Geology and Ground-Water Resources of the Lower Little Bighorn River Valley Big Horn County, Montana

WITH SPECIAL REFERENCE TO THE DRAINAGE OF WATERLOGGED LANDS

By E. A. MOULDER, M. F. KLUG, D. A. MORRIS, *and* F. A. SWENSON

With a section on CHEMICAL QUALITY OF THE WATER

By R. A. KRIEGER

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By E. A. Moulder, M. F. Klug, D. A. Morris, and F. A. Swenson

ABSTRACT

The lower Little Bighorn River valley, Montana, is in the unglaciated part of the Missouri Plateau section of the Great Plains physiographic province. The river and its principal tributaries rise in the Bighorn Mountains, and the confluence of this northward-flowing stream with the Bighorn River is near the east edge of Hardin, Mont.

The normal annual precipitation ranges from about 12 inches in the northern part of the area to 15 inches in the southern part. The economy of the area is founded principally on farming, much of the low-lying land adjacent to the river being irrigated. The irrigated land is within the Crow Indian Reservation, although a part is privately owned.

The bedrock formations exposed in the area are of Cretaceous age and include the Parkman sandstone, Claggett shale, Eagle sandstone, Telegraph Creek shale, and Cody shale. The Cloverly formation, Tensleep sandstone, and Madison limestone, which underlie but are not exposed in the area, and the Parkman sandstone in the southern half of the area appear to be the principal bedrock aquifers. All except the Parkman lie at depths ranging from a few feet to several thousand feet, and all appear to be capable of yielding water in commercial quantities. Some of the other formations are capable of yielding enough water for domestic and stock needs.

The river alluvium of Recent age and the Pleistocene terrace deposits are the principal unconsolidated formations in the area with respect to water supply and drainage. Wells yielding as much as 100 gallons per minute may be developed in favorable areas.

Pumping tests reveal that the transmissibility of the coarser unconsolidated materials probably ranges from about 15,000 to 30,000 gallons per day per foot. Two tests of the Parkman sandstone showed transmissibilities of 6,000 and 20,000 gallons per day per foot. Although a test of the Cloverly formation showed a transmissibility of only 3,000 gallons per day per foot, the high artesian pressure—80 pounds per square inch at the land surface—in the Cloverly caused the tested well to yield about 200 gallons per minute by natural flow; this is greater than the yield of any other single well in the area.

Textural properties were compared with the hydraulic properties determined by laboratory tests to show the relation between different types of water-bearing materials. Materials classified as heavy soils—normally somewhat dense and impervious—had an average permeability of 7.2 gallons per day per square foot, which was more than expected. One sample of very coarse alluvial material had a permeability of 6,000 gallons per day per square foot.

The depth to water beneath irrigation units was mapped, thus showing the waterlogged areas. Waterlogging is not a serious problem where the water table is more than 6 feet below the land surface.

For the drainage studies the unconsolidated deposits are classified in two zones—coarse-grained sediments resting on the relatively impermeable bedrock floor and overlying fine-grained sediments which extend to the land surface. The transmissibility of the coarse-sediment zone generally is many times greater than that of the fine-sediment zone.

Because in many places drains could not be economically dug deep enough to enter the coarse zone, the study of the effectiveness of drains completed in the fine zone received much attention. The studies showed that, despite a considerable thickness of fine-grained sediments between the bottom of the drain and the top of the coarse zone, drainage ditches frequently were effective in relieving waterlogging of fields nearby. Pilot relief wells installed in existing drains showed that the effectiveness of some drains could be increased appreciably by installing a series of relief wells.

Records of fluctuations of water levels in 196 observation wells and water-level contour maps were studied to show the principal areas of recharge and discharge in the irrigable areas. These studies show, for example, that canal leakage and underflow from small tributaries caused waterlogging by concentrating recharge in some localized areas. Tests made on one section of canal indicate that the canals leak at a rate of 100 to 400 gallons a day per foot of their length.

Specific proposals for draining waterlogged areas were made by considering all pertinent factors. The suggested depths and locations of the drains were based on (a) the type and thickness of material to be drained, (b) the source and amount of recharge to the area, (c) the transmitting properties of both the coarse- and fine-sediment zones, (d) the possible effects from proposed irrigation units, and (e) the topography. Consideration of the drainage of surplus irrigation water and runoff is beyond the scope of this report.

Surface water from the Little Bighorn River and Lodge Grass Creek is the principal source of water for irrigation in the area.

Chemical analyses were made of 71 samples of water collected from several sources. Water from the Cloverly formation and the Parkman sandstone is soft and has a high sodium content. Although in the southern part of the area the water from these bedrock aquifers is suitable for domestic and many industrial uses, its high percent sodium makes it undesirable for irrigation. In general, the ground water from unconsolidated aquifers and the surface water are hard; the predominant ions in the ground water are sodium and sulfate and in the surface water are calcium, magnesium, and bicarbonate. The surface water from the perennial streams is best for irrigation, whereas ground water from the unconsolidated deposits is highly variable in mineral content and its suitability varies correspondingly. Ground water from the unconsolidated deposits generally is suitable for either irrigation or domestic use, but in a few localities the content of dissolved solids exceeds 4,000 parts per million and the water is undesirable for most purposes.

INTRODUCTION

PURPOSE AND SCOPE OF INVESTIGATION

In April 1952, at the request of the U.S. Bureau of Indian Affairs, the U.S. Geological Survey began an investigation of the factors affecting drainage of irrigated and irrigable lands on the Crow Indian Reservation along the Little Bighorn River and its tributary Lodge Grass Creek. The primary purpose of the investigation was to collect and interpret geologic and hydrologic data pertinent to the design and construction of proper drainage facilities on land that was irrigated or proposed for irrigation. Because most of the information needed for the drainage study is also pertinent to a study of the ground-water resources of the area, a secondary purpose was an evaluation of the present and potential development of the ground-water resources of the area.

The study was under the general direction of G. H. Taylor, regional engineer of the Ground Water Branch in charge of ground-water investigations in the Missouri River basin. F. A. Swenson, district geologist for Montana, supervised both the fieldwork and the preparation of the report.

The study of the chemical quality of the water was under the supervision of P. C. Benedict, regional engineer of the Quality of Water Branch, in charge of investigations in the Missouri River basin. The quality-of-water study was begun during the 1952 field season by E. R. Jochens, who prepared some of the maps and charts.

The measurement of stream discharge was supervised by Frank Stermitz, district engineer for the Surface Water Branch in Montana.

LOCATION AND EXTENT OF AREA

The area included in the investigation extends downstream along the valley of Lodge Grass Creek from a point about 4 miles southwest of Lodge Grass and downstream along the valley of the Little Bighorn River from Lodge Grass to Hardin, Mont. (See fig. 1.) Within the area are three operating irrigation units—Lodge Grass No. 1, Reno, and Agency—which total 14,617 acres. Also included in the area are two proposed irrigation units—the Benteen Flat and the Battlefield units. The total area described in this report is about 100 square miles.

PREVIOUS INVESTIGATIONS

The geology and natural resources of Big Horn County and the Crow Indian Reservation were described by Thom, Hall, Wegemann, and Moulton (1935). A soil survey by Nunns (1945) included the valleys of both the Bighorn and Little Bighorn Rivers. Buck (1947) reported on the history of land and water use in irrigated areas within Big Horn County and pointed out that "drainage is a real problem" on the Crow Irrigation Project. Richards and Rogers (1951) described and discussed the possible occurrence of oil and gas in the Hardin vicinity, which includes the northern part of the area described in this report.

More recently, Richards (1955) has described the geology of the Bighorn Canyon–Hardin area and Knechtel and Patterson (1956) have described the deposits of bentonite in the Hardin district. Their

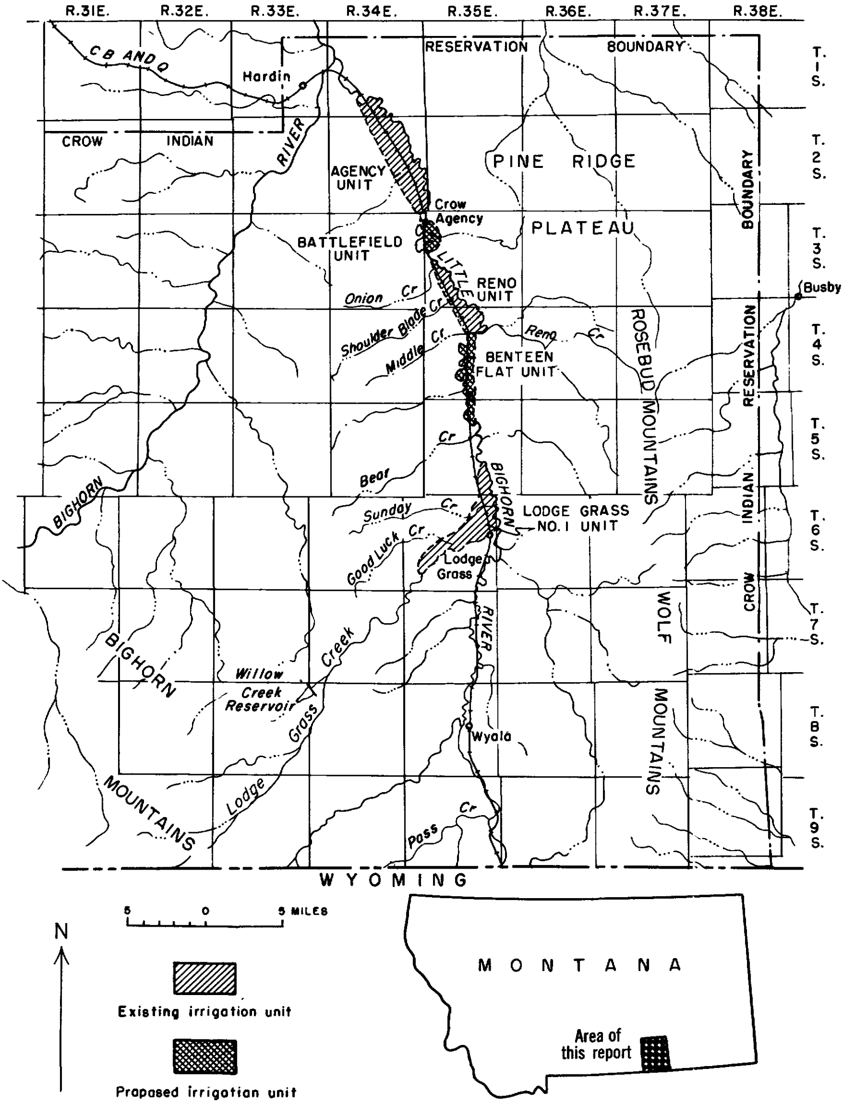

FIGURE 1.—Map showing location of area described in this report.

geologic maps are based largely on the maps of Richards and Rogers (1951).

METHODS USED IN THIS INVESTIGATION

The surficial geology of the report area was mapped originally on aerial photographs (scale, 1:12,000 or 1 inch=1,000 feet) and the data were later transferred to base maps (pls. 1–4). Previously published geologic maps of the area served as guides for the more detailed mapping done during this investigation. Information on the lithology, thickness, and structural attitude of the subsurface bedrock formations was obtained from published reports and from geologists' and drillers' logs of oil wells and test holes (table 21) and deep water wells (table 22). Supplemental information on the unconsolidated deposits in the Agency unit was obtained from logs of seismic shotholes drilled by oil companies (table 23).

Jetting equipment was used to install 196 observation wells and test holes (pls. 1–4, fig. 2, and tables 25 and 28). The altitude of the land surface at all of these points was determined by spirit leveling. An additional 29 test holes were bored to determine only the depth to water. The location of these test holes and the altitude of the water level in them are indicated on the maps showing the depth to water (pls. 5, 6, 8, 10, 11) and the contour of the water

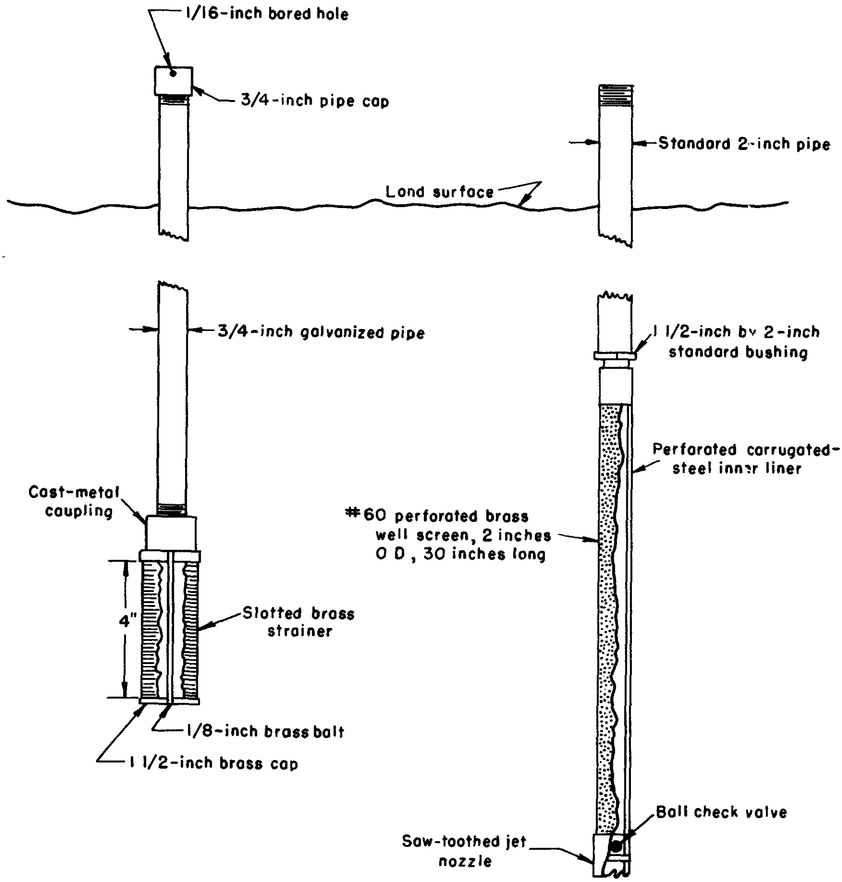

FIGURE 2.—Sketch showing construction details for wells installed during this investigation: water-level observation well (at left) and well pumped for aquifer test (at right).

table[1] (pls. 5–11). Supplemental information on the position of the water table was obtained by determining the altitude of the water level in domestic wells, in test holes drilled by the U.S. Bureau of Indian Affairs, and of ponds considered to be hydraulically connected to the ground-water reservoir.

Water-level measurements were made in 181 wells. Of these wells, 10 were equipped with automatic recording gages, 151 were measured biweekly during the irrigation season and at monthly intervals during the remainder of the year, and 20 were measured at irregular intervals. (See tables 26 and 27.)

The hydrologic properties of the principal water-bearing beds in the report area were determined by making aquifer tests at six sites. Soil samples were collected at 19 sites and analyzed in the hydrologic laboratory of the U.S. Geological Survey at Lincoln, Nebr., to obtain information on their hydrologic and physical properties. (See table 24.)

Surface-water gaging stations of the Geological Survey provided daily records of discharge and gage heights at 4 points along the Little Bighorn River and at 1 point on Lodge Grass Creek. A temporary gaging station was established on the Agency Canal to estimate the quantity of water being diverted into the canal.

The effect of canal leakage on the water table during periods of known canal stage was determined by making water-level measurements in wells along a line perpendicular to the canal.

The chemical laboratory of the Geological Survey at Lincoln, Nebr., analyzed 55 samples of ground water and 16 samples of surface water. Results showed the type of water characteristic of the various sources of supply and the general suitability of each type for irrigation and domestic use.

Topographic and soils maps furnished by the Bureau of Indian Affairs were used in studying drainage problems. Some of the observation wells were installed adjacent to, and in, drains so that the effectiveness of the drains could be determined by measuring the difference in head between the water in the drain and the water in the aquifer.

ACKNOWLEDGMENTS

Personnel of the Bureau of Indian Affairs, under the direction of William Farmer, engineer, assisted in the fieldwork and supplied valuable data pertaining to irrigation and drainage. The Carter Oil Co. and the Geotechnical Corp. furnished logs of seismic shotholes drilled by them in the area. Local residents, town and city officials,

[1] The term "water table," as used herein, refers to that surface that coincides with the water level in wells tapping the unconsolidated aquifers, whether the water in the aquifer is under water-table (unconfined) or artesian (confined) conditions.

and well drillers gave information on water wells, use of ground water, history and practices of irrigation, cause and extent of waterlogging, and efforts to improve drainage in the area.

WELL-NUMBERING SYSTEM

Most of the wells and test holes in the report area were assigned two numbers, one a temporary field number and the other a permanent number based on the location of the well according to a survey of the area by the Bureau of Land Management. Field numbers were not assigned to wells and test holes used for only a single water-level measurement or the collection of a single water sample for chemical analysis. Within each irrigation unit, observation wells were assigned consecutive field numbers in an upstream direction; however, supplementary wells installed later were numbered without regard to their location within the unit. An explanation of the field numbering system follows.

Observation wells measured at regular intervals.—The letter preceding the field number designates the unit in which the well is located. The letters are as follows: A, Agency unit; B, Battlefield and Reno units; C, Benteen Flat unit; and D, Lodge Grass No. 1 unit. (Example, D–24.)

Wells pumped during aquifer tests.—The letter "P" is followed by a digit designating the test-site number. (Example, P–5.)

Observation wells measured during aquifer tests.—The first digit refers to the test-site number, the following letter or letters indicates the direction from the pumped well, and the second digit indicates the position of the observation well in relation to the position of the pumped well and the other observation wells. (Example, well 2–E3 is the third well east of the pumped well at test site 2.)

Wells measured in studying canal leakage.—The letters "CP" are followed by a well number. (Example, CP–6.)

Wells measured in studying drain effectiveness.—The letters "DR" are followed by two numbers, the first indicating the drain and the second the individual well along that drain. (Example, DR13–1.)

Seismic shotholes.—The numbers assigned by the seismograph companies were retained for use in this study. (Example, 7340.)

Soil-sample test holes.—The number assigned to the test hole is identical to that given the first soil sample collected from the hole. (Example, 31.)

Each permanent well number begins with a capital letter which indicates the quadrant of the principal meridian and base-line system for Montana. The quadrants are designated A, B, C, and D, beginning with the northeast quadrant and continuing in a counterclockwise direction. The first numeral of a well number indicates the township, the second the range, and the third the section in which the well is located. The lowercase letters following the section number indicate the location of the well within the section. The first letter denotes the quarter section, and the second letter the quarter-quarter section, or 40-acre tract. The subdivisions of the section are lettered a, b, c, and d in a counterclockwise direction, beginning with the northeast quarter. A graphical illustration of this method of well numbering is shown in figure 3. If more than one well is in the same 40-acre tract, their otherwise identical numbers are distinguished by adding different digits after the lowercase letters. These digits are assigned consecutively, beginning with 1, in the order in which each well would be encountered by the counterclockwise sweep of a line extending from the center of the tract to the northeast corner.

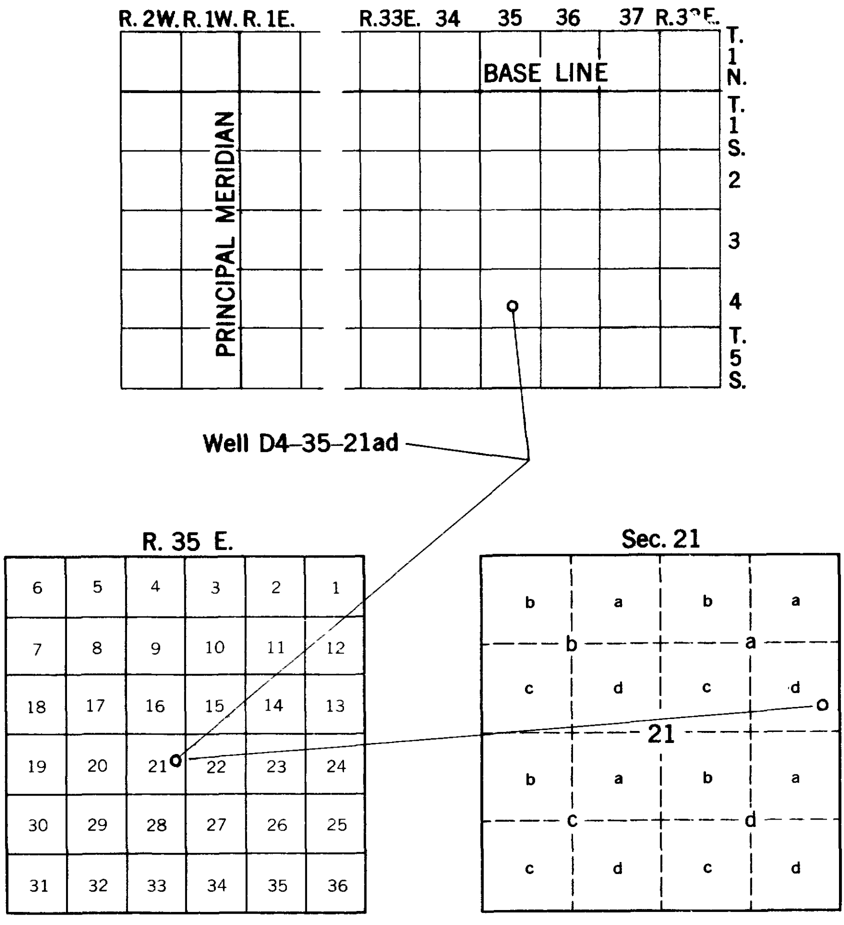

FIGURE 3.—Well-numbering system.

The sites at which water samples were collected from streams and drains were assigned numbers according to the same system used for assigning permanent well numbers.

GEOGRAPHY

PHYSIOGRAPHY

The lower Little Bighorn River valley is in the unglaciated part of the Missouri Plateau section of the Great Plains physiographic province (Fenneman, 1928, pl. 1). It is bounded on the west by an upland of rough hills that lie between it and the Bighorn River, and on the east by a rough, hilly area—known as the Rosebud Mountains—and the Pine Ridge plateau, which lies north of the Rosebud Mountains. The Bighorn Mountains, on the northwest slope of which the Little Bighorn River rises, lie about 35 miles southwest of the south end of the area.

The maximum altitude of the Rosebud Mountains is about 5,600 feet and the average altitude of the Pine Ridge plateau is about 4,100 feet. The highest peaks of the Bighorn Mountains are nearly 10,000 feet above sea level. Although the total relief within the drainage basin of the Little Bighorn River is about 7,000 feet, it is only about 650 feet in the area described by this report.

The most conspicuous topographic features within the area are the prominent stream terraces and pediment slopes, which were formed as the Little Bighorn River became entrenched in the easily eroded bedrock. The terraces are principally on the west side of the river and consist of a series of gently sloping surfaces that range in height from 10 to 650 feet above the present level of the stream. The upper edges of the terraces merge with erosional surfaces, or pediments, developed on the bedrock formations of the upland. A large part of the area designated as undifferentiated Upper Cretaceous rocks on plate 4 is such a pediment and is mantled by a thin deposit of unconsolidated material. The terraces and pediments are crossed in places by the fairly wide drainageways of intermittent tributaries of the Little Bighorn River. Several of these intermittent streams have built alluvial fans out onto the lower terraces. The pediments on the east side of the Little Bighorn River rise sharply from the alluvial bottom to the abrupt escarpment that forms the east valley wall.

Apparently the Little Bighorn River has migrated downslope on the eastward-dipping bedrock formations, as is indicated by terrace remnants that are preserved almost exclusively on the west side of the valley. Probably the alluvial fans of the tributaries that enter the valley from the west also have been a factor in forcing the river

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to flow along the east valley wall. The terraces and pediment slopes and, in many places, also the scarps between terraces are mantled by slopewash.

CLIMATE

The climate of the region is characterized by abundant sunshine, low relative humidity, light precipitation, and wide daily and seasonal variations in temperature.

The monthly precipitation and average monthly temperature at Wyola, Crow Agency, and Hardin during 1951 and 1952 are shown in figure 4. Although in both years the average monthly temperature was above normal and the monthly precipitation below normal, the seasonal distribution of precipitation was so favorable that dryland crops generally were successful. The normal annual precipitation is 14.71 inches at Wyola, based on 21 years of record; 15.07 inches at Crow Agency, based on 71 years of record; and 12.14 inches at Hardin, based on 12 years of record. Records of precipitation at other stations in the vicinity of the report area, some of which are short or incomplete, indicate that annual precipitation generally increases westward from Busby, which is about 24 miles east of Crow Agency, and southward from Hardin. Wide variations in monthly precipitation at the various stations indicate that much of the precipitation is from localized storms. Although the distribution of rainfall generally is favorable for crop growth, wide deviations from the normal make dryland farming an uncertain venture.

During the period of record at Crow Agency, precipitation ranged from 4.65 inches in 1934 to 25.25 inches in 1912. (See fig. 5.) The least precipitation recorded in any year was 30 percent of normal annual precipitation. The frequency of occurrence of various departures from normal annual precipitation in this area may be estimated from curves (fig. 5) based on precipitation data collected at the Crow Agency station. It may be deduced from the curves that about 27 percent of the years of record had a departure of 2 inches or more below normal—or 18 of 66 years had less than 13 inches of precipitation.

SURFACE WATER

The Little Bighorn River drains an area of about 1,275 square miles. From its headwaters in the Bighorn Mountains in Wyoming to the base of the Bighorn Mountains in Montana, the Little Bighorn River flows swiftly and turbulently through a narrow canyon about 2,000 feet deep. From the mountains to its junction with the Bighorn River at Hardin, however, the Little Bighorn is a meandering stream and is bordered by terraces and pediment slopes. About 2 miles above its confluence with the Bighorn River at Hardin, the Little Bighorn River has been diverted from its natural channel

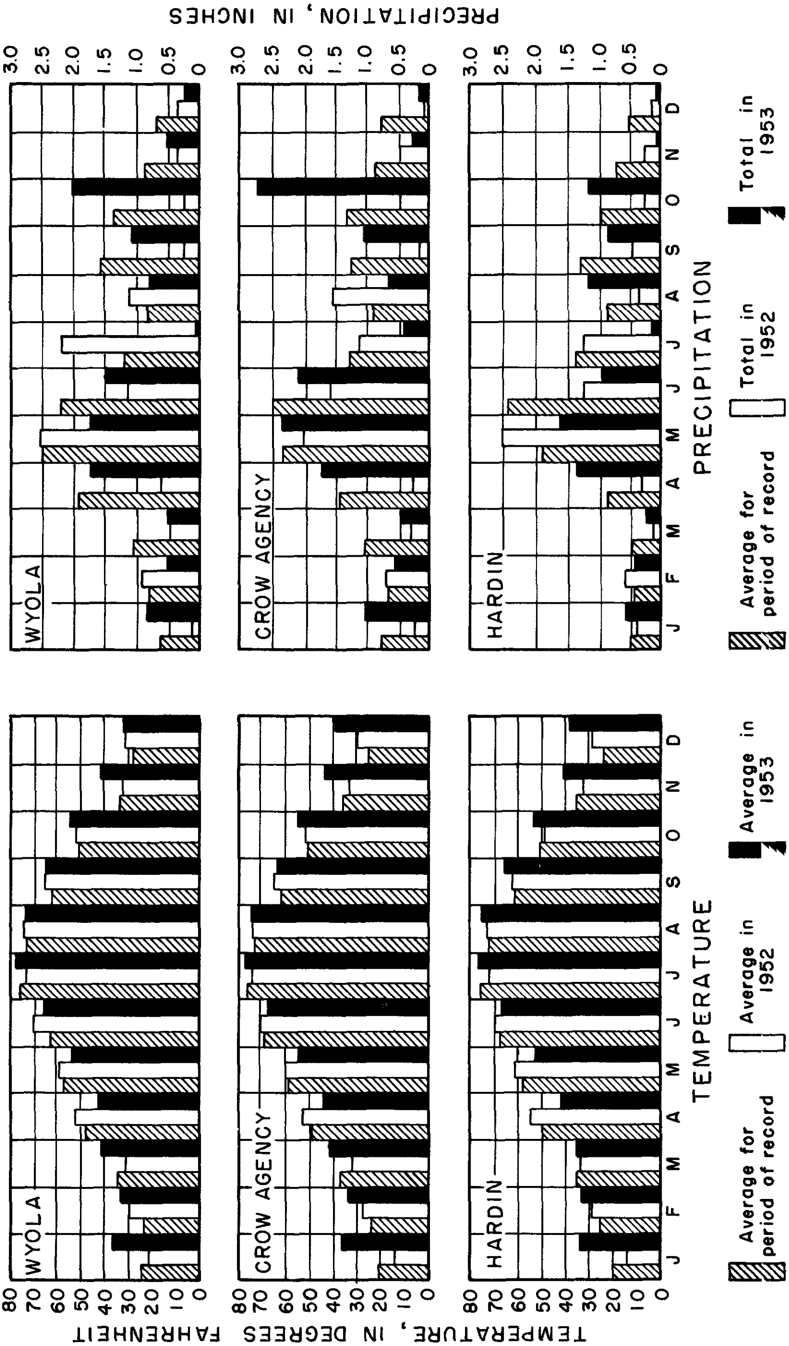

FIGURE 4.—Graphs showing climatological data for Wyola, Crow Agency, and Hardin, Mont.

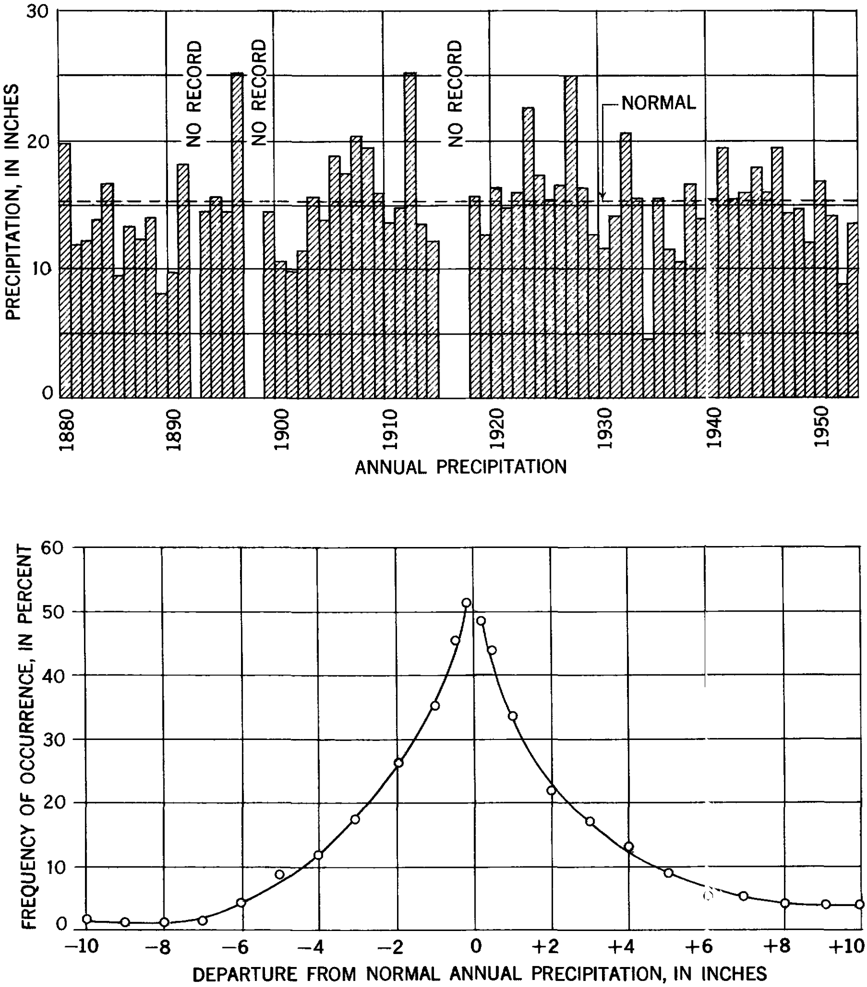

FIGURE 5.—Graphs showing annual precipitation and frequency of precipitation at Crow Agency, Mont.

on the west side of the valley to a manmade channel along the east side of the valley.

The quantity of flow per unit area of drainage becomes progressively less downstream principally because precipitation is progressively less toward the north and proportionately more of the precipitation is discharged by evapotranspiration. Occasionally ice jams during high spring runoff cause flooding of the low-lying alluvial lands, which are chiefly pasture or woodland.

The flow of the Little Bighorn River is measured at three gaging stations and the flows of Pass and Lodge Grass Creeks at one station each. (See fig. 6.) Daily discharge measurements at these stations are published annually by the Geological Survey in a series of water-supply papers entitled "Surface water supply of Missouri River basin." The maximum, minimum, and average flows recorded at each station are given in table 1. The table shows also the acreage irrigated in 1952 by upstream diversions.

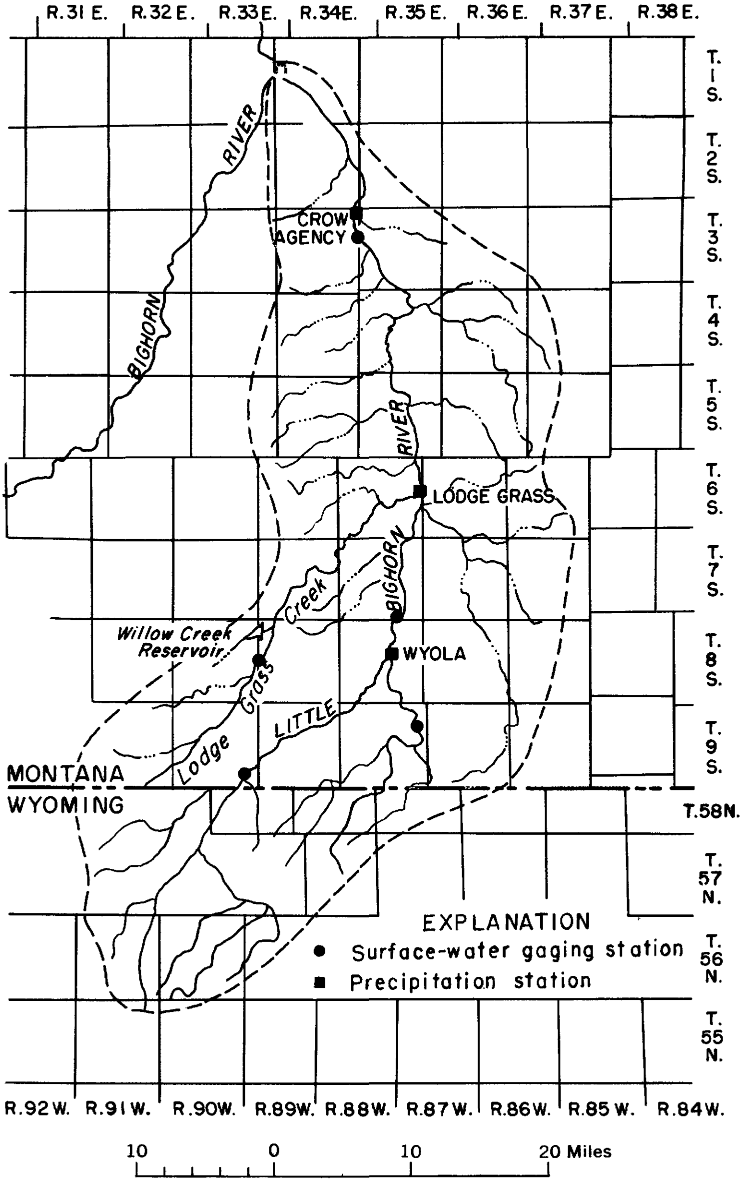

FIGURE 6.—Map showing drainage basin of the Little Bighorn River and locations of stream-gaging and precipitation stations.

TABLE 1.—*Summary of streamflow measurements in the Little Bighorn River drainage basin*

Station	Drainage area (sq mi)	Period of record	Maximum discharge (cfs)	Date of maximum discharge	Minimum discharge (cfs)	Date of minimum discharge	Average discharge (cfs)	Acres irrigated in 1952 by upstream diversions
Little Bighorn River at State line.	199	Mar. 1939–Sept. 1952.	2, 730	June 3, 1944	22	Jan. 16, 17, 1943	148	0
Pass Creek near Wyola.	119	June 1935–Sept. 1952.	1, 150	do	0	Aug. 3, 9, 10, 1935	39. 2	2, 500
Little Bighorn River below Pass Creek, near Wyola.	429	Mar. 1939–Sept. 1952.	3, 200	do	27	Sept. 9, 1940	200	7, 700
Lodge Grass Creek above Willow Creek diversion.	83	Mar. 1939–Sept. 1952.	762	do	3	Jan. 17, 18, 25, 30, 31, 1950.	46. 5	400
Little Bighorn River near Crow Agency.	1, 190	Sept. 1911–Sept. 1924; Aug. 1928–Dec. 1932; Apr. 1938- Sept. 1952.	8, 200	July 23, 1923	0	July 28–Aug. 6, 1921.	280	13, 700

Almost all the water used for irrigation in the area is derived from either the Little Bighorn River or Lodge Grass Creek. To insure a more adequate supply, a 114-foot dam was constructed about 15 miles southwest of the town of Lodge Grass on Willow Creek near its confluence with Lodge Grass Creek. Its reservoir has a storage capacity of 23,000 acre-feet of water, most of which is diverted from Lodge Grass Creek by a low dam and carried by canal to the reservoir. Water released from the reservoir is diverted at successive points downstream into canals that supply the Lodge Grass No. 1, Reno, and Agency units. Some water is pumped directly from the Little Bighorn River to irrigate land not supplied with water from the principal canals. Part of this water is delivered to the fields by ditches and the rest by sprinkler systems. A small amount of ground water is used for lawn and garden sprinkling and for irrigation.

Before the construction of Willow Creek Reservoir, water for irrigation in the lower valley was in short supply. Inadequate diversion structures have been partly responsible for water shortages during periods of low flow even since construction of the reservoir. The design capacity of the principal diversions within the Little Bighorn River basin and the quantities of water for which appropriative rights have been filed are given below:

Diversion	Design capacity (cfs)	Appropriative right (cfs)
Federal and private diversions upstream from report area		237
Lodge Grass No. 1 Unit Canal	200	134. 5
Reno Canal	85	112
Agency Canal	210	166. 6
Total		650. 1

In the Little Bighorn River drainage basin, as in many drainage basins throughout the West, the appropriative rights exceed the total supply. The amount of water diverted, therefore, is less than the appropriative rights.

The municipal supply for the city of Hardin is obtained from the Bighorn River. During extended hot, dry periods the system is barely adequate because treatment facilities are a limiting factor. Together, the larger stores and the creameries are the major users of the water; they are supplied 8,000–16,000 gpd (gallons per day) in the summer, and some supplement the water obtained from the municipal supply with water pumped from wells on the premises.

Both the railroad and sugar refinery pump water directly from the river. During its 60-day production season, the refinery pumps about 5 mgd (million gallons per day). The water is passed through settling tanks and part of it is treated for use in boilers. Water for culinary purposes in the refinery is trucked from the municipal supply at Hardin. After the sugar-beet season, the refinery ceases operations and water consumption is reduced to the small amount needed for the heating system.

Pass Creek, which enters the Little Bighorn River at Wyola, and Lodge Grass Creek, which enters at Lodge Grass, are the principal tributaries. Both are perennial streams. Although the many other smaller tributaries flow only during periods of heavy runoff, the underflow in the coarse alluvial fill of some of their valleys contributes, in places, to the waterlogging of irrigated land. To impound water for livestock, dams have been constructed in several of the small tributary drainageways.

HISTORY

Probably the first white men to visit what is now Big Horn County were a small party of Frenchmen, led by Chevalier de la Verendrye, who were searching for a route to the Pacific Ocean. In 1743 they reached the Bighorn Mountains but turned back because of warfare among the Indians.

In the early 1800's a few trappers and prospectors explored the area in their quest for furs and gold. Although forts and trading posts were established along the Yellowstone River as early as 1807, and many miners and settlers passed through Big Horn County along the old Bozeman Emigrant Trail, it was not until about 1876 that settlements were established in the Little Bighorn River valley.

The attempt by Indians to halt the settlement by white men reached its climax when the Sioux and Northern Cheyennes joined forces to resist the U.S. Army in its efforts to force them back onto the reservation. Plans were made for the infantry, led by General Gibbon, to proceed westward up the Yellowstone River to the mouth of the Bighorn River and then continue southward up the valleys of the Bighorn and Little Bighorn Rivers; and for the cavalry, under General Custer, to proceed southwestward up Rosebud Creek, cross the divide to the west, and continue westward down Reno Creek to the Little Bighorn River valley. Discovery of the Indian forces in the Little Bighorn River valley prompted Custer to divide his cavalry troops into three separate commands and to attack. The overwhelming Indian forces quickly gained the advantage, however, and succeeded not only in completely annihilating Custer's command but in inflicting heavy losses on the commands led by Major Reno and Captain Benteen. This was the last great battle staged by the Sioux. The following day, June 26, 1876, the Indians became aware of the approaching infantry troops and retreated to the south. In 1877, in its effort to prevent Indian uprisings, the Federal Government established Fort Custer at the confluence of the Bighorn and Little Bighorn Rivers. The Custer Battlefield National Cemetery is within the area described by this report.

An act of Congress in 1851 established the Crow Indian Reservation as the area bounded on the north and west by the Yellowstone River, on the south by the 45th parallel, and on the east by the 107th meridian. In 1880, 1890, and 1904, the areal extent of the reservation was reduced successively to its present size of about 3,300 square miles. The Federal Government has built schools and a hospital on the reservation and also has done much to encourage the development of agriculture. Very little of the farming, however, is done by the Indians.

According to the 1950 census, the population of Big Horn County was 9,824, or an average of about 2 persons per square mile. About 20 percent of the population is Indian.

AGRICULTURE

The wanton slaughter of buffalo in the late 1800's left the range ideally suited to cattle raising, which developed rapidly in Big Horn County between 1880 and 1890. Despite strong resistance from the cattlemen, sheep raising expanded extensively in the early 1900's. As dryland farming generally was considered impractical, some ranchers irrigated bottom-land meadows by diverting river water onto them.

To help make the Indian lands self-supporting, the Federal Government constructed irrigation projects in the valley. The Reno unit in the valley of the Little Bighorn River was completed in 1885. Six years later, the Federal Government authorized the Crow Irrigation Project for the development of irrigation in the valleys of the Bighorn and Little Bighorn Rivers and of Pryor Creek. In the Little Bighorn River valley, the Agency unit was completed in 1895 and Lodge Grass No. 1 unit in 1896. Several subsequent acts of Congress have provided for the further development and improvement of these units.

Meanwhile, enthusiasm for irrigation was spreading throughout the State. In January 1892 a convention held in Helena passed resolutions asking the Federal Government for aid in the Statewide development of irrigation and the sinking of wells. Homesteaders came to Big Horn County in 1906 and, when climatic conditions were favorable, successfully farmed the dry land. Although a series of poor crop years caused widespread abandonment of farms and added impetus to the growth of irrigation farming, improved agricultural practices and the planting of drought-resistant varieties of grain have made dry farming practicable on the benchland bordering the irrigated valley land.

Before 1915, when sugar beets were first grown in the area, the principal irrigated crops were alfalfa and small grains. Since then, and especially since the construction in 1927 of a sugar refinery at Hardin, more and more acreage has been planted in sugar beets.

Most of the Indian-owned farmlands in the area are leased to white farmers on a competitive-bid basis and for short terms only. Consequently, the tenants seldom stay on a farm long enough to become interested in long-term conservation measures and providing for adequate drainage. Also, only a few of the Indian owners have sufficient capital to make the improvements. In recent years the increase in owner-operated farms has resulted in a growing demand for a coordinated drainage program.

Irrigation probably will be extended to benchlands in the Bighorn River valley if an adequate supply of water can be made available. The Federal Government has proposed the construction of a dam on the Little Bighorn River, just north of the Wyoming State line, to impound 50,000 acre-feet of water. The project is indefinite, however, because of problems involving land values, construction methods, and other factors.

INDUSTRIES AND MARKETING

The production and processing of livestock and other agricultural products are the principal occupations in the area. Most of the livestock is shipped to marketing centers outside Big Horn County, and only that consumed locally is processed locally. A sugar refinery just north of Hardin processes all the beets produced on the reservation and some of the surplus production from other areas. Other industries, all of which are small and serve only local demands, include two creameries, machine and blacksmith shops, and coal mines.

Hardin and Lodge Grass are marketing centers for seed and grain; Billings is the chief market for livestock.

TRANSPORTATION

The Chicago, Burlington & Quincy Railroad traverses the Little Bighorn River valley from Wyola to Hardin. Paralleling the railroad is Highway 87—a paved road connecting Hardin with Sheridan, Wyo., and Billings, Mont. Paving programs that were underway in 1954 were designed to provide better routes to the east and north.

MINERALS AND TIMBER RESOURCES

Large deposits of low-grade bituminous coal are present in the eastern part of Big Horn County but until 1954 had been mined on only a small scale. The possibility of mining bentonite that crops out a few miles south and west of the area was studied by Knechtel and Patterson (1952). Known deposits of gypsum and limestone west of the area have not been developed commercially.

Wells in and around Hardin formerly produced sufficient natural gas to supply the local demand, but increased use of this resource has so depleted the gas pressure that a supplementary supply had to be piped into the city. A well on the W. Lynde ranch on Lodge Grass Creek yields sufficient natural gas for domestic heating and cooking. Similar supplies have been developed at a few other places within the area. Oil exploration was active in Big Horn County during the early 1950's, and producing wells have been completed a few miles east of Hardin.

Very little timber grows in the area. Although valuable stands of coniferous trees grow in the adjacent mountainous areas, no extensive lumbering operations were in progress in 1952–54.

GEOLOGY

STRATIGRAPHY

The area is underlain by a great thickness of sedimentary rocks. From exposures within the area and on the flanks of the Bighorn Mountains, and from logs of oil test wells (table 21), the sequence of these rocks is fairly well known. Two bedrock formations of Cretaceous age, the Cloverly formation and the Parkman sandstone, and most of the unconsolidated deposits of Quaternary age are sources of water supply. Several other bedrock formations are potential sources of supply. The thickness, lithologic character, and water-bearing properties of the exposed stratigraphic units, as well as those believed to be present in the subsurface, are given in the following composite geologic section (table 2). The areal extent of the unconsolidated deposits and the outcrops of the bedrock formations are shown in plates 1 to 4.

STRUCTURE

The most prominent structural feature in the area is a northeast-trending monocline, which crosses the Little Bighorn River valley between secs. 11 and 25, T. 2 S., R. 34 E. Dips on the flank of the fold are as much as 17° southeast. Northwestward between the fold and Hardin, the bedrock formations are gently arched over the axis of a northeast-plunging anticlinal nose. Southward, between the fold and the town of Lodge Grass, the strike of the bedrock formations veers progressively from southwest to south to southeast and the dips are, respectively, to the southeast, east, and northeast. Along Lodge Grass Creek the bedrock formations dip gently northeast. No faulting is evident within the area.

TABLE 2.—*Generalized geologic section of the lower Little Bighorn River valley, Montana*

System	Series	Formation	Thickness (feet)	Lithologic character	Water-bearing properties
Quaternary	Recent	Alluvial fans	0–40	Present where major tributary streams enter main valley. Consist principally of sand and gravel deposited during periods of heavy rainfall or rapid snowmelt. Mantle low terraces and alluvial bottom land and, in places, completely mask terrace edges. Extensively irrigated.	Recharged principally by canal leakage, infiltrating irrigation water, and influent seepage from streams. Water table generally shallow and drainage problems common, particularly near the edges of the fans. Locally, yields of 100 gpm can be developed from wells.
		Alluvium	0–25	Flood-plain deposits of the Little Bighorn River, as much as half a mile wide in places. Consists of 5–10 feet of sand, silt, and clay overlying 10–15 feet of very coarse gravel. Generally mantled by slope wash from higher lands or by alluvial fans of tributary streams. Surface brushy and cut by old meanders; used principally for grazing.	Recharged principally by infiltrating flood water, by precipitation, and by underflow from both irrigated terraces and tributary stream valleys. The finer materials overlying the gravel drain slowly and are much less permeable than the gravel. Locally, yields of 100 gpm can be developed from wells. Water varies widely in chemical quality; in some places is too mineralized for irrigational or domestic use.
		Undifferentiated surficial deposits	0–60	Principally slope wash consisting of unsorted sediments. Present along base of steep slopes on the east side of the Little Bighorn River and in an area north and west of Lodge Grass.	Relatively impermeable.
	?——				
	Pleistocene	Deposits underlying terrace 1	0–30	River deposits of about 10–20 feet of sand, silt, and clay resting on coarse gravel 10–15 feet thick. In most places gravel appears to be continuous with that underlying the alluvial bottoms. Mantled, in places, by alluvial fans. Surface is gently sloping and is 10–15 feet above the river and somewhat less above the alluvial bottom land. Most irrigated land is on terrace 1.	In many places the surficial layer of fine-grained sediments partially confines water under pressure in the gravel. Recharged principally by applied irrigation water, canal seepage, and underflow. Locally, supplies as much as 100 gpm can be developed from wells. Water varies widely in chemical quality and in some places is too highly mineralized for either irrigational or domestic use.
		Deposits underlying terrace 2	0–25	River deposits of about 5–10 feet of sand, silt, and clay, overlying a bed of moderately coarse gravel 15–20 feet thick. Surface is 100–125 feet above the Little Bighorn River. Terrace 2 is most prominent terrace in area but occurs only as disconnected remnants on west side of river. Irrigated northwest of Lodge Grass. Most of land proposed for irrigation is on this terrace.	Where terrace deposits are recharged by infiltrating irrigation water, domestic and stock supplies can be obtained readily from the gravel; but where they are recharged solely by precipitation, water can be obtained only near the middle of the more extensive remnants and from small springs issuing from the base of the gravel along the terrace escarpment. Because terrace 2 is naturally well drained, waterlogging is not likely even though the terrace is irrigated extensively. Ground-water discharge from the terrace, however, could result in additional waterlogging of the lower lying terrace 1.

Cretaceous	Upper Cretaceous		Hell Creek	600±	[frass]; consists of interbedded massive light-brown to gray concretionary sandstone and dark-gray to green shale. Sandstone beds support a scattered growth of coniferous trees.	supply sufficient water for domestic and stock wells. No wells in the area are known to tap this formation.
		Montana group	Bearpaw shale	600±	Borders the area for 12 miles on the east side of the river, underlies the valley for about 7 miles north of Lodge Grass, and is poorly exposed west of the river valley near Ionia. Upper part consists of dark-gray drab shale that weathers to covered slopes, except where erosion is active. Lower part is more sandy, rich brown, and better exposed; the outcrops are characterized by abundant gypsum crystals. The basal contact is marked by a 1-foot bed of bentonite. About 15 feet above the bentonite is a prominent, dense, dark-gray concretionary bed several feet thick. In sec. 34, T. 3 S., R. 35 E., 40 feet above the bentonite bed, is a 2-foot bed of well-cemented conglomerate containing pebbles half an inch in diameter. The conglomerate is exposed also in secs. 4 and 26, T. 4 S., R. 35 E., but the largest pebbles are about one-eighth of an inch in diameter. Farther south, the conglomerate grades into coarse sandstone.	Relatively impermeable. Weathered part may contain some water, but probably the quantity would be small and the water highly mineralized. Surface deposits of alkali are prominent in some places on lower slopes underlain by the Bearpaw shale. Very low permeability and high salt content characterize soil derived from erosion of this shale. Soil not believed to be irrigable.
		Montana group	Parkman sandstone	250–300	Lower part consists of massive brown sandstone and upper part of sandstone interbedded with drab gray shale. Basal sandstone is prominent from Lodge Grass to Benteen and forms sheer cliffs but northward grades to sandy mudstone, shows a more subdued topography, and appears to be gradational with the underlying Claggett shale member of the Cody. Locally, a massive ferruginous sandstone bed is in the upper part of of the Parkman, but it is not as uniform nor as continuous as the lower sandstone bed.	Lodge Grass obtains its municipal supply from a well that taps the Parkman. Wells that tap the basal sandstone yield adequate supplies of water; but toward the north, where mudstone is present, yields are smaller and the water is more mineralized.
		Montana group	Cody shale*: Claggett shale member	360–400	Dark marine shale containing a few lenses of silty sandstone. Exposed slopes are gradual except where severely eroded.	Small supplies of mineralized water can be obtained from the weathered shale. Wells D5–35–3cc and D4–35–21cdl are reported to obtain water from sandstone beds in the Claggett. Because the shale contains a somewhat large amount of soluble material, the slopes underlain by it are covered in some places with alkali.
		Montana group	Cody shale*: Shale member equivalent to Eagle sandstone	275±	Dark-gray shale containing numerous ironstone concretionary zones and thin sandy and bentonitic beds. Poorly exposed in the area. Gradational with both overlying and underlying members, thus the mapped boundaries are not exact.	Locally, yields small amounts of highly mineralized water.

Footnote on p. 24.

TABLE 2.—*Generalized geologic section of the lower Little Bighorn River valley, Montana*—Continued

System	Series	Formation			Thickness (feet)	Lithologic character	Water-bearing properties
Cretaceous	Upper Cretaceous	Montana group	Cody shale*	Telegraph Creek member	850±	Gray to black sandy shale exposed extensively near the north end of the area. The lower part is more sandy than the upper and is characterized near the base and at the middle by thin, rim-forming concretionary sandstone.	Relatively impermeable. Water probably highly mineralized.
Cretaceous	Upper Cretaceous	Colorado group	Cody shale*	Niobrara and Carlile shale members	800–900	Dark-gray shale containing thin concretionary and bentonite beds. Only upper part exposed in the report area. Except where actively eroded by streams, outcrops weather to covered slopes.	Nearly impermeable. Would yield little or no water to wells.
Cretaceous	Upper Cretaceous	Colorado group	Cody shale*	Greenhorn calcareous member	100±	Calcareous dark-gray shale containing concretionary beds.	Do.
Cretaceous	Upper Cretaceous	Colorado group	Cody shale*	Lower shale member	200±	Dark-gray bentonitic shale containing bentonite and concretionary beds.	Do.
Cretaceous	Upper Cretaceous	Colorado group	Frontier		250–400	Gray sandy shale interbedded with shaly sandstone. Upper and middle parts contain prominent bentonite beds; lower part is less sandy and consists mainly of dark-gray shale.	Upper part may yield small amounts of water; lower part is not water bearing.
Cretaceous	Upper Cretaceous	Colorado group	Mowry shale		300–350	Siliceous gray shale interbedded with thin beds of siltstone and sandstone; thin beds of bentonite near top and base of formation. Resistant to erosion and forms bare silver-gray hogbacks and ridges.	Possibly would yield small amounts of mineralized water.
Cretaceous	Lower Cretaceous	Colorado group	Thermopolis shale		550–650	Soft dark-gray shale. Upper part contains beds of bentonite; lower part sandier than upper part.	Nearly impermeable. Would yield little or no water to wells.
Cretaceous	Lower Cretaceous	Cloverly			200–300	Upper part consists of interbedded thin layers of sandstone, siltstone, and shale. Lower part consists of conglomeratic sandstone as much as 150 feet thick but which, in some places, is interbedded with siltstone and shale.	Yields moderate to large supplies of water to wells that tap the lower part of the formation. Water is under artesian pressure and wells in favorable topographic locations will flow. Water is mineralized but is suitable for stock, domestic, and limited irrigational use. Despite its great depth, this formation may be the only significant source of water supply in wide areas in this general region.

Jurassic	Upper Jurassic		Morrison	150–300	Greenish-gray to red variegated shale, siltstone, and sandstone.	Yields small quantities of water to wells tapping the more permeable beds.
Jurassic	Upper Jurassic	Ellis group	Swift	150–175	Greenish-gray shale and sandstone; some glauconite-rich beds.	Possibly would yield small quantities of water to wells.
Jurassic	Upper Jurassic	Ellis group	Rierdon	300–325	Soft light-brown calcareous shale; thin beds of calcareous sandstone and limestone near top.	Probably not water bearing.
Jurassic	Lower Jurassic	Ellis group	Piper	225–250	Interbedded red siltstone, sandstone, and shale, limestone, and a basal red gypsiferous siltstone and sandstone; thin beds of gypsum near middle of formation locally.	Relatively impermeable. Water probably too mineralized for general use.
Triassic ? Permian			Chugwater	350–375	Interbedded red silty sandstone and shale; some beds of gypsum locally.	Relatively impermeable.
Pennsylvanian			Tensleep sandstone	40–150	White to light yellowish-gray medium- to fine-grained sandstone.	Yields moderate to large supplies of water to wells that tap thick sections of the formation. Oil companies that have made drill-stem tests report that water is fresh. Some flowing wells in Soap Creek area, T. 6 S., R. 32 E., have yielded more than 500 gpm with several hundred feet of head (Thom and others, 1935, p. 31, 131–2).
Pennsylvanian			Amsden	250–300	Dark-red and purple to gray shale, sandstone, and siltstone; some limestone and cherty beds.	Large yields of water reportedly are obtained where rocks are brecciated or limestone is cavernous (Thom and others, 1935, p. 31, 132). However, whether the water comes from this or the overlying or underlying formations is difficult to determine.
Mississippian			Madison limestone	700–1, 000	Massive light-gray limestone, locally dolomitic. Forms prominent cliffs and canyon walls.	Formation contains numerous caverns, open joints, and fissures, and is the most prolific water-bearing formation underlying the area. However, because the water is highly mineralized and the aquifer lies at such great depth, the Madison limestone is not considered as an economical source of supply. Oil test well D1-32-23bdd has a very large flow of water under high pressure. The water is used to supply a hot-water bathing pool and, after storage in surface reservoirs, to irrigate a large acreage 5 miles west of Hardin.
Devonian (?)			Three Forks(?) and Jefferson(?), undifferentiated	200–300	Light grayish-brown sandy limestone, dolomitic near base.	Probably would yield considerable water to wells, especially where brecciated.

Footnote on p. 24.

TABLE 2.—*Generalized geologic section of the lower Little Bighorn River valley, Montana*—Continued

System	Series	Formation	Thickness (feet)	Lithologic character	Water-bearing properties
Ordovician	Upper Ordovician	Bighorn dolomite	200–400	Massive light-brown to gray dolomite and limestone. Forms prominent cliffs and breaks characteristically into very large blocky boulders.	Locally, may yield large quantities of water from open joints or cavernous limestone beds.
Cambrian	Upper Cambrian	Gallatin	200–250	Thin-bedded gray to brown glauconitic limestone; conglomerate composed of flat limestone pebbles locally.	Possibly would yield small quantities of water to wells, especially where brecciated.
	Middle Cambrian	Gros Ventre	500–600	Chiefly soft greenish-gray shale containing sandy shale and thin glauconitic sandstone beds at base and limy shale and shaly limestone near top.	Nearly impermeable. Would yield little or no water to wells.
		Flathead sandstone	50–75	Coarse-grained reddish-brown sandstone and conglomerate.	Possibly would yield small to moderate supplies to wells.
Precambrian				Gray to reddish granitic rocks	Nearly impermeable. Would yield little or no water to wells.

*The division of the Cody shale is according to the official usage of the U.S. Geological Survey. The authors of this report believe that the members of the Cody are of formational rank in this area.

GROUND WATER

Water precipitated from the atmosphere may follow one of many devious paths before it finally returns to the atmosphere. The principal routes that may be followed within the drainage basin of the Little Bighorn River are shown on the graphic representation of the hydrologic cycle (fig. 7). In certain phases of this cycle the quantities of water involved can be determined by making only a few direct measurements, in some other phases the quantities can be estimated

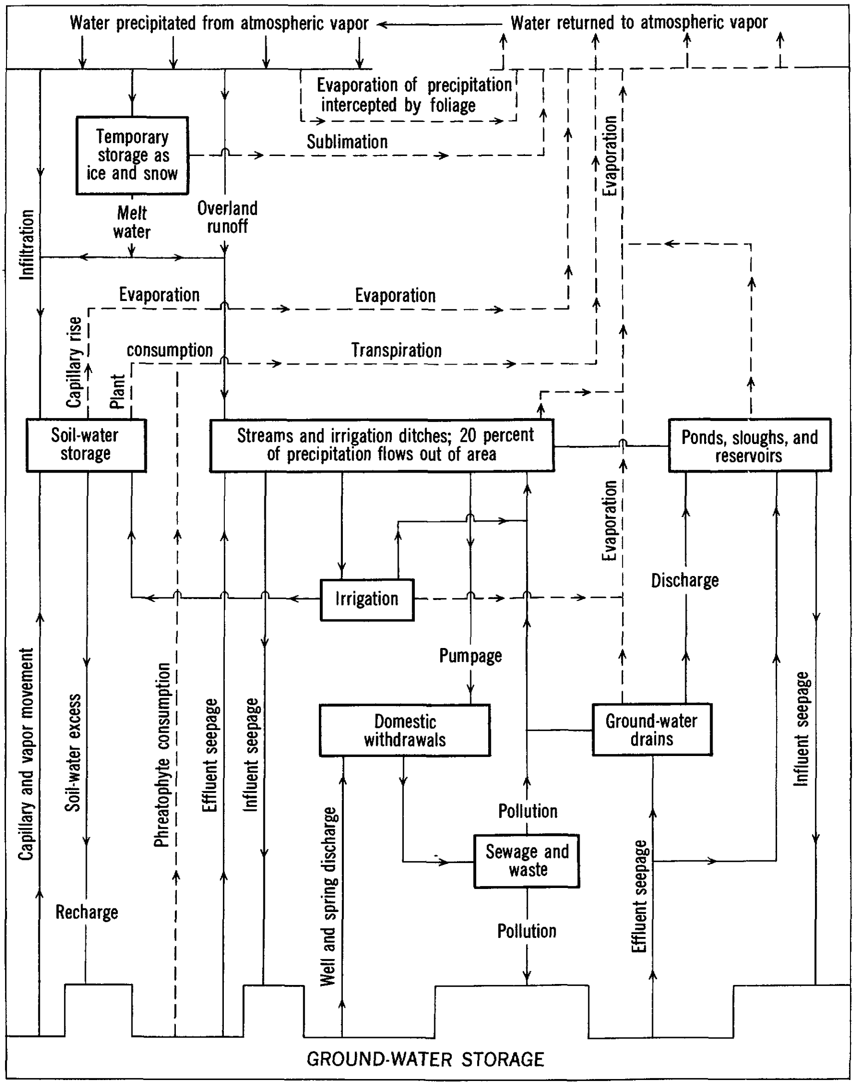

FIGURE 7.—Components of the hydrologic cycle in the Little Bighorn River drainage basin.

with fair accuracy, but in the remainder a great many measurements would be necessary to obtain even a rough approximation of the amounts involved.

Computations, from measurements of precipitation and streamflow over a period of 15 years, indicate that about 20 percent of the annual precipitation on the Little Bighorn River drainage basin leaves the basin as streamflow; whereas for the United States, this figure is about 30 percent. If the relatively small amount discharged from the basin as underflow is disregarded, the other 80 percent either evaporates immediately or sinks into the soil and eventually is transpired by vegetation or evaporated from the soil.

PRINCIPLES OF OCCURRENCE

Water not held by molecular attraction in the interstices of the soil is drawn down by gravity to the zone of saturation, the zone in which all openings are filled with water under hydrostatic pressure. The upper surface of the zone of saturation is the water table. Its position coincides with the level of water in uncased holes dug or drilled into the zone of saturation.

The principal forces that act upon water in a porous medium are gravity, capillary attraction, and friction. The force of gravity is downward, capillary attraction increases in the direction of decreasing moisture content, and frictional force is opposite to the direction of water movement. In a fine-grained porous medium having a low moisture content, the capillary force may exceed the gravitational force and cause the water to move upward.

Where the water table is within fine-grained sediments and is only a few feet below the land surface, considerable ground water may evaporate after being lifted to the land surface by capillarity. Conversely, where the water table is within coarse-grained sediments or is several feet below the land surface, or both, little or no ground water is discharged to the atmosphere by evaporation from the soil surface.

Ground water confined under pressure between two layers of impermeable material is artesian, and, where the upper confining layer is penetrated by drilling, the water rises in the hole to a level that coincides with the piezometric surface of the confined water.

As water percolates through the ground it dissolves minerals in the soil. The degree of mineralization of ground water is proportional to the time the water has been in contact with the minerals, the chemical nature and the temperature of the water, and the solubility of the minerals with which it is in contact.

HYDROLOGIC PROPERTIES OF BEDROCK AQUIFERS, UNCONSOLIDATED AQUIFERS, AND SURFICIAL FINE-GRAINED SEDIMENTS

The rate of water movement within the zone of saturation is governed by the hydraulic gradient and by the type of material through which the water flows. In general, the larger the minimum diameter of the interstitial passages and the greater the ratio of spaces to solids in a given rock material, the faster water can move through it. The diameter of the interstitial passages is governed by the size, shape, distribution, and arrangement of the individual rock particles. A coarse, rounded gravel containing only a few fine particles or a rock containing large fractures or solution channels is capable of transmitting water rapidly; conversely, a dense, fine-grained material, such as clay or shale, transmits water very slowly.

The ability of a unit cross section to transmit water is called permeability, and the ability of an aquifer as a whole to transmit water is called transmissibility. The coefficient of permeability is defined as the quantity of water at 60°F that will flow in a given time under a unit hydraulic gradient through a cross section of unit area. The field coefficient of permeability is the same unit except that is measured at the existing temperature of the water. As the coefficient of transmissibility is the product of the field coefficient of permeability and the thickness of the aquifer, it is the amount of water that will flow in a specified time under unit hydraulic gradient through a cross section of unit width extending the full thickness of the aquifer. The coefficient of permeability is expressed in units called meinzers—gallons per day per square foot—and the coefficient of transmissibility is expressed in gallons per day per foot. The hydraulic gradient is 1 foot per foot in both coefficients.

The volume of water an aquifer releases from, or takes into, storage per unit of surface area of the aquifer per unit change in the component of head normal to that surface is called the coefficient of storage. If the aquifer is unconfined—a nonartesian, or water-table, aquifer—the coefficient of storage is almost the same as the specific yield. The specific yield is defined as the ratio of the volume of water that a material, after being saturated, will yield by gravity to its own volume. The specific retention is a related unit expressing the quantity of water retained against the pull of gravity. It may be computed by subtracting the specific yield from the porosity.

An evaluation of the ground-water resources of an area necessitates knowledge of the hydrologic properties of the principal aquifers. Therefore, the coefficients of storage and transmissibility of the aquifers that are sources of water supply in the area were computed insofar as possible from data collected during field tests. The values computed for the unconsolidated aquifers have been used in preparing suggestions for solving the drainage problems. As knowledge of the hydrologic properties of the fine-grained sediments overlying the unconsolidated aquifers also was needed, laboratory tests were made on samples of representative soils from the Agency and Battlefield units.

FIELD TESTS OF AQUIFERS

The wells used in testing the consolidated formations were either privately or municipally owned, and the wells used in testing the unconsolidated aquifers were installed by the Geological Survey. The two types of wells installed for the tests are shown in figure 2, and the type of pumping unit used is shown in figure 8; the test-site locations are shown on plates 1, 3, and 4. Pumping rates were controlled during the tests by adjusting valves, and the discharge was measured by using an orifice meter. Periodic measurements of water levels were made in the wells during either the pumping or recovery period. The data were analyzed by the "nonequilibrium" methods described by Theis (1935), Wenzel (1942), and Cooper and Jacob (1946). All test data are included in tables 3 through 8, and representative test data and computations from curves at each test site are shown in figures 9 through 14.

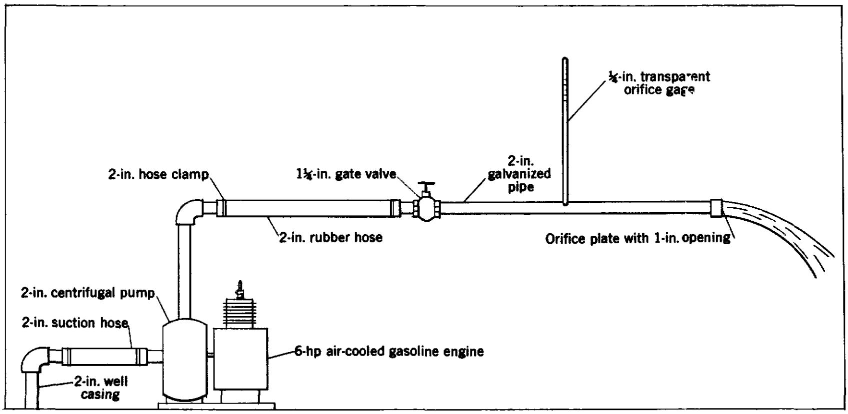

FIGURE 8.—Sketch showing type of pumping unit used in making aquifer tests.

TABLE 3.—*Water-level drawdown in three observation wells during pumping of well D5-35-27bb5 (P-4), Lodge Grass No. 1 unit*

Time since pumping began [1] (minutes)	Drawdown (feet) [2]		
	Well D5-35-27bb3 (4-N1) [3]	Well D5-35-27bb2 (4-N2) [4]	Well D5-35-27bb1 (4-N3) [5]
0	0.00	0.00	0.00
2½	.46	.34	.06
4	.45	.36	.07
5½	.51	.40	.11
7	.63	.49	.15
8½	.66	.53	.17
10	.63	.53	.19
12	.61	.53	.20
14	.66	.56	.21
16	.68	.56	.22
18	.69	.58	.23
20	.71	.61	.25
23	.74	.62	.27
26	.76	.64	.28
29	.76	.65	.29
32	.77	.66	.30
36	.78	.66	.31
40	.79	.67	.32
45	.80	.69	.33
50	.81	.69	.34
55	.81	.70	.35
60	.82	.71	.36
66	.83	.71	.38
72	.84	.72	.38
80	.85	.74	.39
90	.85	.74	.40
100	------	.76	.41
110	.87	.77	.42
120	.89	.78	.44
140	.91	.81	.45
160	.92	.82	.47
180	.94	.82	.49
210	.94	.85	.52
215	.94	.85	.52

[1] Pumping at constant rate of 15 gpm.
[2] No wells pumped nearby; water levels assumed to be constant before test pumping began.
[3] 25 feet from pumped well.
[4] 50 feet from pumped well.
[5] 100 feet from pumped well.

TABLE 4.—*Approximate water-level recovery in observation well D6–35–13ac3 (5–S1) after pumping of well D6–35–13ac4 (P–5), Lodge Grass No. 1 unit*

[Well D6-35-13ac4 (P-5), a Lodge Grass municipal well, was pumped continuously at 75 gpm for several days prior to test. Pumped well is cased to depth of 156 feet and uncased below; casing is perforated from depth of 100 to 146 feet. Observation well D6-35-13ac3 (5-S1) is cased to depth of 143 feet and uncased below; casing is not perforated. Observation well is 45 feet southwest of pumped well. Assumption was made that water level in pumped well was essentially stable at end of pumping period]

Time since pumping stopped (minutes)	Depth to water below measuring point (feet)	Total water-level recovery (feet)	Time since pumping stopped (minutes)	Depth to water below measuring point (feet)	Total water-level recovery (feet)
0	9.03	0.00	13	7.19	1.84
1	8.30	.73	16	7.10	1.93
2	8.06	.97	19	7.02	2.01
3	7.90	1.13	24	6.92	2.11
4	7.76	1.27	29	6.84	2.19
5	7.65	1.38	35	6.75	2.28
6	7.56	1.47	39	6.70	2.33
7	7.48	1.55	49	6.59	2.44
8	7.41	1.62	59	6.50	2.53
9	7.36	1.67			

TABLE 5.—*Approximate artesian-pressure recovery in well D6–35–21db (P–6), Lodge Grass No. 1 unit*

[Well D6-35-21db (P-6) discharged at average rate of 158 gpm for 52.5 minutes. Shut-in pressure prior to discharge was stabilized at 75 psi. Thickness of aquifer, 15 feet; depth to aquifer below land surface, 3,365 feet]

Time since discharge began (t) (minutes)	Time since discharge stopped (t') (minutes)	t/t'	Shut-in pressure (psi)
53.00	0.50	106.0	64
53.17	.67	79.4	65
53.25	.75	71.0	66
53.47	.97	55.1	67
53.75	1.25	43.0	68
54.25	1.75	31.0	69
54.92	2.42	22.7	70
55.83	3.33	16.8	71
57.67	5.17	11.2	72
60.00	7.50	8.0	73
64.50	12.00	5.4	74

TABLE 6.—*Water-level recovery in well D3-35-18dc (P-3), Battlefield unit*

[Well D3-35-18dc (P-3) was pumped continuously for 71.7 minutes at a rate of 70 gpm prior to test. Depth to water before pumping started, 10.86 feet]

Time since pumping started (*t*) (minutes)	Time since pumping stopped (*t'*) (minutes)	*t/t'*	Depth to water below measuring point (feet)
72.7	1.0	72.7	14.98
73.7	2.0	36.8	14.62
74.7	3.0	24.9	14.39
75.7	4.0	18.9	14.19
76.7	5.0	15.3	14.02
77.7	6.0	12.9	13.84
78.9	7.2	10.9	13.73
79.7	8.0	10.0	13.65
80.7	9.0	9.0	13.54
81.7	10.0	8.2	13.45
82.7	11.0	7.5	13.37
83.7	12.0	7.0	13.29
84.7	13.0	6.5	13.21
86.7	15.0	5.8	13.07
87.7	16.0	5.5	13.01
90.7	19.0	4.8	12.84
93.2	21.5	4.3	12.73
96.5	24.7	3.90	12.59
98.7	27.0	3.66	12.52
101.7	30.0	3.39	12.40
105.2	33.5	3.14	12.31
109.2	37.5	2.91	12.23
113.7	42.0	2.71	12.09
115.7	44.0	2.63	12.05
122.7	51.0	2.41	11.93
127.7	56.0	2.28	11.86
131.7	60.0	2.20	11.79
146.7	75.0	1.96	11.62
161.7	90.0	1.80	11.51
176.7	105.0	1.68	11.41
191.7	120.0	1.60	11.34
206.7	135.0	1.53	11.30
221.7	150.0	1.48	11.25
251.7	180.0	1.40	11.16
281.7	210.0	1.34	11.12
311.7	240.0	1.30	11.08
371.7	300.0	1.24	11.03
431.7	360.0	1.20	10.99
491.7	420.0	1.17	10.96
551.7	480.0	1.15	10.94
671.7	600.0	1.12	10.91+
851.7	780.0	1.09	10.89
1,271.7	1,200.0	1.06	10.88
1,511.7	1,440.0	1.05	10.87

TABLE 7.—*Water-level drawdown in three observation wells during pumping of well D2-34-3dc2 (P-1), Agency unit*

Time since pumping began [1] (minutes)	Drawdown (feet)		
	Well D2-34-3dc3 (1-E) [2]	Well D2-34-10ab1 (1-S) [3]	Well D2-34-3dc1 (1-W) [4]
0.0	0.00	0.00	0.00
.5		.05	.01
1.5		.09	.04
3.0		.13	.07
4.5		.14	.08
6.0		.18	.10
8.0	.32	.20	.11
10.0	.34	.21	.12
12.0	.35	.22	.13
15.0	.36	.23	.14
18.0	.37	.24	.15
21.0	.38	.25	.16
24.0	.38	.25	.16
27.0	.39	.26	.17
30.0	.40	.26	.17
34.0	.39	.26	.17
38.0	.39	.27	.17
42.0	.40	.27	.17
47.0	.40	.29	.17
52.0	.41	.29	.18
58.0	.41	.29	.18
64.0	.42	.28	.19
70.0	.43	.30	.19
77.0		.30	.20
84.0	.42	.30	.20
92.0	.43	.31	.20
100.0	.43	.32	.20
115.0	.44	.32	.21
130.0	.45	.33	.21
145.0	.46	.33	.21
165.0	.48	.35	.23
200.0	.48	.37	.23

[1] Pumping at constant rate of 14 gpm.
[2] 30 feet from pumped well.
[3] 40 feet from pumped well.
[4] 50 feet from pumped well.

