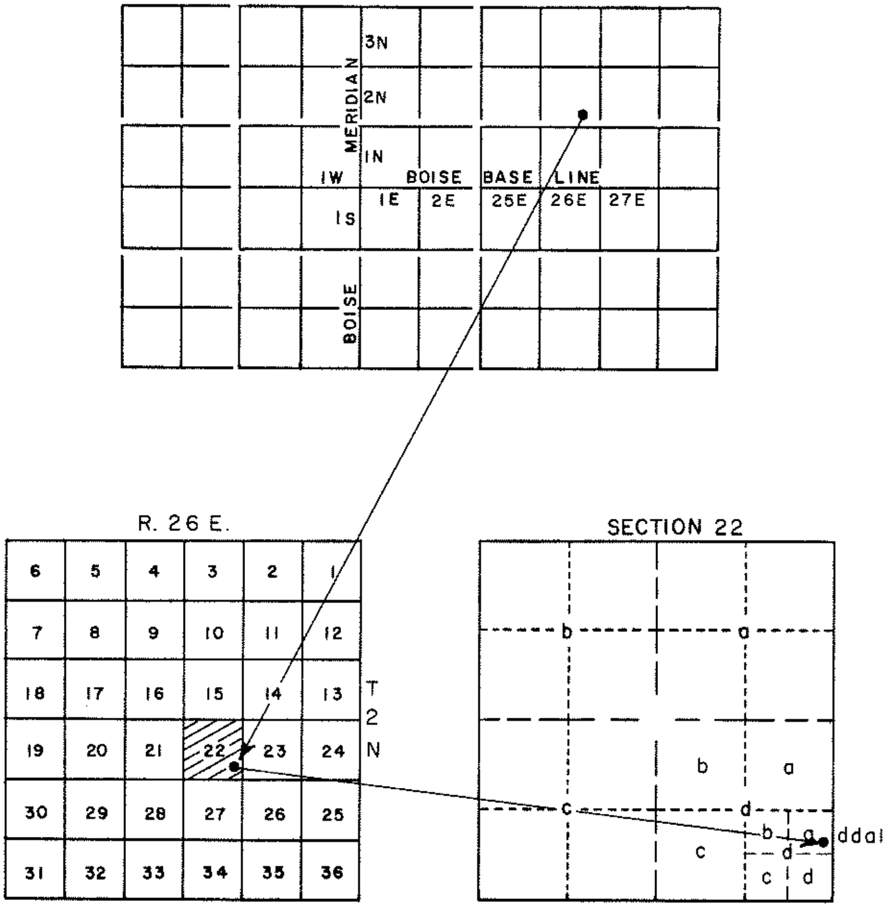

FIGURE 2. Diagram showing well-numbering system. (Using well 2N-26-22dda1.)

3-foot bed of silt and clay at 186 feet and another 5-foot bed at 412 feet. No perched water was found above or in these beds. The regional water table is at a depth of 980 feet below land surface.

Well 1S-27E-14dcc1

Well 1S-27E-14dcc1 (fig. 3) was drilled to a depth of 1,041 feet and cased with 4-inch casing to 1,031 feet. A 4-foot bed of baked silt and clay was found at 790 feet, an 8-foot bed of baked red sand at 988 feet, and a fine red sand bed at 1,033 to 1,041 feet. The regional water table is 995 feet below land surface. No perched water was found in this well.

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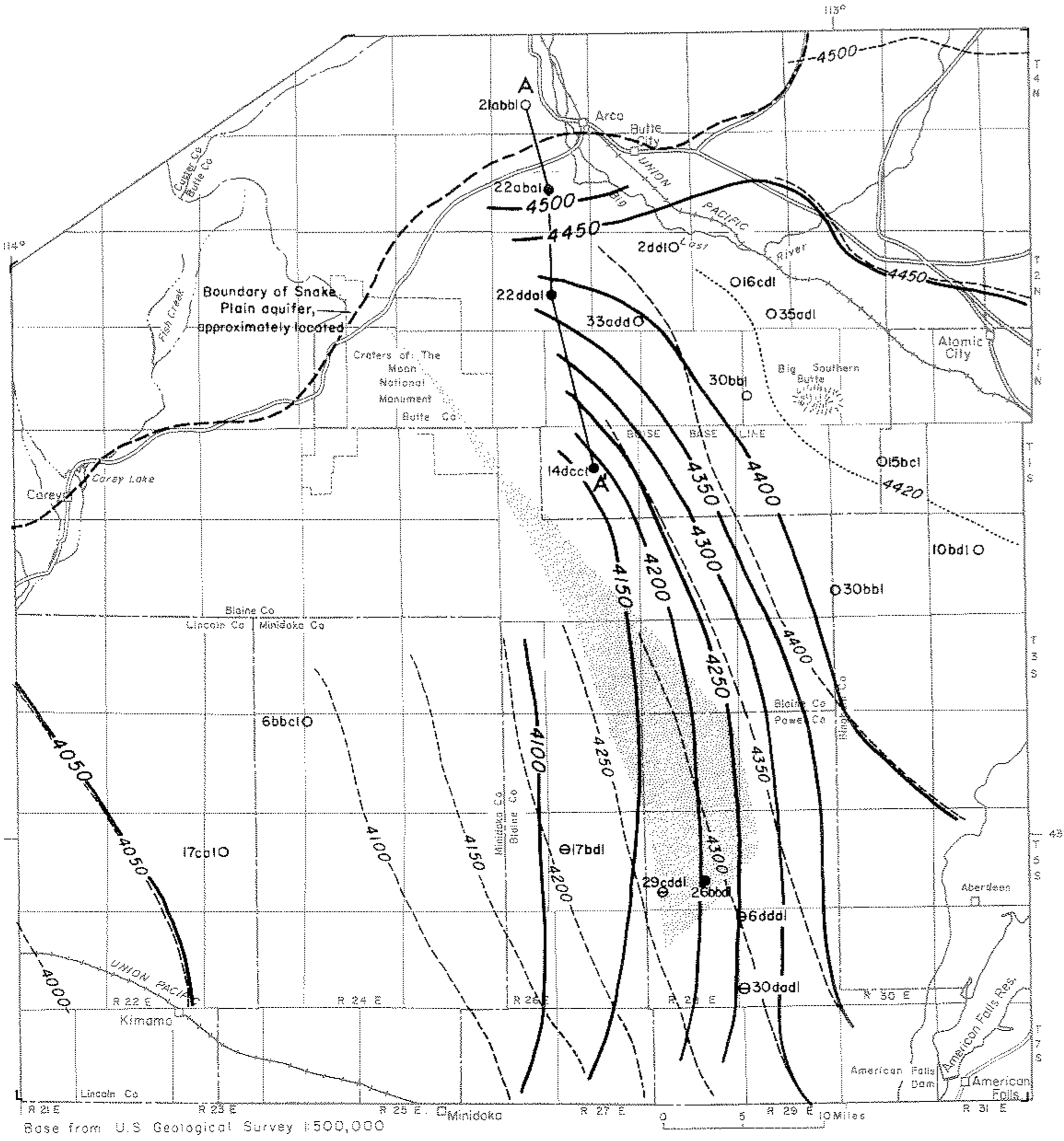

