Ground-Water Resources of the Wind River Indian Reservation Wyoming

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1576-I

Prepared as part of the program of the Department of the Interior for development of the Missouri River basin

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By LAURENCE J. McGREEVY, WARREN G. HODSON, *and* SAMUEL J. RUCKER IV

WATER SUPPLY OF INDIAN RESERVATIONS

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By Laurence J. McGreevy, Warren G. Hodson, and Samuel J. Rucker iv

ABSTRACT

The area of this investigation is in the western part of the Wind River Basin and includes parts of the Absaroka, Washakie, Wind River, and Owl Creek Mountains. The purposes of the study were to determine the general hydrologic properties of the rocks in the area and the occurrence and quality of the water in them. Structurally, the area is a downfolded basin surrounded by upfolded mountain ranges. Igneous and metamorphic rocks of Precambrian age are exposed in the mountains; folded sedimentary rocks representing all geologic periods, except the Silurian, crop out along the margins of the basin; and relatively flat-lying Tertiary rocks are at the surface in the central part of the basin. Surficial sand and gravel deposits of Quaternary age occur along streams and underlie numerous terraces throughout the basin.

The potential yield and quality of water from most rocks in the area are poorly known, but estimates are possible, based on local well data and on data concerning similar rocks in nearby areas. Yields of more than 1,000 gpm are possible from the rocks comprising the Bighorn Dolomite (Ordovician), Darby Formation (Devonian), Madison Limestone (Mississippian), and Tensleep Sandstone (Pennsylvanian). Total dissolved solids in the water range from about 300 to 3,000 ppm.

Yields of as much as several hundred gallons per minute are possible from the Nugget Sandstone (Jurassic? and Triassic?). Yields of 20 gpm or more are possible from the Crow Mountain Sandstone (Triassic) and Sundance Formation (Jurassic). Dissolved solids are generally high but are less than 1,000 ppm near outcrops in some locations.

The Cloverly and Morrison (Cretaceous and Jurassic), Mesaverde (Cretaceous) and Lance(?) (Cretaceous) Formations may yield as much as several hundred gallons per minute, but most wells in Cretaceous rocks yield less than 20 gpm. Dissolved solids generally range from 1,000 to 5,000 ppm but may be higher. In some areas, water with less than 1,000 ppm dissolved solids may be available from the Cloverly and Morrison Formations.

Tertiary rocks yield a few to several hundred gallons per minute and dissolved solids generally range from 1,000 to 5,000 ppm. Wells in the Wind River Formation (Eocene) yield about 1–500 gpm of water having dissolved solids of about 200–5,000 ppm.

Yields of a few to several hundred gallons per minute are available from alluvium (Quaternary). Dissolved solids range from about 200 to 5,000 ppm.

Many parts of the Wind River Irrigation Project have become waterlogged. The relation of drainage problems to geology and the character and thickness of rocks in the irrigated areas are partly defined by sections drawn on the basis of test drilling. The drainage-problem areas are classified according to geologic similarities into five general groups: flood plains, terraces, underfit-stream valleys, slopes, and transitional areas.

Drainage can be improved by open drains, buried drains, relief wells, and pumped wells or by pumping from sumps or drains. The methods that will be most successful depend on the local geologic and hydrologic conditions. In several areas, the most effective means of relieving the drainage problem would be to reduce the amount of infiltration of water by lining canals and ditches and by reducing irrigation water applications to the optimum.

Water from underground storage in alluvium could supplement water from surface storage in some areas. A few thousand acre-feet of water per square mile are in storage in some of the alluvium. The use of both surface and underground storage would reduce the need for additional surface-storage facilities and also would alleviate drainage problems in the irrigated areas.

INTRODUCTION

LOCATION AND EXTENT OF THE AREA

The area of this investigation consists of about 3,500 square miles in west-central Wyoming and includes most of central and western Fremont County and part of southern Hot Springs County. It is the area within the outer boundary of the Wind River Indian Reservation. The area of the investigation and areas of related ground-water studies are shown in figure 1.

PURPOSE AND SCOPE OF THE INVESTIGATION

This study was conducted by the U.S. Geological Survey at the request of the U.S. Bureau of Indian Affairs as a part of the program of the Department of the Interior for development of the Missouri River basin.

The purposes of this investigation were to determine the general hydrologic properties of geologic formations in the area and the occurrence and quality of ground water in them. Of particular need were data concerning the availability of water for domestic and stock use and data concerning drainage problems in the Wind River Irrigation Project.

Fieldwork for this investigation was carried on during 1965 and 1966. Records of 387 wells in the area were collected and tabulated; water samples were collected from selected wells for chemical analysis. Specific conductances were determined in the field for some waters. Periodic measurements of selected wells were made to observe water-level fluctuations. Drillers' logs were collected from local drillers, from

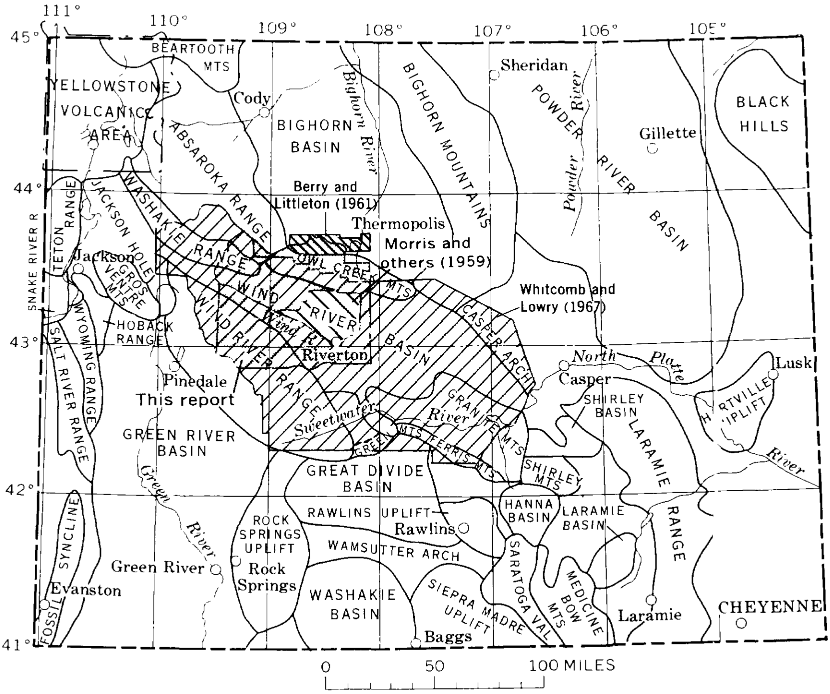


FIGURE 1.—Structural feature map showing the area of this study and areas of related ground-water studies. Adapted from Love (1961).

the Indian Health Center on the Wind River Indian Reservation, and from the files of the Wyoming State Engineer. Additional subsurface information was obtained from several hundred feet of test augering in 1965 and from about 6,000 feet of test drilling contracted in 1966. The general thickness and character of the alluvium and the relation of the deposits to areas of drainage problems were determined by test drilling in the principal valleys, mostly in the irrigated areas. Additional drilling was done in remote areas of the reservation, previously untested for water, to determine the ground-water potential for the stock-grazing industry. Data collected for previous studies (Morris and others, 1959; Berry and Littleton, 1961) were also used in arriving at the conclusions of the report.

A geologic map was compiled at a scale of 1:125,000 from existing geologic maps of the area (pl. 2). The details, purposes, and scales of the existing maps varied considerably and, at the scale of the compilation, all geologic contacts must be considered approximate. Discrepancies in contacts of Quaternary units were minimized by using 7½-minute topographic maps, aerial photographs, and data from test drilling.

PREVIOUS INVESTIGATIONS

Reports of ground-water studies have been published on the Riverton Irrigation Project (Morris and others, 1959), which includes an area of about 500 square miles between the Wind River and the south flank of the Owl Creek Mountains, and on the Owl Creek area (Berry and Littleton, 1961), which includes an area of about 250 square miles along the north flank of the Owl Creek Mountains. Little additional fieldwork in these areas was done in conjunction with this investigation. A reconnaissance of the ground-water resources of the Wind River Basin was made by Whitcomb and Lowry (1967). The locations of areas of these previous ground-water investigations are shown in figure 1.

Geologic studies pertinent to this study include reports by Keefer and Van Lieu (1966) on Paleozoic formations in the Wind River Basin; by Keefer (1965a) on the Upper Cretaceous, Paleocene, and Eocene rocks of the Wind River Basin; and by Keefer and Troyer (1964) on the geology of the Shotgun Butte area in the north-central part of the Wind River Indian Reservation. The index map on plate 2 shows the locations of areas of these studies and of areas described by other maps and reports that provide the principal sources of geologic data used in this study. References to other pertinent reports are listed at the end of this report.

ACKNOWLEDGMENTS

The authors are indebted to well owners and drillers who furnished essential information regarding wells and to the many persons who assisted in the collection of information and in the preparation and review of this report. Special thanks are due John T. Myers, of the U.S. Public Health Service, and William L. Benjamin and the late John Jolley, of the U.S. Bureau of Indian Affairs, who gave assistance in obtaining data.

WELL-NUMBERING SYSTEM

Wells, springs, and test holes referred to in this report are numbered according to their location within the Federal system of land subdivision. Each number shows the location by township, range, section, and location within the section. The uppercase letter that begins the number designates the quadrant of the Wind River Meridian and Base Line system. The quadrants are lettered A, B, C, and D in a counterclockwise direction beginning with A in the northeast quadrant. The first numeral denotes the township; the second numeral, the range; and the third numeral, the section in which the well or test hole is located. The lowercase letters after the section number indicate the location within the section as follows: The first letter denotes the quarter section; the second letter, the quarter-quarter section; and the third letter, if used, the quarter-quarter-quarter section (10-acre tract). The subdivisions of the sections are lettered a, b, c, and d in a counterclockwise direction beginning with "a" in the northeast quarter. If more than one well is listed in the smallest subdivision used, they are differentiated by consecutive numerals (starting with 1) that are added to the well or test-hole number. For example, well D1–2–15abc is in the SW¼NW¼NE¼ sec. 15, T. 1 S., R. 2 E. (fig. 2).

TERMINOLOGY

Many terms and abbreviations that are used in this report may be unfamiliar to the reader, or the terms may be used in other reports in a less restricted or in a slightly different sense than they are used in this report. The following definitions should clarify the intended meanings.

Aquifer. A rock formation, bed, or zone that will yield water to wells or springs. If one or more water-bearing units are hydraulically connected, these units may be considered as one aquifer. An aquifer may be *confined* (artesian) or *unconfined* (water table). A *confined aquifer* is overlain by relatively impermeable rock, and the water in a well will rise above the top of the aquifer. In an *unconfined aquifer*, the level to which water will rise in a well is below the top of the aquifer.

Alluvium. Deposits that have been transported and deposited by streams. Alluvium, as herein used, is restricted to deposits of Quaternary age that underlie the flood plains and terraces. Alluvium grades into slope wash along the valley sides; deposits that are predominantly stream laid are referred to as alluvium.

Clastic rock. A rock composed of fragments of preexisting rock. Most clastic rocks are shale, sandstone, conglomerate, clay, silt, sand, or gravel.

Coefficient of storage. The coefficient of storage of an aquifer is defined as the volume of water released from or taken into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface (Ferris and others, 1962).

Colluvial deposits. Slope wash and material transported principally by gravity.

Cuesta. A ridge with one long and gentle slope and one relatively steep slope.

Dissolved solids. Minerals in solution in water. As used in this report, it refers to the total concentration of dissolved solids in water.

gpd. Abbreviation of *gallons per day.*

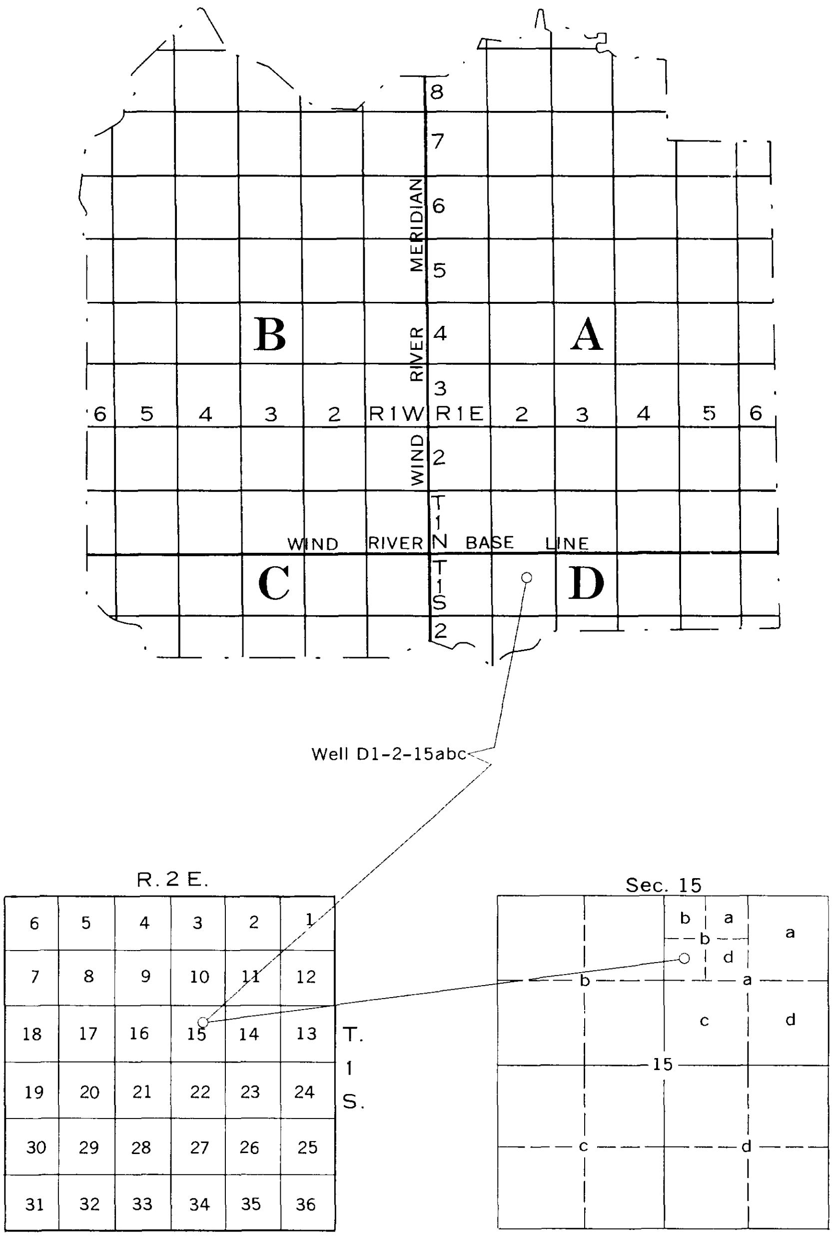


FIGURE 2.—Well-numbering system.

gpm. Abbreviation of *gallons per minute.*

Infiltration. The flow or seepage of water into rocks or soil through pores or small openings.

Intermittent stream. A stream that flows only part of the time.

ppm. Abbreviation of *parts per million;* the unit of expression for the concentration of dissolved material in water. One part per million is one unit weight of dissolved material per million unit weights of water.

Perennial stream. A stream that flows all the time.

Permeability. The capacity of materials to transmit water. The measure of permeability used in this report is the *field coefficient of permeability*, which is defined as the rate of flow of water in gallons per day through a cross-sectional area of 1 square foot under a hydraulic gradient of 1 foot per foot at the prevailing water temperature (Ferris and others, 1962). It is expressed in gallons per day per square foot (gpd/ft^2).

Physiography. As used in this report, it is restricted to description of landforms, the topographic features.

Recharge. The process by which water moves into an aquifer, or the amount of water that moves into an aquifer.

Specific capacity. The amount of water discharged from a well per unit of drawdown. It is expressed as gallons per minute per foot of drawdown (gpm/ft).

Specific conductance. A measure of the ability of a water to conduct electricity. Specific conductance is expressed in mhos (reciprocal of ohms) per centimeter times 10^6 (micromhos per centimeter) and is adjusted to a standard temperature of 25° C. Specific conductance is related to the amount of dissolved solids in water, but the relation depends on the particular minerals present. The ratio of total dissolved solids (in parts per million) to specific conductance (in micromhos per centimeter at 25° C) ranges from about ½ : 1 to 1 : 1, but is usually nearer ⅔ : 1. Specific conductance is easily measured in the field and provides a quick estimate of the dissolved solids.

Specific yield. The ratio of the volume of water that will drain by gravity from a saturated material to the volume of the material. It is expressed as a percentage

$$\left(\frac{\text{volume of water}}{\text{volume of material}} \times 100\right).$$

Transmissibility. The capacity of the full saturated thickness of an aquifer to transmit water. The measure of transmissibility used in this report is the *coefficient of transmissibility*, which is defined as the rate of flow of water, at the prevailing water temperature, in gallons per day, through a vertical strip of the aquifer 1 foot wide extending the full saturated height of the acquifer under a hydraulic gradient of 1 foot per foot (Ferris and others, 1962). It is expressed in gallons per day per foot (gpd/ft). The coefficient of transmissibility is equal to the product of the saturated thickness times the field coefficient of permeability.

Transpiration. The process by which water moves from living plants to the atmosphere.

Underfit stream. A stream that occupies a valley that was formed by a much larger stream. Dury (1964a, b) discusses underfit streams.

Water table. The top of the zone of saturation in an unconfined aquifer.

GEOGRAPHIC SETTING

PHYSIOGRAPHY AND DRAINAGE

The Wind River Indian Reservation is in the western part of the Wind River Basin, which is a structural and topographic basin typical of the Rocky Mountain physiographic system. The southwestern boundary of the reservation extends along the crest of the Wind River Mountains; the northern part of the reservation includes parts of the Washakie, Absaroka, and Owl Creek Mountains. The Wind River Basin is a large structural basin that approximately coincides with the topographic basin. Altitudes range from about 4,400 feet at the north end of the Wind River Canyon to more than 13,000 feet on the crest of the Wind River Mountains. In most of the central part of the basin, the altitude is between 4,800 and 6,000 feet. Upturned rocks of Paleozoic and Mesozoic age form distinct cuestas and hogbacks along the mountain fronts, and, in the central part of the basin, nearly horizontal rocks of Tertiary age form generally broad valleys and prominent gravel-capped mesas and buttes. The Wind River valley is relatively deep compared to most other stream valleys in the basin, and high bluffs border the river in many places. Mesas and buttes form drainage divides between the smaller streams.

The Wind River is the master stream in the area, originating in the Absaroka Mountains in the northwest corner of the Wind River Basin. The Wind River flows southeastward parallel to the Wind River Mountains to its confluence with the Little Wind River near Riverton where it turns northward, eventually flowing through the Wind River Canyon into the Bighorn Basin where the river is called the Bighorn River. The larger tributaries to the Wind River head in the Wind River and Absaroka Mountains. The principal tributaries, within the area of this investigation, are Bull Lake Creek, the Little Wind River, and the Popo Agie River in the southern part of the area; Crow Creek in the northwestern part; and Fivemile Creek and Muddy Creek in the central part.

CLIMATE AND POPULATION

The climate ranges from humid in the Wind River and Owl Creek Mountains to arid in the central part of the area. Mean annual temperature at Riverton for the period of reference, 1931–60, is 43.5° F. Wide ranges in seasonal temperatures are common—winter temperatures commonly dropping far below 0° F, and summer temperatures frequently exceeding 100° F. Mean annual precipitation at Riverton for the period 1931–60 was 8.79 inches. Annual precipitation ranged from 4.85 to 14.74 inches. Mean annual precipitation at Lander, just south of the report area at the edge of the Wind River Mountains, was 13.58 inches. The generalized areal distribution of mean annual precipitation on the reservation has been mapped by the U.S. Bureau of Indian Affairs (1962) and is shown in figure 3.

Much of the population is rural. Riverton, the largest town in the area, has a population of about 6,900. The Wind River Reservation is the home of more than 3,000 Shoshone and Arapahoe Indians.

OWNERSHIP OF THE LAND

Ownership of the lands of the report area has evolved from historical events discussed in Duntsch (1965), Gerharz (1949), U.S. Bureau of Indian Affairs (1962), and U.S. Bureau of Reclamation (1950). The first non-Indians settled in the Wind River Basin in the early 1860's. Treaties of 1863 and 1868 with the Shoshone Indians established the Wind River Reservation with boundaries nearly identical to the area of this study. In 1877 the Federal Government obtained permission from the Shoshone Tribe to bring a tribe of Northern Arapahoe to the reservation, temporarily, until one for the Arapahoes could be established. The reservation was never established and the Arapahoe and Shoshone Indians now share the Wind River Reservation.

In 1904 the land north of the Wind River and the land southeast of the Popo Agie River, which together consisted of about two-thirds of the reservation, were ceded to the United States. The ceded land was opened to homesteading in 1906, and the townsite of Riverton was established. Part of the ceded land was repurchased by the tribes, and part was restored to tribal ownership by legislation; however, some is still privately owned by non-Indians. Most of the land within the outer boundary of the reservation, except for the Riverton Irrigation Project and Boysen Reservoir withdrawal areas (pl. 3), is owned by the tribes.