TABLE 8.—*Water-level drawdown in five observation wells during pumping of well D2-34-36db3 (P-2), Agency unit*

Time since pumping began [1] (minutes)	Drawdown (feet)				
	Well D2-34-36db4 (2-E1) [2]	Well D2-34-36db5 (2-E2) [3]	Well D2-34-36db6 (2-E3) [4]	Well D2-34-36db7 (2-E4) [5]	Well D2-34-36db2 (2-S1) [6]
0.0	0.00	0.00	0.00	0.00	0.00
0.5	.53	.25			
1.5	1.08	.46			.28
3.0	1.20	.55			.34
4.5	1.24	.58		.36	.39
6.0	1.27		.63	.38	.41
8.0	1.30	.65		.40	.45
10.0	1.32		.70	.43	.47
12.0	1.35	.70		.44	.49
14.0	1.37		.74	.45	.51
16.0	1.38	.73		.46	.52

See footnotes at end of table.

TABLE 8.—*Water-level drawdown in five observation wells during pumping of well D2-34-36db3 (P-2), Agency unit*—Continued

Time since pumping began[1] (minutes)	Drawdown (feet)				
	Well D2-34-36db4 (2-E1)[2]	Well D2-34-36db5 (2-E2)[3]	Well D2-34-36db6 (2-E3)[4]	Well D2-34-36db7 (2-E4)[5]	Well D2-34-36db2 (2-S1)[6]
18.0	1.39		0.76	0.47	0.53
20.0	1.40	0.75		.48	.55
22.0	1.41		.78	.49	.56
24.0	1.42	.76		.50	.56
26.0	1.43		.79	.50	.57
28.0	1.44			.51	.57
29.0		.77			
30.0	1.44		.80	.52	.58
32.0	1.45	.79		.52	.58
34.0	1.46		.82	.52	.59
36.0	1.46	.80		.53	.59
38.0	1.47		.83	.53	.60
40.0	1.47	.82		.54	.61
43.0	1.48		.85	.54	.62
46.0	1.49	.83		.55	.63
49.0	1.50		.87	.55	.64
52.0	1.50	.84		.56	.64
55.0	1.51		.88	.57	.65
58.0	1.52	.86		.57	.66
62.0	1.53		.89	.58	.67
66.0	1.55	.87		.58	.68
70.0	1.56		.91	.59	.69
75.0	1.56	.89		.60	.70
80.0	1.56		.92	.60	.71
85.0	1.57	.90		.61	.71
90.0	1.58		.94	.61	.72
95.0	1.59	.92		.62	.73
100.0	1.60		.94	.63	.74
110.0	1.61	.94			.75
111.0			.97	.64	
120.0	1.62	.94		.64	.76
121.0			.97		
130.0	1.62	.94			.77
132.0				.65	
133.0			.97		
152.0	1.63	.96		.66	.79
153.0			.98		
170.0	1.66	.98			.81
171.0			1.00		
172.0				.67	
190.0	1.67	.99			.83
192.0			1.01	.68	
210.0	1.69	1.01			.85
211.0			1.02		
212.0				.69	
230.0	1.70	1.02			.87
231.0			1.03		
233.0				.71	
252.0	1.72	1.02			.89
253.0			1.04	.71	
280.0			1.06	.72	
282.0	1.74	1.04			.90
312.0	1.76	1.06		.73	.92
313.0			1.07		
350.0	1.78	1.08			.96
360.0				.76	

[1] Pumping at constant rate of 15.5 gpm.
[2] 30 feet from pumped well.
[3] 50 feet from pumped well.
[4] 80 feet from pumped well.
[5] 100 feet from pumped well.
[6] 40 feet from pumped well.

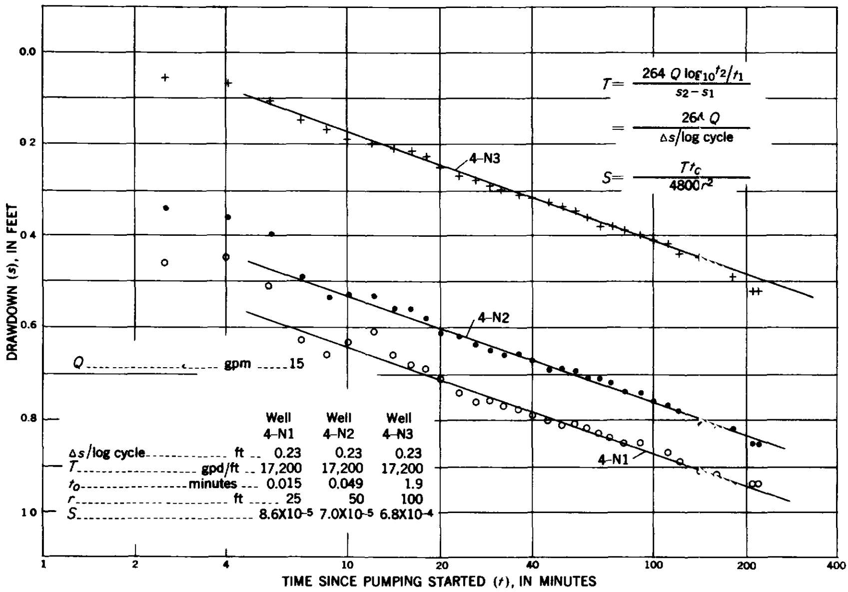

FIGURE 9.—Semilogarithmic graph of water-level drawdown in three observation wells during pumping of well D5–35–27bb5 (P–4), Lodge Grass No. 1 unit.

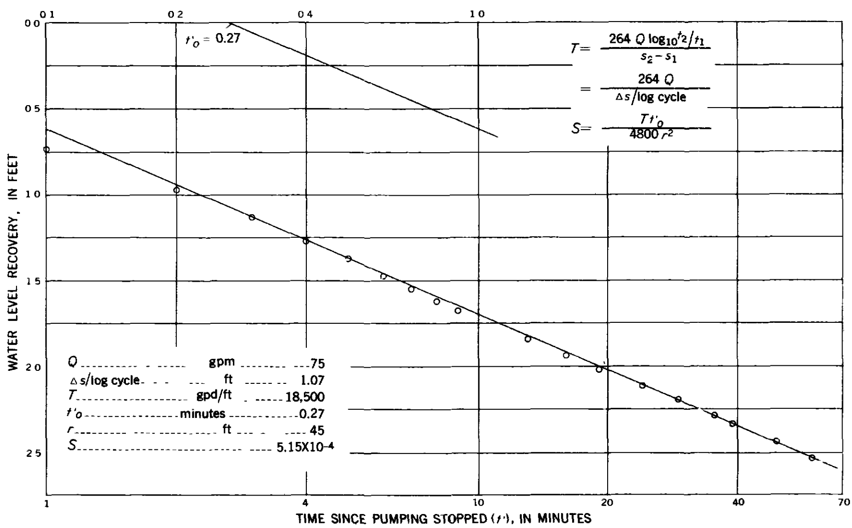

FIGURE 10.—Semilogarithmic graph of water-level recovery in observation well D6–35–13ac3 (5–S1) after pumping of well D6–35–13ac4 (P–5), Lodge Grass No. 1 unit.

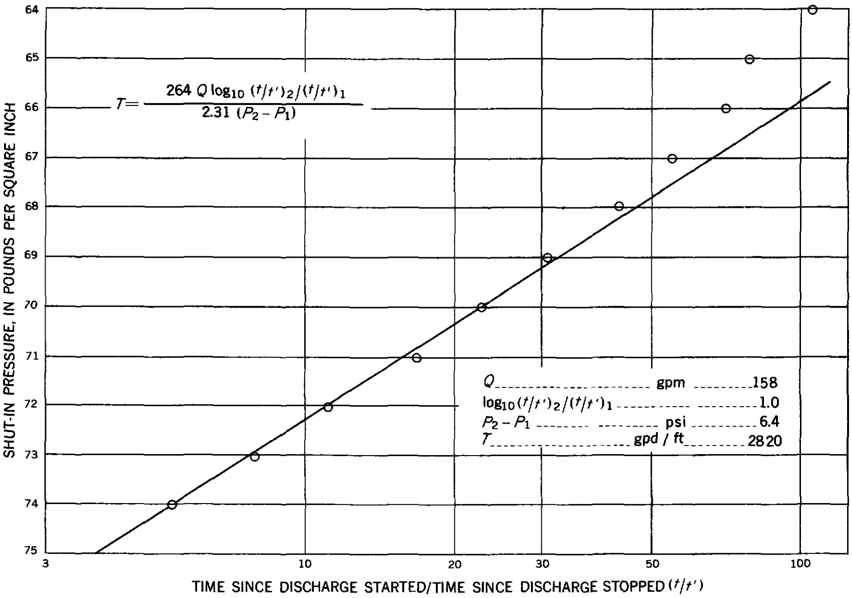

Figure 11.—Semilogarithmic graph of artesian-pressure recovery in well D6–35–21db (P–6), Lodge Grass No. 1 unit.

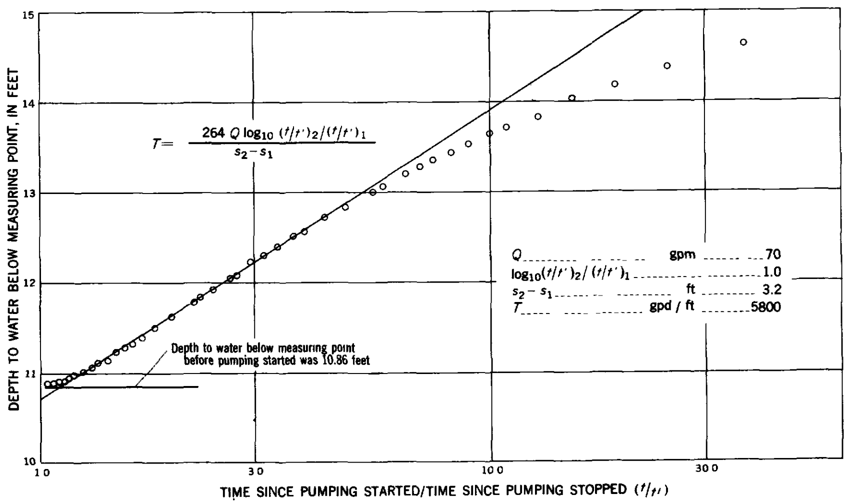

Figure 12.—Semilogarithmic graph of water-level recovery in well D3–35–18dc (P–3), Battlefield unit.

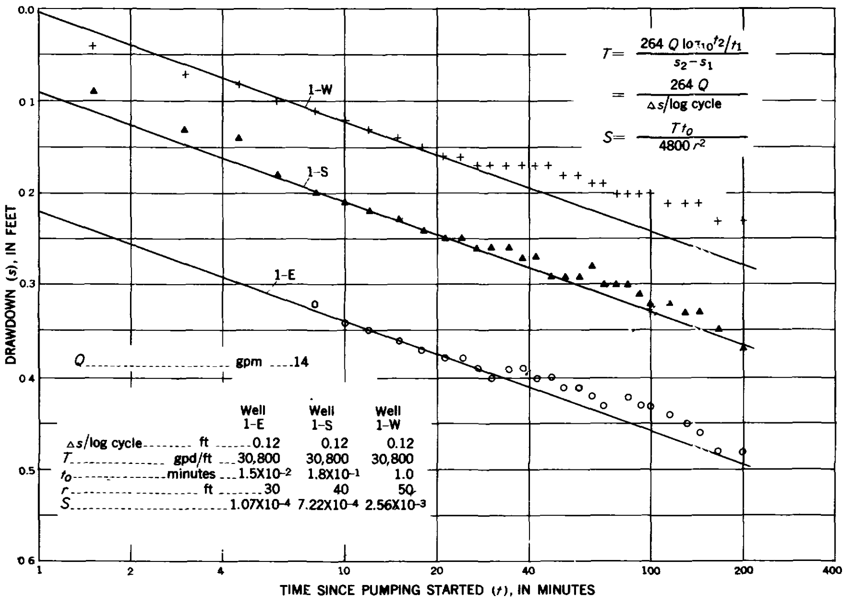

FIGURE 13.—Semilogarithmic graph of water-level drawdown in three observation wells during pumping of well D2–34–3dc2 (P–1), Agency unit.

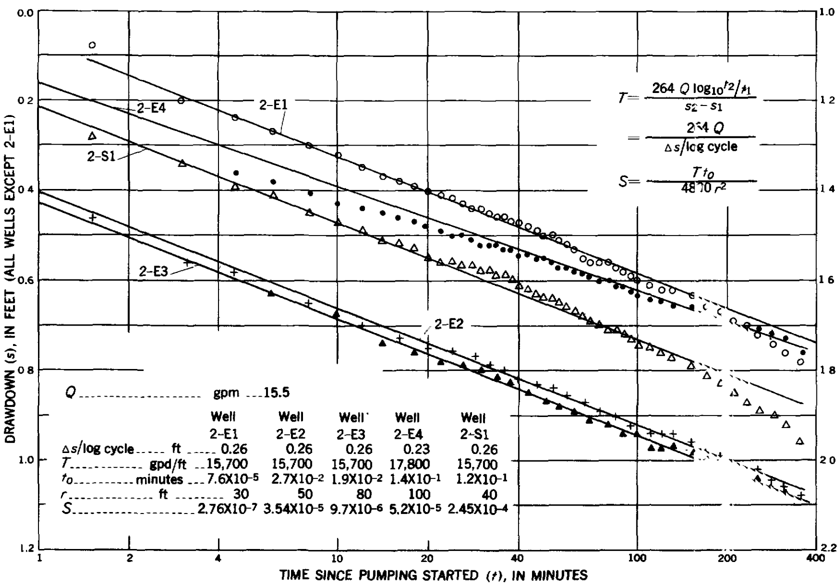

FIGURE 14.—Semilogarithmic graph of water-level drawdown in five observation wells during pumping of well D2–34–36db3 (P–2), Agency unit.

TABLE 9.—*Results of pumping tests*

Test well		Coefficient of transmissibility (gpd per ft)	Field coefficient of permeability (gpd per sq ft)	Coefficient of storage
Coordinate system	Field			
Terrace deposits				
D2-34-3dc2	P-1	30, 000	1, 600	(1)
D2-34-36db3	P-2	15, 000-20, 000	1, 600	(1)
D5-35-27bb5	P-4	15, 000	1, 000	(1)
Parkman sandstone				
D3-35-18dc	P-3	6, 000	60	----------
D6-35-13ac4	P-5	20, 000	370	5 x 10^{-4}
Cloverly formation				
D6-35-21db	P-6	3, 000	190	----------

[1] Results erratic; all values very small.

The results of the tests are summarized in table 9. The calculated values of transmissibility for the tests of the unconsolidated aquifers may be somewhat in error because of the hydraulic properties of the overlying deposits. The test sites were selected in areas where the piezometric surface was several feet above the top of the coarse-grained sediments, in the expectation that drainage of the fine-grained sediments during the testing period would be slight and that the water levels in the observation wells would respond like those in a true artesian system. If drainage was not appreciable, the calculated values of transmissibility would be approximately correct; if appreciable, the values would be too high. Although the values appear to be correct for this type of aquifer, the wide variation in calculated values of storage coefficient make the test results look doubtful.

The values given for the coefficient of permeability were obtained by dividing the coefficient of transmissibility by the approximate thickness of the aquifer. The thickness of the water-yielding beds in the bedrock aquifers was estimated. The materials penetrated in drilling wells D3-35-18dc (P-3) and D6-35-21db (P-6) were logged accurately (table 22), but well P-3 was drilled only part way into the water-yielding formation and well P-6 possibly taps more water-bearing material than the log indicates. No log for well D6-35-13ac4 (P-5) was available. Although the values for the bedrock aquifers probably are correct, they are more likely to be too high than too low. The thickness of saturated gravel through which wells D2–34–3dc2 (P–1) and D2–34–36db3 (P–2) were drilled was known from logs (table 25), but the thickness penetrated in drilling well D5–35–27bb5 (P–4) was estimated from logs of nearby seismic shotholes.

Because the data collected in two of the tests of bedrock aquifers consisted of water-level measurements in the pumped well only, the storage coefficient could not be determined. However, by assuming that the loss of head at the pumped well is negligible and by comparing the water-level drawdown with the yield of the well and the computed coefficient of transmissibility, certain general conclusions may be made about the storage coefficient of the aquifer. For example, although two wells may have been similarly constructed and may tap aquifers of equal transmissibility, their specific capacities (yield per unit of drawdown) are different if the storage coefficients of the aquifers are unlike—that is, the well tapping the formation having the smaller storage coefficient has the smaller specific capacity.

As well D6–35–13ac4 (P–5) was sealed, no measurements of water-level drawdown could be made. However, a nearby well having the same diameter and tapping the same formation had a specific capacity of about 10 gpm per foot of drawdown after 1 hour of pumping, so this value was projected to apply to well D6–35–13ac4 (P–5). Well D3–35–18dc (P–3) had a specific capacity of about 11 gpm per foot of drawdown after 1 hour of pumping. Although the specific capacity of well D3–35–18dc (P–3) was nearly equal to that applied to well D6–35–13ac4 (P–5), the transmissibility at well D3–35–18dc (P–3) was only about one-fourth of that at well D6–35–13ac4 (P–5). It can be concluded, therefore, that the storage coefficient at well D3–35–18dc (P–3) is larger than that at well D6–35–13ac4 (P–5).

Because well D6–35–21db (P–6) definitely is artesian and because its specific capacity in relation to the transmissibility coefficient of the aquifer is small, it is believed that the storage coefficient of the aquifer also is very small—probably between 2×10^{-5} and 2×10^{-4}.

LABORATORY TESTS OF SURFICIAL FINE-GRAINED SEDIMENTS

The physical and hydrologic properties of the major soil types in the Agency and Battlefield units were determined in the hydrologic laboratory of the Geological Survey at Lincoln, Nebr. The sampling sites are shown on plates 3 and 4 and the textural classification of the samples, together with the results of the tests, are given in table 10.

The textural classification was made at the time of sampling. Samples of clay and silty clay were designated as "heavy"; clay loam, silty clay loam, and sandy clay loam as "moderately heavy"; loam, silty loam, and very fine sandy loam as "medium"; material composed predominantly of particles coarser than very fine sand as "coarse"; and material composed predominantly of particles larger than medium-grained sandy as "very coarse."

Test holes were bored to a desired depth by a hand auger and the samples were collected by forcing or driving a cylindrical sampler into the material to be tested. Each time the sampler was used, a brass liner was inserted in it to receive the soil sample. When the liner containing the sample was extracted from the sampler, the liner was sealed at both ends.

A constant-head permeameter was used in determining the coefficient of permeability. The sample in the brass liner was inserted in the water-circulating system, and the coefficient of permeability was computed from measurements of the differential head of water, the cross-sectional area and length of sample, and the rate of water flow through the sample.

The centrifuge moisture equivalent was determined by measuring the amount of water yielded by a saturated sample subjected for 1 hour to a centrifugal force 1,000 times the force of gravity. The specific retention, which is the measure of water retained in a sample against the force of gravity, and the specific yield, which represents the amount of water yielded from a saturated sample by gravity, were computed from the centrifuge moisture equivalent by applying a correction factor proposed by Piper (1933). Both are expressed as percentages by volume.

Porosity is defined as the ratio of the volume of void spaces in a material to the volume of the material and is expressed in percentage. The porosity of each sample was determined from the following equation:

$$\text{Porosity} = \frac{\text{specific gravity} - \text{apparent specific gravity}}{\text{specific gravity}} \times 100$$

The specific gravity of the grains was determined by comparing the dry weight of the sample with the volume of grains, and the apparent specific gravity by comparing the dry weight to the volume of the sample.

TABLE 10.—*Physical and hydrologic properties of unconsolidated materials*

Test hole: Coordinate system	Test hole: Field	Sample	Interval sampled (feet): From—	Interval sampled (feet): To—	Textural classification	Clay (<0.004)	Silt (0.004–0.0625)	Sand: Very fine (0.0625–0.125)	Sand: Fine (0.125–0.25)	Sand: Medium (0.25–0.5)	Sand: Coarse (0.5–1.0)	Sand: Very coarse (1.0–2.0)	Gravel: Very fine (2–4)	Gravel: Fine (4–8)	Gravel: Medium (8–16)	Gravel: Coarse (16–32)	Gravel: Very coarse (32–64)	Porosity (percent by volume)	Specific retention (percent by volume)	Specific yield (percent by volume)	Laboratory coefficient of permeability (meinzers)
D1-34-29aac	40	40	2.1	2.3	Heavy	36.8	58.6	3.6	0.2	0.0	0.2	0.0	0.2	0.4				49.1	21.7	27.4	7
		41	3.4	3.6	Moderately heavy	27.0	65.2	7.2	.4	.2								48.9	19.1	29.8	13
		42	5.1	5.3	Heavy	43.2	54.6	1.4	.6	.0	.0	.0	.2					44.0	29.4	14.6	<1
		43	11.1	11.3	Medium	15.0	28.8	34.4	20.0	1.8								33.6	9.0	24.6	36
		44	16.3	16.5	Coarse	10.3	6.5	12.8	59.4	10.6	.4							40.5	7.1	33.4	63
30adb	31	31	1.0	1.2	Moderately heavy	28.6	40.0	7.0	8.6	11.6	3.0	.4	.2	.6				46.4	19.0	27.4	29
		32	2.3	2.5	do	27.7	34.9	3.8	9.0	17.2	5.8	1.2	.4					39.7	20.7	19.0	2
		33	4.8	5.0	Coarse	11.4	4.4	4.6	24.4	45.0	7.7	2.4	.0	.0	0.1			39.8	6.8	33.0	160
		34	9.3	9.5	Heavy	43.0	35.6	4.8	12.0	4.0	.2	.2	.2					44.9	28.1	16.8	20
		35	17.5	17.7	Medium	7.1	78.7	13.0	1.0	.0	.0	.2						39.1	37.4	1.7	<1
31adc	36	36	1.1	1.3	Moderately heavy	22.4	28.6	18.6	24.6	5.4	.2	.0	.2					44.2	13.5	30.7	64
		37	2.4	2.6	Medium	16.0	27.0	24.2	24.0	8.6	.2							39.9	9.0	30.9	19
		38	5.2	5.4	do	14.8	27.6	27.2	22.6	7.6	.2							41.7	10.0	31.7	44
32ddd	39	39	1.2	1.4	Moderately heavy	30.8	37.6	8.4	13.2	8.2	1.2	.4	.2					40.1	21.7	18.4	6
		39x	3.0	3.5	Very coarse	2.6		.6	1.5	5.5	6.5	5.4	9.2	16.1	18.5	22.3	11.8	24.9	0	24.9	[1] 6,000
33dcc	49	49	2.1	2.3	Heavy	31.0	49.0	13.8	4.8	.6								42.1	20.3	21.8	21
		50	3.3	3.5	Moderately heavy	29.2	59.0	9.2	2.4	.2								47.5	17.5	30.0	4
		51			Medium to coarse	11.4	9.6	21.6	48.8	8.6	.2										
		52	7.6	7.8	Medium	13.8	21.0	25.2	30.4	9.4	.2							39.9	8.0	31.9	5
D2-34- 3abb	59	59	3.1	3.3	do	13.2	12.8	28.0	43.0	2.8	.2							47.4	7.6	39.8	7
		60	7.0	7.2	Coarse	11.0	5.4	16.0	39.0	19.6	8.0	.6	.4					41.7	7.5	34.2	10
3bcd	65	65	2.4	2.6	Heavy	41.0	57.4	1.2	.4									39.7	39.7	0	<1
		66	3.8	4.0	do	47.2	50.4	2.0	.4									43.2	34.3	8.9	<1
		67	5.3	5.5	Coarse	15.0	13.8	15.8	44.8	10.4	.2							40.1	13.3	26.8	<1
3ddc	45	45	.4	.6	Heavy	32.7	36.5	13.0	16.6	1.2								48.1	22.7	25.4	29
		46	7.8	8.0	do	67.0	33.0											42.0	42.0	0	<1
		47			do	61.5	38.5														
		48	20.0	20.5	Coarse	7.5	1.3	8.6	67.6	14.4	.4	.2						41.0	2.9	38.1	77
11ccd	71	71	2.4	2.6	Moderately heavy	25.9	55.3	11.8	5.4	1.6								42.0	23.3	18.7	<1
		72	4.8	5.0	Heavy	31.0	62.4	5.2	1.2	.2								41.6	25.7	15.9	4
36cda	73	73	1.6	1.8	do	35.8	57.0	5.0	1.8	.4								42.1	28.1	14.0	2

		74	3.4	3.6	Moderately heavy	22.7	59.1	13.4	4.0	.8								48.0	15.2	32.8	58
		75	6.7	6.9	Heavy	37.2	59.8	2.6	.4									44.8	23.9	20.9	2
		76	12.3	12.5	do	31.3	55.3	9.6	3.8									39.8	25.2	14.6	<1
		77			do	34.2	63.6	2.0	.0	.2											
		78			do	51.7	42.1	3.6	2.2	.4											
D3-34- 1ac1	53	53			Moderately heavy	25.1	22.3	22.8	27.4	2.4											
1ac2	54	54			Very coarse	10.3		2.5	10.6	14.2	9.7	8.0	8.9	11.4	10.0	14.4					
		55			Medium to coarse	10.0	11.2	25.6	39.4	10.2	1.8	1.0	.6	.2							
1ac3	56	56	5.3	5.5	Moderately heavy	22.8	48.6	19.0	9.0	.4	.2							55.7	13.8	41.9	6
12abd	68	68	2.1	2.3	Heavy	42.0	54.2	3.2	.6									51.3	24.2	27.1	4
		69	5.1	5.3	do	45.6	52.4	1.8	.2									50.2	33.0	17.2	8
		70	8.9	9.1	Medium	16.8	24.6	34.4	23.8	.4								47.8	12.0	35.8	56
12db1	61	61	1.9	2.1	Moderately heavy	31.2	61.6	5.6	1.4	.2								54.4	19.2	35.2	35
		62	5.7	5.9	do	29.9	60.1	7.8	2.2									49.8	19.5	30.3	30
		63	8.4	8.6	do	22.9	56.5	15.6	5.0									39.8	21.4	18.4	<1
		64			Medium	18.9	32.7	26.4	21.8	.2											
12db2	79	79	2.0	2.2	Moderately heavy	30.4	62.0	6.6	1.0									53.2	20.5	32.7	40
		80	4.0	4.2	Coarse	19.0	8.0	4.0	15.9	34.0	7.4	1.8	1.4	3.4	5.1			44.3	13.1	31.2	280
13ab2	81	81	2.3	2.5	Moderately heavy	24.2	50.0	22.2	3.6									51.3	16.4	34.9	
		82	4.3	4.5	Heavy to moderately heavy.	30.0	60.6	7.8	1.6									46.5	22.6	23.9	8
		83			Moderately heavy	27.5	52.3	15.4	2.8	.4	.6	1.0									
		84			do	29.9	54.9	14.6	.6												
D3-35-18bd	85	85	2.3	2.5	Heavy	36.8	30.6	19.8	12.0	.8								44.8	27.4	17.4	8
		86	3.1	3.3	do	40.6	36.4	12.8	9.0	1.2								46.1	28.1	18.0	10
D4-35- 9aa2	57	57	2.4	2.6	do	36.1	52.1	7.8	3.8	.2								45.2	22.5	22.7	2
		58			Medium	16.2	15.0	25.0	38.6	5.0	.2										

[1] Disturbed sample.

The particle-size analyses were made after the other tests had been completed. The average porosity, specific retention, specific yield, and coefficient of permeability for each textural classification is given in table 11.

TABLE 11.—*Average physical and hydrologic properties of unconsolidated materials*

Textural classification	Porosity (percent by volume)	Specific retention (percent by volume)	Specific yield (percent by volume)	Coefficient of permeability (meinzers)
Heavy (clay and silty clay)	44.7	27.7	17.0	7.2
Moderately heavy (clay loam, silty clay loam, and sandy clay loam)	47.2	18.6	28.6	22
Medium (loam, silty loam, and very fine sandy loam)	41.3	13.2	28.1	24
Coarse (predominantly coarser than very fine sand)	38.9	7.2	31.7	98
Very coarse (predominantly gravel)	[1] 24.9	[1] 0	[1] 24.9	[1] 6,000

[1] Only one sample tested.

DRAINAGE IN RELATION TO HYDROLOGIC PROPERTIES OF THE TERRACE DEPOSITS

Tests indicate that the coarse-grained terrace deposits are moderately to highly permeable and, therefore, conducive to good drainage. The rate of flow through a cross section of these deposits in the vicinity of an aquifer test can be estimated from the computed coefficient of permeability and the hydraulic gradient. Similarly, the rate of flow in an area which is not tested, but where the thickness of the aquifer is known, can be estimated by assuming a permeability coefficient similar in magnitude to others determined elsewhere for the same aquifer.

The properties of the fine-grained sediments overlying the coarse-grained terrace deposits are important in determining whether the land is irrigable and whether it can be drained. Laboratory tests indicate that the hydrologic properties vary greatly even though the textural properties are similar. For example, some samples classified as medium had a lower coefficient of permeability than some samples classified as heavy. The specific retention generally proved to be the only property consistent with the particle-size analysis; hence, the textural classification apparently is a good measure of the capillary retentiveness of the material and the height of the capillary fringe above the water table. Because of this relationship between capillarity and soil texture, soil-classification maps were used in deciding how deep the drains must be to lower the water table sufficiently to alleviate waterlogging.

Because the laboratory determinations of test-hole samples show a wide range in values for the coefficient of permeability, average values should be used with caution as determining factors in designing drains.

A comparison of specific yields determined by laboratory tests with the storage coefficients determined by field tests suggests that the larger values obtained in the laboratory represent the storage coefficient to be expected after a very long period of draining and that the smaller values obtained from the field tests represent the storage coefficient of the fine-grained sediments during only the short period of the field test. Therefore, the laboratory values are more nearly representative of the effectiveness of drainage measures.

The theoretical considerations discussed above have been applied in suggesting drainage programs for specific units in the Little Bighorn valley. These units are discussed separately beginning on page 96.

BEDROCK AQUIFERS

The consolidated aquifers underlying the area are recharged principally where they are exposed or lie close to the land surface. The Parkman sandstone is exposed or underlies the stream deposits throughout much of the area but the other bedrock aquifers are exposed outside the area along the foot or on the slopes of the Bighorn Mountains. From these recharge areas, the aquifers dip below shale layers, which—owing to their low permeability—probably prevent any significant natural discharge within Big Horn County. Little water is withdrawn from the aquifers through wells.

Water in artesian aquifers below the Parkman sandstone is under fairly great pressure because the recharge areas are from 500 to 2,000 feet higher than the report area. The water pressure at the land surface in well D6–35–21db (P–6), which taps the Cloverly formation, was 80 psi, or equivalent to about 185 feet of head.

Water within the Parkman sandstone occurs under relatively slight artesian pressure or under water-table conditions. The piezometric surface was between 10 feet below and 10 feet above the land surface at all points where it could be measured. In the vicinity of Lodge Grass the water level in the Parkman sandstone is relatively high probably because the formation is recharged by the infiltration of irrigation water applied to overlying terrace deposits. The sandstone beds of the Parkman transmit the water downdip to the east where the water becomes confined below a layer of shale.

The Parkman sandstone is tapped by the municipally owned well of Lodge Grass and by several privately owned wells within the city. The largest withdrawals from this formation are made by well D6–35–13ac4 (P–5). The effect of pumping this well is shown by the hydrograph of the water-level fluctuations in well D6–35–13ab (5–N1). (See fig. 15.)

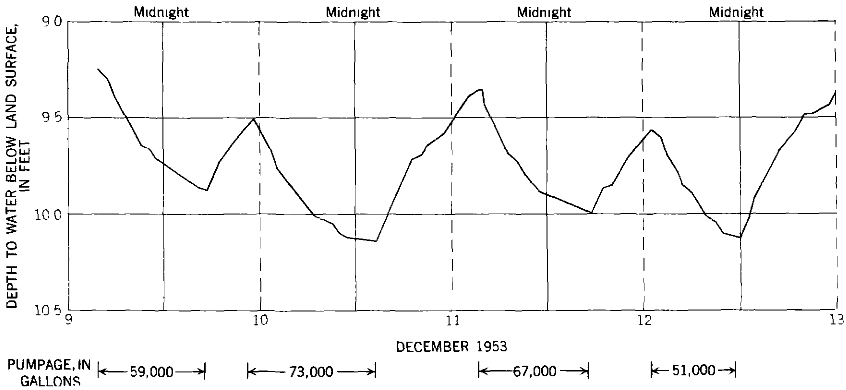

Figure 15.—Hydrograph of water-level fluctuations in well D6–35–13ab (5–N1), showing effect of intermittent pumping of well D6–35–13ac4 (P–5), Lodge Grass No. 1 unit. Wells are 800 feet apart. Average pumping rate was about 75 gpm.

Because the Parkman sandstone crops out along the river bank and fluctuations of the river level are similar to the water-level fluctuations in nearby wells (fig. 16), it is believed that the river water is hydraulically continuous with the ground water in the Parkman sandstone. Pumping of large quantities of water from the Parkman sandstone in this vicinity would induce infiltration of river water, which, in turn, would sustain the yield of the wells. That effect, however, would tend to reduce the flow in the river and the possible effect on downstream water rights would have to be considered.

Because the dense shale beds separating the bedrock aquifers transmit water so slowly and because no faults or joints along which water might pass are known to exist in the shale, no appreciable interchange of water is believed to occur from one bedrock aquifer to another.

UNCONSOLIDATED AQUIFERS

Precipitation is the initial source of recharge to all aquifers within the Little Bighorn River drainage basin. In this report, however, the sources of recharge are referred to in terms of the status of the water just prior to its entry into an aquifer. Therefore, precipitation is considered a source of recharge only when it infiltrates directly to the zone of saturation. Influent streams, irrigation canals and laterals, irrigation water applied to cropland, and subsurface inflow are also sources of recharge.

All ground water discharged from the basin ultimately is returned to the atmosphere. However, in this report, the means of discharge are referred to in terms of the status of the water immediately after it leaves an aquifer, or leaves the area within an aquifer. Thus, effluent streams, springs and seeps, evapotranspiration, underflow, and manmade drains all are regarded as means of discharge.

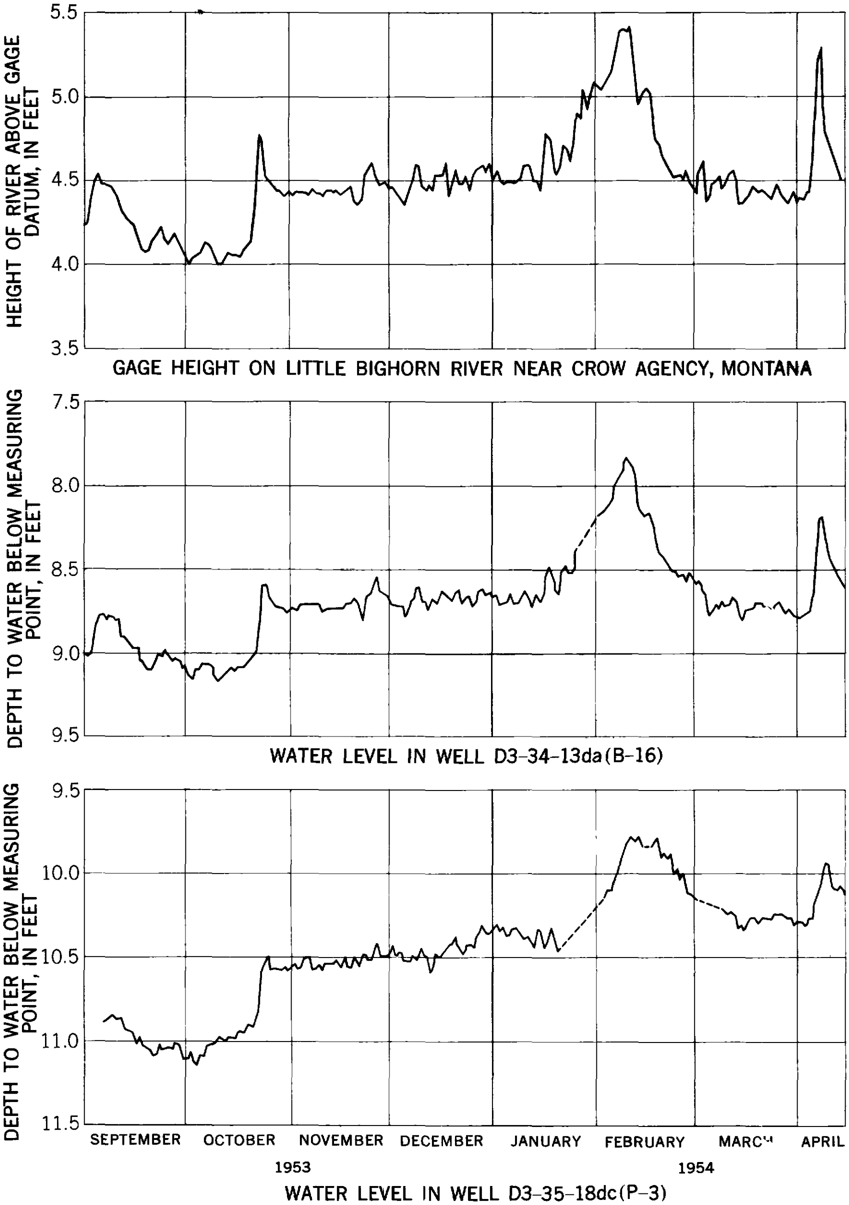

FIGURE 16.—Hydrographs of river stage near Crow Agency, Mont., and water-level fluctuations in wells D3-34-13da (B-16) and D3-35-18dc (P-3).

The relative magnitude of the several sources of potential recharge to the 14,617 acres of irrigated land in the area during the irrigation season, expressed in feet of water, are estimated as follows: delivered irrigation water, 2 to 3 feet; leakage from the irrigation distribution system, 1 to 1.5 feet; precipitation, about 0.75 foot; and influent streams and subsurface inflow, less than 0.5 foot. Whereas only a part of the irrigation water delivered and of the precipitation reaches the zone of saturation, all the water from canal and ditch leakage and from influent streams and underflow probably reaches the ground-water reservoir. The relative magnitude of the various sources of recharge to the unconsolidated deposits underlying individual farms is extremely variable with locality. For instance, the principal source of recharge on a farm adjacent to the main canal may be canal leakage, whereas that on a farm at the mouth of a large drainageway may be underflow.

The amount of precipitation that infiltrates to the zone of saturation is not directly related to the amount of rainfall. On gently sloping land that is poorly drained, the duration and intensity of rainfall become less important than other factors in determining the percentage of precipitation recharging the ground-water reservoir. A comparison of the hydrographs of the water levels in wells D2–34–3cc1 (A–25) and D2–34–36db1 (A–62) (fig. 17) with the daily precipitation graphs for Crow Agency and Hardin (pl. 12) illustrates the varying effect of precipitation on ground-water storage. When the moisture content of the soil zone above the water table was low, a large part of the precipitation was stored as soil moisture and only the small remainder infiltrated to the zone of saturation. Conversely, when the moisture content of the soil was high, a greater part of the precipitation infiltrated to the zone of saturation. For example, during the period October 21 to 26, 1953, when the soil moisture was low, the water level in well D2–34–3cc1 (A–25) rose 8.28 inches in response to 2.46 inches of precipitation; and during the period of May 20 to 23, 1952, when the moisture content was high, the water level in the same well rose 7.66 inches in response to 1.14 inches of precipitation. In other words, in the vicinity of this well proportionately only half as much precipitation reached the water table in October 1953 as in May 1952. The fields surrounding this well are not irrigated. The water-level fluctuations that do not correlate with the periods of precipitation were caused by varying rates of evapotranspiration (fig. 18) and varying canal stage. The relationship of the water level in well D3–34–1ac7 (A–64), 50 feet from the canal, is shown by hydrographs in figure 19.

Records of water-level fluctuations in observation wells provide information on the ratio of recharge to discharge. A rising water

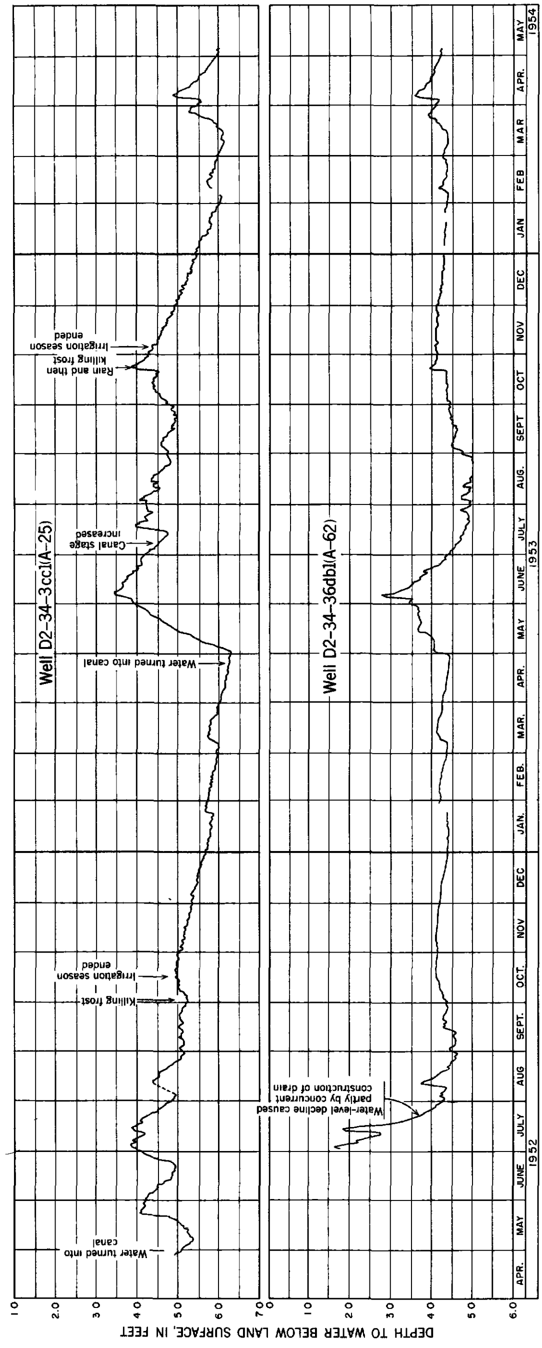

FIGURE 17.—Hydrographs of water-level fluctuations in well D2-34-3cc1 (A-25) and D2-34-36db1 (A-62).

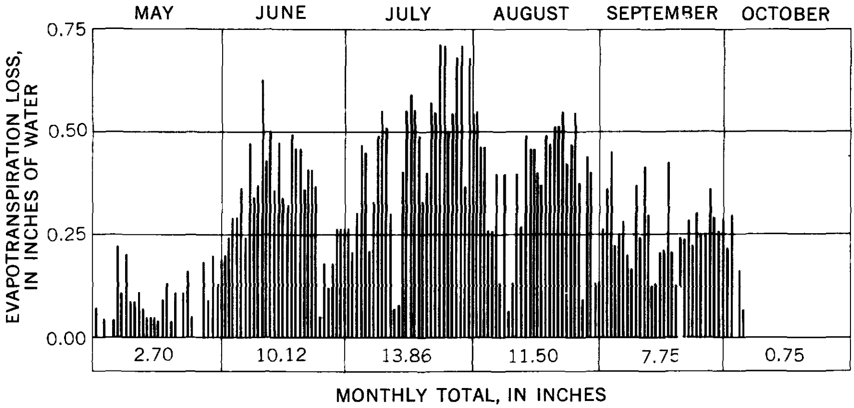

FIGURE 18.—Daily evapotranspiration loss in vicinity of well D2–34–3cc1 (A–25) during irrigation season, 1952.

level indicates that recharge is greater than discharge, and vice versa. For example, the hydrograph for well D2–34–3cc1 (A–25) (fig. 17) is interpreted as follows:

Discharge by natural subsurface drainage exceeded recharge from upland drainage during the first 4 months of 1953, except for short periods when rain and thawing caused recharge from the surface to exceed drainage. About a week after water was turned into the canal, additional recharge from canal leakage and spring rains caused the total recharge to exceed the discharge. After the first week in June, the increased rate of evapotranspiration caused discharge to exceed recharge once again, but in July the relationship reversed once more because the canal leakage increased as a result of a higher canal stage. From mid-July through September the recharge-discharge relationship reversed several times owing to variations in the evapotranspiration rate, canal stage, and amount of precipitation. In the latter part of September, the water level rose because of a decrease in evapotranspiration, but warmer daytime temperatures and a reduction in canal stage during October reversed that trend. An abrupt rise in water level coincided with a period of heavy rainfall that began on October 22. As a killing frost followed the rain and as water was turned out of the canal, the water-level declined during the latter part of the year, thus indicating that natural drainage exceeded subsurface recharge. It is unlikely that distant irrigation caused any water-level changes in the vicinity of well D2–34–3cc1 (A–25).

Hydrographs of the water level in wells D2–34–14ba (A–35) and D4–35–9aa1 (B–45) in figure 20 illustrate the effect of infiltrating irrigation water on ground-water storage. The effect of leakage from a canal is illustrated in figure 21 by a hydrograph of the water level in well D3–34–1ac7 (A–64).

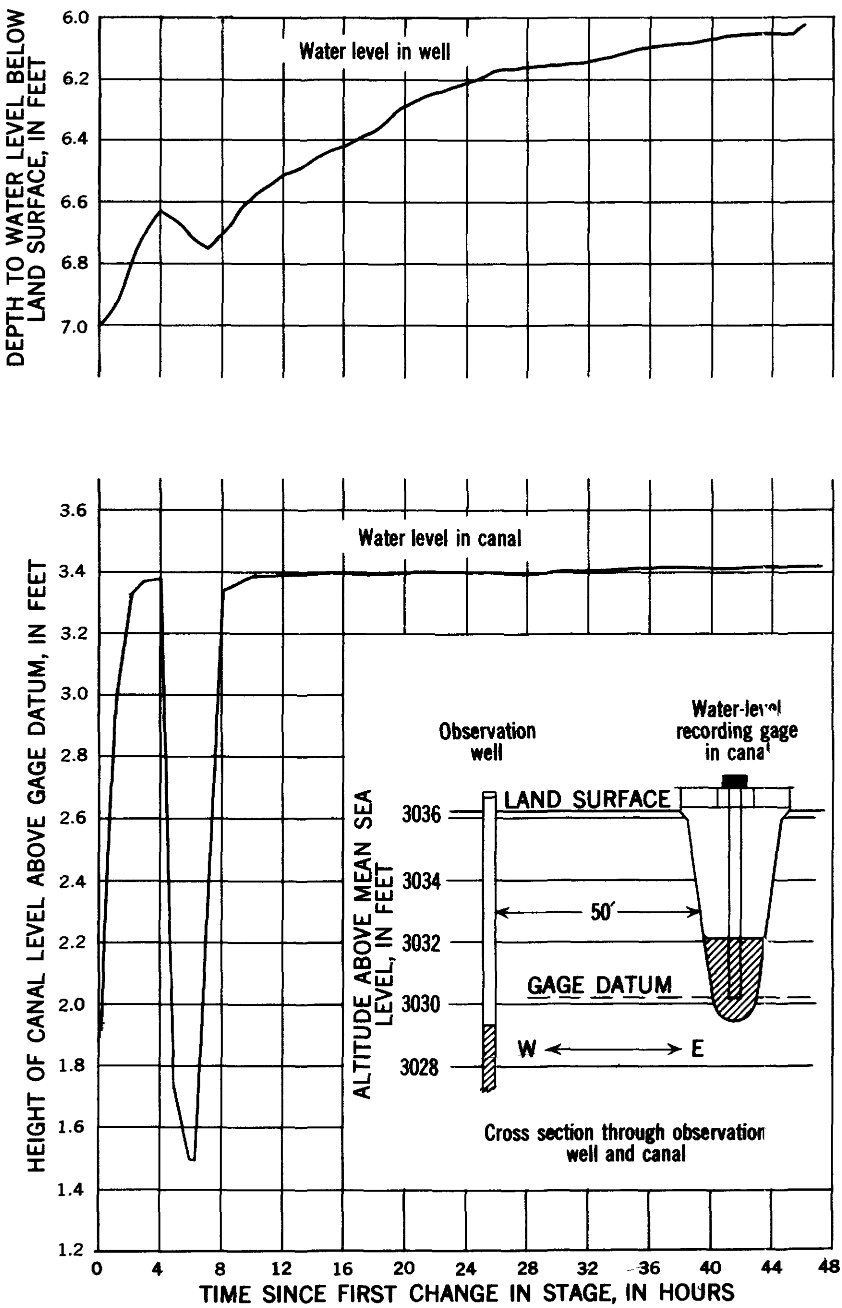

FIGURE 19.—Hydrographs of canal stage near Crow Agency, Mont., and water-level fluctuations in well D3–34–1ac7 (A–64). Water level in canal had been about 1.44 feet above gage datum for 72 hours before test.

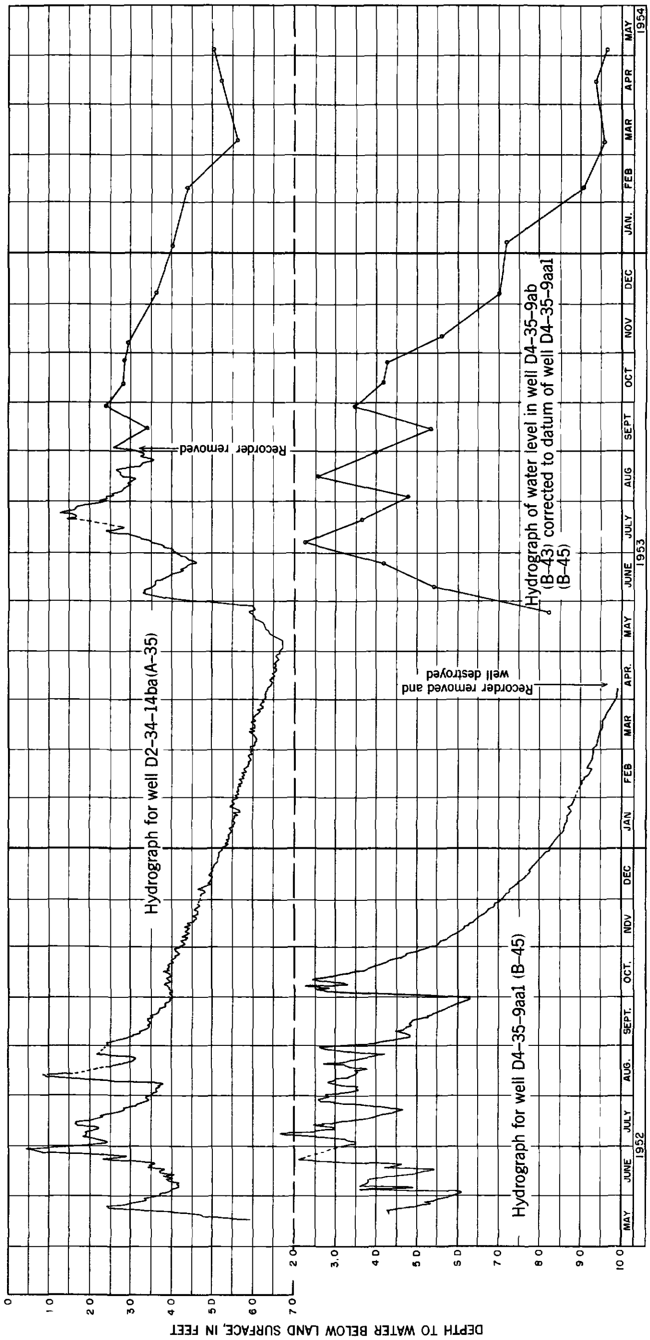

Figure 20.—Hydrographs of water-level fluctuations in wells D2-34-14ba (A-35) and D4-35-9aa1 (B-45).

Evapotranspiration probably is the principal cause of water-level decline in well D3–34–1dc (B–1) during the growing season. (See fig. 22.) Because plant growth keeps the soil-moisture content low, probably most of the precipitation that infiltrates the ground is held above the water table by capillarity and is used subsequently by the plants. After the growing season, recharge soon exceeds discharge and, consequently, the water table rises. The effect of evapotranspiration on water levels in dryland areas is hardly noticeable where the depth to water is several feet below the land surface.

Hydrographs of the water-level fluctuations in well D2–34–3cc1 (A–25) show the effect of withdrawals of water by evapotranspiration during the growing season. (See figs. 23 and 24.) Daily withdrawals were computed by using a formula proposed by White (1932, p. 61) and the seasonal withdrawal was computed by totaling the daily withdrawals (fig. 18). White's formula is based on the assumptions that the rate of evapotranspiration between sunset and sunrise is negligible and that the rate of rise of the water level between midnight and 4 a.m. represents the average rate of recharge for the entire day. The formula is stated as

$$q=y(24r\pm s),$$

in which

q=the depth of water withdrawn, in inches;
y=the specific yield of the soil in which the daily water-level fluctuations take place;
r=the hourly rate of water-level rise from midnight to 4 a.m., in inches;

and

s=the net fall or rise of the water level during the 24-hour period, in inches.

The formula requires a determination of the specific yield of the material in which the water-level fluctuations occur. However, as specific yield, under field conditions, can be determined only by making elaborate tests, estimated values were used in the formula. Assumed values from 5 to 10 percent implied that the seasonal withdrawal owing to evapotranspiration was about 3 feet, which is of the same magnitude as the seasonal withdrawal by alfalfa in areas of similar climate (Houk, 1951, p. 315). Although the value used for specific yield may not be volumetrically accurate, the results computed from the formula show at least the relative changes The evapotranspiration graph (fig. 18) is also an aid in interpreting observed water-level fluctuations.

The fine-grained sediments are much less permeable than the underlying coarse-grained sediments and tend to confine the water stored

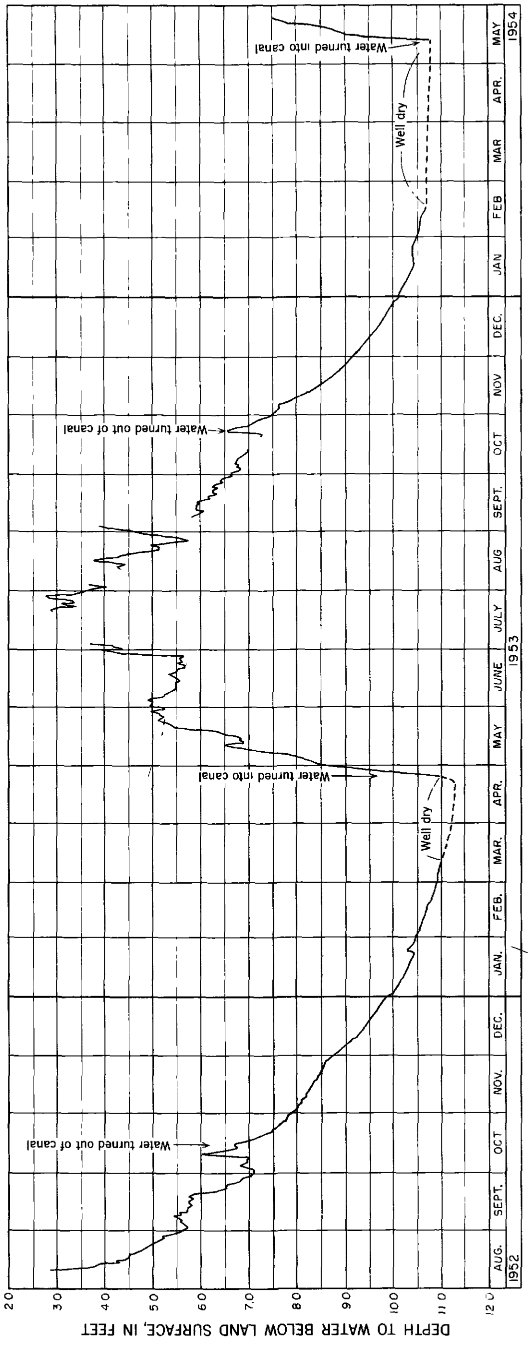

FIGURE 21.—Hydrograph of water-level fluctuations in well D3–34–1ac7 (A–64).

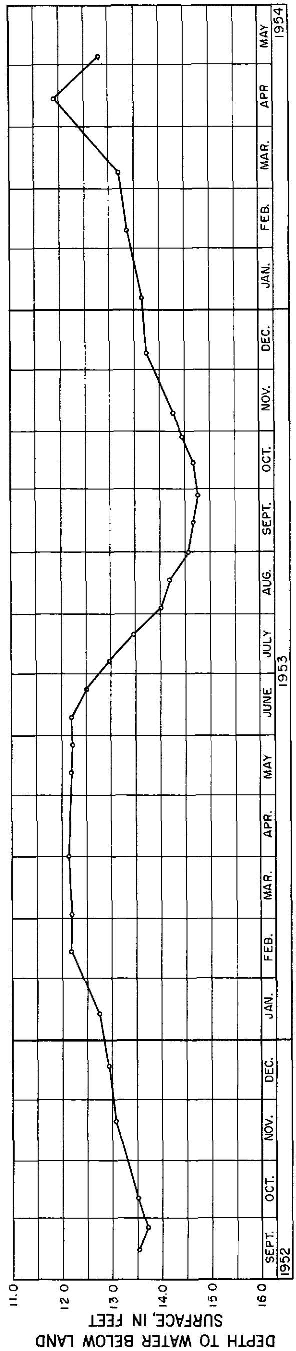

FIGURE 22.—Hydrograph of water-level fluctuations in well D3–34–1dc (B–1).

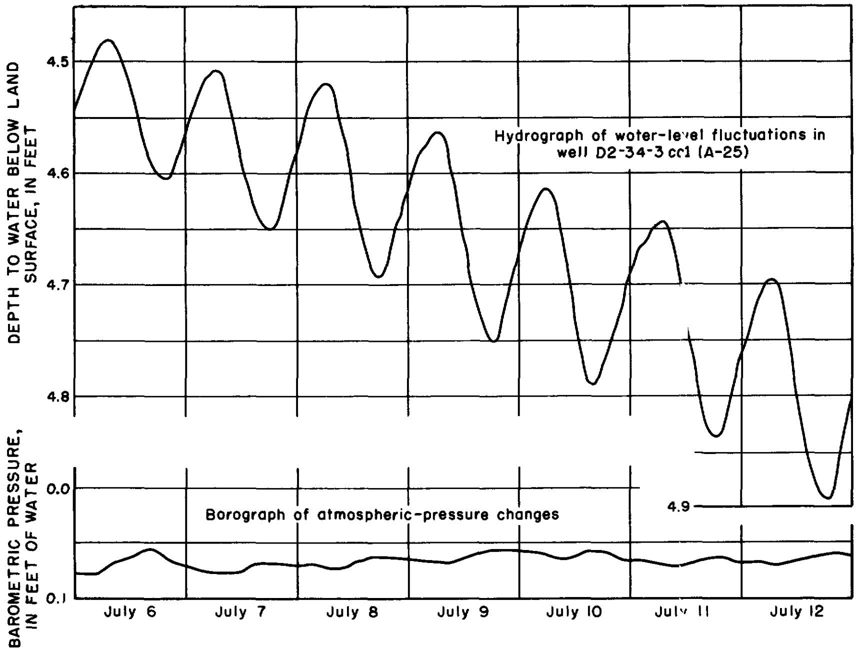

FIGURE 23.—Hydrograph of water-level fluctuations in well D2–34–3cc1 (A–25) and barograph of atmospheric-pressure changes, July 6–12, 1953.

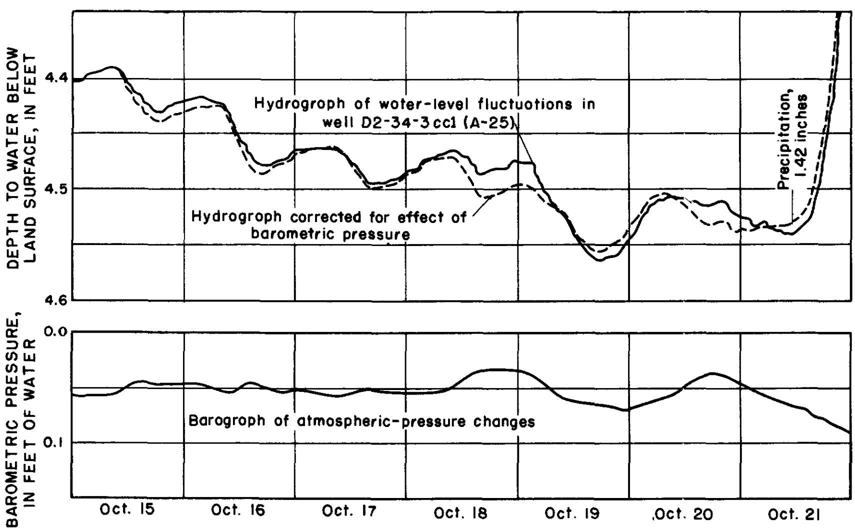

FIGURE 24.—Hydrograph of water-level fluctuations in well D2–34–3cc1 (A–25) and barograph of atmospheric-pressure changes, October 15–21, 1953.

in the coarse-grained sediments. In the resulting artesian system, changes in air pressure at the water surface in a well are only partly compensated by changes in pressure on the water in the aquifer, where the pressure effects are dampened by the slow transmission of pressure through the material of the confining stratum. The well, therefore, is an inefficient water barometer. The water level in well D2–34–3cc1 (A–25), as in several other wells also equipped with recording gages, fluctuated in response to changes in barometric pressure. (See fig. 25.) Such water-level fluctuations are more pronounced during the winter months when the ground is frozen. The rate of change in barometric pressure affects the barometric efficiency of the well—rapid changes cause proportionately larger water-level fluctuations than do slow changes.

When water is turned into the canal and laterals at the beginning of the irrigation season, the ground-water level adjacent to these ditches starts to rise rapidly. In some places the rise is as much as 10 feet by the middle of the irrigation season. The amount of rise is not dependent wholly upon the quantity of leakage, however, but varies also with differences in rates of subsurface drainage which may be faster in one place than in another.

Measurements with a current meter of the difference in flow between two stations 3 miles apart were not sufficiently accurate to determine the quantity of canal leakage because the difference in flow was within the probable error of the measuring equipment. An attempt was made, therefore, to measure leakage by an indirect method.

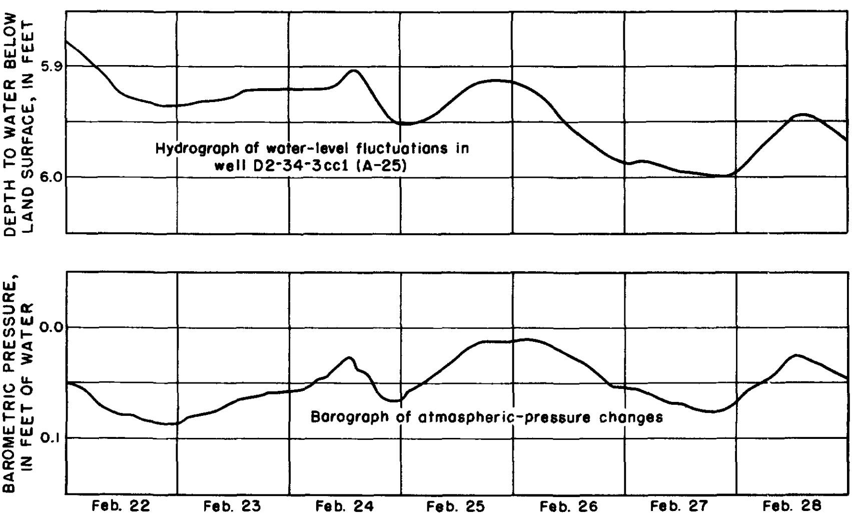

FIGURE 25.—Hydrograph of water-level fluctuations in well D2–34–3cc1 (A–25) and barograph of atmospheric-pressure changes, February 22–28, 1954.

It was reasoned that, if changes in canal stage cause corresponding changes in ground-water levels, pertinent data could be collected and analyzed in terms of rate of leakage. Accordingly, eight wells were installed along a line perpendicular to a straight section of the canal (pl. 4) and the canal stage was controlled by opening and closing a check gate a short distance downstream from the line of wells. The data collected from these tests are given in tables 12 and 13 and were substituted in two formulas (p. 59–60), which were developed by Jacob (1950) and later tested and revised by Ferris (1950, 1951).

TABLE 12.—*Water-level measurements in nine observation wells during canal-leakage test, Agency unit*

[Feet below measuring point]

Date and time	Depth to water (feet)	Date and time	Depth to water (feet)	Date and time	Depth to water (feet)
D3-34-1ac1 (CP-3)					
Oct. 8, 1952		*Oct. 8, 1952*		*Oct. 10, 1952*	
9:39 a.m.	10.64	2:44 p.m.	10.34	10:03 a.m.	9.69
10:06	10.65	2:49	10.36	10:14	9.66
10:18	10.63	3:07	10.34	10:26	9.66
10:30	10.63	3:23	10.33	10:39	9.67
10:48	10.62	3:40	10.34	10:57	9.66
11:03	10.60	3:55	10.35	11:11	9.67
11:18	10.60	4:10	10.35	11:26	9.68
11:44	10.56	4:28	10.35	11:43	9.68
12:05 p.m.	10.54	4:43	10.36	12:20 p.m.	9.74
12:31	10.50	4:55	10.36	12:58	9.76
12:43	10.49	5:31	10.36	1:38	9.79
1:05	10.45			2:13	9.80
1:32	10.41	*Oct. 10, 1952*		2:52	9.81
2:05	10.37			3:45	9.88
2:11	10.37	9:06 a.m.	9.70	4:52	9.87
2:20	10.35	9:38	9.67		
2:31	10.35	9:47	9.66		
D3-34-1ac2 (CP-2)					
Oct. 8, 1952		*Oct. 8, 1952*		*Oct. 10, 1952*	
9:41 a.m.	13.24	2:40 p.m.	12.76	9:44 a.m.	12.01
10:08	13.24	2:53	12.78	9:57	12.02
10:21	13.16	3:04	12.80	10:07	12.03
10:32	13.16	3:21	12.80	10:24	12.04
10:51	13.13	3:36	12.80	10:36	12.05
11:06	13.13	3:52	12.81	10:55	12.05
11:21	13.09	4:06	12.84	11:09	12.06
11:41	13.07	4:25	12.84	11:24	12.07
12:03 p.m.	13.09	4:39	12.84	11:41	12.08
12:28	12.99	4:50	12.86	12:17 p.m.	12.14
12:41	12.95	4:59	12.86	12:55	12.15
1:03	12.89	5:12	12.88	1:36	12.17
1:30	12.82	5:26	12.87	2:16	12.17
2:03	12.76			2:50	12.17
2:09	12.75	*Oct. 10, 1952*		3:43	12.25
2:16	12.75			4:47	12.28
2:29	12.75	9:34 a.m.	12.00		

TABLE 12.—*Water-level measurements in nine observation wells during canal-leakage test, Agency unit*—Continued

Date and time	Depth to water (feet)	Date and time	Depth to water (feet)	Date and time	Depth to water (feet)
D3-34-1ac3 (CP-1)					
Oct. 8, 1952		*Oct. 8, 1952*		*Oct. 10, 1952*	
9:43 a.m.	8.54	2:46 p.m.	8.09	9:42 a.m.	7.38
10:10	8.50	2:58	8.12	9:49	7.38
10:23	8.47	3:15	8.13	9:55	7.38
10:35	8.46	3:33	8.15	10:05	7.40
10:53	8.42	3:46	8.16	10:21	7.41
11:08	8.40	4:00	8.18	10:34	7.43
11:23	8.36	4:20	8.19	10:53	7.48
11:37	8.32	4:37	8.20	11:07	7.51
11:59	8.23	4:47	8.19	11:22	7.53
12:27 p.m.	8.15	4:57	8.17	11:39	7.57
12:37	8.11	5:10	8.18	12:15 p.m.	7.62
1:00	8.08	5:22	8.17	12:52	7.66
1:28	7.99			1:34	7.69
2:00	7.99	*Oct. 10, 1952*		2:05	7.71
2:07	8.02			2:47	7.74
2:14	8.04	9:00 a.m.	7.37	3:41	7.78
2:35	8.07	9:32	7.37	4:42	7.80
D3-34-1ac4 (CP-4)					
Oct. 8, 1952		*Oct. 8, 1952*		*Oct. 10, 1952*	
9:30 a.m.	10.12	2:10 p.m.	9.81	10:14 a.m.	9.21
10:04	10.11	2:26	9.82	10:21	9.22
10:12	10.11	2:44	9.81	10:34	9.23
10:17	10.11	3:03	9.83	10:45	9.24
10:23	10.11	3:23	9.83	10:57	9.25
10:29	10.10	4:03	9.85	11:07	9.25
10:40	10.09	4:23	9.86	11:20	9.27
10:55	10.08	4:55	9.87	11:23	9.28
11:10	10.06	5:31	9.86	11:37	9.29
11:25	10.04			11:53	9.28
11:41	10.01	*Oct. 10, 1952*		12:31 p.m.	9.32
12:09 p.m.	9.93			1:21	9.35
12:38	9.86	8:56 a.m.	9.22	1:51	9.36
1:00	9.86	9:32	9.21	2:31	9.39
1:27	9.83	9:47	9.21	3:13	9.40
1:53	9.82	9:59	9.21	4:21	9.44
D3-34-1ac5 (CP-5)					
Oct. 8, 1952		*Oct. 8, 1952*		*Oct. 10, 1952*	
9:32 a.m.	11.28	2:28 p.m.	11.12	10:11 a.m.	10.62
10:09	11.40	2:50	11.12	10:23	10.61
10:14	11.40	3:10	11.12	10:32	10.61
10:20	11.41	3:28	11.12	10:48	10.61
10:26	11.42	4:10	11.21	10:55	10.62
10:32	11.42	4:29	11.22	11:09	10.61
10:50	11.42	5:03	11.22	11:18	10.62
10:57	11.41	5:37	11.22	11:27	10.62
11:12	11.39			11:35	10.63
11:27	11.38	*Oct. 10, 1952*		11:55	10.55
11:43	11.35			12:34 p.m.	10.61
12:12 p.m.	11.29	8:54 a.m.	10.57	1:24	10.63
12:39	11.17	9:34	10.57	1:53	10.58
1:01	11.16	9:44	10.59	2:34	10.59
1:29	11.12	9:49	10.60	3:15	10.60
1:57	11.09	9:57	10.62	4:25	10.67
2:16	11.13	10:01	10.62		

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TABLE 12.—*Water-level measurements in nine observation wells during canal-leakage test, Agency unit*—Continued

Date and time	Depth to water (feet)	Date and time	Depth to water (feet)	Date and time	Depth to water (feet)
D3-34-1ac6 (CP-8)					
Oct. 8, 1952		*Oct. 8, 1952*		*Oct. 10, 1952*	
9:25 a.m.	7.42	3:37 p.m.	7.20	10:30 a.m.	6.65
10:34	7.42	4:13	7.23	10:53	6.66
11:00	7.40	4:32	7.24	11:11	6.67
11:14	7.40	5:06	7.24	11:16	6.68
11:30	7.38			11:29	6.68
11:45	7.36	*Oct. 10, 1952*		11:33	6.68
12:14 p.m.	7.32			11:57	6.68
12:40	7.27	8:52 a.m.	6.66	12:39 p.m.	6.71
1:06	7.25	9:37	6.63	1:26	6.72
1:33	7.24	9:42	6.64	1:55	6.73
1:59	7.19	9:51	6.65	2:36	6.75
2:18	7.20	9:55	6.65	3:22	6.76
2:30	7.20	10:03	6.65	4:30	6.80
2:52	7.20	10:08	6.65		
3:13	7.20	10:25	6.65		
D3-34-1ac7 (A-64)					
Oct. 8, 1952		*Oct. 10, 1952*		*Oct. 10, 1952*	
9:45 a.m.	7.01	9:05 a.m.	6.03	12:18 p.m.	6.20
10:23	6.98	10:00	6.03	12:40	6.22
10:33	6.96	10:15	6.04	1:10	6.25
10:43	6.95	10:25	6.05	1:45	6.28
10:54	6.93	10:35	6.06	2:20	6.31
11:19	6.90	10:45	6.07	3:03	6.33
11:29	6.87	10:52	6.08	4:00	6.35
11:49	6.84	11:00	6.09	4:55	6.38
12:04 p.m.	6.81	11:07	6.10	6:10	6.41
12:31	6.75	11:13	6.11	7:30	6.43
12:50	6.72	11:19	6.12	8:45	6.44
1:13	6.68	11:30	6.14	10:20	6.45
1:30	6.66	11:45	6.16	11:59	6.46
2:00	6.62	12:03 p.m.	6.18		
D3-34-1ac8 (CP-6)					
Oct. 8, 1952		*Oct. 8, 1952*		*Oct. 10, 1952*	
9:20 a.m.	8.21	2:55 p.m.	8.02	10:28 a.m.	7.51
10:38	8.21	3:15	8.05	10:52	7.52
11:02	8.20	3:39	8.05	11:13	7.53
11:17	8.20	4:16	8.06	11:31	7.53
11:32	8.19	4:38	8.07	11:59	7.51
11:47	8.17	5:11	8.07	12:41 p.m.	7.55
12:16 p.m.	8.15			1:28	7.57
12:42	8.10	*Oct. 10, 1952*		1:57	7.57
1:07	8.08			2:39	7.58
1:38	8.06	8:50 a.m.	7.50	3:31	7.60
2:01	8.05	9:40	7.50	4:33	7.62
2:20	8.05	9:53	7.51		
2:32	8.04	10:05	7.51		
D3-34-1bd (CP-7)					
Oct. 8, 1952		*Oct. 10, 1952*		*Oct. 10, 1952*	
9:25 a.m.	10.54	9:10 a.m.	10.32	1:41 p.m.	10.28
12:47 p.m.	10.50	11:28	10.29	2:55	10.27
1:09	10.51	12:23 p.m.	10.29	3:50	10.28
1:35	10.50	1:03	10.29	4:57	10.28

TABLE 13.—*Altitude, in feet, of water surface in canal at three points during canal-leakage test, Agency unit*

[Altitude of canal bottom at bridge, 3,029.7 ft; at check gate, 3,029.9 ft]

Date and time	Bridge [1]	Turnout gate [2]	Check gate [3]
Oct. 8, 1952			
9:50 a.m.			3,031.23
9:55	3,031.67		
9:57	3,031.93		
10:02	3,032.20		
10:07	3,032.41		
10:12	3,032.58		
10:17	3,032.71		
10:22	3,082.83		
10:27	3,032.93		3,032.66
10:32	3,033.02		
10:37	3,033.10		
10:42	3,033.17		
10:47	3,033.22		
10:52	3,033.27		
10:57	3,033.31		
11:02	3,033.35		
11:07	3,033.39		
11:12	3,033.42		
11:17	3,033.44		
11:22	3,033.46		
11:27	3,033.48		3,033.23
11:32	3,033.50		
11:37	3,033.51		
11:42	3,033.53		
11:47	3,033.54		
11:52	3,033.55		
12:07 p.m.	3,033.56		
12:24	3,033.58		
12:31	3,033.59		
12:49	3,033.60		
1:12	3,033.60		
1:54	3,033.61		
1:55		3,033.56	
2:00	3,033.61		3,033.45
2:01	3,033.61		
2:02	3,033.59		
2:03	3,033.56		
2:04	3,033.48		
2:05	3,033.41		
2:06	3,033.29		
2:07	3,033.13		3,032.85
2:08	3,033.09		
2:09	3,033.05		
2:10	3,033.01		3,032.75
2:11	3,032.97		
2:12	3,032.93		
2:13	3,032.89		
2:14	3,032.83		
2:15	3,032.81		3,032.54
2:18		3,032.56	
2:20	3,032.63		
2:25	3,032.53		
2:26			3,032.25
Oct. 8, 1952			
2:30 p.m.	3,032.37		3,032.08
2:35	3,032.29		3,032.00
2:38		3,032.11	
2:40	3,032.21		
2:45	3,032.15		3,031.89
2:50	3,032.07		
2:55	3,032.03		3,031.72
3:00	3,031.97	3,031.86	
3:05	3,031.93		
3:10	3,031.91		
3:15	3,031.87	3,031.74	
3:20	3,031.85		3,031.46
3:25	3,031.83		
3:30	3,031.81		
3:35	3,031.79		
3:40	3,031.77		
3:45	3,031.77		
3:50	3,031.77		
3:55	3,031.75		
4:00	3,031.73		
4:05	3,031.73		
4:10	3,031.73		
4:15	3,031.73		
4:20	3,031.71		
4:25		3,031.54	
Oct. 10, 1952			
9:00 a.m.			
9:28	3,033.65		
9:38			3,033.45
9:48			3,033.30
9:53			3,033.20
9:58	3,033.42		
10:08			3,033.13
10:10			3,033.06
10:18	3,033.27		
10:28			3,032.92
10:38			3,032.79
10:48			3,032.62
10:50			3,032.41
10:58	3,032.63		
11:08			3,032.18
11:18			3,031.94
11:28			3,031.73
12:10 p.m.			3,031.60
12:48	3,031.89		
1:30	3,031.88		3,031.55
2:00	3,031.86		
2:45	3,031.86		
3:38	3,031.85		
4:08	3,031.84		
5:00			3,031.55
	3,031.83		

[1] Upstream from line of observation wells.
[2] Opposite well D3-34-1ac3 (CP-1).
[3] Downstream from line of observation wells; used to control canal stage during test.