EXPLANATION

——4450——

Contour on the water table, fall 1970
Contour interval 50 feet
Datum is mean sea level

- - - -4400- - - -
······4420······

Contours on the water table, 1959, as shown in Mundorff and others 1964 (plate 4)

Contour interval 50 feet, except where dotted
Datum is mean sea level

● 24ddal

Observation well drilled for this project and number

○ 17cal

Observation well and number

⊖ 17bdl

Well with water-level data and number

▨

Great Rift of the Craters of the Moon National Monument and Great Rift National Landmark

A———A'

Line of geologic section (refer to fig. 5)

FIGURE 3. Map showing contours on the water table and location of wells in area covered by Part 2.

Well 5S-28E-26bbd1

Well 5S-28E-26bbd1 (fig. 3) was drilled to a depth of 763.5 feet and cased with 4-inch casing. Although a small amount of water was found at approximately 670 feet, the regional water level is taken to be 680 feet below land surface.

EVALUATION OF DATA

Revision of Water-Level Contour Map

In the past, insufficient data were available to define adequately the position of the water table in that area of the Snake River Plain encompassed by a line connecting the towns of Carey, Arco, Aberdeen, and Minidoka. The configuration of the water table in this part of the Plain, as interpreted by Mundorff, Crosthwaite, and Kilburn (1964, pl. 4) on the basis of data available at that time, is shown in figure 3. Although a few stock wells have been drilled in this part of the Plain since 1964, wells from which water-level measurements can be obtained are still sparse. Water-level measurements in observation wells drilled for this study, and a few recently available water levels in other wells, permitted revision of the previous water-level contour map. The two interpretations are shown in figure 3. Southwest of the 4,050-foot contour and northeast of the 4,420-foot contour, well data are adequate to define the position of the water table with a reasonable degree of confidence. As can be noted in figure 3, the contours from 4,100 to 4,400 feet, inclusive, have been shifted eastward and northeastward resulting in a map with a very low water-table gradient between the 4,050 and 4,100-foot contours and a much steeper gradient between the 4,100 and 4,400-foot contours. Except immediately south of Arco, the gradient is very low northeast of the 4,400-foot contour. As more observation wells are drilled and more water-level data become available, further revision of the water-level contour map may be required.

Evaluation of Hydrologic Data

As noted previously, perched water was found in well 2N-26E-22dda1 and several perched water-bearing zones were found in well 3N-26E-22aba1. These wells and well 1S-27E-14dcc1 are shown in the geologic section (fig. 5). In addition, a test well (4N-26E-21abb1), drilled in 1969, 4 miles northwest of Arco is shown (Crosthwaite and others, 1970, p. 72, fig. 25). The geologic section shows the geologic and hydrologic conditions southward from the mouth of the Big Lost River basin, a major valley tributary to the Snake River Plain. Water was encountered at successively greater depths in wells 4N-26E-21aba1 and 3N-26E-22aba1 as the wells were drilled and cased during construction. Thus, the water levels shown by triangles on the geologic section are the water levels when the bore hole was open between the bottom of the casing and the bottom of the hole. The lowermost triangle shows the water level in the completed well. Well 3N-26E-22aba1 was constructed so as to penetrate saturated basalt, sand, and gravel which are several tens of