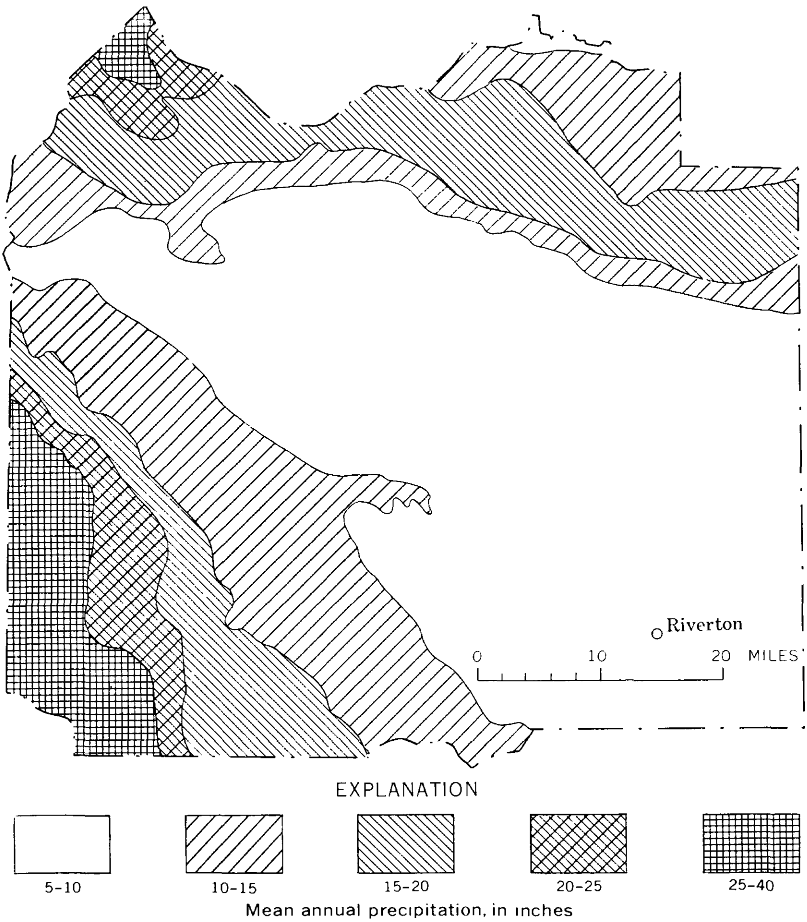


FIGURE 3.—Generalized areal distribution of mean annual precipitation. Adapted from U.S. Bureau of Indian Affairs (1962).

PRESENT DEVELOPMENT OF GROUND WATER

Development of ground water has been principally for stock watering and for domestic and public supplies. Privately owned wells furnish water to oil fields and a few industries at Riverton. In the Owl Creek valley, irrigation water from streams is supplemented with water from wells, but in the rest of the reservation, irrigation depends entirely on surface supplies.

Most wells are in the area of the Riverton Irrigation Project (pl. 3) and in the areas along the Wind and Little Wind Rivers. Except for test drilling that was done for this study, many remote areas are virtually untested for water. Locations of wells and data concerning the chemical quality of water from the wells are shown on plate 1.

Domestic and public supplies generally utilize ground water, although surface water is used at some localities. Municipally owned wells furnish water to Riverton, Pavillion, Hudson, and Shoshoni. The wells furnishing water to Hudson are south of the reservation boundary (Whitcomb and Lowry, 1967); Shoshoni, 3 miles east of the reservation boundary, is supplied by wells inside the boundary. An infiltration gallery in the bed of the South Fork Little Wind River supplies water to Fort Washakie. Mill Creek School, 3 miles south of Ethete, and the community of Ethete are supplied by separate infiltration galleries in the bed of the Little Wind River near Ethete. Cooperative community wells are being considered to serve homes in the Arapahoe area. In other communities and in rural areas, homes depend on individually owned wells.

GEOLOGIC SETTING

STRUCTURE

The structural framework of the area consists of a downfolded basin bounded on the north and southwest by upfolded and faulted mountain ranges. Vertical structural displacement is more than 30,000 feet between the basin and the mountains. Keefer (1965a) gives a detailed account of the structural development of the area during Laramide deformation. Major structures and generalized structure contours are shown on plate 2. Two deep structural troughs are separated by a central anticlinal structure which trends northwestward through the basin approximately parallel to the Wind River Mountains. Major oil fields in the area are on the central anticlinal structure and on a parallel structure of lesser magnitude to the northeast.

Formation of the basin began in Late Cretaceous time and continued into Eocene time. As the basin subsided in relation to the bordering highlands, sediments accumulated in the depression. Along the margins of the basin, the rocks of Paleozoic and Mesozoic age dip basinward at angles ranging from about 10° on the flanks of the Wind River Mountains to vertical or overturned along the northern mountains. Rocks of early Eocene age, which occur at the surface in much of the basin, are nearly flat lying in most of the area. Dips measured in the lower Eocene Wind River Formation (pl. 2) indicate that the structure of this formation is extremely subdued, but corresponds to the structure of the underlying rocks. The subdued structure may be partly depositional, but some deformation of the formation has occurred along the margins of the basin and on the central anticlinal structure.

STRATIGRAPHY

Igneous and metamorphic rocks of Precambrian age comprise the core of the mountain ranges and underlie sedimentary rocks within the basin. Sedimentary rocks have a maximum thickness of more than 40,000 feet and represent all geologic periods except the Silurian. Descriptions of sedimentary units are given in table 1, and the relation of these units to ground water are discussed in the table and in another section. Outcrop areas of the rocks are shown on the geologic map (pl. 2).

GROUND WATER

OCCURRENCE

Ground water occurs in rocks in the open spaces between grains, in fractures, or in solution openings. The water is derived from precipitation either directly or from seepage of surface waters. Water moves through the rocks from recharge areas to discharge areas at rates dependent on the gradient and the permeability of the rocks. Principles of occurrence are described in Meinzer (1923a) and in E. E. Johnson, Inc. (1966).

RECHARGE AND DISCHARGE

Rocks older than the Wind River Formation are recharged primarily in their outcrop areas by streams and by direct infiltration of precipitation; some movement of water between formations probably occurs where the rocks are buried. Most discharge from the rocks is through springs where the rocks have been cut into by streams. Discharge to wells is minor because few wells tap these rocks.

The Wind River Formation crops out, or is thinly covered by alluvium or slope wash, in most of the basin. In their upper reaches, streams crossing the formation generally contribute water to it. In their lower reaches, many of these streams drain parts of the formation. Some water-bearing rocks of the formation are at higher altitudes than nearby streams. Water in these rocks comes from direct infiltration of precipitation or, in some areas, from irrigation.

Hundreds of wells tap the Wind River Formation, but most wells discharge only a small amount of water. Almost 500 million gallons of water per year are withdrawn from the formation by wells in the Riverton well field. Figures are not available for other wells, but the total withdrawal from the formation by wells, including those in the Riverton well field, is estimated at 700–800 million gallons per year.

Alluvium is recharged primarily from streams and irrigation, but some water is derived from direct infiltration of precipitation. Water in alluvium adjacent to the streams moves to or from the streams, de-

TABLE 1.—*Generalized section of the geologic units and potential water supply*

Era	System	Series	Map unit where stratigraphic units are combined	Stratigraphic unit (approximate thickness, in feet [1])	Physical character [2]	Potential water supply [3]
CENOZOIC	Quaternary	Pleistocene and Recent		Alluvium of flood plains and related low terraces (0–100±)	Gravel, sand, silt, clay, cobbles and boulders, unconsolidated. Present in stream valleys throughout the area.	Yields range from a few gallons to several hundred gallons per minute. Dissolved solids in the water range from about 200 to 2,000 ppm.
				Slope wash and alluvium (includes some windblown deposits) (0–80±)	Silt, clay, sand, and gravel, unconsolidated. Present in valleys and on moderate slopes in much of the area.	Yields range from zero to as much as several hundred gallons per minute. Dissolved solids range from about 500 to 5,000 ppm.
				Terrace and pediment deposits (0–80±)	Gravel, sand, silt, cobbles, and boulders, unconsolidated. Underlie terraces and pediments throughout the basin and along the margins of the mountains.	In irrigated areas, yields range from a few gallons to several hundred gallons per minute; dissolved solids generally range from about 300 to 2,000 ppm, but may be much higher where drainage is poor. In unirrigated areas, the deposits are largely drained.
				Landslide and steep-slope colluvial deposit	Rubble, blocks, and talus, unconsolidated. Occur in or along the margins of the mountains.	Not considered an aquifer, but may yield water locally to springs. Dissolved solids are probably less than 2,000 ppm.
				Travertine deposits	Spring deposits associated with dissected high terraces west of Bull Lake along the northeast slope of the Wind River Mountains.	
				Glacial deposits	Silt, sand, gravel, cobbles, and boulders; unconsolidated till and outwash. Present on northeast slope of Wind River Mountains.	Yields of 50 gpm or more may be possible from outwash, but till generally does not yield water. Dissolved solids are probably less than 500 ppm. Many of these rocks are topographically high and are largely drained.
		Oligocene		Wiggins Formation (0–1,000±)	Volcanic conglomerate, breccia, and tuff; tuff is pink, light gray, and white; volcanic fragments are generally dark. Present in the extreme northwestern part of the area.	

See footnotes at end of table.

TABLE 1.—*Generalized section of the geologic units and potential water supply*—Continued

Era	System	Series	Map unit where stratigraphic units are combined	Stratigraphic unit (approximate thickness, in feet [1])	Physical character [2]	Potential water supply [3]
CENOZOIC	Tertiary	Eocene	Tepee Trail Formation (0–1,500±)	Unnamed tuff (0–300+)	Tepee Trail Formation: Volcanic conglomerate, breccia, sandstone, shale, and tuff; interbedded; green, olive, and brown. Present in the extreme northwestern part of the area. Unnamed tuff: Tuff, fine- to coarse-grained, volcanic conglomerate, and some limestone; yellow green, green, olive, and gray. Present along the north-central margin of the basin. These rocks are probably contemporaneous in part to the Tepee Trail Formation of the northwestern part of the basin and to the Wagon Bed Formation (Van Houten, 1964) of the southern part of the basin.	Water wells are not known to tap these units. The units are largely drained because of their high topographic position. Where the units contain water, yields of as much as 50 gpm may be possible. Dissolved solids in water from most of these rocks would probably be less than 2,000 ppm.
			Aycross Formation (0–1,000+)		Tuff, claystone, shale, sandstone, and conglomerate; greenish gray to brightly variegated; highly tuffaceous; contains abundant volcanic rock fragments. Present in the northwestern part of the area.	
			Wind River Formation (0–5,000±)		Sandstone, conglomerate, siltstone, claystone, and shale; contains a small amount of bentonite, tuff, and limestone; red, gray, green, purple, white, tan, and brown. Present throughout the central part of the area.	Many wells tap this formation. Yields of wells range from about 1 to 500 gpm. Dissolved solids range from about 200 to 5,000 ppm.
			Indian Meadows Formation (0–3,000±)		Conglomerate, sandstone, claystone, siltstone, and some algal-ball limestone; variegated red, purple, lavender, tan, gray, green, buff, brown, and white; reddish colors are generally predominent. The formation crops out in	Water wells are not known to tap this formation. Yields of as much as 50 gpm may be possible, but some of the rocks will not yield water. Dissolved solids probably range from about 1,000 to 5,000 ppm.

				the northern part of the area, but is not known in the southern. It underlies the Wind River Formation in most of the central part of the area.	
		Paleocene	Fort Union Formation (0–7,000±)	Sandstone, conglomerate, shale, and siltstone, interbedded. Along the north side of the Wind River Basin, the formation has been divided into upper and lower parts. The upper part consists of the Shotgun and Waltman Shale Members. The Shotgun Member (0–2,800+ ft) consists of even-bedded, soft siltstone, shale, sandstone, and some conglomerate; colors are gray, olive, buff, brown, tan, red, and purple. Sandstones are mostly fine-grained and porous. To the east, the Shotgun Member interbeds with and overlies the Waltman Shale Member (0–1,000+ ft), which consists of dark-brown and black shale with some interbedded sandstone. The lower part is not named. It is predominantly sandstone and conglomerate with lesser amounts of gray and brown shale. Sandstone is fine to coarse grained, thin bedded to massive; conglomerate is lenticular; colors are white, gray, buff, and brown. The formation thins toward the southwest. In the south, the formation is not divided. It consists of interbedded white, gray, tan, and brown sandstone, conglomerate, shale, and siltstone. The formation is not present in the western part of the area.	Yields of several hundred gallons per minute may be possible from the complete section of rocks, but most wells tap only a small part of the formation and have yields of less than 10 gpm. Dissolved solids range from about 1,000 to 5,000 ppm.
MESOZOIC	Cretaceous	Upper	Lance(?) Formation (0–1,200)	Sandstone, conglomerate, claystone, and shale. Sandstones are gray, buff, and brown; fine to coarse grained; massive to thin bedded. Conglomerate occurs with the sandstone in thin beds or irregular lenses; it locally contains rounded pebbles and cobbles. Claystone and shale are mostly gray and black with some maroon and purple. Carbonaceous shale and thin coal are present locally. The formation is not present in the southwestern and western parts of the area.	Yields of as much as several hundred gallons per minute may be possible. Dissolved solids probably range from about 1,000 to 5,000 ppm.

See footnotes at end of table.

TABLE 1.—*Generalized section of the geologic units and potential water supply*—Continued

Era	System	Series	Map unit where stratigraphic units are combined	Stratigraphic unit (approximate thickness, in feet [1])	Physical character [2]	Potential water supply [3]
	Cretaceous	Upper		Meeteetse Formation (0–1,400)	Sandstone, siltstone, shale, carbonaceous shale, and coal; interbedded; soft; banded gray, black, yellow, buff, and brown. Sandstone is gray and buff, fine to coarse grained, thin bedded to massive, porous; concretions are common. Individual sandstone beds in the upper 300± ft of the formation are as much as 120 ft thick. The formation is not present in the southern or western parts of the area.	Yields of as much as 50 gpm may be available from sandstone beds. Dissolved solids probably range from about 1,000 to 5,000 ppm.
				Mesaverde Formation (0–2,000)	Sandstone, very fine grained to coarse grained, porous, massive, crossbedded, lenticular; and interbedded sandstone, siltstone, shale, carbonaceous shale, and coal; white, gray, brown, and buff colors predominant. Sandstone beds range in thickness from a few feet to a few hundred feet. The formation ranges in thickness from about 1,000 to 2,000 ft except toward the southwest where it was eroded before deposition of the Fort Union Formation.	Yields of as much as several hundred gallons per minute may be possible. Dissolved solids generally range from about 1,000 to more than 5,000 ppm.
				Cody Shale (2,500–5,000)	Upper part is gray to buff, very fine grained, silty, mostly thinbedded sandstone and siltstone, interbedded with lesser amounts of gray to black shale. Lower part is gray to black shale, partly bentonitic, partly silty and sandy; contains a few thin silty sandstone beds.	Yields of as much as 20 gpm are possible from sandstone beds, but most of the formation is not an aquifer. Dissolved solids generally range from about 1,500 to 5,000 ppm, but are much higher in some oil-field waters.
				Frontier Formation (600–1,000)	Shale and sandstone, alternating beds, some thin beds of tuff, coal, and bentonite. Sandstone is white, gray, and brown, fine to coarse grained, commonly crossbedded; some beds are porous. Shale is black, partly carbonaceous and bentonic.	Yields of as much as 50 gpm are available from sandstone beds. Dissolved solids generally range from about 1,000 to 5,000 ppm, but are much higher in some oil-field waters.

Era	System	Series	Group	Formation (thickness, ft)	Lithology	Water-bearing properties
MESOZOIC	Cretaceous (?)	Lower		Mowry and Thermopolis Shales (700–900)	Mowry Shale at top: Black and silver gray siliceous shale; contains thin beds of yellow bentonite and greenish-gray sandstone. Thermopolis Shale at base: Black and brown soft locally sandy shale; includes gray thinbedded sandstone of the Muddy Sandstone Member (0–150 ft).	Yields of as much as 10 gpm may be possible from sandstone beds, but most of the unit is not an aquifer. Dissolved solids will generally be greater than 2,000 ppm.
MESOZOIC	—?— Jurassic	—?— Upper		Cloverly and Morrison Formations (350–650)	Upper part is gray, tan, and brown thinbedded fine to coarse grained sandstone interbedded with gray and black siltstone and shale. Middle part is brightly variegated claystone and clean, porous sandstone, locally conglomeratic. Lower part is lenticular white fine- to medium-grained soft sandstone that is interbedded with, and grades laterally, to variegated red, purple, gray, blue, and green claystone.	Yields of as much as several hundred gallons per minute are possible from the complete section of rocks. Dissloved solids range from less than 500 ppm near *outcrops to more than 10,000 ppm in some oil-field waters.*
MESOZOIC	Jurassic	Upper	Jurassic, Jurassic(?) and Triassic(?) rocks (400–800)	Sundance Formation (200–400)	Upper glauconitic unit is sandstone, siltstone, shale, and minor amount of interbedded limestone; green and gray. *Lower nonglauconitic unit is oolitic limestone,* shale, siltstone, and minor amount of sandstone; green and gray, contains red beds near the top except in the northern part of the area.	Yields of 20 gpm or more may be possible. Dissolved *solids may be less than 1,000 ppm near outcrops,* but are probably higher elsewhere.
MESOZOIC	Jurassic	Middle	Jurassic, Jurassic(?) and Triassic(?) rocks (400–800)	Gypsum Spring Formation (50–250)	Siltstone and shale, red; green and gray limestone and dolomite; and white gypsum; interbedded, mostly thin bedded; massive gypsum in lower part, locally removed by leaching. The formation thins to the southeast and pinches out southeast of the area.	Not considered an aquifer, but local solution cavities may yield water with dissolved solids of about 3,000 ppm or more.
MESOZOIC	—?—	—?—	Jurassic, Jurassic(?) and Triassic(?) rocks (400–800)	Nugget Sandstone (0–400)	Sandstone, fine to medium grained, massive to thick bedded, locally crossbedded, porous; red, salmon, and gray; contains rounded frosted sand grains; thin red shales in lower part. The formation thins to the east and to the north and is missing along the northern edge of the area.	Yields of as much as several hundred gallons per minute may be possible. Dissolved solids may be less than 1,000 ppm near outcrops, but will be much higher elsewhere and may be more than 20,000 ppm in some oil-field waters.

See footnotes at end of table.

TABLE 1.—*Generalized section of the geologic units and potential water supply*—Continued

Era	System	Series	Map unit where stratigraphic units are combined	Stratigraphic unit (approximate thickness, in feet [1])	Physical character [2]	Potential water supply
MESOZOIC	Triassic		Triassic rocks (1,000–1,400)	Chugwater Group (950–1,300): Popo Agie Formation (200–300)	Siltstone, shale, and silty sandstone, red and purple; lenses of purplish-gray limestone-pebble conglomerate; and analcime-bearing red and ochre dolomitic claystone.	Some of the rocks may yield as much as 10 gpm, but most of the formation does not yield water. Dissolved solids will generally range from about 1,500 to 5,000 ppm, but may be less than 1,500 ppm near outcrops.
				Chugwater Group: Crow Mountain Sandstone (10–90)	Sandstone, fine- to coarse-grained, thick-bedded, cross-bedded in part, porous; generally contains rounded frosted sand grains; red, orange, and gray.	Yields of 20 gpm or more may be possible. Dissolved solids may be less than 1,000 ppm near outcrops, but will be much higher elsewhere and may be more than 10,000 ppm in some oil-field waters.
				Chugwater Group: Alcova Limestone (0–20)	Limestone, hard, finely crystalline, laminated bedding, gray to pink. Very persistent marker bed generally 5–15 ft thick; missing in extreme northern part of the area.	Not considered an aquifer.
				Chugwater Group: Red Peak Formation (700–1,000)	Siltstone, shale, and fine grained silty sandstone, interbedded, thin- to thick-bedded; red.	Some of the rocks may yield as much as 10 gpm, but most of the rocks do not yield water. Dissolved solids will generally range from about 1,500 to 5,000 ppm, but may be less than 1,500 ppm near outcrops.
				Dinwoody Formation (50–150)	Siltstone, sandstone, and shale, interbedded; thin bedded, hard, tight, and dolomitic; minor amounts of limestone and dolomite and, locally, gypsum; tan, yellow, gray, green, and red. The formation thins eastward and is 50–100 ft thick throughout most of the area.	
	Permian		Permian rocks (180–310)		Park City Formation and interbedded tongues of the Phosphoria Formation (Sheldon, 1963). Park City Formation: Mudstone, dolomite, and limestone, cherty; minor amount of sandstone; yellow, brown, green, and gray. Phosphoria Formation: Chert and gray, brown, and black phosphatic shale.	Yields of as much as 500 gpm may be possible where artesian pressures are high and solution cavities or fractures are present. In most areas, yields would probably be less than 100 gpm. Dissolved solids range from about 1,000 ppm to more than 10,000 ppm.

PALEOZOIC	Carboniferous	Pennsylvanian		Pennsylvanian and Mississippian rocks (500–700)	Tensleep Sandstone (210–400)	Sandstone, fine- to coarse-grained, thick-bedded, crossbedded; mostly porous; buff, white, and gray; contains a few hard quartzitic beds and a few thin beds of chert and dolomite.	Yields of as much as 1,000 gpm may be available. Dissolved solids range from about 300 to 3,000 ppm.
					Amsden Formation (180–400)	Dolomite, shale, siltstone, sandstone, limestone, and chert, interbedded; hematite in some sandstone and shale beds; red, green, brown, gray, and buff.	Yields of 20 gpm or more may be possible from parts of the formation, but most of the rocks would yield little water unless fractured. Dissolved solids will probably be less than 1,500 ppm.
		Mississippian			Darwin Sandstone Member (0–170)	Sandstone, fine- to medium-grained, thin-bedded to massive, crossbedded, friable, moderately porous; pyritic in part; white, red, gray, and buff. The thickness varies irregularly; locally absent or indistinguishable.	
				Mississippian and Devonian rocks (400–1,000)	Madison Limestone (400–800)	Limestone and dolomite; contains abundant bedded and nodular chert. Upper part is thin-bedded gray and tan limestone, red shale, and limestone breccia (0–100± ft). Middle part is gray and blue limestone with carbonate cemented breccia zone at base (130± ft). Lower part is gray and brown dolomite and dolomitic limestone; intergranular and vuggy porosity common (300± ft).	Yields of as much as 1,000 gpm may be available. Dissolved solids range from about 300 to 3,000 ppm.
	Devonian				Darby Formation (0–250)	Dolomite, massive, and interbedded dolomite, limestone, sandstone, siltstone, and shale. Upper part is interbedded clastics and carbonates; green, gray, red, brown, and tan. Lower part is massive; buff, brown, and gray dolomite; generally vuggy and porous; clastic channel fill present locally at base. The formation thins toward the east, and is missing in the eastern part of the area.	