One formula may be used if the rate of discharge to or recharge from a line sink or line source is changed from one constant rate to another constant rate. The formula is as follows:

$$s=\frac{Q_b x}{2T}\left[\frac{e^{-u^2}}{u\sqrt{\pi}}-1+\frac{2}{\sqrt{\pi}}\int_0^{\frac{x}{2\sqrt{Tt/S}}} e^{-u^2}du\right],$$

where

s=drawdown, in feet, at any point in the vicinity of the drain (or canal) discharging at a constant rate;

Q_b=constant discharge (that is, base flow) of the drain (or canal), in gallons per minute per lineal foot of drain (or canal);

x=distance, in feet, from the drain (or canal) to the point of observation;

t=time, in days, since the drain (or canal) began discharging;

and

S and T have the meaning and units already defined.

A constant change in the rate of recharge was assumed to accompany a constant change in head in the canal because the water level in the aquifer was below the bottom of the canal. By substituting values determined at a nearby pumping test for S and T, the equation was solved for Q.

The second formula was for cyclic sinusoidal changes in stage:

$$s_r = 2s_o e^{-4.8\sqrt{S/t_oT}},$$

where

s_r=range of ground-water stage, in feet;

s_o=amplitude or half range of the surface-water stage, in feet;

x=distance from the observation well to the surface-water contact with the aquifer ("suboutcrop"), in feet;

t_o=period of the stage fluctuation, in days;

and

S and T have the meaning and units already defined.

An attempt was made to create changes of this type by controlled operation of a downstream canal check gage. This equation was solved to verify the S/T ratio used in the first formula.

A combination of operational difficulties, inadequate time for testing, and natural deviations from ideal conditions produced results that were inconsistent and, therefore, questionable. However, by assuming extreme conditions and by assuming that changes in rates of ground-water flow were proportional to changes in the slope of the piezometric surface (that is, Darcy's law, $Q=TIL$) both when water was flowing in the canal and when the canal was empty, it was computed that canal leakage ranged between 100 and 400 gpd per lineal foot of canal.

The formulas for determining rate of leakage required that the coefficients of transmissibility and storage be known. As no aquifer test was made in the immediate vicinity of the canal-leakage test, coefficients of transmissibility and storage from the test at D2–34–36db3 (P–2) were substituted in the formulas.

Study of the data collected during this test may prove valuable in planning similar tests and in developing this method of measuring canal leakage.

UTILIZATION

DOMESTIC AND STOCK USES

Throughout most of the area, wells yield sufficient water for domestic and stock uses although at places deep drilling is necessary to obtain an adequate supply. Throughout most of the irrigated part of the area, the unconsolidated deposits are water bearing below a level ranging in depth from less than 1 foot to about 10 feet below land surface. (See pls. 5, 6, 8, 10, 11.) In nonirrigated parts of the area the unconsolidated deposits are water bearing, but the zone of saturation is much thinner and the depth to water ranges from about 10 to 30 feet. All the wells north and some of the wells south of Crow Agency tap the unconsolidated deposits.

West of the Little Bighorn River, in places where there are no unconsolidated deposits, water suitable for domestic and stock use generally is not present at shallow depth. Farmers who have no wells, or whose wells yield water of unsuitable quality, generally purchase water in town, truck it home, and store it in cisterns.

In most places south of Crow Agency, abundant supplies of water can be obtained readily from the Parkman sandstone at depths of less than 200 feet, but north of Crow Agency the Parkman either is too thin to be a source of supply or is missing entirely. Small supplies of water probably could be obtained from the deeper bedrock aquifers. The Eagle sandstone equivalent and the Frontier formation are potential sources of water supply within a depth of 3,000 feet, but the supply is not likely to be large. The high cost of drilling to these formations has discouraged development of supplies from these sources.

INDUSTRIAL AND MUNICIPAL USES

Sufficient water for many industrial uses could be obtained from the unconsolidated stream deposits wherever they are recharged by infiltrating river or irrigation water. Even in the most favorable locations, however, the maximum yield from a properly constructed well 12 inches in diameter probably would not exceed 300 gpm. Wells tapping unconsolidated deposits that are not close to a source of recharge probably would not have a sustained yield of more than 20 gpm.

Crow Agency obtains water from a large-diameter, brick-walled, dug well near the edge of the river. This well is connected by pipe to a collection gallery, and when the water level in the well is lowered by pumping, water flows from the collection gallery into the well. During extended periods of pumping the capacity of the pump exceeds the rate of inflow to the well and a temporary water shortage results; during critical periods the vicinity of the collection gallery is artificially flooded to increase recharge to the collector.

Apparently the low yield of the supply system is largely a reflection of entrance losses at the well and the shallow depth of the well and collection gallery. Improvement of the present system or drilling a more modern well is necessary to make the supply adequate. A suitably situated well having a diameter of 8 to 12 inches, screened throughout the full thickness of the water-bearing material and properly developed, should yield at least 100 gpm; and the present system could be retained as an emergency source of supply. Favorable areas for the site of a new well are shown in figure 26.

The Parkman sandstone is the most important aquifer for potential industrial supplies in the area. A well drilled through the full thickness of this formation might, under favorable conditions, yield as much as 500 gpm with a drawdown of 50 to 60 feet.

A single well tapping the Parkman sandstone supplied water to the town of Lodge Grass until 1954, when a second well was drilled. The first well was pumped continuously during the summer but the demand often exceeded the yield of the well. A pump of larger capacity set deeper in the well probably would materially increase its yield. But before such an installation is made, it would be advisable to check the total depth of the well and the length of casing, and to determine the specific capacity of the well by a thorough test. The second well was drilled into the same aquifer and is used both as a supplemental supply and as a standby in case the older pump fails.

The theoretical drawdown of the water level in the Parkman sandstone at various distances from the city well is shown in figure 27. This figure may be used to determine whether, by increased pumping of the city well, the water level in nearby wells would be lowered below the reach of the pumps.

Other bedrock aquifers in this area that would yield large quantities of water are 3,000 feet or more below the land surface.

IRRIGATION USE

The only known use of ground water for irrigation in this area, other than for watering lawns and gardens, is the irrigation of hay fields with water from well D6–35–21db (P–6), which taps the Cloverly formation. The water is applied by sprinkler. For many years gardens and lawns in and around Lodge Grass also have been watered from wells tapping the Parkman sandstone. At several locations in the southern part of the area, wells capable of delivering about 2 acre-feet of water per day could be installed in the Parkman sandstone. Although the water from bedrock aquifers is unsuitable for irrigation according to accepted standards (fig. 33 and p. 87), no ill effects from its use had been detected to 1954.

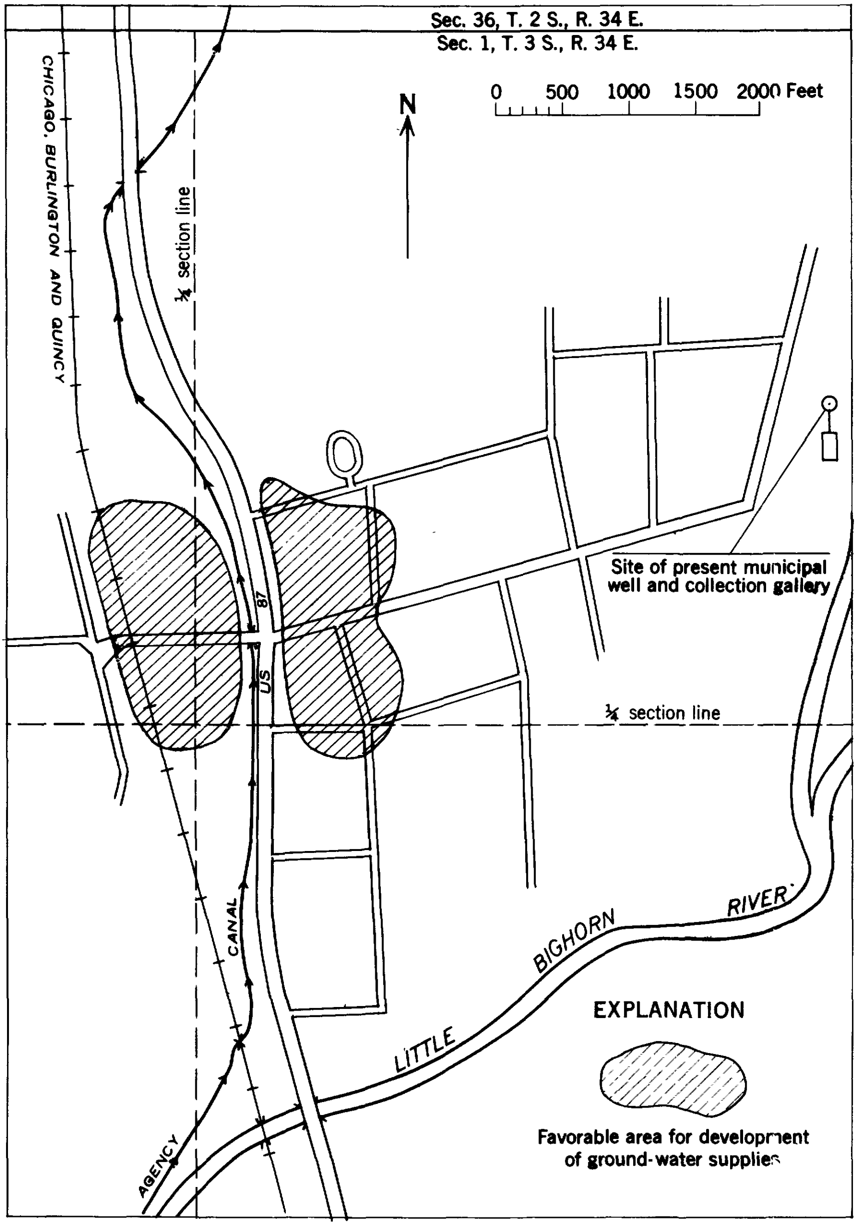

FIGURE 26.—Map of Crow Agency, Mont., showing favorable areas (shaded) for development of ground-water supplies.

Very little irrigable land in the area could be irrigated more easily with water from the unconsolidated deposits than from surface sources. The alluvium in the small tributary valleys possibly would yield sufficient water for irrigation, but evidence indicates that the quality of the water is unsuitable.

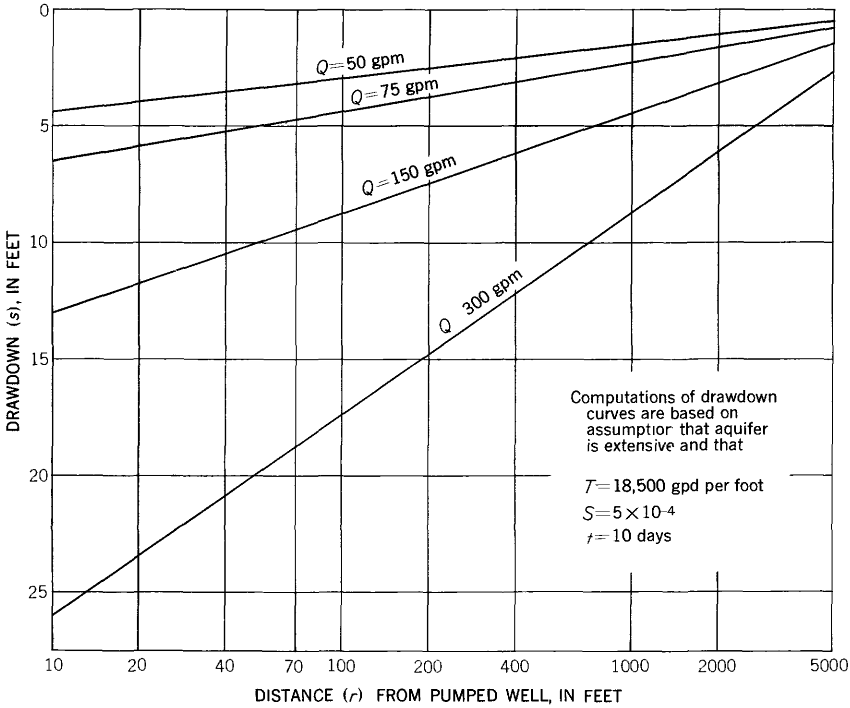

FIGURE 27.—Graph showing theoretical drawdown of water level in Parkman sandstone at end of 10-day pumping period, Lodge Grass No. 1 unit.

FACTORS AFFECTING DEVELOPMENT OF LARGE SUPPLIES

Most of the drilled wells in the unconsolidated deposits are constructed by sinking an unperforated, 4- or 6-inch open-end casing into the saturated gravel to a depth of several feet below the water table; then the casing is bailed until it is free of fine-grained material and the water is clear. Some of the wells tapping the unconsolidated deposits have become so silted that water cannot enter the casing.

Bedrock wells are drilled until they penetrate a water-bearing sandstone sufficiently thick to yield enough water to meet the expected demand. The wells are usually cased only from the surface to a level a few feet below the base of the unconsolidated deposits and are completed as open holes in the water-bearing rock. They then are bailed until the water becomes clear. Some of the wells drilled into bedrock have caved and are no longer usable.

Few, if any, of the wells have been designed for maximum yield or efficiency. Where insurance against failure is important, a large yield necessary, or increased efficiency demanded, improved practices of drilling and developing wells must be followed.

If a well is to have the greatest possible yield, the loss in head that occurs as the water enters the well must be kept at a minimum.

In constructing wells in the unconsolidated deposits, use of perforated casing or commercial-type well screen instead of blank open-end casing would greatly facilitate entry of water into the well and, thereby, reduce the total head loss. Wells that fully penetrate and are screened throughout the full thickness of the aquifer are the most efficient because the flow lines are parallel rather than convergent. (See fig. 28.) The openings in the perforated casing or well screen should be large enough to admit only the finer grained particles surrounding it. Surging of the well loosens the small particles outside the screen and pulls them into the well, thus creating a network of coarse particles adjacent to the outside of the screen and increasing the effective diameter of the well. The fine-grained material that enters the well as a result of the surging can be removed by bailing.

No screen is necessary if a well drilled into a bedrock aquifer will stand open without it. In doubtful cases, or to insure a long life for the well, a screen or perforated casing through the entire thickness of the aquifer is desirable. In general, to prevent caving above the water-bearing horizon and ultimate failure of the well, it is wise to install unperforated casing from the land surface down to the top of the aquifer. This precaution is especially necessary where wells derive water from the loosely consolidated beds of Cretaceous age or younger.

Where no bedrock aquifer is present at a shallow depth, the installation of a battery of wells, an infiltration gallery, or a horizontal collector well may be necessary if quantities of water are required in

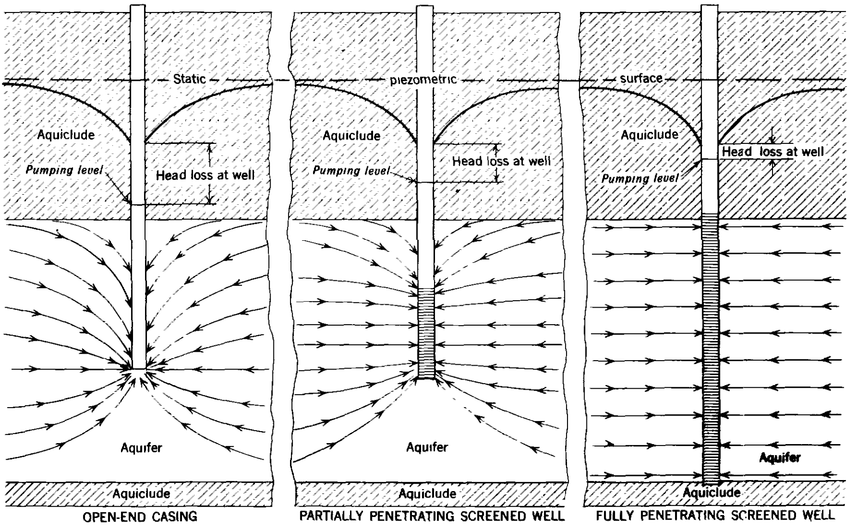

FIGURE 28.—Sketch showing differences in pumping levels and head loss in three types of wells.

excess of that supplied by the conventional-type drilled well. If a multiple-well system is selected, the wells should be spaced so as to avoid excessive interference. Infiltration galleries or horizontal collector wells generally are installed only where a small drawdown is possible and where a source of recharge is nearby.

CHEMICAL QUALITY OF THE WATER

By R. A. Krieger

SOURCE AND SIGNIFICANCE OF THE MAJOR DISSOLVED CONSTITUENTS

Calcium and magnesium are dissolved from many rocks, especially limestone, dolomite, gypsum, and gypsiferous shale. Some of the bedrock formations cropping out along the streams that drain the Bighorn Mountains consist, at least in part, of one or more of these rock types. Calcium and magnesium cause hardness and form scale in boilers, hot-water pipes, and heaters. If present in suitable proportions, however, they are desirable constituents in irrigation water because they counteract the harmful effects of sodium on the soil and tend to preserve a desirable soil texture.

Sodium and potassium are dissolved from nearly all rocks. Sodium generally is present in much higher concentrations than potassium in both ground and surface waters of arid regions of the United States. If sodium constitutes most of the basic ions in a water, the water may not be satisfactory for irrigation because of the detrimental effect of sodium on the soil.

Carbonate is dissolved from many rocks, particularly those containing calcium and magnesium carbonates. Carbon dioxide in water aids in the dissolving process. However, the amount of carbonate in water generally is very small, but *bicarbonate*, formed from carbonate during solution of some rocks, may be present in appreciable quantity. Water from such rocks as granite and gneiss may contain only a small amount of bicarbonate, but water from limestone may contain several hundred parts per million. In the evaluation of the suitability of water for irrigation, carbonate and bicarbonate are important constituents. (See p. 83.)

Sulfate is dissolved mainly from gypsum but is derived also by oxidation of iron sulfides. Sulfur is an essential plant nutrient. In combination with calcium and magnesium, sulfate forms a hard scale in boilers, hot-water pipes, and heaters.

Chloride is dissolved from many rocks and soils. A large amount of chloride in water may be present naturally or may have been caused by return drainage from irrigated lands or by industrial, municipal, or domestic effluents.

Fluoride is present in natural water in concentrations generally less than 1 ppm. If water containing more than about 1.5 ppm of fluoride is used for drinking by children during the period of tooth formation, the enamel of the teeth may become mottled or discolored. However, the incidence of tooth decay may be decreased if the concentration of fluoride in drinking water is about 1 ppm (Dean, 1938, p. 1443–1452).

Nitrate is the final product of aerobic decomposition of nitrogenous organic matter, such as sewage, plants, and animal wastes Thus, appreciable quantities of nitrate may be an indication of pollution. Usually the quantity of nitrate is not sufficient to cause harm, but water containing more than about 45 ppm of nitrate, when used in infant-feeding formulas, may cause a serious blood condition (Comly, 1945, p. 112–116).

Boron is one of the trace, but essential, elements necessary for plant growth. However, the concentration of boron necessary to plants is very small. Plants differ markedly in their tolerance to excessive concentrations of boron, but some crops may be injured when the concentration in irrigation water is greater than about 1 ppm.

Specific conductance is a measure of the ability of a solution to conduct an electrical current. As the concentration of dissolved material increases, the electrical resistance of the water decreases and the electrical conductance of the water increases. Thus, specific conductance is a measure, though not a direct one as is the *dissolved-solids* determination, of the total amount of dissolved mineral matter in a water.

Percent sodium is computed by dividing the concentration of sodium in equivalents per million by the sum of the equivalents per million of the principal cations—calcium, magnesium, sodium, and potassium—and multiplying by 100. The ratio of sodium to the cations is important in irrigation water because it affects the degree to which sodium will replace calcium and magnesium in the base-exchange complex of the soil. Excessive percent sodium in water tends to cause soils to become relatively impermeable and difficult to till and irrigate properly. In combination with the carbonate radical, sodium can cause the soil condition known as "black alkali."

GEOCHEMISTRY

Samples of ground water for chemical analysis were collected from the Cloverly formation, Claggett shale member of the Cody shale, and Parkman sandstone of Cretaceous age and from the unconsolidated stream deposits of Quaternary age. The results of analysis are given in parts per million in table 14 and in equivalents per million in table 15.

TABLE 14.—*Mineral constituents, in parts per million, and other characteristics of ground water*

[Geologic source: Kcv, Cloverly formation; Kcl, Claggett shale member of the Cody shale; Kp, Parkman sandstone; Ku, undifferentiated rocks of Cretaceous age; Qt, terrace deposits; Qal, alluvium; Qalf, alluvial fan; and Qu, undifferentiated deposits of Quaternary age]

Well: Coordinate system	Well: Field	Geologic source	Well depth (feet)	Date of collection	Temperature (°F)	Silica (SiO_2)	Total iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Residue on evaporation at 180° C	Dissolved solids: Sum	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Specific conductance (micromhos at 25° C)	pH
Lodge Grass No. 1 unit																									
				1953																					
D5-35-22cc	D-3	Qt1	19.1	Aug. 26	48	23		95	98	230	5.0	465	0	730	6.5	0.4	0.3	0.62	1,420		639	258	44	1,920	8.1
22dc	D-2	Qal(?)	17.4	do	50	20		83	47	278	6.3	485	0	608	6.5	.3	.5	.28	1,290		401	3	60	1,830	8.0
27ba		Kp	100.0	Sept. 15	61	10	0.04	3.5	.1	348	1.4	419	13	408	4.5	.2	2.0	.38	1,000		9	0	99	1,530	8.5
27db	D-5	Qt1	16.7	Aug. 26	50	20		91	78	126	4.7	441	0	445	3.0	.5	3.7	.25	999		547	185	33	1,390	7.4
D6-35-1cb	D-10	Qt1	26.2	do	50	13		89	52	122	3.1	387	0	365	6.0	.3	2.0	.31		844	436	119	38	1,230	7.8
11bd		Qt2(?)	Spring	Aug. 24	55	15	.08	108	38	62	4.2	452	0	178	6.5	.2	5.5	.18		641	426	55	24	985	7.5
12dd	D-13	Qt1	8.0	Aug. 26	59	17		87	57	98	3.0	449	0	288	4.5	.3	6.0	.26		782	452	84	32	1,140	8.0
13ac4	P-5	Kp	210.0	Sept. 1	52	8.8	.04	5.5	.1	406	1.1	455	17	480	13	.8	1.8	.54	1,160		14	0	98	1,750	8.5
13ba	D-15	Qu	12.9	Aug. 26	60	16	.65	124	41	18	1.8	507	0	100	3.0	.1	.2	.06		555	479	63	7	887	7.3
14ca	D-21	Qt2	7.7	do	63	12		129	41	34	2.6	543	0	106	3.0	.2	11	.16		606	490	45	13	963	7.2
14db	D-24	Qal	16.2	do	50	11		129	74	110	2.8	456	0	485	6.5	.3	.1	.40	1,070		626	252	28	1,450	7.4
21db	P-6	Kcv	3,507.0	Aug. 27[1]	83	23	.15	.5	.1	157	.6	201	6	161	5.5	.2	.2	.07	460		2	0	99	697	8.4
				do[2]	104	20	.12	.7	.1	155	.8	215	0	159	5.0	.3	.1	.06	452		2	0	99	697	7.8
29ab	D-26	Qal	15.4	Aug. 26	50	11	3.5	101	34	34	2.4	370	0	154	2.0	.1	1.3	.16	530		390	87	16	818	7.3
Benteen Flat unit																									
				1953																					
D4-35-21cd1		Kp or Kcl	325	Sept. 15	66	10	0.17	3.0	0.1	412	1.2	413	20	520	8.0	0.3	2.5	0.24	1,180		8	0	99	1,780	8.3
21cd2	C-8	Qal	23.7	Aug. 26	49	16	1.1	82	40	46	2.8	349	0	162	3.5	.2	3.8	.11	555		367	81	21	835	7.4
33ac	C-11	Qal	14.5	do	52	16	3.9	148	46	127	6.1	496	0	420	7.5	.2	.1	.10	1,020		557	150	33	1,430	7.5
D5-35-3cc		Kcl	505	do	55	11	.03	1.0	.1	320	.8	494	32	233	12	.6	1.7	.40	857		3	0	99	1,340	8.8

Reno and Battlefield units

				1953																					
D3-34-13da	B-16	Qal	7.9	Aug. 25	59	19	3.4	174	92	600	7.3	550	0	1,600	45	0.5	0.2	1.3	2,880	---	814	363	61	3,580	7.4
36dc	---	Ku	---	Aug. 24	51	21	.59	63	35	28	3.0	335	0	80	6.5	.3	1.7	.43	---	405	300	25	17	649	7.3
D3-35-18bc	---	Qt1	23.2	Aug. 25	49	22	1.7	76	31	42	2.6	283	0	173	3.5	.1	.6	.07	492	---	319	87	22	740	7.5
18cc	B- 4	Qt1	13.3	do	55	22	5.5	189	208	872	8.4	626	0	2,600	72	.6	.3	2.0	4,630	---	1,330	817	59	5,340	7.4
18dc	P- 3	Kp	120	Sept. 4	53	9.9	.64	6.5	1.5	624	1.5	450	0	935	29	.3	3.3	.42	1,830	---	22	0	98	2,670	8.1
20cc	B- 7	Qt1	14.8	Aug. 25	61	19	---	82	58	356	5.0	600	0	695	12	.5	.0	.48	1,530	---	442	0	63	2,120	7.6
29cc1	B-35	Qalf	28.2	do	50	25	---	166	132	843	9.5	542	0	2,330	18	.6	1.0	.23	3,920	---	958	514	65	4,600	7.6
29cc2	B-34	Qalf	31.0	do	52	23	2.0	223	155	434	7.7	479	0	1,730	17	.5	1.9	.53	3,040	---	1,190	797	44	3,430	7.5
29cd	B-36	Qalf	26.4	do	52	25	.84	86	76	187	6.4	433	0	570	4.0	.3	.1	.40	1,180	---	525	170	43	1,610	7.6
29da2	B-41	Qal	8.9	do	56	19	---	163	84	242	7.6	500	0	830	15	.5	.3	.44	1,650	---	750	340	41	2,120	7.4
29db	B-42	Qal	17.7	do	58	18	---	113	79	376	6.6	538	0	960	13	.4	1.1	.71	1,840	---	606	165	57	2,470	7.8
D4-34-11da	---	Qal	43.7	do	51	14	2.3	430	382	1,250	8.6	596	0	4,630	148	.7	.0	1.4	7,720	---	2,650	2,160	51	7,690	7.4
D4-35- 4ab	B-26	Qt1	15.2	do	56	24	1.6	60	66	65	5.5	432	0	207	3.0	.5	2.1	.25	---	648	420	66	25	975	7.6
16bd	B-31	Qal	12.0	do	68	15	3.1	58	28	31	3.5	218	6	135	2.0	.3	.3	.20	400	---	260	71	20	600	8.3

Agency unit

				1952																					
D1-34-19dc	A- 4	Qal	12.4	Sept. 5	68	10	---	68	39	67	3.6	244	0	269	3.0	0.3	1.2	0.22	600	---	330	130	30	892	7.6
20cc	A- 5	Qal	22.4	Oct. 7	51	---	---	---	---	1,300	---	672	0	---	---	---	---	---	---	---	2,110	1,560	57	7,390	7.5
29ab2	A- 7	Qt1	25.8	do	64	---	---	---	---	55	---	297	0	---	---	---	---	---	---	---	348	104	26	872	7.5
33bb3	A-12	Qal	17.5	do	58	---	---	---	---	262	---	211	6	---	---	---	---	---	---	---	646	463	47	2,120	8.3
33cd3	A-17	Qalf	33.9	do	55	---	---	---	---	564	---	415	0	---	---	---	---	---	---	---	1,670	1,330	42	4,500	7.3
33da	A-14	Qt1	20.0	Sept. 5	49	22	---	207	155	230	6.6	429	0	1,240	17	.4	.9	.47	2,330	---	1,150	798	30	2,600	7.5
D2-34- 2cc2	A-30	Qt1	19.5	Oct. 7	52	---	---	---	---	171	---	419	0	---	---	---	---	---	---	---	485	141	43	1,500	7.4
2cd	A-31	Qal	12.9	do	53	---	---	---	---	688	---	685	0	---	---	---	---	---	---	---	1,150	588	57	4,260	7.2
3aa2	A-20	Qt1	17.3	do	61	---	---	---	---	91	---	366	0	---	---	---	---	---	---	---	420	120	32	1,120	7.6
3bc	A-21	Qt1	19.1	do	53	---	---	---	---	380	---	288	0	---	---	---	---	---	---	---	1,290	1,050	39	3,340	8.1
3dc2	P- 1	Qt1	21.7	Sept. 4	56	28	0.24	251	152	202	7.1	393	0	1,300	17	.5	.8	.89	2,380	---	1,250	928	26	2,620	7.4
11da	A-32	Qt1	13.6	Oct. 7	57	---	---	---	---	122	---	418	0	---	---	---	---	---	---	---	439	96	38	1,250	7.5
13dd	A-43	Qal	17.9	do	54	---	---	---	---	388	---	448	0	---	---	---	---	---	---	---	542	175	61	2,460	7.5
14ab2	A-36	Qt1	19.2	do	53	---	---	---	---	217	---	447	0	---	---	---	---	---	---	---	615	248	43	1,880	7.6
14ca	A-38	Qt1	23.0	do	53	---	---	---	---	195	---	355	0	---	---	---	---	---	---	---	662	371	39	1,880	7.5
23aa	A-40	Qal	37.3	do	57	---	---	---	---	54	---	357	0	---	---	---	---	---	---	---	350	57	25	839	7.5
24db	A-45	Qt1	26.1	Sept. 5	54	20	---	63	52	52	4.1	362	0	189	3.0	.4	.6	.30	563	---	371	74	23	895	7.6
24dd	A-49	Qal	16.4	Oct. 7	53	---	---	---	---	230	---	488	0	---	---	---	---	---	---	---	483	83	51	1,750	7.4
25cd	A-54	Qalf	39.4	do	59	---	---	---	---	424	---	455	0	---	---	---	---	---	---	---	1,130	757	45	3,360	7.3
36db3	P- 2	Qt1	22.0	Sept. 9	49	18	.74	55	37	64	3.2	263	0	209	5.5	.5	1.0	.37	524	---	291	75	32	817	7.6
D2-35-30cb	A-53	Qal	19.6	Oct. 7	53	---	---	---	---	174	---	559	0	---	---	---	---	---	---	---	631	173	37	1,720	7.4
D3-34- 1ad1	---	Qal	20.1	Sept. 5	60	16	.97	95	42	60	3.6	344	0	245	9.5	.2	.7	.17	649	---	408	126	24	969	7.6
1ad2	A-63	Qal	23.9	Oct. 7	49	---	---	---	---	80	---	520	0	---	---	---	---	---	---	---	596	170	23	1,310	7.3

[1] 3 minutes after start of test. [2] 270 minutes after start of test.

TABLE 15.—*Mineral constituents and residual sodium carbonate, in equivalents per million, of ground water*

[Geologic source: Kcv, Cloverly formation; Kcl, Claggett shale member of the Cody shale; Kp, Parkman sandstone; Ku, undifferentiated rocks of Cretaceous age; Qt, terrace deposits; Qal, alluvium; Qalf, alluvial fan; and Qu, undifferentiated deposits of Quaternary age]

Well: Coordinate system	Well: Field	Geologic source	Well depth (feet)	Date of collection	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Residual sodium carbonate
Lodge Grass No. 1 unit															
				1953											
D5-35-22cc	D- 3	Qt1	19.1	Aug. 26	4.74	8.04	10.00	0.13	7.62	0.00	15.20	0.18	0.02	0.00	0.00
22dc	D- 2	Qal(?)	17.4	do	4.14	3.88	12.09	.16	7.95	.00	12.66	.18	.02	.01	.00
27ba		Kp	100.0	Sept. 15	.17	.01	15.13	.04	6.87	.43	8.49	.13	.01	.03	6.69
27db	D- 5	Qt1	16.7	Aug. 26	4.54	6.40	5.48	.12	7.23	.00	9.26	.08	.03	.06	.00
D6-35- 1cb	D-10	Qt1	26.2	do	4.44	4.28	5.31	.08	6.34	.00	7.60	.17	.02	.03	.00
11bd		Qt2(?)	Spring	Aug. 24	5.39	3.13	2.70	.11	7.41	.00	3.71	.18	.01	.09	.00
12dd	D-13	Qt1	8.0	Aug. 26	4.34	4.70	4.26	.08	7.36	.00	6.00	.13	.02	.10	.00
13ac4	P- 5	Kp	210.0	Sept. 1	.27	.01	17.65	.03	7.46	.57	9.99	.37	.04	.03	7.75
13ba	D-15	Qu	12.9	Aug. 26	6.19	3.39	.78	.05	8.31	.00	2.08	.08	.01	.00	.00
14ca	D-21	Qt2	7.7	do	6.44	3.36	1.48	.07	8.90	.00	2.21	.08	.01	.18	.00
14db	D-24	Qal	16.2	do	6.44	6.08	4.78	.07	7.47	.00	10.10	.18	.02	.00	.00
21db	P- 6	Kcv	3,507.0	Aug. 27[1]	.02	.01	6.83	.02	3.29	.20	3.35	.16	.01	.00	3.56
				do[2]	.03	.01	6.74	.02	3.52	.00	3.31	.14	.02	.00	3.48
29ab	D-26	Qal	15.4	Aug. 26	5.04	2.76	1.48	.06	6.06	.00	3.21	.06	.01	.02	.00
Benteen Flat unit															
				1953											
D4-35-21cd1		Kp or Kcl	325	Sept. 15	0.15	0.01	17.92	0.03	6.77	0.67	10.83	0.23	0.02	0.04	7.28
21cd2	C- 8	Qal	23.7	Aug. 26	4.09	3.25	2.00	.07	5.72	.30	3.37	.10	.01	.05	.00
33ac	C-11	Qal	14.5	do	7.39	3.75	5.52	.16	8.13	.00	8.74	.21	.01	.00	.00
D5-35- 3cc		Kcl	505	do	.05	.01	13.91	.02	8.10	1.07	4.85	.34	.03	.03	9.11

Reno and Battlefield units

				1953											
D3-34-13da	B-16	Qal	7.9	Aug. 25	8.68	7.60	26.09	0.19	9.01	0.00	33.31	1.27	0.03	0.00	0.00
36dc		Ku		Aug. 24	3.14	2.86	1.22	.08	5.49	.00	1.67	.18	.02	.03	.00
D3-35-18bc		Qtl	23.2	Aug. 25	3.79	2.59	1.83	.07	4.64	.00	3.60	.10	.01	.01	.00
18cc	B- 4	Qtl	13.3	do	9.43	17.07	37.92	.21	10.26	.00	54.13	2.03	.03	.00	.00
18dc	P- 3	Kp	120	Sept. 4	.32	.12	27.13	.04	7.37	.00	19.47	.82	.02	.05	6.93
20cc	B- 7	Qtl	14.8	Aug. 25	4.09	4.75	15.48	.13	9.83	.00	14.47	.34	.03	.00	.99
29cc1	B-35	Qalf	28.2	do	8.28	10.88	36.66	.24	8.88	.00	48.51	.51	.03	.02	.00
29cc2	B-34	Qalf	31.0	do	11.13	12.75	18.87	.20	7.85	.00	36.02	.48	.03	.03	.00
29cd	B-36	Qalf	26.4	do	4.29	6.21	8.13	.16	7.10	.00	11.87	.11	.02	.00	.00
29da2	B-41	Qal	8.9	do	8.13	6.87	10.52	.19	8.19	.00	17.28	.42	.03	.00	.00
29db	B-42	Qal	17.7	do	5.64	6.48	16.35	.17	8.82	.00	19.99	.37	.02	.02	.00
D4-34-11da		Qal	43.7	do	21.46	31.44	54.35	.22	9.77	.00	96.39	4.17	.04	.00	.00
D4-35- 4ab	B-26	Qtl	15.2	do	2.99	5.41	2.83	.14	7.08	.00	4.31	.08	.03	.03	.00
16bd	B-31	Qal	12.0	do	2.89	2.31	1.35	.09	3.57	.20	2.81	.06	.02	.00	.00

Agency unit

				1952											
D1-34-19dc	A- 4	Qal	12.4	Sept. 5	3.39	3.21	2.91	0.09	4.00	0.00	5.60	0.08	0.02	0.02	0.00
20cc	A- 5	Qal	22.4	Oct. 7	42.10		56.53		11.01	.00					.00
29ab2	A- 7	Qtl	25.8	do	6.96		2.39		4.87	.00					.00
33bb3	A-12	Qal	17.5	do	12.96		11.39		3.46	.20					.00
33cd3	A-17	Qalf	33.9	do	33.44		24.52		6.80	.00					.00
33da	A-14	Qtl	20.0	Sept. 5	10.33	12.71	10.00	.17	7.03	.00	24.82	.48	.02	.01	.00
D2-34- 2cc2	A-30	Qtl	19.5	Oct. 7	9.70		7.44		6.87	.00					.00
2cd	A-31	Qal	12.9	do	22.96		29.92		11.23	.00					.00
3aa2	A-20	Qtl	17.3	do	8.40		3.96		6.00	.00					.00
3bc	A-21	Qtl	19.1	do	25.72		16.52		4.72	.00					.00
3dc2	P- 1	Qtl	21.7	Sept. 4	12.52	12.48	8.78	.18	6.44	.00	27.07	.48	.03	.01	.00
11da	A-32	Qtl	13.6	Oct. 7	8.78		5.31		6.85	.00					.00
13dd	A-43	Qal	17.9	do	10.84		16.87		7.34	.00					.00
14ab2	A-36	Qtl	19.2	do	12.30		9.44		7.33	.00					.00
14ca	A-38	Qtl	23.0	do	13.24		8.48		5.82	.00					.00
23aa	A-40	Qal	37.3	do	7.00		2.35		5.85	.00					.00
24db	A-45	Qtl	26.1	Sept. 5	3.14	4.28	2.26	.10	5.93	.00	3.93	.08	.02	.01	.00
24dd	A-49	Qal	16.4	Oct. 7	9.66		10.00		8.00	.00					.00
25cd	A-54	Qalf	39.4	do	22.68		18.44		7.46	.00					.00
36db3	P- 2	Qtl	22.0	Sept. 9	2.74	3.08	2.78	.08	4.31	.00	4.35	.16	.03	.02	.00
D2-35-30cb	A-53	Qal	19.6	Oct. 7	12.62		7.57		9.16	.00					.00
D3-34- 1ad1		Qal	20.1	Sept. 5	4.74	3.42	2.61	.09	5.64	.00	5.10	.27	.01	.01	.00
1ad2	A-63	Qal	23.9	Oct. 7	11.92		3.48		8.52	.00					.00

[1] 3 minutes after start of test. [2] 270 minutes after start of test.

WATER FROM BEDROCK AQUIFERS

The chemical composition of water from bedrock aquifers is summarized in table 16.

TABLE 16.—*Composition, in percentages of chemical equivalents of cations and anions, of water from bedrock aquifers*

Well		Dissolved solids (ppm)	Percent of total cations			Percent of total anions	
Coordinate system	Field		Calcium (Ca)	Magnesium (Mg)	Sodium plus potassium (Na+K)	Bicarbonate plus carbonate (HCO_3+CO_3)	Sulfate (SO_4)
Parkman sandstone							
D6-35-13ac4	P-5	1,160	1.5	0.1	98.4	43.5	54.1
D5-35-27ba		1,000	1.1	.1	98.8	45.7	53.2
D3-35-18dc	P-3	1,830	1.2	.4	98.4	26.6	70.2
D1-35- 8cb [1]		322	34.2	36.7	29.1	80.4	17.5
Parkman sandstone or Claggett shale member of the Cody shale							
D4-35-21cd1		1,180	0.8	0.1	99.1	40.1	58.4
Claggett shale member of the Cody shale							
D5-35-3cc		857	0.4	0.1	99.5	63.6	33.6
Cloverly formation							
D6-35-21db	P-6	460	0.3	0.1	99.6	49.8	47.8
32-16d [1]		734	1.3	1.0	97.7	57.2	31.0
Undifferentiated rocks of Cretaceous age							
D3-34-36dc		405	43.0	39.2	17.8	74.3	22.5

[1] Thom and others (1935).

Water from the Parkman sandstone is characterized by extreme softness (low calcium and magnesium concentration) and very high percent sodium. The principal anion is sulfate, although the concentration of bicarbonate very nearly equals that of sulfate. One water sample from a well (D1–35–8cb) outside of the area contained more calcium and magnesium than sodium and more bicarbonate than sulfate (Thom and others, 1935). However, the water from the Parkman sandstone in the lower Little Bighorn River valley may be described as essentially a solution of sodium sulfate and bicarbonate.

Water from well D6–35–21db (P–6), which taps the Cloverly formation, was similar in composition to water from the Parkman sandstone, except that the percentage of bicarbonate plus the carbonate slightly exceeded the percentage of sulfate. Water from well D5–45–3cc, which taps the Claggett shale member of the Cody shale, was similar to water from the Cloverly formation, except the percentage of bicarbonate was almost double that of sulfate.

Crawford (1940) gives the results of analysis of water samples collected from the Cloverly formation in oil fields in Wyoming. He attributes the low concentration of calcium and magnesium in water from the Cloverly formation to base exchange in the lenticles and beds of bentonite. The similarity in chemical composition of water from the Parkman, Cloverly, and Claggett in the Little Bighorn River and Lodge Grass Creek valleys may be caused by deposits of bentonite throughout the rocks of Cretaceous age (Knechtel and Patterson, 1952).

Water from well D3–34–36dc probably is representative of that from upland areas where precipitation is the only source of recharge.

WATER FROM UNCONSOLIDATED DEPOSITS

Whereas water from bedrock aquifers generally is soft and has a percent sodium greater than 95, water from the unconsolidated deposits generally is hard and has a percent sodium of less than 70. In addition, water from unconsolidated deposits varies widely in composition and in concentration of dissolved salts.

Ground water in the unconsolidated deposits is derived from the infiltration of precipitation and irrigation water, canal seepage, and underflow from the uplands. Water from wells in the vicinity of the canals was similar in chemical composition to that in the canals, and water from the older, higher terrace deposits generally was more mineralized than that from the younger, lower terrace deposits. The more mineralized water contained higher proportions of sulfate and of sodium than did the less mineralized water. (See figs. 29 and 30.) The increase in sodium and sulfate may be caused by inflow of water from adjacent Cretaceous formations or from deposits of material eroded from these formations.

LODGE GRASS NO. 1 UNIT

Water diverted from Lodge Grass Creek for irrigation of the Lodge Grass No. 1 unit is of the calcium bicarbonate type, low in percent sodium, and relatively low in dissolved minerals. The effect of seepage from the canal and of irrigation water on the quality of the ground water in the Lodge Grass No. 1 unit is shown in plate 13*A* by Stiff diagrams (Stiff, 1951). Stiff diagrams are useful for depicting the chemical character or type of water. They are constructed by plotting the concentration (in equivalents per million) of calcium, magnesium, sodium, and potassium to the left of an ordinate on four successive separate abscissas. The concentrations of bicarbonate plus carbonate, sulfate, chloride, and fluoride plus nitrate are plotted to the right of the vertical line on the four successive separate abscissas. Lines joining these plots enclose an area that has a distinctive shape, depending on the type of water. The size of the diagram is roughly

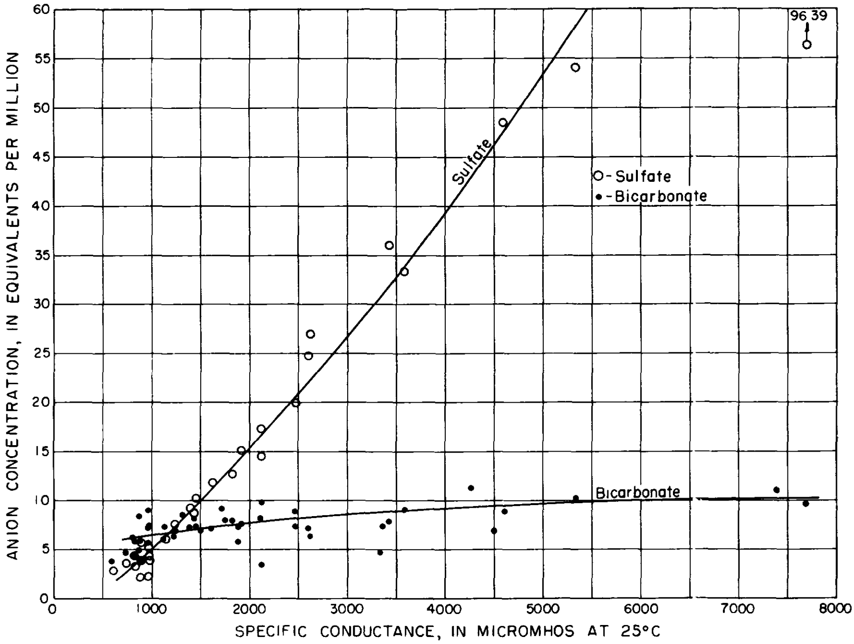

FIGURE 29.—Relation of concentrations of sulfate and of bicarbonate to specific conductance of water from unconsolidated deposits.

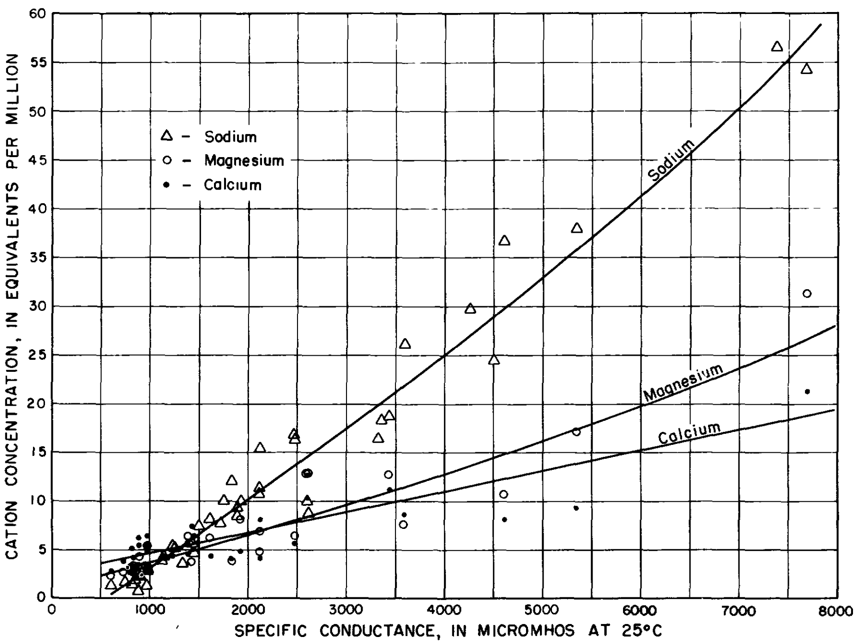

FIGURE 30.—Relation of concentrations of sodium, of magnesium, and of calcium to specific conductance of water from unconsolidated deposits.

proportional to the total concentration of dissolved minerals. For example, the similarity in chemical character and total mineralization of water from the two wells in the Lodge Grass No. 1 unit that tap the Parkman sandstone can easily be seen by comparing the Stiff diagrams.

The similarity in chemical composition of water from well D6–35–29ab (D–26) and from the nearby canal indicates that the ground water in the vicinity of the well may have been derived almost entirely from canal seepage. Water from wells D6–35–14ca (D–21) and D6–35–13ba (D–15) and from spring D6–35–11bd represents ground-water underflow from the irrigated benchland west and northwest of the town of Lodge Grass. Water from these wells also is of the calcium bicarbonate type, low in percent sodium (24 percent, maximum), and relatively low in dissolved solids (555–641 ppm). Evidently the passage of the water through the unconsolidated deposits of Quaternary age hardly changed its chemical quality, except to increase the concentration of dissolved solids. The increase in concentration probably was caused by evaporation and plant intake. Water from wells in unconsolidated deposits farther downstream and also from wells D6–35–14db (D–24) and D6–35–12dd (D–13) in the vicinity of the town of Lodge Grass contained the highest proportions of sodium, magnesium, and sulfate of any water from unconsolidated deposits in the unit.

An example of possible mixing of water from unconsolidated deposits of Quaternary age and water from rocks of Cretaceous age is shown in figure 31, which is based on a diagram proposed by Piper (1945). Percentage composition, based on equivalents per million, of water from well D5–35–27ba, which taps bedrock, and from wells D5–35–22dc (D–2) and D5–35–22cc (D–3), which tap unconsolidated deposits, are plotted as A, M, and B, respectively, on the lower triangles; the position of the points is projected to the diamond-shaped part of the diagram. The plotted points in all parts of the diagram lie on straight lines. Indicating that water M may be a mixture similar to a mixture of water A and water B. The similarity of computed and determined concentrations in water M, as shown below, is additional evidence of the mixed character of the water.

Constituent or property	Concentration computed from equation	Concentration determined by analysis
Specific conductance micromhos	1, 770	1, 830
Dissolved solids ppm	1, 260	1, 290
Total anions or cations epm	20. 1	20. 5
Sodium epm	11. 1	12. 1
Sulfate epm	12. 3	12. 7
Bicarbonate epm	7. 5	8. 0
Hardness as $CaCO_3$ ppm	392	401

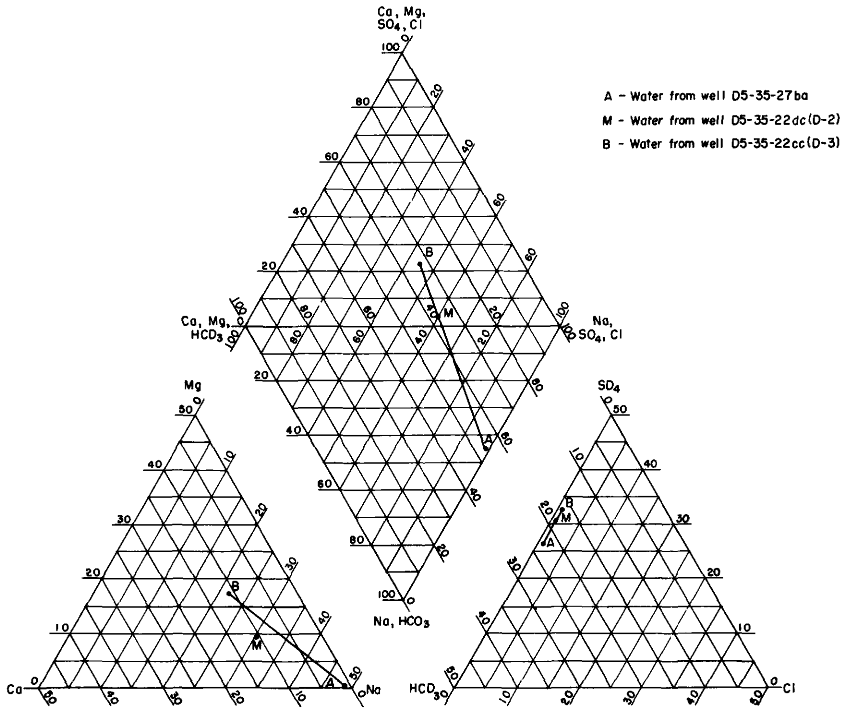

FIGURE 31.—Water analysis diagram (Piper, 1945).

The computed concentrations were derived from the following equation:

$$E_m = \frac{E_a E_b (a+b)}{aE_a + bE_b},$$

where

E_m = concentration in water M;

E_a = concentration in water A;

E_b = concentration in water B;

a = Length of line between points A and M (fig. 31), measured in any of the three fields of the diagram and at any convenient scale;

and

b = length of line between points B and M, measured in the same field and at the same scale as for a.

BENTEEN FLAT UNIT

In the Benteen Flat unit samples of water for chemical analysis were collected from only 2 wells in the unconsolidated deposits and 2 wells in the bedrock (pl. 13*B*). One of the samples was obtained from well D4–35–33ac (C–11), which taps unconsolidated deposits where underflow from the uplands to the east is the principal source of recharge. Water from well D4–35–21cd2 (C–8), which taps the unconsolidated deposits where infiltrating irrigation water pumped from the river is the principal source of recharge, was similar in chemical quality to water from the river.

Samples were collected from two flowing wells that were drilled into bedrock. One of the wells (D4–35–21cd1) is 325 feet deep and possibly taps the Parkman sandstone; the other (D5–35–3cc) is 505 feet deep and taps the Claggett shale member of the Cody shale. Water from the shallower well is similar in chemical quality to water from wells tapping the Parkman sandstone; it is of the sodium bicarbonate sulfate type and contains small amounts of calcium, magnesium, and chloride. Water from the deeper well has a different bicarbonate-sulfate ratio than water from wells tapping either the Parkman sandstone or the Cloverly formation. The diagram (pl. 13*B*) for water from the deeper well does not resemble the diagram for any other sample of water from the area (pl. 13). However, the water does have a high percent sodium (99), which is characteristic of water from bedrock in the area.

RENO AND BATTLEFIELD UNITS

The chemical quality of the water in the Reno and Battlefield units is shown by diagrams in plate 13*C*. Water from well D4–35–16bd (B–31) is similar in chemical quality to water from the Reno Canal; the similarity shows the effect of leakage from the canal. Except for differences in total mineralization, the chemical characteristics of water from many of the wells in the unconsolidated deposits are similar; sodium is the predominant cation, sulfate is the predominant anion, and the concentration of magnesium is greater than that of calcium. The quality of water from the alluvium near the river is similar to that from terrace deposits and alluvial fans except that water from the river alluvium usually contains more calcium than magnesium.

Water from well D3–34–36dc probably is representative of water from upland areas where recharge is solely from precipitation. This well is on the ridge between Shoulder Blade and Medicine Trail Creeks and taps undifferentiated rocks of Cretaceous age.

AGENCY UNIT

For the study of the Agency unit, water samples were collected from the river, Agency Canal, and drains, and from wells tapping the unconsolidated deposits.

Diagrams in plate 13*D* illustrate some of the types of water obtained from wells in the unconsolidated deposits. The effect of water from the Little Bighorn River and from the irrigation canal on the quality of the ground water is apparent in the upstream part of the unit. The similarity of the quality of the water from well D2–34–36db3 (P–2) and from the canal (represented by the sample from the river at site D3–34–13dd, pl. 13*C*) indicates that leakage from the canal is a significant source of recharge to the unconsolidated deposits.

As in the other units, percolating water tends to undergo an increase in sodium sulfate concentration. Such an increase is illustrated by the diagram (pl. 13*D*) for the sample collected from a drain at site D2–34–36da, in an area where canal leakage is the principal source of recharge, and by the diagram (pl. 13*C*) for the sample collected from the Little Bighorn River at site D3–34–13dd.

Water from many of the wells in the unconsolidated deposits is highly mineralized. Specific conductance was more than 2,000 micromhos in more than one-third of the samples and as much as 7,390 micromhos in one sample. The high mineralization may be the result of concentration by evapotranspiration in areas of a locally high water table and of leaching of gypsum from rocks and soils.

SURFACE WATER

Chemical analyses of surface-water samples given in tables 17 and 18 are represented diagrammatically in figure 32 and also on plate 13.

The chemical quality of the water in Lodge Grass Creek differs from that in the Little Bighorn River. Analyses of three samples collected from Lodge Grass Creek in August 1953 show that the water is of relatively low mineralization (specific conductance, 415–575 micromhos) and that the percent sodium is low (3–16). The analyses indicate that the river water was more highly mineralized (657–889 micromhos) and had a higher percent sodium (23–34) than water from Lodge Grass Creek.

In semiarid areas the concentration of dissolved materials in effluent streams generally increases rather uniformly with distance downstream. The increase in Lodge Grass Creek was not uniform at the time of sampling, however, because water—largely snowmelt—stored in Willow Creek Reservoir was being released into the stream a short distance upstream from the middle of the three sampling points. In Lodge Grass Creek the concentrations of sodium, magnesium, and sulfate increase with distance downstream; in the Little Bighorn River, the concentrations of the three principal cations—calcium, magnesium, and sodium—tend to become equal. The concentration

TABLE 17.—*Mineral constituents, in parts per million, and other characteristics of surface water*

Sampling site	Source	Mean discharge (cfs)	Date of collection	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (residue on evaporation at 180° C)	Hardness as $CaCO_3$		Percent sodium	Specific conductance (micromhos at 25° C)	pH
																	Calcium, magnesium	Noncarbonate			
D6-35-24aa	Little Bighorn River upstream from Lodge Grass Creek.		*1953* Aug. 26	6.0	0.00	61	33	39	2.3	257	152	1.0	0.2	0.4	0.15	428	286	75	23	669	7.7
D8-33-35ac	Lodge Grass Creek near Graham diversion.		do	6.8	.01	62	16	3.1	1.1	219	46	1.0	.1	.5	.03	244	221	41	3	415	8.1
D6-35-29ca	Lodge Grass No. 1 Unit Canal at diversion dam.		do	8.3	.03	60	18	13	2.1	218	72	1.0	.2	1.1	.06	283	225	46	11	467	7.7
13db	Lodge Grass Creek at Lodge Grass.		do	6.0	.00	61	27	24	2.3	243	112	2.0	.2	.5	.10	356	261	62	16	575	7.6
D5-35-15cc	Little Bighorn River near Ionia.		do	7.8	.00	59	34	40	2.4	251	161	1.0	.2	.6	.12	433	286	80	23	676	8.0
D4-35-16bd	Reno Canal at diversion dam.		Aug. 25	7.9	.00	52	34	40	2.1	231	165	1.0	.2	.5	.14	421	270	81	24	657	8.1
D3-34-13dd	Little Bighorn River near Crow Agency.	77	*1952* Sept. 4	6.6	.04	55	35	53	2.2	234	208	2.5	.2	.6	.15	490	281	89	29	752	8.2
		102	Oct. 7					47		275							315	89	24	756	8.1
		48	*1953* Aug. 25	8.0	.00	56	36	54	3.0	252	200	1.5	.2	.6	.16	487	288	81	29	742	8.0
D2-34-24cc	Agency Canal		*1952* Oct. 7					49		272							311	88	26	758	8.1
4dd	Agency Canal near Dunmore.		do					51		273							315	91	26	771	8.2
36da	Drain at flume near Crow Agency.		*1953* Aug. 25	19	.00	56	42	99	3.4	281	283	8.0	.4	.3	.50	[1] 650	313	83	40	962	8.2
	Crow Drain		*1952* Oct. 7					104		291							414	175	35	1,150	7.9
3dd	Drain (buried) near Dunmore.		do					144		416							747	406	30	1,770	7.5
D1-34-18dc	Little Bighorn River near mouth.		Sept. 4	6.6	.04	56	41	74	3.0	240	268	4.5	.2	.9	.22	589	308	111	34	886	8.1
			Oct. 7					68		274							342	117	30	889	8.1

[1] Sum of determined constituents.

TABLE 18.—*Mineral constituents and residual sodium carbonate, in equivalents per million, of surface water*

Sampling site	Source	Date of collection	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Residual sodium carbonate
		1953										
D6-35-24aa	Little Bighorn River upstream from Lodge Grass Creek.	Aug. 26	3.04	2.68	1.70	0.06	4.21	3.16	0.03	0.01	0.01	0.00
D8-33-35ac	Lodge Grass Creek near Graham diversion.	do	3.09	1.33	.13	.03	3.59	.96	.03	.01	.01	.00
D6-35-29ca	Lodge Grass No. 1 Unit Canal at diversion dam.	do	2.99	1.51	.57	.05	3.57	1.50	.03	.01	.02	.00
13db	Lodge Grass Creek at Lodge Grass	do	3.04	2.18	1.04	.06	3.98	2.33	.06	.01	.01	.00
D5-35-15cc	Little Bighorn River near Ionia	do	2.94	2.78	1.74	.06	4.11	3.35	.03	.01	.01	.00
D4-35-16bd	Reno Canal at diversion dam	Aug. 25	2.59	2.81	1.74	.05	3.79	3.44	.03	.01	.01	.00
		1952										
D3-34-13dd	Little Bighorn River near Crow Agency	Sept. 4	2.74	2.88	2.30	.06	3.83	4.33	.07	.01	.01	.00
		Oct. 7	6.30		2.04	---	4.51	---	---	---	---	.00
		1953										
		Aug. 25	2.79	2.97	2.35	.08	4.13	4.16	.04	.01	.01	.00
		1952										
D2-34-24cc	Agency Canal	Oct. 7	6.22		2.13	---	4.46	---	---	---	---	.00
4dd	Agency Canal near Dunmore	do	6.30		2.22	---	4.47	---	---	---	---	.00
		1953										
36da	Drain at flume near Crow Agency	Aug. 25	2.79	3.47	4.30	.09	4.61	5.89	.23	.02	.00	.00
		1952										
	Crow Drain	Oct. 7	8.28		4.52	---	4.77	---	---	---	---	.00
3dd	Drain (buried) near Dunmore	do	14.94		6.26	---	6.82	---	---	---	---	.00
D1-34-18dc	Little Bighorn River near mouth	Sept. 4	2.79	3.37	3.22	.08	3.93	5.58	.13	.01	.01	.00
		Oct. 7	6.84		2.96	---	4.49	---	---	---	---	.00

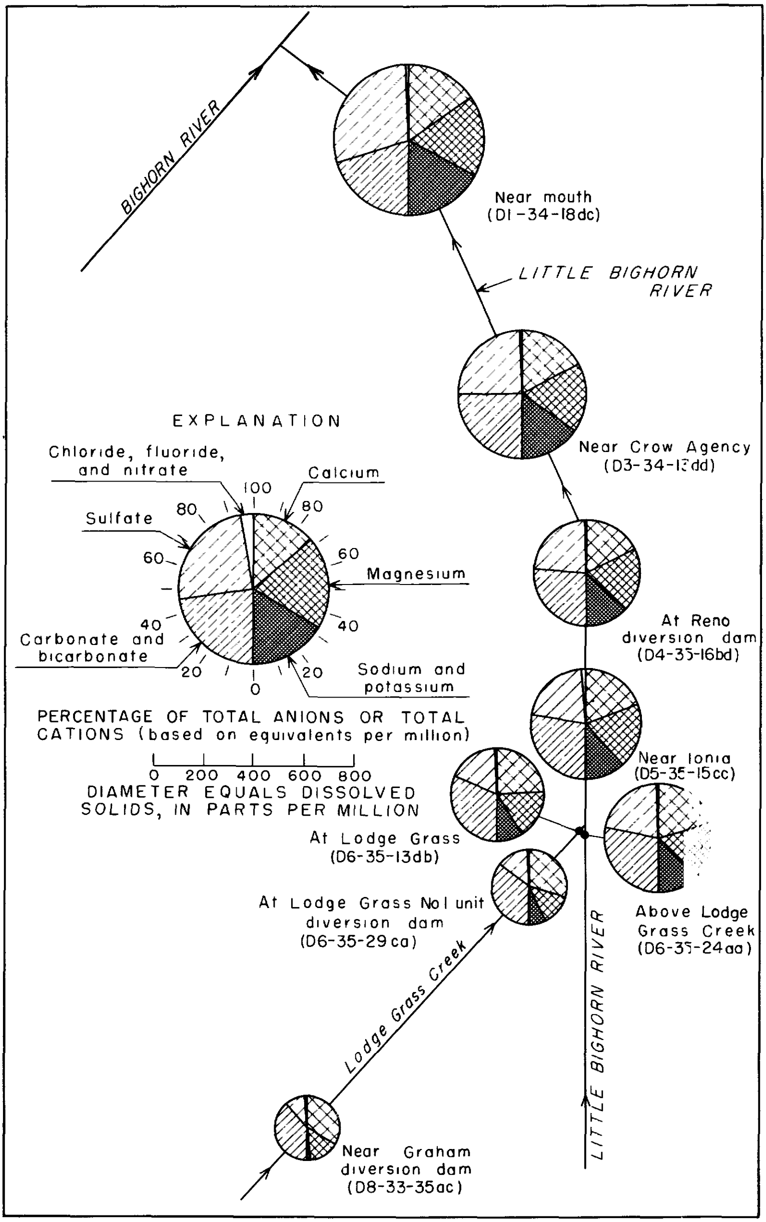

FIGURE 32.—Chemical quality of surface water, lower Little Bighorn River valley.

of sulfate in the Little Bighorn River increases with distance downstream and at the mouth of the river is greater than the concentration of bicarbonate. (See fig. 32).

SUITABILITY OF THE WATER FOR IRRIGATION

The suitability of water for irrigation depends not only on the amount and kind of dissolved material, but also on other factors, such as the type of crop grown, soil texture, climate, and drainage.

The amount of dissolved salts may affect the ability of plant roots to take in water. A high salt content in the soil solution upsets the normal osmotic-pressure balance between the plant and the soil solution. Where the soil solution is highly saline, plants may die from lack of water even though the amount of moisture ordinarily would be sufficient to sustain plant life. Plants are more susceptible to salt injury during germination than they are later in the growth cycle, and different species of plants have widely varying salt tolerances.

Water having a high dissolved-solids content (salinity) can be used with greater success on coarse-textured soil where internal drainage is good than on fine-textured soil where drainage is poor. In poorly drained soil especially, concentration of the salts dissolved in the water takes place in the soil through evapotranspiration. This, in turn, produces a still more saline soil solution. Water having a salinity in terms of electrical conductivity of less than 750 micromhos is suitable for use on practically all types of soil, and water of more than 5,000 micromhos generally is unsuitable for irrigation on any soil (Thorne and Thorne, 1951; U.S. Salinity Laboratory Staff, 1954).

Sodium in the soil solution may have a physicochemical effect on soil structure and may replace essential nutrients in the soil by cation-exchange reactions. Not only the quantity of sodium but also the ratio (percent sodium) between it and the other basic ions (cations) in the water affects soil structure. The ratio affects the degree to which sodium may replace calcium and magnesium in the cation-exchange complex of the soil. Positively charged ions (cations) of the soil solution are adsorbed by the soil colloids. As the adsorbed ions are in equilibrium with the kind and quantity of cations in solution, chemical changes in the soil solution affect the cations adsorbed by the soil colloids—the chemically active part of the soil. Calcium and magnesium are cations that, when adsorbed, tend to flocculate the colloids and thus increase soil porosity. However, if the adsorbed cations consist mainly of sodium, the colloids are deflocculated; the result is a structureless, puddled soil in which the movement of air and water is so hindered that plant growth is retarded. Because the adsorbed ions are in a dynamic state, the application of water having a high percent sodium to a calcium-rich soil can change a soil of good structure to one of poor structure. The upper limit of percent sodium in a water suitable for irrigation depends in part on the texture of the soil and the length of time the water is used. For example, water in which the percent sodium is high may be used on a coarse-textured soil on a long-term basis or on a fine-textured soil for a brief time without serious damage to soil structure.

Irrigation water containing appreciable concentrations of carbonate and bicarbonate, even though having an initially low percent sodium, also may affect soil structure adversely. Evaporation and plant intake may cause precipitation of calcium and magnesium carbonates and thereby increase the percent sodium. Any carbonate and bicarbonate remaining in the water in excess of the calcium and magnesium is known as "residual sodium carbonate" (Eaton, 1950, p. 123–133). Eaton's formula for calculating residual sodium carbonate —concentrations in equivalents per million—is as follows:

$$\text{Residual } Na_2CO_3 = (HCO_3 + CO_3) - (Ca + Mg)$$

Carbonates of sodium raises the pH of the soil, and generally a "black alkali" condition results.

Wilcox, Blair, and Bower (1954, p. 259–266) found by experiment on plots of Rhodes grass, at both 25 percent and 6.25 percent drainage, that water containing more than 2.5 epm (equivalents per million) of residual sodium carbonate is not suitable for irrigation, that containing from 1.25 to 2.5 epm is marginal, and that containing less than 1.25 epm probably is safe. They also found that the accumulation of exchangeable sodium in the soil from water having more than 2.5 epm of residual sodium carbonate is greater under a low-leaching regime than under a high-leaching regime.

Calcium and magnesium in reasonable concentrations are desirable constituents in irrigation water. Not only do they promote good soil structure, but they also are essential plant nutrients. If the ratio of calcium plus magnesium to sodium is favorable in the water, calcium and magnesium may replace sodium adsorbed on the soil colloids.

Although boron is an essential plant nutrient, even small amounts of it can be toxic to certain plants. According to Scofield (1936, p. 275–287) the permissible limits for boron in irrigation water are as follows:

TABLE 19.—*Permissible limits for concentration of boron in irrigation water*

Classification of water	Limits for concentration of boron (ppm)		
	Sensitive crops [1]	Semitolerant crops [2]	Tolerant crops [3]
Excellent	<0. 33	<0. 67	<1. 00
Good	0. 33- . 67	0. 67-1. 33	1. 00-2. 00
Permissible	. 67-1. 00	1. 33-2. 00	2. 00-3. 00
Doubtful	1. 00-1. 25	2. 00-2. 50	3. 00-3. 75
Unsuitable	>1. 25	>2. 50	>3. 75

[1] Citrus and deciduous fruits, nuts, beans, and others.
[2] Most truck crops, cereals, cotton, and others.
[3] Lettuce, alfalfa, beets, asparagus, dates, and others.

Boron was present in concentrations of as much as 2.0 ppm in the ground water and 0.50 ppm in the surface water. The surface-water sample containing 0.50 ppm was from a drain near Crow Agency. However, surface water used for irrigation contained less than 0.23 ppm. The maximum concentration of boron in water from the Parkman sandstone was 0.54 ppm, and the water would be classified as excellent to good for irrigation with respect to the concentration of boron. However, water from 14 wells in the unconsolidated deposits contained from 0.37 to 2.0 ppm boron and would be classified as good to permissible for semitolerant crops.

Tables 15 and 18 give the chemical quality of ground and surface waters in equivalents per million together with Eaton's residual sodium carbonate. Water from the unconsolidated deposits, with one exception, contained no residual sodium carbonate, but water from the Parkman sandstone, Claggett shale member of the Cody shale, and Cloverly formation contained much more than 2.5 epm of residual sodium carbonate. Although water from the bedrock aquifers probably should not be used for irrigation, the ill effects would be minimized if enough water is applied and if subsurface drainage is adequate to remove residual salts by leaching as the excess water passes through the soil and drains away.

A diagram, based on specific conductance and percent sodium, for rating the suitability of irrigation water was proposed by Wilcox (1948) and revised later by Thorne and Thorne (1951). The Thorne and Thorne diagram was designed for irrigation water in Utah and, because it is applicable principally to arid areas, it may not be strictly applicable to this area. However, because the Thorne and Thorne diagram is in general agreement with other methods for classifying irrigation water, it is used in this report. The samples of ground and surface waters are classified on the Thorne and Thorne diagram in figure 33, and the interpretation that follows the diagram gives the limits of use for each class of irrigation water.

Water from Lodge Grass Creek is classified as 1A and, therefore, is highly suitable for irrigation; water from the Little Bighorn River is rated between 1A and 2A and so is slightly less suitable than that from Lodge Grass Creek. Water from the unconsolidated deposits in the valley is rated from 1A to 5C. Most of the water in the Lodge Grass No. 1 and Benteen Flat units is classified as 2A, whereas water in the Reno, Battlefield, and Agency units generally is less suitable.