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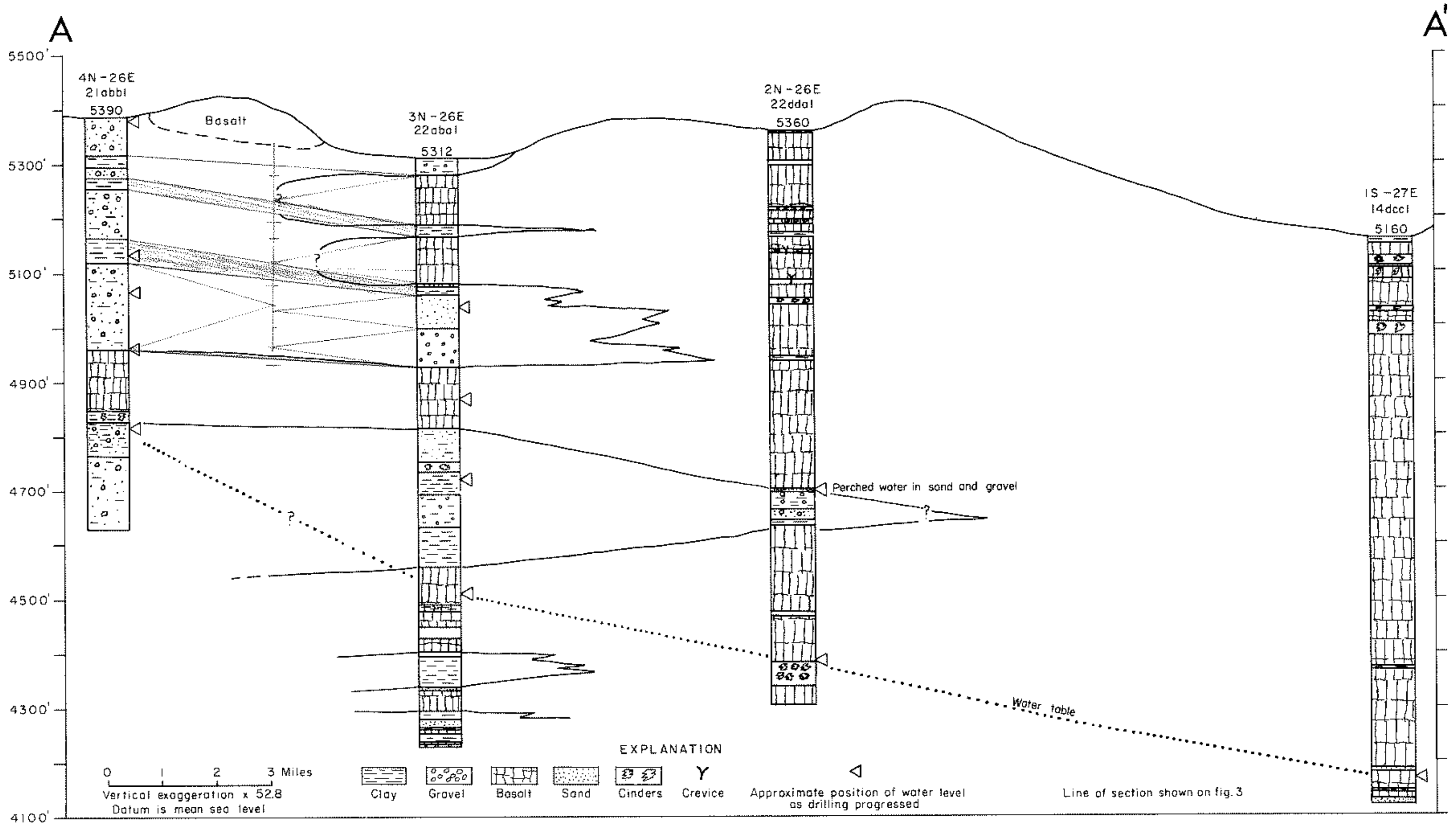

FIGURE 5. Geologic section through observation wells near Arco.

feet below the elevation of the water table in the Snake Plain aquifer several miles to the south. Thus, the water levels in the well should be representative of the water level in the main aquifer.

The water-level contour map shows that ground water is moving to the south and southwest from the Big Lost River basin to the Snake River Plain and that the gradient is relatively steep, on the order of 25 feet per mile. Ground water in the Big Lost River basin moves to the Snake Plain aquifer in several water-bearing zones, separated by less permeable zones which are several hundred feet above the regional water table. As the water percolates downward, these zones become progressively drained until no ground water remains on the perching layers.

The sequence of basalt and sediments at the mouth of the Big Lost River basin is the result of sediment deposition by the Big Lost River alternating with volcanic activity. Lava flows have dammed the river several times and thereby caused it to change its course. The sediments encountered in the drill holes were most likely deposited behind lava dams or laid down in stream channels after the river topped the lava dams. The gravel overlying the clay in well 2N-26E-22dda1 is a typically clean river gravel. Its geographic location implies that the river had a more southerly course than the present one which is southeast, east, and finally northward to the southern end of the Lemhi Range.

The reason for the steep water-table gradient between the 4,150 and 4,400-foot contour is not clear. One possible explanation is its proximity to an extensive fissure or rift zone. The most recent volcanic activity on the Snake River Plain has occurred along the Great Rift in the Craters of the Moon National Monument (Stearns, 1928, p. 6). The Great Rift extends across the Monument in a southeasterly direction from the mountains bordering the Monument on the north and is marked by a double line of cinder cones. To the southeast of the Monument, three major rifts and fissures with several sets of subsidiary fractures can be traced for 25 miles. Buttes and craters occur along the rifts. The Great Rift in the Monument and the rift zone to the southeast are part of a rift system that extends more than three-fourths the distance across the Snake River Plain (fig. 3). The National Park Service, U. S. Department of the Interior, has designated that part of the rift zone outside the Craters of the Moon National Monument as the Great Rift National Landmark. The most spectacular feature of the national landmark is an open rift in the west part of T. 5 S., R. 28 E., and in the northwest part of T. 6 S., R. 28 E. This rift is open for almost 7 miles and is as much as 20 feet wide. The open crack extends to a depth of several hundred feet. Subsidiary cracks which generally parallel the main rift are as much as 8 to 10 inches wide, several hundred yards long, and appear to be several tens of feet deep. As many as half a dozen cracks may occur within a distance of a quarter of a mile. There is no discernible vertical displacement along the fractures or rifts.