See footnotes at end of table.

TABLE 1.—*Generalized section of the geologic units and potential water supply*—Continued

Era	System	Series	Map unit where stratigraphic units are combined	Stratigraphic unit (approximate thickness, in feet [1])	Physical character [2]	Potential water supply [3]
PALEOZOIC	Ordovician	Middle and Upper	Ordovician and Cambrian rocks (800–1,600)	Bighorn Dolomite (0–300)	Dolomite, massive, buff; the thin-bedded light-colored Leigh Dolomite Member (0–85 ft) occurs at the top in the northwestern part of the area; Lander Sandstone Member (0–20 ft) occurs locally at the base. The formation thins toward the southeast, and is missing in the southeast corner of the area.	
	Cambrian	Upper		Gallatin Limestone (200–450)	Limestone, thin-bedded to massive; some siltstone and shale; contains many beds of limestone pebble conglomerate; gray, green, brown, and tan.	Yields of as much as 10 gpm may be possible from parts of the section, but most of the rocks would not yield water unless fractured. Dissolved solids will probably be less than 1,500 ppm.
		Middle		Gros Ventre Formation (400–700)	Siltstone and silty shale interbedded with silty fine-grained sandstone. Limestone, and limestone-pebble conglomerate; very glauconitic throughout; green, gray, brown, tan, red, and purple.	
				Flathead Sandstone (120–300)	Sandstone, fine- to coarse-grained; contains thin siltstone and shale partings; conglomerate at base; varies from soft sandstone to quartzite; brown, tan, green, gray, pink, and purple.	Yields of as much as 20 gpm may be possible. Dissolved solids will probably be less than 1,500 ppm.

Precambrian		Metamorphic and igneous rocks.	Yields of as much as 30 gpm may be possible where open fractures or weathered zones occur. Dissolved solids will generally be less than 200 ppm near outcrops. Where the rocks are deeply buried, dissolved solids will be greater.

[1] Thickness of Cretaceous and older rocks are of complete sections that do not reflect removal or thinning by post-Fort Union Formation erosion.

[2] Based primarily on works by many authors. Refer to geologic reports listed at the end of this report for more detailed descriptions.

[3] Based on limited local well data, on data concerning quality of oil-field water (Crawford, 1940, 1957; Crawford and Davis, 1962), and on data concerning water in the same of similar lithologic units in nearby areas (Lowry, 1962; Whitcomb and Lowry, 1967; and unpublished chemical analyses).

pending on local conditions, but the general movement is down the valley. Alluvium that lies at levels above the streams derives water from precipitation or, in many areas, from irrigation, and discharges most of the water to springs at terrace scarps. Discharge from the alluvium to existing wells is minor because only a few wells are pumped at high rates.

Evaporation and transpiration return a large portion of the precipitated water to the atmosphere. Evaporation continues from open-water surfaces and from the water table in areas where it is near the land surface. Large amounts of water are transpired by plants during the growing season.

WATER LEVELS

Water levels in wells reflect the pressure of water in confined aquifers and show the top of the zone of saturation in unconfined aquifers. Changes in the balance between recharge and discharge cause water-level fluctuations. Discharge of water from an aquifer by pumping alters the natural balance and lowers the water level until a new balance is established. Hydrographs of several types of water-level fluctuations are shown in figure 4.

Confined aquifers in the area are large, and effects of changes in the balance between recharge and discharge on water levels are dampened. Water levels may vary only a few tenths of a foot during a year, but may change several feet over a period of many years in reaction to long-term changes in balance between recharge and discharge (fig. 5). However, water levels may decline several tens of feet in a short period in response to local pumping.

Unconfined aquifers in the area are small, and changes in the balance of recharge and discharge have an immediate and pronounced effect on water levels. Short-term variations in precipitation and daily and seasonal variations in evaporation and transpiration may cause water levels to rise or fall in a short period. Artificial influences, such as irrigation, overcome natural influences and control water levels in many areas (fig. 4).

Data concerning water levels in rocks older than the Wind River Formation are sparse. Except in outcrop areas, water in these rocks is generally confined. Well depths are as much as several thousand feet, but water generally will rise to near the surface and, in some areas, will flow. Specific data are given in table 3 and on plate 1.

The Wind River Formation consists of numerous separate aquifers. At a single location, aquifers at different depths will have very different water levels. Differences in depth to water of as much as 140 feet were measured in adjacent wells, A3–3–21ada1 and –21ada2 (fig. 4), and also in well A1–2–21bbb (table 3), which was cased and completed at two different depths.

Most wells in the Wind River Formation tap confined aquifers Well depths are as much as 900 feet, and depths of more than 400 feet are common. Water rises far above the producing zones in most wells and, in some areas flows at the surface. Depths to water generally range from the surface to about 200 feet; but there are many exceptions, and depths to water of more than 500 feet have been measured.

In the part of the Wind River Formation tapped by the Riverton well field, water levels have declined in response to pumping. Figure 6 compares 1951 and 1966 water levels in well A1–4–33ddb, which is influenced by pumping of the well field. Pumpage records for 1951 are not available, but annual pumpage in 1966 is estimated to have been about one-third larger than in 1951.

A few shallow wells in the Wind River Formation tap unconfined aquifers. The water-table wells are generally less than 70 feet deep, and depths to water are generally less than 30 feet.

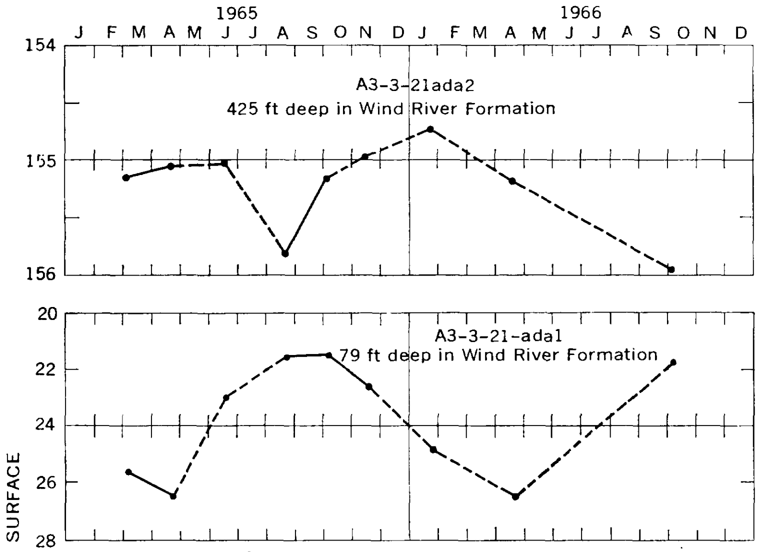
Water in alluvium and other unconsolidated rock of Quaternary age is unconfined. Wells tapping these rocks are generally less than 50 feet deep, and depths to water are generally less than 20 feet.

AQUIFER CHARACTERISTICS

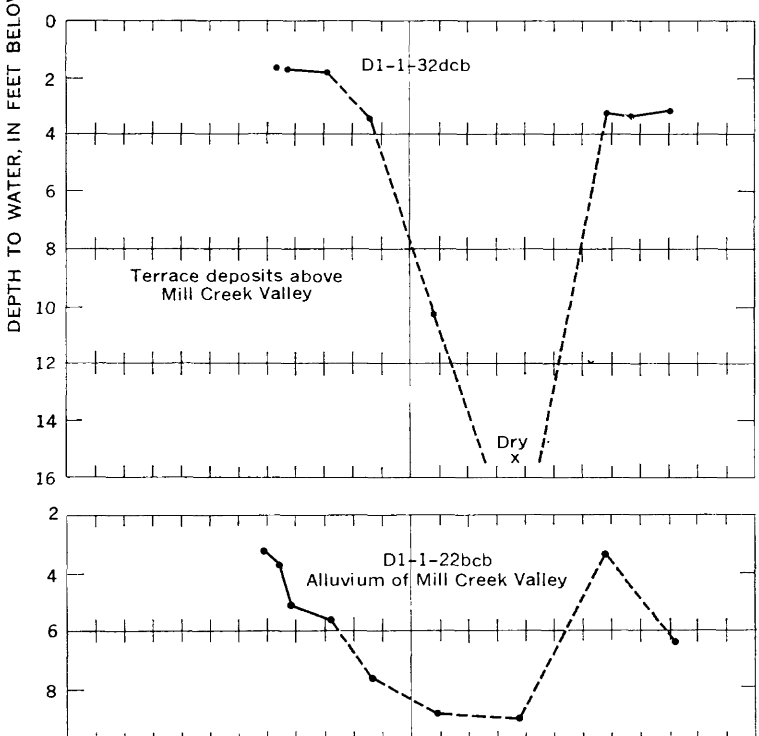
Data on aquifer characteristics are available for the Wind River Formation and for the alluvium. The data consists of specific capacities reported by drillers and a few pumping tests. The following discussion relates the data to the thickness of rock that contributes water to a well. Thicknesses of contributing rock were taken from drillers' logs. The data are used to define the range of permeability and specifc capacity per foot of contribution. Specific capacity per foot of contribution is the discharge in gallons per minute, per foot of drawdown, per vertical foot of rock that contributes water to a well. It is related to specific capacity in the same way that permeability is related to transmissibility.

Definitions of several terms related to aquifer characteristics are given in the section on terminology. Symbols used in the discussion include:

m = Saturated thickness or thickness of section that contributes water to a well, in feet.
P = Permeability, in gpd/ft^2.
Q = Discharge, in gpm.
s = Drawdown, in feet.
Δs = Change in drawdown per log cycle, in feet.
T = Transmissibility, in gpd/ft.
t = Time since pumping began, in minutes.
t' = Time since pumping stopped, in minutes.



Independent fluctuation of water levels in adjacent wells tapping different parts of the Wind River Formation. Shallow well shows influence of irrigation



Water levels influenced by irrigation

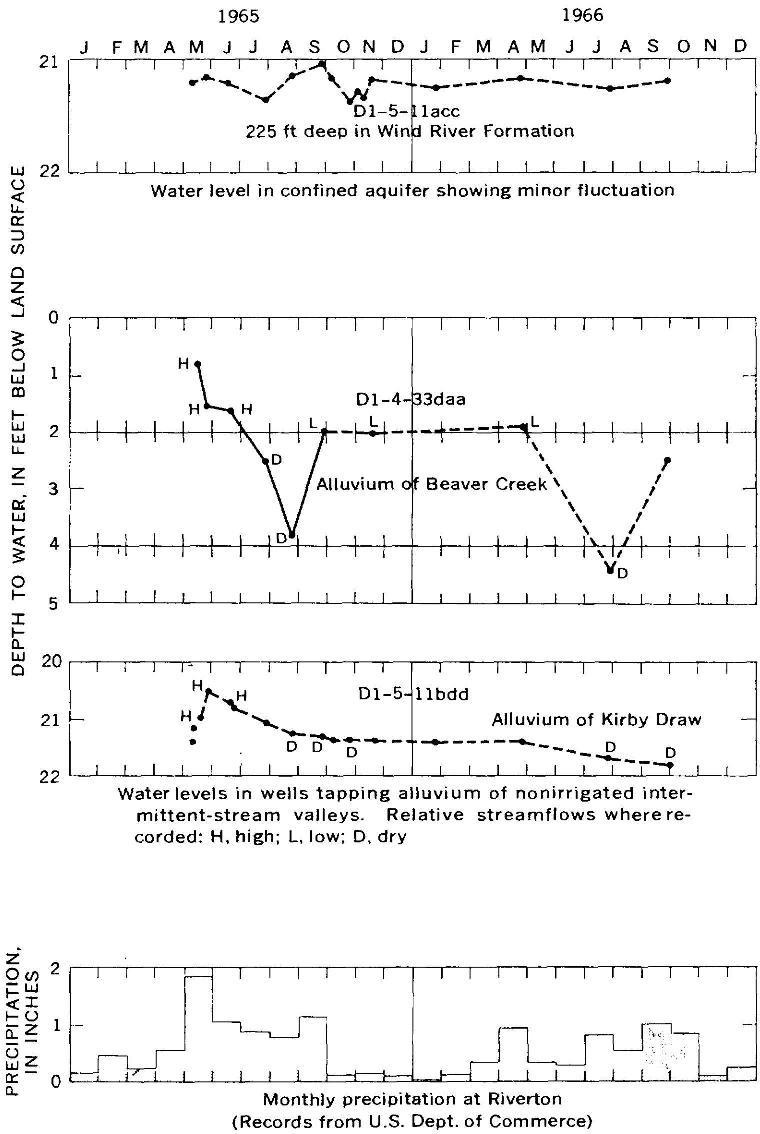


FIGURE 4.—Several types of water-level fluctuations in wells. See figure 5 for longer record of well A3-3-21ada2.

WIND RIVER FORMATION

Data from four pumping tests and specific capacity per foot of contribution for 139 wells tapping the Wind River Formation were available for analysis. The data are from wells in the eastern half of the area, but the formation probably has similar characteristics throughout the area.

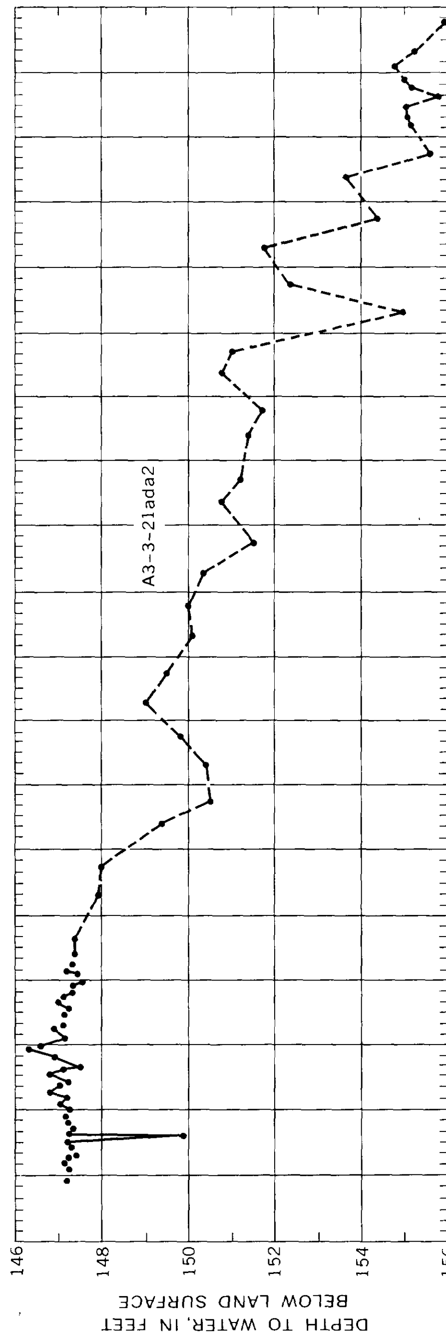


FIGURE 5.—Hydrograph of well A3-3-21ada2.

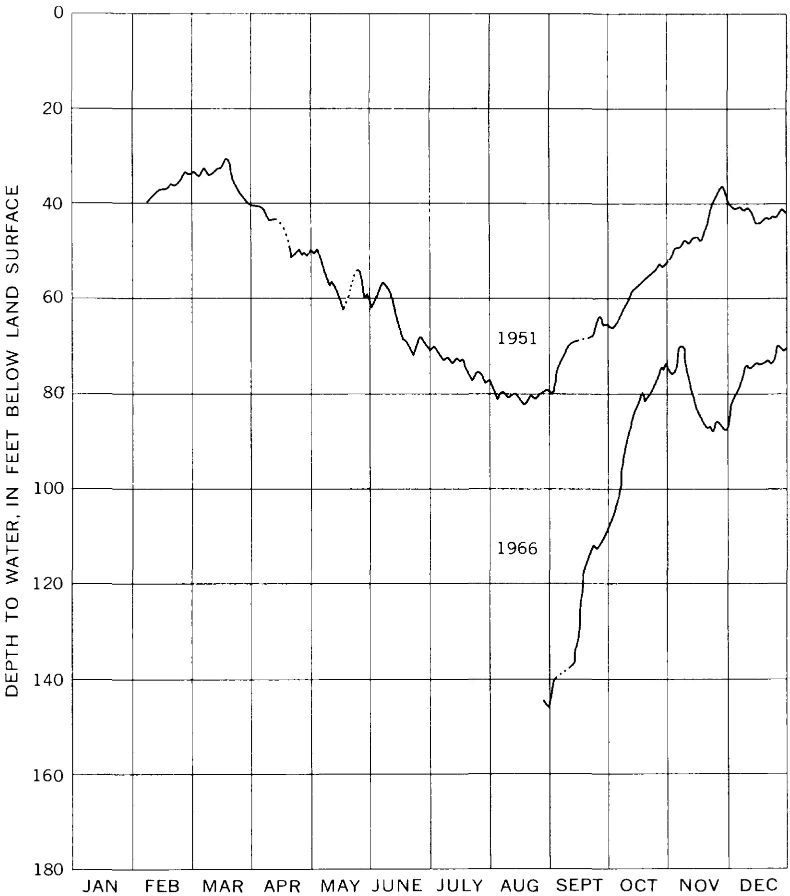


FIGURE 6.—Hydrograph of well A1–4–33ddb comparing the influence of the Riverton well field in 1951 and 1966. Data from recorder charts.

PUMPING TESTS

Results of pumping tests (table 2) are expressed as permeability rather than transmissibility, because the Wind River Formation contains numerous separate aquifers and transmissibility of the formation has little meaning. Some water-bearing beds of the formation are hydraulically connected, but others, perhaps most, are only remotely connected; some are completely separated.

Data from pumping tests were analyzed by methods described by Ferris and others (1962) and also in E. E. Johnson, Inc. (1966). Recovery data were used for analyzing the tests; drawdown data were not considered usable, either because of variation in discharge, or because prepumping trends could not be defined. Adjusted residual drawdown was plotted against t/t' where the prepumping trend was defined. Where only the drawdown trend was defined, adjusted recovery was plotted against t'. Both plots theoretically give the same result. Figure 7 is a sketch showing the relation of drawdown, residual drawdown, and recovery. Table 2 gives principal data concerning the tests.

Well A3-6-15bcb.—At the time this test was started, water levels were recovering from effects of previous pumping. The trend of the pretest rise in water level was not defined; thus drawdown data could not be adjusted. The drawdown trend was defined, and recovery data were adjusted accordingly. Figure 8 shows the drawdown, the adjustment for the drawdown trend, and the adjusted recovery data.

A step-drawdown test of well A3-6-15bcb was made in November 1951. Discharges ranged from about 7 to 50 gpm. The specific capacity was 1.3 gpm/ft, which is comparable to that from the 1966 test (table 2).

Well D1-4-4cdd.—The test of well D1-4-4cdd was conducted by a consultant for the owner, Susquehanna-Western, Inc., and data were obtained from the owner. Drawdown was large compared to any probable influence from the Riverton well field, which is about 1 mile north of the well, and interpretation of the test was probably not affected. This well had been pumped irregularly for several months and was shut down for only 15 hours before the test began. The trend of recovery from previous pumping was not known; thus, drawdown data could not be adjusted. The drawdown trend was known, and recovery data were adjusted accordingly. Figure 9 shows the water levels during drawdown, the adjustment for the drawdown trend, and the adjusted recovery data.

Specific capacity from various pumping data were not consistent. Table 2 gives an approximate specific capacity of 2.3 gpm/ft, which was interpreted from the data.

Well D1-5-11acc.—Depth-to-water measurements before this test showed a change of only 0.03 foot in 16 hours; thus, no adjustment was required for the prepumping trend, and residual drawdown was analyzed (fig. 10). Drawdown was very sensitive to minor variations in the pumping rate and could not be analyzed.