Although the bedrock aquifers have the greatest volume potential for ground-water development, they contain water that is unsuitable for irrigation. (See fig. 33.) Success in using water from the Parkman sandstone and the Cloverly formation for watering lawns and irrigating hayfields may be more apparent than real; if irrigation is continued, serious damage to the soil may result.

In summary, the most suitable waters for irrigation are those from Lodge Grass Creek and the Little Bighorn River. Water from the unconsolidated deposits is less desirable, and water from bedrock generally is unsuitable.

SUITABILITY OF THE WATER FOR DOMESTIC USE

One of the properties of water that most concerns the domestic user is hardness, which when high is revealed by the soft curd or scum that forms when soap is added to the water. Hard water wastes soap and forms unsightly deposits on utensils. Softening of water having a hardness of 120 to 200 ppm is desirable, and softening of water having a hardness of more than 200 ppm may be necessary, if economical use of the water is to be made.

Generally, in the lower Little Bighorn River valley, water from the bedrock aquifers is very soft, but water from the unconsolidated deposits and surface water are very hard. The hardness of water from unconsolidated deposits ranged from 260 to 2,650 ppm and that of surface water from 221 to 747 ppm.

Standards established by the U.S. Public Health Service (1946) for drinking water used on interstate carriers have been adopted by the American Water Works Association as criteria of quality for public water supplies. The concentrations, which preferably should not be exceeded, for some of the chemical constituents of water are as follows:

Constituent	*Concentration (parts per million)*
Fluoride	[1] 1.5
Iron plus manganese	.3
Magnesium	125
Chloride	250
Sulfate	250
Dissolved solids	[2] 500

[1] Maximum permitted.
[2] 1,000 ppm permitted if no better water is available.

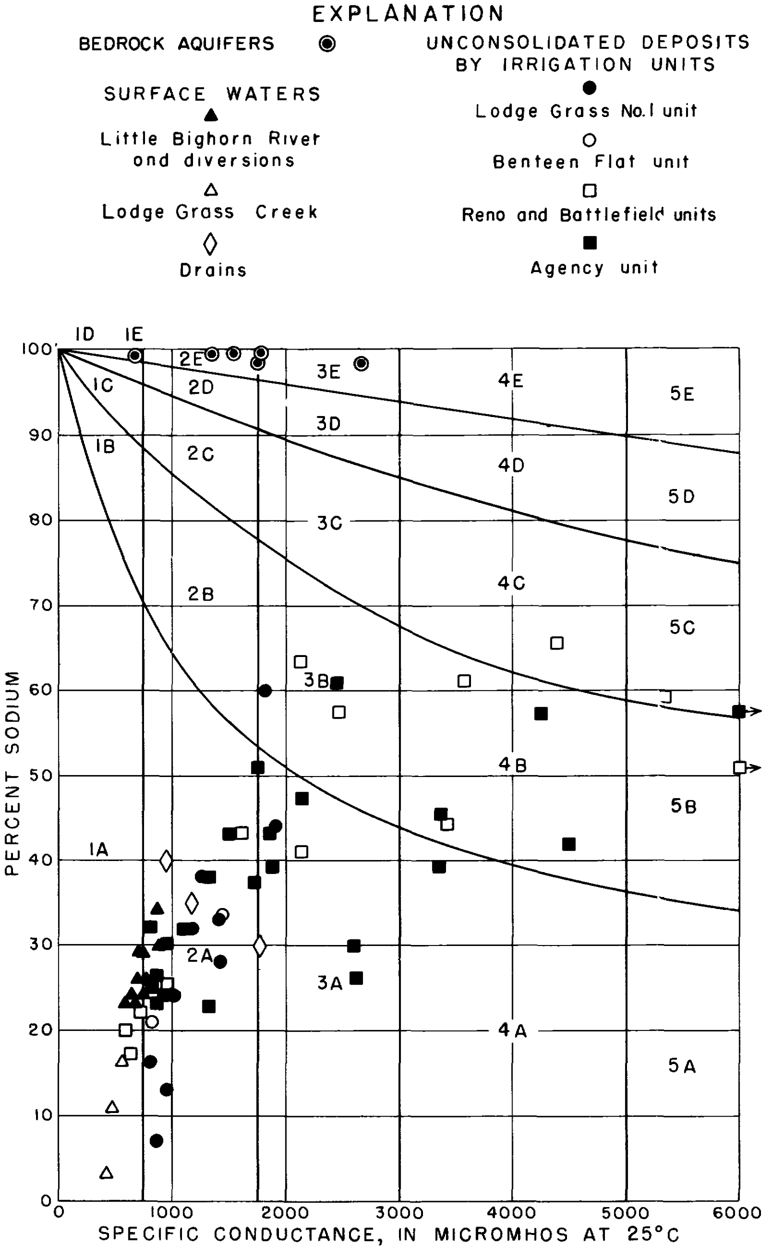

FIGURE 33.—Classification of ground and surface waters for irrigation (Thorne and Thorne, 1951). See interpretation on facing page.

Interpretation of diagram showing classification of ground and surface waters for irrigation (Thorne and Thorne, 1951)

Class	Rating
1	Water can be used safely on all soils.
2	Water may cause problems where drainage is poor and leaching of residual salts from previous irrigation is not consistently practiced.
3	Water can be used on crops of medium to high salt tolerance, on soils of good permeability, and with irrigation practices which provide some leaching.
4	Water can be used in successful farming only with crops of high salt tolerance, on permeable and well-drained soils, and with carefully devised and conducted irrigation and soil management practices.
5	Waters are generally unsuitable and should be used for irrigation only under special situations.
Group	
A	There should be no difficulty from sodium accumulation in soils.
B	Where soils are of fine texture and do not contain gypsum or lime, where drainage is poor, and where small quantities of water are applied with each irrigation, there may be some evidence of sodium accumulation but usually not enough to injure seriously soils or crops. Serious sodium accumulation may occur if waters high in carbonates or bicarbonates are used.
C	Serious alkali formation should not occur on permeable soils (sands to silt loams), unless poor drainage, residual carbonates in waters, or limited water use are problems. Fine textured soils must be managed with care.
D	Some alkali formation should be expected in all soils irrigated with group D waters. Sandy or permeable soils high in gypsum might be irrigated with such waters without highly injurious sodium accumulations. Loams or finer textured soils irrigated for some time with 3D or 4D waters and then irrigated with waters of low salt content would probably puddle and require gypsum for reclamation.
E	Generally unsatisfactory for irrigation.

NOTE.—1C, 1D, and 1E waters often can be improved in quality by treating with gypsum to reduce the percent sodium.

Fluoride concentrations were 0.8 ppm or less in all samples of water collected in the lower Little Bighorn River valley. Iron, which stains utensils and textiles, exceeded 0.3 ppm in many of the samples of ground water. Magnesium exceeded 125 ppm in 6 samples of ground water; one sample of water from the alluvium in Shoulder Blade Creek valley (Reno unit) contained 382 ppm. The maximum chloride concentration in all the samples was 148 ppm. A total of 23 samples of ground water and 2 of surface water had more than 250 ppm of sulfate; concentrations of sulfate were as much as 4,630 ppm. In combination with calcium, sulfate forms a hard boiler scale; in combination with magnesium in drinking water, it produces a laxative effect on some persons. Concentrations of dissolved solids exceeded 500 ppm in nearly all the samples of ground water and exceeded 1,000 ppm in many of the samples; the maximum concentration was 7,720 ppm.

Water containing concentrations in excess of those recommended is often used with no apparent ill effects to the user who has become physiologically adjusted to it through prolonged use.

DRAINAGE OF WATERLOGGED LAND

Land is said to be waterlogged if the moisture content in the root zone is so great that it adversely affects crop growth. Waterlogging not only causes harmful salts to accumulate near the surface, but reduces aeration and decreases workability of the soil.

CAUSE AND EXTENT OF WATERLOGGING

The textural and hydrologic properties of the material above the water table and the temperature and salinity of the water govern the height to which capillarity causes water to rise. In tightly packed fine-grained material the zone of excessive moisture extends farther above the water table than in loosely packed coarse-grained material. In the lower Little Bighorn River valley, even where the material above the water table is heavy clay, waterlogging generally does not occur if the water table is more than 6 feet below the land surface. Generally, medium-textured material is safe from waterlogging if the depth to water is more than 4 feet, and sandy material is not likely to become waterlogged if the average depth to water during the growing season is at least 3 feet. The depth to water in the irrigated parts of the area (pls. 5, 6, 8, 10, 11) is believed to represent average conditions during the irrigation season. Those places where the depth to water is less than 4 feet generally are waterlogged because the soils in the area are characteristically fine to medium textured.

The position of the water table with respect to the land surface is governed by such factors as the configuration of the impermeable floor on which the water-bearing material rests, the rate of recharge, the transmissibility of the aquifer, and the topography. The relation of these factors to the position of the water table in the lower Little Bighorn River valley is illustrated in figure 34.

Sketch *A* (fig. 34) illustrates the following ideal conditions in a river valley underlain by uniformly stratified unconsolidated material resting on a smooth bedrock surface; The water table is at a nearly uniform depth below the land surface and slopes uniformly toward the effluent stream; underflow from the uplands and uniform infiltration of irrigation water and precipitation are the only sources of recharge to the unconsolidated deposits; the riverward gradient of the water table is governed by the quantity of the recharge, and the downstream gradient is equal to the gradient of the river; and no part of the area is waterlogged.

Sketches *B* through *G* (fig. 34) illustrate the effects of modifying some of these ideal conditions. Sketch *B* shows how a ridge on the bedrock floor could impound ground water in the unconsolidated material to the extent that waterlogging results. Sketches *C* and *D* show how local recharge could cause a mounding of the water table and resultant waterlogging in nearby areas; in sketch *C* the source of recharge is underflow through the alluvial fan of a tributary stream normal to the sketch, and in sketch *D* it is leakage from an irrigation canal. A third source of local recharge—not illustrated—could be excess irrigation water that becomes ponded in undrained depressions. Sketch *E* illustrates how a constriction in the cross-sectional area of the principal transmitting material could cause a compensatory rise of the water table. Sketch *F* illustrates how a downgradient decrease in the permeability of the principal transmitting material could cause impounding of the ground water. Sketch *G* shows why low-lying areas are likely to be waterlogged.

The infiltration of precipitation and applied irrigation water causes a more or less uniform rise of the water table throughout the irrigated part of the area. Where the water table is shallow, the rise may be enough to cause waterlogging of the lower lying land, or, in combination with local recharge, cause waterlogging of higher lying land. Most of the waterlogging in the area, however, is caused by a combination of two or more of these factors.

POSSIBLE MEASURES TO RELIEVE WATERLOGGING

Measures that would reduce or eliminate waterlogging include canal and ditch lining, relocation of irrigation structures and distribution systems, modification and control of irrigation practices,

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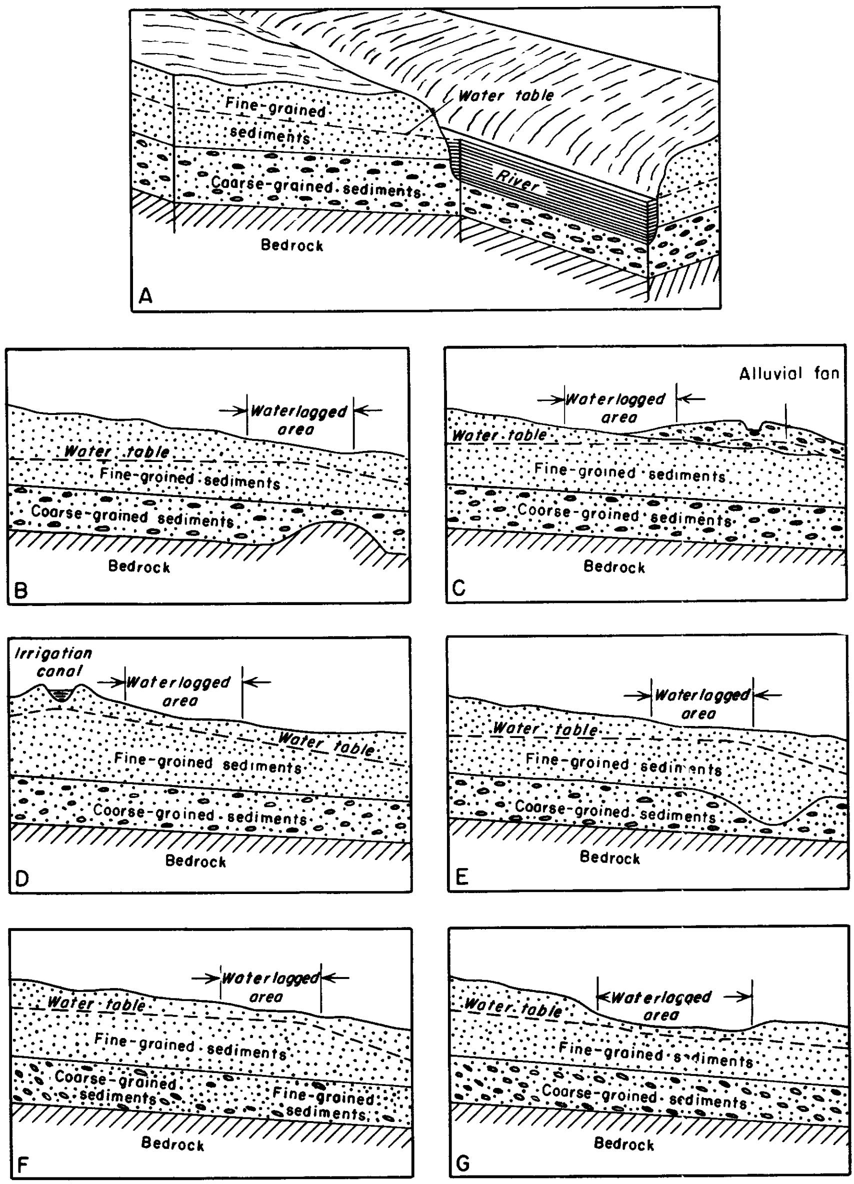


FIGURE 34.—Sketches illustrating principal causes of waterlogging in the lower Little Bighorn River valley.

provision for removal of excess runoff and irrigation waste water, and construction of deep drains for lowering the water table.

In places where canal leakage is responsible for waterlogging, and other sources of recharge are comparatively small, lining of the canals should be effective. Some lined irrigation canals in other areas leak as much as do the unlined canals in the report area; hence, care must be taken to obtain watertight linings.

Use of former natural drainageways as conduits for irrigation water often results in large quantities of water infiltrating to the zone of saturation. In some places erosion of broad, deep holes in stream bottoms has increased leakage. Improvement of structures in the irrigation system to minimize erosion and relocation of some of the drainage ditches would help greatly to reduce waterlogging.

Charges for irrigation water in the area are based on an established rate per year per irrigated acre and are independent of the amount of water used. Because an excess supply is available at no extra cost, the natural tendency is to overirrigate. However, if charges were based on the quantity of water delivered, the excessive application of irrigation water might be discouraged and recharge from irrigation water lessened considerably.

Very few farms in the area are adequately drained. Waste water is allowed to accumulate at the ends of fields and in borrow pits, sloughs, and other depressions and to remain until it either sinks into the ground or evaporates. A system of shallow surface drains that would convey this water rapidly to the river would greatly reduce the total ground-water recharge in the area. The feasibility of constructing such drains, however, would depend on their cost and the extent to which farming operations would be inconvenienced.

In parts of the area where subsurface drainage is inadequate and the principal causes of waterlogging are recharge from excess irrigation water or underflow from upland areas, deep drainage—drainage to depths greater than can be achieved by means of shallow surface drains—will be required. Furthermore, because higher lying terraces may be irrigated in the future, deep drainage undoubtedly would be the longest lasting and most effective corrective measure.

VARIOUS TYPES OF DEEP DRAINAGE

Common devices for achieving deep drainage are pumped wells, open ditches, and buried tile drains.

To relieve waterlogging effectively throughout a large area by pumping from wells, the wells must be situated so that a large drawdown is possible in the vicinity of the pumped wells, thus causing an appreciable lowering of the water table at greater distances from the points of withdrawal. The unconsolidated deposits in the lower Little Bighorn River valley generally are less than 25 feet thick; thus only a very small area could be drained by pumping from a single well. This method of drainage is not recommended because of the large number of wells required to lower the water table appreciably over a large area.

Open drains cost less than buried drains and not only remove ground water but also surface runoff and irrigation waste water as well. An open drain, however, reduces the area of arable land and requires maintenance to remove material caved in from the banks and to prevent vegetation and debris from retarding water movement. Buried drains, on the other hand, require little or no maintenance and do not hinder farming operations or reduce the area of tillable land. All drains in the area but one are of the open type. The buried drain (DR–2) in sec. 3, T. 2 S., R. 34 E., has functioned at peak efficiency with no maintenance since its installation about 20 years ago. Buried drains, therefore, may be the most effective and least expensive means of controlling waterlogging in the long run.

The approximate pattern of ground-water flow in the vicinity of a drain constructed in fine-grained sediments to a depth of 8 feet is shown in figure 35. The fine-grained sediments are assumed to be underlain by coarse-grained materials about 10 times more permeable. The source of recharge (canal leakage) is to the left of the area shown in figure 35, and ground-water discharge to the river is at some point to the right. The land on the downgradient side of the drain is no longer waterlogged because the water table has been lowered to a depth of 4 feet or more below the land surface.

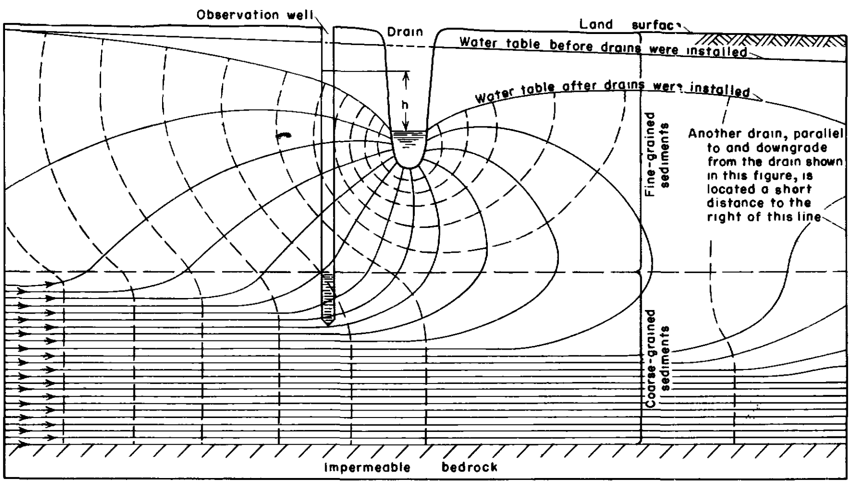


Figure 35.—Sketch showing pattern of ground-water flow in vicinity of discharging drain.

The factors that determine the shape and position of the water table in the vicinity of a discharging drain would include the depth of the drain, the permeability and thickness of the sediments incised by it, and the permeability and thickness of the underlying coarse-grained sediments. Laminar flow at a constant velocity through a water-bearing material of uniform thickness produces a smooth, uniformly sloping water table. When a drain is installed, the water table at the edges of the drain is lowered to a level coinciding with the water surface in the drain. Flow lines, which formerly paralleled the base of the aquifer, are deflected upward toward the drain. Where the flow lines converge, the velocity of flow increases and the gradient of the water table becomes progressively steeper toward the drain. The effect of drain depth on the slope and position of the water table is illustrated by figure 36, and the effect of the relationship of the permeability of fine-grained sediments to the permeability of coarse-grained sediments is shown by figure 37.

To measure the effectiveness of the drains in relieving hydrostatic pressure, wells were installed close to existing drains to determine differences in head, *h* (fig. 35), between the water surface in the drains and the hydrostatic pressure in the coarse-grained sediments below. The effectiveness at each site is indicated by the maximum values of *h* shown in table 20. The table suggests that a drain need not penetrate the coarse-grained sediments to be effective. It also is helpful in determining whether relief wells could be used effectively.

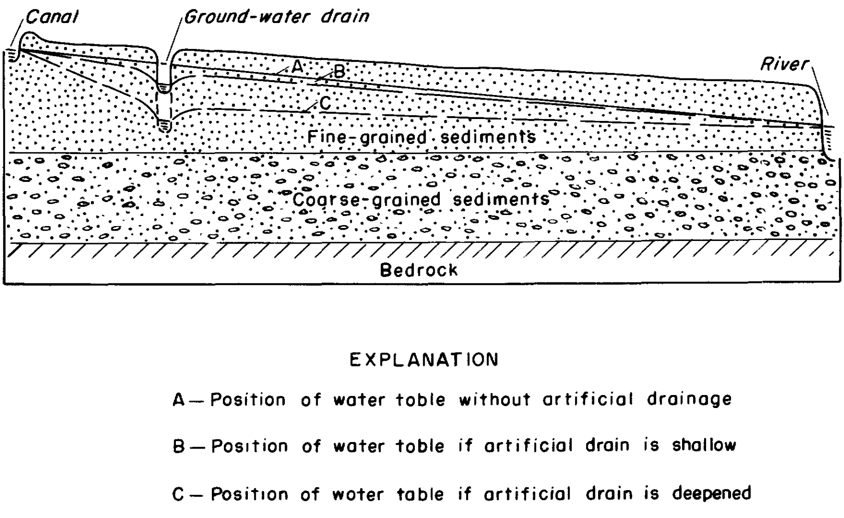
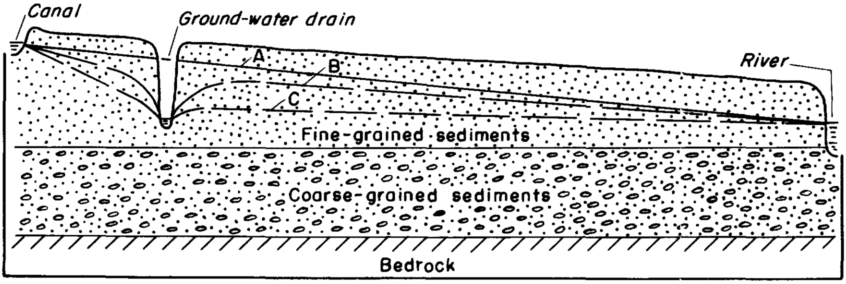


FIGURE 36.—Sketch showing effect of drain depth on position of water table.



EXPLANATION

A— Position of water table without artificial drainage

B— Position of water table if coarse-grained sediments are only slightly more permeable than fine-grained sediments

C— Position of water table if coarse-grained sediments are much more permeable than fine-grained sediments

Figure 37.—Sketch showing effect of permeability of water-bearing materials on position of water table.

Wells installed in the floor of a drain will flow if they are deep enough to tap the underlying gravel and if the piezometric surface of the water in the gravel is above the level of water in the drain. A series of such relief wells along a drain may augment the effectiveness of the drain by increasing discharge of water. Relief wells may be effective in alleviating waterlogging where the head in the aquifer is large. During this investigation several experimental wells, some three-quarters of an inch in diameter and others 2 inches in diameter, were installed in existing drains. The measured flows from the wells ranged from 2 to 5 gpm per foot of head; the flow from a 24-inch well probably would not exceed 7 gpm per foot of head. By assuming a value of this magnitude for the flow per well and by determining the average head in aquifers underlying the drain, the approximate number of wells needed to produce a given increase in drain discharge can be determined. The probable effectiveness of a system of relief wells must be judged separately for the individual waterlogged areas. The efficiency of relief wells in performing the job for which they are designed is dependent upon the way in which they are constructed. Relief wells equipped with a screen and drilled several feet into the water-bearing gravel generally would be much more effective than pipes filled with sand or gravel and reaching only to the top of the gravel.

TABLE 20.—*Drain data and difference in head between water level in drains and in adjacent wells*

Drain	Drain depth (feet)	Material between bottom of drain and top of gravel		Well		Maximum difference in head (feet)
		Textural classification	Thickness (feet)	Coordinate system	Field	
Lodge Grass No. 1 unit						
DR-12	2.7	Heavy	8.1	D5-35-27bb4	DR12-1	2.9
13	3.0	Heavy to moderately heavy	16.6	34cd	13-2	1.9
13	2.9	Moderately heavy	5.1	34db	13-1	2.4
14	3.6	Heavy to moderately heavy	7.1	D6-35-14da	14-1	4.1
Reno unit						
DR-8	2.2	Medium	11.8	D3-35-19cd	DR8-1	2.3
8	4.1	Heavy	13.6	30ba	8-2	2.4
9	3.9	Moderately heavy to medium	5.1	32ab	9-1	2.7
9	4.9	Moderately heavy	3.5	32ac	9-2	2.1
10	4.9	Medium	11.5	D4-35- 4bb2	10-1	.6
Agency unit						
DR-1	5.1	Moderately heavy	4.8	D2-34- 4aa2	DR1-1	2.6
4	4.9	Medium	7.6	25ca1	4-1	2.1
5	6.4	Heavy	8.5	36ac	5-1	1.0
6	7.5	Heavy to moderately heavy	6.4	36ca2	6-1	2.1

PRINCIPLES GOVERNING THE SELECTION OF DRAIN SITES

The most effective drains are those that have been located wholly according to hydrologic and topographic considerations and without regard to landownership or surface developments. By obtaining right-of-way easements, drains generally may be constructed where they will be most effective for the least cost.

If waterlogging is caused by underflow from an upgradient source, a drain to intercept the underflow (interceptor drain) should be located near to the source, and its course should be as nearly as possible at right angles to the direction of ground-water movement. On the other hand, if waterlogging is caused by one or more of the conditions shown in sketches *B*, *E*, and *F* of figure 34, a drain (relief drain) should be located far enough downgradient to induce ground-water flow from the lower end of the area to be drained but upgradient from any area of restricted flow.

If the entire length of a drain cannot be incised below the water table, then that part above the water table should be either lined or constructed with a gradient steep enough to minimize seepage losses. Unless drains are constructed where the gradients of the land surface and the drain are nearly equal, the cost of excavation may be excessive.

Because a drain will discharge the most possible water where the water table and permeable water-bearing material are near the land surface, the choice of location necessarily is limited to a narrow area, and, within that narrow area, the drain should, if possible, be constructed along the lowest part of a natural drainageway.

The planning of a drainage system should be based not only on present requirements but on probable future requirements as well. For example, on waterlogged land that is to be irrigated after drainage, the drainage system should be designed to facilitate runoff of excess irrigation water and have sufficient capacity to carry the combined expected discharge. Such a drainage system not only must prevent waterlogging of the land it is designed to drain but also of adjacent lower lying land. Although no definite plans have been made to irrigate higher terrace lands in the area, the possibility that these lands may be irrigated in the future should be considered in making plans for the drainage of land now waterlogged.

Many factors, some of them difficult or impossible to evaluate before construction, govern the effectiveness of drains. Consequently, the exact depth to which a drain should be dug generally is impossible to determine. Drain depths suggested in this report are based on a comparison of the hydrologic conditions in each area requiring drainage with conditions in areas already supplied with adequate drainage. The hydrologic properties and thickness of the fine-grained sediments in which the drain is to be dug, the present as well as the possible future amount of recharge, and the topography of the land to be drained were considered. All drain depths recommended for draining specific areas should be considered as minimum values, and if a safety factor is desired the depths should be greater than those indicated as desirable.

The U.S. Bureau of Indian Affairs prepared a preliminary plan for drainage of each irrigation unit within the reservation to meet the demands of certain farm owners who wished to drain their lands before the investigation was completed. In the Agency unit several test holes were bored to determine the position of the water table; this information, coupled with field observations and a study of soil and topographic maps, formed the basis of the Bureau's drainage plan for that unit. Tentative plans for the other units were made without the benefit of test-hole information. The drainage systems were designed so that individual drains could be connected to central trunk drains for the purpose of achieving a well-coordinated drainage program.

SUGGESTIONS FOR DRAINING INDIVIDUAL WATERLOGGED AREAS

The plans suggested for drainage are based on data collected during this investigation and they conform, wherever practicable, to the preliminary plans drafted by the Bureau of Indian Affairs.

Suggestions for drain locations are based wholly on hydrologic considerations; however, economic and property-line considerations may prevent strict adherence to the proposals.

LODGE GRASS NO. 1 UNIT

Field studies in the Lodge Grass No. 1 unit were less detailed than those in the other units farther downstream, and test holes and observation wells were more widely scattered. Accordingly, the contour interval selected to depict the configuration of the water table in this unit is 5 feet rather than 1 foot, and the minimum depth to water represented is 5 feet instead of 2 feet as in the other units. Some of the conclusions on cause and extent of waterlogging in the Lodge Grass No. 1 unit are less firmly based than might be desired, but the recommendations on drainage are believed to be sound.

The Lodge Grass No. 1 unit is unique in the area because a part of terrace 2, in addition to terrace 1, is irrigated. Water for irrigation is diverted from Lodge Grass Creek near the center of sec. 29, T. 6 S., R. 35 E., about 5 miles upstream from its confluence with the Little Bighorn River (pl. 10). From that diversion point a canal carries water to terrace 2 above the town of Lodge Grass. The canal crosses terrace 2 northward to Sunday Creek and there the water flows down a steeply inclined flume to the creek bottom. The creek serves as a conduit for about a mile and the water then is diverted into a canal that follows the break in slope between terrace 2 and 1 to the north end of the unit.

The contour of the land surface and of the water table, the depth to water, the altitude of the gravel surface, and the location of existing and proposed drains in the Lodge Grass No. 1 unit are shown on plates 5 and 6. The causes of waterlogging and possible remedial measures in individual areas within the Lodge Grass No. 1 unit are described in the following paragraphs.

W½ SEC. 22, SEC. 21, NW¼ SEC. 28, AND NE¼ SEC. 29, T. 6 S., R. 35 E.

The land surface in this area is so near river level that the water table, which is continuous with the water surface in the river, intersects the land surface.

The water-level records for well D6–35–29ab (D–26) indicate that canal leakage is the principal cause of waterlogging. That the springs along the roadside discharge a larger quantity of water when the canal is carrying water supports this conclusion. The lowest lying part of the area is waterlogged throughout the year, whereas the land close to the canal generally is waterlogged only during, and a short time after, the irrigation season. Areas adjacent to irrigated fields are more likely to be waterlogged during the irrigation season than at other times of the year. In this area the soil is medium to moderately heavy textured and the top of the gravel probably is relatively close to the land surface.

Drains in this area need be no deeper than 6 feet at any point. The drains should be constructed with a minimum gradient consistent with removal of the water and should be located at the foot of the slight escarpment that borders the flood plain so that they will intercept water from the uplands. Because the waterlogged land is so near stream level, the proposed drainage system probably will not be effective unless the farmers make a firm practice of applying only minimum amounts of irrigation water on these and adjacent lands. Wasteways should be constructed for rapid removal of excess surface water.

The small waterlogged area west of well D6-35-29ab (D-26) is a wooded swamp. Drainage of this area is not proposed because the land surface is so close to river level that drainage appears impractical.

SW¼ SEC. 14, T. 6 S., R. 35 E.

Leakage from the main lateral along the north edge of the area and underflow through two small natural drainageways are the principal sources of recharge in this area. The main canal, which follows the edge of terrace 2, crosses these drainageways and leakage from the canal undoubtedly contributes to underflow in those gullies. Although a high water table persists throughout the year and affects plant growth, it is not so high as to prevent some farming in most of the area. Because the water table a short distance inland from the creek bank is much higher than creek level, it is believed that subsurface geologic conditions account for the poor drainage of this area.

The most effective drain would be one that approximately follows the contour of the water table through the length of the waterlogged area. However, because such a drain would split a small field now under irrigation, a more suitable plan would be the deepening of the present natural channel that passes through the area. Although the exact depth to the coarse-grained sediments along the natural drainage course is unknown, information from test holes drilled in this area indicates that the top of the gravel surface is within 10 feet of the present land surface. Therefore, the channel should be deepened by about 8 feet.

Changing the course of the stream might improve drainage of the area. An additional short channel would help to make the land north of it irrigable and also lower the water table in the vicinity of the abandoned channel.

SW¼ SEC. 13 AND SE¼ SEC. 14, T. 6 S., R. 35 E.

Ditch leakage is the cause of waterlogging in the vicinity of well D6–35–13cb (D–23). Water-level records show that the water table drops several feet after the irrigation season, indicating the waterlogging is seasonal. Lining the ditch probably would be the best way to prevent recurrence of waterlogging.

Waterlogging in the vicinity of wells D6–35–14da (DR14–1) and D6–35–14db (D–24) is caused by underflow through the colluvium that mantles the slopes between terraces, by leakage from the main irrigation lateral that borders the south edge of the county road at the north edge of the area, and by infiltration of applied irrigation water. The drop in water table at the end of the irrigation season relieves waterlogging in much of the area.

Although recharge could be reduced by lining the ditch, waterlogging probably could be relieved more effectively by digging a deep drain. The existing drain, DR–14, which is about 4 feet deep, is not effective in relieving the hydrostatic pressure in the gravel underlying the area—the water level in well D6–35–14da (DR14–1) was above the land surface throughout the period of record. Borings indicated that the depth to gravel along any possible drain site is about 8 to 10 feet and that the material above the gravel is heavy textured. A drain through this area should be dug to a depth of at least 8 feet. If, after completion of the drain, the difference in head between the ground water in the gravel and the water in the drain remains large, the installation of relief wells along the floor of the drain should be considered.

SE¼ SEC. 10, SEC. 11, W½ SEC. 12, NW¼ SEC. 13, AND N½ SEC. 14, T. 6 S., R. 35 E.

This area is 80 to 100 feet above stream level. The western three-fourths of the area is on terrace 2; the remainder is on a lower plain, which probably is a remnant of a terrace formed by Lodge Grass Creek. Test-hole data indicate that the surface of the gravel layer underlying the area slopes uniformly east-northeastward and that it is less than 8 feet below the land surface throughout most of the area. The fine-grained sediments overlying the gravel are moderately heavy to medium textured.

Because the gravel underlying the area is extremely coarse, the jetting method of installing observation wells met with little success. Consequently, only a few wells were installed. Measurements of the water level in these wells indicated that leakage from the canal and the infiltration of applied irrigation water account for the seasonal high water level. The water level drops several feet within a short time after irrigation ceases.

As the gravel is very permeable and is close to the land surface, most of the proposed drains on terrace 2 need be only about 6 feet deep to provide adequate drainage for all adjacent irrigable lands. Suggested locations for the drains were governed by the topography of the area.

Several depressions on terrace 2, as well as part of the slope between terrace 2 and the creek terrace, are waterlogged. The depression in the SW¼NW¼ sec. 11 has no natural drainage outlet. Alleviation of waterlogging in this part of the area will require a deep drain.

The drainage system proposed for the waterlogged area on the slope between terrace 2 and the creek terrace is based on meager hydrologic data. Before definite plans for draining this area are made, a series of test holes should be drilled so that the places of shallowest depth to the water table and the texture of the underlying soil can be determined more precisely.

S½ SEC. 1 AND N½ SEC. 12, T. 6 S., R. 35 E.

East of the highway, along the boundary line between secs. 1 and 12, is an area where the depth to water is less than 4 feet. Crop production in parts of the fields on both sides of the section-line road is affected somewhat by waterlogging. Water-level fluctuation records for wells D6–35–1cd (D–11) and D6–35–1dc (D–12) indicate that the recharge and discharge are nearly in balance throughout the year and that rises caused by infiltrating irrigation water are of short duration. Apparently the high water level is the result of the damming effect upon water of the alluvial fan of Sunday Creek, which transmits underflow from terrace 2. (See sketch *C*, fig. 34.)

Shallow drains should be dug west of the highway right-of-way so that excess surface water will be channeled away from that part of the area and that a deep drain be dug along the section-line road from the highway to the river. Along the proposed deep drain the soil is heavy to moderately heavy and the depth to gravel ranges from 14 feet at the upper end of the drain to about 8 feet at the lower end. If a single drain is to be effective over the entire waterlogged area, it probably should be at least 7 feet deep. If the drain is shallower, installation of relief wells along the floor of the drain may be necessary to make it effective.

Near the center of sec. 12 is a slough that is a breeding spot for mosquitoes. It could be drained easily by cutting an outlet to the river, which is only a short distance from the edge of the slough.

SEC. 34, T. 5 S., R. 35 E., AND N½ SECS. 1 AND 2, T. 6 S., R. 35 E.

Most of the waterlogged area east of the highway is undeveloped bottom land. Abundant tree growth and irregular topography caused by abandoned stream channels tend to decrease the value of the land for farming. The waterlogged land west of the highway is on terrace 1 and is developed for irrigation. The fine-grained sediments overlying the gravel are heavy to moderately heavy and relatively thick.

Waterlogging east of the highway is the result of a combination of factors, among which are the following: (a) Recharge from terrace 1 is concentrated along the escarpment marking the boundary between the alluvium and terrace 1; (b) surface drainage is generally poor because the outlets of the natural drainageways are blocked; and (c) subsurface drainage is slow because the land surface is only slightly higher than river level.

Records of water-level fluctuations in wells on terrace 1, west of the highway, indicate that canal leakage and drainage from still higher lying land are the principal sources of recharge. Waterlogging is severe during the irrigation season only; afterwards the water table lowers rapidly. Because the normal slope of the land in the vicinity of well D5–35–34cd (DR13–2) is greater than the slope of the water table, waterlogging persists throughout the year. The present drain passes through only a part of the area and is too shallow to effect appreciable drainage of ground water.

The suggested drainage plan for this area is based on the assumption that all the land will be cleared and developed for irrigation; if only part of the area is to be reclaimed, the plan should be modified accordingly.

The existing drain on terrace 1 should be deepened to at least 8 feet and extended into sec. 2. Then, if the difference in head between the water in the underlying gravel and the water surface in the drain remains too large, relief wells should be installed in the floor of the drain for better drainage. The existing drain should be much more effective, especially where it crosses the alluvial bottom land.

A proposed drainage system for the alluvial bottom land is shown on the map. As it was planned without adequate topographic control, it may need modification so that proper grades can be obtained without excessive excavation. The proposed system will probably drain the landlocked, abandoned river channels and thereby drain the land adjacent to the channels. The drains must be at least 4 feet deep, however, if they are to be effective.

S½ SEC. 27, T. 5 S., R. 35 E.

The fields on both sides of the highway between wells D5–35–27bd (D–4) and D5–35–27cd (D–6) are heavily irrigated. In the waterlogged area east of the road, the depth to water is less than 4 feet during the irrigation season. The logs of wells D5–35–27bd (D–4), D5–35–27db (D–5), and D5–35–27cd (D–6) show that the layer of clay above the gravel thins toward the east. Although productive at the present time (1954), the area is in need of effective drainage. Construction of a system of shallow wasteways to remove excess irrigation water and the lining of irrigation laterals to decrease leakage might prove satisfactory corrective measures. However, if these fail to relieve the waterlogging effectively, a drain at least 6 feet deep should be constructed at the location shown on the map.

SW¼ SEC. 22 AND NW¼ SEC. 27, T. 5 S., R. 35 E.

Available information indicates that this area is waterlogged throughout the year. As neither the water-level contours nor the logs of wells indicate any subsurface restrictions to ground-water movement, the waterlogging is probably due to the intersection of the steeply sloping land surface with a normally sloping water table.

A layer of heavy clay nearly 10 feet thick overlies the water-bearing gravel in the vicinity of well D5–35–27bb4 (DR12–1)—as indicated by the log of this well in table 25—and surface observations indicate that this layer probably extends over a large part of the waterlogged area. The drain that passes through that part of the area west of the road is shallow and discharges almost no water. On the banks of this drain 4 wells of small diameter were drilled a few feet into the underlying gravel. The top of 3 of the wells is 1 to 2 feet below the adjacent land surface. These wells have flowed steadily since they were installed. Because the clay layer has a very low permeability and a high capillarity, waterlogging cannot be eliminated unless the water table is lowered to a depth of at least 6 feet below the land surface. Drains, therefore, should be dug to a depth of at least 8 feet.

A network of test holes should be bored to the underlying gravel in the area of shallowest water table to determine whether a location other than the present one would be more suitable. If, upon completion of the drains, the hydrostatic pressure of the water in the gravel aquifer has not been reduced sufficiently, relief wells should be installed along the floor of the drains to increase the discharge of ground water. The southward extension of the drain in the NW¼ sec. 27 probably would not need to be as deep as 8 feet, because waterlogging here is restricted to a narrow area.

NW¼ SEC. 22, T. 5 S., R. 35 E.

This area is partly wooded and is used for pasture. Most of the cleared land, however, could be drained adequately by digging a shallow ditch and draining the abandoned river channel that nearly surrounds the area.

RENO UNIT

A dam on the Little Bighorn River in the NW¼ sec. 16, T. 4 S., R. 35 E., diverts water into a canal that extends to the NW¼ sec. 13, T. 3 S., R 34 E., a distance of about 7 miles. Except where it crosses the alluvial fans of tributary streams, the canal follows the foot of the bedrock slope on the west side of the river. (See pl. 3.) Land irrigated from the canal is on terrace 1 or on the alluvial-fan deposits.

The contour of the land surface and of the water table, the depth to water, the altitude of the gravel surface, and the location of existing and proposed drains in the Reno unit are shown on plate 8.

E½ SEC. 9 AND W½ SEC. 10, T. 4 S., R. 35 E.

The principal sources of ground-water recharge in this area are leakage from the canal and laterals and infiltration of irrigation water. In parts of this area the depth to water is less than 4 feet but elsewhere is between 4 and 8 feet. Measurements of the water level in well D4–35–9ad (B–29) show that, although the depth to water below land surface was as little as 2 feet at times during July and August, drainage was fairly rapid both between applications of irrigation water and after the irrigation season ended. Although the land in the vicinity of this well is farmed, crop production is affected somewhat adversely by waterlogging which, except for that in the depression west of well D4–35–9ad (B–29), probably could be eliminated either by lining the irrigation canals and laterals in this vicinity or by digging a drain along the line shown on the map. As the depth to gravel is between 12 and 16 feet, the drain should be at least 8 feet deep; and if it is not sufficiently effective, relief wells should be installed in the floor of the drain. The depression could be drained by digging an outlet, or it could be filled in.

Most of the low-lying land southeast of well D4–35–9ad (B–29) is drained adequately except for an abandoned stream meander. If the adjacent irrigated land is drained as proposed, underflow to this depression will be reduced and waterlogging will be alleviated.

The waterlogged land extending eastward from well D4–35–9db (B–15) is mostly wooded pasture; the part most severely waterlogged is in the abandoned stream channel. As the top of the gravel is between 5 and 10 feet below the land surface, a drain 4 or 5 feet deep along the lowest part of the depression probably would provide effective drainage.

W½ SEC. 3, T. 4 S., R. 35 E.

This waterlogged area is bounded by an abandoned meander of the river. It could be drained by cutting an outlet to the river.

E½ SEC. 4, T. 4 S., R. 35 E.

This area of medium- to moderately heavy-textured soil becomes waterlogged only during the irrigation season largely owing to leakage from irrigation laterals and the infiltration of applied irrigation water.

To improve drainage from this area and from the area immediately to the south in sec. 9, a drain (DR–11) was constructed in the spring of 1953. The average flow of water in the drain is between 200 and 300 gpm during the irrigation season, but the drain is dry the rest of the year. A continuous record of water-level fluctuations in well D4–35–9aa1 (B–45) was obtained for nearly a year prior to construction of the drain, and occasional water-level measurements were made in nearby well D4–35–9ab (B–43) for a year after the drain was completed. (See fig. 20.) Comparison of these records indicates that improved drainage lowered the water table significantly—a conclusion confirmed by owners of fields east of the wells. Two experimental relief wells were installed in the bottom of this drain; each flowed as much as 5 gpm during periods when the adjacent fields were being irrigated, but stopped flowing a day or two after irrigation was discontinued. Because the drain is effective without relief wells, little would be gained by installing them.

W½ SEC. 4, T. 4 S., R. 35 E.

Periodic measurement of the water levels in wells indicates that irrigation and ditch leakage are the principal sources of recharge in this area, the water table rising to a level less than 3 feet below the land surface when the fields are irrigated heavily. The rapid water-level decline that follows each application of irrigation water indicates that drainage is rapid, probably because the deep drain (DR–10) is effective. Although waterlogging is not likely to become a problem in this area, improved drainage may be needed at some future time and the drain could be deepened and extended eastward from well D4–35–4bc (B–12).

SECS. 32 AND 33, T. 3 S., R. 35 E.

The drain (DR–9) east of wells D3–35–32ba (B–10) and D3–35–32db1 (B–33) skirts the edge of the alluvial fan of Shoulder Blade Creek and intercepts underflow from the west. Completed in 1952, this drain has alleviated the waterlogging of the field to the east of it. This field, once badly waterlogged, is being farmed successfully at present (1954).

The fine-grained material between the floor of the drain and the underlying gravel is medium to moderately heavy textured. The difference in head between the pressure surface of the ground water and the water surface in the drain was more than 2 feet at the two sites where it was measured. To insure adequate drainage during heavy applications of irrigation water, which are necessary if undesirable salts are to be leached from the formerly waterlogged land, the drain should be deepened from 1 to 2 feet.

A small area in the SW¼ sec. 33 is waterlogged by underflow from irrigated adjacent upland. Because the depth to gravel is not very great, a drain 5 feet deep should be adequate to relieve the waterlogging. The rest of the waterlogged land that is cleared or level enough to be made irrigable probably could be reclaimed if drained by a deep ditch that would connect the lower end of the landlocked, abandoned meanders of the river with the present river channel.

SE¼ SEC. 29, T. 3 S., R. 35 E.

Waterlogging in this area is caused principally by underflow from higher lying irrigated land and by leakage from the lateral between wells D3–35–29ca (B–9) and D3–35–29db (B–42). The water level in these wells rises during the irrigation season, whereas the water level in wells D3–35–29da1 (B–40) and D3–35–29da2 (B–41) declines during the same period because of ground-water discharge by evapotranspiration.

The fine-grained material overlying the gravel is medium textured throughout the area, and the depth to gravel generally is about 5 feet. A system of drains should be constructed to intercept underflow from the adjacent upland. If dug to a depth of about 5 feet, the drains probably would incise the underlying gravel throughout part of their course and, because of the good hydraulic connection thus afforded, be effective throughout a wide area. Probably all the irrigable land could be restored to productivity.

Southeast of well D3–35–29da1 (B–40) water is ponded in an abandoned channel of the river to a level almost equal to that of the adjacent land surface. If an outlet were provided, the ponded water could be drained and the waterlogging of adjacent land alleviated.

E½ SEC. 30, W½ SEC. 29, AND SW¼ SEC. 20, T. 3 S., R. 35 E.

In the E½ sec. 30, part of the alluvial fan of Shoulder Blade Creek is waterlogged. Although the creek, which follows the valley wall west of the waterlogged area, usually does not flow, the persistent swampiness indicates much underflow. Measurements of the water level in observation wells in this area indicate that the irrigation laterals lose large quantities of water; probably leakage from the canal also is a major cause of waterlogging.

Throughout the waterlogged area, the fine-grained sediments overlying the gravel are medium to moderately heavy textured and the depth to gravel probably ranges from about 20 to 25 feet. The most effective drain would cross the waterlogged area where the water table is nearest the land surface and also would be deep enough to counteract the loss of head caused by the great thickness of fine-grained material. The recommended depth of such a drain is at least 8 feet. Relief wells may be required to make the drainage effective.

In sec. 29 some of the bottom land adjacent to the alluvial fan of Shoulder Blade Creek is waterlogged owing to underflow from higher lying irrigated land. The depth to water along the base of the slope between the alluvial fan and the bottom land is less than 2 feet; but a short distance farther north, it is as much as 4 feet. The floors of former oxbow lakes also have depths to water of less than 2 feet.

The drainage system proposed for this area is designed to intercept underflow from the south and to drain local spots where ground-water movement is slow. However, only that part of the proposed drainage system shown by a solid line on plate 8 should be constructed first and its effectiveness observed to determine whether construction of the drain shown by a dashed line is warranted. Because the depth to gravel is only 4 or 5 feet, a drain averaging 6 feet deep probably would be effective.

SW¼ SEC. 19 AND NW¼ SEC. 30, T. 3 S., R. 35 E.

Most of the area between the canal and the highway and between wells D3–35–19ca (B–19) and D3–35–30ab (B–39) is badly waterlogged. The area where the depth to water is less than 2 feet is adjacent to the alluvial fan of Onion Creek. Influent seepage from the creek and leakage from the canal maintain a high water table in the fan.

The canal along the bedrock slope between terraces 1 and 2 is about 20 feet higher than the waterlogged area. Leakage from the canal, especially in the vicinity of the drop structure in the SW¼SW¼ sec. 19, probably is the major source of recharge and causes year-round waterlogging. The two existing drains do not lower the water table effectively. Both are shallow and neither incises very permeable material. The difference in head between the water level in wells D3–35–19cd (DR8–1) and D3–35–30ba (DR8–2) and in the adjacent drain was 2.3 and 2.4 feet, respectively, indicating that the drain is ineffective.

Throughout most of the area, the material overlying the gravel is moderately heavy to medium textured and the depth to gravel ranges from 14 to 18 feet. Because of the great depth to gravel, drains must be as deep as practicable if they are to be reasonably effective.

Because canal leakage is one of the principal sources of recharge and because natural subsurface drainage is slow, lining the canal may be advisable if the proposed drainage system proves ineffective. The drains should be at least 8 feet deep; and, if they are not sufficiently effective at that depth, a series of relief wells should be installed along the floor of each drain. Construction of a drain paralleling the highway should prevent waterlogging of the land east of the highway.

NE¼ SEC. 24, T. 3 S., R. 34 E., AND NW¼ SEC. 19, T. 3 S., R. 35 E.

Most of the area between well D3–35–19ca (B–19) and the lower end of the irrigation unit is severely waterlogged. A ditch passing through the waterlogged area is only 2 or 3 feet deep and occasionally serves as a wasteway for the canal. Because water seeps from the ditch into the ground, it tends to raise rather than to lower the water table. The drain is much deeper where it parallels the highway.

Measurements of water levels in wells in and near the waterlogged area indicate that the water table is close to the land surface throughout the year. The water levels in those wells farthest from the canal decline in midsummer, thereby showing that the evapotranspiration rate exceeds the recharge rate. Early in the fall, as evaporation and transpiration rates decline, the water level rises again.

Leakage from the canal and the canal wasteway, underflow from the upland, and seepage from upgradient irrigated lands are the principal sources of recharge in this area. Recharge probably is greater on the alluvial fan of Onion Creek than elsewhere in this area because the canal and wasteway are more deeply incised and because Onion Creek is an influent stream in this stretch.

Test holes drilled in this area indicated that the fine-grained sediments overlying the gravel are medium to moderately heavy textured and that the depth to gravel is 10 to 15 feet. Therefore, to be effective, the existing drain should be deepened to at least 8 feet throughout its entire length. Another drain should be dug parallel to the canal to intercept canal leakage; it also should be about about 8 feet deep. Such a drainage system probably would be adequate to protect the area from waterlogging, except possibly some of the irrigated land east of the existing drain. A spur drain, parallel to the highway as far as the half-section line, probably would give the additional drainage required. Observation wells should be installed adjacent to the drains in several places to determine the difference in head between the pressure surface of the ground water and the water surface in the drain. If the difference in head is great, installation of relief wells in the drains probably would increase their effectiveness.

AGENCY UNIT

Water is diverted from the Little Bighorn River into the Agency Canal by a dam in the SW¼ sec. 1, T. 3 S., R. 35 E. Throughout most of its length the canal is incised in the slope between terraces 1 and 2, and the irrigated land is on terrace 1 and on the alluvial fans of tributary creeks that drain higher land to the west. In the NW¼ sec. 32, T. 1 S., R 34 E., water reaching the northern end of the canal empties into the abandoned channel of the Little Bighorn River. (See pl. 4.)

The contour of the land surface and of the water table, the depth to water, the altitude of the gravel surface, and the location of existing and proposed drains in the Agency unit are shown on plates 10 and 11.

E½ SEC. 36, T. 2 S., R. 34 E.

Canal leakage, infiltration of irrigation water, and underflow from the nearby upland are the principal sources of ground-water recharge in this area. Underflow is greatest near the center of sec. 36, where a small drainageway enters the area. Surface flow in this drainageway is conducted eastward through a large culvert beneath the canal, thence through a smaller culvert under an irrigation lateral into a shallow branch of drain DR–5. During periods of heavy runoff the smaller culvert often becomes plugged with debris and the water spreads over the low-lying land to the south. This water, plus leakage from the canal in the summer months, contributes to the waterlogging of the land between the small culvert and the upper end of drain DR–6.

Drain DR–5, constructed prior to this investigation, has lowered the water table and is generally adequate. The branch of drain DR–5 that was dug along the center of sec. 36, however, is too shallow to intercept appreciable quantities of ground water, and the fields on both sides are waterlogged for part of the year. To improve drainage in this part of the area that branch of drain DR–5 should be deepened to its greatest practicable depth, the capacity of the culvert under the irrigation lateral should be increased, and a spur drain to intercept part of the underflow should be extended southward along the base of the escarpment.

The small waterlogged area midway between wells D2–35–31bb (A–56) and D2–35–31bc (A–58) is cultivated, but crop production is noticeably affected by the high water table. To improve this condition, drain DR–5 needs to deepened in the NE¼NE¼ sec. 36 and, probably, eastward to its outlet.

The east-west part of drain DR–6, together with its northward extension, was completed during the summer of 1952. Late in the fall of that year the southward extension was finished. The fine-grained sediments into which the drain was cut are medium textured; in no place did the drain incise gravel, which is 10 to 15 feet below the surface. The depth to water before the drain was extended southward is shown on plate 10; the depth to water now is generally greater than 2 feet.

Well D2–34–36ca2 (A–62) was drilled during the first phase of drain construction, and the hydrograph for this well (fig. 17) shows a marked lowering of the water level which was due to, at least in part, the effectiveness of the new drain. By the summer of 1953 the swampy conditions had disappeared and the land was dry enough to drive across it in an automobile.

Although waterlogging now appears to have been eliminated, it may reoccur if the area is too heavily irrigated. When irrigation is started, water-level measurements should be made periodically to determine whether additional drainage is needed.

The north spur of drain DR–6 is too shallow toward its north end to be very effective. The usefulness of the drain would be increased considerably if the shallow section were deepened and extended to drain DR–5.

E½ SECS. 24 AND 25, T. 2 S., R. 34 E.

Because the abandoned river channels in this area lack suitable surface outlets to the river, water accumulates in them and forms ponds and marshes. The drainage system proposed for this area is designed to remove surface water and provide subsurface drainage so that land adjacent to the drain may be cultivated. The depth of the drain should be about 4 feet below the floor of the abandoned channels.

W½ SECS. 24 AND 25, T. 2 S., R. 34 E.

Because the water level in wells in this area rises abruptly at the beginning of the irrigation season, canal leakage probably is the principal cause of the high water table. Underflow from nearby upland areas, however, is also a source of much recharge, and, as a result, the water table in part of the area remains close to the surface throughout the year.

Some of the excess ground water is carried away by a natural drainageway which empties into a low, swampy area near the southeast corner of the NW¼NW¼ sec. 24. An attempt was made to supplement natural drainage by digging shallow ditches, but drainage of the area has not yet improved noticeably.

Canal leakage could be eliminated as a source of recharge in this area by lining the canal. Digging a drain, however, is the only possible means of intercepting underflow from the uplands. A deep drain close to the highway would intercept recharge from both underflow and canal leakage and lining the canal would be unnecessary. Deepening the existing natural drainageway and extending it southward would help remove some of the excess ground water and drain at least part of the area. The effectiveness of such measures should be observed before plans are made for additional drainage.

Poor surface drainage in the abandoned landlocked river channel at the base of the escarpment in the SE¼NW¼ sec. 24 causes swampiness at the end of the natural drainageway. Deepening this drainageway and extending it to the river should drain the swampy area satisfactorily.

Because the top of the gravel in this area is fairly deep and the fine-grained sediments overlying the gravel are quite heavy and not very permeable, the proposed drain probably should be dug to an average depth of at least 8 feet near the highway and to a depth of at least 6 feet through the main waterlogged area. In the low, swampy area the drain would need be only 3 or 4 feet deep to be effective.

E½ SEC. 14, T. 2 S., R. 34 E.

A narrow, low-lying strip of land parallel to the river is waterlogged because the underflow from irrigated lands upgradient is excessive and surface drainage is poor. The southern part of this area could be drained easily by cutting a drain through it and the adjacent abandoned river channel. Drainage of the northern part may not be economically feasible, but could be accomplished by cutting a drain that would empty into the river at a point about half a mile northeast of well D2–34–14ab2 (A–36). If the drain were to follow a fairly long course, it could be of nearly uniform depth; but if the drain were to follow the most direct route to the river, it would need to be fairly deep through the rises.

NORTH-CENTRAL SEC. 14 AND SOUTH- AND NORTH-CENTRAL SEC. 11, T. 2 S., R. 34 E.

Excess irrigation water and ditch leakage are the principal causes of the high water table in this area. During the irrigation season the water table in the southern part of the area rises to within 2 or 3 feet of the land surface, but during the winter it lowers to a level of more than 6 feet below land surface. Pasture land west of the center of sec. 11 is badly waterlogged, and water stands at, or is close to, the land surface in the abandoned river meander in the northern part of sec. 11.

Deepening the natural drainageway in sec. 11 and extending it into sec. 14 would facilitate both surface and subsurface drainage and thereby prevent a rise of the water table during the irrigation season. Although the gravel surface is below the depth to which a drain is likely to be dug, the drain probably would be fairly effective because the fine-grained sediments are medium textured. A drain 6 feet deep on the upgradient side of the abandoned river meander probably would provide ample subsurface drainage for this area.

SEC. 10 AND WEST-CENTRAL SEC. 11, T. 2 S., R. 34 E.

Underflow from two natural drainageways, together with canal leakage, are the principal causes of waterlogging in this area. Although lining the reach of the canal where leakage occurs undoubtedly would reduce waterlogging, properly located deep drains would intercept not only underflow from the drainageways but also leakage from the canal as well. Two drains should be constructed, one on each side of the road. The drain on the west side of the road would intercept both canal leakage and underflow from higher lying land. As the depth to gravel on this side of the road is between 10 and 15 feet and as the fine-grained sediments overlying the gravel are moderately heavy textured, the drain must be at least 8 feet deep to be effective. Relief wells installed in the drain would increase its efficiency. The drain on the east side of the road would intercept underflow from the two natural drainageways. Although the depth to gravel on this side of the road is about the same as that on the west side of the road, the fine-grained sediments are lighter textured. The drain, therefore, need not be as deep as the one on the west side of the road—probably only about 6 feet.

If heavy applications of irrigation water are necessary to leach the salts from the soil, a drain along the lower end of the area now waterlogged would facilitate removal of the excess water.

SE¼ SEC. 3 AND SW¼ SEC. 2, T. 2 S., R. 34 E.

This area is only 5 to 7 feet above river level and is bounded on three sides by an abandoned channel of the river. The area is waterlogged because underflow from adjacent higher lands is excessive and because the abandoned river channel is poorly drained. A ditch incising the abandoned river channel to a depth of about 5 feet would relieve the waterlogging. Because gravel underlies the area at a depth of only 5 to 6 feet and because fine-grained sediments overlying the gravel are fairly permeable, the area then could probably be heavily irrigated and yet remain free from further waterlogging.

SOUTH-CENTRAL AND N½ SEC. 3, T. 2 S., R. 34 E., AND SW¼ SEC. 34, T. 1 S., R. 34 E.

To reclaim the area east of the highway where the depth to water is less than 4 feet, an extensive system of deep drains would be required. Fluctuations of water levels in wells in and near this area indicate that leakage from irrigation laterals is a major source of recharge to the unconsolidated deposits and that evapotranspiration is a major cause of discharge. After the growing season, the water level in most of the wells changes only slightly, apparently because recharge by underflow is greater than, or almost equal to, the natural discharge. The slight difference between the altitude of the water level in wells D2–34–3aa2 (A–20) and D2–34–3ac (A–22) indicates that subsurface drainage toward the river is slight—during the summer the altitude of the water surface in the two wells is very nearly the same, and during the winter the altitude of the water surface in well D2–34–3aa2 (A–20) is only about 3 to 4 feet lower than in the other. Although lining the irrigation laterals would decrease recharge somewhat, the benefits gained probably would be counteracted if the land is irrigated again and no provision made for subsurface drainage. A drainage system 6 feet or more deep probably would increase the subsurface drainage from the area so that lining of the irrigation laterals would be unnecessary. Construction of the proposed drains would relieve existent waterlogging in the area between wells D1–34–34cd (A–15) and D2–34–10ab2 (A–27). The proposed development should provide ample drainage for the southern three-fourths of sec. 3, even if the land is heavily irrigated.

The northern part of sec. 3 and the southern part of sec. 34 is low-lying land, and the depth to water for the most part is less than 2 feet. Subsurface inflow from the adjacent higher lying land, which probably is the principal source of recharge to this area, should be intercepted if the area is to be developed for irrigation. Construction of the proposed drains would help lower the water table, and construction of wasteways to carry away excess water would help prevent a rise of the water table after irrigation is begun. Drains 6 feet deep probably would remove ground water effectively.

SEC. 4, T. 2 S., R. 34 E.

In 1954 much interest was shown in reclaiming this land. The Irrigation Department of the Bureau of Indian Affairs had constructed a pilot drain (DR–1) extending from the river upgradient to a point in sec. 4 just west of the highway. Farm operators in sec. 4 were expected to dig connecting lateral drains.

Measurements of the water level in wells D2–34–4bb2 (A–16) and D2–34–4db1 (A–68) indicate that canal leakage is a source of much ground-water recharge to this area. Measurements in wells D2–34–4da1 (A–67) and D2–34–4ab (A–69), at a greater distance from the canal, indicate that recharge from canal leakage is not significant, largely because most of the water is consumed by evapotranspiration in the intervening distance. The water level in well D2–34–4da2 (A–65) is lower in the summer than in the winter; thereby indicating that the amount of ground water discharged by evapotranspiration in this part of the area exceeds the amount of recharge by canal leakage. Water-level fluctuations in well D1–34–33cd3 (A–17) indicate that infiltrating irrigation water in the irrigated areas is the principal source of recharge.

The low gradient of the water table shows that ground-water movement toward the river is slow. Apparently underflow in the alluvial fan north of the area maintains the water table at such a high level that it impedes normal downstream movement of ground water.

If this land is to be reclaimed, canal leakage must be either reduced significantly or intercepted near its source; furthermore, the discharge of ground water from the area must be increased.

Canal leakage could be stopped by lining the canal where it crosses sec. 4. Canal leakage together with natural underflow, however, could be intercepted by constructing drains. The rate of ground-water discharge from the area could be increased by deepening the natural drainageway along the east edge of sec. 4, thereby increasing the riverward gradient of the water table between the canal and the drainageway.

Because the depth to gravel throughout the area exceeds the depth to which drains usually are incised, the efficiency of the drains is likely to be low. Soils maps and well logs indicate that the subsoil in this area is moderately heavy and has low permeability. If the classification and thickness of the fine-grained sediments penetrated by well D2–34–4aa2 (DR1–1) are representative of the area, the loss of head between the pressure surface of the water in the coarse-grained deposits and the bottom of a drain would exceed 2 feet. Therefore, the drains should be dug to the deepest practicable depth. If a depth greater than 6 feet is impractical and if the head in the coarse-grained sediments—measured after the drains have been constructed—proves to be excessive, relief wells could be installed along the floor of the drain and the effectiveness of the drain thereby increased. The soil in this area is moderately saline and the applications of irrigation water must be large if the undesirable salts are to be leached out.

SECS. 19, 20, 28, 29, 32, AND 33, T. 1 S., R. 34 E.

Prior to the construction of the railroad, the Little Bighorn River flowed from the east side of the valley to the west side near test hole D1–34–28cb (A–10A) and then returned to the east side of the valley between wells D1–34–19ba (A–1) and D1–34–19ac (A–2). To facilitate construction of the railroad, the river was diverted into its present channel along the east side of the valley. The abandoned channel is meandering and deep, and the land surface slopes toward it rather than toward the new river channel. The main irrigation canal wasteway discharges excess water into the abandoned channel southwest of well D1–34–29db (A–9) and the water is stored behind a dam near well D1–34–19dc (A–4). The stored water is used to irrigate nearby land. Because of leakage from the reservoir and because part of the water applied to the land infiltrates to the zone of saturation, the water table has risen and in several low-lying places waterlogging has resulted. Drainage of most of the waterlogged land is impracticable because the natural drain is blocked by the dam. This condition could be alleviated by supplying irrigation water only from the main canal, destroying the dam in the abandoned channel, using the former channel of the river only as a drain for disposal of excess water, and digging a cutoff channel from the abandoned channel in the NW¼NE¼ sec. 19 due north to the river.

The waterlogged land surrounding well D1–34–19da (A–3) could be drained even though the above changes were not made. In this tract the depth to water ranges from 3 to 5 feet during the year and the depth to gravel is about 6 feet. A drain about 6 feet deep should be dug through this area, parallel to the highway, and should empty into the old river channel.

If, as suggested, the old river channel is used as a drain, it may be necessary to regrade some stretches so that water will flow through unimpeded. If waterlogging persists in some low areas, additional drains discharging into the drainageway may be needed.

DRAINAGE OF LAND PROPOSED FOR IRRIGATION

Much of the land not irrigated in 1954 is topographically suitable for irrigation. Two irrigation projects have been proposed: One, the Benteen Flat unit, is on the west side of the Little Bighorn River between the Lodge Grass No. 1 and the Reno units; the other, the Battlefield unit, is on the east side of the river between the Reno unit and Crow Agency. Both units have been partly developed for irrigation by private interests. Water pumped from the river for irrigation on these units apparently has caused no serious drainage problems. The geology of the Benteen Flat and Battlefield units and locations of wells and test holes are shown on plates 2 and 3. Contours on the water table in the two units are shown on plates 7 and 9.

The potentially irrigable land in the lower Little Bighorn River valley is on terrace 2—usually called "bench land"—and, in addition to tracts already irrigated, on terrace 1 and the flood plain. Locally, the gentle slopes underlain by undifferentiated surficial deposits also are suitable for irrigation. Topographic and soils maps of the Benteen Flat and Battlefield units have not yet been made. When these maps become available they could be used, together with hydrologic data collected during this investigation, to determine the location and extent of areas likely to become waterlogged as a result of irrigation.

The "bench land" is the least likely to become waterlogged because underflow from adjacent dryland areas is insignificant, and the underlying coarse and permeable gravel assures good drainage. Springs and seeps along the terrace edges indicate that ground water is discharged freely from these terrace deposits. The places that are likely to become waterlogged, however, are (a) those adjacent to leaking canals and laterals; (b) those where recharge—largely the infiltration of irrigation water—exceeds subsurface drainage; (c) those where surface drainage is poorly developed; and (d) low-lying areas or depressions.

Conditions likely to cause waterlogging are present on the flood plain and on terrace 1 outside the units already irrigated. Land adjacent to higher lying irrigated terraces will be more severely and extensively waterlogged.

The gentle slopes on the east side of the Little Bighorn River are the most susceptible to waterlogging because subsurface drainage is very poor. The unconsolidated material underlying these slopes is fine grained and rests directly on bedrock; no layer of gravel intervenes. Such land should not be developed for irrigation until a detailed study of subsurface conditions proves conclusively that drainage is possible.

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BASIC DATA

Table 21.—*Logs of oil wells and test holes*[1]

Formation	Thickness of formation (feet)	Depth to top of formation (feet)
A1-34-34cdd		
[Oil test. George J. Greer, Trustee. Drilled July 1952. Altitude of land surface, approximately 3,125 ft. On drill-stem test, discharged 5,000 gallons of fresh water in 12 minutes from a 40-ft zone between depths of 2,510 and 2,550 ft. Artesian pressure sufficient to lift water to land surface. Total depth, 2,700 ft]		
Niobrara formation	430	450
Frontier sandstone	300	880
Mowry shale	910	1,180
Thermopolis shale	110	2,090
Dakota sandstone	240	2,200
Kootenai and Morrison formations	+260	2,440
A1-35-28b		
[Oil test. Glen H. McCarthy. Drilled July 1950. Altitude of land surface, approximately 3,450 ft. Total depth, 8,554 ft]		
Bearpaw shale	984	592
Judith River formation	870	1,576
Eagle sandstone	167	2,446
Virgelle sandstone	95	2,613
Colorado shale	2,082	2,708
Dakota sandstone (transition zone)	140	4,790
Cloverly formation	90	4,930
Fuson shale	63	5,020
Morrison formation	305	5,083
Ellis formation	160	5,388
Rierdon formation	199	5,548
Piper formation	215	5,747
Chugwater formation	136	5,962
Phosphoria formation	82	6,098
Tensleep sandstone	146	6,180
Amsden formation, upper part	131	6,326
Amsden formation, lower part	108	6,457
Charles formation	477	6,565
Mission Canyon limestone	481	7,042
Lodgepole limestone	547	7,523
Rocks of Devonian age, undifferentiated	231	8,070
Rocks of Ordovician age, undifferentiated	23	8,301
Red River formation, upper part	31	8,324
Red River formation, lower part	20	8,355
Rocks of Cambrian age, undifferentiated	179	8,375
D1-32-23bdd		
[Oil test. H. I. Crowe. Drilled June 1950. Altitude of land surface, 3,027 ft. Flow of water from this well used for hot water plunge and for irrigation. Total depth, 4,000 ft]		
Muddy sandstone	145	1,666
Dakota sandstone	385	1,811
Lakota sandstone	39	2,196
Morrison formation	211	2,235
Ellis formation	579	2,446
Embar formation	209	3,025

See footnote at end of table.

Table 21.—*Logs of oil wells and test holes*[1]—Continued

Formation	Thickness of formation (feet)	Depth to top of formation (feet)
D1-32-23bdd—Continued		
No record	88	3,234
Tensleep sandstone (water)	81	3,322
Amsden formation	86	3,403
Madison limestone (large flow of water)	511	3,489

D1-34-27dd

[Oil test. Carter Oil Co. Drilled May 1953. Altitude of land surface, 3,157 ft. Total depth, 5,464 ft]

Formation	Thickness of formation (feet)	Depth to top of formation (feet)
Frontier formation	1,431	442
Muddy sandstone	115	1,873
Dakota sandstone	229	1,988
Fuson shale	155	2,217
Lakota sandstone	61	2,372
Morrison formation	130	2,433
Swift formation	206	2,563
Rierdon formation	181	2,769
Piper formation	219	2,950
Chugwater formation	203	3,169
Embar formation	4	3,372
Tensleep sandstone	374	3,376
No record	33	3,750
Amsden formation	623	3,783
Mission Canyon limestone	279	4,406
Lodgepole limestone	285	4,685
Rocks of Devonian age, undifferentiated	215	4,970
Rocks of Ordovician age, undifferentiated	279	5,185

D1-35-6bbb

[Oil well. George J. Greer, Trustee. Drilled October 1952. Altitude of land surface, 3,329 ft. Pumped 50 barrels of oil and 100 barrels of water per day through perforated casing between depths of 4,620 and 4,656 ft. On drill-stem test, discharged 8,600 gallons of fresh water in 1 hour from 29-ft zone between depths of 5,361 and 5,390 ft. Total depth, 6,808 ft]

Formation	Thickness of formation (feet)	Depth to top of formation (feet)
Eagle sandstone and Colorado shale	2,055	685
Mowry shale	550	2,740
Dakota sandstone	229	3,290
Morrison formation	279	3,519
Swift formation	214	3,798
Rierdon formation	156	4,012
Piper formation	242	4,168
Chugwater formation	216	4,410
Tensleep sandstone	102	4,626
Amsden sandstone	263	4,728
Charles formation	508	4,991
Mission Canyon limestone	561	5,499
Lodgepole limestone	208	6,060
Rocks of Devonian age, undifferentiated	259	6,268
Rocks of Ordovician age, undifferentiated	252	6,527
Rocks of Cambrian age, undifferentiated	29	6,779

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Table 21.—*Logs of oil wells and test holes*[1]—Continued

Formation	Thickness of formation (feet)	Depth to top of formation (feet)

D6-32-34ab

[Oil well. Inland Empire Oil Co. Drilled August 1948. Altitude of land surface, 3,613 ft. During test, pumped 400 barrels of oil per day through perforated casing between depths of 1,990 and 2,010 ft. Discharged 3,200 gallons of sulphur water during 20-minute test through perforated casing between depths of 2,113 and 2,123 ft. Total depth, 4,470 ft]

Formation	Thickness of formation (feet)	Depth to top of formation (feet)
Morrison formation	254	101
Sundance formation	555	355
Gypsum Springs formation	160	910
Chugwater formation	522	1,070
Embar formation	38	1,592
Tensleep sandstone	52	1,630
Amsden formation	187	1,682
Madison limestone	1,036	1,869
Bighorn dolomite	191	2,905
Rocks of Cambrian age, undifferentiated	1,342	3,096
Rocks of Precambrian age, undifferentiated	30	4,438
Granite	2	4,468

D6-35-31cc

[Oil test. Union Oil Co. of California. Drilled in fall of 1952. Altitude of land surface, approximately 3,482 ft. On drill-stem test, well flowed approximately 10,000 gallons of fresh water in 28 minutes from 27-ft section between depths of 5,039 and 5,066 ft. Total depth, 5,066 ft]

Formation	Thickness of formation (feet)	Depth to top of formation (feet)
Eagle sandstone	430	380
Telegraph Creek formation	400	810
Niobrara formation	370	1,210
Carlile shale	310	1,580
Frontier sandstone	660	1,890
Thermopolis shale	420	2,550
Muddy sandstone	100	2,970
Dakota sandstone	200	3,070
Lakota sandstone	165	3,270
Morrison formation	290	3,435
Sundance formation	503	3,725
Chugwater formation	504	4,228
Tensleep sandstone	43	4,732
Amsden formation	275	4,775
Madison limestone	16	5,050

[1]Logs prepared by oil-company geologists; nomenclature does not necessarily follow usage of the U. S. Geological Survey. Formational contacts based on electric logs.