The southern part of the Great Rift National Landmark, in the northern part of Power County, almost coincides with the steep gradient of the water table described above and shown in figure 3. Farther north in the area of the steep water-table gradient there is no surface evidence of a rift. The available evidence could be interpreted to indicate that a buried rift system is the cause of the steep gradient; however, other factors could produce the same effect. For example, the saturated thickness of basalt may be greater both upgradient and downgradient from the area of the steep water-table gradient. This change in thickness could be caused by a ridge representing a buried north-south trending mountain range. Another possible explanation could be a fault in the underlying basalt whose trace has been obliterated by younger flows. Thus, until more evidence is available, the reason for the steep gradient cannot be determined.

REFERENCES

Crosthwaite, E. G., Thomas, C. A., and Dyer, K. L., 1970, Water resources in the Big Lost River basin, south-central Idaho: U. S. Geol. Survey open-file report, 109 p., 31 figs.

Mundorff, M. J., Crosthwaite, E. G., and Kilburn, Chabot, 1964, Ground water for irrigation in the Snake River basin in Idaho: U. S. Geol. Survey Water-Supply Paper 1654, 224 p., 6 pls., 54 figs.

Stearns, H. T., 1928, Craters of the Moon National Monument, Idaho: Idaho Bur. Mines and Geol. Bull. 13, 57 p., 22 pl.

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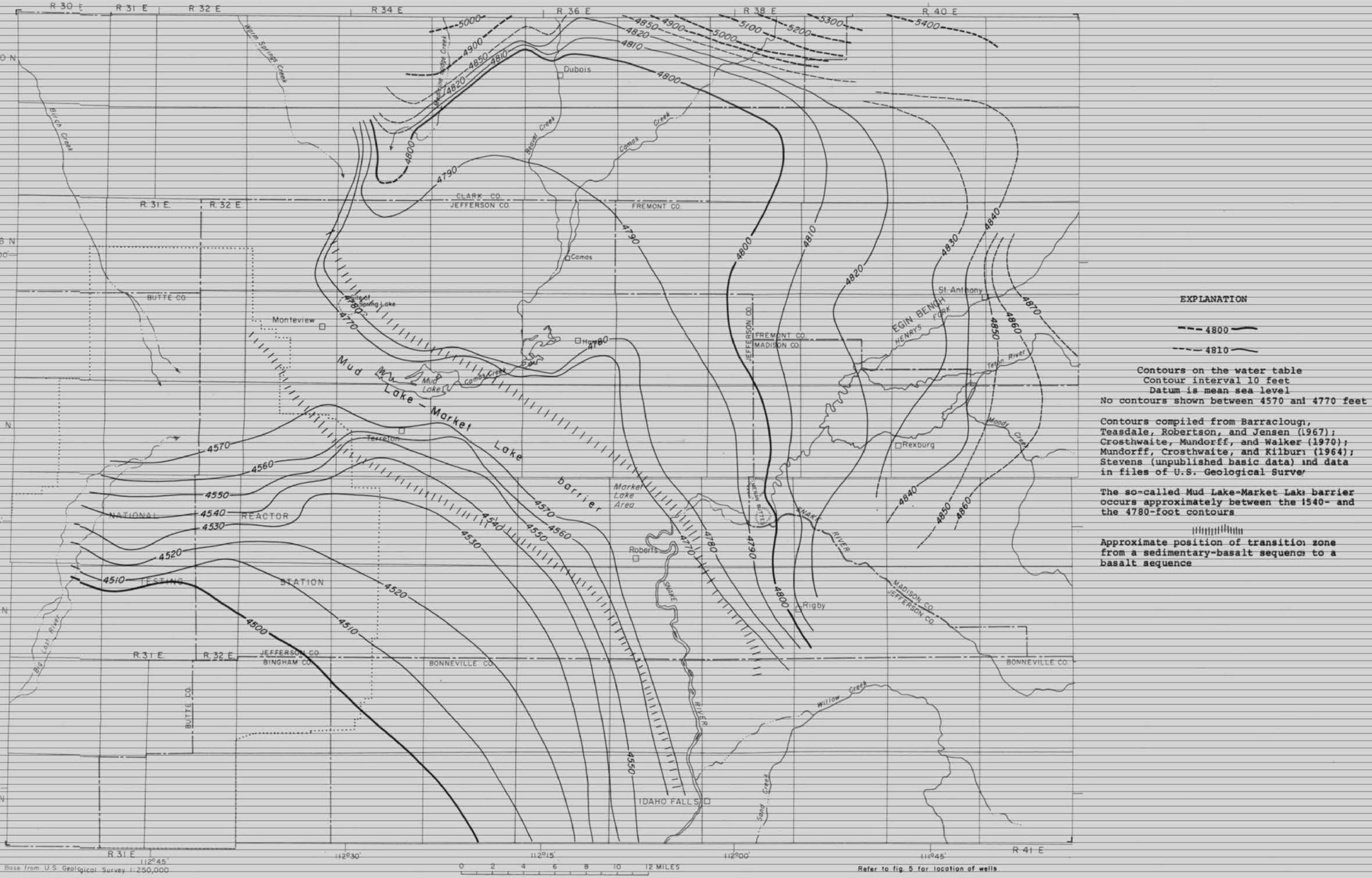