Riverton well field.—A pumping test of the Riverton well field was conducted for a previous study in March 1951. The test is described in detail by Morris and others (1959). The test indicates a coefficient of transmissibility of about 6,000 to 10,000 gpd/ft and a coefficient of storage of about 2×10^{-4}. The permeability of 180 gpd/ft^2 that was computed in 1951, however, seems too high to be representative of the formation. It was based on a thickness of 55 feet, which was the thick-

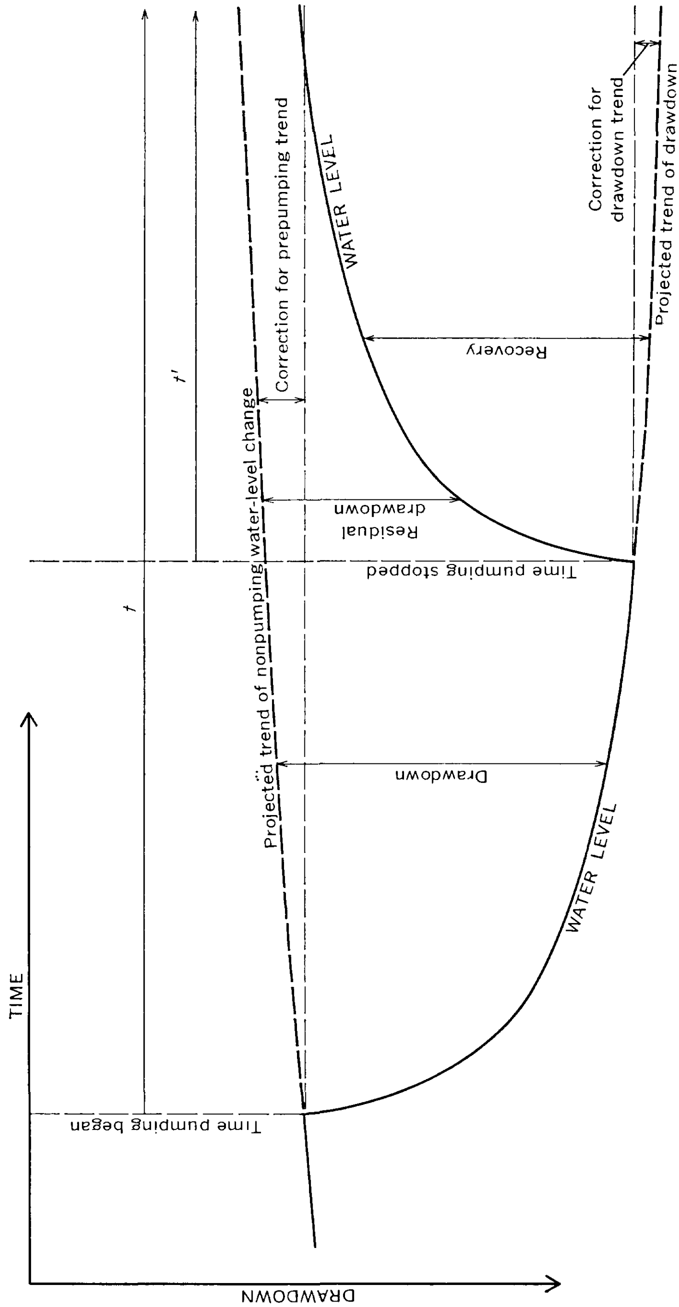


FIGURE 7.—Relation of drawdown, residual drawdown, and recovery.

TABLE 2.—*Principal data concerning pumping tests*

Wells in Wind River Formation

Well	Date	Depth of well (feet)	Thickness of contributing sandstone (feet)	Depth to water before pumping started (feet)	Duration of pumping (minutes)	Discharge (gpm)		Specific capacity (gpm/ft)	Specific capacity per foot of contribution (gpm/ft^2)	Permeability (gpd/ft^2)
						Range	Average			
A3-6-15bcb	Oct. 28, 1966	495	44	66.0	360	160–175	165	1.5	0.034	43
D1-4-4cdd	Sept. 12–17, 1958	450	63	--------	3,716	540–605	550	[1] 2.3	.037	45
D1-5-11acc	Nov. 5, 1965	225	40	22.32	500	2.6–4.2	3.6	1.5	.038	43

Wells in alluvium

Well	Date	Depth of well (feet)	Depth to bedrock (feet)	Thickness of saturated sand and gravel (feet)	Depth to water before pumping started (feet)	Drawdown before pumping stopped (feet)	Duration of pumping (minutes)	Discharge, average (gpm)	Specific capacity (gpm/ft)	Specific capacity per foot of contribution (gpm/ft^2)	Estimated yield at two-thirds of maximum drawdown (gpm)
A1-1-34bcb	Nov. 1, 1966	28	28	22	6.47	5.0	120	20	[1] 4	[1] 0.2	[1] 150–250
A1-4-31dcc	Nov. 6, 1965	9	9	5	3.97	4.5	160	5	1	.2	[1] 5
B4-4-2cda	Oct. 26, 1966	[2] 33	44	40	3.80	1.0	120	65	65	1.6	[3] 1,200
B4-4-22aba	Oct. 26, 1966	[2] 33	35	23	12.32	2.1	120	42	20	.9	[3] 200
D1-1-15ccc	Oct. 25, 1966	38	38	25	11.50	1.2	240	40	33	1.3	[3] 350

[1] Qualified in text.
[2] Not cased to bedrock.
[3] Based on graph relating drawdown to yield (E. E. Johnson, Inc., 1966, p. 107).

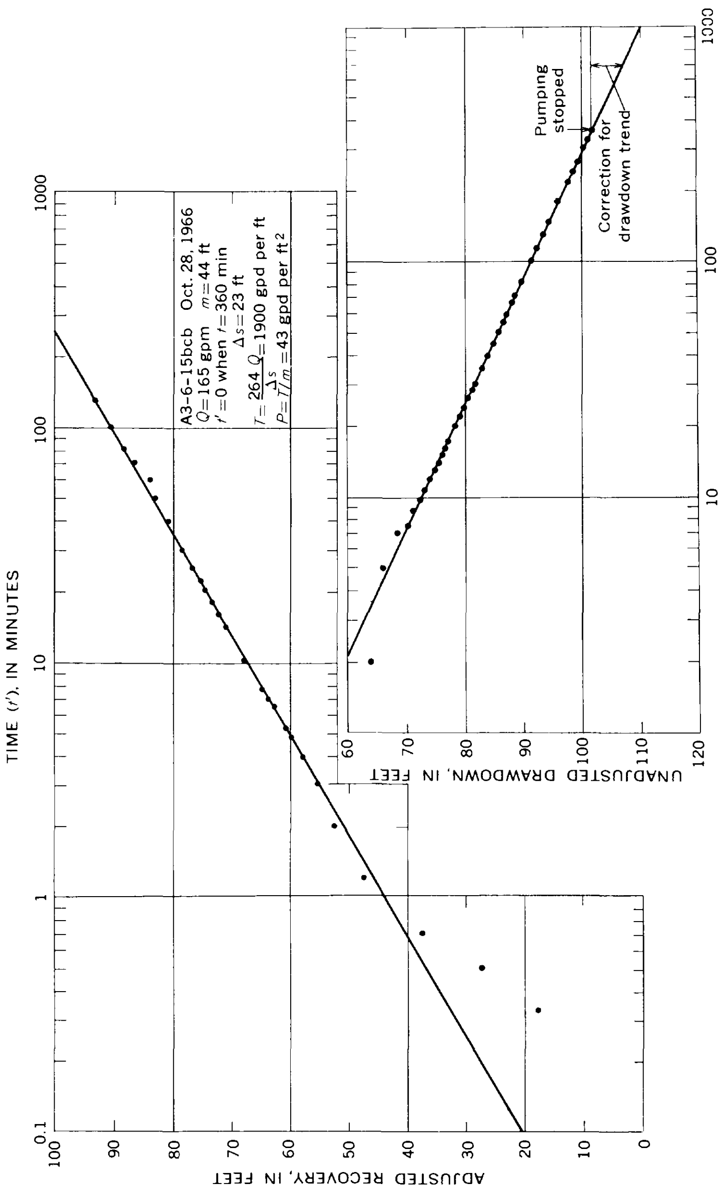


FIGURE 8.—Adjusted recovery of well A3-6-15bcb.

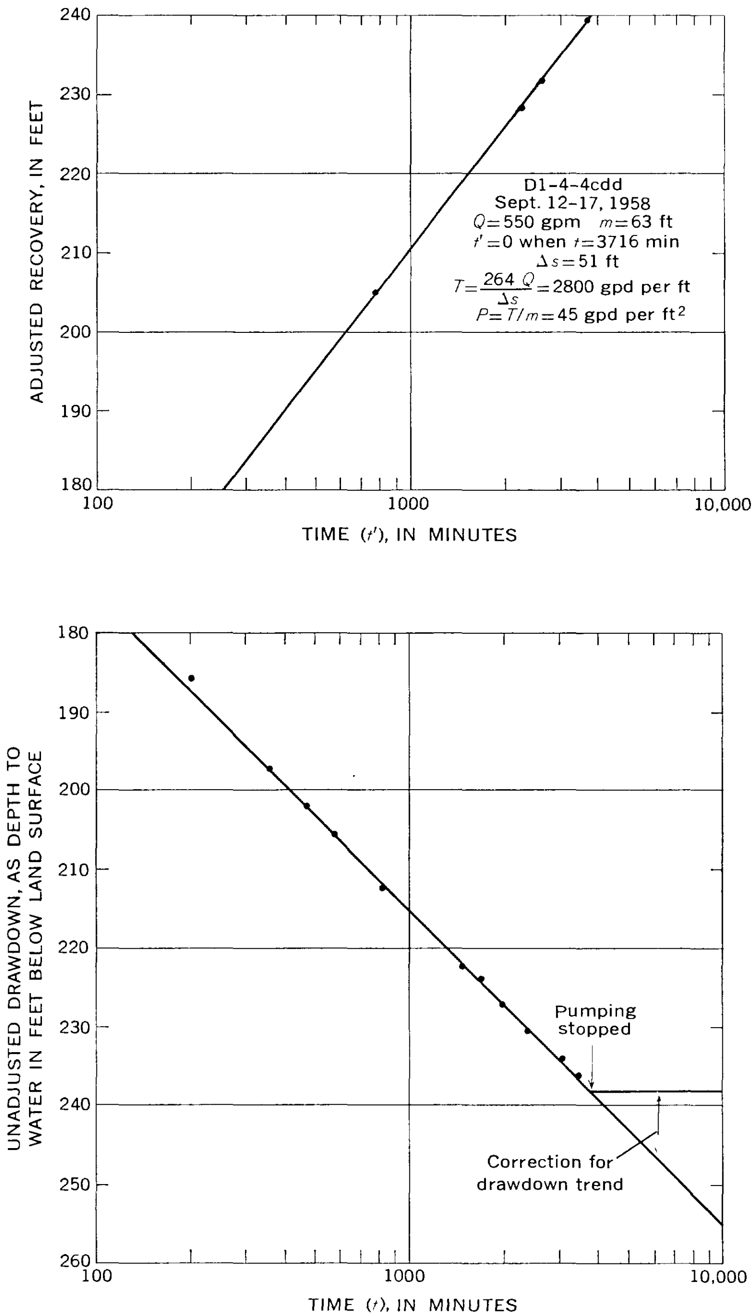


FIGURE 9.—Adjusted recovery of well D1–4cdd.

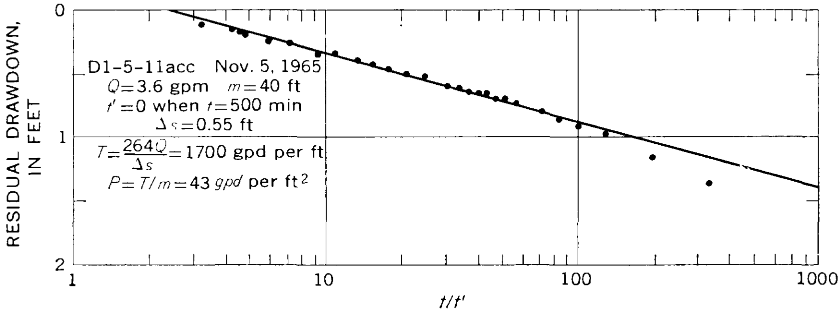


FIGURE 10.—Residual drawdown of well D1-5-11acc.

ness of water-bearing sandstone open to the pumped well of the test. Drillers' logs show that the "water sands" open to the Riverton wells have thicknesses that range from 45 to 148 feet and average about 100 feet per well. Therefore, average permeability based on the average thickness and the transmissibility is between about 60 and 100 gpd/ft^2.

SPECIFIC-CAPACITY DATA

Specific capacity per foot of contributing section for 139 wells in the Wind River Formation is shown in figure 11. Specific capacity and contributing section were obtained primarily from drillers' records or other reported data. Figure 12 shows the distribution of the data.

Estimates of permeability can be made from the specific capacity per foot of contribution of a well. Specific capacity per foot of contribution $\frac{Q/s}{m}$ and permeability are related in the same way as specific capacity (Q/s) and transmissibility. This relation has been described by Theis, Brown, and Meyer (in Bentall, 1963) and by Johnson and others (1966) and can be expressed as:

$$T=K(Q/s), \text{ or}$$

$$P=K\left(\frac{Q/s}{m}\right),$$

where K combines all factors that affect the relation. Included in K are factors that depend on aquifer characteristics, on well efficiency, and on rate and duration of pumping. Generally, K has a value of 1,500–2,100, but it can be outside this range. Values for K cannot be accurately determined because of the many factors involved, but it can be estimated fairly closely. Even with fairly large errors in K, the estimates of permeability will be of the correct order of magnitude.

A value of K that would apply to the data on the Wind River Formation is probably near 1,500. Generally, K is larger than this for artesian aquifers; but the available data are for very short pumping

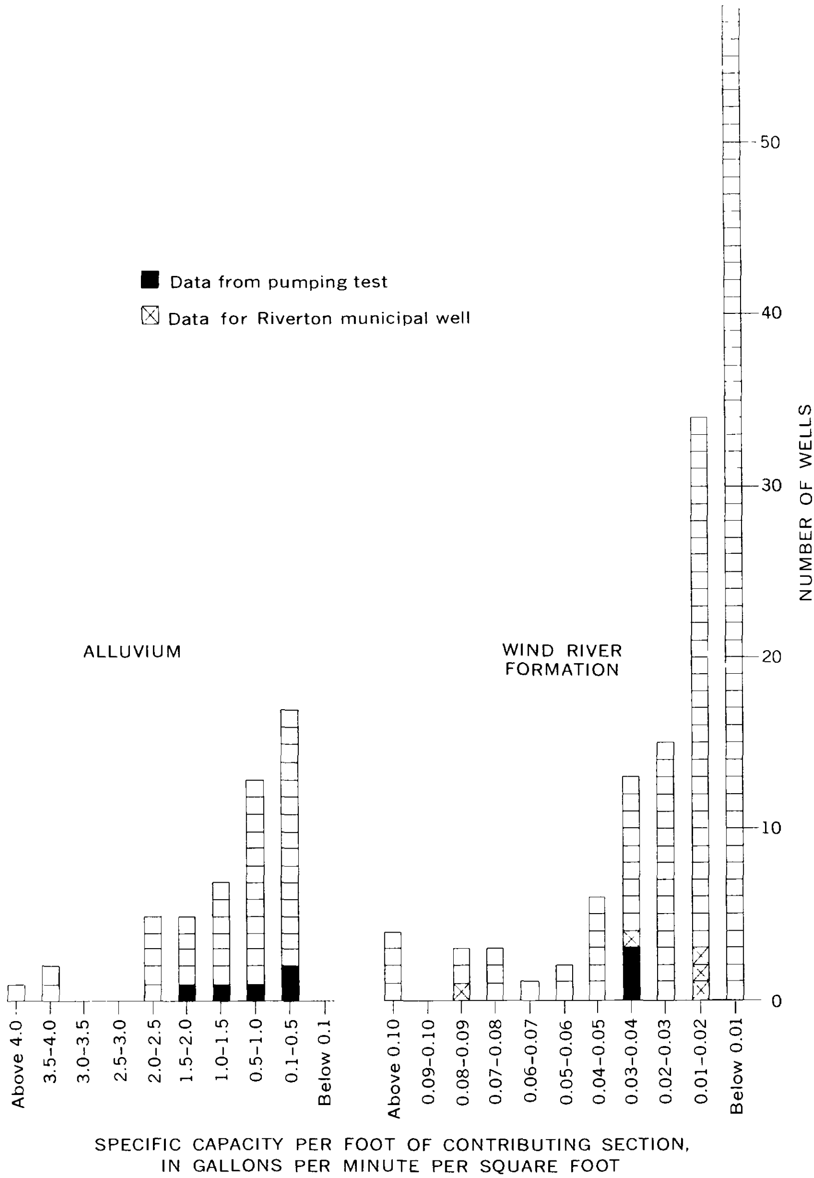


FIGURE 11.—Histograms of specific capacity per foot of contribution for wells in alluvium and in the Wind River Formation.

periods, and the shorter the pumping period, the smaller the value of K. Most of the data are from drillers' tests of probably 2 hours or less. The relation between specific capacity per foot of contribution and permeability for the tested wells (table 2) indicates a very low K of

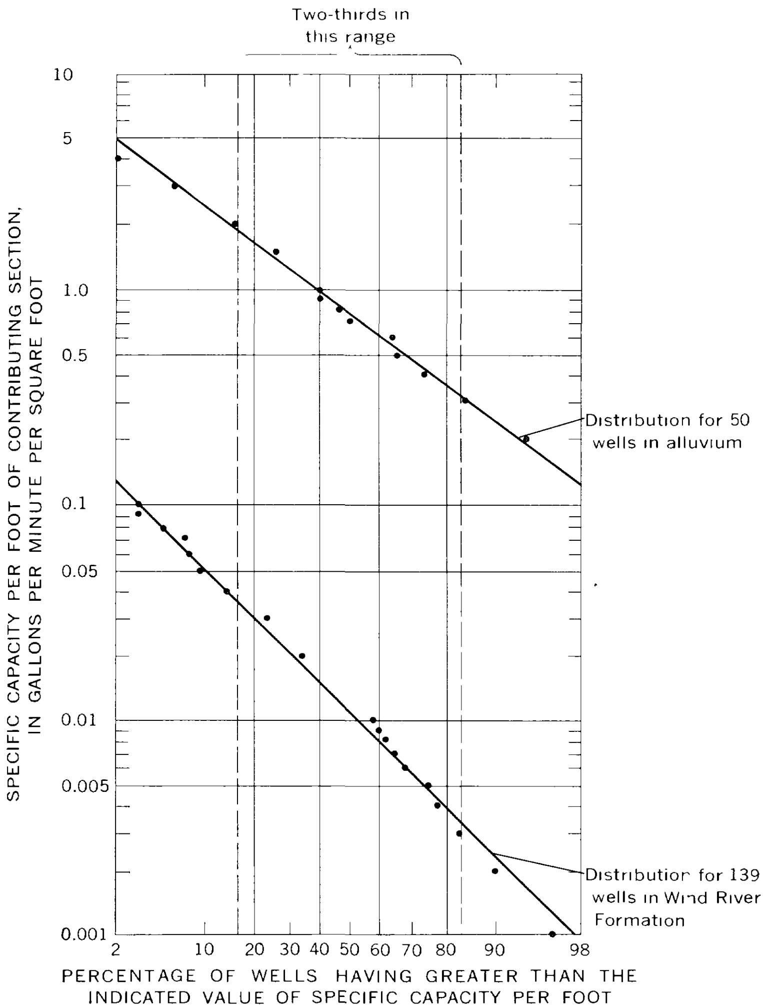


FIGURE 12.—Distribution of specific capacity per foot of contribution for wells in alluvium and in the Wind River Formation.

1,200. A general value of K of 1,500 is probably adequate for estimating permeabilities from the available data.

The probable range of specific capacity per foot of contribution for water-bearing sandstone of the Wind River Formation is shown in figure 12. This interpretation assumes that the data adequately represent the formation, and that the line drawn through the data plot correctly describes the distribution of the data. The probable range of permeability can be estimated by assuming that the K value of 1,500 approximately defines the relation between permeability and the specific capacity per foot of contribution. Figure 12 shows that, neglecting the high and low extremes, the probable range of specific capacity per foot of contributions is about 0.001–0.15 gpm/ft^2, and the mean is 0.01 gpm/ft^2. The indicated permeability is about 1 to 220 gpd/ft^2, and the mean is 15 gpd/ft^2. Two-thirds of the wells in the formation will have a specific capacity per foot of contribution between 0.003 and 0.04 gpm/ft^2 and an indicated permeability between 4 and 60 gpd/ft^2.

ALLUVIUM

Data from five pumping tests and specific capacity per foot of contribution for 50 wells tapping the alluvium were available for analysis. All the data are from wells in alluvium underlying flood plains or terraces in the valley of the Wind River or in those tributary-stream valleys that drain the Wind River Mountains. The deposits are generally coarse grained and similar in character. They are quite different from the finer grained deposits of valleys in the southeast, such as the valleys of Beaver Creek and Kirby Draw, and in the center of the basin, such as the valleys of Fivemile and Muddy Creeks. No pumping-test nor specific-capacity data are available for wells in the finer grained deposits; consequently, the following discussion concerns only the coarser deposits.

PUMPING TESTS

Specific-capacity data were obtained from the pumping tests of the wells in alluvium, and estimates were made of potential yields of the alluvium at the test sites. Principal data concerning the tests are given in table 2.

Four of the wells were pumped at minor rates compared to their potential yields because large-capacity pumps were not available for the tests. To estimate potential yields, the relation of the drawdown to the yield was used. Under water-table conditions that exist in the alluvium, specific capacity cannot be used directly to estimate yields at increased drawdowns because the specific capacity decreases significantly with dewatering of the aquifer. As drawdown increases, specific capacity decreases. A graph showing the general relation between drawdown and yield under water-table conditions is given in E. E. Johnson, Inc. (1966, p. 107). When drawdown at a particular yield is known, the yield at a different drawdown for a similar pumping period can be estimated from the graph. According to the graph, the yield at two-thirds of the maximum drawdown is about 90 percent of the maximum yield; table 2 gives the estimated yield at two-thirds of the maximum drawdown.

Well A1-1-34bcb.—The specific capacity determined by the test of well A1-1-34bcb near Ethete was 4 gpm/ft. This well was poorly developed and was partly plugged with sand. Results of the test were affected by well conditions, are not indicative of the aquifer conditions, and cannot be used to estimate the yield of a properly developed well: Test drilling indicated that the water-bearing deposits were similar to those tapped by the other tested wells. Based on comparison with the other well tests, an estimated yield of about 150–250 gpm at two-thirds of the maximum drawdown may be possible for a properly developed well in the Ethete area.