Table 22.—*Drillers' logs of wells tapping bedrock aquifers*

Material	Thickness (feet)	Depth (feet)
LODGE GRASS NO. 1 UNIT		
D6-35-13ac3 (5-S1)		
Soil	4	4
Shale and gravel	2	6
Gravel and sand	15	21
Shale, gray	1	22
Sand, white	18	40
Shale, light-gray	5	45
Shale and hard shell	2	47
Shale, light-gray	28	75
Lime, light-gray, very hard	5	80
Shale, light-gray	3	83
Shale, very hard	5	88
Shell, hard	2	90
Shale, sandy, light-gray	20	110
Shale, brown	2	112
Shale, brown, soft	21	133
Shale, sandy, hard	2	135
Shale, sandy, dark	7	142
Shell, hard	3	145
Sand	5	150
Sand, white	10	160
Shale, brown	8	168
Sand, white	6	174
Shell, very hard	1	175
Sand, white	10	185
Shale, white, sandy	5	190
Shale, brown	10	200
Shale, white, sandy	10	210
Shale, sandy	10	220
D6-35-21db (P-6)		
Soil	3	3
Gravel (water bearing)	17	20
Shale, gray	50	70
Shale, blue	85	155
Sand (water and gas)	10	165
Shale, blue, hard	5	170
Shale, light-gray	17	187
Shale, gray	123	310
Shale, gray (gas)	110	420
Shale, gray	60	480
Shale, blue	110	590
Shale, brown (gas)	30	620
Shale, blue, hard	20	640
Shale, gray	20	660
Sand, muddy (Telegraph Creek)	30	690
Shale, gray	30	720
Shale, dark-gray	60	780
Shale, gray, muddy (gas)	130	910
Shale, blue	163	1,073
Sand, coarse, gray (gas)	4	1,077
Shale, blue, soft	23	1,100
(Cave)	110	1,210
Shale, brown	20	1,230
Shale, brown (gas)	10	1,240
Shale, brown	20	1,260

Table 22.—*Drillers' logs of wells tapping bedrock aquifers*—Continued

Material	Thickness (feet)	Depth (feet)
LODGE GRASS NO. 1 UNIT—Continued		
D6-35-21db (P-6)—Continued		
Shale, blue	105	1,365
Shale, brown (gas)	45	1,410
Shale, blue	40	1,450
Shale, gray	90	1,540
Shale, sandy, gray	70	1,610
Shale, sandy, muddy (show of oil and gas)	30	1,640
Shale	20	1,660
Sand, muddy (Frontier?)	10	1,670
Shale, sandy (oil and gas)	5	1,675
Shale, light-gray	35	1,710
Shale, dark (gas)	20	1,730
Shale, gray, muddy	10	1,740
Shale, light-gray	30	1,770
Shale, blue, sandy	20	1,790
Shale, blue, dark	20	1,810
Shale, blue	45	1,855
Shale, gray, sandy (gas)	15	1,870
Shale, light-gray	10	1,880
Shale, brown	10	1,890
Shale, dark-blue (gas at all times)	10	1,900
Shale, dark-gray (gas)	40	1,940
Shale, blue	20	1,960
Shale, sandy, blue (gas)	40	2,000
Shale, sandy, gray, hard	40	2,040
Shale, blue, hard	10	2,050
Gypsum, white	10	2,060
Soapstone, white	30	2,090
Shale, light-blue	15	2,105
Shale, sandy, blue, hard	55	2,160
Shale, gray	10	2,170
Shale, gray, muddy	30	2,200
Shale, blue	40	2,240
Shale, brown	20	2,260
Shale, blue	20	2,280
Shale, brown	40	2,320
No record	20	2,340
Shale, black, hard	10	2,350
Shale, sandy, gray	110	2,460
Shale, gray, hard	5	2,465
Shale, black, hard	25	2,490
Soapstone, white	15	2,505
Shale, gray, hard	35	2,540
No record	80	2,620
Shale, gray, hard	35	2,655
Shale, black, hard	35	2,690
Shells, hard	7	2,697
Shale, black	33	2,730
Shells, blue, hard	15	2,745
Shale, dark	20	2,765
Shale, sandy, blue	10	2,775
Shale, sandy, black, and hard blue shells; specks of white bentonite	35	2,810
Shale, black; specks of bentonite	15	2,825
Shale, sandy, blue, hard and flinty	25	2,850
Shale, blue-black	10	2,860
Shale, sandy, blue, hard and flinty	10	2,870

Table 22.—*Drillers' logs of wells tapping bedrock aquifers*—Continued

Material	Thickness (feet)	Depth (feet)
LODGE GRASS NO. 1 UNIT—Continued		
D6-35-21db (P-6)—Continued		
Shale, sandy, gray	15	2,885
Shale, gray	15	2,900
Shale, light-blue	40	2,940
Shale, light-blue, with brown, thin lime shells and specks of bentonite	20	2,960
Sand, light-gray, muddy with black specks	30	2,990
Shell, soft, dark-gray when wet, blue-gray when dry	66	3,056
Shale, dark, soft	4	3,060
Shale, black	35	3,095
Shale, sandy, blue, with iron pyrite	40	3,135
Shale, sandy, hard	25	3,160
Shale, sandy, blue	80	3,240
Shale	10	3,250
Shale, sandy, blue	25	3,275
Shale, sandy, blue, with hard shells	35	3,310
Shale, sandy, gray, with hard shells	35	3,345
Shale, pink (Cloverly?)	20	3,365
Sand (water filled up 600 feet)	15	3,380
Shale, pink	10	3,390
Sand (little water)	10	3,400
Shale, pink	5	3,405
BATTLEFIELD UNIT		
D3-35-18dc (P-3)		
Soil	16	16
Sandstone, dark-gray	19	35
Shale, blue, hard	1	36
Sandstone, gray, hard	10	46
Shale, dark-brown	13	59
Sandstone, light-blue	64	123

Table 23.—*Logs of seismic shotholes in the Agency unit*

Material	Thickness (feet)	Depth (feet)
D1-34-20bb1 (7293)		
Clay	15	15
Gravel	6	21
Shale, blue	41	62
D1-34-20bb2 (7294)		
Clay	15	15
Gravel	11	26
Shale, blue	36	62
D1-34-20bd (7295)		
Clay	20	20
Gravel	6	26
Shale, blue	36	62
D1-34-20db (7296)		
Clay	21	21
Shale	41	62
D1-34-20dc (7297)		
Clay	30	30
Gravel	12	42
Shale, blue	20	62
D1-34-20dd (7298)		
Clay	25	25
Gravel	10	35
Shale, blue	27	62
D1-34-21cc1 (7410)		
Clay	22	22
Sand and gravel	37	59
Shale, blue	21	80
D1-34-21cc2 (7411)		
Clay	19	19
Gravel	8	27
Shale, blue	33	60
D1-34-21cd (7412)		
Clay	23	23
Shale, blue	37	60
D1-34-27ca (7306)		
Clay	15	15
Shale	47	62
D1-34-27cc (7305)		
Clay	12	12
Shale	50	62

Table 23.—*Logs of seismic shotholes in the Agency unit*—Continued

Material	Thickness (feet)	Depth (feet)
D1-34-27db1 (7307)		
Clay	18	18
Shale	44	62
D1-34-27db2 (7307A)		
Clay	16	16
Gravel	2	18
Shale, dark-gray	282	300
D1-34-28bc (7300)		
Clay	21	21
Gravel	12	33
Shale, blue	29	62
D1-34-28bd (7301)		
Clay	21	21
Gravel	9	30
Shale, blue	32	62
D1-34-28cd (7484)		
Clay	7	7
Gravel	13	20
Shale, blue	40	60
D1-34-28da1 (7303)		
Clay	12	12
Shale	50	62
D1-34-28da2 (7304)		
Sand	12	12
Shale	48	60
D1-34-28db (7302)		
Clay	21	21
Gravel	11	32
Shale, blue	30	62
D1-34-28dc (7478)		
Sand	7	7
Gravel	16	23
Shale, blue	37	60
D1-34-29aa1 (7299)		
Clay	19	19
Gravel	12	31
Shale, blue	31	62

Table 23.—*Logs of seismic shotholes in the Agency unit*—Continued

Material	Thickness (feet)	Depth (feet)
D1-34-29aa2 (7386)		
Clay	14	14
Gravel	15	29
Shale, blue	31	60
D1-34-29ab1 (7385)		
Gravel and sand	23	23
Shale, blue	27	50
D1-34-29bc1 (7383)		
Gravel	21	21
Shale, blue	29	50
D1-34-29bc2 (7382)		
Gravel	14	14
Shale, blue	36	50
D1-34-29bd (7384)		
Clay	8	8
Gravel	12	20
Shale, blue	30	50
D1-34-29cc (7289)		
Gravel	23	23
Shale, blue	57	80
D1-34-30ab (7292)		
Gravel	23	23
Shale, blue	37	60
D1-34-30ad (7291)		
Gravel	21	21
Shale, blue	39	60
D1-34-30da (7290)		
Gravel	18	18
Shale, blue	42	60
D1-34-32ac (7285)		
Gravel	12	12
Shale, blue	68	80
D1-34-32ba (7286)		
Clay	3	3
Gravel	16	19
Shale, blue	43	62

Table 23.—*Logs of seismic shotholes in the Agency unit*—Continued

Material	Thickness (feet)	Depth (feet)
D1-34-32bb1 (7288)		
Clay	5	5
Gravel	15	20
Shale, blue	40	60
D1-34-32bb2 (7287)		
Clay	5	5
Gravel	15	20
Shale, blue	40	60
D1-34-32da (7283)		
Sand and gravel	22	22
Shale, blue	38	60
D1-34-32db (7284)		
Clay	15	15
Gravel	5	20
Shale, blue	60	80
D1-34-32dd (7282)		
Gravel	24	24
Shale, blue	46	70
D1-34-33bb1 (7485)		
Sand	10	10
Gravel	15	25
Shale, blue	35	60
D1-34-33bb2 (7486)		
Sand and gravel	23	23
Shale, blue	37	60
D1-34-33cc (7281)		
Sand and gravel	54	54
Shale, blue	26	80
D1-34-33cd1 (7280)		
Sand and gravel	19	19
Shale	43	62
D1-34-33cd2 (7280A)		
Loam, clayey	28	28
Gravel, coarse	6	34
Shale, dark-gray	266	300
D1-34-33dc (7323)		
Clay	11	11
Gravel	20	31
Shale, blue	29	60

Table 23.—*Logs of seismic shotholes in the Agency unit*—Continued

Material	Thickness (feet)	Depth (feet)
D1-34-33dd (7324)		
Clay	8	8
Gravel	22	30
Shale	30	60
D1-34-34dd (7373)		
Clay	8	8
Gravel	14	22
Shale, blue	28	50
D2-34-2cc3 (7468)		
Gravel	23	23
Shale, blue	37	60
D2-34-3aa1 (7328)		
Clay	6	6
Gravel	14	20
Shale, blue	32	52
D2-34-3ab1 (7327)		
Clay	8	8
Gravel	9	17
Shale, blue	35	52
D2-34-3ad1 (7329)		
Clay	11	11
Gravel	6	17
Shale, blue	35	52
D2-34-3ad2 (7330)		
Clay	10	10
Gravel	16	26
Shale, blue	14	40
D2-34-3ba (7326)		
Clay	8	8
Gravel	14	22
Shale, blue	28	50
D2-34-3bb (7325)		
Clay	7	7
Gravel	16	23
Shale, blue	39	62
D2-34-3cd (7334)		
Clay	5	5
Gravel	22	27
Shale, blue	25	52

Table 23.—*Logs of seismic shotholes in the Agency unit*—Continued

Material	Thickness (feet)	Depth (feet)
D2-34-3dc5 (7331)		
Clay	8	8
Sand and gravel	14	22
Shale, blue	28	50
D2-34-3dc6 (7333)		
Clay	12	12
Gravel	16	28
Shale, blue	22	50
D2-34-3dc7 (7332)		
Clay	10	10
Gravel	13	23
Shale, blue	29	52
D2-34-3dd (7469)		
Clay	11	11
Gravel	16	27
Shale, blue	33	60
D2-34-4bb1 (7279)		
Sand and gravel	17	17
Shale, blue	43	60
D2-34-4bc (7278)		
Sand and gravel	28	28
Shale, blue	32	60
D2-34-5da (7277)		
Sand and gravel	18	18
Shale, blue	42	60
D2-34-5dd (7276)		
Sand and gravel	20	20
Shale, blue	60	80
D2-34-8aa (7275)		
Sand and gravel	23	23
Shale, blue	57	80
D2-34-8ad1 (7274)		
Sand	20	20
Shale, blue	60	80
D2-34-8ad2 (7273)		
Clay and gravel	17	17
Shale, blue	63	80

Table 23.—*Logs of seismic shotholes in the Agency unit*—Continued

Material	Thickness (feet)	Depth (feet)
D2-34-8db (7272)		
Sand and gravel	15	15
Shale, blue	65	80
D2-34-8dc (7271)		
Clay and gravel	16	16
Shale, blue	64	80
D2-34-9ad (7336)		
Clay	3	3
Gravel	18	21
Shale, blue	30	51
D2-34-9da (7337)		
Clay	8	8
Gravel	14	22
Shale, blue	28	50
D2-34-9dd (7338)		
Clay	5	5
Gravel	6	11
Shale	41	52
D2-34-10ab3 (7455)		
Clay	9	9
Gravel	18	27
Shale, blue	35	62
D2-34-10ad (7456)		
Clay	12	12
Gravel	12	24
Shale, blue	36	60
D2-34-10bb (7335)		
Sand and gravel	15	15
Gravel	12	27
Shale, blue	23	50
D2-34-10da1 (7457)		
Clay	10	10
Gravel	15	25
Shale, blue	35	60
D2-34-11ab2 (7466)		
Clay	7	7
Gravel	8	15
Shale, blue	35	50

Table 23.—*Logs of seismic shotholes in the Agency unit*—Continued

Material	Thickness (feet)	Depth (feet)
D2-34-11ac (7465)		
Clay	8	8
Gravel	10	18
Shale, blue	32	50
D2-34-11ba (7467)		
Clay	9	9
Gravel	12	21
Shale, blue	31	52
D2-34-11cc1 (7458)		
Clay	8	8
Sand and gravel	11	19
Gravel	9	28
Shale, blue	32	60
D2-34-11cd (7460)		
Clay	12	12
Gravel	10	22
Shale, blue	38	60
D2-34-11db (7464)		
Clay	5	5
Gravel	13	18
Shale, blue	32	50
D2-34-11dca (7463)		
Sand	8	8
Gravel	11	19
Shale, blue	41	60
D2-34-11dcc (7461)		
Clay	14	14
Gravel	8	22
Shale, blue	38	60
D2-34-14ab1 (7462)		
Sand and gravel	21	21
Shale, blue	39	60
D2-34-14bb (7459)		
Clay, sandy	18	18
Gravel	9	27
Shale, blue	33	60
D2-34-16aa (7339)		
Clay	4	4
Gravel	8	12
Shale	40	52

Table 24.—*Logs of test holes from which samples were obtained for tests of physical and hydrological properties*

Material	Thickness (feet)	Depth (feet)
RENO AND BATTLEFIELD UNITS		
D3-34-12abd (68)		
Clay, silty	1.7	1.7
Loam, calcareous	3.3	5.0
Loam, sandy, calcareous	3.0	8.0
Sand, fine to very fine	3.5	11.5
Gravel	....	....
D3-34-12db1 (61)		
Loam, silty	1.5	1.5
Sand, very fine	2.5	4.0
Sand, fine	1.0	5.0
Silt, sandy	3.0	8.0
Clay, silty	1.0	9.0
Sand, silty, very fine	4.0	13.0
Gravel	....	....
D3-34-12db2 (79)		
Loam, sandy	1.0	1.0
Loam, sandy, fine	2.5	3.5
Sand, fine to coarse	.8	4.3
Gravel	....	....
D3-34-13ab2 (81)		
Loam, sandy, very fine, calcareous	2.0	2.0
Loam	2.0	4.0
Silt	1.0	5.0
Sand, silty, fine	3.5	8.5
Sand, silty	.5	9.0
Gravel	....	....
D3-35-18bd (85)		
Loam, silty, calcareous	1.0	1.0
Loam, sandy, fine	2.0	3.0
Sand, silty, very fine	5.2	8.2
Gravel	....	....
D4-35-9aa2 (57)		
Loam, silty	3.0	3.0
Sand, silty, fine to very fine	6.0	9.0
Gravel(?)	....	....
AGENCY UNIT		
D1-34-29aac (40)		
Loam, silty and clayey	1.5	1.5
Loam, clayey	1.0	2.5
Sand, very fine, silty	2.5	5.0
Clay	6.0	11.0
Sand, very fine to fine, silty	2.0	13.0
Clay	2.5	15.5

Table 24.—*Logs of test holes from which samples were obtained for tests of physical and hydrological properties*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D1-34-29aac (40)—Continued		
Sand, fine to medium	2.5	18.0
Gravel	....	....
D1-34-30adb (31)		
Loam, sandy	1.5	1.5
Silt, sandy	1.5	3.0
Sand, very fine to fine, silty	4.0	7.0
Gravel, fine to medium, sandy	1.8	8.8
Clay	2.4	11.2
Gravel, coarse	5.8	17.0
Shale, gray	8.0	25.0
Shale, dark-gray	1.0	26.0
D1-34-31adc (36)		
Loam, sandy	1.8	1.8
Silt, sandy	2.7	4.5
Sand, very fine, silty	2.0	6.5
Sand and gravel, coarse	....	....
D1-34-32ddd (39)		
Loam, sandy	3.0	3.0
Gravel, coarse	.5	3.5
D1-34-33dcc (49)		
Loam, silty	3.0	3.0
Sand, very fine to fine, silty	4.8	7.8
D2-34-3abb (59)		
Loam, silty	1.5	1.5
Sand, very fine, silty	1.5	3.0
Sand, fine to coarse	8.0	11.0
D2-34-3bcd (65)		
Clay	3.0	3.0
Clay, silty	1.8	4.8
Sand, silty, fine	1.2	6.0
D2-34-3ddc (45)		
Loam, silty and clayey	1.5	1.5
Loam, clayey	2.0	3.5
Clay	12.5	16.0
Clay, silty	2.0	18.0
Silt	3.0	21.0
Gravel	.1	21.1

Table 24.—*Logs of test holes from which samples were obtained for tests of physical and hydrological properties*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D2-34-11ccd (71)		
Loam, silty, calcareous	1.5	1.5
Loam, sandy	.5	2.0
Silt, sandy	2.0	4.0
Silt	2.5	6.5
D2-34-36cda (73)		
Loam, silty, calcareous	1.5	1.5
Loam, sandy	1.5	3.0
Silt, sandy	3.0	6.0
Silt	4.0	10.0
Silt, clayey	5.5	15.5
Silt, sandy, and clay, silty	6.5	22.0
Clay	1.0	23.0
Silt, clayey	....	....
D3-34-1ac1 (53)		
Loam, silty	3.5	3.5
Clay, silty	1.0	4.5
Silt	1.8	6.3
D3-34-1ac2 (54)		
Loam, silty	2.0	2.0
Clay, silty	1.5	3.5
Gravel, coarse	1.0	4.5
Sand, fine to very fine	.5	5.0
D3-34-1ac3 (56)		
Loam, silty	1.8	1.8
Clay, silty	.7	2.5
Sand, fine to very fine	3.7	6.2
Clay, silty	.3	6.5
Sand, fine to very fine	.5	7.0

Table 25.—*Logs of jetted wells and test holes*

Material	Thickness (feet)	Depth (feet)
LODGE GRASS NO. 1 UNIT		
D5-35-22bb (D-27)		
Loam, sandy and clayey	2.0	2.0
Silt, sandy	1.0	3.0
Sand	.7	3.7
Sand and clay	2.3	6.0
Clay and sand	2.6	8.6
Sand	.6	9.2
Gravel	4.3	13.5
D5-35-22cb (D-1)		
Loam, sandy	1.5	1.5
Clay, sandy	3.5	5.0
Clay	2.0	7.0
Clay, sandy	1.0	8.0
Sand	.5	8.5
Sand and gravel	4.6	13.1
D5-35-22cc (D-3)		
Clay, sandy	6.0	6.0
Clay, heavy	1.0	7.0
Clay, sandy	6.0	13.0
Gravel	6.1	19.1
D5-35-22dc (D-2)		
Clay, sandy	2.0	2.0
Sand	1.0	3.0
Clay, sandy	.5	3.5
Sand	1.0	4.5
Clay, sandy	4.5	9.0
Gravel	8.5	17.5
D5-35-27bb1 (4-N3)		
Clay	8.5	8.5
Loam, sandy	1.0	9.5
Gravel	1.5	11.0
D5-35-27bb2 (4-N2)		
Clay	8.5	8.5
Loam, sandy	1.0	9.5
Gravel	2.7	12.2
D5-35-27bb3 (4-N1)		
Clay	8.0	8.0
Gravel	2.4	10.4
D5-35-27bb4 (DR12-1)		
Clay, black	2.0	2.0
Clay, gray	5.0	7.0
Clay, brown, and some sand	2.7	9.7
Sand and gravel	2.3	12.0

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Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
LODGE GRASS NO. 1 UNIT—Continued		
D5-35-27bb5 (P-4)		
Clay	11.0	11.0
Loam, sandy	1.0	12.0
Gravel	3.7	15.7
D5-35-27bd (D-4)		
Clay, sandy	6.0	6.0
Clay, heavy	7.0	13.0
Clay, sandy	1.0	14.0
Clay, very heavy	1.5	15.5
Sand	.5	16.0
Gravel	1.0	17.0
D5-35-27cd (D-6)		
Clay, sandy	5.0	5.0
Clay	2.0	7.0
Clay, sandy	10.0	17.0
Clay	5.0	22.0
Gravel, very coarse	3.5	25.5
D5-35-27db (D-5)		
Clay, sandy	6.0	6.0
Clay, heavy	2.5	8.5
Gravel	8.2	16.7
D5-35-34bd (D-7)		
Loam, silty and clayey	5.5	5.5
Clay, sandy	1.0	6.5
Loam, silty, and clayey loam	25.5	32.0
Gravel, very coarse	3.5	35.5
D5-35-34cd (DR13-2)		
Clay	10.0	10.0
Silt and clayey loam	10.0	20.0
Gravel	1.0	21.0
D5-35-34db (DR13-1)		
Loam, clayey	8.0	8.0
Gravel and sand	6.0	14.0
Gravel, sandy and silty	3.0	17.0
D5-35-34dc (D-8)		
Loam, silty and clayey	3.0	3.0
Clay	2.5	5.5
Clay, silty	1.5	7.0
Clay	6.0	13.0
Clay, some gravel	6.0	19.0
Gravel	7.5	26.5

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
LODGE GRASS NO. 1 UNIT—Continued		
D6-35-1bc (D-9)		
Clay, silty	15.0	15.0
Clay, sandy	4.0	19.0
Sand and sandy clay	6.5	25.5
Gravel	2.5	28.0
D6-35-1cb (D-10)		
Loam, silty	12.0	12.0
Loam, sandy	3.0	15.0
Gravel	2.0	17.0
Clay, red	5.0	22.0
Gravel	4.2	26.2
D6-35-1cd (D-11)		
Loam, silty	2.0	2.0
Clay, heavy	3.0	5.0
Loam, clayey	6.0	11.0
Sand	3.0	14.0
Gravel	3.5	17.5
D6-35-1dc (D-12)		
Loam, silty	1.0	1.0
Loam, clayey	1.0	2.0
Soil, organic	1.0	3.0
Loam, clayey	5.0	8.0
Gravel, medium	5.0	13.0
D6-35-10dc (D-16)		
Clay, silty	13.5	13.5
Gravel	2.9	16.4
D6-35-11cd (D-17A)		
Loam, silty	4.5	4.5
Gravel	3.0	7.5
D6-35-11da (D-19A)		
Clay, silty	1.5	1.5
Gravel	6.0	7.5
D6-35-11dd (D-20)		
Gravel and small cobbles; calcareous lens at 2.0 ft	6.5	6.5
D6-35-12dd (D-13)		
Loam, silty	5.0	5.0
Gravel; contains sand lenses	5.0	10.0

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
LODGE GRASS NO. 1 UNIT—Continued		
D6-35-13aa (D-14)		
Loam, silty	6.0	6.0
Sand, medium	2.0	8.0
Gravel; contains sand lenses	7.1	15.1
D6-35-13ba (D-15)		
Loam, clayey	4.5	4.5
Gravel	7.5	12.0
Sandstone	1.0	13.0
D6-35-13cb (D-23)		
Gravel	1.5	1.5
Loam, silty	9.5	11.0
Loam, sandy and silty	6.0	17.0
Gravel and sand	7.4	24.4
D6-35-14aa1 (D-18)		
Clay, silty	6.5	6.5
Gravel	3.4	9.9
D6-35-14bc (D-22A)		
Loam, silty	4.5	4.5
Gravel	4.5	9.0
D6-35-14ca (D-21)		
Gravel and small cobbles	8.0	8.0
D6-35-14da (DR14-1)		
Clay and clayey loam	9.0	9.0
Gravel	1.0	10.0
Loam, clayey	1.0	11.0
Gravel, fine	3.0	14.0
D6-35-14db (D-24)		
Loam, silty	4.5	4.5
Clay	4.5	9.0
Loam, clayey	1.5	10.5
Gravel and sand	5.7	16.2
D6-35-22ab (D-25)		
Loam	10.5	10.5
Gravel and sand	6.6	17.1
D6-35-29ab (D-26)		
Loam, silty	13.5	13.5
Gravel	1.9	15.4

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
BENTEEN FLAT UNIT		
D4-35-10cc (C-1)		
Loam, silty	8.5	8.5
Gravel; contains sand lenses	7.3	15.8
D4-35-16ad (C-2)		
Loam, clayey	5.0	5.0
Gravel; grading downward to sand	12.6	17.6
D4-35-16dc1 (C-4)		
Loam, clayey	2.0	2.0
Clay	4.0	6.0
Loam, clayey	2.5	8.5
Gravel, coarse	5.5	14.0
D4-35-16dd (C-3)		
Clay	4.0	4.0
Loam, clayey	3.5	7.5
Gravel, coarse	9.8	17.3
D4-35-21aa (C-5)		
Loam, silty	13.0	13.0
Gravel	16.0	29.0
D4-35-21ad (C-6)		
Loam, clayey	17.0	17.0
Gravel, coarse-grained	3.0	20.0
Sand and gravel	7.0	27.0
D4-35-21cd2 (C-8)		
Loam, sandy	4.0	4.0
Loam, silty	7.6	11.6
Gravel, coarse	12.2	23.8
D4-35-21dc (C-7)		
Loam, clayey, and silty loam	19.8	19.8
Gravel; some clay and sand	11.3	31.1
D4-35-28bd (C-10)		
Loam, clayey, heavy	24.0	24.0
Gravel, very coarse	6.5	30.5
D4-35-28db (C-9)		
Loam, silty	4.0	4.0
Loam, sandy	4.0	8.0
Loam, silty	30.0	38.0
Gravel	4.0	42.0

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
BENTEEN FLAT UNIT—Continued		
D4-35-33ac (C-11)		
Loam, silty	9.0	9.0
Gravel, coarser with depth	5.5	14.5
D4-35-33db (C-12)		
Loam, silty	3.0	3.0
Loam, sandy	14.0	17.0
Gravel and sand	5.5	22.5
D5-35-4ab (C-13)		
Loam, sandy	1.6	1.6
Silt, sandy	3.4	5.0
Clay, sandy	1.0	6.0
Silt, sandy	3.0	9.0
Sand	2.0	11.0
Clay, sandy	1.5	12.5
Sand	2.5	15.0
Gravel, sandy	.5	15.5
Gravel and sand	3.5	19.0
D5-35-4db (C-14)		
Silt, sandy	4.0	4.0
Clay, sandy	1.5	5.5
Sand	1.5	7.0
Sand; some gravel	1.2	8.2
Gravel and sand	10.8	19.0
D5-35-9ad (C-15)		
Loam, silty	1.5	1.5
Clay, sandy	3.5	5.0
Sand	.8	5.8
Clay, sandy	1.2	7.0
Sand	4.0	11.0
Gravel	5.0	16.0
D5-35-9dd (C-16)		
Sand	2.0	2.0
Gravel	6.5	8.5
D5-35-15cb (C-18)		
Silt, sandy	5.5	5.5
Clay, sandy	.5	6.0
Sand	.5	6.5
Clay, sandy	1.5	8.0
Clay, very sandy	1.0	9.0
Clay and sand	1.0	10.0
Clay	1.5	11.5
Clay, sandy	1.0	12.5
Sand, medium	3.7	16.2
Gravel	3.0	19.2

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
BENTEEN FLAT UNIT—Continued		
D5-35-16aa (C-17)		
Silt, sandy	5.0	5.0
Clay, sandy	8.0	13.0
Clay	2.5	15.5
Gravel	.5	16.0
Clay, sandy; some gravel	6.0	22.0
Gravel	2.5	24.5
RENO AND BATTLEFIELD UNITS		
D3-34-1dc (B-1)		
Loam, clayey	9.0	9.0
Gravel and cobbles	4.0	13.0
Sand	1.5	14.5
Gravel, coarse	3.5	18.0
D3-34-12da (B-2)		
Clay	11.0	11.0
Loam, clayey	5.0	16.0
Gravel, very coarse; some sand	10.3	26.3
D3-34-13aa (B-3)		
Loam, silty	7.0	7.0
Gravel, medium to coarse	10.1	17.1
D3-34-13ab1 (B-38)		
Loam, silty	6.5	6.5
Loam, sandy	2.0	8.5
Gravel	10.7	19.2
D3-34-13da (B-16)		
Loam, silty	0.8	0.8
Sand, silty, very fine	1.7	2.5
Gravel and silty sand, fine	1.0	3.5
Sand, silty, very fine	.5	4.0
Gravel and silty sand, very coarse	1.5	5.5
Gravel, medium to coarse	3.5	9.0
D3-34-24aa (B-17)		
Loam, clayey	6.0	6.0
Loam	2.5	8.5
Gravel, coarse, and cobbles	6.4	14.9
D3-35-18ba (B-37)		
Clay	10.0	10.0
Loam, silty	3.0	13.0
Loam, clayey	3.0	16.0
Loam, sandy	4.5	20.5
Gravel	7.6	28.1

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
RENO AND BATTLEFIELD UNITS—Continued		
D3-35-18cc (B-4)		
Loam, sandy	8.5	8.5
Gravel, medium to coarse	5.0	13.5
D3-35-19ba (B-18)		
Loam, clayey	3.0	3.0
Loam, sandy	6.0	9.0
Gravel, coarse	8.3	17.3
D3-35-19bc (B-5)		
Clay, loamy	8.0	8.0
Sand	4.5	12.5
Gravel, coarse	4.5	17.0
D3-35-19ca (B-19)		
Loam; contains some sand lenses	15.5	15.5
Gravel	2.0	17.5
Gravel, sandy	1.5	19.0
Gravel, coarse	3.9	22.9
D3-35-19cc (B-20)		
Clay, silty	16.0	16.0
Gravel	2.5	18.5
Clay, fine sandy	.5	19.0
D3-35-19cd (DR8-1)		
Loam, silty	14.5	14.5
Gravel	1.9	16.4
D3-35-19dc (B-6)		
Loam, sandy	5.0	5.0
Loam, sandy, and sand	9.5	14.5
Gravel, coarse	5.5	20.0
D3-35-19dd (B-21)		
Clay	5.0	5.0
Loam, silty	5.5	10.5
Gravel, coarse	6.6	17.1
D3-35-20cc (B-7)		
Loam, sandy	11.0	11.0
Gravel, coarse	4.5	15.5
D3-35-29ca (B-9)		
Loam, clayey	4.0	4.0
Loam, sandy, and sand	6.0	10.0
Clay	2.5	12.5
Loam, sandy, and sand	8.1	20.6

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
RENO AND BATTLEFIELD UNITS—Continued		
D3-35-29cc1 (B-35)		
Clay	3.0	3.0
Loam, clayey; contains some silt lenses	15.0	18.0
Loam, silty	5.5	23.5
Gravel, coarse	4.7	28.2
D3-35-29cc2 (B-34)		
Loam, silty	7.5	7.5
Loam, sandy	9.5	17.0
Loam, silty	8.0	25.0
Gravel and clay	1.2	26.2
Gravel, coarse	4.8	31.0
D3-35-29cd (B-36)		
Loam, clayey	13.0	13.0
Loam, silty	4.0	17.0
Clay	6.3	23.3
Gravel	3.1	26.4
D3-35-29da1 (B-40)		
Loam, clayey	8.0	8.0
Gravel; contains sand lenses	7.0	15.0
D3-35-29da2 (B-41)		
Loam, silty	3.0	3.0
Gravel; contains sand lenses	6.0	9.0
Shale interbedded with sandstone	.5	9.5
D3-35-29db (B-42)		
Loam, silty	6.0	6.0
Gravel; contains sand lenses	12.0	18.0
D3-35-30ab (B-39)		
Clay	8.0	8.0
Loam, silty	6.0	14.0
Gravel and sand	7.2	21.2
D3-35-30ba (DR8-2)		
Clay	15.5	15.5
Sand interbedded with clay and gravel	2.5	18.0
Gravel	5.0	23.0
D3-35-30da (B-8)		
Loam, clayey	13.0	13.0
Loam, sandy and clayey	3.0	16.0
Gravel, coarse; contains some sand	4.6	20.6

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
RENO AND BATTLEFIELD UNITS—Continued		
D3-35-32ab (DR9-1)		
Loam, clayey	5.0	5.0
Loam, silty	5.0	10.0
Gravel	4.3	14.3
D3-35-32ac (DR9-2)		
Loam, silty, and clayey loam	6.0	6.0
Gravel	5.6	11.6
D3-35-32ba (B-10)		
Loam, clayey	8.0	8.0
Loam, sandy, and sand	13.0	21.0
Loam, clayey	9.0	30.0
Sand	1.0	31.0
Gravel, coarse	2.1	33.1
D3-35-32db1 (B-33)		
Loam, clayey	34.5	34.5
Gravel and sand	2.5	37.0
D3-35-32db2 (B-11)		
Loam, sandy and clayey	6.0	6.0
Loam, sandy	10.0	16.0
Loam, clayey, and clay	13.0	29.0
Gravel, fine to medium	2.7	31.7
D4-35- 3bb (B-27)		
Loam, clayey	3.5	3.5
Loam, silty	5.8	9.3
Gravel	7.3	16.6
D4-35- 3cb (B-25)		
Loam, silty	6.5	6.5
Loam, sandy	3.3	9.8
Gravel; contains some sand lenses	7.2	17.0
D4-35- 3cd (B-14)		
Loam, sandy, and sandy, clayey loam	11.0	11.0
Loam, clayey, gray	5.5	16.5
Gravel, fine; contains clay lenses	2.6	19.1
D4-35- 4ab (B-26)		
Clay	5.5	5.5
Loam, sandy	3.7	9.2
Gravel	6.0	15.2

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
RENO AND BATTLEFIELD UNITS—Continued		
D4-35- 4bb1 (B-32)		
Loam, clayey	7.0	7.0
Loam; contains some sand	7.0	14.0
Gravel, very coarse	3.8	17.8
D4-35- 4bb2 (DR10-1)		
Loam, silty	14.5	14.5
Gravel	1.9	16.4
D4-35- 4bc (B-12)		
Loam, clayey	5.0	5.0
Loam, sandy and clayey	6.0	11.0
Loam, sandy	4.0	15.0
Gravel, coarse	4.9	19.9
D4-35- 5aa (B-22)		
Clay	18.0	18.0
Gravel, very coarse	1.5	19.5
D4-35- 5ab (B-23)		
Loam, clayey	10.5	10.5
Loam, silty	29.5	40.0
Sand and gravel	2.0	42.0
Shale	3.0	45.0
D4-35- 9aa1 (B-45)		
Loam, silty	3.0	3.0
Sand, silty, fine to very fine	6.0	9.0
Gravel	.6	9.6
D4-35- 9ab (B-43)		
Loam, clayey	6.5	6.5
Loam, silty	4.5	11.0
Loam, clayey	6.0	17.0
Gravel, coarse; contains some sand	2.3	19.3
D4-35- 9ac (B-28)		
Loam, silty	8.5	8.5
Loam, clayey	2.0	10.5
Loam, silty	7.5	18.0
Gravel	4.0	22.0
Gravel, clayey	1.0	23.0
Gravel	3.0	26.0
Sand, dark	1.0	27.0
Gravel, fine	.6	27.6
D4-35- 9ad (B-29)		
Loam, clayey	13.0	13.0
Gravel; contains some sand lenses	3.6	16.6

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
RENO AND BATTLEFIELD UNITS—Continued		
D4-35- 9ba (B-13)		
Loam, clayey	9.0	9.0
Loam, silty	4.0	13.0
Gravel, medium to coarse	6.1	19.1
D4-35- 9db (B-15)		
Loam, clayey	6.0	6.0
Loam, sandy and clayey	9.0	15.0
Gravel, very coarse	4.1	19.1
D4-35- 9dc (B-30)		
Loam, clayey	17.5	17.5
Gravel	3.7	21.2
D4-35-10bb (B-24)		
Loam, clayey	8.5	8.5
Gravel; contains some sand lenses	9.8	18.3
D4-35-16bd (B-31)		
Loam, clayey	8.0	8.0
Gravel	4.0	12.0
AGENCY UNIT		
D1-34-19ac (A-2)		
Loam, sandy	7.5	7.5
Loam, sandy and clayey	1.0	8.5
Loam, sandy, and gravel	3.0	11.5
Shale, dark-gray	.6	12.1
D1-34-19ba (A-1)		
Loam, sandy and clayey	5.5	5.5
Gravel, coarse	5.0	10.5
Clay	2.5	13.0
D1-34-19da (A-3)		
Loam, clayey	5.5	5.5
Gravel, coarse	2.5	8.0
Sand	1.0	9.0
Gravel	.5	9.5
Shale, dark-gray	.5	10.0
D1-34-19dc (A-4)		
Loam, sandy	6.0	6.0
Gravel, medium to coarse	6.0	12.0
Shale, dark-gray	1.0	13.0

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D1-34-20cc (A-5)		
Loam, clayey	9.5	9.5
Loam, sandy	4.0	13.5
Gravel, coarse, and sand	8.5	22.0
Shale, dark-gray	1.5	23.5
D1-34-28cb (A-10A)		
Gravel, coarse	7.0	7.0
Sand	2.5	9.5
Shale, dark-gray	1.0	10.5
D1-34-29aa3 (A-8)		
Loam, sandy and clayey	9.0	9.0
Loam, clayey	2.0	11.0
Loam, sandy and clayey	7.5	18.5
Gravel, sandy, coarse	7.5	26.0
Shale, dark-gray	1.0	27.0
D1-34-29ab2 (A-7)		
Loam, clayey	7.5	7.5
Loam, sandy	8.0	15.5
Gravel, coarse, and sand	9.0	24.5
Sand	1.5	26.0
Shale, dark-gray	.5	26.5
D1-34-29ad (A-10)		
Loam, sandy	1.0	1.0
Loam, clayey	9.0	10.0
Gravel, coarse	10.0	20.0
Sand	3.0	23.0
Shale, dark-gray	1.5	24.5
D1-34-29bc3 (A-6)		
Loam, sandy	3.0	3.0
Gravel, coarse	4.0	7.0
Shale, dark-gray	1.2	8.2
D1-34-29db (A-9)		
Clay, loamy	7.0	7.0
Sand	1.0	8.0
Clay, loamy	3.5	11.5
Gravel, coarse	2.5	14.0
Sand	2.0	16.0
Shale, dark-gray	1.2	17.2
D1-34-29dd (A-11)		
Loam, sandy	2.0	2.0
Gravel, coarse	4.0	6.0
Loam, sandy and clayey	2.5	8.5

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D1-34-29dd (A-11)—Continued		
Gravel, medium to coarse	5.0	13.5
Shale, dark-gray	1.1	14.6
D1-34-33bb3 (A-12)		
Loam, sandy	5.0	5.0
Loam, clayey	4.5	9.5
Gravel, medium to coarse	7.0	16.5
Shale, dark-gray	1.0	17.5
D1-34-33cd3 (A-17)		
Loam, sandy	23.5	23.5
Gravel, medium to coarse	9.5	33.0
Shale, dark-gray	2.0	35.0
D1-34-33da (A-14)		
Loam, sandy	8.5	8.5
Clay	2.0	10.5
Gravel, medium to coarse	8.5	19.0
Gravel, fine	4.0	23.0
Shale, dark-gray	.5	23.5
D1-34-33db (A-13)		
Loam, clayey	17.5	17.5
Loam, sandy	1.0	18.5
Gravel, medium to coarse	7.5	26.0
Shale, dark-gray	1.0	27.0
D1-34-34cd (A-15)		
Loam, sandy	14.5	14.5
Gravel, coarse	2.0	16.5
Gravel, medium	2.5	19.0
Shale, dark-gray	.7	19.7
D2-34- 2cc1 (A-29)		
Loam, silty	10.0	10.0
Gravel	6.5	16.5
Shale, dark-gray	.6	17.1
D2-34- 2cc2 (A-30)		
Loam, sandy and clayey	8.5	8.5
Gravel and sand	13.0	21.5
D2-34- 2cd (A-31)		
Loam, sandy and clayey	7.0	7.0
Gravel	7.0	14.0
Shale, dark-gray	1.0	15.0

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D2-34- 2dc (A-31A)		
Loam, sandy and clayey	5.0	5.0
Loam, sandy	4.0	9.0
Sand and gravel, coarse	4.0	13.0
Shale, dark-gray	3.0	16.0
D2-34- 3aa2 (A-20)		
Loam, sandy	2.0	2.0
Loam, clayey, and gravel	8.0	10.0
Gravel, medium	1.0	11.0
Gravel, coarse	5.5	16.5
Shale, dark-gray	1.0	17.5
D2-34- 3ab2 (A-19)		
Sand, loamy	13.5	13.5
Gravel	2.0	15.5
Sand, silty	1.5	17.0
Shale, dark-gray	.5	17.5
D2-34- 3ac (A-22)		
Loam, silty, and gravel	10.5	10.5
Gravel and sand	10.5	21.0
Shale, dark-gray	1.4	22.4
D2-34- 3bc (A-21)		
Loam, silty	12.0	12.0
Gravel	7.0	19.0
Sand	2.0	21.0
Shale, dark-gray	1.0	22.0
D2-34- 3cc1 (A-25)		
Silt, sandy	17.0	17.0
Silt, sandy, and gravel	4.5	21.5
D2-34- 3cc2 (A-26)		
Loam, sandy	7.5	7.5
Sand and gravel, coarse	13.5	21.0
Sand and gravel	5.0	26.0
D2-34- 3da (A-23)		
Loam, sandy	3.0	3.0
Gravel	4.0	7.0
Sand and gravel	1.0	8.0
Gravel, coarse	2.0	10.0
Sand and gravel	2.0	12.0
Gravel, coarse	1.5	13.5
Sand	2.5	16.0
Shale, dark-gray	.5	16.5

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D2-34- 3dc1 (1-W)		
Loam, clayey, and gravel	9.0	9.0
Gravel	9.5	18.5
D2-34- 3dc2 (P-1)		
Loam, clayey	11.0	11.0
Gravel	11.0	22.0
D2-34- 3dc3 (1-E)		
Loam, clayey	4.0	4.0
Sand, loamy	2.0	6.0
Loam, clayey	2.5	8.5
Gravel	14.0	22.5
D2-34- 3dc4 (A-28)		
Clay, silty	14.0	14.0
Loam, sandy and clayey	2.0	16.0
Sand, fine	5.0	21.0
Gravel	2.5	23.5
Shale, dark-gray	2.0	25.5
D2-34- 4aa1 (A-18)		
Loam, clayey	3.0	3.0
Clay, loamy	8.5	11.5
Gravel and sand	9.3	20.8
Shale, dark-gray	1.5	22.3
D2-34- 4aa2 (DR1-1)		
Loam, clayey	7.5	7.5
Gravel	2.4	9.9
D2-34- 4aa3 (A-70)		
Loam, silty	14.0	14.0
Gravel	4.1	18.1
D2-34- 4ab (A-69)		
Loam, silty	13.0	13.0
Clay	9.5	22.5
Gravel, coarse	3.0	25.5
D2-34- 4bb2 (A-16)		
Loam, clayey	10.0	10.0
Loam, sandy	6.0	16.0
Loam, clayey	3.0	19.0
Loam, sandy	5.0	24.0
Sand and gravel	2.0	26.0
Sand and gravel, coarse	9.0	35.0
Sand and gravel, fine	18.0	53.0

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D2-34- 4da1 (A-67)		
Loam, clayey, and sandy loam	13.0	13.0
Gravel	9.0	22.0
D2-34- 4da2 (A-65)		
Loam, clayey	13.0	13.0
Gravel and sand	10.0	23.0
Shale, dark-gray	.5	23.5
D2-34- 4db1 (A-68)		
Clay, silt, sand, and gravel, interbedded	33.0	33.0
Shale, silty, black	.5	33.5
D2-34- 4db2 (A-66)		
Loam, sandy, and silty loam	15.0	15.0
Clay	1.0	16.0
Loam, silty	2.0	18.0
Gravel	4.7	22.7
D2-34- 9aa (A-24)		
Loam, silty	3.0	3.0
Silt and sand, coarse	2.0	5.0
Clay	2.5	7.5
Shale, dark-gray	.5	8.0
D2-34-10ab1 (1-S)		
Loam, clayey	7.0	7.0
Gravel, very coarse	1.0	8.0
Gravel, fine to medium	15.0	23.0
Sand and gravel	2.5	25.5
Shale, dark-gray	.5	26.0
D2-34-10ab2 (A-27)		
Loam, clayey	5.0	5.0
Loam, sandy	8.5	13.5
Sand and gravel, coarse	13.5	27.0
D2-34-10da2 (A-33)		
Loam, sandy and clayey	21.0	21.0
Gravel, coarse	7.9	28.9
D2-34-11cc2 (A-34)		
Loam, sandy	13.0	13.0
Clay, loamy	7.0	20.0
Gravel	9.5	29.5
Shale, dark-gray	.5	30.0

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Table 25.—*Logs of jetted wells and test holes* —Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D2-34-11da (A-32)		
Loam, sandy and clayey	7.0	7.0
Loam, sandy	1.5	8.5
Gravel	9.5	18.0
Shale, dark-gray	.5	18.5
D2-34-13cb (A-39)		
Clay, loamy	6.0	6.0
Loam, sandy	14.0	20.0
Gravel, coarse, and sand	4.5	24.5
Shale, dark-gray	1.9	26.4
D2-34-13cc (A-41)		
Loam, sandy and clayey	27.0	27.0
Gravel and sand	6.0	33.0
Gravel, coarse	3.0	36.0
D2-34-13cd (A-42)		
Loam, sandy	5.0	5.0
Loam, sandy and clayey	2.5	7.5
Sand and gravel	13.5	21.0
Shale, dark-gray	.5	21.5
D2-34-13dd (A-43)		
Loam, sandy and clayey	6.0	6.0
Gravel and sand	11.5	17.5
Shale, dark-gray	.5	18.0
D2-34-14aa (A-37)		
Loam, sandy	16.0	16.0
Gravel and clay	3.0	19.0
Gravel, medium	2.0	21.0
Shale, dark-gray	1.0	22.0
D2-34-14ab2 (A-36)		
Loam, sandy	12.5	12.5
Gravel, coarse	9.5	22.0
Shale, dark-gray	1.0	23.0
D2-34-14ba (A-35)		
No record	12.0	12.0
Gravel	3.4	15.4
D2-34-14ca (A-38)		
Clay, loamy	13.0	13.0
Gravel, very coarse	10.0	23.0

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D2-34-23aa (A-40)		
Clay, loamy	29.0	29.0
Gravel, coarse	3.0	32.0
Sand, fine	3.0	35.0
Gravel, very coarse	4.0	39.0
D2-34-23ad (A-44)		
Clay, loamy, and clay	21.5	21.5
Gravel, very coarse	4.5	26.0
Shale, dark-gray	1.0	27.0
D2-34-24da (A-46)		
Loam, sandy and clayey	6.0	6.0
Gravel, coarse	13.0	19.0
Sandstone, gray	.5	19.5
D2-34-24db (A-45)		
Loam, sandy	8.0	8.0
Clay	4.0	12.0
Loam, sandy, and sand	5.0	17.0
Gravel and sand	8.0	25.0
Shale, dark-gray	1.1	26.1
D2-34-24dc (A-48)		
Loam, clayey	11.5	11.5
Gravel, coarse	8.5	20.0
Shale, dark-gray	.5	20.5
D2-34-24dd (A-49)		
Loam, silty	5.5	5.5
Gravel, coarse	3.5	9.0
Sand and gravel	3.0	12.0
Gravel	4.4	16.4
Sandstone, gray	.6	17.0
D2-34-25ad (A-51)		
Loam, sandy and clayey	10.0	10.0
Gravel, coarse	11.5	21.5
D2-34-25bb (A-47)		
Clay, loamy	11.0	11.0
Gravel	11.5	22.5
Shale, dark-gray	1.0	23.5
D2-34-25bd (A-50)		
Silt, clayey	11.0	11.0
Gravel	.5	11.5
Gravel and sand	2.5	14.0

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D2-34-25ca1 (DR4-1)		
Clay	11.5	11.5
Sand and gravel	2.5	14.0
D2-34-25ca2 (A-52)		
Loam, sandy and clayey	23.0	23.0
Gravel	7.0	30.0
Shale, dark-gray	.5	30.5
D2-34-25cd (A-54)		
Loam, sandy and clayey	29.0	29.0
Sand and gravel	7.0	36.0
Shale and sand	2.5	38.5
Shale, dark-gray	1.0	39.5
D2-34-36ab (A-55)		
Loam, sandy and clayey, and sand	19.0	19.0
Gravel, coarse	7.8	26.8
D2-34-36ac (DR5-1)		
Loam, silty	10.0	10.0
Sand and gravel	6.8	16.8
D2-34-36ca1 (A-57)		
Loam, sandy and clayey	9.0	9.0
Loam, silty	10.0	19.0
Loam, clayey	6.0	25.0
Gravel, coarse	1.0	26.0
D2-34-36ca2 (DR6-1)		
Loam, clayey, and clay	10.3	10.3
Sand and gravel	3.8	14.1
D2-34-36db1 (A-62)		
Loam, clayey	4.0	4.0
Loam, sandy	6.8	10.8
Gravel	.7	11.5
D2-34-36db2 (2-S1)		
Loam, sandy and clayey	5.0	5.0
Loam, clayey	5.0	10.0
Gravel and sand	8.5	18.5
Sand, fine	2.5	21.0
D2-34-36db3 (P-2)		
Loam, clayey	4.0	4.0
Loam, sandy	6.0	10.0
Gravel	12.0	22.0

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D2-34-36db4 (2-E1)		
Loam, sandy and clayey	11.0	11.0
Gravel, sandy	7.1	18.1
D2-34-36db5 (2-E2)		
Loam, clayey	3.0	3.0
Loam, sandy and clayey	9.0	12.0
Gravel and sand	10.0	22.0
Shale, dark-gray	1.0	23.0
D2-34-36db6 (2-E3)		
Loam, sandy and clayey	11.0	11.0
Gravel, sandy	8.0	19.0
D2-34-36db7 (2-E4)		
Loam, sandy and clayey	11.0	11.0
Gravel	7.4	18.4
D2-34-36dd (A-59)		
Loam, sandy	15.5	15.5
Gravel, coarse, and sand	7.5	23.0
Sandstone, gray, fine	1.2	24.2
D2-35-30cb (A-53)		
Loam, sandy and clayey	7.5	7.5
Sand and gravel	6.5	14.0
Gravel	2.5	16.5
Sandstone, gray	3.1	19.6
D2-35-31bb (A-56)		
Loam, clayey	3.0	3.0
Clay	13.0	16.0
Loam, sandy and clayey	2.0	18.0
Gravel, coarse	8.0	26.0
Sandstone, gray	.4	26.4
D2-35-31bc (A-58)		
Loam, sandy	5.0	5.0
Sand and gravel	7.0	12.0
Gravel, coarse	6.5	18.5
Sandstone, gray	.6	19.1
D3-34- 1aa (A-61)		
Loam, sandy and clayey	7.5	7.5
Gravel and sand	12.5	20.0
Sandstone, gray, fine	1.0	21.0

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D3-34- 1ac1 (CP-3)		
Loam, clayey	3.0	3.0
Gravel and sand	16.2	19.2
D3-34- 1ac2 (CP-2)		
Loam, sandy, and gravel	7.0	7.0
Gravel and sand	12.8	19.8
D3-34- 1ac3 (CP-1)		
Loam, sandy, and sand	16.5	16.5
Gravel, coarse	9.5	26.0
Shale, dark-gray	1.1	27.1
D3-34- 1ac4 (CP-4)		
Loam, sandy and clayey	8.5	8.5
Gravel	1.5	10.0
D3-34- 1ac5 (CP-5)		
Loam, sandy and clayey	6.0	6.0
Gravel	6.0	12.0
D3-34- 1ac6 (CP-8)		
Loam, sandy and clayey	8.0	8.0
Gravel	7.0	15.0
D3-34- 1ac7 (A-64)		
Loam	6.0	6.0
Sand, loamy	5.3	11.3
Gravel	1.2	12.5
D3-34- 1ac8 (CP-6)		
Loam, silty	5.0	5.0
Loam, clayey	3.5	8.5
Gravel	3.1	11.6
D3-34- 1ad2 (A-63)		
Loam, clayey	4.0	4.0
Loam, sandy and clayey	2.5	6.5
Gravel and sand	13.5	20.0
Sandstone, gray	4.4	24.4
D3-34- 1ba (A-60)		
Loam, clayey	11.0	11.0
Loam, silty	3.0	14.0
Clay, silty	6.5	20.5
Gravel	5.5	26.0
Shale(?)	.5	26.5

Table 25.—*Logs of jetted wells and test holes*—Continued

Material	Thickness (feet)	Depth (feet)
AGENCY UNIT—Continued		
D3-34- 1bd (CP-7)		
Loam, clayey, and sandy loam	13.0	13.0
Gravel	1.4	14.4

Table 26.—*Water-level measurements by tape*

[In feet above (+) or below land surface]

Date	Water level	Date	Water level	Date	Water level
LODGE GRASS NO. 1 UNIT					
D5-35-22bb (D-27)					
July 21, 1953......	6.89	Sept. 28, 1953....	7.29	Jan. 6, 1954.....	6.62
Aug. 4, 1953......	6.99	Oct. 12, 1953....	7.25	Feb. 8, 1954.....	6.40
Aug. 18, 1953......	7.22	Oct. 26, 1953....	6.56	Mar. 8, 1954.....	6.35
Sept. 1, 1953......	7.30	Nov. 9, 1953....	6.45	Apr. 13, 1954.....	6.09
Sept. 15, 1953......	8.19	Dec. 7, 1953....	6.32	May 3, 1954.....	6.42
D5-35-22cb (D-1)					
July 21, 1953......	5.21	Sept. 28, 1953....	5.19	Jan. 6, 1954.....	4.86
Aug. 4, 1953......	4.30	Oct. 12, 1953....	5.34	Feb. 8, 1954.....	4.91
Aug. 18, 1953......	4.75	Oct. 26, 1953....	4.81	Mar. 8, 1954.....	4.95
Sept. 1, 1953......	5.13	Nov. 9, 1953....	4.20	Apr. 13, 1954.....	4.60
Sept. 14, 1953......	5.07	Dec. 7, 1953....	4.60	May 3, 1954.....	5.06
D5-35-22cc (D-3)					
July 21, 1953......	4.77	Sept. 28, 1953....	5.44	Jan. 6, 1954.....	5.33
Aug. 4, 1953......	4.12	Oct. 12, 1953....	5.99	Feb. 8, 1954.....	4.64
Aug. 18, 1953......	5.18	Oct. 26, 1953....	4.88	Mar. 8, 1954.....	4.93
Sept. 1, 1953......	4.42	Nov. 9, 1953....	4.89	Apr. 13, 1954.....	4.36
Sept. 14, 1953......	5.68	Dec. 7, 1953....	5.13	May 3, 1954.....	4.81
D5-35-22dc (D-2)					
July 21, 1953......	9.27	Sept. 28, 1953....	9.73	Jan. 6, 1954.....	9.85
Aug. 4, 1953......	7.65	Oct. 12, 1953....	10.13	Feb. 8, 1954.....	9.48
Aug. 18, 1953......	9.32	Oct. 26, 1953....	7.34	Mar. 8, 1954.....	9.99
Sept. 1, 1953......	4.45	Nov. 9, 1953....	8.37	Apr. 13, 1954.....	9.68
Sept. 14, 1953......	8.88	Dec. 7, 1953....	9.54	May 3, 1954.....	9.84
D5-35-27bb1 (4N-3)					
Sept. 25, 1953......	+1.09	Nov. 9, 1953....	+0.22	Mar. 8, 1954.....	+1.43
Oct. 13, 1953......	+ .53	Dec. 7, 1953....	+1.50	Apr. 13, 1954.....	+1.65
Oct. 26, 1953......	+1.36	Jan. 6, 1954....	+1.62		
D5-35-27bb4 (DR12-1)					
[No measurements by tape; for measurements from recorder charts, see table 27]					
D5-35-27bd (D-4)					
July 21, 1953......	3.73	Sept. 28, 1953....	6.14	Jan. 6, 1954.....	6.49
Aug. 4, 1953......	3.46	Oct. 12, 1953....	6.96	Feb. 8, 1954.....	6.57
Aug. 18, 1953......	4.93	Oct. 26, 1953....	6.34	Mar. 8, 1954.....	6.96
Sept. 1, 1953......	5.14	Nov. 9, 1953....	6.36	Apr. 13, 1954.....	6.59
Sept. 14, 1953......	5.95	Dec. 7, 1953....	6.38	May 3, 1954.....	6.93
D5-35-27cd (D-6)					
July 21, 1953......	5.70	Sept. 1, 1953....	6.82	Oct. 12, 1953.....	8.15
Aug. 4, 1953......	2.90	Sept. 14, 1953....	5.80	Oct. 26, 1953.....	6.67
Aug. 18, 1953......	6.03	Sept. 28, 1953....	6.22	Nov. 9, 1953.....	7.87

Table 26.—*Water-level measurements by tape*—Continued

Date	Water level	Date	Water level	Date	Water level
LODGE GRASS NO. 1 UNIT—Continued					
D5-35-27cd (D-6) —Continued					
Dec. 7, 1953......	8.91	Feb. 8, 1954......	10.59	Apr. 13, 1954......	10.70
Jan. 6, 1954......	9.56	Mar. 8, 1954......	11.22	May 3, 1954......	11.42
D5-35-27db (D-5)					
July 21, 1953......	5.28	Sept. 28, 1953......	4.10	Jan. 6, 1954......	7.73
Aug. 4, 1953......	2.44	Oct. 12, 1953......	6.34	Feb. 8, 1954......	7.45
Aug. 18, 1953......	3.66	Oct. 26, 1953......	3.90	Mar. 8, 1954......	7.98
Sept. 1, 1953......	4.11	Nov. 9, 1953......	6.19	Apr. 13, 1954......	5.90
Sept. 14, 1953......	3.03	Dec. 7, 1953......	7.23	May 3, 1954......	6.95
D5-35-34bd (D-7)					
July 21, 1953......	8.28	Sept. 28, 1953......	8.10	Jan. 6, 1954......	14.02
Aug. 4, 1953......	5.03	Oct. 12, 1953......	10.00	Feb. 8, 1954......	15.17
Aug. 18, 1953......	8.50	Oct. 26, 1953......	10.58	Mar. 8, 1954......	15.97
Sept. 1, 1953......	10.27	Nov. 9, 1953......	11.19	Apr. 13, 1954......	16.72
Sept. 14, 1953......	7.45	Dec. 7, 1953......	12.68	May 3, 1954......	17.05
D5-35-34cd (DR13-2)					
Sept. 18, 1953......	1.33	Nov. 9, 1953......	1.71	Mar. 8, 1954......	3.36
Oct. 13, 1953......	1.86	Dec. 7, 1953......	2.26	Apr. 13, 1954......	2.15
Oct. 26, 1953......	1.23	Jan. 6, 1954......	2.69	May 3, 1954......	2.74
D5-35-34db (DR13-1)					
Sept. 22, 1953......	0.40	Nov. 9, 1953......	0.31	Mar. 8, 1954......	0.86
Oct. 13, 1953......	.45	Dec. 7, 1953......	.45	Apr. 13, 1954......	.50
Oct. 26, 1953......	.27	Jan. 6, 1954......	.70	May 3, 1954......	.67
D5-35-34dc (D-8)					
July 21, 1953......	3.20	Sept. 28, 1953......	5.37	Jan. 6, 1954......	7.30
Aug. 4, 1953......	4.10	Oct. 12, 1953......	6.30	Feb. 8, 1954......	7.52
Aug. 18, 1953......	5.53	Oct. 26, 1953......	5.65	Mar. 8, 1954......	8.03
Sept. 1, 1953......	2.07	Nov. 9, 1953......	6.34	Apr. 13, 1954......	6.82
Sept. 14, 1953......	4.74	Dec. 7, 1953......	7.00	May 3, 1954......	6.87
D6-35- 1bc (D-9)					
July 21, 1953......	9.06	Sept. 28, 1953......	11.31	Jan. 6, 1954......	13.09
Aug. 4, 1953......	8.73	Oct. 12, 1953......	12.46	Feb. 8, 1954......	13.25
Aug. 18, 1953......	9.77	Oct. 26, 1953......	11.63	Mar. 8, 1954......	13.41
Sept. 1, 1953......	8.30	Nov. 9, 1953......	11.89	Apr. 13, 1954......	13.02
Sept. 14, 1953......	10.74	Dec. 7, 1953......	12.64	May 3, 1954......	12.91
D6-35- 1cb (D-10)					
July 21, 1953......	8.28	Sept. 28, 1953......	8.94	Jan. 6, 1954......	11.58
Aug. 4, 1953......	7.65	Oct. 12, 1953......	9.61	Feb. 8, 1954......	11.32
Aug. 18, 1953......	8.43	Oct. 26, 1953......	9.50	Mar. 8, 1954......	11.70
Sept. 1, 1953......	6.68	Nov. 9, 1953......	9.95	Apr. 13, 1954......	11.32
Sept. 14, 1953......	6.93	Dec. 7, 1953......	10.85	May 3, 1954......	11.08

Table 26.—*Water-level measurements by tape*—Continued

Date	Water level	Date	Water level	Date	Water level
LODGE GRASS NO. 1 UNIT—Continued					
D6-35- 1cd (D-11)					
July 21, 1953......	3.56	Sept. 28, 1953......	2.93	Jan. 6, 1954......	4.62
Aug. 4, 1953......	2.88	Oct. 12, 1953......	3.59	Feb. 8, 1954......	4.03
Aug. 18, 1953......	3.49	Oct. 26, 1953......	3.10	Mar. 8, 1954......	3.96
Sept. 1, 1953......	2.20	Nov. 9, 1953......	3.48	Apr. 13, 1954......	3.13
Sept. 14, 1953......	2.91	Dec. 7, 1953......	3.92	May 3, 1954......	3.91
D6-35- 1dc (D-12)					
July 21, 1953......	2.31	Sept. 28, 1953......	3.33	Jan. 6, 1954......	3.57
Aug. 4, 1953......	2.57	Oct. 12, 1953......	3.77	Feb. 8, 1954......	2.50
Aug. 18, 1953......	3.56	Oct. 26, 1953......	3.51	Mar. 8, 1954......	3.34
Sept. 1, 1953......	1.17	Nov. 9, 1953......	3.58	Apr. 13, 1954......	2.52
Sept. 14, 1953......	2.88	Dec. 7, 1953......	3.58	May 3, 1954......	3.14
D6-35-10dc (D-16)					
Aug. 4, 1953......	8.03	Oct. 12, 1953......	10.03	Feb. 8, 1954......	Dry
Aug. 18, 1953......	8.54	Oct. 26, 1953......	10.15	Mar. 8, 1954......	Dry
Sept. 1, 1953......	7.30	Nov. 9, 1953......	11.02	Apr. 13, 1954......	Dry
Sept. 14, 1953......	8.18	Dec. 7, 1953......	13.42	May 3, 1954......	Dry
Sept. 28, 1953......	9.08	Jan. 6, 1954......	15.05		
D6-35-11dd (D-20)					
Aug. 4, 1953......	4.08	Oct. 12, 1953......	4.89	Feb. 8, 1954......	Dry
Aug. 18, 1953......	4.39	Oct. 26, 1953......	4.61	Mar. 8, 1954......	Dry
Sept. 1, 1953......	4.31	Nov. 9, 1953......	4.85	Apr. 13, 1954......	Dry
Sept. 14, 1953......	4.73	Dec. 7, 1953......	5.17	May 3, 1954......	Dry
Sept. 28, 1953......	4.79	Jan. 6, 1954......	5.51		
D6-35-12dd (D-13)					
July 21, 1953......	8.07	Sept. 28, 1953......	7.22	Jan. 6, 1954......	8.12
Aug. 4, 1953......	6.87	Oct. 12, 1953......	7.32	Feb. 8, 1954......	8.77
Aug. 18, 1953......	6.25	Oct. 26, 1953......	7.39	Mar. 8, 1954......	Dry
Sept. 1, 1953......	6.52	Nov. 9, 1953......	7.53	Apr. 13, 1954......	Dry
Sept. 14, 1953......	6.70	Dec. 7, 1953......	7.78	May 3, 1954......	Dry
D6-35-13aa (D-14)					
July 21, 1953.....	7.50	Sept. 28, 1953......	7.65	Jan. 6, 1954......	7.20
Aug. 4, 1953......	7.46	Oct. 12, 1953......	7.66	Feb. 8, 1954......	6.22
Aug. 18, 1953......	7.34	Oct. 26, 1953......	7.65	Mar. 8, 1954......	6.87
Sept. 1, 1953......	7.07	Nov. 9, 1953......	7.50	Apr. 13, 1954......	6.98
Sept. 14, 1953......	7.68	Dec. 7, 1953......	7.29	May 3, 1954......	6.86
D6-35-13ab (5-N1)					
[No measurements by tape; for measurements from recorder charts, see table 27]					
D6-35-13ba (D-15)					
Aug. 4, 1953......	8.85	Sept. 14, 1953......	9.68	Oct. 26, 1953......	8.45
Aug. 18, 1953......	10.98	Sept. 28, 1953......	11.10	Nov. 9, 1953......	10.64
Sept. 1, 1953......	7.09	Oct. 12, 1953......	12.12	Dec. 7, 1953......	12.20

Table 26.—*Water-level measurements by tape*—Continued

LODGE GRASS NO. 1 UNIT—Continued

D6-35-13ba (D-15)—Continued

Date	Water level	Date	Water level	Date	Water level
Jan. 6, 1954......	Dry	Mar. 8, 1954......	Dry	May 3, 1954......	Dry
Feb. 8, 1954......	Dry	Apr. 13, 1954......	12.83		

D6-35-13cb (D-23)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1953......	3.68	Oct. 12, 1953......	6.29	Feb. 8, 1954......	10.75
Aug. 18, 1953......	6.19	Oct. 26, 1953......	6.56	Mar. 8, 1954......	11.20
Sept. 1, 1953......	3.40	Nov. 9, 1953......	7.51	Apr. 13, 1954......	10.80
Sept. 14, 1953......	4.42	Dec. 7, 1953......	8.80	May 3, 1954......	11.20
Sept. 28, 1953......	5.42	Jan. 6, 1954......	10.32		

D6-35-14aa1 (D-18)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1953......	7.53	Oct. 12, 1953......	9.54	Feb. 8, 1954......	Dry
Aug. 18, 1953......	Dry	Oct. 26, 1953......	Dry	Mar. 8, 1954......	Dry
Sept. 1, 1953......	Dry	Nov. 9, 1953......	Dry	Apr. 13, 1954......	Dry
Sept. 14, 1953......	Dry	Dec. 7, 1953......	Dry	May 3, 1954......	Dry
Sept. 28, 1953......	Dry	Jan. 6, 1954......	Dry		

D6-35-14ca (D-21)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1953......	2.58	Oct. 12, 1953......	5.13	Feb. 8, 1954......	Dry
Aug. 18, 1953......	3.37	Oct. 26, 1953......	5.37	Mar. 8, 1954......	Dry
Sept. 1, 1953......	3.55	Nov. 9, 1953......	5.90	Apr. 13, 1954......	Dry
Sept. 14, 1953......	4.05	Dec. 7, 1953......	6.85	May 3, 1954......	Dry
Sept. 28, 1953......	4.50	Jan. 6, 1954......	Dry		

D6-35-14da (DR14-1)

Date	Water level	Date	Water level	Date	Water level
Oct. 13, 1953......	+0.31	Dec. 7, 1953......	+0.33	Apr. 13, 1954......	+0.22
Oct. 26, 1953......	+ .56	Jan. 6, 1954......	.12	May 3, 1954......	.44
Nov. 9, 1953......	+ .45	Mar. 8, 1954......	.25		

D6-35-14db (D-24)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1953......	2.97	Sept. 14, 1953......	3.50	Oct. 26, 1953......	3.51
Aug. 18, 1953......	4.03	Sept. 28, 1953......	3.78	Nov. 9, 1953......	4.08
Sept. 1, 1953......	2.61	Oct. 12, 1953......	3.78	Well destroyed	

D6-35-22ab (D-25)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1953......	15.16	Oct. 12, 1953......	Dry	Feb. 8, 1954......	Dry
Aug. 18, 1953......	Dry	Oct. 26, 1953......	Dry	Mar. 8, 1954......	Dry
Sept. 1, 1953......	Dry	Nov. 9, 1953......	14.61	Apr. 13, 1954......	14.42
Sept. 14, 1953......	15.50	Dec. 7, 1953......	14.51	May 3, 1954......	13.05
Sept. 28, 1953......	15.40	Jan. 6, 1954......	14.73		

D6-35-29ab (D-26)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1953......	1.45	Oct. 12, 1953......	12.43	Feb. 8, 1954......	Dry
Aug. 18, 1953......	3.55	Oct. 26, 1953......	13.57	Mar. 8, 1954......	Dry
Sept. 1, 1953......	2.03	Nov. 9, 1953......	14.67	Apr. 13, 1954......	Dry
Sept. 14, 1953......	6.62	Dec. 7, 1953......	Dry	May 3, 1954......	Dry
Sept. 28, 1953......	9.79	Jan. 6, 1954......	Dry		

Table 26.—*Water-level measurements by tape*—Continued

BENTEEN FLAT UNIT

D4-35-10cc (C-1)

Date	Water level	Date	Water level	Date	Water level
June 9, 1953......	6.60	Sept. 1, 1953......	8.07	Dec. 7, 1953.....	7.20
June 15, 1953......	6.58	Sept. 15, 1953......	7.90	Jan. 6, 1954.....	7.08
June 23, 1953......	6.62	Sept. 28, 1953......	7.82	Feb. 15, 1954.....	6.89
July 7, 1953......	7.02	Oct. 12, 1953......	7.72	Mar. 8, 1954.....	6.72
July 21, 1953......	7.53	Oct. 26, 1953......	7.57	Apr. 13, 1954.....	5.76
Aug. 3, 1953......	7.69	Nov. 9, 1953......	7.41	May 3, 1954.....	6.20
Aug. 18, 1953......	7.95				

D4-35-16ad (C-2)

Date	Water level	Date	Water level	Date	Water level
June 9, 1953......	7.29	Sept. 1, 1953......	8.48	Dec. 7, 1953.....	8.07
June 15, 1953......	7.19	Sept. 15, 1953......	8.26	Jan. 6, 1954.....	7.95
June 23, 1953......	7.24	Sept. 28, 1953......	8.57	Feb. 15, 1954.....	7.46
July 7, 1953......	7.85	Oct. 12, 1953......	8.53	Mar. 8, 1954.....	7.62
July 21, 1953......	8.16	Oct. 26, 1953......	8.31	Apr. 13, 1954.....	7.56
Aug. 3, 1953......	8.19	Nov. 9, 1953......	8.15	May 3, 1954.....	7.53
Aug. 18, 1953......	8.25				

D4-35-16dc2

Date	Water level	Date	Water level	Date	Water level
June 9, 1953......	12.27	Sept. 1, 1953......	13.80	Dec. 7, 1953.....	13.38
June 15, 1953......	11.99	Sept. 15, 1953......	13.88	Jan. 6, 1954.....	13.26
June 23, 1953......	11.92	Sept. 28, 1953......	13.95	Feb. 15, 1954.....	13.04
July 7, 1953......	12.52	Oct. 12, 1953......	13.94	Mar. 8, 1954.....	12.95
July 21, 1953......	12.93	Oct. 26, 1953......	13.75	Apr. 13, 1954.....	12.75
Aug. 3, 1953......	13.23	Nov. 9, 1953......	13.57	May 3, 1954.....	12.72
Aug. 18, 1953......	13.56				

D4-35-16dd (C-3)

Date	Water level	Date	Water level	Date	Water level
June 9, 1953......	9.22	Sept. 1, 1953......	10.11	Dec. 7, 1953.....	10.25
June 15, 1953......	10.29	Sept. 15, 1953......	10.00	Jan. 6, 1954.....	10.20
June 23, 1953......	9.38	Sept. 28, 1953......	10.24	Feb. 15, 1954.....	10.06
July 7, 1953......	9.65	Oct. 12, 1953......	10.26	Mar. 8, 1954.....	10.00
July 21, 1953......	9.67	Oct. 26, 1953......	10.25	Apr. 13, 1954.....	9.78
Aug. 3, 1953......	9.90	Nov. 9, 1953......	10.17	May 3, 1954.....	9.79
Aug. 18, 1953......	10.00				

D4-35-21aa (C-5)

Date	Water level	Date	Water level	Date	Water level
June 9, 1953......	13.43	Sept. 1, 1953......	14.02	Dec. 7, 1953.....	14.27
June 15, 1953......	12.49	Sept. 15, 1953......	14.09	Jan. 6, 1954.....	14.22
June 23, 1953......	13.48	Sept. 28, 1953......	14.15	Feb. 15, 1954.....	13.79
July 7, 1953......	13.64	Oct. 12, 1953......	14.19	Mar. 8, 1954.....	14.11
July 21, 1953......	13.79	Oct. 26, 1953......	14.20	Apr. 13, 1954.....	13.95
Aug. 3, 1953......	13.81	Nov. 9, 1953......	14.17	May 3, 1954.....	13.86
Aug. 18, 1953......	13.95				

D4-35-21ad (C-6)

Date	Water level	Date	Water level	Date	Water level
June 9, 1953......	20.87	Aug. 4, 1953......	21.16	Oct. 12, 1953.....	21.49
June 15, 1953......	20.96	Aug. 18, 1953......	21.27	Oct. 26, 1953.....	21.51
June 23, 1953......	20.97	Sept. 1, 1953......	21.34	Nov. 9, 1953.....	21.41
July 7, 1953......	20.99	Sept. 15, 1953......	21.36	Dec. 7, 1953.....	21.48
July 21, 1953......	21.07	Sept. 28, 1953......	21.45	Jan. 6, 1954.....	21.43