EXPLANATION

Contours on the water table
Contour interval 10 feet
Datum is mean sea level
No contours shown between 4570 and 4770 feet

Contours compiled from Barraclough, Teasdale, Robertson, and Jensen (1967); Crosthwaite, Mundorff, and Walker (1970); Mundorff, Crosthwaite, and Kilburn (1964); Stevens (unpublished basic data) and data in files of U.S. Geological Survey

The so-called Mud Lake-Market Lake barrier occurs approximately between the 4540- and the 4780-foot contours

Approximate position of transition zone from a sedimentary-basalt sequence to a basalt sequence

FIGURE 3.--Map showing contours on the water table in the Mud Lake region, Idaho.

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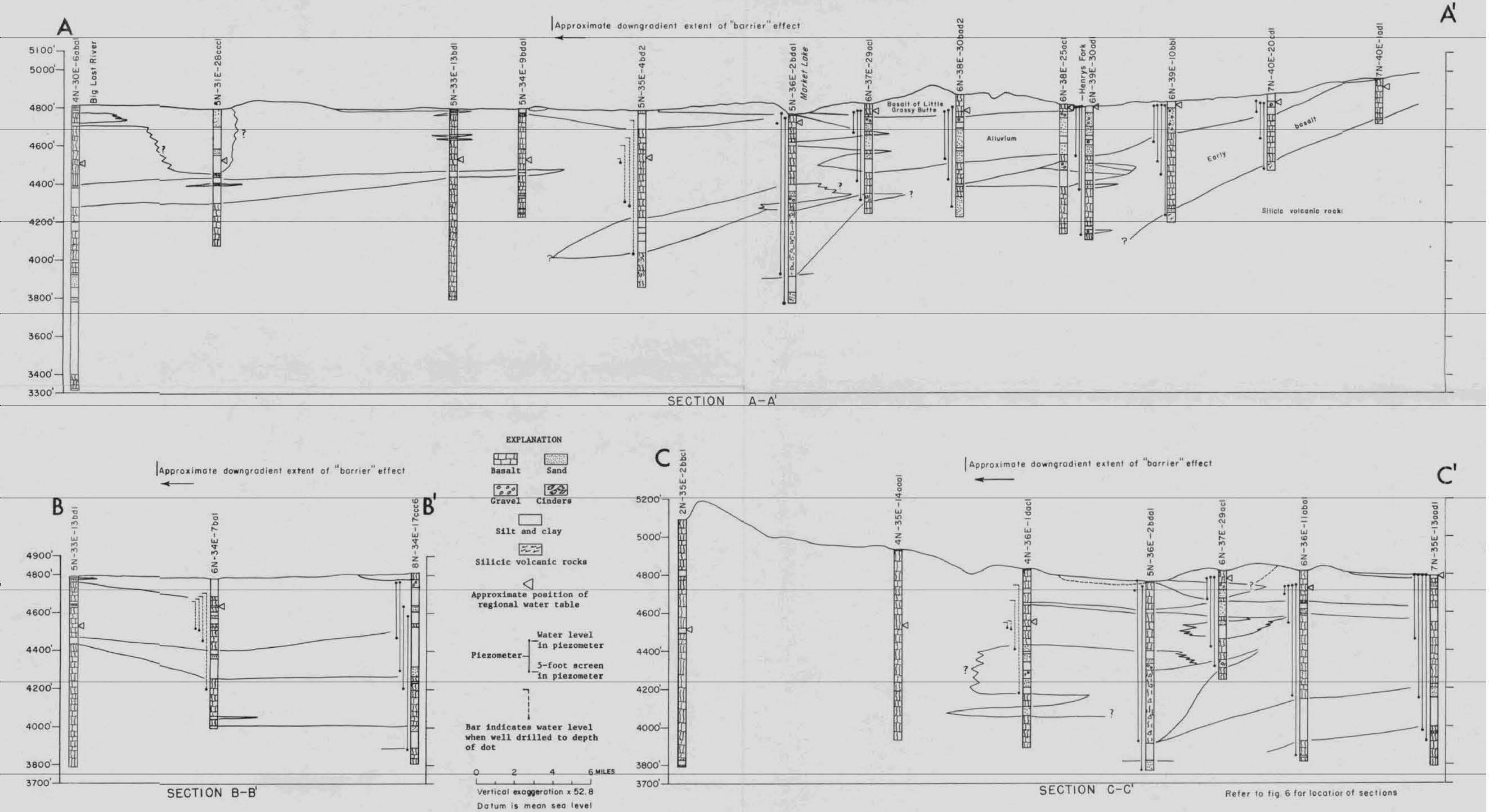

FIGURE 4.-- Geologic sections in the Mud Lake region, Idaho.