Well A1–4–31dcc.—Well A1–4–31dcc was pumped at about its maximum discharge, 5 gpm. This well is probably less productive than is possible for the area, but large yields are not possible from wells because of the limited saturated thickness. However, very large sumps or other methods of greatly increasing the effective diameter could produce larger yields.

Wells B4–4–2cda and B4–4–22aba.—Wells B4–4–2cda and B4–4–22aba did not penetrate the full thickness of alluvium, but drawdowns were very small and effects of partial penetration were probably negligible.

Well D1–1–15ccc.—At well D1–1–15ccc, the sand and gravel is overlain by 13 feet of sandy silt, which is partly saturated. The silt is of relatively low permeability, and, for the short test, it was not considered as part of the contributing thickness.

SPECIFIC-CAPACITY DATA

Specific capacity per foot of contributing section for 50 wells in alluvium are shown in figure 11. About 80 percent of the data is taken from drillers' reports of wells in the Little Wind River valley near Fort Washakie. The deposits in the Fort Washakie area are generally similar to those in other valleys draining the Wind River Mountains, and the range of specific capacity per foot of contribution is probably also similar. Figure 12 shows the distribution of the data.

The approximate relation between specific capacity per foot of contribution and permeability has already been discussed relative to the Wind River Formation. It is expressed as:

$$P=K\left(\frac{Q/s}{m}\right).$$

A value of K that would apply to the data of the alluvium is probably near 1,500, but there are no permeability data available for comparison.

The probable range of specific capacity per foot of contribution for the alluvium is shown in figure 12. This interpretation assumes that the data adequately represent the alluvium and that the line drawn through the data plot correctly describes the distribution of the data.

The probable range of permeability can be estimated by assuming that the K value of 1,500 approximately defines the relation between permeability and the specific capacity per foot of contribution. Figure 12 shows that, neglecting the high and low extremes, the probable range of specific capacity per foot of contribution is about 0.1–5 gpm/ft^2, and the mean is 0.8 gpm/ft^2. The indicated permeability is about 150–7,500 gpd/ft^2, and the mean is 1,200 gpd/ft^2. Two-thirds of the wells in the alluvium will have a specific capacity per foot of contribution between 0.3 and 2 gpm/ft^2 and an indicated permeability of 450–3,000 gpd/ft^2.

GEOLOGIC UNITS IN RELATION TO GROUND WATER

Most water wells in the area derive water from the Wind River Formation and from alluvium. Consequently, most of the data collected in conjunction with this study concerns these deposits. Discussions of other units are based on limited local well data, on data concerning quality of oil-field waters (Crawford, 1940, 1957; Crawford and Davis, 1962), and on data concerning water in nearby areas (Lowry, 1962; Whitcomb and Lowry, 1967; and unpublished chemical analyses). Lithologic descriptions of the rocks are based largely on published works of other authors. The selected references at the end of the report provide references to more detailed descriptions of the geologic formations and their stratigraphic relations. (See table 1 for descriptions of individual formations.)

PRECAMBRIAN ROCKS

Metamorphic and igneous rocks of Precambrian age are exposed in the Wind River Mountains and in scattered outcrops in the Washakie and Owl Creek Mountains. Yields of as much as 30 gpm may be possible where open fractures or weathered zones occur. Dissolved solids in the water will generally be less than 200 ppm near outcrops. Two springs (B7–1–1cad and B7–1–2aab), which probably derive water from Precambrian rocks, have specific conductances of 200 and 140 micromhos (dissolved solids of less than 150 ppm). Dissolved solids will be greater where the rocks are deeply buried.

PALEOZOIC ROCKS

Paleozoic rocks consist predominantly of limestone, dolomite, and sandstone, but include lesser amounts of chert, shale, siltstone, and claystone. The rocks are mostly gray, brown, and buff, but some are green, red, purple, and white. Outcrops are predominantly gray and buff. Paleozoic rocks range in thickness from about 1,900 to 3,600 feet. The thickness is greatest in the southwest; the rocks thin eastward and, to a lesser degree, northward. Most Paleozoic rocks are massive; steep cliffs and narrow valleys occur in outcrop areas.

Paleozoic rocks crop out along the flanks of the mountains and are deeply buried in most of the basin. The rocks dip steeply along the northeast slope of the Wind River Mountains toward a deep trough paralleling the range. Northeast of this trough, the rocks are relatively near the surface—but do not crop out—in a central anticlinal structure that runs generally parallel to the Wind River Mountains (pl. 2). The rocks are very deeply buried in the north-central part of the Wind River Basin near Boysen Reservoir, and occur in folded and complexly faulted blocks along the south slope of the Washakie and Owl Creek Mountains. The rocks also crop out along the north slope of the Owl Creek Mountains where they dip regionally northward toward the Bighorn Basin.

Many of the Paleozoic rock units are potentially high yielding aquifers. Yields of more than 1,000 gpm are possible from the rocks comprising the Bighorn Dolomite, Darby Formation, Madison Limestone, and Tensleep Sandstone. Wells tapping similar rocks near Tensleep, Wyoming, in the Bighorn Basin, flow as much as 2,500 gpm (Lowry, 1962). Except in cavernous or intensely fractured zones, permeabilities are not high, but large flows are possible because of thick sections of water-bearing rock and because of high pressures. Where pressures are low, as near outcrops, yields may be relatively low except where the rocks are cavernous or intensely fractured.

Water from Paleozoic rocks commonly contains various gases and oil. Dissolved solids in water from most Paleozoic rocks range from about 300 to 3,000 ppm, but Permian rocks yield water having about 1,000 to more than 10,000 ppm dissolved solids.

Economic drilling depths limit the potential development of ground water from Paleozoic rocks to a narrow belt along the northeast flank of the Wind River Mountains, to a somewhat wider belt along the north flank of the Owl Creek Mountains, and to parts of the central anticlinal structure. Depths to the Paleozoic rocks in the basin may be estimated from the generalized structure contours shown on plate 2. The top of the Paleozoic rocks is about 2,000–3,000 feet below the horizon shown by the contours.

MESOZOIC ROCKS

LOWER MESOZOIC ROCKS

The lower Mesozoic rocks (Triassic and Jurassic rocks excluding the Morrison Formation) consist of siltstone, shale, and sandstone and lesser amounts of limestone, dolomite, and gypsum. The rocks are mostly red, salmon, and green, but some are purple, ochre, gray, tan, and yellow. Outcrops are predominantly red and light green. The lower Mesozoic rocks range in thickness from about 1,400 to 2,200 feet. They are thickest in the southwest and thin eastward and northward. The lower Mesozoic rocks are generally less resistant to erosion than Paleozoic rocks; hills and ridges and moderately broad valleys occur in outcrop areas.

The lower Mesozoic rocks crop out along the flanks of the mountains and on some of the structures within the basin. The rocks dip from the flanks of the Wind River Mountains toward the deep trough paralleling the range. Northeast of this trough, the rocks crop out, or are at relatively shallow depths on the central anticlinal structure and on the structures in the Maverick Springs-Circle Ridge area. The rocks are very deeply buried in the north-central part of the Wind River Basin near Boysen Reservoir and occur in folded and complexly faulted blocks along the south slope of the Washakie and Owl Creek Mountains. The rocks also crop out along the north slope of the Owl Creek Mountains where they dip regionally northward toward the Bighorn Basin.

Moderate to high yields of water may be available from some of the lower Mesozoic rocks. Yields of as much as several hundred gallons per minute may be possible from the Nugget Sandstone. Yields of 20 gpm or more are possible from the Sundance Formation and Crow Mountain Sandstone. Yields of as much as 10 gpm may be possible from some of the other lower Mesozoic rocks, but most of these rocks will yield little, if any, water.

Water from the lower Mesozoic rocks generally contains high concentrations of dissolved solids, but, near outcrops in some locations, the dissolved solids are less than 1,000 ppm. Some oil-field waters have dissolved solids of more than 20,000 ppm.

Economic drilling depths limit the potential development of ground water from lower Mesozoic rocks to narrow belts along the flanks of the mountains and to parts of the major anticlinal structures within the basin. Depths to the lower Mesozoic rocks in the basin may be estimated from the generalized structure contours shown on plate 2. The top of this sequence of rocks, the top of the Sundance Formation, is about 350–650 feet below the horizon shown by the contours.

UPPER MESOZOIC ROCKS

The upper Mesozoic rocks (Cretaceous rocks and the Morrison Formation) consist of shale and sandstone and lesser amounts of siltstone, claystone, conglomerate, coal, and bentonite. The rocks are mostly gray, black, and brown, but some are buff, red, purple, and white. Outcrops are predominantly gray and brown. The upper Mesozoic rocks range in thickness from about 4,000 to 12,000 feet. The thickness is greatest in the north-central and east-central parts of the area. The rocks are mostly nonresistant shale and soft sandstone, but some are resistant beds of harder sandstone. Broad shallow valleys separated by numerous hogbacks and cuestas occur in outcrop areas.

The youngest of the upper Mesozoic rocks were removed by erosion in the southwestern half of the area before rocks of Eocene age were deposited. Remaining upper Mesozoic rocks crop out in a thin belt along the flanks of the Wind River Mountains and on the central anticlinal structure. The complete section of upper Mesozoic rocks is exposed on structures in the north-central part of the area; eastward, near Boysen Reservoir, they are deeply buried. Part of the section is exposed at Alkali Butte in the southeast corner of the area. The rocks also crop out along the north slope of the Owl Creek Mountains where they dip regionally northward toward the Bighorn Basin.

Moderate to high yields of water may be available from some of the upper Mesozoic rocks but most yields will be low. Yields of as much as several hundred gallons per minute may be available from the Cloverly and Morrison Formations and from the Mesaverde and Lance(?) Formations. Yields of as much as 50 gpm may be available from sandstone of the Frontier and Meeteetse Formations. Yields of as much as 20 gpm may be possible from sandstone beds in the Mowry and Thermopolis Shales and Cody Shale.

Dissolved solids generally range from about 1,000 to 5,000 ppm, but may be much higher in some oil-field waters. In some areas, water with less than 1,000 ppm dissolved solids may be available from the Cloverly and Morrison Formations.

Economic drilling depths limit the potential development of ground water from upper Mesozoic rocks to the major anticlinal structures within the basin. The generalized structure contours (pl. 2) show the top of the Cloverly Formation, which is about 350–650 feet above the base of the upper Mesozoic rocks.

CENOZOIC ROCKS

TERTIARY ROCKS

FORT UNION FORMATION

The Fort Union Formation consists of interbedded sandstone, conglomerate, shale, and siltstone. The rocks are gray, olive, buff, brown, and tan; some zones are red and purple. The thickness ranges from 0 to about 7,000 feet. The rocks are thickest in the north-central part of the Wind River Basin near Boysen Reservoir; they thin toward the southwest.

The Fort Union Formation is not present southwest of the central anticlinal structure but crops out along the northeast side of this structure, on Alkali Butte, and in the Shotgun Butte area. It underlies rocks of Eocene age in the center of the basin.

The few water wells in the area that tap the Fort Union Formation have yields of less than 10 gpm of water having dissolved solids of about 1,000 ppm. These wells tap only a small part of the formation. The potential yield of a well tapping the complete formation could be as much as several hundred gallons per minute. Existing wells, which are near outcrops, provide water that is of better quality than water from most of the formation. Generally, dissolved solids in water from the Fort Union would range from about 1,000 to 5,000 ppm.

INDIAN MEADOWS FORMATION

The Indian Meadows Formation or equivalent rocks underlie the Wind River Formation in much of the basin, but are not differentiated in the subsurface. The Indian Meadows consists of conglomerate, sandstone, claystone, siltstone, and some limestone. The rocks are brick red and variegated red, purple, lavender, tan, gray, green, buff, brown, and white; reddish colors are generally predominant. The thickness ranges from 0 to about 3,000 feet. The formation crops out in the northern and northwestern parts of the area but not in the southern part.

The Indian Meadows Formation is a potential aquifer, but no water wells are known to tap it. Yields of as much as 50 gpm may be possible, but some of the rocks will not yield water. Dissolved solids probably range from about 1,000 to 5,000 ppm.

WIND RIVER FORMATION

The Wind River Formation consists of sandstone, conglomerate, siltstone, claystone, and shale; some parts of the formation contain small amounts of bentonite, tuff, and limestone. The rocks are partly gray, green, and yellow; partly red, maroon, and brown; and partly varicolored. The thickness ranges from 0 to about 5,000 feet.

A diagrammatic section (fig. 13) shows the approximate relations of the major facies of part of the Wind River Formation in the eastern part of the reservation, east and north of the central anticlinal structure. The diagram and the following discussion are based on interpretation of published descriptions of the formation, on oil-well logs, and on data obtained from test drilling (table 5). This interpretation of the relations is oversimplified and should be regarded as preliminary.

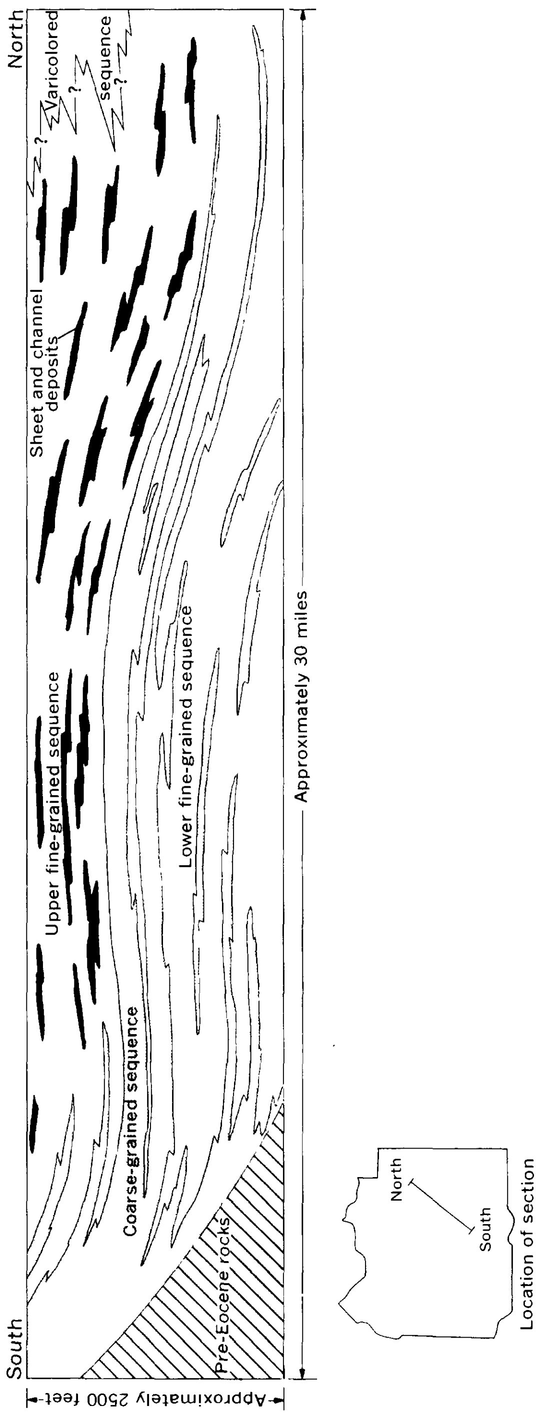


FIGURE 13.—Diagrammatic section showing approximate relations of major facies of part of the Wind River Formation.

Further refinement of the relations would require investigations beyond the scope of this report. Although preliminary, the relations as presented form a reasonable basis for exploration for water in the formation.

The oldest Eocene rocks shown on the diagram are the lower fine-grained sequence of the Wind River Formation, which is probably several thousand feet thick. These rocks are mostly brown, maroon, red, and gray siltstone and shale and some sandstone. Undifferentiated older rocks of the Wind River Formation and rocks of the Indian Meadows Formation underlie the sequence, but are not shown on the diagram (fig. 13). The lower fine-grained sequence is overlain by, and intertongues toward the south with, a coarse-grained sequence.

The main body of the coarse-grained sequence is probably about 1,000 feet thick along the northeast side of the central anticlinal structure, but the sequence thins toward the northeast. The rocks consist of green and gray, largely arkosic sandstone, conglomerate, and siltstone. Many of the coarse-grained sandstone and conglomerate beds are very well sorted, loosely cemented, and very porous. The coarse-grained sequence crops out along the northeast side of the central anticlinal structure and north of Alkali Butte. On the outcrop, most of the rocks have weathered to rusty tan and yellow colors. The coarse-grained sequence intertongues with and underlies an upper fine-grained sequence.

The upper fine-grained sequence is at the surface in most of the eastern part of the reservation. The maximum thickness of the sequence is about 800 feet in most of the area, but it is thicker in the northeast near the structural trough (pl. 2). These rocks are mostly gray and green siltstone, shale, and sandstone, but there are also thin beds of red, maroon, and green siltstone and shale. Toward the north, the red, maroon, and green rocks are thicker and become a large part of the sequence. Numerous sheet and channel deposits of brown siltstone and sandstone occur in the sequence.

The youngest rocks of the Wind River Formation in the eastern part of the reservation are a complex varicolored sequence that occurs along the north margin of the basin. These rocks are grouped together for simplicity because they are poorly known, but they contain several facies and probably exceed 1,000 feet in maximum thickness. The rocks consist of claystone, siltstone, shale, sandstone, conglomerate, and limestone. They are generally colorful; red, green, yellow, maroon, and violet are common. Most of the rocks are composed of Paleozoic and Mesozoic rock fragments. Relations of the varicolored sequence in the northeastern part of the reservation with other rocks of the Wind River Formation are assumed to be as shown in figure 13.

In the western part of the reservation, the rock sequences are similar to those in the eastern part. The basin, however, is narrower in the west, and conglomeratic rocks along the margins of the basin are a larger part of the formation and the basinward finer grained facies, a lesser part. The lower fine-grained sequence is probably represented in the deep part of the structural trough (pl. 2) west and south of the central anticlinal structure. Rocks similar to the coarse-grained sequence are present and crop out in many places along the Wind River valley. Along the margin of the basin to the southwest, the sequence becomes largely conglomeratic. The upper fine-grained sequence is present and intertongues northward with conglomerate and brightly colored finer grained rocks that are similar to the varicolored sequence present in the east. Overlying the upper fine-grained sequence and parts of the varicolored sequence are 200–300 feet of tuffaceous rocks, which consist mostly of buff sandstone and white and pink tuff.

Most wells in the Wind River Formation tap sandstone of the upper fine-grained sequence. Yields are as much as 50 gpm, but most wells have lower yields. The most productive aquifers are in the coarse-grained sequence. Wells tapping these rocks, as in the Riverton well field, yield as much as 500 gpm. Few, if any, wells tap the other rocks of the Wind River Formation.

The Wind River Formation contains water having dissolved solids that generally range from about 200 to 5,000 ppm. Most of the water in the upper fine-grained sequence contains more than 1,500 ppm of dissolved solids. Water with lower concentrations of dissolved solids, however, occurs in some sandstones where recharge water contains low concentrations of dissolved solids and where the water infiltrates through rocks containing small amounts of soluble salts.

Water from many wells tapping the coarse-grained sequence has dissolved solids of 200–1,000 ppm; however, some rocks in this sequence have water containing very high concentrations of dissolved solids. Most wells that yield water containing dissolved solids of less than 1,000 ppm, including the Riverton well field, tap the coarse-grained sequence at altitudes lower than where the sequence is crossed by the Wind and Little Wind Rivers (Kinnear and Johnstown Valleys along the Wind River south of Morton, and about 5 miles west of Arapahoe on the Little Wind River). These are assumed to be principal recharge areas for part of the coarse-grained sequence.

The Wind River Formation has a large potential for continued development. Water of quantity and quality suitable for stock use is available from the formation in almost any area, although well depths of 500 feet or more will be necessary in a few places. Wells yielding several hundred gallons per minute are possible from some aquifers in the coarse-grained sequence. Water of quality suitable for drinking or other uses requiring low concentrations of dissolved solids is available from some aquifers of the formation. The dissolved solids and specific-conductance data shown on plate 1 indicate the quality of water and the depths at which it is found locally.

OTHER TERTIARY ROCKS

Other Tertiary rocks in the area are the Aycross, Tepee Trail, and Wiggins Formations and an unnamed tuff. These rocks consist of conglomerate, breccia, tuff, sandstone, and claystone. Volcanic rock fragments and tuff are predominant. Colors are pink, white, green, olive, brown, yellow green, and gray. The combined thickness ranges from 0 to more than 3,000 feet. The rocks and their equivalents have been removed by erosion from most of the area. The Aycross, Tepee Trail, and Wiggins occur only in the northwest corner of the area. The unnamed tuff is present only along the north margin of the basin near Boysen Reservoir.

The rocks are largely drained because of their high topographic position. Where they contain water, yields of as much as 50 gpm may be possible; but no water wells are known to tap them in the area. Water from most of these rocks would probably contain less than 2,000 ppm of dissolved solids.

QUATERNARY ROCKS

A few deposits of travertine occur along the northeast slope of the Wind River Mountains in the western part of the area. They are associated with dissected high terraces and may yield water locally to springs. Landslide and steep-slope colluvial deposits occur along the margins of the mountain ranges. These rocks may also yield water locally to springs. Glacial deposits occur in and along the northeast flank of the Wind River Mountains. They are described in detail by Richmond and Murphy (1965) and by Murphy and Richmond (1965). Some of the glacial deposits will yield water. (See table 1.)