Table 26.—*Water-level measurements by tape*—Continued

Date	Water level	Date	Water level	Date	Water level
BENTEEN FLAT UNIT—Continued					
D4-35-21ad (C-6) —Continued					
Feb. 15, 1954......	21.40	Mar. 8, 1954......	21.20	Apr. 13, 1954.....	21.20
D4-35-21cd2 (C-8)					
June 15, 1953......	16.81	Sept. 1, 1953......	17.25	Dec. 7, 1953.....	17.24
June 23, 1953......	16.58	Sept. 15, 1953......	17.40	Jan. 6, 1954.....	17.20
July 7, 1953......	16.73	Sept. 28, 1953......	17.40	Feb. 15, 1954.....	16.95
July 21, 1953......	17.05	Oct. 12, 1953......	17.34	Mar. 8, 1954.....	16.97
Aug. 4, 1953......	17.13	Oct. 26, 1953......	17.30	Apr. 13, 1954.....	17.16
Aug. 18, 1953......	17.15	Nov. 9, 1953......	17.26	May 3, 1954.....	17.21
D4-35-21dc (C-7)					
June 15, 1953......	25.78	Sept. 1, 1953......	25.72	Dec. 7, 1953.....	25.80
June 23, 1953......	25.75	Sept. 15, 1953......	25.68	Jan. 6, 1954.....	25.87
July 7, 1953......	25.59	Sept. 28, 1953......	25.76	Feb. 15, 1954.....	25.74
July 21, 1953......	25.75	Oct. 12, 1953......	25.80	Mar. 8, 1954.....	25.68
Aug. 4, 1953......	25.67	Oct. 26, 1953......	25.80	Apr. 13, 1954.....	25.83
Aug. 18, 1953......	25.70	Nov. 9, 1953......	25.83	May 3, 1954.....	25.90
D4-35-28bd (C-10)					
June 15, 1953......	25.19	Sept. 1, 1953......	25.46	Dec. 7, 1953.....	25.57
June 23, 1953......	25.16	Sept. 15, 1953......	25.48	Jan. 6, 1954.....	25.56
July 7, 1953......	25.00	Sept. 28, 1953......	25.53	Feb. 15, 1954.....	25.28
July 21, 1953......	25.34	Oct. 12, 1953......	25.54	Mar. 8, 1954.....	25.41
Aug. 4, 1953......	25.36	Oct. 26, 1953......	25.57	Apr. 13, 1954.....	25.55
Aug. 18, 1953......	25.41	Nov. 9, 1953......	25.48	May 3, 1954.....	24.75
D4-35-28db (C-9)					
June 15, 1953......	33.27	Sept. 1, 1953......	33.20	Dec. 7, 1953.....	33.63
June 23, 1953......	33.24	Sept. 15, 1953......	33.10	Jan. 6, 1954.....	33.74
July 7, 1953......	32.89	Sept. 28, 1953......	33.21	Feb. 15, 1954.....	33.80
July 21, 1953......	32.86	Oct. 12, 1953......	33.37	Mar. 8, 1954.....	33.84
Aug. 4, 1953......	32.97	Oct. 26, 1953......	33.44	Apr. 13, 1954.....	33.79
Aug. 18, 1953......	33.00	Nov. 9, 1953......	33.46	May 3, 1954.....	33.94
D4-35-33ac (C-11)					
June 15, 1953......	12.42	Sept. 1, 1953......	Dry	Dec. 7, 1953.....	13.99
June 23, 1953......	12.38	Sept. 15, 1953......	Dry	Jan. 6, 1954.....	13.72
July 7, 1953......	12.73	Sept. 28, 1953......	Dry	Feb. 15, 1954.....	13.05
July 21, 1953......	13.04	Oct. 12, 1953......	Dry	Mar. 8, 1954.....	13.24
Aug. 4, 1953......	13.48	Oct. 26, 1953......	Dry	Apr. 13, 1954.....	13.20
Aug. 18, 1953......	13.38	Nov. 9, 1953......	Dry	May 3, 1954.....	13.14
D4-35-33db (C-12)					
June 15, 1953......	14.94	Sept. 1, 1953......	16.27	Dec. 7, 1953.....	16.48
June 23, 1953......	14.94	Sept. 15, 1953......	16.27	Jan. 6, 1954.....	16.29
July 7, 1953......	15.27	Sept. 28, 1953......	16.62	Feb. 15, 1954.....	16.09
July 21, 1953......	15.64	Oct. 12, 1953......	16.73	Mar. 8, 1954.....	15.80
Aug. 4, 1953......	15.84	Oct. 26, 1953......	16.77	Apr. 13, 1954.....	15.72
Aug. 18, 1953......	16.10	Nov. 9, 1953......	16.66	May 3, 1954.....	15.60

Table 26.—*Water-level measurements by tape*—Continued

BENTEEN FLAT UNIT—Continued

D5-35- 4ab (C-13)

Date	Water level	Date	Water level	Date	Water level
July 21, 1953......	14.19	Sept. 28, 1953......	15.03	Jan. 6, 1954.....	14.43
Aug. 4, 1953......	14.30	Oct. 12, 1953......	15.24	Feb. 15, 1954.....	14.03
Aug. 18, 1953......	14.55	Oct. 26, 1953......	14.91	Apr. 13, 1954.....	13.64
Sept. 1, 1953......	14.75	Dec. 7, 1953......	14.52	May 3, 1954.....	13.58
Sept. 15, 1953......	14.98				

D5-35- 4db (C-14)

Date	Water level	Date	Water level	Date	Water level
July 21, 1953......	10.15	Sept. 28, 1953......	10.23	Jan. 6, 1954.....	9.50
Aug. 4, 1953......	10.03	Oct. 12, 1953......	10.18	Feb. 15, 1954.....	9.03
Aug. 18, 1953......	10.28	Oct. 26, 1953......	9.78	Mar. 8, 1954.....	9.23
Sept. 1, 1953......	10.23	Nov. 9, 1953......	9.76	Apr. 13, 1954.....	9.28
Sept. 15, 1953......	10.12	Dec. 7, 1953......	9.67	May 3, 1954.....	9.24

D5-35- 9ad (C-15)

Date	Water level	Date	Water level	Date	Water level
July 21, 1953......	9.53	Sept. 28, 1953......	9.59	Jan. 6, 1954.....	9.46
Aug. 4, 1953......	9.41	Oct. 12, 1953......	9.62	Feb. 15, 1954.....	9.07
Aug. 18, 1953......	9.45	Oct. 26, 1953......	9.56	Mar. 8, 1954.....	9.16
Sept. 1, 1953......	9.44	Nov. 9, 1953......	9.56	Apr. 13, 1954.....	9.28
Sept. 15, 1953......	9.88	Dec. 7, 1953......	9.54	May 3, 1954.....	9.22

D5-35- 9dd (C-16)

Date	Water level	Date	Water level	Date	Water level
July 21, 1953......	5.58	Sept. 28, 1953......	5.89	Jan. 6, 1954.....	4.72
Aug. 4, 1953......	5.60	Oct. 12, 1953......	5.66	Feb. 15, 1954.....	4.42
Aug. 18, 1953......	5.98	Oct. 26, 1953......	5.25	Mar. 8, 1954.....	4.41
Sept. 1, 1953......	6.14	Nov. 9, 1953......	5.07	Apr. 13, 1954.....	4.13
Sept. 15, 1953......	5.90	Dec. 7, 1953......	4.91	May 3, 1954.....	4.42

D5-35-15cb (C-18)

Date	Water level	Date	Water level	Date	Water level
July 21, 1953......	12.84	Sept. 28, 1953......	12.90	Jan. 6, 1954.....	13.05
Aug. 4, 1953......	12.64	Oct. 12, 1953......	13.12	Feb. 15, 1954.....	12.96
Aug. 18, 1953......	12.66	Oct. 26, 1953......	12.25	Mar. 8, 1954.....	13.00
Sept. 1, 1953......	12.87	Nov. 9, 1953......	12.38	Apr. 13, 1954.....	12.89
Sept. 15, 1953......	12.73	Dec. 7, 1953......	12.51	May 3, 1954.....	13.06

D5-35-16aa (C-17)

Date	Water level	Date	Water level	Date	Water level
July 21, 1953......	15.64	Sept. 28, 1953......	16.68	Jan. 6, 1954.....	16.35
Aug. 4, 1953......	16.20	Oct. 12, 1953......	16.69	Feb. 15, 1954.....	16.20
Aug. 18, 1953......	16.42	Oct. 26, 1953......	16.58	Mar. 8, 1954.....	15.90
Sept. 1, 1953......	14.58	Nov. 9, 1953......	16.30	Apr. 13, 1954.....	15.80
Sept. 15, 1953......	16.48	Dec. 7, 1953......	16.34	May 3, 1954.....	15.91

RENO AND BATTLEFIELD UNITS

D3-34- 1dc (B-1)

Date	Water level	Date	Water level	Date	Water level
Sept. 15, 1952......	13.53	Jan. 13, 1953......	12.75	May 25, 1953.....	12.21
Sept. 26, 1952......	13.71	Feb. 13, 1953......	12.19	June 9, 1953.....	12.20
Oct. 10, 1952......	13.52	Mar. 2, 1953......	12.19	June 23, 1953.....	12.51
Nov. 21, 1952......	13.08	Mar. 31, 1953......	12.14	July 6, 1953.....	12.97
Dec. 17, 1952......	12.93	May 11, 1953......	12.19	July 20, 1953.....	13.45

Table 26.—*Water-level measurements by tape*—Continued

RENO AND BATTLEFIELD UNITS—Continued

D3-34- 1dc (B-1)—Continued

Date	Water level	Date	Water level	Date	Water level
Aug. 3, 1953......	14.00	Oct. 13, 1953......	14.68	Feb. 9, 1954.....	13.36
Aug. 17, 1953......	14.18	Oct. 26, 1953......	14.45	Mar. 8, 1954.....	13.19
Aug. 31, 1953......	14.56	Nov. 9, 1953......	14.25	Apr. 14, 1954.....	11.89
Sept. 14, 1953......	14.67	Dec. 8, 1953......	13.72	May 4, 1954.....	12.79
Sept. 28, 1953......	14.77	Jan. 6, 1954......	13.64		

D3-34-12da (B-2)

Date	Water level	Date	Water level	Date	Water level
Sept. 1, 1952......	20.20	Apr. 30, 1953......	20.04	Sept. 28, 1953.....	20.68
Sept. 15, 1952......	20.34	May 11, 1953......	19.70	Oct. 13, 1953.....	20.68
Sept. 26, 1952......	20.38	May 25, 1953......	19.79	Oct. 27, 1953.....	20.44
Oct. 10, 1952......	20.30	June 8, 1953......	19.77	Nov. 9, 1953.....	20.39
Nov. 7, 1952......	20.25	June 23, 1953......	19.59	Dec. 8, 1953.....	20.39
Nov. 21, 1952......	20.17	July 6, 1953......	19.77	Jan. 6, 1954.....	20.35
Dec. 17, 1952......	20.16	July 20, 1953......	20.11	Feb. 9, 1954.....	20.14
Jan. 13, 1953......	20.11	Aug. 3, 1953......	20.33	Mar. 8, 1954.....	20.19
Feb. 13, 1953......	20.00	Aug. 17, 1953......	20.45	Apr. 14, 1954.....	20.15
Mar. 2, 1953......	20.02	Aug. 31, 1953......	20.52	May 4, 1954.....	20.16
Mar. 31, 1953......	20.08	Sept. 14, 1953......	20.60		

D3-34-13aa (B-3)

Date	Water level	Date	Water level	Date	Water level
Sept. 15, 1952......	6.97	Apr. 30, 1953......	6.17	Sept. 28, 1953.....	7.58
Sept. 26, 1952......	7.00	May 25, 1953......	6.12	Oct. 13, 1953.....	7.52
Oct. 10, 1952......	7.01	June 8, 1953......	6.05	Oct. 27, 1953.....	7.40
Nov. 10, 1952......	6.80	June 22, 1953......	6.25	Dec. 7, 1953.....	7.08
Nov. 21, 1952......	6.74	July 6, 1953......	6.28	Jan. 6, 1954.....	6.92
Dec. 17, 1952......	6.64	July 20, 1953......	6.83	Feb. 9, 1954.....	6.68
Jan. 13, 1953......	6.50	Aug. 3, 1953......	7.05	Mar. 8, 1954.....	6.67
Feb. 13, 1953......	6.41	Aug. 17, 1953......	7.26	Apr. 14, 1954.....	6.52
Mar. 2, 1953......	6.81	Aug. 31, 1953......	7.45	May 3, 1954.....	6.46
Mar. 31, 1953......	6.26	Sept. 14, 1953......	7.54		

D3-34-13da (B-16)

[No measurements by tape; for measurements from recorder charts, see table 27]

D3-34-24aa (B-17)

Date	Water level	Date	Water level	Date	Water level
May 25, 1953......	7.79	Aug. 17, 1953......	8.34	Dec. 8, 1953.....	7.56
June 9, 1953......	7.81	Aug. 31, 1953......	8.65	Jan. 6, 1954.....	7.70
June 12, 1953......	7.72	Sept. 14, 1953......	8.75	Feb. 9, 1954.....	7.69
June 23, 1953......	7.85	Sept. 28, 1953......	8.34	Mar. 8, 1954.....	7.62
July 6, 1953......	6.92	Oct. 13, 1953......	7.87	Apr. 14, 1954.....	7.20
July 20, 1953......	7.38	Oct. 27, 1953......	7.51	May 4, 1954.....	7.25
Aug. 3, 1953......	7.83	Nov. 9, 1953......	7.49		

D3-35-18ba (B-37)

Date	Water level	Date	Water level	Date	Water level
June 9, 1953......	19.57	Aug. 31, 1953......	19.66	Dec. 7, 1953.....	19.80
June 12, 1953......	19.47	Sept. 15, 1953......	19.71	Jan. 6, 1954.....	19.78
June 23, 1953......	19.50	Sept. 28, 1953......	19.63	Feb. 9, 1954.....	19.67
July 6, 1953......	19.49	Oct. 13, 1953......	19.79	Mar. 8, 1954.....	19.70
July 20, 1953......	19.55	Oct. 27, 1953......	19.80	Apr. 14, 1954.....	19.68
Aug. 3, 1953......	19.60	Nov. 9, 1953......	19.83	May 3, 1954.....	19.63
Aug. 17, 1953......	19.64				

Table 26.—*Water-level measurements by tape*—Continued

RENO AND BATTLEFIELD UNITS—Continued

D3-35-18cc (B-4)

Date	Water level	Date	Water level	Date	Water level
Sept. 15, 1952......	6.60	Apr. 30, 1953......	6.10	Sept. 28, 1953.....	6.37
Sept. 26, 1952......	6.13	May 11, 1953......	6.52	Oct. 13, 1953.....	6.20
Oct. 10, 1952......	6.00	May 25, 1953......	5.74	Oct. 27, 1953.....	6.10
Oct. 27, 1952......	6.17	June 9, 1953......	5.42	Nov. 9, 1953.....	6.18
Nov. 7, 1952......	6.19	June 23, 1953......	5.50	Dec. 8, 1953.....	6.16
Nov. 21, 1952......	6.25	July 6, 1953......	5.37	Jan. 6, 1954.....	6.17
Dec. 17, 1952......	6.21	July 20, 1953......	5.82	Feb. 9, 1954.....	5.80
Jan. 13, 1953......	6.13	Aug. 3, 1953......	5.86	Mar. 8, 1954.....	6.30
Feb. 13, 1953......	6.14	Aug. 17, 1953......	5.93	Apr. 14, 1954.....	5.90
Mar. 2, 1953......	6.15	Aug. 31, 1953......	6.22	May 4, 1954.....	5.93
Mar. 31, 1953......	6.13	Sept. 14, 1953......	6.02		

D3-35-18dc (P-3)

[No measurements by tape; for measurements from recorder charts, see table 27]

D3-35-19ba (B-18)

Date	Water level	Date	Water level	Date	Water level
May 25, 1953......	5.12	Aug. 17, 1953......	6.63	Dec. 8, 1953.....	5.35
June 9, 1953......	4.90	Aug. 31, 1953......	6.76	Jan. 6, 1954.....	5.30
June 12, 1953......	4.90	Sept. 14, 1953......	6.35	Feb. 9, 1954.....	5.08
June 23, 1953......	5.60	Sept. 28, 1953......	6.75	Mar. 8, 1954.....	4.90
July 6, 1953......	5.79	Oct. 13, 1953......	6.08	Apr. 14, 1954.....	4.62
July 20, 1953......	6.38	Oct. 27, 1953......	5.79	Well destroyed	
Aug. 3, 1953......	6.23	Nov. 9, 1953......	5.70		

D3-35-19bc (B-5)

Date	Water level	Date	Water level	Date	Water level
Sept. 15, 1952......	2.90	Feb. 13, 1953......	3.20	July 6, 1953.....	2.21
Sept. 26, 1952......	3.09	Mar. 2, 1953......	3.15	July 20, 1953.....	1.73
Oct. 10, 1952......	2.95	Mar. 31, 1953......	3.15	Aug. 3, 1953.....	1.97
Oct. 27, 1952......	2.94	Apr. 30, 1953......	2.83	Aug. 17, 1953.....	2.52
Nov. 7, 1952......	3.02	May 11, 1953......	2.67	Aug. 31, 1953.....	2.60
Nov. 21, 1952......	3.08	May 25, 1953......	2.42	Sept. 28, 1953.....	3.06
Dec. 17, 1952......	3.50	June 9, 1953......	2.44	Oct. 13, 1953.....	1.97
Jan. 13, 1953......	3.44	June 23, 1953......	3.03	Well destroyed	

D3-35-19ca (B-19)

Date	Water level	Date	Water level	Date	Water level
May 25, 1953......	4.83	Aug. 17, 1953......	4.73	Dec. 8, 1953.....	4.00
June 9, 1953......	4.58	Aug. 31, 1953......	4.36	Jan. 6, 1954.....	4.32
June 12, 1953......	4.75	Sept. 14, 1953......	4.71	Feb. 9, 1954.....	3.58
June 23, 1953......	5.19	Sept. 28, 1953......	5.69	Mar. 8, 1954.....	3.96
July 6, 1953......	4.38	Oct. 13, 1953......	4.47	Apr. 14, 1954.....	3.50
July 20, 1953......	4.79	Oct. 27, 1953......	2.92	May 4, 1954.....	3.92
Aug. 3, 1953......	4.14	Nov. 9, 1953......	3.42		

D3-35-19cc (B-20)

Date	Water level	Date	Water level	Date	Water level
May 25, 1953......	10.13	Aug. 17, 1953......	9.49	Dec. 8, 1953.....	10.22
June 9, 1953......	9.56	Aug. 31, 1953......	9.28	Jan. 6, 1954.....	10.63
June 12, 1953......	9.45	Sept. 14, 1953......	9.26	Feb. 9, 1954.....	9.87
June 23, 1953......	9.98	Sept. 28, 1953......	9.65	Mar. 8, 1954.....	10.80
July 6, 1953......	8.69	Oct. 13, 1953......	8.92	Apr. 13, 1954.....	10.80
July 20, 1953......	8.94	Oct. 27, 1953......	9.00	May 4, 1954.....	10.87
Aug. 3, 1953......	8.86	Nov. 9, 1953......	9.50		

Table 26.—*Water-level measurements by tape*—Continued

Date	Water level	Date	Water level	Date	Water level
RENO AND BATTLEFIELD UNITS—Continued					
D3-35-19cd (DR8-1)					
Oct. 13, 1953......	+0.07	Dec. 8, 1953......	0.63	Mar. 8, 1954.....	1.08
Oct. 27, 1953......	+ .15	Jan. 6, 1954......	.91	Apr. 14, 1954.....	.88
Nov. 9, 1953......	.13	Feb. 9, 1954......	.80	May 4, 1954.....	1.11
D3-35-19dc (B-6)					
Sept. 15, 1952......	1.09	Apr. 30, 1953......	4.06	Sept. 28, 1953.....	3.37
Sept. 26, 1952......	2.95	May 11, 1953......	4.18	Oct. 13, 1953.....	3.92
Oct. 10, 1952......	3.87	May 25, 1953......	3.98	Oct. 27, 1953.....	2.23
Oct. 27, 1952......	4.14	June 9, 1953......	3.39	Nov. 9, 1953.....	3.02
Nov. 7, 1952......	4.20	June 23, 1953......	4.55	Dec. 8, 1953.....	3.70
Nov. 21, 1952......	4.31	July 6, 1953......	2.75	Jan. 6, 1954.....	3.94
Dec. 17, 1952......	4.32	July 20, 1953......	2.46	Feb. 9, 1954.....	3.37
Jan. 13, 1953......	4.30	Aug. 3, 1953......	1.89	Mar. 8, 1954.....	3.37
Feb. 13, 1953......	3.89	Aug. 17, 1953......	1.29	Apr. 14, 1954.....	2.60
Mar. 2, 1953......	4.05	Aug. 31, 1953......	4.28	May 4, 1954.....	3.31
Mar. 31, 1953......	4.00	Sept. 14, 1953......	3.02		
D3-35-19dd (B-21)					
May 25, 1953......	5.39	June 23, 1953......	5.90	Aug. 3, 1953.....	4.15
June 9, 1953......	5.62	July 6, 1953......	4.17	Aug. 17, 1953.....	4.12
June 12, 1953......	5.40	July 20, 1953......	4.16	Well destroyed	
D3-35-20cc (B-7)					
Sept. 15, 1952......	4.52	Apr. 30, 1953......	8.42	Sept. 28, 1953.....	6.54
Sept. 26, 1952......	4.93	May 13, 1953......	8.40	Oct. 13, 1953.....	6.37
Oct. 10, 1952......	6.06	May 25, 1953......	7.90	Oct. 27, 1953.....	7.16
Oct. 27, 1952......	6.83	June 9, 1953......	8.18	Nov. 9, 1953.....	7.43
Nov. 7, 1952......	7.09	June 23, 1953......	7.97	Dec. 8, 1953.....	7.78
Nov. 21, 1952......	7.31	July 6, 1953......	6.28	Jan. 6, 1954.....	8.02
Dec. 17, 1952......	8.10	July 20, 1953......	3.08	Feb. 9, 1954.....	8.04
Jan. 13, 1953......	8.27	Aug. 3, 1953......	4.22	Mar. 8, 1954.....	7.55
Feb. 13, 1953......	8.23	Aug. 17, 1953......	6.20	Apr. 14, 1954.....	7.57
Mar. 2, 1953......	8.33	Aug. 31, 1953......	4.88	May 3, 1954.....	7.62
Mar. 31, 1953......	8.33	Sept. 14, 1953......	6.54		
D3-35-29ca (B-9)					
Sept. 26, 1952......	7.85	Apr. 30, 1953......	10.28	Sept. 14, 1953.....	9.23
Oct. 10, 1952......	5.82	May 13, 1953......	6.54	Sept. 28, 1953.....	9.79
Oct. 27, 1952......	7.91	May 25, 1953......	7.44	Oct. 13, 1953.....	9.62
Nov. 7, 1952......	8.39	June 9, 1953......	7.11	Nov. 9, 1953.....	10.00
Nov. 21, 1952......	8.88	June 23, 1953......	8.24	Dec. 8, 1953.....	10.29
Dec. 17, 1952......	9.44	July 6, 1953......	5.97	Jan. 6, 1954.....	10.49
Jan. 13, 1953......	9.84	July 20, 1953......	3.99	Feb. 9, 1954.....	10.53
Feb. 13, 1953......	9.92	Aug. 3, 1953......	7.67	Mar. 8, 1954.....	10.50
Mar. 2, 1953......	10.07	Aug. 17, 1953......	7.82	Apr. 14, 1954.....	9.89
Mar. 31, 1953......	10.16	Aug. 31, 1953......	7.62	May 4, 1954.....	9.23
D3-35-29cc1 (B-35)					
June 9, 1953......	4.83	June 23, 1953......	5.21	July 20, 1953.....	4.44
June 12, 1953......	4.88	July 6, 1953......	4.26	Aug. 3, 1953.....	4.49

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Table 26.—*Water-level measurements by tape*—Continued

Date	Water level	Date	Water level	Date	Water level
RENO AND BATTLEFIELD UNITS—Continued					
D3-35-29cc1 (B-35)—Continued					
Aug. 15, 1953......	5.12	Oct. 26, 1953......	5.77	Feb. 9, 1954.....	6.38
Aug. 31, 1953......	5.79	Nov. 9, 1953......	5.83	Mar. 8, 1954.....	6.20
Sept. 15, 1953......	6.07	Dec. 8, 1953......	6.15	Apr. 13, 1954.....	5.69
Sept. 28, 1953......	6.20	Jan. 6, 1954......	6.23	May 3, 1954.....	6.17
Oct. 13, 1953......	6.06				
D3-35-29cc2 (B-34)					
June 9, 1953......	9.03	Aug. 31, 1953......	7.53	Dec. 8, 1953.....	9.82
June 12, 1953......	9.09	Sept. 15, 1953......	8.00	Jan. 6, 1954.....	10.32
June 23, 1953......	8.66	Sept. 28, 1953......	8.13	Feb. 9, 1954.....	10.74
July 6, 1953......	5.56	Oct. 13, 1953......	7.77	Mar. 8, 1954.....	10.99
July 20, 1953......	4.57	Oct. 26, 1953......	7.97	Apr. 13, 1954.....	11.09
Aug. 3, 1953......	5.90	Nov. 9, 1953......	8.64	May 3, 1954.....	11.29
Aug. 17, 1953......	6.66				
D3-35-29cd (B-36)					
June 9, 1953......	7.54	Aug. 31, 1953......	7.64	Dec. 8, 1953.....	9.36
June 12, 1953......	7.42	Sept. 14, 1953......	8.36	Jan. 6, 1954.....	9.58
June 23, 1953......	7.47	Sept. 28, 1953......	8.59	Feb. 9, 1954.....	9.62
July 6, 1953......	6.06	Oct. 13, 1953......	8.33	Mar. 8, 1954.....	9.65
July 20, 1953......	4.95	Oct. 26, 1953......	8.72	Apr. 14, 1954.....	9.38
Aug. 3, 1953......	5.86	Nov. 9, 1953......	8.95	May 3, 1954.....	9.58
Aug. 17, 1953......	6.98				
D3-35-29da1 (B-40)					
June 9, 1953......	4.93	Aug. 31, 1953......	7.41	Dec. 8, 1953.....	6.19
June 12, 1953......	5.06	Sept. 15, 1953......	7.49	Jan. 6, 1954.....	6.05
June 23, 1953......	5.61	Sept. 28, 1953......	7.28	Feb. 9, 1954.....	5.89
July 6, 1953......	6.06	Oct. 13, 1953......	6.96	Mar. 8, 1954.....	5.76
July 20, 1953......	6.39	Oct. 26, 1953......	6.69	Apr. 14, 1954.....	5.19
Aug. 3, 1953......	6.89	Nov. 9, 1953......	6.43	May 3, 1954.....	5.24
Aug. 17, 1953......	7.18				
D3-35-29da2 (B-41)					
June 9, 1953......	3.43	Aug. 31, 1953......	5.96	Dec. 8, 1953.....	3.75
June 12, 1953......	3.58	Sept. 15, 1953......	5.25	Jan. 6, 1954.....	3.71
June 23, 1953......	3.97	Sept. 28, 1953......	5.48	Feb. 9, 1954.....	3.34
July 6, 1953......	4.79	Oct. 13, 1953......	4.96	Mar. 8, 1954.....	3.31
July 20, 1953......	5.24	Oct. 26, 1953......	4.20	Apr. 14, 1954.....	3.33
Aug. 3, 1953......	5.19	Nov. 9, 1953......	3.98	May 3, 1954.....	3.39
Aug. 17, 1953......	5.68				
D3-35-29db (B-42)					
June 9, 1953......	9.81	Aug. 31, 1953......	3.27	Dec. 8, 1953.....	8.88
June 12, 1953......	9.86	Sept. 15, 1953......	4.90	Jan. 6, 1954.....	9.51
June 23, 1953......	9.98	Sept. 28, 1953......	6.10	Feb. 9, 1954.....	9.95
July 6, 1953......	7.88	Oct. 13, 1953......	7.02	Mar. 9, 1954.....	9.86
July 20, 1953......	3.53	Oct. 26, 1953......	7.34	Apr. 14, 1954.....	9.92
Aug. 3, 1953......	6.73	Nov. 9, 1953......	7.96	May 3, 1954.....	10.06
Aug. 17, 1953......	7.28				

Table 26.—*Water-level measurements by tape*—Continued

RENO AND BATTLEFIELD UNITS—Continued

D3-35-30ab (B-39)

Date	Water level	Date	Water level	Date	Water level
June 9, 1953......	2.30	Aug. 17, 1953......	3.36	Dec. 8, 1953.....	3.09
June 12, 1953......	2.31	Aug. 31, 1953......	3.48	Jan. 6, 1954.....	3.18
June 23, 1953......	3.20	Sept. 15, 1953......	3.48	Feb. 9, 1954.....	2.81
July 6, 1953......	2.75	Sept. 28, 1953......	3.47	Mar. 8, 1954.....	3.06
July 20, 1953......	1.77	Oct. 13, 1953......	3.40	Apr. 14, 1954.....	2.93
Aug. 3, 1953......	2.90	Nov. 9, 1953......	2.87	May 3, 1954.....	3.13

D3-35-30ba (DR8-2)

Date	Water level	Date	Water level	Date	Water level
Oct. 13, 1953......	1.44	Jan. 6, 1954......	1.90	Apr. 14, 1954.....	1.97
Nov. 9, 1953......	1.24	Feb. 9, 1954......	1.50	May 4, 1954.....	2.20
Dec. 8, 1953......	1.70	Mar. 8, 1954......	1.82		

D3-35-30da (B-8)

Date	Water level	Date	Water level	Date	Water level
Sept. 26, 1952......	2.37	Apr. 25, 1953......	2.64	Sept. 28, 1953.....	2.72
Oct. 10, 1952......	2.13	May 30, 1953......	.00	Oct. 13, 1953.....	2.06
Oct. 27, 1952......	2.30	June 9, 1953......	1.81	Oct. 26, 1953.....	1.93
Nov. 7, 1952......	2.23	June 23, 1953......	2.34	Nov. 9, 1953.....	2.25
Nov. 21, 1952......	2.42	July 6, 1953......	1.86	Dec. 8, 1953.....	2.57
Dec. 17, 1952......	2.49	July 20, 1953......	1.73	Jan. 6, 1954.....	2.50
Jan. 13, 1953......	2.84	Aug. 3, 1953......	1.80	Mar. 8, 1954.....	2.31
Feb. 13, 1953......	2.37	Aug. 17, 1953......	2.56	Apr. 14, 1954.....	1.68
Mar. 31, 1953......	2.43	Sept. 3, 1953......	2.50	May 3, 1954.....	1.93
Apr. 11, 1953......	2.23	Sept. 14, 1953......	2.83		

D3-35-32ab (DR9-1)

Date	Water level	Date	Water level	Date	Water level
Oct. 1, 1953......	1.75	Dec. 8, 1953......	1.75	Mar. 8, 1954.....	2.00
Oct. 13, 1953......	1.64	Jan. 6, 1954......	1.86	Apr. 14, 1954.....	1.92
Oct. 26, 1953......	1.56	Feb. 9, 1954......	1.87	May 4, 1954.....	1.94
Nov. 9, 1953......	1.67				

D3-35-32ac (DR9-2)

Date	Water level	Date	Water level	Date	Water level
Oct. 26, 1953......	+0.12	Jan. 6, 1954......	0.26	Apr. 14, 1954.....	0.48
Nov. 9, 1953......	.16	Feb. 9, 1954......	.39	May 3, 1954.....	.60
Dec. 8, 1953......	.13	Mar. 8, 1954......	.37		

D3-35-32ba (B-10)

Date	Water level	Date	Water level	Date	Water level
Sept. 26, 1952......	13.04	May 11, 1953......	15.70	Sept. 28, 1953.....	14.30
Oct. 10, 1952......	12.56	May 25, 1953......	14.16	Oct. 13, 1953.....	14.22
Oct. 27, 1952......	13.71	June 9, 1953......	15.23	Oct. 26, 1953.....	14.29
Nov. 7, 1952......	14.20	June 23, 1953......	15.16	Nov. 9, 1953.....	14.93
Nov. 21, 1952......	14.82	July 6, 1953......	10.34	Dec. 8, 1953.....	15.56
Dec. 17, 1952......	15.56	July 20, 1953......	8.00	Jan. 6, 1954.....	16.59
Jan. 13, 1953......	16.10	Aug. 3, 1953......	11.03	Feb. 9, 1954.....	17.07
Feb. 13, 1953......	16.50	Aug. 17, 1953......	7.09	Mar. 8, 1954.....	17.56
Mar. 2, 1953......	16.74	Aug. 31, 1953......	12.20	Apr. 13, 1954.....	17.91
Mar. 31, 1953......	17.02	Sept. 14, 1953......	11.53	May 4, 1954.....	18.02
Apr. 30, 1953......	17.36				

Table 26.—*Water-level measurements by tape*—Continued

Date	Water level	Date	Water level	Date	Water level
RENO AND BATTLEFIELD UNITS—Continued					
D3-35-32db1 (B-33)					
June 9, 1953......	22.71	Aug. 31, 1953......	21.98	Dec. 8, 1953.....	22.70
June 12, 1953......	22.79	Sept. 15, 1953......	22.43	Jan. 6, 1954.....	23.21
June 23, 1953......	22.49	Sept. 28, 1953......	22.26	Feb. 9, 1954.....	23.56
July 6, 1953......	20.31	Oct. 13, 1953......	20.59	Mar. 8, 1954.....	23.84
July 20, 1953......	20.45	Oct. 26, 1953......	21.54	Apr. 13, 1954.....	23.90
Aug. 3, 1953......	21.28	Nov. 9, 1953......	22.10	May 3, 1954.....	24.28
Aug. 17, 1953......	21.72				
D3-35-32db2 (B-11)					
Sept. 1, 1952......	22.39	Mar. 31, 1953......	25.94	Sept. 14, 1953.....	24.52
Sept. 15, 1952......	23.94	Apr. 30, 1953......	26.02	Sept. 28, 1953.....	24.47
Sept. 26, 1952......	24.42	May 11, 1953......	26.26	Oct. 13, 1953.....	23.20
Oct. 10, 1952......	21.04	May 25, 1953......	24.77	Oct. 26, 1953.....	24.63
Oct. 27, 1952......	24.65	June 9, 1953......	25.33	Nov. 9, 1953.....	25.12
Nov. 7, 1952......	24.67	June 23, 1953......	21.09	Dec. 8, 1953.....	25.65
Nov. 21, 1952......	24.97	July 6, 1953......	19.18	Jan. 6, 1954.....	25.97
Dec. 17, 1952......	25.25	July 20, 1953......	21.69	Feb. 9, 1954.....	26.27
Jan. 13, 1953......	25.42	Aug. 3, 1953......	23.83	Mar. 8, 1954.....	26.42
Feb. 12, 1953......	25.65	Aug. 17, 1953......	22.82	Apr. 13, 1954.....	26.51
Mar. 2, 1953......	25.71	Aug. 31, 1953......	23.47	May 4, 1954.....	26.63
D4-35- 3bb (B-27)					
May 25, 1953......	8.05	Aug. 17, 1953......	9.27	Nov. 10, 1953.....	8.96
June 9, 1953......	8.42	Aug. 31, 1953......	9.43	Jan. 6, 1954.....	8.49
June 12, 1953......	7.98	Sept. 15, 1953......	9.47	Feb. 9, 1954.....	8.42
June 23, 1953......	8.34	Sept. 28, 1953......	9.49	Mar. 8, 1954.....	8.21
July 6, 1953......	8.49	Oct. 13, 1953......	9.42	Apr. 13, 1954.....	8.26
July 20, 1953......	8.77	Oct. 26, 1953......	9.19	May 3, 1954.....	8.37
Aug. 3, 1953......	8.98				
D4-35- 3cb (B-25)					
May 25, 1953......	9.29	Aug. 17, 1953......	7.18	Dec. 7, 1953.....	7.96
June 9, 1953......	5.86	Aug. 31, 1953......	6.06	Jan. 6, 1954.....	8.29
June 12, 1953......	6.40	Sept. 14, 1953......	7.26	Feb. 9, 1954.....	8.39
June 23, 1953......	6.60	Sept. 28, 1953......	7.73	Mar. 8, 1954.....	8.44
July 6, 1953......	2.14	Oct. 13, 1953......	6.90	Apr. 13, 1954.....	8.26
July 20, 1953......	6.10	Oct. 26, 1953......	5.33	May 3, 1954.....	8.57
Aug. 3, 1953......	6.69	Nov. 10, 1953......	6.75		
D4-35- 3cd (B-14)					
Sept. 1, 1952......	9.14	Jan. 13, 1953......	11.53	June 23, 1953.....	8.56
Sept. 15, 1952......	10.75	Feb. 12, 1953......	11.77	July 6, 1953.....	8.59
Sept. 26, 1952......	11.28	Mar. 2, 1953......	11.87	July 20, 1953.....	8.72
Oct. 10, 1952......	10.37	Mar. 31, 1953......	12.09	Aug. 3, 1953.....	9.65
Oct. 27, 1952......	10.65	Apr. 30, 1953......	12.09	Aug. 17, 1953.....	9.56
Nov. 7, 1952......	11.02	May 13, 1953......	12.06	Aug. 31, 1953.....	9.35
Nov. 21, 1953......	11.21	May 25, 1953......	12.19	Sept. 14, 1953.....	10.29
Dec. 17, 1952......	11.47	June 9, 1953......	8.50		

Table 26.—*Water-level measurements by tape*—Continued

RENO AND BATTLEFIELD UNITS—Continued

D4-35- 4ab (B-26)

Date	Water level	Date	Water level	Date	Water level
May 25, 1953......	8.35	Aug. 17, 1953......	5.56	Dec. 8, 1953.....	6.88
June 9, 1953......	5.78	Aug. 31, 1953......	4.07	Jan. 6, 1954.....	7.10
June 12, 1953......	6.13	Sept. 15, 1953......	5.59	Feb. 9, 1954.....	8.32
June 23, 1953......	5.97	Sept. 28, 1953......	6.65	Mar. 8, 1954.....	7.29
July 6, 1953......	6.10	Oct. 13, 1953......	7.09	Apr. 13, 1954.....	6.64
July 20, 1953......	2.88	Oct. 26, 1953......	6.78	May 4, 1954.....	7.39
Aug. 3, 1953......	4.59	Nov. 10, 1953......	6.87		

D4-35- 4bb1 (B-32)

Date	Water level	Date	Water level	Date	Water level
June 9, 1953......	8.36	Aug. 31, 1953......	3.17	Dec. 8, 1953.....	8.65
June 12, 1953......	8.77	Sept. 14, 1953......	7.12	Jan. 6, 1954.....	9.02
June 23, 1953......	9.34	Sept. 28, 1953......	8.05	Feb. 9, 1954.....	9.33
July 6, 1953......	9.17	Oct. 13, 1953......	8.80	Mar. 8, 1954.....	9.18
July 20, 1953......	5.29	Oct. 26, 1953......	8.85	Apr. 13, 1954.....	9.02
Aug. 3, 1953......	6.89	Nov. 10, 1953......	9.06	May 3, 1954.....	9.45
Aug. 17, 1953......	6.99				

D4-35- 4bb2 (DR10-1)

Date	Water level	Date	Water level	Date	Water level
Oct. 13, 1953......	2.33	Dec. 7, 1953......	2.59	Mar. 8, 1954.....	3.43
Oct. 26, 1953......	2.13	Jan. 6, 1954......	2.98	Apr. 14, 1954.....	2.99
Nov. 10, 1953......	2.29	Feb. 9, 1954......	3.43	May 4, 1954.....	3.55

D4-35- 4bc (B-12)

Date	Water level	Date	Water level	Date	Water level
Sept. 1, 1952......	3.67	Mar. 31, 1953......	6.92	Sept. 14, 1953.....	4.65
Sept. 15, 1952......	3.04	Apr. 30, 1953......	7.24	Sept. 28, 1953.....	5.50
Sept. 26, 1952......	4.27	May 11, 1953......	7.23	Oct. 13, 1953.....	5.86
Oct. 10, 1952......	5.14	May 25, 1953......	7.03	Oct. 26, 1953.....	5.39
Oct. 27, 1952......	5.28	June 9, 1953......	6.15	Nov. 10, 1953.....	5.81
Nov. 7, 1952......	5.23	June 22, 1953......	6.03	Dec. 7, 1953.....	6.17
Nov. 21, 1952......	5.37	July 6, 1953......	5.22	Jan. 6, 1954.....	6.60
Dec. 17, 1952......	5.88	July 20, 1953......	4.75	Feb. 9, 1954.....	6.87
Jan. 13, 1953......	6.02	Aug. 3, 1953......	4.46	Mar. 8, 1954.....	6.85
Feb. 12, 1953......	6.42	Aug. 17, 1953......	4.49	Apr. 13, 1954.....	6.50
Mar. 2, 1953......	6.67	Aug. 31, 1953......	4.43	May 4, 1954.....	6.98

D4-35- 5aa (B-22)

Date	Water level	Date	Water level	Date	Water level
May 25, 1953......	12.71	Aug. 17, 1953......	8.24	Dec. 8, 1953.....	13.14
June 9, 1953......	12.63	Aug. 31, 1953......	9.04	Jan. 6, 1954.....	13.78
June 12, 1953......	12.78	Sept. 14, 1953......	10.69	Feb. 9, 1954.....	14.32
June 23, 1953......	13.18	Sept. 28, 1953......	11.09	Mar. 8, 1954.....	14.62
July 6, 1953......	10.14	Oct. 13, 1953......	11.65	Apr. 13, 1954.....	14.58
July 20, 1953......	8.02	Oct. 26, 1953......	11.62	May 4, 1954.....	14.84
Aug. 3, 1953......	10.51	Nov. 10, 1953......	12.17		

D4-35- 5ab (B-23)

Date	Water level	Date	Water level	Date	Water level
May 25, 1953......	11.60	Aug. 17, 1953......	4.46	Dec. 8, 1953.....	12.71
June 9, 1953......	12.22	Aug. 31, 1953......	4.32	Jan. 6, 1954.....	14.73
June 12, 1953......	12.54	Sept. 14, 1953......	7.00	Feb. 9, 1954.....	16.39
June 23, 1953......	13.01	Sept. 28, 1953......	6.81	Mar. 8, 1954.....	17.23
July 6, 1953......	5.03	Oct. 13, 1953......	8.22	Apr. 13, 1954.....	18.02
July 20, 1953......	2.97	Oct. 26, 1953......	7.94	May 4, 1954.....	18.30
Aug. 3, 1953......	6.71	Nov. 10, 1953......	9.82		

Table 26.—*Water-level measurements by tape*—Continued

Date	Water level	Date	Water level	Date	Water level

RENO AND BATTLEFIELD UNITS—Continued

D4-35- 6aa (B-44)

[For measurements from recorder charts, see table 27]

Oct. 13, 1953......	23.91	Dec. 8, 1953......	23.99	Apr. 13, 1954.....	24.27
Oct. 26, 1953......	23.88	Jan. 6, 1954......	24.10	May 3, 1954.....	24.33
Nov. 10, 1953......	23.93	Feb. 9, 1954......	24.17		

D4-35- 9ab (B-43)

May 25, 1953......	9.74	Aug. 31, 1953......	5.48	Dec. 7, 1953.....	8.52
June 9, 1953......	6.95	Sept. 14, 1953......	6.80	Jan. 6, 1954.....	9.67
June 23, 1953......	5.72	Sept. 28, 1953......	4.95	Feb. 9, 1954.....	10.56
July 6, 1953......	3.71	Oct. 13, 1953......	5.67	Mar. 8, 1954.....	11.07
July 20, 1953......	5.17	Oct. 26, 1953......	5.77	Apr. 14, 1954.....	10.86
Aug. 3, 1953......	6.28	Nov. 10, 1953......	7.10	May 4, 1954.....	11.16
Aug. 17, 1953......	4.09				

D4-35- 9ac (B-28)

June 9, 1953......	7.01	Aug. 31, 1953......	2.95	Dec. 7, 1953.....	9.24
June 12, 1953......	6.84	Sept. 14, 1953......	4.98	Jan. 6, 1954.....	10.54
June 23, 1953......	6.76	Sept. 28, 1953......	4.10	Feb. 9, 1954.....	10.41
July 6, 1953......	3.45	Oct. 13, 1953......	4.94	Mar. 8, 1954.....	12.09
July 20, 1953......	3.03	Oct. 26, 1953......	5.89	Apr. 13, 1954.....	12.47
Aug. 3, 1953......	3.98	Nov. 9, 1953......	7.44	May 3, 1954.....	12.61
Aug. 17, 1953......	3.78				

D4-35- 9ad (B-29)

June 9, 1953......	5.20	Aug. 31, 1953......	1.61	Dec. 7, 1953.....	6.99
June 12, 1953......	4.98	Sept. 14, 1953......	3.89	Jan. 6, 1954.....	7.93
June 23, 1953......	3.78	Sept. 28, 1953......	5.32	Feb. 9, 1954.....	8.85
July 6, 1953......	2.10	Oct. 13, 1953......	4.79	Mar. 8, 1954.....	8.99
July 20, 1953......	2.12	Oct. 26, 1953......	5.23	Apr. 13, 1954.....	9.64
Aug. 3, 1953......	4.49	Nov. 9, 1953......	5.89	May 3, 1954.....	9.92
Aug. 17, 1953......	2.49				

D4-35- 9aa1 (B-45)

[No measurements by tape; for measurements from recorder charts, see table 27]

D4-35- 9ba (B-13)

Sept. 1, 1952......	4.47	Mar. 31, 1953......	11.88	Sept. 14, 1953.....	5.90
Sept. 15, 1952......	4.65	Apr. 30, 1953......	12.30	Sept. 28, 1953.....	6.12
Sept. 26, 1952......	6.20	May 11, 1953......	12.27	Oct. 13, 1953.....	6.46
Oct. 10, 1952......	7.24	May 25, 1953......	11.82	Oct. 26, 1953.....	5.52
Oct. 27, 1952......	7.87	June 9, 1953......	9.95	Nov. 10, 1953.....	6.42
Nov. 7, 1952......	8.35	June 22, 1953......	8.89	Dec. 7, 1953.....	8.14
Nov. 21, 1952......	8.99	July 6, 1953......	4.54	Jan. 6, 1954.....	9.37
Dec. 17, 1952......	9.92	July 20, 1953......	3.05	Feb. 9, 1954.....	9.97
Jan. 13, 1953......	10.37	Aug. 3, 1953......	4.65	Mar. 8, 1954.....	10.46
Feb. 12, 1953......	11.03	Aug. 17, 1953......	4.84	Apr. 13, 1954.....	10.20
Mar. 2, 1953......	11.44	Aug. 31, 1953......	4.88	May 4, 1954.....	10.10

Table 26.—*Water-level measurements, by tape*—Continued

RENO AND BATTLEFIELD UNITS—Continued

D4-35- 9db (B-15)

Date	Water level	Date	Water level	Date	Water level
Sept. 1, 1952......	8.47	Mar. 31, 1953......	11.45	Sept. 14, 1953.....	8.79
Sept. 15, 1952......	8.72	Apr. 30, 1953......	11.78	Sept. 28, 1953.....	9.26
Sept. 26, 1952......	8.97	May 11, 1953......	11.79	Oct. 13, 1953.....	9.24
Oct. 10, 1952......	8.61	May 25, 1953......	11.11	Oct. 26, 1953.....	8.90
Oct. 27, 1952......	9.04	June 9, 1953......	9.79	Nov. 9, 1953.....	8.61
Nov. 7, 1952......	9.29	June 23, 1953......	9.77	Dec. 7, 1953.....	10.07
Nov. 21, 1952......	9.60	July 6, 1953......	7.37	Jan. 6, 1954.....	10.60
Dec. 17, 1952......	10.08	July 20, 1953......	5.80	Feb. 9, 1954.....	11.00
Jan. 13, 1953......	10.41	Aug. 3, 1953......	7.37	Mar. 8, 1954.....	11.32
Feb. 12, 1953......	10.79	Aug. 17, 1953......	7.86	Apr. 13, 1954.....	11.56
Mar. 2, 1953......	11.10	Aug. 31, 1953......	8.18	May 3, 1954.....	11.74

D4-35- 9dc (B-30)

Date	Water level	Date	Water level	Date	Water level
June 11, 1953......	15.37	Aug. 31, 1953......	15.28	Dec. 7, 1953.....	17.26
June 12, 1953......	15.26	Sept. 15, 1953......	16.06	Jan. 6, 1954.....	17.46
June 23, 1953......	15.63	Sept. 28, 1953......	16.51	Feb. 9, 1954.....	16.24
July 6, 1953......	12.90	Oct. 13, 1953......	16.33	Mar. 8, 1954.....	17.04
July 20, 1953......	13.07	Oct. 26, 1953......	16.34	Apr. 13, 1954.....	16.90
Aug. 3, 1953......	14.34	Nov. 9, 1953......	16.85	May 3, 1954.....	17.04
Aug. 17, 1953......	14.67				

D4-35-10bb (B-24)

Date	Water level	Date	Water level	Date	Water level
May 25, 1953......	8.25	Aug. 17, 1953......	4.22	Dec. 8, 1953.....	6.90
June 9, 1953......	5.69	Aug. 31, 1953......	4.03	Jan. 6, 1954.....	7.76
June 12, 1953......	4.68	Sept. 14, 1953......	5.21	Feb. 9, 1954.....	8.44
June 23, 1953......	3.68	Sept. 28, 1953......	4.52	Mar. 8, 1954.....	8.84
July 6, 1953......	4.47	Oct. 13, 1953......	4.16	Apr 13, 1954.....	8.75
July 20, 1953......	5.02	Oct. 26, 1953......	5.09	May 3, 1954.....	8.96
Aug. 3, 1953......	5.34	Nov. 10, 1953......	5.72		

D4-35-16bd (B-31)

Date	Water level	Date	Water level	Date	Water level
June 11, 1953......	9.71	Aug. 31, 1953......	10.33	Dec. 7, 1953.....	11.19
June 12, 1953......	9.50	Sept. 14, 1953......	10.73	Jan. 6, 1954.....	11.21
June 23, 1953......	9.57	Sept. 28, 1953......	10.99	Feb. 9, 1954.....	10.22
July 6, 1953......	9.27	Oct. 13, 1953......	10.82	Mar. 8, 1954.....	10.81
July 20, 1953......	9.39	Oct. 26, 1953......	10.82	Apr. 13, 1954.....	10.77
Aug. 3, 1953......	9.87	Nov. 9, 1953......	11.11	May 3, 1954.....	10.82
Aug. 17, 1953......	10.05				

AGENCY UNIT

D1-34-19ac (A-2)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	4.64	Jan. 13, 1953......	5.11	Aug. 31, 1953.....	4.64
July 7, 1952......	4.54	Feb. 10, 1953......	5.07	Sept. 14, 1953.....	4.17
July 21, 1952......	4.23	Mar. 4, 1953......	5.04	Sept. 28, 1953.....	4.18
Aug. 4, 1952......	4.81	Mar. 31, 1953......	5.02	Oct. 12, 1953.....	4.53
Aug. 18, 1952......	4.60	Apr. 30, 1953......	5.00	Oct. 27, 1953.....	4.66
Sept. 1, 1952......	4.40	May 11, 1953......	4.10	Nov. 6, 1953.....	4.67
Sept. 15, 1952......	4.34	May 25, 1953......	4.17	Dec. 7, 1953.....	4.88
Sept. 26, 1952......	4.73	June 8, 1953......	3.74	Jan. 4, 1954.....	5.01
Oct. 10, 1952......	4.72	June 22, 1953......	4.56	Feb. 9, 1954.....	4.70
Oct. 24, 1952......	5.04	July 6, 1953......	4.57	Mar. 8, 1954.....	4.75
Nov. 7, 1952......	5.20	July 20, 1953......	5.05	Apr. 13, 1954.....	4.62
Nov. 21, 1952......	5.18	Aug. 3, 1953......	4.22	May 4, 1954.....	4.80
Dec. 17, 1952......	5.13	Aug. 17, 1953......	5.23		

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D1-34-19ba (A-1)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	9.58	Sept. 15, 1952......	Dry	Nov. 21, 1952.....	Dry
July 7, 1952......	9.58	Sept. 26, 1952......	Dry	Feb. 10, 1953.....	10.71
July 21, 1952......	9.60	Oct. 10, 1952......	Dry	Mar. 4, 1953.....	10.78
Aug. 4, 1952......	Dry	Oct. 24, 1952......	Dry	Mar. 31, 1953.....	10.75
Aug. 18, 1952......	Dry	Nov. 7, 1952......	Dry	Apr. 29, 1953.....	Dry
Sept. 1, 1952......	Dry				

D1-34-19da (A-3)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	3.60	June 9, 1953......	3.41	Oct. 12, 1953.....	4.66
July 7, 1952......	3.70	June 22, 1953......	4.19	Oct. 27, 1953.....	4.25
July 21, 1952......	3.37	July 6, 1953......	4.79	Nov. 6, 1953.....	4.42
Aug. 4, 1952......	3.53	July 20, 1953......	4.89	Dec. 7, 1953.....	4.54
Aug. 18, 1952......	3.50	Aug. 3, 1953......	4.64	Jan. 4, 1954.....	5.62
Sept. 1, 1952......	3.77	Aug. 17, 1953......	5.08	Feb. 9, 1954.....	4.33
Sept. 15, 1952......	4.03	Aug. 31, 1953......	4.83	Mar. 8, 1954.....	4.70
Sept. 26, 1952......	3.99	Sept. 14, 1953......	4.72	Apr. 13, 1954.....	4.35
May 25, 1953......	4.44	Sept. 28, 1953......	4.75	May 4, 1954.....	4.48

D1-34-19dc (A-4)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	6.66	Jan. 13, 1953......	6.62	Aug. 31, 1953.....	6.64
July 7, 1952......	5.54	Feb. 10, 1953......	6.56	Sept. 14, 1953.....	6.57
July 21, 1952......	6.11	Mar. 4, 1953......	6.49	Sept. 28, 1953.....	6.27
Aug. 4, 1952......	6.80	Mar. 31, 1953......	6.83	Oct. 12, 1953.....	6.85
Aug. 18, 1952......	6.57	Apr. 30, 1953......	6.32	Oct. 27, 1953.....	6.79
Sept. 1, 1952......	6.90	May 13, 1953......	6.02	Nov. 6, 1953.....	6.78
Sept. 15, 1952......	6.50	May 25, 1953......	5.94	Dec. 7, 1953.....	6.68
Sept. 26, 1952......	6.80	June 8, 1953......	5.90	Jan. 4, 1954.....	6.67
Oct. 10, 1952......	6.66	June 22, 1953......	6.49	Feb. 9, 1954.....	6.21
Oct. 28, 1952......	6.83	July 6, 1953......	6.64	Mar. 9, 1954.....	6.32
Nov. 7, 1952......	6.80	July 20, 1953......	6.68	Apr. 13, 1954.....	6.35
Nov. 21, 1952......	6.75	Aug. 3, 1953......	6.29	May 4, 1954.....	6.45
Dec. 17, 1952......	6.68	Aug. 17, 1953......	6.74		

D1-34-20cc (A-5)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	14.44	Jan. 13, 1953......	16.30	Aug. 31, 1953.....	11.19
July 7, 1952......	13.39	Feb. 10, 1953......	16.60	Sept. 14, 1953.....	12.20
July 21, 1952......	14.20	Mar. 4, 1953......	16.78	Sept. 28, 1953.....	12.73
Aug. 4, 1952......	11.17	Mar. 31, 1953......	16.95	Oct. 12, 1953.....	13.49
Aug. 18, 1952......	12.64	May 11, 1953......	17.05	Oct. 27, 1953.....	13.88
Sept. 1, 1952......	12.60	May 25, 1953......	15.82	Nov. 6, 1953.....	14.17
Sept. 15, 1952......	13.21	June 8, 1953......	14.98	Dec. 7, 1953.....	15.06
Sept. 26, 1952......	13.63	June 22, 1953......	14.60	Jan. 4, 1954.....	15.60
Oct. 10, 1952......	14.16	July 6, 1953......	14.14	Feb. 9, 1954.....	16.09
Oct. 24, 1952......	14.62	July 20, 1953......	13.21	Mar. 9, 1954.....	16.22
Nov. 7, 1952......	15.03	Aug. 3, 1953......	11.85	Apr. 13, 1954.....	16.66
Nov. 21, 1952......	15.48	Aug. 17, 1953......	12.15	May 4, 1954.....	16.84
Dec. 17, 1952......	15.91				

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D1-34-29aa3 (A-8)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	17.40	Jan. 13, 1953......	19.10	Aug. 31, 1953.....	17.96
July 7, 1952......	17.12	Feb. 10, 1953......	19.32	Sept. 14, 1953.....	18.05
July 21, 1952......	16.97	Mar. 4, 1953......	19.56	Sept. 28, 1953.....	18.29
Aug. 4, 1952......	17.08	Mar. 31, 1953......	19.79	Oct. 12, 1953.....	18.18
Aug. 18, 1952......	17.25	Apr. 29, 1953......	19.99	Oct. 27, 1953.....	17.88
Sept. 1, 1952......	17.47	May 13, 1953......	19.64	Nov. 6, 1953.....	17.73
Sept. 15, 1952......	17.32	May 25, 1953......	19.52	Dec. 7, 1953.....	18.52
Sept. 26, 1952......	17.67	June 8, 1953......	18.26	Jan. 4, 1954.....	19.02
Oct. 10, 1952......	17.87	June 22, 1953......	17.83	Feb. 9, 1954.....	18.76
Oct. 24, 1952......	18.08	July 6, 1953......	17.15	Mar. 9, 1954.....	19.31
Nov. 7, 1952......	18.38	July 20, 1953......	17.51	Apr. 13, 1954.....	19.50
Nov. 21, 1952......	18.62	Aug. 3, 1953......	17.73	May 4, 1954.....	19.66
Dec. 17, 1952......	18.95	Aug. 17, 1953......	17.99		

D1-34-29ab2 (A-7)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	14.89	Jan. 13, 1953......	18.70	Aug. 31, 1953.....	15.75
July 7, 1952......	13.63	Feb. 10, 1953......	19.19	Sept. 14, 1953.....	16.11
July 21, 1952......	15.44	Mar. 4, 1953......	19.49	Sept. 28, 1953.....	16.31
Aug. 4, 1952......	13.17	Mar. 31, 1953......	19.83	Oct. 12, 1953.....	13.27
Aug. 18, 1952......	10.47	Apr. 29, 1953......	20.14	Oct. 27, 1953.....	15.03
Sept. 1, 1952......	13.88	May 11, 1953......	19.57	Nov. 6, 1953.....	15.63
Sept. 15, 1952......	14.23	May 25, 1953......	18.89	Dec. 7, 1953.....	17.27
Sept. 26, 1952......	13.79	June 8, 1953......	17.50	Jan. 4, 1954.....	18.18
Oct. 10, 1952......	15.43	June 22, 1953......	15.97	Feb. 9, 1954.....	18.73
Oct. 24, 1952......	16.18	July 6, 1953......	13.19	Mar. 9, 1954.....	19.17
Nov. 7, 1952......	16.82	July 20, 1953......	14.39	Apr. 13, 1954.....	19.65
Nov. 21, 1952......	17.36	Aug. 3, 1953......	15.27	May 4, 1954.....	19.75
Dec. 17, 1952......	18.10	Aug. 17, 1953......	15.42		

D1-34-29ad (A-10)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	13.93	Jan. 13, 1953......	15.83	Aug. 31, 1953.....	14.79
July 7, 1952......	13.53	Feb. 10, 1953......	15.86	Sept. 14, 1953.....	14.94
July 21, 1952......	13.84	Mar. 4, 1953......	16.00	Sept. 28, 1953.....	15.15
Aug. 4, 1952......	13.84	Mar. 31, 1953......	16.13	Oct. 12, 1953.....	15.04
Aug. 18, 1952......	14.16	Apr. 29, 1953......	16.23	Oct. 27, 1953.....	15.05
Sept. 1, 1952......	14.70	May 11, 1953......	15.87	Nov. 6, 1953.....	14.99
Sept. 15, 1952......	14.44	May 25, 1953......	15.65	Dec. 7, 1953.....	15.45
Sept. 26, 1952......	14.71	June 8, 1953......	14.83	Jan. 4, 1954.....	15.76
Oct. 10, 1952......	15.02	June 22, 1953......	14.57	Feb. 9, 1954.....	15.71
Oct. 24, 1952......	15.20	July 6, 1953......	13.67	Mar. 9, 1954.....	15.80
Nov. 7, 1952......	15.46	July 20, 1953......	14.17	Apr. 13, 1954.....	15.91
Nov. 21, 1952......	15.59	Aug. 3, 1953......	14.47	May 4, 1954.....	15.97
Dec. 17, 1952......	15.75	Aug. 17, 1953......	14.83		

D1-34-29bc3 (A-6)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	4.72	Sept. 15, 1952......	4.74	Dec. 17, 1952.....	3.65
July 7, 1952......	4.90	Sept. 26, 1952......	4.47	Jan. 13, 1953.....	3.62
July 21, 1952......	4.95	Oct. 10, 1952......	4.09	Feb. 10, 1953.....	3.70
Aug. 4, 1952......	5.30	Oct. 24, 1952......	3.87	Mar. 4, 1953.....	3.77
Aug. 18, 1952......	5.12	Nov. 7, 1952......	3.76	Mar. 31, 1953.....	3.88
Sept. 1, 1952......	4.99	Nov. 21, 1952......	3.73	Apr. 29, 1953.....	3.80

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D1-34-29bc3 (A-6)—Continued

Date	Water level	Date	Water level	Date	Water level
May 13, 1953......	3.87	Aug. 17, 1953......	4.81	Dec. 7, 1953.....	2.45
May 25, 1953......	3.94	Aug. 31, 1953......	4.78	Jan. 4, 1954.....	2.72
June 8, 1953......	3.90	Sept. 28, 1953......	4.31	Feb. 9, 1954.....	2.46
June 22, 1953......	4.20	Oct. 12, 1953......	.70	Mar. 9, 1954.....	2.72
July 6, 1953......	4.57	Oct. 27, 1953......	1.24	Apr. 13, 1954.....	2.84
July 20, 1953......	4.99	Nov. 6, 1953......	1.98	May 3, 1954.....	3.04
Aug. 3, 1953......	4.89				

D1-34-29db (A-9)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	11.31	Jan. 13, 1953......	14.41	Aug. 31, 1953.....	14.10
July 7, 1952......	12.75	Feb. 10, 1953......	14.52	Sept. 14, 1953.....	14.21
July 21, 1952......	12.42	Mar. 4, 1953......	14.59	Sept. 28, 1953.....	14.32
Aug. 4, 1952......	12.08	Mar. 31, 1953......	14.66	Oct. 12, 1953.....	14.18
Aug. 18, 1952......	12.43	Apr. 29, 1953......	14.71	Oct. 27, 1953.....	14.10
Sept. 1, 1952......	13.12	May 13, 1953......	14.18	Nov. 9, 1953.....	14.24
Sept. 15, 1952......	13.20	May 25, 1953......	13.20	Dec. 7, 1953.....	14.19
Sept. 26, 1952......	13.71	June 8, 1953......	12.17	Jan. 4, 1954.....	14.48
Oct. 10, 1952......	14.04	June 22, 1953......	13.02	Feb. 9, 1954.....	14.00
Oct. 24, 1952......	14.19	July 6, 1953......	13.49	Mar. 9, 1954.....	13.37
Nov. 7, 1952......	14.32	July 20, 1953......	13.55	Apr. 13, 1954.....	14.52
Nov. 21, 1952......	14.38	Aug. 3, 1953......	13.92	May 4, 1954.....	14.34
Dec. 17, 1952......	14.42	Aug. 17, 1953......	13.99		

D1-34-29dd (A-11)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	5.15	Jan. 13, 1953......	5.57	Aug. 31, 1953.....	5.79
July 7, 1952......	5.24	Feb. 10, 1953......	5.20	Sept. 14, 1953.....	5.77
July 21, 1952......	5.33	Mar. 4, 1953......	5.34	Sept. 28, 1953.....	5.83
Aug. 4, 1952......	5.57	Mar. 31, 1953......	5.32	Oct. 12, 1953.....	5.72
Aug. 18, 1952......	5.45	Apr. 29, 1953......	5.39	Oct. 27, 1953.....	5.52
Sept. 1, 1952......	5.76	May 13, 1953......	5.22	Nov. 6, 1953.....	5.30
Sept. 15, 1952......	5.59	May 25, 1953......	5.30	Dec. 7, 1953......	5.20
Sept. 26, 1952......	5.66	June 8, 1953......	4.97	Jan. 4, 1954.....	5.58
Oct. 10, 1952......	5.59	June 22, 1953......	5.27	Feb. 9, 1954.....	5.36
Oct. 24, 1952......	5.35	July 6, 1953......	5.39	Mar. 9, 1954.....	5.17
Nov. 7, 1952......	5.38	July 20, 1953......	5.85	Apr. 13, 1954.....	5.08
Nov. 21, 1952......	5.37	Aug. 3, 1953......	8.59	May 3, 1954.....	5.28
Dec. 17, 1952......	5.48	Aug. 17, 1953......	5.96		

D1-34-33bb3 (A-12)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	2.77	Jan. 13, 1953......	5.38	Aug. 31, 1953.....	3.29
July 7, 1952......	3.10	Feb. 10, 1953......	5.46	Sept. 14, 1953.....	3.77
July 21, 1952......	3.13	Mar. 4, 1953......	5.58	Sept. 28, 1953......	4.52
Aug. 4, 1952......	3.30	Mar. 31, 1953......	5.68	Oct. 12, 1953.....	4.15
Aug. 18, 1952......	2.41	Apr. 29, 1953......	5.82	Oct. 27, 1953.....	3.32
Sept. 1, 1952......	2.52	May 11, 1953......	4.10	Nov. 6, 1953.....	3.92
Sept. 15, 1952......	3.30	May 25, 1953......	4.11	Dec. 7, 1953.....	4.93
Sept. 26, 1952......	3.68	June 8, 1953......	3.39	Jan. 4, 1954.....	5.24
Oct. 10, 1952......	3.43	June 22, 1953......	3.55	Feb. 9, 1954.....	4.99
Oct. 24, 1952......	3.95	July 6, 1953......	3.43	Mar. 9, 1954.....	5.52
Nov. 7, 1952......	4.50	July 20, 1953......	3.12	Apr. 13, 1954.....	5.37
Nov. 21, 1952......	4.84	Aug. 3, 1953......	3.03	May 4, 1954.....	5.49
Dec. 17, 1952......	5.16	Aug. 17, 1953......	3.92		

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D1-34-33cd3 (A-17)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	7.83	Jan. 13, 1953......	12.34	Aug. 31, 1953.....	6.79
July 7, 1952......	7.48	Feb. 10, 1953......	12.96	Sept. 14, 1953.....	8.40
July 21, 1952......	6.77	Mar. 4, 1953......	13.61	Sept. 28, 1953.....	9.55
Aug. 4, 1952......	8.15	Mar. 31, 1953......	13.13	Oct. 12, 1953.....	10.15
Aug. 18, 1952......	6.52	Apr. 29, 1953......	14.72	Oct. 27, 1953.....	9.45
Sept. 1, 1952......	7.37	May 13, 1953......	12.36	Nov. 6, 1953.....	9.90
Sept. 15, 1952......	8.61	May 25, 1953......	11.10	Dec. 7, 1953.....	11.45
Sept. 26, 1952......	7.77	June 8, 1953......	11.18	Jan. 4, 1954.....	12.71
Oct. 10, 1952......	7.17	June 22, 1953......	10.32	Feb. 9, 1954.....	13.77
Oct. 25, 1952......	8.48	July 6, 1953......	8.73	Mar. 9, 1954.....	14.53
Nov. 7, 1952......	9.22	July 20, 1953......	8.03	Apr. 13, 1954.....	14.85
Nov. 21, 1952......	10.08	Aug. 3, 1953......	8.64	May 4, 1954.....	15.20
Dec. 17, 1952......	11.19	Aug. 17, 1953......	7.38		

D1-34-33da (A-14)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	5.52	Jan. 13, 1953......	6.68	Aug. 31, 1953.....	5.34
July 7, 1952......	5.77	Feb. 10, 1953......	6.74	Sept. 14, 1953.....	5.33
July 21, 1952......	5.90	Mar. 4, 1953......	6.91	Sept. 28, 1953.....	5.53
Aug. 4, 1952......	6.33	Mar. 31, 1953......	6.99	Oct. 12, 1953.....	5.83
Aug. 18, 1952......	6.15	Apr. 29, 1953......	7.14	Oct. 27, 1953.....	5.98
Sept. 1, 1952......	6.56	May 13, 1953......	7.03	Nov. 6, 1953.....	5.73
Sept. 15, 1952......	6.08	May 25, 1953......	6.70	Dec. 7, 1953.....	6.13
Sept. 26, 1952......	6.36	June 8, 1953......	6.19	Jan. 4, 1954.....	6.62
Oct. 10, 1952......	5.68	June 22, 1953......	6.13	Feb. 9, 1954.....	6.74
Oct. 24, 1952......	5.87	July 6, 1953......	5.30	Mar. 9, 1954.....	7.02
Nov. 7, 1952......	6.26	July 20, 1953......	4.88	Apr. 13, 1954.....	7.04
Nov. 21, 1952......	6.42	Aug. 3, 1953......	5.15	May 4, 1954.....	7.01
Dec. 17, 1952......	6.50	Aug. 17, 1953......	5.29		

D1-34-33db (A-13)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	2.05	Jan. 13, 1953......	8.72	Aug. 31, 1953.....	1.77
July 7, 1952......	2.26	Feb. 10, 1953......	9.06	Sept. 14, 1953.....	4.24
July 21, 1952......	3.80	Mar. 4, 1953......	9.55	Sept. 28, 1953.....	4.58
Aug. 4, 1952......	3.83	Mar. 31, 1953......	9.90	Oct. 12, 1953.....	5.39
Aug. 18, 1952......	3.60	Apr. 29, 1953......	10.32	Oct. 27, 1953.....	4.56
Sept. 1, 1952......	3.90	May 11, 1953......	6.47	Nov. 6, 1953.....	5.33
Sept. 15, 1952......	4.57	May 25, 1953......	7.62	Dec. 7, 1953.....	7.48
Sept. 26, 1952......	4.84	June 8, 1953......	7.05	Jan. 4, 1954.....	8.59
Oct. 10, 1952......	4.47	June 22, 1953......	4.35	Feb. 9, 1954.....	9.39
Oct. 24, 1952......	5.21	July 6, 1953......	2.82	Mar. 9, 1954.....	9.89
Nov. 7, 1952......	6.12	July 20, 1953......	2.70	Apr. 13, 1954.....	10.04
Nov. 21, 1952......	6.98	Aug. 3, 1953......	4.31	May 4, 1954.....	10.24
Dec. 17, 1952......	7.90	Aug. 17, 1953......	3.67		

D1-34-34cd (A-15)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	4.18	Sept. 26, 1952......	7.26	Feb. 10, 1953.....	7.55
July 7, 1952......	5.75	Oct. 10, 1952......	5.97	Mar. 4, 1953.....	7.67
July 21, 1952......	6.39	Oct. 25, 1952......	5.91	Mar. 31, 1953.....	7.50
Aug. 4, 1952......	6.93	Nov. 7, 1952......	6.60	Apr. 29, 1953.....	7.72
Aug. 18, 1952......	7.50	Nov. 21, 1952......	6.99	May 13, 1953.....	7.85
Sept. 1, 1952......	4.99	Dec. 17, 1952......	7.32	May 25, 1953.....	5.33
Sept. 15, 1952......	6.64	Jan. 13, 1953......	7.60	June 8, 1953.....	6.39

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D1-34-34cd (A-15)—Continued

Date	Water level	Date	Water level	Date	Water level
June 22, 1953......	5.28	Sept. 14, 1953......	5.80	Jan. 6, 1954.....	7.60
July 6, 1953......	6.65	Sept. 28, 1953......	6.16	Feb. 9, 1954.....	7.68
July 20, 1953......	5.34	Oct. 12, 1953......	6.88	Mar. 9, 1954.....	7.61
Aug. 3, 1953......	6.62	Oct. 27, 1953......	6.58	Apr. 13, 1954.....	6.98
Aug. 17, 1953......	7.03	Nov. 6, 1953......	6.52	May 4, 1954.....	7.16
Aug. 31, 1953......	6.99	Dec. 7, 1953......	7.14		

D2-34-2cc1 (A-29)

Date	Water level	Date	Water level	Date	Water level
May 26, 1952......	3.51	Nov. 7, 1952......	4.75	Aug. 31, 1953.....	3.07
June 10, 1952......	1.35	Nov. 21, 1952......	4.72	Sept. 14, 1953.....	3.74
June 26, 1952......	3.05	Dec. 17, 1952......	4.67	Sept. 28, 1953.....	4.31
July 7, 1952......	2.27	Jan. 13, 1953......	4.78	Oct. 12, 1953.....	4.87
July 21, 1952......	3.37	May 13, 1953......	4.85	Oct. 27, 1953.....	3.97
Aug. 4, 1952......	1.90	May 25, 1953......	4.70	Nov. 6, 1953.....	3.93
Aug. 18, 1952......	3.58	June 8, 1953......	3.90	Dec. 7, 1953.....	4.35
Sept. 1, 1952......	3.98	June 22, 1953......	4.49	Jan. 4, 1954.....	4.52
Sept. 15, 1952......	4.03	July 6, 1953......	1.05	Feb. 9, 1954.....	3.68
Sept. 26, 1952......	4.29	July 20, 1953......	2.64	Mar. 9, 1954.....	4.07
Oct. 10, 1952......	4.54	Aug. 3, 1953......	3.39	Apr. 13, 1954.....	3.56
Oct. 25, 1952......	4.61	Aug. 17, 1953......	3.10	May 4, 1954.....	4.07

D2-34-2cc2 (A-30)

Date	Water level	Date	Water level	Date	Water level
May 26, 1952......	8.44	Nov. 21, 1952......	8.39	Aug. 3, 1953.....	3.54
June 10, 1952......	8.89	Dec. 17, 1952......	8.55	Aug. 17, 1953.....	3.85
June 26, 1952......	5.29	Jan. 13, 1953......	8.67	Aug. 31, 1953.....	3.23
July 7, 1952......	3.51	Feb. 10, 1953......	8.61	Sept. 14, 1953.....	4.50
July 21, 1952......	4.73	Mar. 4, 1953......	8.70	Sept. 28, 1953.....	5.35
Aug. 4, 1952......	3.95	Mar. 31, 1953......	8.69	Oct. 12, 1953.....	5.66
Aug. 18, 1952......	6.56	Apr. 30, 1953......	8.76	Oct. 27, 1953.....	4.78
Sept. 1, 1952......	6.48	May 13, 1953......	8.68	Nov. 6, 1953.....	5.80
Sept. 15, 1952......	5.34	May 25, 1953......	7.32	Dec. 7, 1953.....	6.57
Sept. 26, 1952......	6.90	June 8, 1953......	7.02	Jan. 4, 1954.....	7.00
Oct. 10, 1952......	7.65	June 22, 1953......	7.84	Apr. 13, 1954.....	6.72
Oct. 25, 1952......	8.02	July 6, 1953......	4.47	May 4, 1954.....	6.62
Nov. 7, 1952......	8:21	July 20, 1953......	5.09		

D2-34- 2cd (A-31)