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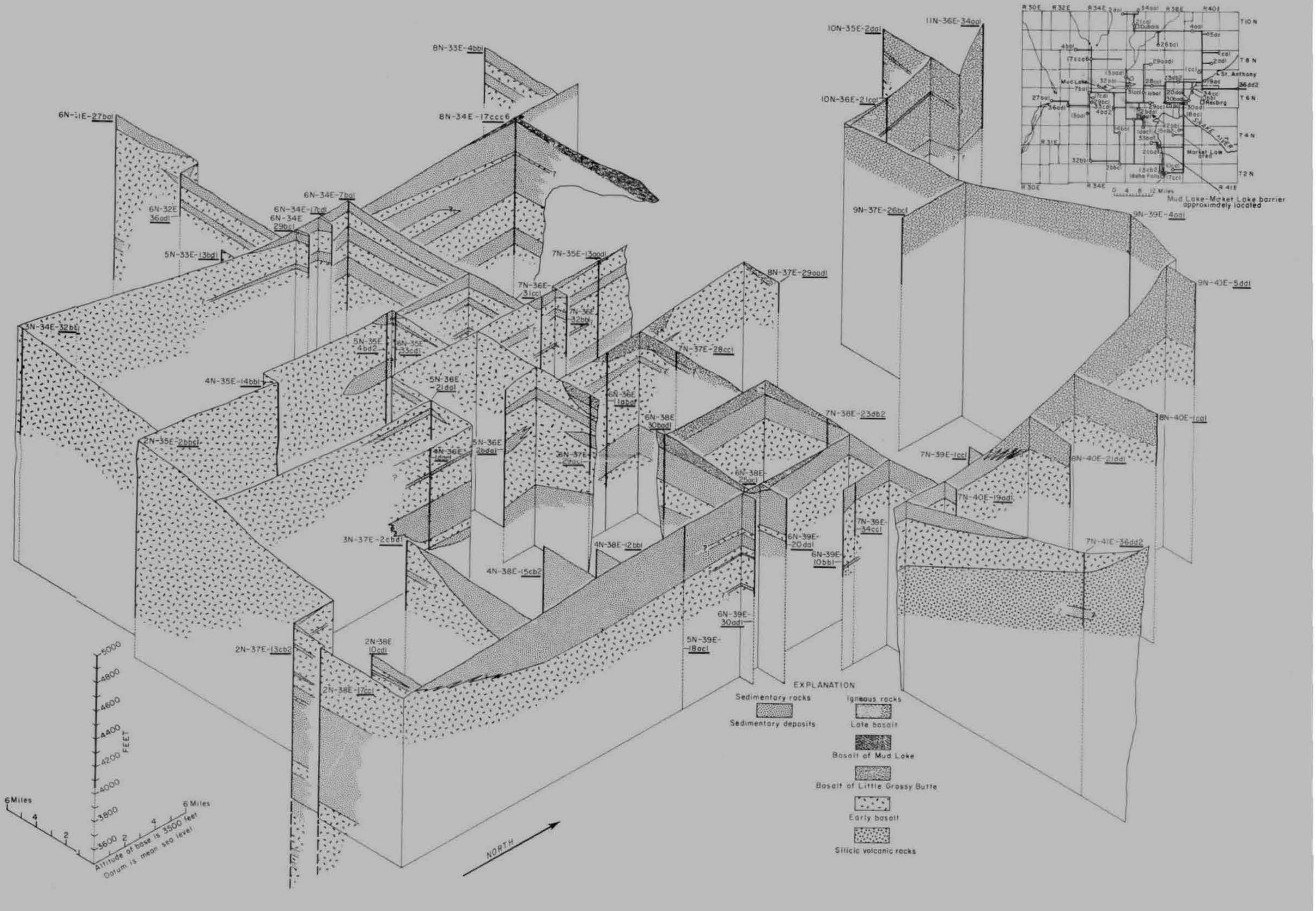

FIGURE 5.--Fence diagram showing the subsurface geology in the Mud Lake region, Idaho

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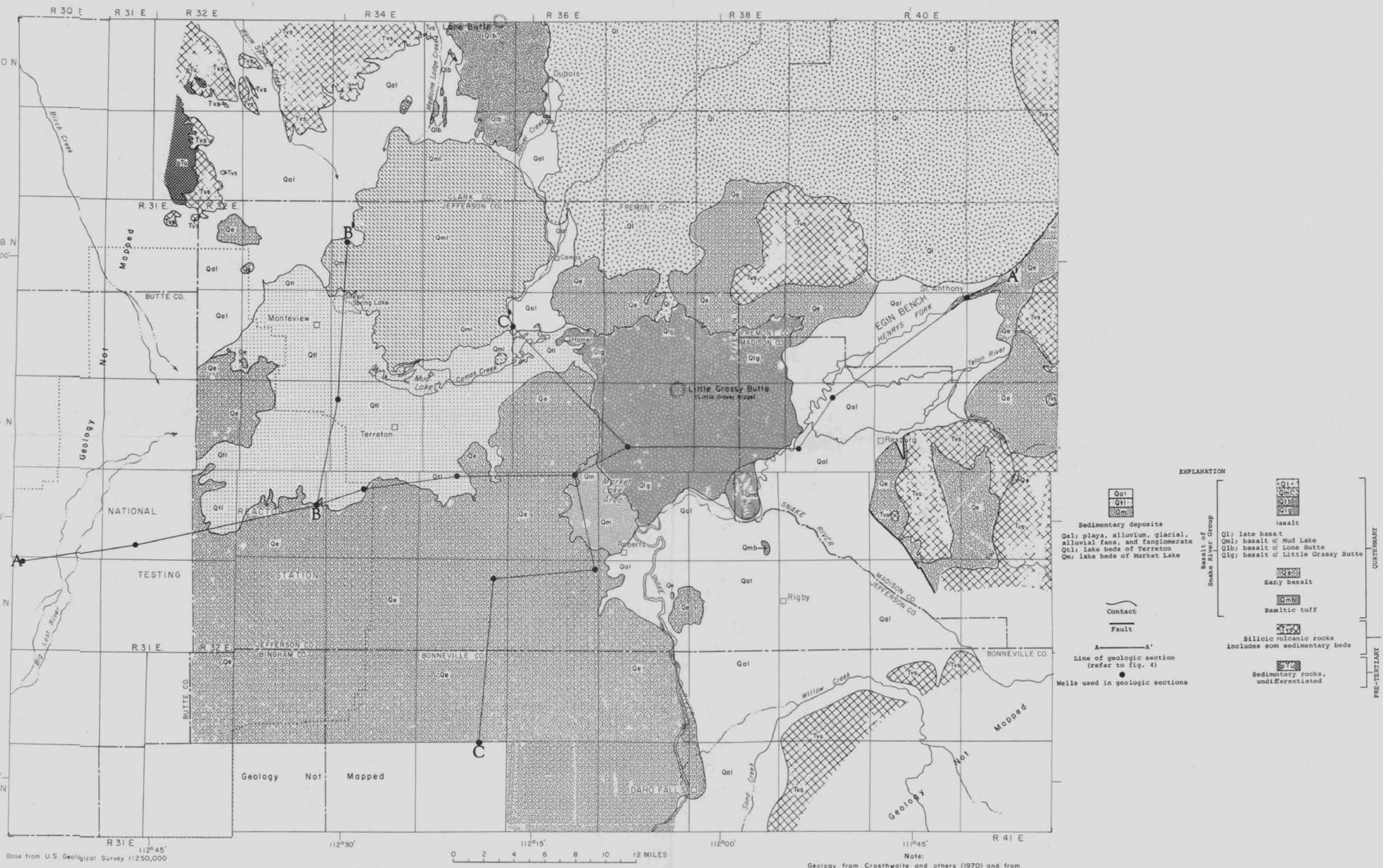