TERRACE AND PEDIMENT DEPOSITS

Remnants of many terraces and pediments occur throughout the basin and along the margins of the mountains. Deposits that consist predominantly of gravel, sand, and cobbles underlie these surfaces to depths of as much as about 80 feet, but generally the thickness is less than 30 feet.

These deposits are largely drained except in irrigated areas. Thin saturated zones probably underlie some of the more extensive nonirrigated terraces and would yield a few gallons per minute. This water would probably contain more than 1,500 ppm dissolved solids.

Deposits underlying irrigated terraces will contain water, at least through the irrigation season. The saturated thickness will decrease after irrigation ceases, and some of these deposits may be nearly drained before irrigation resumes. Potential yields range from a few gallons to a few hundred gallons per minute and depend to a large extent on the thickness of saturation. The water will generally contain about 300–2,000 ppm dissolved solids, but the concentration may be much higher in areas of poor drainage. The quality will change seasonally because of the irrigation, and the concentration of dissolved solids will be highest in the spring before irrigation begins.

SLOPE WASH AND ALLUVIUM

Deposits mapped as slope wash and alluvium on the geologic map (pl. 2) include slope wash, slope wash and interbedded or underlying alluvium, and alluvium of smaller stream valleys where slope wash and alluvium have not been mapped separately. The thickness of these rocks range from 0 to about 80 feet. Slope wash is generally fine grained and consists predominantly of silt, clay, and sand. Alluvium is both fine and coarse grained.

In the upper reaches of many of the stream valleys, the alluvium has not been mapped separately from slope wash. Yields of a few gallons per minute are available from many of these rocks.

In the Mill Creek valley, alluvium interbeds with and underlies slope wash. The alluvium consists predominantly of sand and gravel, and the slope wash is predominantly sand and silt. Sections of these rocks are shown on plate 3. Yields of a few to several hundred gallons per minute are available. Dissolved solids range from about 500 to 5,000 ppm.

In Kirby Draw and Beaver Creek valley in the southeast, the alluvium is predominantly sand and silt; slope wash and alluvium are very similar and have not been mapped separately. Sections of the alluvium of Kirby Draw are shown in figure 14. A few test holes augered in the Beaver Creek valley penetrated similar deposits. Part of the alluvium is well-sorted sand and very fine gravel that would probably yield as much as 20 gpm. Chemical analyses (table 6) indicate that water having dissolved solids of about 1,500 ppm is available from shallower wells in at least parts of the valleys. Some of the water in the deeper part of the alluvium contains more than 4,000 ppm dissolved solids, as is shown by the analysis of water from well D1–5–11bdd (table 6).

North of the Wind River in the central part of the basin, the rocks consist mostly of fine-grained slope wash and poorly sorted fine- to coarse-grained alluvium that underlies slope wash. These rocks contain water in some places, but mostly they are thin, tight, or drained.

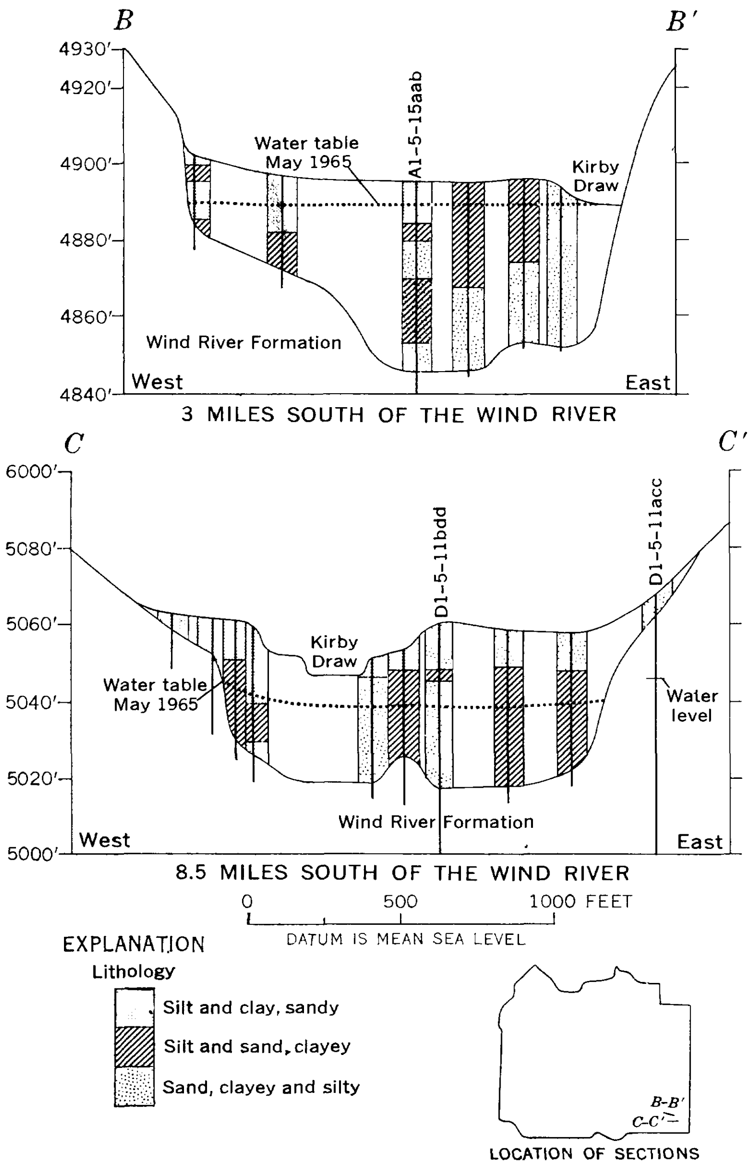


FIGURE 14.—Sections of alluvium in Kirby Draw. Lines of sections are shown on geologic map. Numbered holes are cased wells for which data are given in tables.

Where they will yield water, less than 20 gpm would generally be expected. The water probably contains about 1,000–5,000 ppm dissolved solids.

ALLUVIUM OF FLOOD PLAINS AND RELATED LOW TERRACES

Deposits mapped as alluvium of flood plains and related low terraces (pl. 2) are of two general types, coarse grained and relatively fine grained. The thickness ranges from 0 to about 100 feet, but most of the alluvium is less than 40 feet thick.

Alluvium is generally coarse grained in the Wind River valley and in the valleys of those tributaries that flow northeastward from the Wind River Mountains. Representative sections of alluvium in these valleys are shown on plate 3. Crow Creek valley in the northwest and Owl Creek valley along the northern border of the area also have generally coarse-grained alluvium. Gravel, sand, and cobbles are predominant; silt, clay, and boulders are present in lesser amounts. Yields of a few to several hundred gallons per minute are available from these rocks. The water will contain about 200–2,000 ppm dissolved solids.

Alluvium in the valleys of Fivemile, Muddy, and Cottonwood Creeks is relatively fine grained. Sand and silt are predominant; clay, gravel, and cobbles are present in lesser amounts. Yields of a few gallons per minute are available from some of these rocks. The water from most of these rocks probably contains about 1,000–2,000 ppm dissolved solids.

CHEMICAL QUALITY OF WATER

Chemical analyses of 146 ground-water samples are given in table 6. In addition to the data in the table, specific conductance and dissolved solids for water from many wells are given on plate 1. Dissolved-solids data from Geological Survey analyses are not shown on plate 1 if data from other sources are available because Geological Survey analyses are given in table 6. Most of the dissolved-solids data on plate 1 are from chemical analyses made by the Wyoming State Department of Agriculture or by the U.S. Bureau of Reclamation. The specific-conductance data on plate 1 were collected in the field during this study.

Chemical analyses of surface waters collected at five sampling stations are given in table 7. Locations of four of the stations are shown on plate 1; the other station is at Dubois about 10 miles west of the reservation. Additional chemical analyses of surface waters of the area have been published in Colby and others (1956) and in the annual series of water-supply papers, "Quality of Surface Waters of the United States."

WATER-QUALITY CRITERIA

The quality of a water is judged according to the use for which it is needed. Generally, the lower the dissolved solids, the better the water; however, for some uses, the concentration of particular substances in a water may be even more important than the total concentration of dissolved solids. Some general criteria for evaluating water for common uses are discussed below. More detailed information may be obtained from the publications cited in the discussion.

DOMESTIC AND MUNICIPAL USE

Chemical-quality standards for potable water used by public carriers and by others subject to Federal quarantine regulations have been established by the U.S. Public Health Service (1962). These standards concern bacteria, radioactivity, and chemical constituents that may be objectionable in a water supply. The following is a partial list of the standards that pertain only to those constituents for which analyses are given in this report:

The following chemical substances should not be present in a water supply in excess of the listed concentrations where * * * other more suitable supplies are or can be made available. (U.S. Public Health Service, 1962)

Substance	*Recommended limit (concentration in ppm)*
Chloride (Cl)	250
Fluoride (F)	0.8–1.7
Iron (Fe)	.3
Nitrate (NO_3)	45
Sulfate (SO_4)	250
Total dissolved solids	500

Fluoride limits are based on the average of maximum daily air temperatures in order to relate the limit to total consumption. For example, when the average is 50.0°–53.7° F, the upper limit is 1.7 ppm; when the average is 79.3°–90.5°F, the upper limit is 0.8 ppm.

Iron in water tends to stain porcelain fixtures and laundry and can be tasted. Nitrate in excess of the recommended concentration presents a potential danger if the water is used for infant feeding. Sulfate in concentrations above the recommended limit may have a laxative effect.

Excessive hardness in water is determined for domestic and municipal use and some industrial uses. It is defined as the property that causes soap to form an insoluble curd. It is also a major contributor to the scale that forms in boilers and pipes. Calcium-magnesium hardness values reported in the analyses (tables 6, 7) are approximately equivalent to the total hardness of a water. Calcium and magnesium cause most of the hardness of natural water; other hardness-causing constituents are generally negligible. Part of the hardness can be removed from water by heating, and an insoluble precipitate or scale is formed. The precipitate is a compound of carbonate, and that part of the hardness that is removed is called carbonate hardness. The remaining hardness is the noncarbonate hardness reported in the analyses. Methods used by the Geological Survey to calculate hardness are given in Rainwater and Thatcher (1960). Adjectival ratings used by the Geological Survey to describe hardness are:

Calcium-magnesium hardness as $CaCO_3$ *(ppm)*	*Adjectival rating*
0–60	Soft
61–120	Moderately hard
121–180	Hard
181+	Very hard

AGRICULTURAL USE

STOCK

The tolerance of animals to dissolved solids in water depends on the species, age, and physiological condition of the animal; on the amount of water consumption; and on the quantity and type of salts present in the water. However, standards for most of these factors have not been determined, and general standards based on the total concentration of dissolved solids are used. McKee and Wolf (1963) discuss some of the criteria that have been used. Beath and others (1953) suggest the following classification as a guide for evaluating stock water in Wyoming.

Classification	*Dissolved solids (ppm)*
Good	Under 1,000
Fair (usable)	1,000–3,000
Poor (usable)	3,000–5,000
Very poor (questionable)	5,000–7,000
Not advisable	7,000 and over

IRRIGATION

Boron, bicarbonate, sodium, and salinity are the principal hazards related to the chemical character of water for irrigation use.

Boron is an essential plant nutrient, but even very low concentrations may be toxic to boron-sensitive crops. Eaton (1935) has classified crops according to their tolerance to boron. For boron-sensitive crops, concentrations of less than about 0.7 ppm have very slight effect; higher concentrations have significant yield depression or may be unusable. For tolerant crops, concentrations of less than 2.0 ppm have very slight effect (Scofield, 1936).

When bicarbonate concentrations are high, calcium and magnesium tend to precipitate as carbonates. The calcium-magnesium concentration is thereby reduced, and the relative proportion of sodium is increased.

When the sodium concentration in water is high compared with that of calcium and magnesium, sodium replaces calcium and magnesium in the soil and a sodium soil remains. Sodium soils may be improved by adding amendments, such as gypsum, which replenish the calcium or magnesium. An index of the sodium hazard is the sodium-adsorption-ratio (SAR) which expresses the relative activity of sodium ions in the exchange reactions with soil (U.S. Salinity Lab. Staff, 1954).

Salinity (dissolved solids) increases the osmotic pressure in the soil solution, and when salinity is high, plant growth is retarded. Because the salinity of water is closely related to the specific conductance of water, specific conductance may be used as a measure of the salinity hazard of water.

Specific conductance and SAR for water from alluvium are plotted (fig. 15) on a diagram (U.S. Salinity Lab. Staff, 1954) that is used for classification of water for irrigation. Other water may be classified in the same manner by use of this diagram. The water is classified according to salinity and sodium hazards as follows:

Salinity hazard

Class

1. Low-salinity water can be used for irrigation of most crops on most soils, with little likelihood that a salinity problem will develop. Some leaching is required, but this occurs under normal irrigation practices except in soils of extremely low permeability.
2. Medium-salinity water can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most instances without special practices for salinity control.
3. High-salinity water cannot be used on soil with restricted drainage. Even with adequate drainage, special management for salinity may be required and plants with good salt tolerance should be selected.
4. Very high salinity water is not suitable for irrigation under ordinary conditions, but may be used occasionally under very special circumstances. The soil must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching, and very salt tolerant crops should be selected.

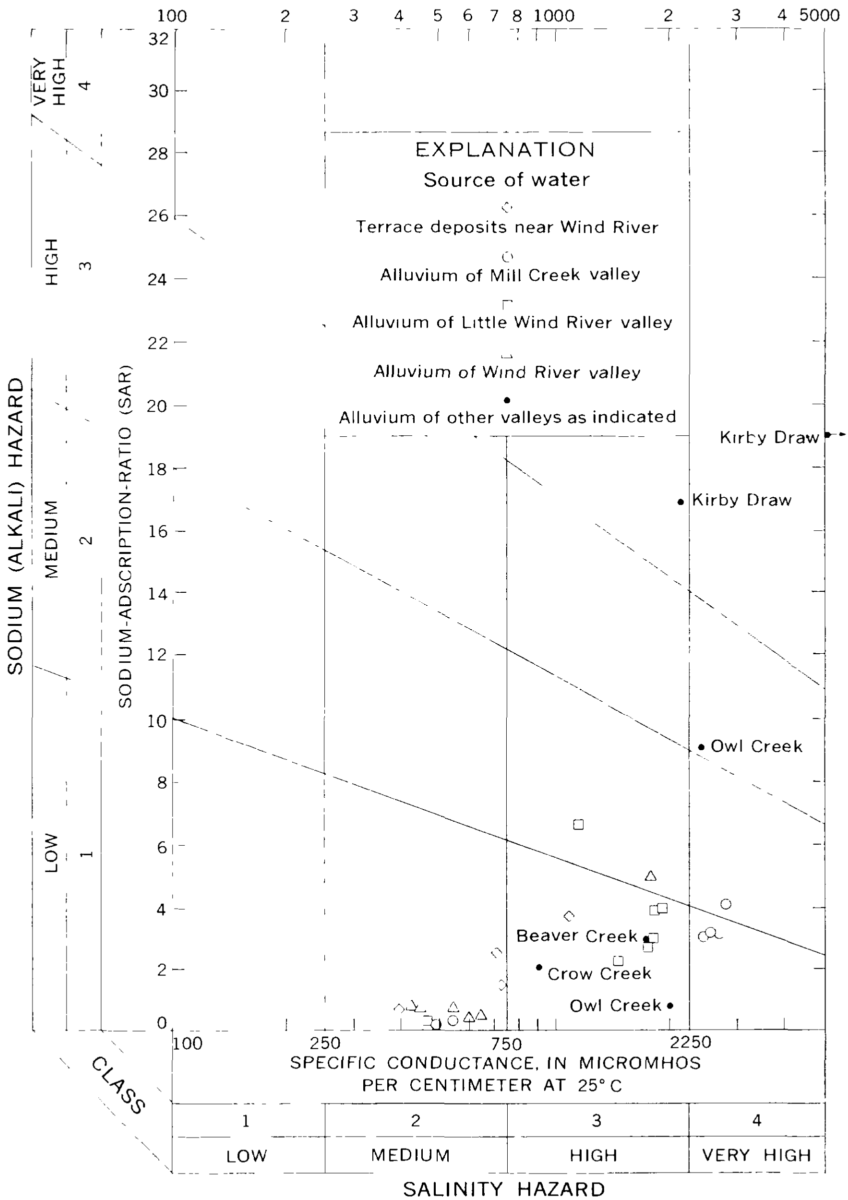


FIGURE 15.—Classification of water from alluvium for irrigation use. Diagram adapted from U.S. Salinity Laboratory Staff, 1954.

Sodium hazard

Class

1. Low-sodium water can be used for irrigation on almost all soils with little danger of the development of a sodium problem. Sodium-sensitive crops, however, may accumulate injurious amounts of sodium in the leaves.
2. Medium-sodium water may present a moderate sodium problem in fine-textured (clay) soils unless there is gypsum in the soil. This water can be used on coarse-textured (sandy) or permeable organic soils.
3. High-sodium water may produce troublesome sodium problems in most soils and will require special management, good drainage, high leaching, and additions of organic matter. If there is plenty of gypsum in the soil, a serious problem may not develop for some time. If gypsum is not present, it or some similar material may have to be added.
4. Very high sodium water is generally unsatisfactory for irrigation except at low- or medium-salinity levels where the use of gypsum or some other amendment makes it possible to use such water.

INDUSTRIAL USE

Water-quality criteria for industrial use vary widely according to use. Some industries have strict quality requirements. Requirements for cooling and waste disposal are generally lenient, although certain waters may require treatment to prevent corrosion and scale. Criteria for many industrial uses are given in McKee and Wolf (1963, p. 92–106).

QUALITY OF SURFACE WATER

The Geological Survey maintains sampling stations near Dubois on the Wind River (about 10 miles west of the reservation), near Riverton on the Wind and Little Wind Rivers, near Arapahoe on the Little Wind River, and near Hudson on the Popo Agie River. Dissolved solids in the Wind River near Dubois range from about 50 to 300 ppm (Colby and others, 1956). The Wind River at Riverton contains a calcium bicarbonate water that is moderately hard to hard; dissolved solids range from about 150 to 350 ppm. Analyses show an appreciable increase in sulfate downstream from Dubois. Much of the water from the Wind River is diverted for irrigation on the Riverton Irrigation Project, but the return flow is discharged into the river by way of Fivemile Creek downstream from the sampling station at Riverton.

Dissolved solids in the Little Wind River near Riverton range from about 300 to 850 ppm; water in the Popo Agie River near Hudson is probably similar, but water in the Little Wind River above Arapahoe has a high concentration of dissolved solids. Water from these streams is used extensively for irrigation, and much of their flow in downstream reaches during the irrigation season is return flow from irrigation.

Fivemile Creek is used as a drain for the Riverton Irrigation Project. The surplus irrigation water and seepage of ground water from the irrigated land has made the formerly intermittent stream a perennial stream. The water is a sodium sulfate type, very hard, and dissolved solids range from about 1,000 to 4,000 ppm (Colby and others, 1956).

QUALITY OF GROUND WATER

Most of the geologic formations in the area have few, if any, wells, and little or no data are available concerning the quality of the ground water in them. A relatively large amount of data is available concerning the quality of the water in the Wind River Formation and in some of the alluvium. Chemical-quality data are presented in table 6 and on plate 1. General estimates of the dissolved solids that may be expected in water from the formations are included with the discussion of the geologic units in the text and in table 1.

DRAINAGE PROBLEMS IN IRRIGATED AREAS

HISTORY OF IRRIGATION

Irrigation began in the early 1860's with simple diversions of water from the Popo Agie and Little Wind Rivers. In 1905 the Wind River Irrigation Project was established on lands under supervision of the Bureau of Indian Affairs. The Wyoming No. 2 canal was built near Riverton in 1907 on land ceded by the Indians. About 1914 the Riverton-Le Clair Irrigation District was formed. In 1920 the Bureau of Reclamation began construction of the Riverton Irrigation Project in the Fivemile Creek drainage; the project was expanded in 1951 to include areas in the Muddy Creek drainage. (See locations of projects and irrigated areas on pl. 3.)

Irrigation began about 1880 in the Owl Creek valley. Several unsuccessful attempts have been made to augment and stabilize the supply of water in Owl Creek, but irrigation in the valley remains dependent on uncontrolled runoff supplemented to a small degree by ground water.

More detailed information on the history of irrigation in the Wind River Reservation can be found in Gerharz (1949), U.S. Bureau of Indian Affairs (1962), and U.S. Bureau of Reclamation (1950).

AREAS OUTSIDE THE WIND RIVER IRRIGATION PROJECT

The discussion of drainage problems is confined to those of the Wind River Irrigation Project, which is under the supervision of the Bureau of Indian Affairs. Other irrigated areas are under the supervision of individuals, private irrigation districts, or the Bureau of Reclamation.

Much detailed work has been done by the Bureau of Reclamation in the study and control of drainage and related problems in the Riverton Irrigation Project. Some work has also been done in the Riverton-Le Clair and Owl Creek Irrigation Districts. Unpublished reports and maps have been prepared by the Bureau of Reclamation. A Geological Survey report on the ground-water resources of the Riverton Irrigation Project (Morris and others, 1959) contains a discussion of drainage problems.

AREAS IN THE WIND RIVER IRRIGATION PROJECT

PREVIOUS DRAINAGE STUDIES

The first recorded drainage canal on the Wind River Irrigation Project was constructed about 1918. The first comprehensive drainage plan, presented by Gerharz (1949), included the location and design of proposed drainage facilities. The plan was based on topographic mapping of problem areas and on some subsurface investigation.