Date	Water level	Date	Water level	Date	Water level
May 26, 1952......	3.41	Dec. 17, 1952......	3.92	Aug. 17, 1953.....	1.62
June 10, 1952......	3.92	Jan. 13, 1953......	3.90	Aug. 31, 1953.....	2.34
June 26, 1952......	2.71	Feb. 10, 1953......	3.76	Sept. 14, 1953.....	3.09
July 7, 1952......	1.97	Mar. 4, 1953......	3.94	Sept. 28, 1953.....	3.32
July 21, 1952......	2.99	Mar. 31, 1953......	3.99	Oct. 12, 1953.....	3.18
Aug. 4, 1952......	2.35	Apr. 30, 1953......	4.01	Oct. 27, 1953.....	2.82
Aug. 18, 1952......	3.40	May 13, 1953......	4.10	Nov. 6, 1953.....	3.16
Sept. 1, 1952......	3.61	May 25, 1953......	2.75	Dec. 7, 1953.....	3.65
Sept. 15, 1952......	3.41	June 8, 1953......	2.37	Jan. 4, 1954.....	3.83
Sept. 26, 1952......	3.97	June 22, 1953......	3.68	Feb. 9, 1954.....	3.44
Oct. 10, 1952......	3.82	July 6, 1953......	2.95	Mar. 9, 1954.....	3.87
Oct. 25, 1952......	3.87	July 20, 1953......	2.55	Apr. 13, 1954.....	3.35
Nov. 7, 1952......	3.98	Aug. 3, 1953......	2.18	May 4, 1954.....	3.65
Nov. 21, 1952......	3.99				

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D2-34-3aa2 (A-20)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	3.50	Jan. 13, 1953......	8.81	Aug. 31, 1953.....	3.79
July 7, 1952......	5.24	Feb. 10, 1953......	8.96	Sept. 14, 1953.....	6.60
July 21, 1952......	6.32	Mar. 4, 1953......	9.08	Sept. 28, 1953.....	7.57
Aug. 4, 1952......	4.12	Mar. 31, 1953......	9.15	Oct. 12, 1953.....	8.11
Aug. 18, 1952......	5.08	Apr. 30, 1953......	9.30	Oct. 27, 1953.....	8.31
Sept. 1, 1952......	6.09	May 13, 1953......	9.00	Nov. 6, 1953.....	8.44
Sept. 15, 1952......	4.37	May 25, 1953......	9.40	Dec. 7, 1953.....	8.80
Sept. 26, 1952......	6.11	June 8, 1953......	9.43	Jan. 4, 1954.....	9.06
Oct. 10, 1952......	7.08	June 22, 1953......	6.03	Feb. 9, 1954.....	8.93
Oct. 25, 1952......	6.54	July 6, 1953......	4.51	Mar. 9, 1954.....	9.29
Nov. 7, 1952......	5.84	July 20, 1953......	2.22	Apr. 13, 1954.....	8.90
Nov. 21, 1952......	8.09	Aug. 3, 1953......	6.19	May 4, 1954.....	8.90
Dec. 17, 1952......	8.50	Aug. 17, 1953......	3.55		

D2-34-3ab2 (A-19)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	5.68	Jan. 13, 1953......	7.37	Aug. 31, 1953.....	6.00
July 7, 1952......	5.98	Feb. 10, 1953......	7.37	Sept. 14, 1953.....	6.96
July 21, 1952......	6.40	Mar. 4, 1953......	7.46	Sept. 28, 1953.....	7.39
Aug. 4, 1952......	6.79	Mar. 31, 1953......	7.46	Oct. 12, 1953.....	7.45
Aug. 18, 1952......	7.22	Apr. 30, 1953......	7.55	Oct. 27, 1953.....	7.14
Sept. 1, 1952......	7.60	May 13, 1953......	7.45	Nov. 6, 1953.....	6.87
Sept. 15, 1952......	7.56	May 25, 1953......	7.53	Dec. 7, 1953.....	7.07
Sept. 26, 1952......	7.64	June 8, 1953......	7.03	Jan. 4, 1954.....	7.40
Oct. 10, 1952......	7.74	June 22, 1953......	6.57	Feb. 9, 1954.....	6.71
Oct. 25, 1952......	7.41	July 6, 1953......	5.86	Mar. 9, 1954.....	7.09
Nov. 7, 1952......	7.49	July 20, 1953......	4.55	Apr. 13, 1954.....	6.78
Nov. 21, 1952......	7.57	Aug. 3, 1953......	6.73	May 4, 1954.....	6.87
Dec. 17, 1952......	7.38	Aug. 17, 1953......	7.14		

D2-34-3ac (A-22)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	2.25	Jan. 13, 1953......	5.42	Aug. 31, 1953.....	4.83
July 7, 1952......	2.65	Feb. 10, 1953......	5.44	Sept. 14, 1953.....	5.13
July 21, 1952......	3.23	Mar. 4, 1953......	5.49	Sept. 28, 1953.....	4.55
Aug. 4, 1952......	3.86	Mar. 31, 1953......	5.50	Oct. 12, 1953.....	4.34
Aug. 18, 1952......	4.28	Apr. 30, 1953......	5.60	Oct. 27, 1953.....	4.19
Sept. 1, 1952......	4.51	May 13, 1953......	5.52	Nov. 6, 1953.....	4.28
Sept. 15, 1952......	4.67	May 25, 1953......	5.58	Dec. 7, 1953.....	5.09
Sept. 26, 1952......	4.86	June 8, 1953......	5.54	Jan. 4, 1954.....	5.52
Oct. 10, 1952......	5.06	July 6, 1953......	3.23	Feb. 10, 1954.....	6.35
Oct. 25, 1952......	4.97	July 20, 1953......	3.75	Mar. 9, 1954.....	5.36
Nov. 7, 1952......	5.13	Aug. 3, 1953......	4.58	Apr. 13, 1954.....	4.35
Nov. 21, 1952......	5.20	Aug. 17, 1953......	4.89	May 4, 1954.....	4.79
Dec. 17, 1952......	5.32				

D2-34-3bc (A-21)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952......	4.99	Sept. 26, 1952......	4.90	Feb. 10, 1953.....	3.92
July 7, 1952......	4.28	Oct. 10, 1952......	3.21	Mar. 4, 1953.....	4.23
July 21, 1952......	4.55	Oct. 25, 1952......	3.73	Mar. 31, 1953.....	4.19
Aug. 4, 1952......	5.05	Nov. 7, 1952......	3.90	Apr. 29, 1953.....	4.43
Aug. 18, 1952......	4.56	Nov. 21, 1952......	4.21	May 11, 1953.....	4.39
Sept. 1, 1952......	4.91	Dec. 17, 1952......	3.94	May 25, 1953.....	3.98
Sept. 15, 1952......	4.74	Jan. 13, 1953......	4.20	June 8, 1953.....	4.47

Table 26.—*Water-level measurements by tape*—Continued

Date	Water level	Date	Water level	Date	Water level
AGENCY UNIT—Continued					
D2-34-3bc (A-21)—Continued					
July 6, 1953......	3.42	Sept. 28, 1953......	4.65	Jan. 4, 1954.....	4.82
July 20, 1953......	4.44	Oct. 12, 1953......	3.37	Feb. 10, 1954.....	4.44
Aug. 3, 1953......	5.15	Oct. 27, 1953......	4.15	Mar. 9, 1954.....	4.68
Aug. 17, 1953......	5.08	Nov. 6, 1953......	4.04	Apr. 13, 1954.....	3.26
Aug. 31, 1953......	5.38	Dec. 7, 1953......	4.34	May 4, 1954.....	4.09
Sept. 14, 1953......	4.30				
D2-34-3cc1 (A-25)					
[No measurements by tape; for measurements from recorder charts, see table 27]					
D2-34-3cc2 (A-26)					
May 26, 1952......	1.92	Dec. 17, 1952......	4.54	Aug. 17, 1953.....	3.62
June 10, 1952......	2.49	Jan. 13, 1953......	4.52	Aug. 31, 1953.....	3.63
June 26, 1952......	3.12	Feb. 10, 1953......	4.52	Sept. 14, 1953.....	3.66
July 7, 1952......	3.38	Mar. 4, 1953......	4.55	Sept. 28, 1953.....	3.81
July 21, 1952......	3.52	Mar. 31, 1953......	4.54	Oct. 12, 1953.....	3.76
Aug. 4, 1952......	3.89	Apr. 29, 1953......	4.58	Oct. 27, 1953.....	3.83
Aug. 18, 1952......	4.14	May 13, 1953......	4.38	Nov. 6, 1953.....	3.78
Sept. 1, 1952......	3.82	May 25, 1953......	3.40	Dec. 7, 1953.....	3.77
Sept. 15, 1952......	4.31	June 8, 1953......	2.82	Jan. 4, 1954.....	4.02
Oct. 10, 1952......	4.57	June 22, 1953......	2.89	Feb. 9, 1954.....	4.41
Oct. 25, 1952......	4.50	July 6, 1953......	3.01	Mar. 9, 1954.....	4.33
Nov. 7, 1952......	4.56	July 20, 1953......	3.36	Apr. 13, 1954.....	3.25
Nov. 21, 1952......	4.52	Aug. 3, 1953......	3.50	May 4, 1954.....	4.03
D2-34-3da (A-23)					
June 26, 1952......	2.07	Jan. 13, 1953......	1.87	Aug. 31, 1953.....	2.26
July 7, 1952......	2.02	Feb. 10, 1953......	1.87	Sept. 14, 1953.....	2.20
July 21, 1952......	1.92	Mar. 4, 1953......	1.91	Sept. 28, 1953.....	2.45
Aug. 4, 1952......	1.86	Mar. 31, 1953......	1.92	Oct. 12, 1953.....	2.46
Aug. 18, 1952......	1.99	May 13, 1953......	3.00	Oct. 27, 1953.....	2.36
Sept. 1, 1952......	2.08	May 25, 1953......	3.59	Nov. 6, 1953.....	2.09
Sept. 15, 1952......	1.27	June 12, 1953......	2.51	Dec. 7, 1953.....	2.31
Sept. 26, 1952......	1.49	June 22, 1953......	2.45	Jan. 4, 1954.....	2.52
Oct. 10, 1952......	1.50	July 6, 1953......	1.75	Feb. 9, 1954.....	2.25
Oct. 25, 1952......	1.54	July 20, 1953......	1.67	Mar. 9, 1954.....	2.30
Nov. 7, 1952......	2.39	Aug. 3, 1953......	1.97	Apr. 13, 1954.....	1.82
Nov. 21, 1952......	1.74	Aug. 17, 1953......	2.21	May 4, 1954.....	2.24
Dec. 17, 1952......	1.80				
D2-34-3dc2 (P-1)					
Sept. 26, 1952......	5.59	Aug. 17, 1953......	4.84	Dec. 7, 1953.....	5.39
May 25, 1953......	5.23	Aug. 31, 1953......	5.01	Jan. 4, 1954.....	5.62
June 8, 1953......	5.01	Sept. 28, 1953......	5.30	Feb. 9, 1954.....	5.44
July 6, 1953......	3.50	Oct. 14, 1953......	5.54	Mar. 10, 1954.....	5.66
July 20, 1953......	4.45	Oct. 27, 1953......	4.99	Apr. 13, 1954.....	4.94
Aug. 3, 1953......	4.44	Nov. 6, 1953......	5.03	May 4, 1954.....	5.47

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D2-34-3dc4 (A-28)

Date	Water level	Date	Water level	Date	Water level
May 26, 1952.....	8.79	Dec. 17, 1952.....	8.80	Aug. 17, 1953....	8.36
June 10, 1952.....	8.73	Jan. 13, 1953.....	8.80	Aug. 31, 1953....	8.08
June 26, 1952.....	8.66	Feb. 10, 1953.....	8.81	Sept. 14, 1953....	8.29
July 7, 1952.....	8.64	Mar. 4, 1953.....	8.81	Sept. 28, 1953....	8.43
July 21, 1952.....	8.35	Mar. 31, 1953.....	8.82	Oct. 12, 1953....	8.36
Aug. 4, 1952.....	8.63	Apr. 30, 1953.....	8.82	Oct. 27, 1953....	8.40
Aug. 18, 1952.....	8.70	May 13, 1953.....	8.73	Nov. 6, 1953....	8.33
Sept. 1, 1952.....	8.77	May 23, 1953.....	8.67	Dec. 7, 1953....	8.32
Sept. 15, 1952.....	8.65	June 8, 1953.....	8.64	Jan. 4, 1954....	8.56
Sept. 26, 1952.....	8.63	June 22, 1953.....	8.61	Feb. 9, 1954....	8.48
Oct. 10, 1952.....	8.73	July 6, 1953.....	8.25	Mar. 9, 1954....	8.49
Oct. 25, 1952.....	8.72	July 20, 1953.....	8.35	Apr. 13, 1954....	8.38
Nov. 7, 1952.....	8.82	Aug. 3, 1953.....	8.33	May 4, 1954....	8.45
Nov. 21, 1952.....	8.81				

D2-34-4aa1 (A-18)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952.....	0.33	Jan. 13, 1953.....	2.35	Aug. 31, 1953....	2.18
July 7, 1952.....	1.30	Feb. 10, 1953.....	2.22	Sept. 14, 1953....	2.00
July 21, 1952.....	1.12	Mar. 4, 1953.....	2.52	Sept. 28, 1953....	2.42
Aug. 4, 1952.....	1.90	Mar. 31, 1953.....	2.62	Oct. 12, 1953....	2.96
Aug. 18, 1952.....	.90	Apr. 29, 1953.....	2.91	Oct. 27, 1953....	2.02
Sept. 1, 1952.....	1.44	May 13, 1953.....	2.38	Nov. 6, 1953....	2.57
Sept. 15, 1952.....	1.42	May 25, 1953.....	1.20	Dec. 7, 1953....	3.27
Sept. 26, 1952.....	1.96	June 8, 1953.....	1.01	Jan. 4, 1954....	3.54
Oct. 10, 1952.....	.27	June 22, 1953.....	1.29	Feb. 9, 1954....	3.53
Oct. 25, 1952.....	1.14	July 6, 1953.....	.33	Mar. 9, 1954....	3.62
Nov. 7, 1952.....	1.40	July 20, 1953.....	.99	Apr. 13, 1954....	3.06
Nov. 21, 1952.....	1.61	Aug. 3, 1953.....	1.37	May 4, 1954....	3.55
Dec. 17, 1952.....	1.92	Aug. 17, 1953.....	.81		

D2-34-4aa2 (DR1-1)

Date	Water level	Date	Water level	Date	Water level
Oct. 12, 1953.....	0.61	Dec. 7, 1953.....	0.77	Apr. 13, 1954....	1.00
Oct. 27, 1953.....	+ .06	Jan. 4, 1954.....	.95	May 4, 1954....	1.38
Nov. 6, 1953.....	+ .07	Mar. 8, 1954.....	1.25		

D2-34-4aa3 (A-70)

Date	Water level	Date	Water level	Date	Water level
Aug. 6, 1953.....	3.69	Oct. 14, 1953.....	3.99	Dec. 7, 1953....	3.87

D2-34-4ab (A-69)

Date	Water level	Date	Water level	Date	Water level
Aug. 6, 1953.....	6.33	Oct. 14, 1953.....	6.95	Dec. 7, 1953....	7.57

D2-34-4bb2 (A-16)

Date	Water level	Date	Water level	Date	Water level
June 26, 1952.....	9.55	Oct. 10, 1952.....	9.32	Mar. 31, 1953....	18.07
July 7, 1952.....	9.01	Oct. 25, 1952.....	10.60	Apr. 29, 1953....	18.58
July 21, 1952.....	8.70	Nov. 7, 1952.....	11.61	May 13, 1953....	15.00
Aug. 4, 1952.....	10.02	Nov. 21, 1952.....	12.60	May 25, 1953....	12.40
Aug. 18, 1952.....	8.43	Dec. 17, 1952.....	14.01	June 8, 1953....	11.03
Sept. 1, 1952.....	9.26	Jan. 13, 1953.....	15.35	June 22, 1953....	11.00
Sept. 15, 1952.....	9.36	Feb. 10, 1953.....	16.37	July 6, 1953....	10.01
Sept. 26, 1952.....	9.57	Mar. 4, 1953.....	16.20	July 20, 1953....	9.60

Table 26.—*Water-level measurements by tape*—Continued

Date	Water level	Date	Water level	Date	Water level
AGENCY UNIT—Continued					
D2-34-4bb2 (A-16)—Continued					
Aug. 3, 1953.....	9.10	Oct. 27, 1953.....	11.38	Feb. 9, 1954....	16.92
Aug. 17, 1953.....	9.84	Nov. 6, 1953.....	11.77	Mar. 9, 1954....	18.11
Sept. 14, 1953.....	10.58	Dec. 7, 1953.....	14.05	Apr. 13, 1954....	19.08
Sept. 28, 1953.....	10.42	Jan. 4, 1954.....	15.63	May 4, 1954....	19.52
Oct. 12, 1953.....	11.09				
D2-34-4da1 (A-67)					
Aug. 6, 1953.....	3.32	Oct. 14, 1953.....	3.12	Dec. 9, 1953....	2.90
D2-34-4da2 (A-65)					
Aug. 6, 1953.....	5.35	Dec. 7, 1953.....	3.48	May 4, 1954....	3.37
Oct. 14, 1953.....	4.00	Feb. 10, 1954.....	3.44		
D2-34-4db1 (A-68)					
Aug. 6, 1953.....	10.85	Dec. 9, 1953.....	18.89	May 4, 1954....	21.24
Oct. 14, 1953.....	14.60	Feb. 10, 1954.....	20.68		
D2-34-4db2 (A-66)					
Aug. 6, 1953.....	7.96	Dec. 9, 1953.....	10.18	May 4, 1954....	11.53
Oct. 14, 1953.....	9.23	Feb. 10, 1954.....	11.11		
D2-34-9aa (A-24)					
June 26, 1952.....	+0.27	Feb. 10, 1953.....	0.67	Aug. 31, 1953....	1.76
July 7, 1952.....	.87	Mar. 4, 1953.....	.88	Sept. 14, 1953....	1.80
July 21, 1952.....	1.00	Mar. 31, 1953.....	1.23	Sept. 28, 1953....	1.37
Aug. 4, 1952.....	1.70	Apr. 30, 1953.....	1.21	Oct. 12, 1953....	1.11
Aug. 18, 1952.....	1.67	May 13, 1953.....	.87	Oct. 27, 1953....	.32
Sept. 1, 1952.....	1.32	May 25, 1953.....	1.33	Nov. 6, 1953....	.10
Sept. 15, 1952.....	1.05	June 8, 1953.....	.84	Dec. 7, 1953....	.07
Sept. 26, 1952.....	1.06	June 22, 1953.....	2.20	Jan. 4, 1954....	.53
Oct. 10, 1952.....	.59	July 6, 1953.....	2.45	Feb. 9, 1954....	.64
Oct. 25, 1952.....	.06	July 20, 1953.....	2.75	Mar. 9, 1954....	1.24
Nov. 7, 1952.....	.05	Aug. 3, 1953.....	2.59	Apr. 13, 1954....	.87
Nov. 21, 1952.....	.03	Aug. 17, 1953.....	2.19	May 4, 1954....	1.78
Dec. 17, 1952.....	.12				
D2-34-10ab2 (A-27)					
May 26, 1952.....	3.96	Nov. 21, 1952.....	6.40	Sept. 14, 1953....	5.42
June 10, 1952.....	4.75	Dec. 17, 1952.....	6.52	Sept. 28, 1953....	5.11
June 26, 1952.....	4.27	Jan. 13, 1953.....	6.67	Oct. 12, 1953....	5.17
July 7, 1952.....	3.96	May 11, 1953.....	5.78	Oct. 27, 1953....	4.65
July 21, 1952.....	3.58	May 25, 1953.....	4.77	Nov. 6, 1953....	5.47
Aug. 4, 1952.....	4.67	June 8, 1953.....	4.68	Dec. 7, 1953....	5.48
Aug. 18, 1952.....	3.76	June 22, 1953.....	4.72	Jan. 4, 1954....	5.65
Sept. 1, 1952.....	5.04	July 6, 1953.....	3.91	Feb. 9, 1954....	5.36
Sept. 26, 1952.....	5.43	July 20, 1953.....	3.43	Mar. 9, 1954....	5.69
Oct. 10, 1952.....	6.06	Aug. 3, 1953.....	3.29	Apr. 13, 1954....	4.64
Oct. 25, 1952.....	6.20	Aug. 17, 1953.....	4.59	May 4, 1954....	5.34
Nov. 7, 1952.....	6.25	Aug. 31, 1953.....	4.78		

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D2-34-10da2 (A-33)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952	6.70	Mar. 4, 1953	11.54	Sept. 14, 1953	6.98
Aug. 18, 1952	7.13	Mar. 31, 1953	11.85	Sept. 28, 1953	7.40
Sept. 1, 1952	5.96	Apr. 30, 1953	12.15	Oct. 12, 1953	8.02
Sept. 15, 1952	7.47	May 11, 1953	11.57	Oct. 27, 1953	8.28
Sept. 26, 1952	8.32	May 25, 1953	9.95	Nov. 6, 1953	8.66
Oct. 10, 1952	8.64	June 8, 1953	6.59	Dec. 7, 1953	9.45
Oct. 25, 1952	9.12	June 22, 1953	7.84	Jan. 4, 1954	10.19
Nov. 7, 1952	9.50	July 6, 1953	4.07	Feb. 9, 1954	11.89
Nov. 21, 1952	9.88	July 20, 1953	4.78	Mar. 9, 1954	12.32
Dec. 17, 1952	10.55	Aug. 3, 1953	6.31	Apr. 13, 1954	11.09
Jan. 13, 1953	11.02	Aug. 17, 1953	6.81	May 4, 1954	11.36
Feb. 10, 1953	11.31	Aug. 31, 1953	5.49		

D2-34-11cc2 (A-34)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952	7.50	Mar. 4, 1953	11.36	Sept. 14, 1953	6.67
Aug. 18, 1952	6.40	Mar. 31, 1953	11.68	Sept. 28, 1953	7.39
Sept. 1, 1952	6.12	Apr. 30, 1953	12.07	Oct. 12, 1953	7.88
Sept. 15, 1952	7.27	May 11, 1953	11.99	Oct. 27, 1953	7.72
Sept. 26, 1952	7.94	May 25, 1953	11.66	Nov. 6, 1953	7.92
Oct. 10, 1952	8.51	June 8, 1953	7.71	Dec. 7, 1953	8.78
Oct. 25, 1952	8.70	June 22, 1953	8.37	Jan. 4, 1954	9.71
Nov. 7, 1952	8.94	July 6, 1953	4.81	Feb. 9, 1954	10.29
Nov. 21, 1952	9.33	July 20, 1953	3.49	Mar. 9, 1954	10.72
Dec. 17, 1952	9.92	Aug. 3, 1953	5.65	Apr. 13, 1954	10.74
Jan. 13, 1953	10.61	Aug. 17, 1953	6.82	May 4, 1954	11.25
Feb. 10, 1953	11.00	Aug. 31, 1953	7.04		

D2-34-11da (A-32)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952	7.99	Mar. 4, 1953	7.80	Sept. 14, 1953	7.65
Aug. 18, 1952	7.78	Mar. 31, 1953	8.36	Sept. 28, 1953	8.15
Sept. 1, 1952	7.34	Apr. 30, 1953	8.55	Oct. 12, 1953	8.50
Sept. 15, 1952	5.40	May 13, 1953	8.10	Oct. 27, 1953	8.64
Sept. 26, 1952	7.32	May 25, 1953	7.18	Nov. 6, 1953	8.43
Oct. 10, 1952	3.77	June 8, 1953	6.73	Dec. 7, 1953	8.70
Oct. 25, 1952	5.73	June 22, 1953	6.65	Jan. 4, 1954	8.72
Nov. 7, 1952	6.31	July 6, 1953	1.59	Feb. 9, 1954	8.62
Nov. 21, 1952	6.88	July 20, 1953	3.69	Mar. 9, 1954	8.61
Dec. 17, 1952	7.42	Aug. 3, 1953	3.39	Apr. 13, 1954	8.33
Jan. 13, 1953	7.94	Aug. 17, 1953	4.35	May 4, 1954	8.33
Feb. 10, 1953	8.09	Sept. 3, 1953	6.23		

D2-34-13cb (A-39)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952	7.56	Mar. 4, 1953	8.96	Sept. 14, 1953	7.95
Aug. 18, 1952	7.82	Mar. 31, 1953	9.20	Sept. 28, 1953	8.10
Sept. 1, 1952	8.24	Apr. 30, 1953	9.40	Oct. 12, 1953	8.19
Sept. 15, 1952	6.89	May 13, 1953	9.37	Oct. 26, 1953	8.30
Sept. 26, 1952	6.70	May 25, 1953	9.37	Nov. 6, 1953	8.23
Oct. 10, 1952	7.20	June 8, 1953	8.67	Dec. 7, 1953	8.27
Oct. 25, 1952	7.34	June 22, 1953	6.39	Jan. 4, 1954	8.63
Nov. 7, 1952	7.50	July 6, 1953	6.69	Feb. 9, 1954	8.71
Nov. 21, 1952	7.72	July 20, 1953	7.11	Mar. 9, 1954	8.90
Dec. 17, 1952	8.02	Aug. 3, 1953	7.44	Apr. 13, 1954	9.15
Jan. 13, 1953	8.43	Aug. 17, 1953	7.76	May 4, 1954	9.42
Feb. 10, 1953	8.68	Aug. 31, 1953	8.04		

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Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D2-34-13cc (A-41)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952	8.05	Mar. 4, 1953	15.58	Sept. 14, 1953	12.10
Aug. 18, 1952	8.88	Mar. 31, 1953	16.13	Sept. 28, 1953	12.70
Sept. 1, 1952	10.83	Apr. 30, 1953	16.60	Oct. 12, 1953	13.21
Sept. 15, 1952	5.19	May 13, 1953	16.53	Oct. 26, 1953	13.50
Sept. 26, 1952	6.98	May 25, 1953	15.12	Nov. 6, 1953	13.68
Oct. 10, 1952	8.70	June 8, 1953	12.89	Dec. 7, 1953	14.47
Oct. 25, 1952	10.02	June 22, 1953	10.38	Jan. 4, 1954	15.20
Nov. 7, 1952	10.87	July 6, 1953	9.37	Feb. 9, 1954	15.97
Nov. 21, 1952	11.87	July 20, 1953	9.47	Mar. 9, 1954	16.42
Dec. 17, 1952	13.15	Aug. 3, 1953	9.43	Apr. 13, 1954	17.00
Jan. 13, 1953	14.25	Aug. 17, 1953	10.54	May 4, 1954	17.22
Feb. 10, 1953	15.04	Aug. 31, 1953	10.79		

D2-34-13cd (A-42)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952	4.00	Mar. 4, 1953	6.06	Sept. 14, 1953	5.93
Aug. 18, 1952	4.76	Mar. 31, 1953	6.09	Sept. 28, 1953	6.25
Sept. 1, 1952	5.49	Apr. 30, 1953	6.19	Oct. 12, 1953	6.31
Sept. 15, 1952	5.83	May 13, 1953	6.10	Oct. 26, 1953	6.10
Sept. 26, 1952	7.06	May 25, 1953	6.15	Nov. 6, 1953	5.79
Oct. 10, 1952	6.29	June 8, 1953	6.03	Dec. 7, 1953	5.79
Oct. 25, 1952	6.31	June 22, 1953	5.60	Jan. 4, 1954	5.95
Nov. 7, 1952	6.26	July 6, 1953	5.49	Feb. 9, 1954	5.68
Nov. 21, 1952	6.23	July 20, 1953	5.50	Mar. 10, 1954	5.46
Dec. 17, 1952	6.13	Aug. 3, 1953	5.71	Apr. 13, 1954	5.42
Jan. 13, 1953	5.76	Aug. 17, 1953	5.93	May 4, 1954	5.45
Feb. 10, 1953	6.01	Aug. 31, 1953	6.11		

D2-34-13dd (A-43)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952	8.12	Mar. 4, 1953	6.01	Sept. 14, 1953	7.58
Aug. 18, 1952	7.50	Mar. 31, 1953	7.22	Sept. 28, 1953	7.57
Sept. 1, 1952	7.83	Apr. 30, 1953	7.35	Oct. 12, 1953	7.74
Sept. 15, 1952	7.72	May 13, 1953	7.19	Oct. 26, 1953	7.22
Sept. 26, 1952	7.68	May 25, 1953	7.41	Nov. 6, 1953	7.14
Oct. 10, 1952	7.48	June 8, 1953	6.50	Dec. 7, 1953	7.10
Oct. 25, 1952	7.24	June 22, 1953	5.96	Jan. 4, 1954	6.88
Nov. 7, 1952	7.19	July 6, 1953	7.31	Feb. 9, 1954	6.18
Nov. 21, 1952	7.23	July 20, 1953	7.67	Mar. 9, 1954	6.85
Dec. 17, 1952	6.68	Aug. 3, 1953	7.42	Apr. 13, 1954	7.01
Jan. 13, 1953	6.35	Aug. 17, 1953	7.66	May 4, 1954	6.95
Feb. 10, 1953	6.97	Aug. 31, 1953	7.81		

D2-34-14aa (A-37)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952	3.18	Mar. 4, 1953	5.01	Sept. 14, 1953	2.74
Aug. 18, 1952	2.75	Mar. 31, 1953	5.26	Sept. 28, 1953	3.19
Sept. 1, 1952	1.48	Apr. 30, 1953	5.56	Oct. 12, 1953	3.38
Sept. 15, 1952	2.76	May 13, 1953	4.70	Oct. 27, 1953	2.87
Sept. 26, 1952	3.23	May 25, 1953	4.43	Nov. 6, 1953	3.01
Oct. 10, 1952	2.84	June 8, 1953	2.08	Dec. 7, 1953	3.47
Oct. 25, 1952	3.27	June 22, 1953	2.90	Jan. 4, 1954	4.04
Nov. 7, 1952	3.42	July 6, 1953	2.96	Feb. 9, 1954	4.07
Nov. 21, 1952	3.68	July 20, 1953	3.52	Mar. 9, 1954	4.50
Dec. 17, 1952	3.95	Aug. 3, 1953	2.57	Apr. 13, 1954	4.13
Jan. 13, 1953	4.30	Aug. 17, 1953	3.30	May 4, 1954	4.77
Feb. 10, 1953	4.80	Aug. 31, 1953	2.18		

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D2-34-14ab2 (A-36)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952.....	4.93	Mar. 4, 1953.....	6.90	Sept. 14, 1953....	5.80
Aug. 18, 1952.....	4.75	Mar. 31, 1953.....	7.03	Sept. 28, 1953....	6.16
Sept. 1, 1952.....	4.95	Apr. 30, 1953.....	7.31	Oct. 12, 1953....	6.32
Sept. 15, 1952.....	5.63	May 13, 1953.....	5.39	Oct. 27, 1953....	5.76
Sept. 26, 1952.....	5.89	May 25, 1953.....	4.55	Nov. 6, 1953....	5.82
Oct. 10, 1952.....	5.49	June 8, 1953.....	4.38	Dec. 7, 1953....	6.15
Oct. 25, 1952.....	5.91	June 22, 1953.....	5.22	Jan. 4, 1954....	6.44
Nov. 7, 1952.....	6.10	July 6, 1953.....	4.87	Feb. 9, 1954....	6.58
Nov. 21, 1952.....	6.31	July 20, 1953.....	4.27	Mar. 9, 1954....	6.58
Dec. 17, 1952.....	6.43	Aug. 3, 1953.....	4.50	Apr. 13, 1954....	6.10
Jan. 13, 1953.....	6.71	Aug. 17, 1953.....	5.19	May 4, 1954....	6.55
Feb. 10, 1953.....	6.70	Aug. 31, 1953.....	5.16		

D2-34-14ba (A-35)

[For measurements from recorder charts, see table 27]

Date	Water level	Date	Water level	Date	Water level
Sept. 14, 1953.....	3.40	Nov. 6, 1953.....	2.92	Mar. 9, 1954....	5.60
Sept. 28, 1953.....	2.38	Dec. 7, 1953.....	3.63	Apr. 13, 1954....	5.24
Oct. 12, 1953.....	2.78	Jan. 4, 1954.....	4.02	May 4, 1954....	5.03
Oct. 27, 1953.....	2.82	Feb. 9, 1954.....	4.37		

D2-34-14ca (A-38)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952.....	3.70	Mar. 4, 1953.....	7.85	Sept. 14, 1953....	2.69
Aug. 18, 1952.....	3.37	Mar. 31, 1953.....	7.27	Sept. 28, 1953....	3.21
Sept. 1, 1952.....	2.92	Apr. 30, 1953.....	8.66	Oct. 12, 1953....	4.05
Sept. 15, 1952.....	3.13	May 11, 1953.....	8.50	Oct. 27, 1953....	3.54
Sept. 26, 1952.....	3.63	May 25, 1953.....	7.75	Nov. 6, 1953....	4.11
Oct. 10, 1952.....	3.91	June 8, 1953.....	2.06	Dec. 7, 1953....	5.60
Oct. 25, 1952.....	4.26	June 22, 1953.....	4.14	Jan. 4, 1954....	6.41
Nov. 7, 1952.....	4.74	July 6, 1953.....	4.22	Feb. 9, 1954....	7.18
Nov. 21, 1952.....	5.38	July 20, 1953.....	2.49	Mar. 9, 1954....	7.78
Dec. 17, 1952.....	6.15	Aug. 3, 1953.....	2.34	Apr. 13, 1954....	7.76
Jan. 13, 1953.....	6.89	Aug. 17, 1953.....	1.27	May 4, 1954....	8.27
Feb. 10, 1953.....	6.98	Sept. 3, 1953.....	2.47		

D2-34-23aa (A-40)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952.....	12.52	Mar. 4, 1953.....	20.71	Sept. 14, 1953....	14.82
Aug. 18, 1952.....	13.06	Mar. 31, 1953.....	21.47	Sept. 28, 1953....	15.07
Sept. 1, 1952.....	14.90	Apr. 30, 1953.....	22.04	Oct. 12, 1953....	16.18
Sept. 15, 1952.....	8.65	May 11, 1953.....	22.67	Oct. 26, 1953....	16.75
Sept. 26, 1952.....	11.60	May 25, 1953.....	18.76	Nov. 6, 1953....	17.07
Oct. 10, 1952.....	12.89	June 8, 1953.....	16.27	Dec. 7, 1953....	18.86
Oct. 25, 1952.....	14.17	June 22, 1953.....	14.73	Jan. 4, 1954....	19.87
Nov. 7, 1952.....	15.16	July 6, 1953.....	13.46	Feb. 9, 1954....	21.09
Nov. 21, 1952.....	16.18	July 20, 1953.....	11.53	Mar. 9, 1954....	21.84
Dec. 17, 1952.....	17.64	Aug. 3, 1953.....	11.74	Apr. 13, 1954....	22.70
Jan. 13, 1953.....	18.93	Aug. 17, 1953.....	12.62	May 4, 1954....	22.98
Feb. 10, 1953.....	19.97	Aug. 31, 1953.....	13.54		

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D2-34-23ad (A-44)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952......	1.55	Mar. 4, 1953......	5.54	Sept. 14, 1953.....	1.58
Aug. 18, 1952......	1.52	Mar. 31, 1953......	5.94	Sept. 28, 1953.....	1.48
Sept. 1, 1952......	1.82	Apr. 30, 1953......	6.06	Oct. 12, 1953.....	1.62
Sept. 15, 1952......	1.50	May 11, 1953......	4.94	Oct. 26, 1953.....	1.48
Sept. 26, 1952......	1.65	May 25, 1953......	2.88	Nov. 6, 1953.....	1.86
Oct. 10, 1952......	1.74	June 8, 1953......	1.45	Dec. 7, 1953.....	3.32
Oct. 27, 1952......	2.02	June 22, 1953......	1.66	Jan. 4, 1954.....	4.75
Nov. 7, 1952......	2.21	July 6, 1953......	1.42	Feb. 9, 1954.....	4.88
Nov. 21, 1952......	2.77	July 20, 1953......	1.15	Mar. 10, 1954.....	5.49
Dec. 17, 1952......	3.77	Aug. 3, 1953......	.98	Apr. 13, 1954.....	5.12
Jan. 13, 1953......	4.80	Aug. 17, 1953......	1.36	May 4, 1954.....	6.08
Feb. 10, 1953......	4.94	Aug. 31, 1953......	1.63		

D2-34-24da (A-46)

Date	Water level	Date	Water level	Date	Water level
Aug. 18, 1952......	6.39	Mar. 31, 1953......	5.48	Sept. 14, 1953.....	5.87
Sept. 1, 1952......	6.47	Apr. 30, 1953......	5.55	Sept. 28, 1953.....	5.43
Sept. 15, 1952......	6.50	May 13, 1953......	5.34	Oct. 12, 1953.....	5.82
Sept. 26, 1952......	6.52	May 25, 1953......	4.80	Oct. 26, 1953.....	5.52
Oct. 10, 1952......	6.34	June 8, 1953......	4.62	Nov. 6, 1953.....	5.30
Oct. 27, 1952......	6.08	June 22, 1953......	4.75	Dec. 7, 1953.....	5.13
Nov. 7, 1952......	5.92	July 6, 1953......	4.51	Jan. 4, 1954.....	5.21
Nov. 21, 1952......	5.81	July 20, 1953......	5.12	Feb. 9, 1954.....	4.83
Dec. 17, 1952......	5.59	Aug. 3, 1953......	5.66	Mar. 10, 1954.....	4.90
Jan. 13, 1953......	5.53	Aug. 17, 1953......	5.55	Apr. 13, 1954.....	4.56
Feb. 10, 1953......	5.41	Aug. 31, 1953......	5.98	May 4, 1954.....	4.89
Mar. 3, 1953......	5.44				

D2-34-24db (A-45)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952......	3.00	Mar. 3, 1953......	6.68	Sept. 14, 1953.....	2.46
Aug. 18, 1952......	3.04	Mar. 31, 1953......	6.61	Sept. 28, 1953.....	2.67
Sept. 1, 1952......	2.87	Apr. 30, 1953......	6.27	Oct. 12, 1953.....	3.13
Sept. 15, 1952......	3.96	May 13, 1953......	3.93	Oct. 26, 1953.....	2.64
Sept. 26, 1952......	4.39	May 25, 1953......	2.12	Nov. 6, 1953.....	3.88
Oct. 10, 1952......	4.90	June 8, 1953......	3.02	Dec. 7, 1953.....	5.18
Oct. 27, 1952......	5.58	June 22, 1953......	2.59	Jan. 4, 1954.....	5.78
Nov. 7, 1952......	5.94	July 6, 1953......	1.53	Feb. 7, 1954.....	5.95
Nov. 21, 1952......	6.18	July 20, 1953......	1.18	Mar. 10, 1954.....	5.64
Dec. 17, 1952......	6.44	Aug. 3, 1953......	2.40	Apr. 13, 1954.....	4.44
Jan. 13, 1953......	6.72	Aug. 17, 1953......	2.11	May 4, 1954.....	5.02
Feb. 10, 1953......	6.50	Aug. 31, 1953......	2.55		

D2-34-24dc (A-48)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952......	1.10	Nov. 21, 1952......	1.67	June 8, 1953.....	0.94
Aug. 4, 1952......	1.20	Dec. 17, 1952......	1.82	June 22, 1953.....	1.19
Aug. 18, 1952......	.93	Jan. 13, 1953......	2.18	July 6, 1953.....	.26
Sept. 1, 1952......	1.19	Feb. 10, 1953......	1.99	July 20, 1953.....	1.40
Sept. 15, 1952......	1.13	Mar. 3, 1953......	2.38	Aug. 3, 1953.....	1.33
Sept. 26, 1952......	1.45	Mar. 31, 1953......	2.47	Aug. 17, 1953.....	1.30
Oct. 10, 1952......	1.40	Apr. 30, 1953......	2.24	Aug. 31, 1953.....	1.08
Oct. 27, 1952......	1.48	May 13, 1953......	.89	Sept. 14, 1953.....	.79
Nov. 7, 1952......	1.36	May 25, 1953......	1.50		

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D2-34-24dd (A-49)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952.....	4.99	Feb. 10, 1953.....	4.16	Aug. 31, 1953.....	5.46
Aug. 4, 1952.....	5.31	Mar. 3, 1953.....	4.26	Sept. 14, 1953.....	5.07
Aug. 18, 1952.....	5.25	Mar. 31, 1953.....	4.36	Sept. 28, 1953.....	5.13
Sept. 1, 1952.....	5.35	Apr. 30, 1953.....	4.36	Oct. 12, 1953.....	5.00
Sept. 15, 1952.....	5.26	May 13, 1953.....	4.31	Oct. 26, 1953.....	4.67
Sept. 26, 1952.....	5.20	May 25, 1953.....	4.43	Nov. 6, 1953.....	4.03
Oct. 10, 1952.....	4.94	June 8, 1953.....	4.13	Dec. 7, 1953.....	4.32
Oct. 27, 1952.....	4.71	June 22, 1953.....	4.25	Jan. 4, 1954.....	4.26
Nov. 7, 1952.....	4.62	July 6, 1953.....	4.71	Feb. 9, 1954.....	3.75
Nov. 21, 1952.....	4.51	July 20, 1953.....	5.21	Mar. 10, 1954.....	3.79
Dec. 17, 1952.....	4.36	Aug. 3, 1953.....	5.37	Apr. 13, 1954.....	3.78
Jan. 13, 1953.....	4.26	Aug. 17, 1953.....	5.46	May 4, 1954.....	4.06

D2-34-25ad (A-51)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952.....	6.69	Feb. 10, 1953.....	8.19	Aug. 31, 1953.....	7.59
Aug. 4, 1952.....	3.75	Mar. 3, 1953.....	8.49	Sept. 14, 1953.....	7.57
Aug. 18, 1952.....	7.52	Mar. 31, 1953.....	8.62	Sept. 28, 1953.....	7.97
Sept. 1, 1952.....	6.90	Apr. 30, 1953.....	8.64	Oct. 12, 1953.....	7.86
Sept. 15, 1952.....	7.38	May 13, 1953.....	7.68	Oct. 26, 1953.....	7.59
Sept. 26, 1952.....	7.38	May 25, 1953.....	7.73	Nov. 6, 1953.....	7.40
Oct. 10, 1952.....	7.65	June 8, 1953.....	7.58	Dec. 7, 1953.....	7.69
Oct. 27, 1952.....	7.65	June 22, 1953.....	7.54	Jan. 4, 1954.....	8.01
Nov. 7, 1952.....	7.61	July 6, 1953.....	7.30	Feb. 9, 1954.....	7.94
Nov. 21, 1952.....	7.68	July 20, 1953.....	7.87	Mar. 10, 1954.....	8.05
Dec. 17, 1952.....	7.72	Aug. 3, 1953.....	7.09	Apr. 13, 1954.....	7.78
Jan. 13, 1953.....	7.95	Aug. 17, 1953.....	7.36	May 4, 1954.....	8.34

D2-34-25bb (A-47)

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1952.....	2.85	Mar. 3, 1953.....	3.72	Sept. 14, 1953.....	2.30
Aug. 18, 1952.....	2.10	Mar. 31, 1953.....	4.04	Sept. 28, 1953.....	2.00
Sept. 1, 1952.....	2.20	Apr. 30, 1953.....	3.99	Oct. 12, 1953.....	2.07
Sept. 15, 1952.....	2.30	May 11, 1953.....	2.94	Oct. 26, 1953.....	1.56
Sept. 26, 1952.....	2.77	May 25, 1953.....	2.50	Nov. 6, 1953.....	1.94
Oct. 10, 1952.....	2.67	June 8, 1953.....	1.98	Dec. 7, 1953.....	2.59
Oct. 27, 1952.....	2.71	June 22, 1953.....	2.63	Jan. 4, 1954.....	3.07
Nov. 7, 1952.....	2.78	July 6, 1953.....	1.89	Feb. 9, 1954.....	2.37
Nov. 21, 1952.....	2.99	July 20, 1953.....	2.59	Mar. 10, 1954.....	3.04
Dec. 17, 1952.....	3.20	Aug. 3, 1953.....	2.01	Apr. 13, 1954.....	2.74
Jan. 13, 1953.....	3.67	Aug. 17, 1953.....	2.51	May 4, 1954.....	3.32
Feb. 10, 1953.....	3.47	Aug. 31, 1953.....	2.44		

D2-34-25bd (A-50)

[For measurements from recorder charts, see table 27]

Date	Water level	Date	Water level	Date	Water level
Apr. 25, 1953.....	2.13	Aug. 31, 1953.....	1.55	Dec. 7, 1953.....	3.06
June 8, 1953.....	1.52	Sept. 14, 1953.....	1.55	Jan. 4, 1954.....	3.90
June 22, 1953.....	1.99	Sept. 28, 1953.....	1.53	Feb. 9, 1954.....	3.99
July 6, 1953.....	1.10	Oct. 12, 1953.....	1.80	Mar. 10, 1954.....	4.54
July 20, 1953.....	1.53	Oct. 26, 1953.....	1.39	Apr. 13, 1954.....	3.64
Aug. 3, 1953.....	1.25	Nov. 6, 1953.....	1.91	May 4, 1954.....	4.60
Aug. 17, 1953.....	1.53				

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D2-34-25ca1 (DR4-1)

Date	Water level	Date	Water level	Date	Water level
Oct. 12, 1953......	1.36	Dec. 8, 1953......	2.54	Apr. 13, 1954.....	4.09
Oct. 27, 1953......	1.25	Jan. 4, 1954......	3.55	May 4, 1954.....	4.84
Nov. 9, 1953......	1.74	Mar. 8, 1954......	4.80		

D2-34-25ca2 (A-52)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952......	6.45	Feb. 11, 1953......	13.00	Aug. 31, 1953.....	5.54
Aug. 4, 1952......	6.35	Mar. 3, 1953......	13.55	Sept. 14, 1953.....	5.89
Aug. 18, 1952......	6.54	Mar. 31, 1953......	13.96	Sept. 28, 1953.....	6.70
Sept. 1, 1952......	6.60	Apr. 30, 1953......	11.98	Oct. 12, 1953.....	7.66
Sept. 15, 1952......	5.04	May 11, 1953......	8.31	Oct. 26, 1953.....	7.82
Sept. 26, 1952......	7.16	May 25, 1953......	7.77	Nov. 6, 1953.....	8.71
Oct. 10, 1952......	8.21	June 8, 1953......	7.91	Dec. 7, 1953.....	10.39
Oct. 27, 1952......	9.34	June 22, 1953......	8.16	Jan. 4, 1954.....	11.55
Nov. 7, 1952......	9.88	July 6, 1953......	6.47	Feb. 9, 1954.....	12.60
Nov. 21, 1952......	10.76	July 20, 1953......	6.08	Mar. 10, 1954.....	13.20
Dec. 17, 1952......	11.77	Aug. 3, 1953......	5.05	Apr. 13, 1954.....	12.92
Jan. 13, 1953......	12.59	Aug. 17, 1953......	5.48	May 4, 1954.....	13.30

D2-34-25cd (A-54)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952......	5.59	Feb. 11, 1953......	16.05	Aug. 31, 1953.....	4.50
Aug. 4, 1952......	5.20	Mar. 3, 1953......	16.54	Sept. 14, 1953.....	4.69
Aug. 18, 1952......	5.18	Mar. 31, 1953......	16.08	Sept. 28, 1953.....	5.11
Sept. 1, 1952......	5.40	Apr. 30, 1953......	12.75	Oct. 12, 1953.....	5.90
Sept. 15, 1952......	4.94	May 11, 1953......	8.29	Oct. 26, 1953.....	6.70
Sept. 26, 1952......	6.19	May 25, 1953......	5.86	Nov. 6, 1953.....	8.19
Oct. 10, 1952......	6.70	June 8, 1953......	6.23	Dec. 7, 1953.....	12.17
Oct. 27, 1952......	9.57	June 22, 1953......	6.23	Jan. 4, 1954.....	14.05
Nov. 7, 1952......	10.77	July 6, 1953......	5.08	Feb. 9, 1954.....	15.36
Nov. 21, 1952......	12.29	July 20, 1953......	4.27	Mar. 10, 1954.....	16.18
Dec. 17, 1952......	13.91	Aug. 3, 1953......	4.65	Apr. 13, 1954.....	16.79
Jan. 13, 1953......	15.12	Aug. 17, 1953......	4.58	May 4, 1954.....	17.05

D2-34-36ab (A-55)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952......	6.53	Feb. 11, 1953......	12.80	Aug. 31, 1953.....	3.03
Aug. 4, 1952......	3.73	Mar. 3, 1953......	13.99	Sept. 14, 1953.....	4.27
Aug. 18, 1952......	5.07	Mar. 31, 1953......	14.41	Sept. 28, 1953.....	5.83
Sept. 1, 1952......	3.70	Apr. 30, 1953......	14.79	Oct. 12, 1953.....	8.28
Sept. 15, 1952......	2.79	May 13, 1953......	9.66	Oct. 26, 1953.....	8.62
Sept. 26, 1952......	6.25	May 25, 1953......	9.29	Nov. 6, 1953.....	8.67
Oct. 10, 1952......	7.45	June 8, 1953......	8.55	Dec. 7, 1953.....	10.84
Oct. 27, 1952......	9.81	June 22, 1953......	8.80	Jan. 4, 1954.....	12.13
Nov. 7, 1952......	10.30	July 6, 1953......	8.72	Feb. 9, 1954.....	13.00
Nov. 21, 1952......	11.01	July 20, 1953......	4.62	Mar. 10, 1954.....	13.54
Dec. 17, 1952......	12.08	Aug. 3, 1953......	4.18	Apr. 13, 1954.....	14.00
Jan. 13, 1953......	13.00	Aug. 17, 1953......	4.24	May 4, 1954.....	14.28

D2-34-36ac (DR5-1)

Date	Water level	Date	Water level	Date	Water level
Oct. 12, 1953......	0.40	Dec. 7, 1953......	0.70	Mar. 8, 1954.....	0.95
Oct. 27, 1953......	.11	Jan. 4, 1954......	.97	May 4, 1954.....	1.34
Nov. 9, 1953......	.40				

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D2-34-36ca1 (A-57)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952......	11.98	Feb. 11, 1953......	17.20	Sept. 14, 1953.....	14.14
Aug. 4, 1952......	12.10	Mar. 3, 1953......	17.55	Sept. 28, 1953.....	14.89
Aug. 18, 1952......	12.28	Mar. 31, 1953......	17.94	Oct. 12, 1953.....	15.50
Sept. 1, 1952......	12.09	Apr. 30, 1953......	18.28	Oct. 26, 1953.....	15.89
Sept. 15, 1952......	12.31	May 11, 1953......	16.12	Nov. 9, 1953.....	17.40
Sept. 26, 1952......	12.74	May 25, 1953......	14.72	Dec. 17, 1953.....	17.18
Oct. 10, 1952......	13.23	June 8, 1953......	14.49	Jan. 4, 1954.....	17.96
Oct. 27, 1952......	13.90	June 22, 1953......	15.07	Feb. 9, 1954.....	18.45
Nov. 7, 1952......	14.40	July 6, 1953......	14.05	Mar. 10, 1954.....	18.82
Nov. 21, 1952......	14.96	July 20, 1953......	13.44	Apr. 13, 1954.....	19.05
Dec. 17, 1952......	15.83	Aug. 17, 1953......	13.50	May 4, 1954.....	19.39
Jan. 13, 1953......	16.62	Aug. 31, 1953......	13.53		

D2-34-36ca2 (DR6-1)

Date	Water level	Date	Water level	Date	Water level
Oct. 12, 1953......	1.47	Dec. 7, 1953......	2.37	Mar. 8, 1954.....	3.08
Oct. 27, 1953......	1.78	Jan. 4, 1954......	2.65	Apr. 13, 1954.....	3.10
Nov. 9, 1953......	1.98	Feb. 10, 1954......	3.75	May 4, 1954.....	3.10

D2-34-36db1 (A-62)

[No measurements by tape; for measurements from recording charts, see table 27]

D2-34-36dd (A-59)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952......	6.59	Feb. 11, 1953......	6.33	Aug. 31, 1953.....	7.28
Aug. 4, 1952......	6.74	Mar. 3, 1953......	6.37	Sept. 14, 1953.....	6.99
Aug. 18, 1952......	6.48	Mar. 31, 1953......	6.48	Sept. 28, 1953.....	6.84
Sept. 1, 1952......	6.48	Apr. 30, 1953......	6.42	Oct. 12, 1953.....	6.70
Sept. 15, 1952......	6.36	May 13, 1953......	5.98	Oct. 26, 1953.....	6.52
Sept. 26, 1952......	6.45	May 25, 1953......	5.85	Nov. 9, 1953.....	6.46
Oct. 10, 1952......	6.30	June 8, 1953......	5.67	Dec. 7, 1953.....	6.37
Oct. 27, 1952......	6.21	June 22, 1953......	5.75	Jan. 4, 1954.....	6.59
Nov. 7, 1952......	6.15	July 6, 1953......	6.27	Feb. 10, 1954.....	6.32
Nov. 21, 1952......	6.45	July 20, 1953......	6.73	Mar. 10, 1954.....	6.46
Dec. 17, 1952......	6.25	Aug. 3, 1953......	6.84	Apr. 13, 1954.....	6.23
Jan. 13, 1953......	6.35	Aug. 17, 1953......	7.18	May 4, 1954.....	6.07

D2-35-30cb (A-53)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952......	3.99	Feb. 11, 1953......	4.84	Aug. 31, 1953.....	2.97
Aug. 4, 1952......	3.46	Mar. 3, 1953......	5.08	Sept. 14, 1953.....	3.45
Aug. 18, 1952......	3.24	Mar. 31, 1953......	5.26	Sept. 28, 1953.....	3.81
Sept. 1, 1952......	.98	Apr. 30, 1953......	5.49	Oct. 12, 1953.....	4.22
Sept. 15, 1952......	.62	May 13, 1953......	3.89	Oct. 26, 1953.....	4.14
Sept. 26, 1952......	2.88	May 25, 1953......	4.47	Nov. 6, 1953.....	3.93
Oct. 10, 1952......	3.72	June 8, 1953......	4.36	Dec. 7, 1953.....	4.37
Oct. 27, 1952......	4.05	June 22, 1953......	3.62	Jan. 4, 1954.....	4.66
Nov. 7, 1952......	4.13	July 6, 1953......	4.35	Feb. 9, 1954.....	4.41
Nov. 21, 1952......	4.31	July 20, 1953......	3.70	Mar. 10, 1954.....	4.71
Dec. 17, 1952......	4.52	Aug. 3, 1953......	3.36	Apr. 13, 1954.....	4.70
Jan. 13, 1953......	4.80	Aug. 17, 1953......	4.02	May 4, 1954.....	5.08

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D2-35-31bb (A-56)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952......	7.26	Feb. 11, 1953......	9.67	Aug. 31, 1953.....	5.43
Aug. 4, 1952......	5.16	Mar. 3, 1953......	9.88	Sept. 14, 1953.....	6.02
Aug. 18, 1952......	6.58	Mar. 31, 1953......	10.11	Sept. 28, 1953.....	7.33
Sept. 1, 1952......	6.02	Apr. 30, 1953......	10.29	Oct. 12, 1953.....	8.16
Sept. 15, 1952......	4.76	May 13, 1953......	8.18	Oct. 26, 1953.....	8.27
Sept. 26, 1952......	7.25	May 25, 1953......	8.62	Nov. 6, 1953.....	8.15
Oct. 10, 1952......	8.15	June 8, 1953......	7.21	Dec. 7, 1953.....	8.66
Oct. 27, 1952......	8.45	June 22, 1953......	7.55	Jan. 4, 1954.....	9.15
Nov. 7, 1952......	8.61	July 6, 1953......	8.26	Feb. 9, 1954.....	9.22
Nov. 21, 1952......	8.86	July 20, 1953......	7.39	Mar. 10, 1954.....	9.45
Dec. 17, 1952......	9.14	Aug. 3, 1953......	6.90	Apr. 13, 1954.....	9.61
Jan. 13, 1953......	9.42	Aug. 17, 1953......	6.92	May 4, 1954.....	9.80

D2-35-31bc (A-58)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952......	4.04	Feb. 11, 1953......	4.15	Aug. 31, 1953.....	3.30
Aug. 4, 1952......	4.59	Mar. 3, 1953......	4.28	Sept. 14, 1953.....	4.05
Aug. 18, 1952......	4.29	Mar. 31, 1953......	4.32	Sept. 28, 1953.....	3.93
Sept. 1, 1952......	4.46	Apr. 30, 1953......	4.42	Oct. 12, 1953.....	4.34
Sept. 15, 1952......	4.31	May 13, 1953......	4.36	Oct. 26, 1953.....	3.95
Sept. 26, 1952......	4.25	May 25, 1953......	3.67	Nov. 9, 1953.....	3.87
Oct. 10, 1952......	4.30	June 8, 1953......	3.36	Dec. 7, 1953.....	3.90
Oct. 27, 1952......	4.23	June 22, 1953......	3.19	Jan. 4, 1954.....	4.12
Nov. 7, 1952......	4.20	July 6, 1953......	3.99	Feb. 10, 1954.....	3.65
Nov. 21, 1952......	4.17	July 20, 1953......	4.27	Mar. 10, 1954.....	3.97
Dec. 17, 1952......	4.08	Aug. 3, 1953......	4.16	Apr. 13, 1954.....	3.54
Jan. 13, 1953......	4.03	Aug. 17, 1953......	4.06	May 4, 1954.....	3.84

D3-34-1aa (A-61)

Date	Water level	Date	Water level	Date	Water level
July 21, 1952.....	7.12	Oct. 27, 1952......	6.71	Mar. 3, 1953.....	6.74
Aug. 4, 1952.....	7.31	Nov. 7, 1952......	6.69	Mar. 31, 1953.....	6.80
Aug. 18, 1952.....	6.78	Nov. 21, 1952......	6.00	Apr. 30, 1953.....	6.81
Sept. 1, 1952.....	6.90	Dec. 17, 1952......	6.60	May 13, 1953.....	6.55
Sept. 15, 1952.....	6.85	Jan. 13, 1953......	6.65	May 25, 1953.....	6.33
Sept. 26, 1952.....	6.95	Feb. 11, 1953......	6.67	Well destroyed	
Oct. 10, 1952.....	6.92				

D3-34-1ac1 (CP-3)

Date	Water level	Date	Water level	Date	Water level
Sept. 22, 1952......	7.72	July 20, 1953......	4.07	Nov. 16, 1953.....	10.05
Sept. 26, 1952......	8.03	July 27, 1953......	4.12	Nov. 23, 1953.....	10.40
Oct. 3, 1952......	8.13	Aug. 3, 1953......	5.29	Nov. 30, 1953.....	10.67
Apr. 18, 1953......	9.57	Aug. 10, 1953......	5.66	Dec. 7, 1953.....	10.98
Apr. 25, 1953......	6.57	Aug. 17, 1953......	5.43	Dec. 14, 1953.....	11.13
June 11, 1953......	6.78	Aug. 24, 1953......	6.12	Jan. 7, 1954.....	11.71
June 12, 1953......	6.77	Aug. 31, 1953......	5.73	Feb. 15, 1954.....	12.35
June 22, 1953......	6.89	Sept. 14, 1953......	7.14	Mar. 10, 1954.....	12.60
June 29, 1953......	5.33	Sept. 28, 1953......	7.56	Apr. 13, 1954.....	12.76
July 6, 1953......	5.45	Oct. 26, 1953......	8.53		

Table 26.—*Water-level measurements by tape*—Continued

AGENCY UNIT—Continued

D3-34-1ac2 (CP-2)

Date	Water level	Date	Water level	Date	Water level
Sept. 22, 1952	10.67	July 6, 1953	7.90	Oct. 26, 1953	11.47
Sept. 26, 1952	11.01	July 20, 1953	6.27	Nov. 16, 1953	12.83
Oct. 3, 1952	11.02	July 27, 1953	6.38	Nov. 23, 1953	13.12
Dec. 18, 1952	14.11	Aug. 3, 1953	8.04	Nov. 30, 1953	13.40
May 18, 1953	9.87	Aug. 10, 1953	8.44	Dec. 7, 1953	13.69
May 25, 1953	9.03	Aug. 17, 1953	8.14	Dec. 14, 1953	13.86
June 11, 1953	9.66	Aug. 24, 1953	8.84	Jan. 7, 1954	14.50
June 12, 1953	9.68	Aug. 31, 1953	8.29	Feb. 15, 1954	15.05
June 22, 1953	9.72	Sept. 14, 1953	10.00	Mar. 10, 1954	15.35
June 29, 1953	7.09	Sept. 28, 1953	10.53	Apr. 13, 1954	15.49

D3-34-1ac3 (CP-1)

Date	Water level	Date	Water level	Date	Water level
Sept. 22, 1952	5.35	June 12, 1953	3.95	Aug. 17, 1953	2.92
Sept. 26, 1952	5.69	June 22, 1953	4.52	Aug. 24, 1953	3.71
Oct. 3, 1952	5.80	June 29, 1953	2.55	Aug. 31, 1953	3.09
Dec. 18, 1952	8.48	July 6, 1953	3.00	Sept. 14, 1953	4.87
May 13, 1953	5.62	July 20, 1953	1.16	Sept. 28, 1953	5.33
May 18, 1953	4.75	July 27, 1953	1.24	Oct. 26, 1953	6.00
May 25, 1953	3.86	Aug. 3, 1953	2.78	Nov. 16, 1953	7.54
June 11, 1953	4.32	Aug. 10, 1953	3.26	Dec. 7, 1953	8.50

D3-34-1ac4 (CP-4)

Date	Water level	Date	Water level	Date	Water level
Sept. 22, 1952	6.04	June 29, 1953	3.98	Sept. 28, 1953	5.84
Sept. 26, 1952	6.36	July 6, 1953	4.20	Oct. 26, 1953	6.61
Oct. 3, 1952	6.47	July 20, 1953	2.36	Nov. 16, 1953	7.93
Dec. 18, 1952	8.80	July 27, 1953	2.26	Nov. 23, 1953	8.17
May 13, 1953	6.40	Aug. 3, 1953	3.74	Nov. 30, 1953	8.42
May 18, 1953	5.58	Aug. 10, 1953	4.36	Dec. 8, 1953	8.79
May 25, 1953	4.74	Aug. 17, 1953	4.05	Dec. 14, 1953	8.96
June 11, 1953	5.08	Aug. 24, 1953	4.81	Jan. 7, 1954	Dry
June 12, 1953	5.09	Aug. 31, 1953	4.21	Feb. 15, 1954	Dry
June 22, 1953	5.60	Sept. 14, 1953	5.45	Mar. 10, 1954	Dry

D3-34-1ac5 (CP-5)

Date	Water level	Date	Water level	Date	Water level
Sept. 22, 1952	4.70	June 29, 1953	2.54	Sept. 28, 1953	4.37
Sept. 26, 1952	4.95	July 6, 1953	2.63	Oct. 26, 1953	4.79
Oct. 3, 1952	5.09	July 20, 1953	.70	Nov. 16, 1953	6.14
Dec. 18, 1952	7.34	July 27, 1953	.56	Nov. 23, 1953	6.44
May 13, 1953	4.86	Aug. 3, 1953	1.92	Nov. 30, 1953	6.69
May 18, 1953	4.17	Aug. 10, 1953	2.65	Dec. 8, 1953	6.97
May 25, 1953	3.31	Aug. 17, 1953	2.01	Dec. 14, 1953	7.48
June 11, 1953	3.50	Aug. 24, 1953	3.26	Jan. 7, 1954	Dry
June 12, 1953	3.51	Aug. 31, 1953	2.75	Feb. 15, 1954	Dry
June 22, 1953	3.82	Sept. 14, 1953	3.90	Mar. 10, 1954	Dry

D3-34-1ac6 (CP-8)

Date	Water level	Date	Water level	Date	Water level
Sept. 22, 1952	5.22	June 11, 1953	4.36	Aug. 3, 1953	2.85
Sept. 26, 1952	5.58	June 12, 1953	4.35	Aug. 10, 1953	3.51
Oct. 3, 1952	5.67	June 22, 1953	4.64	Aug. 17, 1953	3.27
Dec. 18, 1952	7.80	June 29, 1953	3.44	Aug. 24, 1953	4.02
May 13, 1953	5.64	July 6, 1953	3.58	Aug. 31, 1953	3.44
May 18, 1953	5.23	July 20, 1953	1.71	Sept. 14, 1953	6.00
May 25, 1953	4.15	July 27, 1953	1.43	Sept. 28, 1953	5.35

Table 26.—*Water-level measurements by tape*—Continued

Date	Water level	Date	Water level	Date	Water level
AGENCY UNIT—Continued					
D3-34-1ac6 (CP-8)—Continued					
Oct. 26, 1953......	5.65	Dec. 8, 1953......	7.72	Feb. 15, 1954.....	9.02
Nov. 16, 1953......	6.90	Dec. 14, 1953......	7.95	Mar. 10, 1954.....	9.32
Nov. 23, 1953......	7.25	Jan. 7, 1954......	8.55	Apr. 13, 1954.....	9.43
Nov. 30, 1953......	7.50				
D3-34-1ac7 (A-64)					
[No measurements by tape; for measurements from recorder charts, see table 27]					
D3-34-1ac8 (CP-6)					
Sept. 22, 1952......	5.02	July 6, 1953......	3.72	Oct. 26, 1953.....	5.48
Sept. 26, 1952......	5.42	July 20, 1953......	1.76	Nov. 16, 1953.....	6.66
Oct. 3, 1952......	5.52	July 27, 1953......	1.45	Nov. 23, 1953.....	6.97
May 13, 1953......	5.38	Aug. 3, 1953......	2.87	Nov. 30, 1953.....	7.24
May 18, 1953......	4.91	Aug. 10, 1953......	3.49	Dec. 7, 1953.....	7.49
May 25, 1953......	4.10	Aug. 17, 1953......	3.11	Dec. 14, 1953.....	7.64
June 11, 1953......	4.28	Aug. 24, 1953......	4.16	Jan. 7, 1954.....	8.25
June 12, 1953......	4.26	Aug. 31, 1953......	3.53	Feb. 15, 1954.....	8.75
June 22, 1953......	4.60	Sept. 14, 1953......	5.08	Mar. 10, 1954.....	9.06
June 29, 1953......	3.58	Sept. 28, 1953......	5.42	Apr. 13, 1954.....	9.18
D3-34-1ad2 (A-63)					
July 7, 1952......	7.83	Feb. 11, 1953......	7.37	Aug. 31, 1953.....	8.36
July 21, 1952......	8.05	Mar. 4, 1953......	7.52	Sept. 14, 1953.....	8.37
Aug. 4, 1952......	7.50	Mar. 31, 1953......	7.63	Sept. 28, 1953.....	8.59
Aug. 18, 1952......	7.44	Apr. 30, 1953......	7.68	Oct. 12, 1953.....	8.73
Sept. 1, 1952......	8.15	May 11, 1953......	7.76	Oct. 26, 1953.....	8.22
Sept. 15, 1952......	8.30	May 25, 1953......	7.63	Nov. 9, 1953.....	7.95
Sept. 26, 1952......	8.53	June 8, 1953......	7.27	Dec. 7, 1953.....	7.61
Oct. 10, 1952......	8.30	June 22, 1953......	7.10	Jan. 4, 1954.....	7.59
Oct. 27, 1952......	7.96	July 6, 1953......	7.77	Feb. 10, 1954.....	7.27
Nov. 7, 1952......	7.77	July 20, 1953......	5.56	Mar. 10, 1954.....	7.32
Nov. 21, 1952......	7.59	Aug. 3, 1953......	6.83	Apr. 13, 1954.....	7.27
Dec. 17, 1952......	7.44	Aug. 17, 1953......	7.67	May 4, 1954.....	7.48
Jan. 13, 1953......	7.35				
D3-34-1ba (A-60)					
July 21, 1952......	9.19	Feb. 11, 1953......	16.56	Sept. 14, 1953.....	12.83
Aug. 4, 1952......	9.47	Mar. 3, 1953......	16.84	Sept. 28, 1953.....	13.39
Aug. 18, 1952......	8.87	Mar. 31, 1953......	17.12	Oct. 12, 1953.....	14.17
Sept. 1, 1952......	9.80	Apr. 30, 1953......	16.24	Oct. 27, 1953.....	14.82
Sept. 15, 1952......	9.17	May 11, 1953......	14.35	Nov. 9, 1953.....	15.39
Sept. 26, 1952......	10.53	May 25, 1953......	13.27	Dec. 7, 1953.....	16.45
Oct. 10, 1952......	11.40	June 8, 1953......	12.89	Jan. 4, 1954.....	17.02
Oct. 27, 1952......	12.68	June 22, 1953......	13.24	Feb. 10, 1954.....	17.43
Nov. 7, 1952......	13.32	July 6, 1953......	11.85	Mar. 10, 1954.....	17.41
Nov. 21, 1952......	14.16	July 20, 1953......	10.89	Apr. 13, 1954.....	17.66
Dec. 17, 1952......	15.20	Aug. 17, 1953......	11.47	May 4, 1954.....	17.79
Jan. 13, 1953......	16.11	Aug. 31, 1953......	12.04		

Table 26.—*Water-level measurements by tape*—Continued

Date	Water level	Date	Water level	Date	Water level
AGENCY UNIT—Continued					
D3-34-1bd (CP-7)					
Sept. 22, 1952	5.93	July 6, 1953	4.55	Nov. 16, 1953	7.34
Sept. 26, 1952	6.41	July 20, 1953	4.48	Nov. 23, 1953	7.63
Oct. 3, 1952	6.59	July 27, 1953	4.24	Nov. 30, 1953	7.98
Dec. 18, 1952	9.44	Aug. 3, 1953	4.27	Dec. 7, 1953	8.30
May 13, 1953	7.48	Aug. 10, 1953	4.46	Dec. 14, 1953	8.54
May 18, 1953	6.87	Aug. 17, 1953	4.57	Jan. 7, 1954	9.33
May 25, 1953	5.50	Aug. 24, 1953	4.84	Feb. 15, 1954	10.32
June 9, 1953	5.22	Aug. 31, 1953	5.14	Mar. 10, 1954	10.66
June 12, 1953	5.17	Sept. 14, 1953	5.34	Apr. 13, 1954	11.01
June 22, 1953	5.10	Sept. 28, 1953	5.95	May 4, 1954	11.03
June 29, 1953	5.75	Oct. 26, 1953	6.46		

Table 27.—*Daily water levels at 2 a.m. from recorder charts*

[In feet above (+) or below land surface]

Day	1953				1954				
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
					LODGE GRASS NO. 1 UNIT				
					D5-35-27bb4 (DR12-1)				
1	....	0.86	0.41	0.21	0.16	0.67	....	0.30	0.41
2	....	.91	.43	.23	.17	.65	0.30	.30	.33
3	....	.87	.45	.23	.17	.64	.33	.31	.35
4	....	.87	.45	.22	.21	.63	.36	.23	.34
5	....	.89	.43	.25	.21	.62	.39	.04	....
6	....	.88	.41	.26	.18	.61	.42	+.08	....
7	....	.91	.41	.24	.16	.55	.43	+.05	....
8	....	.91	.41	.27	.16	.51	.43	+.02	....
9	....	.92	.43	.27	.19	.40	.42	.02	....
10	....	.93	.41	.22	.20	.38	.37	.09	....
11	....	.94	.40	.26	.26	.39	.31	.15	....
12	....	.96	.40	.24	.28	.37	.32	.17	....
13	....	.97	.39	.25	.29	.35	.35	.18	....
14	....	.99	.38	.23	.32	.35	.35	.21	....
15	....	.99	.37	.22	.32	.37	.36	.23	....
16	....	.98	.38	.23	....	.39	.29	.21	....
17	....	.99	.38	.24	....	.38	.22	.27	....
18	....	.98	.33	.22	....	.34	.23	.30	....
19	....	.96	.33	.21	.51	.38	.26	.27	....
20	....	.93	.33	.18	....	.37	.22	.22	....
21	....	.76	.34	.20	....	.37	.22	.17	....
22	....	.45	.34	.22	....	.36	.22	.21	....
23	....	.43	.19	.17	....	.36	.21	.26	....
24	....	.43	.21	.16	....	.33	.15	.34	....
25	....	.43	.23	.17	....	.33	.16	.38	....
26	....	.43	.22	.19	.73	.30	.18	.40	....
27	....	.43	.24	.16	.79	.26	.18	.44	....
28	....	.44	.23	.16	.78	....	.21	.41	....
29	....	.43	.24	.19	.77		.22	.42	....
30	0.93	.43	.24	.18	.72		.24	.40	....
31		.40		.18	.68		.27		....

Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

Day	1953	1954				
	Dec.	Jan.	Feb.	Mar.	Apr.	May
LODGE GRASS NO. 1 UNIT—Continued						
D6-35-13ab (5-N1)						
1	....	10.52	11.45	10.83	11.49	11.75
2	....	9.70	11.34	10.38	11.61	11.76
3	....	10.43	10.98	10.75	11.55	11.89
4	....	10.35	[1]11.60	11.00	11.49	11.82
5	....	10.08	11.5+	10.85	10.83	11.90
6	....	10.45	11.5+	10.40	11.35	11.85
7	....	10.33	11.5+	10.95	11.48	11.73
8	....	10.65	11.55	10.90	11.38	....
9	9.24	10.58	....	10.73	11.45	....
10	9.78	10.53	10.82	11.17	11.43	....
11	10.13	10.34	10.55	10.23	11.57	11.77
12	9.93	10.50	10.20	10.82	11.43	11.80
13	9.90	10.49	10.80	10.72	11.41	11.86
14	9.82	10.86	10.50	11.00	11.43	11.85
15	10.08	....	10.37	10.75	11.00	11.97
16	10.05	....	10.53	10.88	11.31	11.97
17	10.25	10.90	10.27	11.26	11.43	11.97
18	10.08	10.85	[1]10.65	11.31	11.34	12.26
19	9.98	10.58	....	11.10	11.40	12.27
20	9.80	....	10.49	[1]11.50	11.49	12.37
21	10.15	....	10.39	....	11.55	....
22	9.75	....	10.40	11.11	11.20	....
23	10.28	11.06	11.05	11.36	11.33	....
24	10.04	11.05	[1]10.70	11.16	11.52	....
25	10.08	10.95	11.04	10.75	11.53	....
26	10.27	10.93	10.48	11.36	11.59	....
27	10.34	10.75	10.70	11.5+	11.61	....
28	10.19	[1]11.20	10.74	11.5+	11.61	....
29	9.83	11.05		11.20	11.67	....
30	10.04	10.85		11.38	11.70	....
31	10.35	10.99		11.17		....

[1]Estimated.

Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

Day	1953								1954				
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Feb.	May
							RENO AND BATTLEFIELD UNITS						
							D3-34-13da (B-16)						
1	....	5.06	5.25	5.72	6.02	6.13	5.73	5.70	5.66	....	5.59	5.78	5.56
2	....	5.05	5.35	5.73	6.00	6.16	5.73	5.70	5.68	5.16	5.56	5.78	5.54
3	....	4.98	5.42	5.55	5.84	6.10	5.70	5.71	5.71	5.13	5.62	5.76	5.55
4	....	4.87	5.47	5.48	5.77	6.10	5.70	5.71	5.70	5.11	5.67	5.75	5.57
5	....	4.82	5.51	5.51	5.76	6.07	5.70	5.78	5.69	5.07	5.78	5.68	....
6	....	4.88	5.53	5.66	5.79	6.06	5.70	5.76	5.66	5.00	5.75	5.54	....
7	....	4.88	5.60	5.70	5.77	6.07	5.70	5.71	5.70	4.95	5.70	5.20	....
8	....	4.87	5.68	5.76	5.78	6.08	5.70	5.60	5.70	4.90	5.73	5.18	....
9	....	4.86	5.72	5.80	5.80	6.10	5.70	5.60	5.66	4.83	5.68	5.34	....
10.....	....	4.85	5.72	5.86	5.80	6.16	5.73	5.69	5.63	4.86	5.71	5.42	....
11.....	....	4.74	5.78	5.83	5.90	6.15	5.72	5.70	5.68	4.88	5.70	5.46	....
12.....	5.57	4.49	5.82	5.82	5.92	6.12	5.72	5.74	5.73	4.99	5.66	5.53	....
13.....	5.55	4.18	5.81	5.82	5.94	6.10	5.72	5.67	5.65	5.13	5.68	5.56	....
14.....	5.53	4.06	5.89	5.88	5.96	6.08	5.72	5.68	5.68	5.17	5.77	5.60	....
15.....	5.53	3.90	5.92	5.89	5.97	6.10	5.72	5.69	5.69	5.17	5.80	5.63	....
16.....	5.57	3.77	5.96	5.88	5.97	6.08	5.72	5.64	5.58	5.16	5.74	5.61	....
17.....	5.60	3.52	5.96	5.92	6.05	6.08	5.70	5.65	5.48	5.22	5.73	5.60	....
18.....	5.64	3.70	5.97	5.94	6.05	6.06	5.70	5.66	5.54	5.32	5.72	5.62	....
19.....	5.66	3.85	5.87	5.96	6.10	6.04	5.68	5.68	5.63	5.39	5.70	5.63	....
20.....	5.65	3.94	5.85	6.00	6.10	6.02	5.67	5.66	5.67	5.42	5.70	5.62	....
21.....	5.65	4.08	5.83	6.05	6.05	6.00	5.71	5.63	5.54	5.47	5.70	5.60	....
22.....	5.63	4.26	5.82	6.08	6.01	5.84	5.80	5.70	5.48	5.49	5.70	5.58	....
23.....	5.63	4.44	5.82	6.10	6.01	5.59	5.67	5.68	5.52	5.51	5.72	5.58	....
24.....	5.65	4.58	5.80	6.06	5.99	5.58	5.65	5.66	5.52	5.51	5.74	5.61	....
25.....	5.66	4.66	5.83	6.09	6.03	5.67	5.61	5.71	5.40	5.54	5.70	5.63	....
26.....	5.70	4.71	5.79	6.14	6.04	5.70	5.56	5.69	....	5.53	5.69	5.65	....
27.....	5.71	....	5.70	6.14	6.03	5.71	5.63	5.63	....	5.58	5.73	5.65	....
28.....	5.73	5.13	5.61	6.10	6.04	5.72	5.64	5.61	....	5.52	5.76	5.63	....
29.....	5.63	5.08	5.63	6.00	6.09	5.73	5.64	5.65	....		5.74	5.60	....
30.....	5.27	5.15	5.63	6.02	6.09	5.75	5.66	5.64	....		5.76	5.57	....
31.....	5.15		5.68	6.01		5.74		5.66	....		5.77		....

Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

Day	1953				1954				
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May

RENO AND BATTLEFIELD UNITS—Continued

D3-35-18dc (P-3)

Day	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1	....	11.07	10.56	10.45	10.30	....	10.15	10.28	10.19
2	....	11.12	10.54	10.49	10.35	10.13	....	10.30	10.20
3	....	11.14	10.57	10.48	10.32	10.10	....	10.26	10.18
4	....	11.10	10.56	10.47	10.36	10.10	....	10.26	10.14
5	10.90	11.10	10.52	10.51	10.36	10.05	....	10.18	....
6	10.87	11.04	10.50	10.52	10.34	10.01	....	10.12	....
7	10.87	11.03	10.57	10.50	10.33	9.94	....	10.01	....
8	10.85	11.02	10.57	10.51	10.35	9.87	....	9.93	....
9	10.87	11.00	10.54	10.49	10.38	9.80	10.20	9.93	....
10.......	10.87	10.99	10.56	10.43	10.37	9.78	10.23	10.05	....
11.......	10.87	10.98	10.55	10.49	10.39	9.80	10.22	10.08	....
12.......	10.93	11.00	10.55	10.51	10.42	9.77	10.25	10.08	....
13.......	10.94	10.98	10.55	10.61	10.33	9.82	10.31	10.07	....
14.......	10.95	10.98	10.54	10.47	10.34	....	10.30	10.09	....
15.......	11.01	10.96	10.53	10.49	10.41	....	10.33	10.17	....
16.......	10.98	10.95	10.55	10.47	10.39	9.81	10.28	10.16	....
17.......	11.03	10.96	10.51	10.45	10.32	9.79	10.26	10.13	....
18.......	11.05	10.95	10.56	10.42	10.39	9.78	10.26	10.14	....
19.......	11.06	10.91	10.56	10.41	10.45	9.89	10.28	10.18	....
20.......	11.09	10.91	10.51	10.37	....	9.86	10.27	10.18	....
21.......	11.08	10.86	10.55	10.43	....	9.89	10.26	10.20	....
22.......	11.02	10.76	10.52	10.47	....	9.88	10.26	10.13	....
23.......	11.05	10.58	10.48	10.43	....	10.00	10.26	10.12	....
24.......	11.04	10.51	10.51	10.43	....	9.97	10.24	10.19	....
25.......	11.04	10.57	10.51	10.44	....	10.03	10.24	10.18	....
26.......	11.05	10.57	10.42	10.38	....	10.00	10.23	10.22	....
27.......	11.02	10.56	10.49	10.35	....	10.11	10.24	10.22	....
28.......	11.03	10.57	10.49	10.30	....	10.12	10.25	10.23	....
29.......	11.10	10.55	10.49	10.35	....		10.24	10.23	....
30.......	11.10	10.58	10.48	10.35	....		10.29	10.20	....
31.......		10.57		10.32	....		10.28		....

Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

Day	1953									
	May	June	July	Aug.	Sept.	Day	May	June	July	Aug.	Sept.

RENO AND BATTLEFIELD UNITS—Continued

D4-35- 6aa (B-44)

Day	May	June	July	Aug.	Sept.	Day	May	June	July	Aug.	Sept.
1	....	....	23.67	23.57	23.76	17	....	23.90	23.67	23.70	23.83
2	....	23.80	23.67	23.58	23.77	18	....	23.90	23.66	23.70	23.84
3	....	23.78	23.67	23.58	23.75	19	....	23.90	23.66	23.71	23.84
4	....	23.74	23.67	23.65	23.78	20	23.85	23.79	23.65	23.71	23.85
5	....	23.75	23.67	23.64	23.79	21	23.87	....	23.66	23.71	23.87
6	....	23.76	23.68	23.65	23.80	22	23.86	....	23.67	23.71	23.88
7	....	....	23.68	23.66	23.80	23	23.87	23.67	23.67	23.71	23.87
8	....	....	23.68	[1]23.67	23.81	24	23.87	23.67	23.66	23.71	23.87
9	....	23.83	23.68	[1]23.68	23.82	25	23.86	23.67	23.66	23.71	23.88
10	....	23.85	23.68	[1]23.69	23.82	26	....	23.67	23.65	23.72	23.88
11	....	23.87	23.67	23.69	23.84	27	....	23.65	23.66	23.72	23.88
12	....	23.87	23.67	23.69	23.84	28	....	[1]23.66	23.58	23.73	23.88
13	....	23.88	23.67	23.69	23.84	29	....	[1]23.67	23.58	23.71	23.89
14	....	23.88	23.67	23.69	23.84	30	....	23.67	23.57	23.72	23.90
15	....	23.88	23.65	23.70	23.84	31	....		23.57	23.74	
16	....	23.90	23.66	23.70	23.84						

[1]Estimated.

Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

RENO AND BATTLEFIELD UNITS—Continued

D4-35- 9aa1 (B-45)

Day	1952								1953			
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	....	5.95	3.24	2.80	3.64	5.74	5.36	7.10	8.24	8.87	9.34	9.86
2	....	6.09	3.50	3.08	3.97	4.40	5.50	7.12	8.28	[1]8.89	9.36	9.88
3	....	5.76	3.52	3.30	4.20	3.26	5.54	7.19	8.30	[1]8.91	9.38	[1]9.88
4	....	3.60	3.28	3.54	4.44	2.78	5.58	7.24	8.33	[1]8.93	9.40	[1]9.89
5	....	4.90	3.25	3.52	4.64	2.50	5.70	7.26	8.35	[1]8.96	9.42	[1]9.90
6	....	4.95	2.58	3.52	4.81	3.08	5.78	7.27	[1]8.39	8.97	9.45	[1]9.90
7	....	3.62	2.18	3.18	4.81	2.24	5.80	7.32	[1]8.42	8.99	9.48	[1]9.90
8	....	4.05	1.66	2.94	4.70	3.30	5.90	7.38	8.46	8.99	9.48	[1]9.91
9	....	3.77	2.22	[1]2.82	4.52	3.22	5.98	7.44	8.50	9.02	9.49	....
10....	....	3.80	2.54	[1]2.94	4.66	2.82	6.02	7.48	8.53	9.03	9.50	....
11....	....	4.04	2.96	[1]3.06	4.72	2.44	6.08	7.56	8.55	9.04	9.51	....
12....	....	4.37	2.98	3.31	4.78	2.68	6.14	7.59	8.57	9.06	9.52	....
13....	....	4.82	2.44	3.45	4.86	2.90	6.16	7.64	8.59	9.07	9.53	....
14....	....	5.04	2.70	3.48	4.82	3.04	6.26	7.66	8.62	9.10	9.55	....
15....	....	5.20	2.98	3.56	4.83	3.30	6.30	7.68	8.62	9.10	9.56	....
16....	....	5.45	3.34	3.54	4.88	3.44	6.40	7.72	8.64	9.13	9.57	....
17....	....	4.20	3.62	2.74	5.06	3.70	6.46	7.75	8.66	9.14	9.58	....
18....	....	4.42	3.92	2.34	5.22	3.82	6.52	7.76	8.67	9.17	9.59	....
19....	....	4.60	4.02	3.22	5.26	3.92	6.56	7.80	8.69	9.18	9.59	....
20....	....	3.32	4.20	2.70	5.38	4.00	6.58	7.82	8.70	9.20	9.60	....
21....	4.30	2.46	4.40	3.12	5.47	4.12	6.68	7.86	8.70	9.21	9.62	....
22....	4.30	3.14	4.46	3.30	5.53	4.26	6.70	7.90	8.76	9.22	9.63	....
23....	4.63	3.21	4.64	3.48	[1]5.64	4.32	6.74	7.94	8.78	9.24	9.64	....
24....	4.90	3.24	4.32	3.68	[1]5.75	4.46	6.78	7.97	8.77	9.26	9.66	....
25....	5.08	4.38	3.94	3.94	[1]5.88	4.62	6.84	8.00	8.74	9.28	9.68	....
26....	5.34	4.04	3.68	4.22	[1]5.96	4.72	6.91	8.04	8.76	9.28	9.71	....
27....	5.21	....	2.96	3.68	6.04	4.92	6.92	8.07	8.80	9.31	[1]9.74	....
28....	5.43	3.34	2.62	3.18	6.14	4.96	6.96	8.10	8.81	9.33	[1]9.76	....
29....	5.54	3.12	2.60	2.80	6.22	5.02	7.02	8.13	8.82		[1]9.79	....
30....	5.74	3.16	2.62	2.64	6.28	5.10	7.06	8.18	8.84		[1]9.82	....
31....	5.87		2.86	3.04		5.28		8.21	8.86		[1]9.84	

[1]Estimated.

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Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

Day	1952									1953							
	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
								AGENCY UNIT									
								D2-34- 3cc1 (A-25)									
1	....	5.13	4.22	4.01	4.87	[1]5.07	5.25	5.05	5.33	5.68	5.73	5.96	6.02	6.29	3.91	4.25	4.21
2	....	5.19	4.27	3.97	4.92	5.03	5.23	5.10	5.32	5.73	5.75	5.96	6.05	6.28	3.87	4.31	4.24
3	....	5.23	4.29	3.87	4.92	5.07	5.20	5.09	5.35	5.71	5.75	5.98	6.05	6.19	3.87	4.31	4.09
4	....	5.29	4.32	3.85	4.96	5.14	5.23	5.06	5.38	5.73	5.75	5.99	6.05	6.09	3.72	4.45	4.16
5	....	5.34	4.39	3.88	....	5.16	5.18	5.10	5.36	5.71	5.75	5.99	6.06	5.95	3.51	4.45	4.18
6	....	5.35	4.44	4.02	....	5.14	5.14	5.13	5.30	[1]5.74	5.76	5.99	6.07	5.83	3.47	4.47	4.29
7	....	5.41	4.48	[1]3.90	....	5.12	5.07	5.08	5.35	[1]5.72	5.79	5.92	6.08	5.70	3.47	4.54	4.38
8	....	5.35	4.53	3.95	....	5.09	5.04	5.14	5.37	[1]5.74	5.76	5.88	6.10	5.63	3.55	4.55	4.46
9	....	5.33	4.50	4.02	....	5.03	5.01	5.17	5.42	[1]5.78	5.82	5.79	6.13	5.53	3.63	4.59	4.53
10	....	5.31	4.52	4.12	....	5.09	5.01	5.13	5.42	[1]5.80	5.83	5.75	6.14	5.45	3.65	4.64	4.58
11	....	5.27	4.67	4.20	[1]4.40	5.08	5.03	5.15	5.44	[1]5.79	5.81	5.72	6.14	5.37	3.67	4.67	4.42
12	....	5.28	4.68	4.11	4.39	5.12	5.01	5.16	5.46	[1]5.78	5.85	5.76	6.14	5.31	3.66	4.73	4.39
13	....	5.27	4.82	3.93	4.40	5.11	5.04	5.13	5.48	5.78	5.81	5.73	6.14	5.17	3.65	4.77	4.45
14	....	[1]5.18	4.83	[1]3.88	4.47	[1]5.08	5.03	5.18	5.47	5.79	5.85	5.77	6.15	5.05	3.73	4.76	4.52
15	....	5.17	4.84	3.86	4.55	[1]5.01	4.98	5.14	5.46	5.84	5.80	5.78	6.18	4.99	3.74	4.59	4.35
16	....	5.12	4.87	3.98	4.54	5.04	4.94	5.20	5.47	5.79	5.86	5.76	6.18	4.90	3.78	4.32	4.36
17	....	5.07	4.86	4.04	4.54	5.07	4.99	5.23	5.50	5.78	5.85	5.75	6.19	4.86	3.77	3.99	4.40
18	....	5.02	4.93	4.14	4.54	5.13	4.97	5.25	5.48	5.81	5.86	5.79	6.21	4.79	3.86	3.98	[1]4.44
19	....	4.97	4.92	4.09	4.59	5.08	4.97	5.25	5.50	5.82	5.90	5.80	6.23	4.73	3.92	4.07	4.52
20	....	4.87	4.92	4.10	4.70	5.05	4.95	5.21	5.51	5.85	5.91	5.78	6.22	4.65	3.90	4.11	4.56
21	....	4.81	4.94	4.16	4.75	5.05	4.95	5.27	5.51	5.82	5.91	5.81	6.21	4.60	4.02	4.28	4.60
22	....	4.19	4.91	4.26	4.79	5.05	4.99	5.27	5.54	5.88	5.92	5.85	6.22	4.57	4.03	4.22	4.66
23	....	4.11	4.87	4.32	4.86	5.05	4.97	5.27	5.56	5.86	5.93	5.90	6.22	4.48	4.00	4.20	4.67
24	....	4.12	4.82	4.35	4.90	5.07	4.97	5.26	5.57	5.69	5.95	5.94	6.24	4.35	4.12	4.24	4.75
25	....	4.12	4.60	4.51	4.97	5.12	4.97	5.30	5.57	5.67	5.94	5.93	6.26	4.33	4.11	4.29	4.83
26	....	4.19	4.46	4.53	5.05	5.13	4.97	5.31	5.59	5.68	5.95	5.96	6.26	4.30	4.10	4.37	4.82
27	4.95	4.22	4.34	4.58	5.08	5.14	5.03	5.31	5.60	5.70	5.97	5.98	6.25	4.22	4.11	4.25	4.82

28.......	4.98	4.18	4.22	4.65	5.07	5.20	5.00	5.30	5.62	5.69	5.97	5.97	6.25	4.17	4.12	4.24	4.79
29.......	5.09	4.16	[1]4.16	4.69	5.10	5.19	4.98	5.32	5.62	5.70	....	5.94	6.27	4.08	4.14	4.25	4.77
30.......	5.11	4.19	[1]4.10	4.72	5.17	5.21	4.97	5.32	5.65	5.72		5.99	6.29	3.98	4.19	4.23	4.73
31.......		4.22		4.82	[1]5.11		5.02		5.66	5.75		5.99		3.95		4.23	4.72

[1] Estimated.

Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

Day	1953				1954				
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
	AGENCY UNIT—Continued								
	D2-34- 3cc1 (A-25)—Continued								
1	4.76	4.72	4.30	4.92	5.41	6.03	5.98	5.52	5.96
2	4.75	4.74	4.29	4.97	5.47	6.04	6.01	5.59	6.00
3	4.67	4.70	4.38	4.97	5.44	6.03	6.01	5.58	6.00
4	4.62	4.62	4.39	4.93	5.50	6.05	6.07	5.55	5.99
5	4.59	4.60	4.37	5.03	5.52	6.04	6.09	5.02	....
6	4.62	4.57	4.36	5.02	5.51	....	6.09	4.91	....
7	4.61	4.57	4.51	5.06	5.51	....	6.11	4.98	....
8	4.64	4.50	4.52	5.10	5.55	....	6.11	5.00	....
9	4.64	4.47	4.51	5.07	5.59	5.83	6.12	5.06	....
10........	4.66	4.42	4.53	5.05	5.59	5.78	6.09	5.17	....
11........	4.74	4.40	4.54	5.16	5.61	5.76	6.09	5.28	....
12........	4.74	4.42	4.56	5.11	5.74	5.76	6.09	5.30	....
13........	4.76	4.38	4.59	5.20	5.72	5.74	6.12	5.33	....
14........	4.82	4.42	4.60	5.17	5.72	5.75	[1]6.12	5.38	....
15........	4.87	4.40	4.61	5.21	5.73	5.79	[1]6.12	5.48	....
16........	4.84	4.42	4.65	5.23	5.80	5.84	6.08	5.49	....
17........	4.89	4.46	4.61	5.23	5.80	5.83	6.01	5.51	....
18........	4.85	4.48	4.72	5.23	5.82	5.78	5.97	5.55	....
19........	4.89	4.48	4.74	5.25	5.77	5.86	5.99	5.60	....
20........	4.94	4.53	4.72	5.23	5.77	5.85	5.95	5.67	....
21........	4.92	4.53	4.76	5.32	5.77	5.88	5.88	....	....
22........	4.91	4.01	4.73	5.34	5.78	5.88	5.83	....	....
23........	4.99	3.86	4.77	5.31	5.83	5.93	5.73	....	....
24........	4.96	3.87	4.83	5.33	5.83	5.92	5.61	....	....
25........	4.91	4.01	4.87	5.34	5.83	5.95	5.53	....	....
26........	4.93	4.06	4.82	5.35	5.92	5.92	5.43	....	....
27........	4.85	4.12	4.89	5.39	5.95	5.99	5.30	5.85	....
28........	4.85	4.17	4.90	5.35	5.95	5.99	5.32	5.88	....
29........	4.92	4.19	4.91	5.43	5.98		5.32	5.91	....
30........	4.82	4.26	4.90	5.44	6.01		5.39	5.93	....
31........		4.26		5.41	6.01		5.49		....

[1]Estimated.

Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

Day	1952								1953								
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
								AGENCY UNIT—Continued									
								D2-34-14ba (A-35)									
1	....	3.71	1.93	3.51	....	4.01	4.23	[1]4.70	5.30	5.57	5.95	6.28	6.68	4.27	4.06	2.28	2.92
2	....	3.89	2.35	3.56	2.43	3.95	4.33	4.70	5.37	5.61	5.98	6.31	6.71	3.82	4.00	2.42	2.57
3	....	3.97	2.45	3.63	2.55	3.95	4.29	4.74	5.30	5.60	8.01	6.30	6.73	3.61	3.81	2.39	2.57
4	....	4.04	2.25	3.62	2.74	4.00	4.23	4.82	5.37	5.62	6.02	6.31	6.73	3.39	3.81	2.56	....
5	....	4.18	2.06	3.63	2.92	3.93	4.34	4.81	5.33	5.63	6.03	6.31	6.73	3.28	3.64	2.55	....
6	....	4.18	1.84	3.70	3.03	3.94	4.39	4.65	[1]5.40	5.62	6.08	6.32	6.72	3.32	3.53	2.69	....
7	....	4.15	1.91	3.67	3.09	[1]3.90	4.26	4.77	....	5.67	6.08	6.33	6.71	3.31	3.48	2.80	....
8	....	4.17	1.92	3.79	3.22	[1]3.83	4.40	4.83	5.40	5.62	6.07	6.36	6.67	3.38	3.26	2.81	....
9	....	3.93	1.90	3.20	3.22	....	4.43	4.94	5.45	5.73	6.01	6.41	6.57	3.53	3.22	2.90	....
10	....	3.91	2.10	....	3.35	[1]3.98	4.34	4.91	5.49	5.72	5.96	6.41	6.48	3.58	3.06	3.00	....
11	....	4.02	2.22	....	3.42	3.92	4.40	4.94	5.45	5.68	5.94	6.42	6.41	3.60	2.98	2.95	....
12	....	3.80	2.20	.94	3.44	3.87	4.43	4.97	5.43	5.77	6.01	6.41	6.41	3.61	2.57	2.94	....
13	....	4.07	1.71	.85	3.41	3.97	4.33	4.99	5.47	5.68	5.95	6.43	6.37	3.63	2.39	3.01	....
14	....	3.72	1.65	1.60	3.46	3.97	4.45	4.97	5.51	5.77	6.03	6.44	6.31	3.83	2.55	3.10	....
15	....	3.70	1.67	....	3.45	3.83	4.39	4.93	5.58	5.68	6.03	6.49	6.30	3.91	2.84	2.90	....
16	5.93	3.83	1.97	....	3.41	3.78	4.53	4.96	5.48	5.81	6.01	6.46	6.29	3.99	....	2.78	....
17	5.31	3.43	2.11	....	3.42	3.93	4.56	5.02	5.46	5.78	5.96	6.50	6.27	3.99	....	2.73	....
18	4.78	3.50	2.31	....	3.54	3.91	4.59	4.99	5.51	5.80	6.07	6.52	6.22	4.14	....	2.73	....
19	4.73	3.46	2.27	2.55	3.50	3.93	4.57	5.02	5.54	5.87	6.04	6.54	6.13	4.27	....	2.68	....
20	4.36	3.60	2.39	2.81	3.63	3.91	4.50	5.04	5.59	5.87	6.00	6.50	6.06	4.23	....	2.66	....
21	3.86	3.17	2.58	2.98	3.68	3.96	4.63	5.04	5.50	5.89	6.08	6.51	6.05	4.32	1.62	3.02	....
22	2.96	2.30	2.76	3.08	3.69	4.03	4.62	5.08	5.68	5.87	6.11	6.55	6.03	4.39	1.65	3.23	....
23	2.47	2.57	2.85	3.13	3.70	4.00	4.62	5.12	5.64	5.90	6.15	6.50	6.01	4.47	1.57	3.26	....
24	2.40	2.91	2.85	3.12	3.76	4.02	4.57	[1]5.12	5.53	5.93	6.17	6.57	5.92	4.62	1.23	3.30	....
25	2.72	2.25	3.12	2.92	3.84	4.09	4.66	5.12	5.44	5.92	6.11	6.61	5.94	4.50	1.46	3.53	....
26	[1]2.95	.81	3.15	2.19	3.83	4.09	4.69	5.15	5.50	5.92	6.21	6.60	6.03	4.39	1.62	3.54	....
27	[1]3.20	.60	3.24	2.24	3.83	4.19	4.66	5.16	5.56	5.97	6.21	6.57	6.00	4.34	1.65	3.41	....

[1]Estimated.

Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

Day	1952								1953								
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
	AGENCY UNIT—Continued																
	D2-34-14ba (A-35)—Continued																
28......	3.36	.45	3.40	....	3.95	4.15	....	5.17	5.53	5.96	6.19	6.59	5.98	4.23	1.69	3.24	....
29......	3.34	.83	3.42	....	3.95	4.09	....	5.16	5.51		6.20	6.64	5.66	4.15	1.89	3.31	....
30......	3.56	1.47	3.39	....	3.97	4.08	....	5.22	5.54		6.25	6.66	5.23	4.08	[1]2.22	3.27	....
31......	3.71		3.38	....		4.21		5.23	5.60		6.22		4.81		2.41	3.15	

[1]Estimated.

Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

Day	1952									1953				
	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
							AGENCY UNIT—Continued							
							D2-34-25bd (A-50)							
1	....	4.84	1.94	1.27	1.97	1.21	2.18	2.78	3.71	4.50	4.53	5.03	5.36	4.60
2	....	4.86	2.07	....	1.74	1.28	2.18	2.90	3.72	4.59	4.57	5.06	5.38	3.26
3	....	4.43	2.08	....	1.33	1.36	2.16	2.90	3.79	4.51	4.58	5.11	5.36	2.22
4	....	3.86	2.13	....	1.38	1.45	2.24	2.86	....	4.57	4.59	5.09	5.39	2.58
5	....	3.20	2.20	....	1.49	1.53	2.22	2.97	....	4.53	4.60	5.10	5.37	2.79
6	....	2.37	2.24	....	1.59	1.57	2.24	3.05	....	4.59	4.60	5.10	5.40	[1]2.89
7	....	2.78	1.73	....	1.60	1.60	2.16	[1]2.96	....	....	4.66	5.10	5.42	2.87
8	....	2.83	[1]1.72	1.49	1.53	1.65	2.17	....	....	4.60	4.62	5.05	5.45	3.02
9	....	2.97	[1]1.78	1.48	1.46	1.62	2.16	....	....	....	4.76	4.95	5.49	2.98
10	....	3.07	[1]1.83	1.40	.85	1.69	2.21	[1]3.10	....	....	4.74	4.89	5.48	2.94
11	....	3.01	1.94	1.36	.97	1.63	2.23	3.12	4.00	....	4.73	4.82	5.48	2.86
12	....	3.11	1.78	1.36	1.07	1.57	2.20	3.16	4.02	....	4.82	4.93	5.46	2.77
13	....	3.09	2.04	1.20	1.18	1.60	2.28	3.09	4.04	....	4.71	4.87	5.49	....
14	....	2.57	2.01	[1]1.18	1.25	1.58	2.18	3.21	4.00	4.71	4.82	4.98	5.52	2.50
15	....	1.97	1.93	1.21	1.33	1.58	2.11	3.18	3.98	....	4.71	[1]4.96	5.55	2.58
16	....	1.87	2.06	1.36	1.35	1.58	2.07	3.31	4.03	4.70	4.87	4.98	5.53	2.54
17	....	1.95	2.00	1.44	[1]1.35	1.61	2.18	3.32	4.09	4.68	4.83	4.93	5.56	2.60
18	....	1.82	2.08	1.52	[1]1.37	1.72	2.20	3.37	4.08	4.74	4.85	5.07	5.59	2.54
19	....	1.78	1.92	1.38	1.28	1.69	2.23	3.39	4.12	4.75	4.95	5.02	5.61	2.40
20	....	1.75	1.80	1.35	1.37	1.76	2.24	3.34	4.15	4.79	4.93	4.99	5.55	....
21	....	1.79	1.24	1.48	1.41	1.81	2.30	3.47	4.17	....	4.97	5.09	5.57	....
22	....	....	.91	1.58	1.41	1.79	2.39	3.50	4.21	4.84	4.97	5.13	5.62	....
23	....	....	1.01	1.62	1.45	1.79	2.38	3.50	[1]4.27	4.79	5.01	5.19	5.62	....
24	....	1.67	1.13	1.60	1.48	1.85	2.40	3.49	4.28	4.60	5.04	5.22	5.65	....
25	4.61	1.70	.95	....	[1]1.52	1.93	2.50	3.58	4.27	4.42	5.05	5.14	5.68	....
26	4.61	1.80	.92	....	1.62	1.94	2.52	3.62	4.32	4.44	5.02	5.27	5.68	....
27	4.68	1.88	.98	....	1.63	1.94	2.66	3.61	4.35	4.45	5.08	5.26	5.65	....
28	4.66	1.85	1.00	....	1.61	2.07	2.64	3.63	4.37	4.42	5.05	5.23	5.66	....
29	4.82	1.80	1.10	1.86	1.42	2.09	2.62	3.64	4.35	4.44		5.26	5.60	....
30	[1]4.87	1.86	1.23	1.87	1.18	2.12	2.65	3.66	4.43	4.47		5.31	5.14	....
31		1.95		1.97	1.12		2.76		4.45	4.57		5.29		....

[1]Estimated.

Table 27.—*Daily water levels at 2. a.m. from recorder charts*—Continued

AGENCY UNIT—Continued

D2-34-36dbl (A-62)

Day	1952						1953					
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
1 ...	....	4.30	4.45	4.38	4.14	4.20	4.41	4.25	4.39	4.30	4.11	3.49
2 ...	1.73	4.34	4.46	4.35	4.14	4.21	4.42	4.24	4.39	4.30	4.07	3.52
3 ...	1.64	4.26	4.50	[1]4.31	4.14	4.22	4.42	4.24	4.39	4.31	4.07	3.56
4 ...	1.82	4.30	4.59	4.32	4.12	4.22	4.43	4.22	4.39	4.33	4.07	2.90
5 ...	2.02	4.27	4.60	4.29	4.12	4.22	4.43	4.20	4.38	4.34	4.08	2.79
6 ...	2.23	4.31	4.60	4.28	4.13	4.21	[1]4.43	4.20	4.38	4.35	4.08	[1]3.08
7 ...	2.17	4.34	4.61	4.25	4.12	4.21	[1]4.42	4.20	4.37	4.36	4.07	[1]3.18
8 ...	2.35	4.37	4.60	4.23	[1]4.11	4.22	4.42	4.20	4.25	4.37	4.06	[1]3.28
9 ...	2.45	4.32	4.59	4.22	[1]4.12	[1]4.22	4.44	4.22	4.20	4.38	4.05	3.35
10...	2.57	4.05	4.66	4.21	[1]4.12	4.23	4.45	4.23	4.19	4.38	4.01	3.46
11...	2.77	3.76	4.60	4.21	[1]4.13	4.23	4.45	4.23	4.18	4.38	3.97	3.49
12...	2.72	3.80	4.60	4.20	[1]4.13	4.25	4.44	4.23	4.16	4.38	3.95	3.54
13...	1.92	3.90	4.51	4.20	[1]4.13	4.26	4.44	4.23	4.14	4.38	3.86	3.58
14...	1.85	4.02	4.38	4.18	[1]4.14	4.26	4.44	4.25	4.13	4.38	3.68	3.68
15...	2.08	4.09	4.32	4.14	4.14	[1]4.27	4.41	4.25	4.13	4.38	3.68	3.73
16...	2.48	4.14	4.34	4.12	4.14	[1]4.28	4.40	4.26	4.15	4.39	3.71	3.73
17...	2.83	4.18	4.34	4.12	4.14	4.30	4.40	4.27	4.15	4.39	3.71	3.75
18...	3.08	4.24	4.38	4.12	4.14	4.30	4.41	[1]4.28	4.17	4.40	3.75	3.82
19...	3.27	4.30	4.37	4.12	4.14	4.31	4.41	4.30	4.18	4.41	3.76	3.90
20...	3.40	4.39	4.31	4.12	4.14	4.32	4.40	4.31	4.18	4.41	3.74	3.82
21...	3.53	4.43	4.32	4.12	4.15	4.33	4.40	4.31	4.19	4.42	3.72	3.96
22...	3.66	4.41	4.32	4.12	4.15	4.34	4.40	4.32	4.21	4.43	3.71	4.02
23...	3.76	4.46	....	4.12	4.15	4.34	4.40	4.34	4.23	4.43	3.70	4.12
24...	3.83	4.48	....	4.12	4.15	4.35	....	4.35	4.25	4.44	3.68	4.22
25...	3.91	4.50	....	[1]4.11	4.15	4.35	....	4.36	[1]4.26	4.44	3.68	4.23
26...	3.99	4.57	....	[1]4.12	4.16	4.36	....	4.38	4.28	4.44	3.70	4.27
27...	4.05	4.60	4.40	[1]4.12	4.16	4.37	....	4.39	4.28	4.44	3.69	4.32
28...	4.10	4.58	4.41	[1]4.13	4.17	4.38	....	4.39	4.28	4.45	3.70	4.37
29...	4.16	4.61	4.38	[1]4.14	4.18	4.38	4.22		4.27	4.41	3.65	4.33
30...	4.21	4.64	4.37	[1]4.14	4.19	4.39	4.23		4.27	4.28	3.57	4.39
31...	4.26	4.50		[1]4.15		4.40	4.25		4.27		3.47	

[1]Estimated.

Table 27.—

Day		
	July	Au
1	4.47	-
2	4.47	-
3	4.51	-
4	4.58	-
5	4.60	-
6	4.60	-

Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

Day	1952					1953						
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
						AGENCY UNIT—Continued						
						D3-34- 1ac7 (A-64)						
1	....	5.72	7.10	7.92	8.83	9.98	10.49	10.90	Dry	8.41	4.96	4.38
2	....	5.68	7.08	7.99	8.88	10.01	10.50	10.91	Dry	8.34	4.97	4.19
3	....	5.64	6.93	8.01	8.94	10.03	10.52	10.91	Dry	8.23	4.98	....
4	....	5.57	6.81	8.02	8.99	10.05	10.54	10.91	Dry	8.12	4.91	....
5	....	5.60	6.90	8.06	9.03	10.07	10.55	Dry	Dry	7.96	5.12	....
6	....	5.56	6.95	8.10	9.06	10.10	[1]10.57	Dry	Dry	7.78	5.25	....
7	....	5.43	6.96	8.10	9.10	10.12	[1]10.58	Dry	Dry	7.47	5.26	4.26
8	....	5.59	7.00	8.15	9.15	10.15	[1]10.60	Dry	Dry	7.23	5.38	3.68
9	....	5.59	6.41	8.19	9.20	10.18	[1]10.61	Dry	Dry	7.01	5.46	....
10....	2.86	5.70	6.04	8.20	9.25	10.19	[1]10.63	Dry	Dry	6.67	5.47	....
11....	3.42	5.72	6.45	8.23	[1]9.3	10.21	[1]10.64	Dry	Dry	6.50	5.49	....
12....	3.76	5.73	6.63	8.26	[1]9.4	10.22	10.65	Dry	Dry	6.88	5.48	[1]3.65
13....	3.86	5.79	6.72	8.27	[1]9.4	10.24	10.66	Dry	Dry	6.89	5.47	[1]3.65
14....	4.28	5.78	6.74	8.30	[1]9.4	10.26	10.67	Dry	Dry	6.82	5.56	....
15....	4.24	5.76	6.71	8.32	[1]9.5	10.29	10.69	Dry	Dry	6.82	5.50	....
16....	4.42	5.79	6.72	8.35	[1]9.52	10.31	10.70	Dry	Dry	6.60	5.45	....
17....	4.49	5.82	7.03	8.38	9.56	10.33	10.71	Dry	Dry	6.50	5.34	....
18....	4.52	5.77	7.15	8.43	9.58	10.34	10.73	Dry	Dry	6.38	5.48	....
19....	4.60	5.87	7.26	8.44	9.61	10.36	10.78	Dry	Dry	5.79	5.52	....
20....	4.73	6.31	7.33	8.45	9.64	10.38	10.80	Dry	Dry	5.48	5.53	....
21....	4.81	6.41	7.42	8.49	9.67	10.40	10.81	Dry	Dry	5.43	5.68	2.89
22....	4.88	6.52	7.50	8.51	9.71	10.42	[1]10.83	Dry	Dry	5.37	5.69	3.06
23....	4.94	6.56	7.53	8.53	9.74	10.43	[1]10.84	Dry	Dry	5.25	5.55	3.41
24....	5.01	6.57	7.58	8.54	9.77	10.32	[1]10.86	Dry	Dry	5.12	5.61	3.12
25....	5.05	6.76	7.64	8.57	9.79	10.31	[1]10.87	Dry	10.76	5.16	5.59	3.37
26....	5.24	6.82	7.68	8.59	9.82	10.37	10.87	Dry	10.31	5.24	5.58	3.32
27....	[1]5.36	6.90	7.77	8.61	9.85	[1]10.41	10.89	Dry	9.95	5.15	5.65	2.92
28....	[1]5.34	7.01	7.79	8.65	9.87	[1]10.44	10.90	Dry	9.57	5.14	4.43	2.80
29....	5.42	7.05	7.81	8.72	9.90	10.45		Dry	9.09	4.98	4.06	3.30
30....	5.58	7.08	7.82	8.78	9.93	10.46		Dry	8.59	5.27	3.91	3.49
31....	5.65		7.88		9.96	10.48		Dry		5.19		3.62

[1]Estimated.

Table 27.—*Daily water levels at 2 a.m. from recorder charts*—Continued

Day	1953					1954				
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
	AGENCY UNIT—Continued									
	D3-34- 1ac7 (A-64)—Continued									
1	3.83	4.48	6.66	7.54	9.17	10.13	10.54	Dry	Dry	Dry
2	4.03	4.06	5.82	7.56	9.22	10.16	10.54	Dry	Dry	Dry
3	3.68	3.93	6.84	7.62	9.25	10.17	10.56	Dry	Dry	Dry
4	....	....	6.78	7.66	9.27	10.21	10.57	Dry	Dry	Dry
5	....	....	6.81	7.66	9.33	10.23	10.57	Dry	Dry	....
6	....	....	6.74	7.69	9.36	10.25	10.59	Dry	Dry	....
7	....	....	6.76	7.85	9.40	10.26	10.59	Dry	Dry	....
8	....	5.84	6.80	7.95	9.44	10.29	10.59	Dry	Dry	....
9	....	5.94	6.83	8.01	9.46	10.31	10.59	Dry	Dry	....
10......	....	6.01	6.91	8.12	9.49	10.33	10.60	Dry	Dry	....
11......	4.35	6.08	6.96	8.19	9.54	10.36	10.63	Dry	Dry	....
12......	4.31	5.91	7.00	8.27	9.56	10.37	10.64	Dry	Dry	....
13......	4.31	5.92	6.99	8.35	9.60	10.38	10.66	Dry	Dry	....
14......	4.42	5.93	....	8.41	9.63	10.40	10.68	Dry	Dry	....
15......	3.99	5.98	....	8.46	9.66	10.42	10.70	Dry	Dry	....
16......	3.76	5.97	....	8.51	9.70	10.43	10.71	Dry	Dry	....
17......	4.04	6.20	....	8.57	9.72	10.44	10.71	Dry	Dry	....
18......	4.30	6.17	....	8.66	9.74	10.44	10.71	Dry	Dry	....
19......	4.45	6.25	....	8.71	9.77	10.44	10.72	Dry	Dry	....
20......	4.64	6.34	7.27	8.74	9.79	10.42	Dry	Dry	Dry	....
21......	4.98	6.26	7.29	8.80	9.83	10.42	Dry	Dry	Dry	....
22......	5.14	6.27	6.58	8.83	9.86	10.42	Dry	Dry	Dry	....
23......	5.13	6.36	6.58	8.87	9.88	10.42	Dry	Dry	Dry	....
24......	4.98	6.26	6.71	8.94	9.90	10.43	Dry	Dry	Dry	....
25......	5.23	6.32	6.97	8.99	9.93	10.43	Dry	Dry	Dry	....
26......	5.49	6.47	7.07	9.00	9.95	10.43	Dry	Dry	Dry	....
27......	5.76	6.43	7.17	9.06	9.97	10.45	Dry	Dry	Dry	....
28......	5.52	6.46	7.23	9.09	9.99	10.46	Dry	Dry	Dry	....
29......	5.13	6.66	7.30	9.13	10.07	10.48		Dry	Dry	....
30......	4.80	6.64	7.43	9.16	10.10	10.50		Dry	Dry	....
31......	4.63		7.48		10.11	10.52		Dry		....

Table 28.—*Record of wells and jetted test holes*

Well number: See text for explanation of well numbering system.
Type of well: B, bored; Dr, drilled; Du, dug; J, jetted.
Depth of well: Measured depths are given in feet and tenths; reported depths are given in feet.
Type of casing: A, asphalt composition; G, galvanized iron or steel; I, iron; M, masonry; N, none; S, steel.
Measuring point: Ls, land surface; Tjt, top of jet tube; Tp, top of pipe; Tpf, top of pumphouse floor; Tsf, top of shelter floor.
Water level: Measured water levels are given in feet and tenths; reported levels are given in feet.
Remarks: B, taps bedrock (undifferentiated); C, taps Cloverly formation; Ca, water sample collected for chemical analysis; D, destroyed; F, natural flow (numeral denotes gallons per hour); L, log of well or test hole in report; Nw, does not penetrate to water; O, water-level observation well; OR, water-level observation well equipped with recording gage; P, taps Parkman sandstone; Pl, plugged.

Well		Date drilled	Type of well	Depth below land surface (feet)	Diameter of casing (inches)	Type of casing	Depth to gravel below land surface (feet)	Measuring point			Water level above (+) or below land surface (feet)	Date of measurement	Remarks
Coordinate system	Field							Description	Height above land surface (feet)	Altitude above mean sea level (feet)			
Lodge Grass No. 1 unit													
D5-35-22bb	D-27	July 13, 1953	J	10.8	3/4	G	8.6	Tp	4.6	3,266.33	7.30	Sept. 1, 1953	L,O
22cb	D-1	July 14, 1953	J	13.1	3/4	G	8.0	Tp	3.3	3,274.82	5.13	...do...	L,O
22cc	D-3	...do...	J	19.1	3/4	G	13.0	Tp	1.3	3,280.89	4.42	...do...	Ca,L,O
22dc	D-2	...do...	J	17.4	3/4	G	9.0	Tp	1.0	3,274.92	4.45	...do...	Ca,L,O
27ba	...	...	Dr	100.0	4	...	...	...	...	...	Flows	...	B,Ca
27bb1	4-N3	Sept. 24, 1953	J	11.0	3/4	I	9.5	Tp	3.1	3,281.58	+1.09	Sept. 25, 1953	L,O
27bb2	4-N2	...do...	J	12.2	3/4	I	9.5	Tp	3.2	3,281.11	Flows	...	L
27bb3	4-N1	Sept. 18, 1953	J	10.4	3/4	I	8.0	Tp	4.0	3,281.97	Flows	...	L
27bb4	DR12-1	Sept. 30, 1953	B,J	11.0	6,4	A	9.7	Tsf	3.0	3,283.47	.93	Sept. 30, 1953	L,OR
27bb5	P-4	Sept. 23, 1953	J	15.7	2	I	12.0	Tp	3.8	3,284.02	Flows	...	L

27bd	D-4	July 14, 1953	J	17.1	3/4	I	16.0	Tp	1.3	3,291.76	5.14	Sept. 1, 1953	L,O
27cd	D-6	July 15, 1953	J	25.4	3/4	G	22.0	Tp	1.0	3,308.44	6.82	.....do	L,O
27db	D-5	.....do	J	16.7	3/4	I	8.5	Tp	1.7	3,296.96	4.11	.....do	Ca,L,O
34bd	D-7	July 16, 1953	J	35.3	3/4	G	32.0	Tp	2.2	3,325.61	10.27	.....do	L,O
34cd	DR13-2	Sept. 18, 1953	J	20.5	3/4	G	20.0	Tp	.9	3,320.8	1.33	Sept. 18, 1953	L,O
34db	DR13-1	Sept. 22, 1953	J	16.7	3/4	G	8.0	Tp	2.2	3,307.7	.40	Sept. 22, 1953	L,O
34dc	D-8	July 16, 1953	J	26.1	3/4	G	19.0	Tp	2.5	3,328.35	2.07	Sept. 1, 1953	L,O
D6-35- 1bc	D-9	July 17, 1953	J	26.5	3/4	G	25.5	Tp	2.9	3,339.21	8.30	.....do	L,O
1cb	D-10	July 20, 1953	J	26.2	3/4	G	22.0	Tp	1.2	3,344.93	6.68	.....do	Ca,L,O
1cd	D-11	.....do	J	16.5	3/4	G	14.0	Tp	1.9	3,343.00	2.20	.....do	L,O
1dc	D-12	.....do	J	12.4	3/4	G	8.0	Tp	2.0	3,336.71	1.17	.....do	L,O
10dc	D-16	July 24, 1953	J	16.4	3/4	G	13.5	Tp	1.0	3,515.70	7.30	.....do	L,O
11cd	D-17A	July 27, 1953	J	7.5	....	N	4.5	......	......	3,494	....	....	L,Nw
11da	D-19A	.....do	J	7.5	....	N	1.5	......	......	3,462.5	....	....	L,Nw
11dd	D-20	July 28, 1953	J	6.5	3/4	G	.0	Tp	1.9	3,470.63	4.31	Sept. 1, 1953	L,O
12dd	D-13	July 20, 1953	J	8.0	3/4	G	5.0	Tp	3.4	3,354.49	6.52	.....do	Ca,L,O
13aa	D-14	.....do	J	9.8	3/4	G	8.0	Tp	1.8	3,360.39	7.07	.....do	L,O
13ab	5-N1	....	Dr	97.0	8	I	......	Tsf	3.0	....	9.82	Dec. 14, 1953	O,P
13ac1	5-S2	....	Dr	51	4	S	......	Tp	.8	....	11.09	Sept. 1, 1953	
13ac2	5-NE1	....	Dr	147	4	S	......	Tp	1.3	....	9.29	.....do	
13ac3	5-S1	May 5, 1954	Dr	220	8	I	......	Tp	1.0	....	9.03	May 7, 1954	L
13ac4	P-5	....	Dr	210	8	I	......	......	......	....	....	....	Ca,P
13ac5	5-SW1	....	Dr	65	4	S	......	Tp	.5	....	9.93	Sept. 1, 1953	
13ba	D-15	July 24, 1953	J	12.9	3/4	G	4.5	Tp	1.5	3,437.41	7.09	.....do	Ca,L,O
13cb	D-23	July 29, 1953	J	24.4	3/4	G	17.0	Tp	2.6	3,402.91	3.40	.....do	L,O
14aa1	D-18	July 27, 1953	J	9.9	3/4	G	6.5	Tp	1.5	3,480.0	7.53	Aug. 4, 1953	L,O
14bc	D-22A	July 29, 1953	J	9.0	....	N	4.5	......	......	3,509	....	....	L,Nw
14ca	D-21	July 28, 1953	J	7.7	3/4	G	.0	Tp	2.7	3,488.74	3.55	Sept. 1, 1953	Ca,L,O
14da	DR14-1	Sept. 22, 1953	J	13.4	3/4	G	11.0	Tp	2.5	3,405.0	+.31	Oct. 13, 1953	L,O
14db	D-24	July 29, 1953	J	16.2	3/4	G	10.5	Tp	2.2	3,413.23	2.61	Sept. 1, 1953	Ca,D,L,O
21db	P-6	1928	Dr	3,507	8	......	......	......	......	....	Flows	....	C,Ca,L
22ab	D-25	July 29, 1953	J	15.1	3/4	G	10.5	Tp	4.3	3,458.78	15.16	Aug. 4, 1953	L,O
29ab	D-26	July 30, 1953	J	15.4	3/4	G	13.5	Tp	1.1	3,533.90	2.03	Sept. 1, 1953	Ca,L,O

Table 28.—*Record of wells and jetted test holes*—Continued

Well: Coordinate system	Well: Field	Date drilled	Type of well	Depth below land surface (feet)	Diameter of casing (inches)	Type of casing	Depth to gravel below land surface (feet)	Measuring point: Description	Measuring point: Height above land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Water level above (+) or below land surface (feet)	Date of measurement	Remarks
Benteen Flat unit													
D4-35-10cc	C-1	June 2, 1953	J	15.8	3/4	G	8.5	Tp	1.6	3,145.68	8.07	Sept. 1, 1953	L,O
16ad	C-2	June 3, 1953	J	17.6	3/4	G	5.0	Tp	1.8	3,154.57	8.48	do	L,O
16dc1	C-4	do	J	14.0	......	N	8.5	......	......	......	......	......	L
16dc2	......	......	......	26.0	......	......	8.5	Tp	.5	3,168.17	13.80	Sept. 1, 1953	O
16dd	C-3	June 3, 1953	J	17.3	3/4	G	7.5	Tp	1.6	3,161.69	10.11	do	L,O
21aa	C-5	June 6, 1953	J	19.8	3/4	G	13.0	Tp	1.6	3,171.10	14.02	do	L,O
21ad	C-6	June 5, 1953	J	26.5	3/4	G	17.0	Tp	1.9	3,182.83	21.34	do	L,O
21cd1	......	1948	Dr	325	4	S	......	......	......	......	Flows	do	B,Ca, F(1)
21cd2	C-8	June 8, 1953	J	23.7	3/4	G	11.6	Tp	1.3	3,187.92	17.25	do	Ca,L,O
21dc	C-7	June 5, 1953	J	31.0	3/4	G	19.8	Tp	1.4	3,193.76	25.72	do	L,O
28bd	C-10	June 10, 1953	J	29.8	3/4	G	24.0	Tp	1.6	3,205.29	25.46	do	L,O
28db	C-9	do	J	41.4	3/4	G	38.0	Tp	1.0	3,219.89	33.20	do	L,O
33ac	C-11	June 11, 1953	J	14.5	3/4	G	9.0	Tp	.9	3,206.29	13.38	Aug. 18, 1953	Ca,L,O
33db	C-12	do	J	22.2	3/4	G	17.0	Tp	1.2	3,213.18	16.27	Sept. 1, 1953	L,O
D5-35- 3cc	......	......	Dr	505	6	......	......	......	......	......	Flows	do	Ca,F(15)
4ab	C-13	July 10, 1953	J	18.3	3/4	G	15.0	Tp	3.1	3,222.66	14.75	do	L,O
4db	C-14	do	J	18.7	3/4	G	7.0	Tp	2.7	3,227.68	10.23	do	L,O
9ad	C-15	do	J	15.8	3/4	G	11.0	Tp	2.2	3,234.18	9.44	do	L,O
9dd	C-16	do	J	8.5	3/4	G	2.0	Tp	.8	3,235.19	6.14	do	L,O

	15cb	C-18	July 13, 1953	J	19.2	3/4	G	12.5	Tp	2.2	3,263.04	12.87	....do....	L,O
	16aa	C-17	....do....	J	24.4	3/4	G	22.0	Tp	2.0	3,262.51	14.58	....do....	L,O
Reno and Battlefield units														
D3-34-	1dc	B-1	Sept. 11, 1952	J	17.4	3/4	G	14.5	Tp	4.0	3,041.2	14.56	Aug. 31, 1953	L,O
	12da	B-2	Aug. 26, 1952	J	26.3	3/4	G	16.0	Tp	1.4	3,054.93	20.52	....do....	L,O
	13aa	B-3	Sept. 11, 1952	J	17.1	3/4	G	10.0	Tp	4.4	3,051.22	7.45	....do....	L,O
	13ab1	B-38	June 1, 1953	J	19.2	3/4	G	8.5	Tp	2.2	3,050.09	6.91	June 9, 1953	D,L
	13da	B-16	May 5, 1953	B,J	7.9	6	A	5.5	Tsf	3.0	3,057.81	6.01	Aug. 31, 1953	Ca,L,OR
	24aa	B-17	May 14, 1953	J	12.3	3/4	G	8.5	Tp	2.7	3,068.96	8.65	....do....	L,O
	36dc	....	....	....	....	....	....	....	....	....	....	....	....	Ca
D3-35-	18ba	B-37	June 1, 1953	J	28.1	3/4	G	20.5	Tp	1.3	3,063.65	19.66	Aug. 31, 1953	L,O
	18bc	....	....	Du	23.2	48	S	....	....	....	....	....	....	Ca
	18cc	B-4	Sept. 11, 1952	J	13.3	3/4	G	8.5	Tp	3.7	3,061.52	6.22	Aug. 31, 1953	Ca,L,O
	18dc	P-3	Dec. 13, 1945	Dr	120	10	I	....	Tp	....	3,060.8	[1]10.87	Sept. 7, 1953	Ca,L,P, OR
	19ba	B-18	May 14, 1953	J	16.5	3/4	G	9.0	Tp	2.9	3,067.00	6.76	Aug. 31, 1953	D,L,O
	19bc	B-5	Sept. 12, 1952	J	16.8	3/4	G	12.5	Tp	2.7	3,070.52	2.60	....do....	D,L,O
	19ca	B-19	May 15, 1953	J	22.9	3/4	G	15.5	Tp	2.5	3,078.42	4.36	....do....	L,O
	19cc	B-20	....do....	J	18.6	3/4	G	16.0	Tp	2.8	3,091.40	9.28	....do....	L,O
	19cd	DR8-1	Sept. 18, 1953	J	16.4	3/4	I	14.5	Tp	2.0	3,080.8	.07	Oct. 13, 1953	L,O
	19dc	B-6	Sept. 12, 1952	J	20.0	3/4	G	14.5	Tp	1.5	3,081.95	4.28	Aug. 31, 1953	L,O
	19dd	B-21	May 15, 1953	J	11.4	3/4	I	10.5	Tp	2.9	3,081.21	4.12	Aug. 17, 1953	D,L,O
	20cc	B-7	Sept. 12, 1952	J	14.8	3/4	G	11.0	Tp	3.2	3,084.95	4.88	Aug. 31, 1953	Ca,L,O
	29ca	B-9	Sept. 16, 1952	J	20.6	3/4	G	12.5	Tp	.9	3,102.51	7.62	....do....	L,O
	29cc1	B-35	May 28, 1953	J	28.2	3/4	G	23.5	Tp	2.5	3,104.22	5.79	....do....	Ca,L,O
	29cc2	B-34	....do....	J	31.0	3/4	G	25.0	Tp	2.4	3,113.30	7.53	....do....	Ca,L,O
	29cd	B-36	....do....	J	26.4	3/4	G	23.3	Tp	2.2	3,106.20	7.64	....do....	Ca,L,O
	29da1	B-40	June 2, 1953	J	14.7	3/4	G	8.0	Tp	2.7	3,095.85	7.41	....do....	L,O
	29da2	B-41	....do....	J	8.9	3/4	G	3.0	Tp	1.5	3,088.96	5.96	....do....	Ca,L,O
	29db	B-42	....do....	J	17.7	3/4	G	6.0	Tp	2.7	3,096.36	3.27	....do....	Ca,L,O
	30ab	B-39	....do....	J	21.2	3/4	G	14.0	Tp	2.3	3,089.58	3.48	....do....	L,O
	30ba	DR8-2	Sept. 23, 1953	J	23.0	3/4	I	18.0	Tp	2.0	3,085.4	1.44	Oct. 13, 1953	L,O

[1]Below measuring point.

Table 28.—*Record of wells and jetted test holes*—Continued

Well: Coordinate system	Well: Field	Date drilled	Type of well	Depth below land surface (feet)	Diameter of casing (inches)	Type of casing	Depth to gravel below land surface (feet)	Measuring point: Description	Measuring point: Height above land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Water level above (+) or below land surface (feet)	Date of measurement	Remarks
Reno and Battlefield units—Continued													
D3-35- 30da	B-8	Sept. 16, 1952	J	20.6	3/4	G	16.0	Tp	1.0	3,093.15	2.50	Sept. 3, 1953	L,O
32ab	DR9-1	Sept. 18, 1953	J	14.3	3/4	I	10.0	Tp	2.1	3,097.5	1.64	Oct. 13, 1953	L,O
32ac	DR9-2	do	J	11.6	3/4	I	6.0	Tp	1.8	3,098.2	+ .12	Oct. 26, 1953	L,O
32ba	B-10	Sept. 17, 1952	J	33.1	3/4	G	31.0	Tp	2.4	3,120.38	12.20	Aug. 31, 1953	L,O
32db1	B-33	May 27, 1953	J	37.0	3/4	G	34.5	Tp	2.4	3,125.00	21.98	do	L,O
32db2	B-11	Aug. 28, 1952	J	31.7	3/4	G	29.0	Tp	1.7	3,126.65	23.47	do	L,O
D4-34- 11da			Dr	43.7	6	I		Tp	.7		19.30	May 24, 1954	Ca
D4-35- 3bb	B-27	May 22, 1953	J	16.6	3/4	I	9.3	Tp	1.8	3,119.87	9.43	Aug. 31, 1953	L,O
3cb	B-25	do	J	16.6	3/4	I	9.8	Tp	2.8	3,127.14	6.06	do	L,O
3cd	B-14	Aug. 28, 1952	J	19.1	3/4	I	16.5	Tp	2.3	3,134.23	9.35	do	L,O,Pl
4ab	B-26	May 22, 1953	J	15.2	3/4	I	9.2	Tp	2.2	3,125.00	4.07	do	Ca,L,O
4bb1	B-32	May 27, 1953	J	17.6	3/4	G	14.0	Tp	1.8	3,119.10	3.17	do	L,O
4bb2	DR10-1	Sept. 18, 1953	J	16.4	3/4	I	14.5	Tp	2.0	3,119.5	2.33	Oct. 13, 1953	L,O
4bc	B-12	Aug. 27, 1952	J	19.9	3/4	G	15.0	Tp	1.6	3,126.41	4.43	Aug. 31, 1953	L,O
5aa	B-22	May 19, 1953	J	19.4	3/4	I	18.0	Tp	2.0	3,124.06	9.04	do	L,O
5ab	B-23	May 21, 1953	J	41.8	3/4	I	40.0	Tp	2.4	3,126.85	4.32	do	L,O
6aa	B-44		Dr	50.9	4	G		Tp	1.0	3,157.10	23.74	do	OR
9aa1	B-45	May 16, 1952	B,J	9.6	6	A	9.0	Tsf	3.0	3,139.00	3.04	do	D,L,OR
9ab	B-43	May 19, 1953	J	19.3	3/4	I	17.0	Tp	2.1	3,139.63	5.48	do	L,O

9ac	B-28	May 26, 1953	J	27.6	3/4	I	18.0	Tp	1.8	3,146.87	2.95	....do	L,O
9ad	B-29	....do	J	16.6	3/4	G	13.0	Tp	2.3	3,143.70	1.61	....do	L,O
9ba	B-13	May 27, 1952	J	18.3	3/4	G	13.0	Tp	3.1	3,139.02	4.88	....do	L,O
9db	B-15	Aug. 27, 1952	J	19.1	3/4	G	15.0	Tp	2.4	3,151.09	8.18	....do	L,O
9dc	B-30	May 26, 1953	J	21.2	3/4	G	17.5	Tp	.2	3,158.81	15.28	....do	L,O
10bb	B-24	May 21, 1953	J	18.3	3/4	I	8.5	Tp	3.1	3,137.62	4.03	....do	L,O
16bd	B-31	May 27, 1953	J	12.0	3/4	G	8.0	Tp	1.8	3,160.19	10.33	....do	Ca,L,O
Agency unit													
D1-34- 19ac	A-2	June 20, 1952	J	12.1	3/4	I	10±	Tp	2.4	2,894.94	4.73	Sept. 26, 1952	L,O
19ba	A-1	....do	J	10.8	3/4	I	5.5	Tp	2.6	2,897.40	Dry	....do	L,O
19da	A-3	....do	J	10.9	3/4	G	5.5	Tp	2.5	2,897.68	3.99	....do	L,O
19dc	A-4	June 19, 1952	J	12.4	3/4	I	6.0	Tp	3.4	2,900.72	6.80	....do	Ca,L,O
20cc	A-5	....do	J	22.4	3/4	I	13.5	Tp	2.5	2,919.10	13.63	....do	Ca,L,O
28cb	A-10A	June 18, 1952	J	10.5	......	N	.0	Tjt	9.5	2,925.89	3.0	......	L
29aa3	A-8	....do	J	26.0	3/4	I	18.5	Tp	3.9	2,929.58	17.67	Sept. 26, 1952	L,O
29ab2	A-7	June 19, 1952	J	25.8	3/4	I	15.5	Tp	1.5	2,927.84	13.79	....do	Ca,L,O
29ad	A-10	June 17, 1952	J	23.2	3/4	I	10.0	Tp	3.2	2,929.21	14.71	....do	L,O
29bc3	A-6	June 19, 1952	J	8.2	3/4	I	3.0	Tp	2.3	2,905.73	4.47	....do	L,O
29db	A-9	June 18, 1952	J	17.2	3/4	I	11.5	Tp	2.8	2,924.12	13.71	....do	L,O
29dd	A-11	June 16, 1952	J	14.6	3/4	I	8.5	Tp	3.1	2,924.85	5.66	....do	L,O
33bb3	A-12	June 17, 1952	J	17.5	3/4	I	9.5	Tp	3.8	2,933.80	3.68	....do	Ca,L,O
33cd3	A-17	June 13, 1952	J	33.9	3/4	I	23.5	Tp	2.0	2,960.95	7.77	....do	Ca,L,O
33da	A-14	June 16, 1952	J	20.0	3/4	I	10.5	Tp	1.1	2,942.52	6.36	....do	Ca,L,O
33db	A-13	....do	J	26.0	3/4	I	18.5	Tp	2.2	2,946.98	4.84	....do	L,O
34cd	A-15	....do	J	19.7	3/4	I	14.5	Tp	1.8	2,947.80	7.26	....do	L,O
D2-34- 2cc1	A-29	May 8, 1952	J	17.5	3/4	I	10.0	Tp	2.5	2,962.14	4.29	....do	L,O
2cc2	A-30	....do	J	19.5	3/4	I	8.5	Tp	3.6	2,966.74	6.90	....do	Ca,L,O
2cd	A-31	May 6, 1952	J	12.9	3/4	I	7.0	Tp	5.3	2,964.73	3.97	....do	Ca,L,O
2dc	A-31A	....do	J	16.0	3	N	9.0	Ls	.0	2,959.58	6.76	....do	L
3aa2	A-20	June 12, 1952	J	17.3	3/4	I	10.0	Tp	3.3	2,957.11	6.11	....do	Ca,L,O
3ab2	A-19	June 11, 1952	J	16.0	3/4	I	13.5	Tp	1.4	2,948.44	7.64	....do	L,O
3ac	A-22	....do	J	19.0	3/4	I	10.5	Tp	1.7	2,955.93	4.86	....do	L,O

Table 28.—*Record of wells and jetted test holes*—Continued

Well: Coordinate system	Well: Field	Date drilled	Type of well	Depth below land surface (feet)	Diameter of casing (inches)	Type of casing	Depth to gravel below land surface (feet)	Measuring point: Description	Measuring point: Height above land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Water level above (+) or below land surface (feet)	Date of measurement	Remarks
Agency unit—Continued													
D2-34- 3bc	A-21	June 11, 1952	J	19.1	3/4	I	12.0	Tp	2.3	2,955.77	4.90	Sept. 26, 1952	Ca,L,O
3cc1	A-25	Apr. 22, 1952	J	21.0	6	G	17.0	Tsf	3.55	2,964.25	5.13	.....do	L,OR
3cc2	A-26	May 19, 1952	J	25.8	3/4	I	7.5	Tp	4.0	2,962.36	4.31	Sept. 15, 1952	L,O
3da	A-23	June 12, 1952	J	12.3	3/4	I	3.0	Tp	.0	2,949.28	1.49	Sept. 26, 1952	L,O
3dc1	1-W	Aug. 8, 1952	J	18.4	3/4	I	9.0	Tp	3.0	2,962.13	4.79	.....do	L
3dc2	P-1	Aug. 7, 1952	J	21.7	2	I	11.0	Tp	3.0	2,962.69	5.59	.....do	Ca,L,O
3dc3	1-E	Aug. 14, 1952	J	22.2	3/4	I	8.5	Tp	3.2	2,963.01	5.40	.....do	L
3dc4	A-28	May 20, 1952	J	22.8	3/4	I	21.0	Tp	3.0	2,964.43	8.63	.....do	L,O
4aa1	A-18	June 12, 1952	J	14.7	3/4	I	11.5	Tp	2.8	2,948.72	1.96	.....do	L,O
4aa2	DR1-1	Sept. 16, 1953	J	9.1	3/4	G	7.5	Tp	2.1	2,945.2	.61	Oct. 12, 1953	D,L,O
4aa3	A-70	Aug. 3, 1953	J	18.1	3/4	G	14.0	Tp	3.3	2,954.1	3.99	Oct. 14, 1953	L,O
4ab	A-69	.....do	J	24.9	3/4	G	22.5	Tp	2.5	2,960.1	6.95	.....do	L,O
4bb2	A-16	June 13, 1952	J	51.9	3/4	I	24.0	Tp	.6	2,970.73	9.57	Sept. 26, 1952	L,O
4da1	A-67	July 31, 1953	J	21.7	3/4	G	13.0	Tp	1.7	2,953.6	3.12	Oct. 14, 1953	L,O
4da2	A-65	.....do	J	21.5	3/4	G	13.0	Tp	1.9	2,957.3	4.00	.....do	L,O
4db1	A-68	Aug. 3, 1953	J	33.1	3/4	G	(2)	Tp	3.3	2,975.1	14.60	.....do	L,O
4db2	A-66	July 31, 1953	J	22.7	3/4	G	18.0	Tp	1.7	2,965.4	9.23	.....do	L,O
9aa	A-24	June 11, 1952	J	6.5	3/4	I	(2)	Tp	5.0	3,035.40	1.06	Sept. 26, 1952	L,O
10ab1	1-S	Aug. 20, 1952	J	24.7	3/4	I	7.0	Tp	3.5	2,963.10	5.0	....	L
10ab2	A-27	May 19, 1952	J	23.0	3/4	I	13.5	Tp	1.8	2,961.63	5.43	Sept. 26, 1952	L,O

10da2	A-33	July 31, 1952	J	28.9	3/4	I	21.0	Tp	2.4	2,983.55	8.32	.....do	L,O
11cc2	A-34	July 30, 1952	J	29.8	3/4	I	20.0	Tp	4.0	2,989.19	7.94	.....do	L,O
11da	A-32	July 31, 1952	J	13.6	3/4	I	8.5	Tp	3.6	2,975.61	7.32	.....do	Ca,L,O
13cb	A-39	July 29, 1952	J	26.4	3/4	I	20.0	Tp	2.7	2,991.64	6.70	.....do	L,O
13cc	A-41	July 25, 1952	J	30.0	3/4	I	27.0	Tp	3.5	3,004.89	6.98	.....do	L,O
13cd	A-42	July 24, 1952	J	21.3	3/4	I	7.5	Tp	.1	2,989.19	7.06	.....do	L,O
13dd	A-43	.....do	J	17.9	3/4	I	6.0	Tp	3.5	2,994.49	7.68	.....do	Ca,L,O
14aa	A-37	July 29, 1952	J	17.8	3/4	I	16.0	Tp	3.6	2,983.31	3.23	.....do	L,O
14ab2	A-36	July 30, 1952	J	19.2	3/4	I	12.5	Tp	2.4	2,980.64	5.89	.....do	Ca,L,O
14ba	A-35	May 15, 1952	B	15.4	6	A	12.0	Tp	2.6	2,982.00	3.82	.....do	L,OR
14ca	A-38	July 30, 1952	J	23.0	3/4	I	13.0	Tp	.9	2,987.08	3.63	.....do	Ca,L,O
23aa	A-40	July 28, 1952	J	37.3	3/4	I	29.0	Tp	1.7	3,008.80	11.60	.....do	Ca,L,O
23ad	A-44	July 23, 1952	J	25.1	3/4	I	21.5	Tp	4.0	3,001.35	1.65	.....do	L,O
24da	A-46	Aug. 5, 1952	J	18.5	3/4	I	6.0	Tp	2.7	2,996.42	6.52	.....do	L,O
24db	A-45	July 23, 1952	J	26.1	3/4	I	17.0	Tp	2.3	3,002.64	4.39	.....do	Ca,L,O
24dc	A-48	July 18, 1952	J	15.5	3/4	I	11.5	Tp	2.5	3,005.17	1.45	.....do	D,L,O
24dd	A-49	.....do	J	16.4	3/4	I	5.5	Tp	3.1	3,000.33	5.20	.....do	Ca,L,O
25ad	A-51	July 17, 1952	J	21.4	3/4	I	10.0	Tp	2.1	3,009.62	7.38	.....do	L,O
25bb	A-47	July 22, 1952	J	22.4	3/4	I	11.0	Tp	2.4	3,006.71	2.77	.....do	L,O
25bd	A-50	Apr. 23, 1952	B	14.0	6	G	11.0	Tp	.6	3,008.90	1.94	.....do	L,OR
25ca1	DR4-1	Sept. 16, 1953	J	14.0	3/4	G	11.5	Tp	1.4	3,012.4	1.36	Oct. 12, 1953	L,O
25ca2	A-52	July 16, 1952	J	29.7	3/4	I	23.0	Tp	1.8	3,022.01	7.16	Sept. 26, 1952	L,O
25cd	A-54	July 11, 1952	J	39.4	3/4	I	29.0	Tp	3.0	3,033.22	6.19	.....do	Ca,L,O
36ab	A-55	.....do	J	25.8	3/4	I	19.0	Tp	2.0	3,025.35	6.25	.....do	L,O
36ac	DR5-1	Sept. 16, 1953	J	16.8	3/4	I	10.0	Tp	1.6	3,018.7	.40	Oct. 12, 1953	L,O
36ca1	A-57	July 15, 1952	J	26.0	3/4	I	25.0	Tp	2.9	3,041.56	12.74	Sept. 26, 1952	L,O
36ca2	DR6-1	Sept. 16, 1953	J	14.1	3/4	I	10.3	Tp	2.3	3,024.6	1.47	Oct. 12, 1953	L,O
36db1	A-62	July 1, 1952	B,J	10.5	6	A	10.8	Tsf	3.0	3,025.27	4.40	Sept. 27, 1952	L,OR
36db2	2-S1	Aug. 22, 1952	J	18.9	3/4	I	10.0	Tp	2.5	3,024.98	4.96	Sept. 26, 1952	L
36db3	P-2	Aug. 21, 1952	J	22.0	2	G	10.0	Tp	2.5	3,025.00	4.69	.....do	Ca,L
36db4	2-E1	Sept. 5, 1952	J	13.1	3/4	I	11.0	Tp	3.5	3,026.11	5.17	.....do	L
36db5	2-E2	Aug. 21, 1952	J	22.2	3/4	I	12.0	Tp	3.8	3,026.09	4.93	.....do	L
36db6	2-E3	Sept. 5, 1952	J	18.9	3/4	I	11.0	Tp	2.7	3,024.72	4.64	.....do	L

[2] No gravel penetrated.

Table 28.—*Record of wells and jetted test holes*—Continued

Well: Coordinate system	Well: Field	Date drilled	Type of well	Depth below land surface (feet)	Diameter of casing (inches)	Type of casing	Depth to gravel below land surface (feet)	Measuring point: Description	Measuring point: Height above land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Water level above (+) or below land surface (feet)	Date of measurement	Remarks
Agency unit—Continued													
D2-34-36db7	2-E4	Sept. 5, 1952	J	18.4	3/4	I	11.0	Tp	3.1	3,024.77	4.42	Sept. 26, 1952	L
36dd	A-59	July 9, 1952	J	24.2	3/4	I	15.5	Tp	2.3	3,023.99	6.45	....do....	L,O
D2-35-30cb	A-53	July 11, 1952	J	19.6	3/4	I	7.5	Tp	1.8	3,011.02	2.88	....do....	Ca,L,O
31bb	A-56	July 10, 1952	J	25.1	3/4	I	18.0	Tp	2.2	3,018.68	7.25	....do....	L,O
31bc	A-58	....do....	J	19.1	3/4	I	5.0	Tp	2.1	3,018.23	4.25	....do....	L,O
D3-34-1aa	A-61	July 8, 1952	J	10.1	3/4	I	7.5	Tp	2.5	3,025.61	6.95	....do....	D,L,O
1ac1	CP-3	Sept. 17, 1952	J	19.0	3/4	I	3.0	Tp	2.5	3,039.91	8.03	....do....	L,O
1ac2	CP-2	....do....	J	20.2	3/4	I	7.0	Tp	1.3	3,041.35	11.01	....do....	L,O
1ac3	CP-1	....do....	J	27.1	3/4	I	16.5	Tp	2.6	3,037.24	5.69	....do....	L,O
1ac4	CP-4	Sept. 18, 1952	J	9.6	3/4	I	8.5	Tp	4.0	3,038.83	6.36	....do....	L,O
1ac5	CP-5	....do....	J	8.2	3/4	I	6.0	Tp	3.4	3,036.58	4.95	....do....	L,O
1ac6	CP-8	Sept. 19, 1952	J	11.9	3/4	I	8.0	Tp	1.8	3,035.51	5.58	....do....	L,O
1ac7	A-64	Aug. 8, 1952	B,J	11.5	6	A	11.3	Tsf	3.0	3,039.31	6.82	....do....	L,OR
1ac8	CP-6	Sept. 18, 1952	J	12.8	3/4	I	8.5	Tp	1.6	3,034.89	5.42	....do....	L,O
1ad1	....	....	Du	20.1	30	M	....	Tpf	1.8	....	13	....	Ca
1ad2	A-63	July 2, 1952	J	23.9	3/4	I	6.5	Tp	2.1	3,029.25	8.53	Sept. 26, 1952	Ca,L,O
1ba	A-60	July 15, 1952	J	25.6	3/4	I	20.5	Tp	3.7	3,041.66	10.53	....do....	L,O
1bd	CP-7	Sept. 18, 1952	J	14.4	3/4	I	13.0	Tp	3.9	3,040.17	6.41	....do....	L,O

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Bibliography: p. 115–117.

1. Water, Underground—Montana—Big Horn Co. 2. Water-supply—Montana—Big Horn Co. 3. Water—Analysis. 4. Drainage—Montana—Big Horn Co. I. Krieger, Robert Albert, 1918– II. Title: Lower Little Bighorn River valley, Big Horn County, Montana. (Series)