Base from U.S. Geological Survey 1:250,000

Note:
Geology from Crosthwaite and others (1970) and from unpublished map by P.R. Stevens

FIGURE 6.--Generalized geologic map of the Mud Lake region, Idaho.

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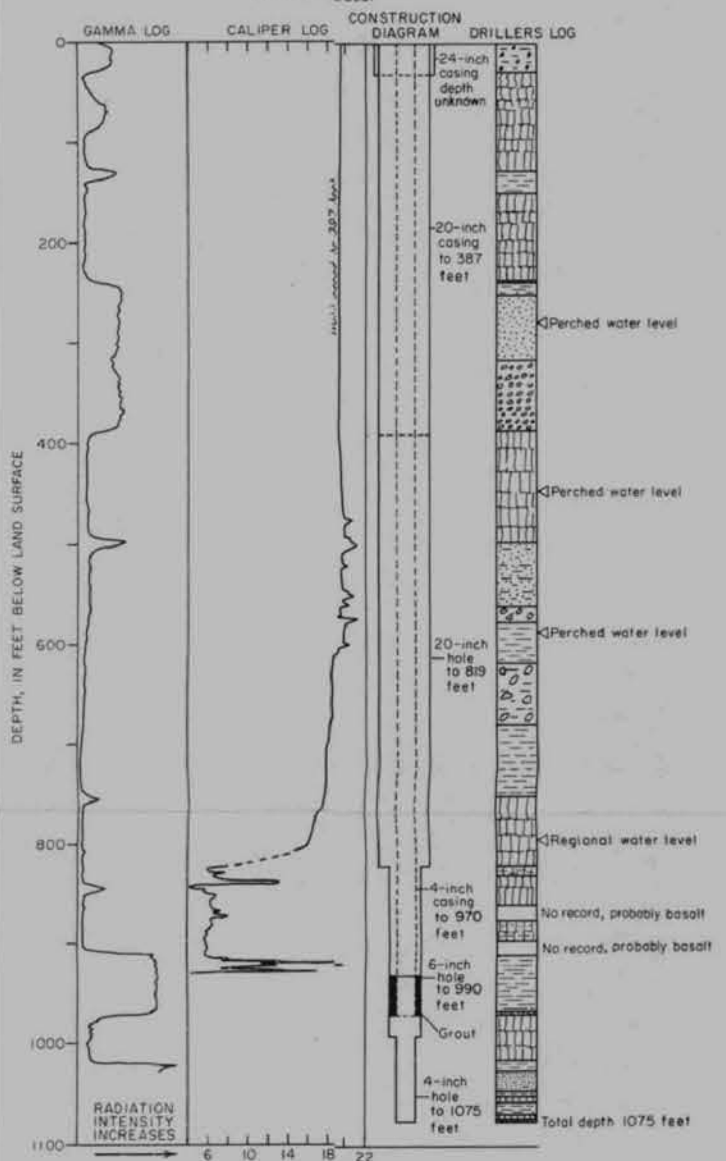