A more detailed drainage investigation was conducted from 1960 to 1965 by Missouri River Basin Investigations (U.S. Bur. Indian Affairs, 1965). Drainage-problem areas of the Left Hand unit, the flood plains of the Sub-Agency system near Arapahoe, the underfit-stream valleys of Mill and Trout Creeks, and the area just east of Ray Lake (pl. 3) were intensely studied and drainage facilities were proposed. Holes were augered in a grid pattern approximately every eighth of a mile, and pipes were installed approximately every quarter of a mile to observe water levels. Hole depths were 9–14 feet (lengths of the auger stem), except where coarse deposits limited augering to shallower depths. Maps were constructed showing the depth to gravel based on auger data. Water levels were measured frequently, and maps were prepared showing water-table conditions at various times during both irrigating and nonirrigating seasons for the years 1961 through 1963. The maps show the depth to water and water-table and land-surface contours. In addition to the areas of intensive study, the investigation included a reconnaissance of the other drainage-problem areas in the Wind River Irrigation Project.

Soil studies have been made, and the lands have been mapped and classified. One such study was made for the Branch of Land Operations as a part of a resource inventory of the reservation (U.S. Bur. Indian Affairs, 1962).

Two reports are now in preparation concerning the Wind River Irrigation Project in general and will include information on drainage. "The Wind River Irrigation Project Completion Report," is in preparation by Missouri River Basin Investigations. The "Report on the Wind Division, Wyoming," is in preparation by the Bureau of Reclamation and will include relations of the Wind River Irrigation Project to other existing or proposed developments in the Wind River Basin.

METHODS FOR IMPROVING DRAINAGE

Methods commonly used to improve drainage are discussed in detail in publications on drainage engineering such as that by Luthin (1957). Methods that are, or could be, used in relieving drainage problems in the Wind River Irrigation Project include the reduction of applied water and the use of drains or wells to remove excess water.

Open drains about 8 feet in depth are used to lower water tables; they increase gradients locally and provide channels for water transport. They are also used to intercept the lateral movement of ground water. Shallower drains, less than 4 feet in depth, are in use in some parts of the area, but they have a limited effect on the water table. Buried drains increase gradients, provide channels for water transport, and have the general effect of increasing the permeability of the material in which they are buried.

Relief wells can be used to make drains more effective where deposits of low permeability extend below practical drain depths but overlie more permeable gravel. The relief wells are constructed in the bottom of drains and are drilled into the underlying gravel. They provide a direct hydraulic connection between the drain and the gravel, and water flows from the wells into the drains.

Pumping from wells can lower the water table and drain waterlogged areas where geologic conditions are suitable. Pumping from sumps or from drains can be used effectively to move water from a waterlogged area, and they can be particularly useful where the gradient between the waterlogged area and the ultimate surface drainage is flat and conditions are not favorable for pumping from wells. The water obtained by pumping would be available for irrigation, and the amount of surface water used could be reduced.

Reduction of the amount of water entering an area may be essential in some areas. The lining of canals and ditches and the reduction of irrigation-water applications to an optimum would relieve the load on the drainage system.

CLASSIFICATION AND EVALUATION OF DRAINAGE-PROBLEM AREAS

The present study is limited chiefly to the relation of drainage problems to geology. Most irrigated lands are unconsolidated slope wash or stream deposits underlying flood plains, terraces, or gentle slopes. Test holes were drilled through these deposits to define their composition and thickness. Sections at nine locations are shown on plate 3. On the basis of the test drilling, the alluvium was divided into coarse-grained alluvium and fine-grained alluvium. The coarse-grained alluvium consists of sand, gravel, cobbles, and boulders and contains very little silt or clay; it generally lies on the bedrock. The fine-grained alluvium grades from a silty soil zone formed on sand and gravel of flood plains and terraces to slope wash of clay, silt, and sand.

Terms used to describe permeability in the discussion of the drainage problems have arbitrarily been given the values: "Low," less than 10 gpd/ft^2; "moderate," 10–100 gpd/ft^2; and "high," greater than 100 gpd/ft^2.

Areas of the Wind River Irrigation Project where drainage problems occur were mapped by the U.S. Bureau of Indian Affairs (1965) and are shown on plate 3. For this report, the drainage-problem areas have been classified according to geologic similarities into five general groups: flood plains, terraces, underfit-stream valleys, slopes, and transitional areas.

FLOOD PLAINS

Many of the drainage-problem areas occur on the flood plains and related low terraces in the river valleys. In these areas, highly permeable coarse-grained alluvium underlies fine-grained alluvium of low to high permeability. Downstream land-surface gradients range from about 20 to 50 feet per mile, but gradients across the valleys, toward the rivers, are generally less than 5 feet per mile. The water-table gradient is approximately parallel to that of the land surface; accordingly, most ground-water movement is parallel to the river rather than toward it. Water tables are naturally high, and some of the area was probably waterlogged before addition of irrigation water. The problem is aggravated in some areas where water from terrace deposits discharges into the flood-plain deposits.

LEFT-HAND UNIT

As section A–A′ and B–B′ (pl. 3) show, the land surface of this area is about 5–8 feet above the level of the Wind and Little Wind Rivers. The water table ranges from the land surface to a depth of about 8 feet. The total thickness of the alluvium is 10–15 feet in most of the area. It consists of highly permeable coarse-grained alluvium overlain by 6 feet, or less, of moderately to highly permeable fine-grained alluxium.

Barriers of low permeability probably contribute to the drainage problems in some areas, but the principal problems are the low gradient and the naturally high water table. Left-Hand Canal and its distribution ditches are unlined and add water to the alluvium. Springs, which are visible along the terrace scarps in several places, are evidence that the irrigated terraces to the south contribute some water.

The alluvium is underlain by siltstone and sandstone of the Wind River Formation. Water in the sandstone in contact with the alluvium is hydraulically connected to the water table in the alluvium. Some deeper sandstones have piezometric heads about the water table, which suggests the possibility that the bedrock could contribute some water to the alluvium. Generally, however, layers of relatively impermeable siltstone separate the deeper standstones from the alluvium. Water from the bedrock probably has no significant effect on the drainage problems.

Drainage problems would be alleviated by reducing the amount of water entering the area. Steps that would improve drainage include the lining of canals and ditches and the reduction of irrigation-water applications to the optimum. Drains would be effective for intercepting canal losses, but would be only partially effective in lowering the water table because of flat gradients across the valley.

The use of wells to aid drainage does not seem feasible because of the thinness of the alluvium. A pumping test on well A1-4-31dcc showed a maximum yield of about 5 gpm. (See discussion on test under "Aquifer characteristics.") A much larger yield would be necessary to lower the water table significantly. Pumping from sump pits or from drains, however, could produce larger discharges and, if pumped into a lined canal system, the water table could be lowered. Ground water recovered from the area would probably be suitable for irrigation or, if marginal in quality, could be diluted with surface water and used.

JOHNSTOWN UNIT

In the problem area shown in section *C–C′* (pl. 3), the land surface is generally about 10 feet above the river level. The water table in the problem area ranges from the land surface to a depth of about 10 feet. The total thickness of the alluvium is about 25–30 feet. About 20 feet of highly permeable coarse-grained alluvium underlie 5–10 feet of fine-grained alluvium, which is mostly of moderate permeability. The other problem area in this unit (pl. 3) is apparently very similar.

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The alluvium is underlain by siltstone, sandstone, and conglomerate of the Wind River Formation. Coarse-grained sandstone and conglomerate, which are moderately to highly permeable, are at places directly in contact with the alluvium as at well A1–2–6aaa. In this area, water movement is from the alluvium to the bedrock, as the water table of section *C–C′* (pl. 3) shows.

Drains should be effective in improving drainage. Where practical, the drains should penetrate the coarse-grained alluvium or be hydraulically connected to it with relief wells. The lining of Johnstown canal would be desirable, but section *C–C′* (pl. 3) indicates that a drain along the south edge of the drainage-problem area would intercept much of the canal losses.

Wells could be used as an alternative or supplement to drains. A battery of wells tapping the coarse-grained alluvium should lower the water table effectively and would yield water suitable for irrigation.

UPPER WIND UNIT

In the problem area shown in the northern part of section *D–D′* (pl. 3), the land surface ranges from 5 to 50 feet above the river level. Water-level data are sparse, but the water table is known to rise to the land surface in parts of the area during the irrigation season. Water-table fluctuations are probably large in the southern part of the problem area. The total thickness of the alluvium ranges from about 40 to 90 feet. About 40–70 feet of highly permeable coarse-grained alluvium underlie fine-grained alluvium. The fine-grained alluvium ranges in thickness and in character from about 1 foot of highly permeable soil in the northeast to about 30 feet of slope wash and alluvial-fan deposits of low to moderate permeability in the southwest. The other problem areas along the flood plain in the Upper Wind unit (pl. 3) are probably very similar.

Ground-water movement is predominantly down the valley, but water also moves laterally into the valley from the streams, draws, and terraces draining from the southwest. Bedrock should have no significant effect on the drainage problems. Drainage problems result from the abundance of surface water, from the low permeability of the surface deposits in the southwest, and from low land near the river in the northeast.

Drains would be effective in some of the area, and wasteways to divert surface flows would be helpful. Wells could produce irrigation supplies of good quality and help lower the water table. (See discussion of test of well B4–4–2cda under "Aquifer characteristics.") Water from canals and irrigation applications are a significant source of the excess water. If ground water from wells were used for irrigation and imported water were reduced to a minimum, many drainage problems would be alleviated.

SUB-AGENCY SYSTEM, LITTLE WIND UNIT

In the problem area, shown in sections *F–F′* and *G–G′* (pl. 3), the land surface is generally about 10 feet above the river level. The water table ranges from the land surface to a depth of about 10 feet, but is less than 5 feet below land surface in most of the area. The total thickness of the alluvium ranges from about 5 to 20 feet. Highly permeable coarse-grained alluvium underlies about 5 feet, or less, of fine-grained alluvium of low to moderate permeability. The other problem area of the flood plain in the Sub-Agency system (pl. 3) is probably very similar.

Ground-water movement is both toward the river and down the valley. Part of the excess ground water in the valley drains from irrigated terraces on the north and part is from local irrigation.

The alluvium is underlain by siltstone and sandstone of the Wind River Formation. Water in the sandstone in contact with the alluvium is hydraulically connected to water in the alluvium. Some deeper sandstones have piezometric heads above the water table. Generally, however, layers of relatively impermeable siltstone separate the deeper sandstones from the alluvium. Water from the bedrock probably has no significant effect on the drainage problems.

Drainage problems would be alleviated by reducing the amount of water entering the area, particularly that water draining from the higher irrigated terraces to the north. Intercept drains along the base of the terrace scarp would be helpful. Flat gradients across the valley, however, would seriously limit the usefulness of drains in most of the area. Other steps that would improve drainage include the lining of canals and ditches and the reduction of irrigation-water applications to the optimum.

The use of wells to aid drainage does not seem feasible because of the thinness of the alluvium in most of the area. Pumping from sump pits or drains, however, would lower the water table and would make drains more effective. Ground water recovered from the area would generally be of poor quality for irrigation, but could be used by diluting with surface water.

COOLIDGE SYSTEM, LITTLE WIND UNIT

In the problem area near Ethete shown in section *H–H′* (pl. 3), the land surface is about 15 feet above the river level. The depth to water is less than 5 feet in most of the area. The total thickness of the alluvium ranges from about 15 to 30 feet. About 15–25 feet of highly permeable coarse-grained alluvium underlie about 5 feet, or less, of fine-grained alluvium of low to moderate permeability.

Ground-water movement is both toward the river and down the valley. The water table rises in the drainage-problem areas in response to applied irrigation water and leakage from ditches. Contribution of water from the bedrock, if any, is probably not significant to the drainage problems. The bedrock is shale and sandy shale of the Cody Shale. Section *H–H′* (pl. 3) arbitrarily shows the base of the coarse-grained alluvium as the contact with the Cody. A zone of clay underlying the coarse-grained alluvium generally could not be distinguished from weathered shale of the Cody.

Drains penetrating the coarse-grained alluvium should be effective. Wells could produce water suitable in quality for irrigation and effectively lower the water table. (See discussion of test of well A1–1–34bcb under "Aquifer characteristics.")

The small drainage-problem areas on the flood plains of the Little Wind River in the eastern part of the Coolidge system (pl. 3) are generally similar to the areas near Ethete. Bedrock is sandstone, siltstone, and shale of the Fort Union or Wind River Formation; bedrock probably has no significant effect on the drainage problems. Water moves laterally into the area from the Mill Creek valley. This water is much higher in dissolved solids than the water upstream in the Little Wind River valley. To be used for irrigation, water pumped from these areas would probably have to be diluted with surface water.

TERRACES

Small drainage-problem areas occur on the irrigated terraces. The alluvium underlying the terraces is similar to that underlying the flood plains. Soil zones are older and better developed, but are still moderately permeable. The terrace deposits are higher in relation to streams and are mostly well drained. Drainage problems occur where the water table is at or near the land surface because of abrupt changes in slope, changes in thickness of the alluvium, topographic lows, or local variations in permeability.

UPPER WIND UNIT

Sections *D–D′* and *E–E′* (pl. 3) show the general relation of the deposits of Crowheart terrace to the Wind River and its tributaries. The total thickness of the alluvium in the drainage-problem areas ranges from about 30 to 60 feet. About 20–50 feet of highly permeable coarse-grained alluvium underlies about 2–15 feet of permeable fine-grained alluvium.

The water table rises as water is applied to the land for irrigation and declines rapidly after the irrigation season as water drains from the terraces to the streams and the river valley. The terraces are mostly well drained; problem areas are small and scattered. Drains, including intercept drains along the base of slopes, should be effective in most of the areas. Wells could produce water for irrigation and help lower the water table. (See discussion of test of well B1–4–22aba under "Aquifer characteristics.")

The problem area at Burris (pl. 3), on a terrace of Dry Creek, is below the Crowheart terrace. Water draining from the Crowheart terrace probably causes most of the waterlogging. This water could be intercepted by a drain.

SUB-AGENCY SYSTEM, LITTLE WIND UNIT

The terrace deposits north of the Little Wind River near Arapahoe range in thickness from about 5 to 30 feet and are mostly 10–20 feet thick. They consist of highly permeable coarse-grained alluvium overlain by fine-grained alluvium of generally moderate permeability.

The water table rises as water is applied for irrigation and declines rapidly after the irrigation season as water drains from the terraces to the Little Wind River valley. Most of the terrace deposits are well drained; problem areas are small and scattered (pl. 3).

Drains penetrating the coarse-grained alluvium should be effective. Because the saturated terrace deposits are generally thin, wells would probably not be very effective in controlling drainage. Pumping into lined ditches, or canals, from sump pits or drains, however, could effectively remove water from the widely scattered drainage-problem areas, and the need for long interconnected drains could be reduced. The water could be used for irrigation if diluted with surface water.

RAY SYSTEM, LITTLE WIND UNIT

Two small problem areas south of Mill Creek have conditions similar to those described for terraces in general. The alluvium is similar to that of the Crowheart terrace in the Upper Wind unit. Most of the water is derived from irrigation. The hydrograph of well D1–1–32dcb (fig. 4) shows the rise in water table during the irrigation season. Drains or wells should be effective in lowering the water table.

UNDERFIT-STREAM VALLEYS

Two large drainage-problem areas are in the lower valleys of Mill and Trout Creeks. In their lower reaches, both Mill and Trout Creeks have stream channels that are small and shallow compared with the size of the valleys they occupy, and they are considered underfit streams. The fine-grained alluvium in the underfit-stream valleys is generally thicker and contains more slope wash than the fine-grained alluvium underlying the flood plains and terraces previously discussed.

RAY SYSTEM, LITTLE WIND UNIT

The land surface ranges from about the level of the Little Wind River to about 20 feet above the river and from about 10 feet below to 10 feet above the level of Trout Creek. (See section *I–I′*, pl. 3.) The water table ranges from the land surface to a depth of about 10 feet.

The general relations of the alluvial deposits are shown in section *I–I′* (pl. 3). The deposits in the northern part of the valley are very coarse, are largely glacial outwash, and are generally well drained. They merge to the south with generally thinner and finer deposits. In the drainage-problem area near section *I–I′*, about 2–15 feet of moderately to highly permeable coarse-grained alluvium underlie about 5–15 feet of fine-grained alluvium, which is of low to moderate permeability. Upstream from section *I–I′*, several valleys merge, and the pattern of alluvial deposition is probably more complex. Downstream, the valley narrows, and the alluvium thins where the Little Wind River passes through a gap in an anticlinal structure.

The Cody Shale underlies all except the northeastern part of the area. Sandy shale of the Cody may contribute some water, but the effect on drainage problems is probably insignificant. In the northeast, artesian water, including that from Washakie Hot Springs, comes from the bedrock formations and may affect the drainage problems locally.

Dark-gray clay, which includes some shale-pebble gravel and a few permeable zones, underlies the coarse-grained alluvium in some of the southern part of the valley (section *I–I′*, pl. 3). The contact between the clay and the underlying Cody Shale could not be distinguished; thus, the thickness of the clay is unknown, but is probably at least as thick as is indicated on section *I–I′*. A few wells derive water from the permeable zones, but the clay probably acts generally as a barrier to downward drainage.

Ground-water movement is generally down the valley, but there is also movement toward the waterlogged area from the irrigated lands in the north-central part of the valley. North and South Forks Little Wind River act as drains, but the small streams in the southern part of the valley, including Trout Creek, probably contribute water to the waterlogged area.

Deep drains would be effective in most of the area. Where possible, the drains should penetrate the coarse-grained alluvium or be hydraulically connected to it with relief wells. Drains could be used to intercept ground water from the north and to intercept salt-laden ground water that moves northward from the irrigated slope wash and shale south of the valley. Wells tapping the coarse-grained alluvium could supplement the drain system; but the permeability and thickness vary, and wells would not be effective everywhere. Ground-water quality is generally better in the north and poorer in the south, but even the water of poorer quality could be used for irrigation if diluted with surface water.

COOLIDGE SYSTEM, LITTLE WIND UNIT

Both the land surface and the water table range from about the level of Mill Creek to about 60 feet above the creek. (See sections *J–J′* and *K–K′*, pl. 3.) These relations are shown slightly distorted because the sections are not drawn perpendicular to the valley. The water table ranges from the land surface to a depth of about 15 feet.

The total thickness of the alluvium ranges from about 15 to 50 feet. About 5–30 feet of highly permeable coarse-grained alluvium underlie about 5–20 feet of fine-grained alluvium. The fine-grained alluvium is mostly of low to moderate permeability, but contains some sand and gravel of moderate to high permeability.

The underlying bedrock is sandstone and shale of the Frontier Formation and Cody Shale. The sections arbitrarily show the base of the coarse-grained alluvium as the contact with the bedrock. A zone of clay underlying the coarse-grained alluvium generally could not be distinguished from weathered shale, and could not be defined. The bedrock probably contributes a minor amount of water to the alluvium, but does not significantly affect the drainage problems.

Ground-water movement is toward and down the Mill Creek valley. One of the most important aspects of the drainage problem is the need for interception of ground water that moves into the valley from the irrigated higher lands south and southwest of Mill Creek.

Deep drains would not penetrate the coarse-grained alluvium in most places, and relief wells would be necessary to connect hydraulically the drains with the coarse-grained alluvium. Wells might be more effective than drains for much of the needed drainage. Wells could effectively lower the water table and produce water for irrigation. (See discussion of test of well D1–1–15ccc under "Aquifer characteristics.") The quality of water from alluvium northwest of Mill Creek is "poor to bad" for irrigation, but could be used if diluted with surface water. Water pumped from alluvium southeast of Mill Creek would be "fair to good" for irrigation.

SLOPES

Several drainage-problem areas in the Ray and Coolidge systems, Little Wind unit, are on gentle slopes above the main valleys (pl. 3). The north ends of sections *J–J′* and *K–K′* (pl. 3) cross two such areas.

A generally thin mantle of slope wash overlies bedrock in these areas. Most of the slope wash is of low permeability, but there are some scattered thin beds of sand and gravel of moderate permeability. Nearly impermeable barriers are scattered irregularly through some of these deposits.

The slope wash is underlain by the Frontier Formation and Cody Shale. The shale, sandy shale, and sandstone of these formations generally act as a barrier to drainage, but, in some places, bedrock may be a source of water. Irrigation water, canal leakage, and possibly artesian flows from the bedrock add water to the slope wash at rates faster than the material can transmit the water. Much of the waterlogged area is above the principal water table, but perched water accumulates during the irrigation season. Much of this perched water evaporates and leaves a concentration of salts in the soil. Drainage would be difficult in most of these areas, but drains that would intercept water below canals or other sources of water would reduce the size of the waterlogged areas.

Slope deposits grade from the slope wash described above to nearly impermeable clay or weathered shale, which cannot be drained adequately and are usually not irrigated. Material underlying the area in the eastern part of the Coolidge system, secs. 17 and 18, T. 1 S., R. 2 E. (pl. 3), is nearly impermeable (U.S. Bur. of Indian Affairs, 1965).

TRANSITIONAL AREAS

Several small drainage-problem areas grade from slope wash over bedrock to slope wash over coarse-grained alluvium. Although details of these areas are unknown, conditions are generally similar, in part, to those of both the underfit-stream valleys and the slopes. Drains could be used where underlying coarse-grained alluvium is present, but most of these areas would be difficult to drain.