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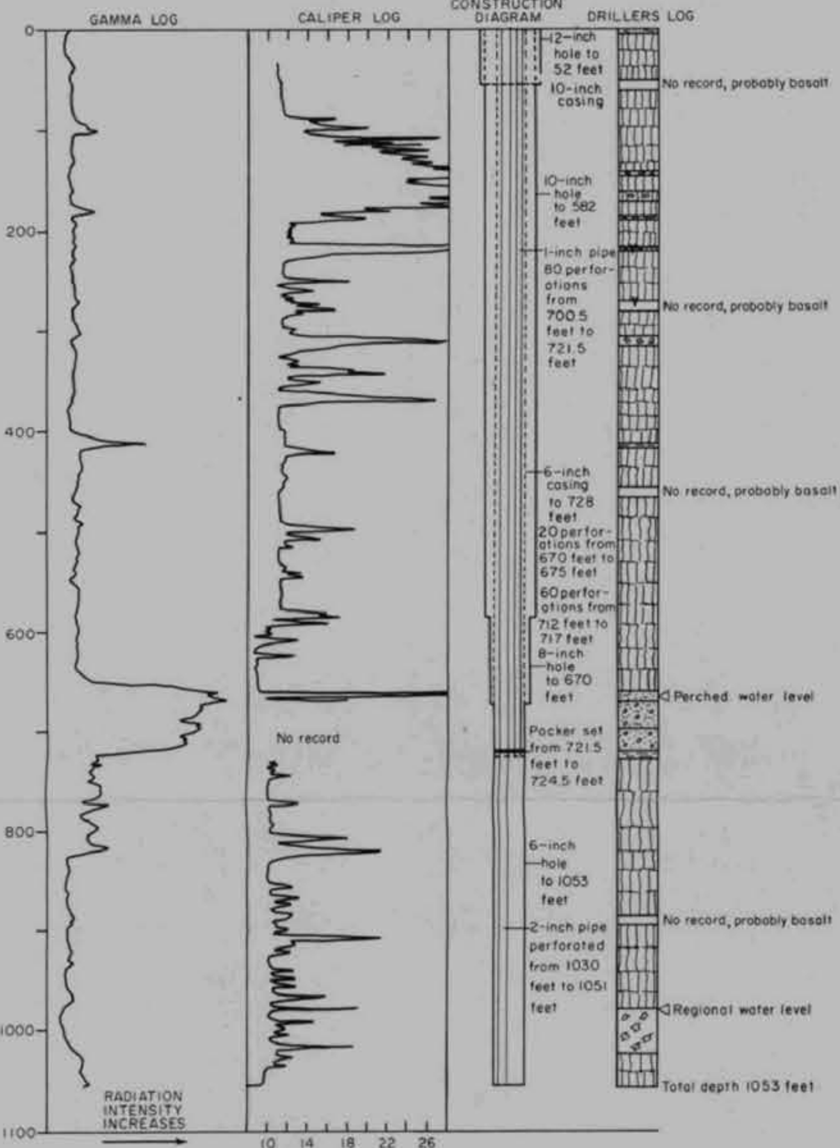

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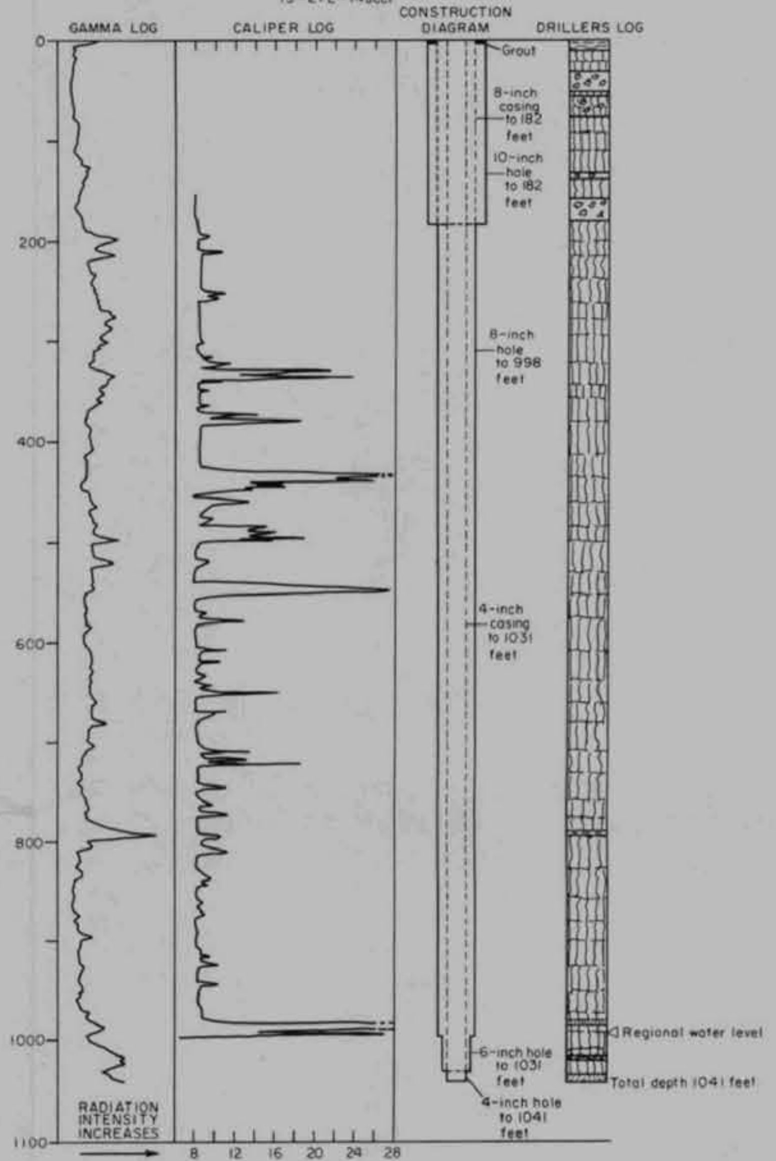

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