POTENTIAL USE OF UNDERGROUND STORAGE

As yet, underground storage of water for irrigation supplies has not been utilized, except to a very small degree in the Owl Creek valley. A large volume of water is stored in alluvium along the Wind River, Little Wind River, and Mill Creek; lesser volumes are stored in deposits underlying irrigated terraces and in alluvium in some of the smaller stream valleys. The water in these deposits is actually in transient storage, that is, the water is moving through the deposits at a fairly slow rate; but at any particular time the deposits contain a certain amount of water. The underground storage could be utilized by pumping ground water from the alluvium during the irrigation season. Water removed by pumping would eventually be replaced by infiltration of precipitation, streamflow, and irrigation water. The process would be somewhat analogous to the way water in a surface-storage facility is used and is eventually replenished by streamflow.

The amount of water that is available from storage is the product of the volume of the saturated deposits and the specific yield of the deposits. The volume of the alluvium is known in a few areas that have been test drilled. The specific yield is unknown, but a specific yield of 10 percent is probably conservative for the type of deposits discussed. In the area along the Wind River near Crowheart (north end of section *D–D′*, pl. 3) saturated coarse-grained alluvial deposits are about 40 feet thick and 1½ miles wide. Using 10 percent as specific yield, about 4,000 acre-feet of water is available from storage for each mile length of the valley. Near Riverton (section *B–B′*, pl. 3), where saturated coarse-grained deposits average about 8 feet in thickness and a little more than 1 mile in width, about 500 acre-feet of water is available from storage per mile length of the valley. Near Ethete (section *H–H′*, pl. 3), where saturated coarse-grained deposits are about 20 feet thick and 1½ miles wide, about 2,000 acre-feet of water is available from storage per mile length of the valley. In the Mill Creek valley (sections *J–J′* and *K–K′*, pl. 3) the saturated coarse-grained deposits average about 15 feet in thickness, and about 1,000 acre-feet of water are available from storage for each square mile.

These values are intended only to give an estimation of the amount of water available in underground storage. Not all this water would be usable because it would be impractical to pump the deposits dry.

The use of both surface and underground storage of water could reduce the need for additional surface storage in some areas. Careful water management would be required because of the close relation of streamflows to the ground water; heavy pumping could divert entire streamflows. Overall planning would be required to make available the most water at the right time and at the least cost.

Both surface and underground storage are means of storing water, not of producing new supplies. The only increase in total water available would be by reduction of evaporation from open-water surfaces and from the water table in waterlogged areas. If underground storage were used rather than surface storage, the water that would have evaporated from that open surface would be salvaged. Lowering water levels in waterlogged areas by pumping would reduce evaporation from the water table. No estimate has been made of the possible amount of water retained by minimizing evaporation, but it would probably be significant.

SUMMARY

Most wells in the area derive water from the Wind River Formation and the alluvium; consequently, hydrologic properties of these rocks are better known than those of other rocks. The range of permeability is estimated to be about 1–220 gpd/ft^2 for water-bearing sandstone of the Wind River Formation and about 150–7,500 gpd/ft^2 for the alluvium.

Geologic units having the largest potential for development of ground-water supplies are the Bighorn Dolomite, Madison Limestone, Tensleep Sandstone, Crow Mountain Sandstone, Nugget Sandstone, Sundance Formation, Cloverly and Morrison Formations, Mesaverde Formation, Lance(?) Formation, Fort Union Formation, Wind River Formation, and the alluvium. Descriptions of these and other geologic units in the area are tabulated (table 1) along with estimates of the potential water supply from the rocks and the probable concentration of dissolved solids.

Many parts of the Wind River Irrigation Project have become waterlogged. The drainage-problem areas are classified according to geologic similarities into five general groups: flood plains, terraces, underfit-stream valleys, slopes, and transitional areas. Local geologic and hydrologic conditions indicate the type of drainage facilities that would be successful.

Water from underground storage in alluvium could supplement water from surface storage in some areas. The use of both surface and underground storage would reduce the need for additional surface-storage facilities and also would alleviate drainage problems in the irrigated areas.

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TABLES OF BASIC DATA

TABLE 3.—*Records of wells and springs, Wind River Indian Reservation, Wyo.*

Additional well records have been published in Water-Supply Papers 1375 (Morris and others, 1959) and 1519 (Berry and Littleton, 1961).

Well No.: See explanation of well-numbering system in text.

Use: C, commercial; H, household (domestic); I, irrigation; N, industrial; P public supply; S stock; T, test; U, unused.

Finish: O, open end; P, perforated; S, screened; T, sand point; X, open hole.

Water level: Reported depths given in feet; measured depths in tens or hundredths; +, indicates artesian head above land surface.

Altitude: Altitude above mean sea level; given in feet and tenths where determined by instrument leveling; given in feet where determined from topographic maps.

Geologic source (symbols listed alphabetically): J₹u, Jurassic, Jurassic(?), and Triassic(?) rocks; Kc, Cody Shale; Kf, Frontier Formation; Kmv, Mesaverde Formation; MDu, Mississippian and Devonian rocks; O€, Ordovician and Cambrian rocks; Pu, Permian rocks; PMu, Pennsylvanian and Mississippian rocks; Qa, alluvium of flood plains and related low terraces; Qg, glacial deposits; Qsa, slope wash and alluvium; Qt, terrace and pediment deposits; Tf, Fort Union Formation; Tw, Wind River Formation; Twi, Wind River and Indian Meadows Formations; ₹u, Triassic.

Well tests: Data are reported except as indicated (M, measured). Drawdown determined while pumping at indicated discharge. F, indicates flow, in gallons per minute.

Remarks: C, chemical analysis in table 6; K, specific conductance given on hydrologic map (pl. 1), date is that of conductance measurement; LD, log in table 4; LT, log in table 5.

Well	Owner or tenant	Use	Depth of well (feet)	Well construction: Diameter (inches)	Well construction: Depth of casing (feet)	Well construction: Finish (depth interval, in feet)	Water level: Distance above(+) or below land surface (feet)	Water level: Date of measurement	Altitude of land surface (feet)	Geologic source of water	Well tests: Discharge or flow (gallons per minute)	Well tests: Drawdown (feet below nonpumping water level)	Remarks
A1-1-3bbb	Indian tribes	S	579	3	559		532.8	6-22-65	5,665	Tw	1		C, K 8-31-66
27ddd	H. Lindauer	H	54	4	44	X			5,290	Kc	20		LD
33bbb	St. Michael's Mission.	H	712	8	385	X	+	1957	5,355	Kf	40	375	C, LD
34aab	N. Quiver	H	21	4	21	P16-21	6	4-25-61	5,302	Qa	10		K 6-22-66
34bcb	USGS	T	28	4	28	P6-28	5.63	6-28-66	5,328.8	Qa	20M	5M	C, K 6-29-66, LT
35adc	C. Trumball	H	21	4	21	P11-21	8	4-13-61	5,270	Qa	5		K 6-22-66, LD
35bbb	A. Goggles	H	20	4	20	P10-20	5.73	4-28-65	5,290	Qa	6		
35ccb	A. Walker	H	32	4	32	P27-32	19.29	4-28-65	5,310	Qa			LD
36cb	Wind River Agency	U	>300							Kc(?)			C
36ccb	R. Rhodes	H	21	4	21	P13-21	5	5-31-61	5,270	Qa	4		
A1-2-6aaa	USGS	T	50	½	44	P37-44	36.32	6- 6-66	5,260.2	Qsa, Tw			LT
6adb	do	T	161	6	5	X	78.91	6- 6-66	5,300.4	Tw			K 6-3-66, LT
21bbb	do	T	300	½	115	X115-300	205.2	11- 3-66	5,303.8	Tw			K 6-27-66, LT, cemented at 115 ft.

21bbb	do	T	300	½	13	X13-100±	64.8	11- 3-66	5,303.8	Tw			K 8-25-66, cemented at 13 ft.
26cbb	do	T	345	4	0	X	283.0	11- 3-66	5,373	Tw	8M		K 10-24-66, LT
33ccc	E. Givens	H	70				55		5,215	Tw			K 8-16-65
A1-3-11bcd	B. Galyean	H	770	6	30	X	300	6- 1-61	5,525	Tw	120		LD
34dac	L. Miller	H, S	115	6	79	X	23	1-65	5,040	Tw	5	57	K 9-14-65, LD
35cdc	J. Miller	H, S	40				20		5,035	Qa			C, K 9-14-65
36ccb	H. Whitehead	H, S	18	2	18	T			5,005	Qa			K 6-22-65
A1-4-21ddd	C. Cook	H	200	4	175	X	62	11- 8-64	5,430	Tw	16	57	LD
26caa	Riverton City	P	700	10	700	P			4,943	Tw	400	70	LD, cemented at 110 ft.
27aca	do	P	730	10	730	P			4,968	Tw	400	49	LD, cemented at 230 ft.
29dcb	do	P	994	8	744	P392-744 X744-994	133	7-53	5,120	Tw	240		LD
31ad	Riverton Country Club.	C	400	6	380	P			5,020	Tw			LD
31dcc		U	9	24	9	P	3.97	11- 6-65	4,978	Qa	5M	4.5M	C, K 11-6-65
33aab	Morning Star Dairy	N	500	8			110	1952	5,035	Tw			LD
34ac	C. Phillips	H	406	4	233	X			4,955	Tw	10		LD
A1-5-10dcd	USGS	T	77	4	0	X	24.67	5-28-65	4,915	Tw			LT
15aab	do	T	29	1	29	O	9.14	9-27-65	4,895	Qsa			C, K 10-26-65, LT
36dbd	Continental Oil	N	750	5	750	P581-750	+	1- 9-66	5,130	Tw			
A2-1-13ccc	R. Weber	H	60	6			4		5,285	Qa			C, K 9-15-65
24ccd	G. Fairfield	H, S	180	6			60		5,283	Tw			C, K 9-15-65
25cdd	C. Henry	H	27			O	14.02	9-15-65	5,275	Qa			K 9-15-65
27bcb	USGS	T	332	4	0	X	145.2	7-25-66	5,479.8	Tw			K 7-25-66, LT
36aaa	C. Henry	H	200	4			160.76	9-15-65	5,250	Tw			K 9-15-65
A2-2-4ddd	Game and Fish	H	460	5	460	P389-400 430-450	60		5,240	Tw	15	140	LD
16cdb	Sunnyside Church	H	80	7	44		50	1959	5,390	Tw	4		LD
18ada1	O. Lund	H	485	6			180		5,403.6	Tw			C
18ada2	Mount Hope Church.	H	435	7	435	P			5,390	Tw	20	200	LD
31add1	L. Saunders	H	230	6	210	X	52.91	8-22-66	5,230	Tw	10	30	K 9-15-65, LD
31add2	do	S	20	8		P	4.29	8-22-66	5,228	Qa			
31bcc	B. Nickeson	H, S	80	6	50	X	22		5,270	Tw			K 9-15-65
31dcc	do	H, S	105						5,275	Tw			

TABLE 3.—*Records of wells and springs, Wind River Indian Reservation, Wyo.*—Continued

Well	Owner or tenant	Use	Depth of well (feet)	Well construction: Diameter (inches)	Well construction: Depth of casing (feet)	Well construction: Finish (depth interval, in feet)	Water level: Distance above(+) or below land surface (feet)	Water level: Date of measurement	Altitude of land surface (feet)	Geologic source of water	Well tests: Discharge or flow (gallons per minute)	Well tests: Drawdown (feet below nonpumping water level)	Remarks
A2-2-32cbc	USGS	T	36	½	21	P	1.19	7-25-66	5,232	Qa			LT
32ccb	J. Enos	H	16	2	16	T	10		5,235	Qa			K 9-15-65
A2-4-12ddb	R. Montgomery	H	210	6	145	X	50	11-50	5,065	Tw	5	50	
A2-5-11abb	A. Traweek	H	364	6	334	X	123	3-51	4,975	Tw			
A2-6-30dcb	Indian tribes	S		5			+	8-19-66	4,775	Tw			K 8-19-66
30ddd	do	S		6			+	3- 8-65	4,780	Tw			K 3-8-65
A3-1-9cda	USGS	T	207	4	0	X	106.4	11- 3-66	5,622	Tw			C, K 11-1-66, LT
24cca	R. Pingetzer	U	560		0		Dry		5,530	Tw			LD, destroyed
A3-2-3bdb	C. Pince	H, S	238	6		X	155		5,390	Tw	5	75	LD
7cda	Pavillion City	P	500	8	338	X	180		5,465	Tw	45	220	LD
7cdb	do	P	500						5,475	Tw			
8ba	R. Henry	S	112	6	75	X	60		5,322	Tw	6	30	
32cbb	T. Stearns	H	485	5	204	X				Tw	25		K 10-5-66, LD
A3-3-36ada	C. Mason	H	50	6	25	X	21	8-52	5,215	Tw	40	19	
A3-6-15bcb	Shoshoni City	P	495	6	440	X	17.3	12-51	4,772	Tw	300	194	C, LD
15bcc	do	P	525	10			45.5	10-28-66	4,763	Tw			
A4-1-11bbd	USGS	T	185	1	9	X	51.0	11- 2-66	5,645	Tw	2M		C, K 11-2-66, LT
18dbc	do	T	272	4	21	X	98.0	11- 2-66	5,810	Tw	10M		Do.
A4-2-11aab	W. Eykamp	S	28	8	11	X			5,350	Tw(?)	20		
12ddd	C. Meigs	S	400	8	56	X	7	12-52	5,315	Tw	90		LD, cemented at 56 ft
29adb	B. White	H	220	6	168	X	70	11-52	5,505	Tw	5	37	
34add	A. Over	S	100	6	59	X	15	2-52	5,415	Tw	2	85	
A4-3-5dcb	E. Darrington	S	325	6	12	X	16	1952	5,360	Tw	10	3	LD, plugged to 60 ft
8aad	L. Rungle	S	500	6	100	X	87	5-52	5,330	TW	1.5	29	
9ddd	R. Mohlman	H	225	6	177	X	105	4-52	5,275	Tw	2	120	
11acd	R. Madsen	H, S	347	6	293	X	78.0	7-10-51	5,153	Tw	4		LD
15aca	L. Harrison	S	310	6	239	X			5,250	Tw	3		

17ccd	M. Smith	H	135	6	39	X	95	3-52	5,298	Tw	2	15	
20abc	H. Fisher	S	122	6	112		75	1952	5,275	Tw	40	25	LD
20bda	W. Neidigh	H, S	385	6	230	P			5,280	Tw	20		
21bbc	D. Moore	S	790	6	669				5,248	Tw			LD
21dcc	A. Trook	H, S	329	6	286		42	7-52	5,220	Tw	10	118	
24dac	M. Walters	H	490	6	422	X	145	4-52	5,200	Tw	5	255	
35abb	K. Harmon	H, S	317	6	251		60	1952	5,147	Tw	1	255	
35adc	F. Newell	H, S	315	6	254		100	2-52	5,155	Tw	3	212	LD
36dbb	W. Marlatt	H, S	120	4	120		50		5,115	Tw			C
A4-5-16ddd		U	30	6			2.96	11-3-66	4,923	Qt(?)			
21daa		S	110				4.74	9-12-64	4,910	Tw			
A5-2-13ac	Intex Oil Co.	N	150							Tw			
26ac	do	N	180							Tw			
27aba	Arapahoe Ranch	U	14				11.36	9-14-64	5,470	Qsa(?)			
A5-3-32bcb	USGS	T	560		0	X	Dry	10-27-66	5,320	Tw			LT, destroyed
A5-4-21ccd	do	T	296	1	9	X	130.3	11-3-66	5,065	Tw	7M		C, K 11-3-66, LT
A5-5-27cda	Phillips Petroleum	N	280						4,804	Tw			
33aba	USGS	T	190	1	9	X	37.6	11-3-56	4,830	Tw	2M		C, K 10-26-66, LT
A5-6-21aa	USBR	H	800				+			(?)			C
A6-2-32aba	Arapahoe Ranch	U	95	4			7.55	4-28-65	5,715	Kmv(?)			
A6-4-14bbb	do	U	740				Dry			Pu, ℙMu			
32add	do	S	44	5			+1	8-17-65	5,430	Twi(?)			K 8-17-65
A7-1-19cca	W. Bradford	U		12			+	4-28-65		(?)	10M		C, K 4-28-65
30ba	Indian tribes	S	1,272	11	306		+	3-1-61	6,760	Pu, ℙMu, MDu			
A7-5-22bbc	Arapahoe Ranch	S	740				>600	3-3-65		ℙMu	5		
B1-1-5acb1	S. Ward	U	40	6	35		6	7-16-63	5,670	Qsa	5	14	K 6-22-66, LD
5acb2	A. Ward	H	35	6	33		7	7-17-63	5,670	Qsa	5	13	K 6-22-66
7ddb	Indian tribes	S							5,740	(?)			K 9-12-64
29bdb	do	S	Spring						5,850	Qt	F1M		K 9-11-64
31add	R. Quiver	H	90	6	90	10-15 P 48-50	15	6-3-63	5,640	Kc	2	60	K 6-21-66, LD
31cba	D. Clare	H	22	6	23		9	10-16-63	5,705	Qa	10	5	K6-21-66
32ddc	B. McAdams	H	40	6	21	P13-16	9	5-28-63	5,600	Qa	10	5	Do.
35cba	Amerada Petroleum	U	435	6	15	X	+		5,480	(?)			Plugged
B1-2-25cbb	F. Enos	H	25	6	24		11	6-22-63	5,812	Qa	10	2	K6-21-66
25dbc	B. Stagner	H	26	6	26		8	9-10-63	5,782	Qa	15	7	Do.
26add	S. Peahrora	H	28	6	28	P20-23	8	6-21-63	5,825	Qa	10	4	K6-21-66, LD
26cbd	E. LeClair	H	28	6	29		4	6-28-63	5,890	Qa	15	5	Do.

TABLE 3.—*Records of wells and springs, Wind River Indian Reservation, Wyo.*—Continued

Well	Owner or tenant	Use	Depth of well (feet)	Well construction: Dia-meter (inches)	Well construction: Depth of casing (feet)	Well construction: Finish (depth interval, in feet)	Water level: Distance above(+) or below land surface (feet)	Water level: Date of measure-ment	Altitude of land surface (feet)	Geologic source of water	Well tests: Discharge or flow (gallons per minute)	Well tests: Draw-down (feet below non-pumping water level)	Remarks
B1-2-26dda	A. Compton	H	22	6	21	P16-17	6	6-19-63	5,830	Qa	10	3	K6-21-66
35adc	J. Tyler	H	32	6	32	P30-31	12	6-11-63	5,875	Qa	10	3	Do.
35baa	B. Teran	H	34	6	27		4	6-11-63	5,885	Qa	18	8	K6-21-66, LD
36cbb	J. Dick	H	36	6	34		11	6- 8-63	5,858	Qa	15	5	Do.
B2-1-2dca	Indian tribes	S	608	4	608		301.0	3- 8-65	5,895	Tw(?)	7		
18ccc	Pan American	N	4,222	13	3,571	X	496	12-62	6,100	MDu, O€u	173		C
B2-2-2bda	J. Brown	S	474	6			362.0	8-24-65	6,083	Tw(?)			
17bca	N. Amboh	H	62	6	62	P25-28 52-56	20	7-24-63	6,000	Tw(?)	15	12	K6-23-66
21cdc	J. Guina	H	60	6	60	P35-50	21	7-23-63	5,960	Tw(?)	15	13	Do.
26aca	V. Hankass	H	40	6	40	P24-35	9	7-26-63	5,821	Tw(?)	6	20	K6-22-66, LD
28bca	D. Roberts	H	127	6	128	P116-122	+2	7-19-63	6,000	Tw(?)	10	26	Do.
31cda1	F. Harris, Sr	U	40	6	40	P30-34	20	7-18-63	6,190	Qsa	15	2	K6-23-66
31cda2	F. Harris, Jr	H	39	6	39	P30-34	20	7-18-63	6,195	Qsa	15	1	K6-23-66, LD
B3-1-5ba	British-American Oil.	N	5,306	9	5,175					J₸u			C
18dba	H. Hall	H	128	6			50			Tw	100		
B3-2-17abc	L. Curby	U	38						5,670	Qg			
17acb	R. Crowe	C	45	6		O	35.30	9-25-64	5,680	Qg			C, K9-25-64
22cbd	A. Winchester	H, S	225	4	100	X			5,675	Tw			K9-30-65
22ddc	A. Morris	H	375	4	350	X	20		5,680	Tw			Do.
23dbd1	R. Hoopengarner	H	180	6	120	X			5,625	Tw			Do.
23dbd2	do	S	50	6		P20	41.6	9-30-65	5,620	Qa			Do.
30baa	Midvale Irrig. Dist	H	10	72			2.39	9-25-64	5,750	Qa			
B3-3-1ddd1	D. Stagner	S	80	6	20		5.12	4-27-65	5,690	Qa(?)			K4-27-65
1ddd2	do	H	80						5,690	Qa(?)			Do.
4aba	H. White	H	55	7	33		35		5,970	Tw			C, K9-30-65
B4-1-4cbb	USGS	T	166	1	9	X	113.6	11- 2-66	6,162	Tw	3M		C, K10-31-66, LT
25daa	J. Barquin	S	487	5			435.5	6-27-66	5,824	Tw			C

B4-2-6add	USGS	T	301	4	0	X	116.8	8-22-66	6,149	Tw			K8-22-66, LT
33daa	do	T	131	4	0	X	44.24	8-22-66	5,776.6	Tw			Do.
B4-3-6acb	J. Hankins	H	11	24	10		9.46	4-27-65	5,980	Qa			K4-27-65
8bbd	C. Henry	H	30	4			10.04	4-27-65	5,918	Qa			C, K4-27-65
17bbb	C. Snyder	H	90	5			15		5,875	Qa			K4-27-65
21cda	L. Meade	H	14	1	14	T	9	4-27-65	5,795	Qa			K4-27-65
29baa	D. Frank	H	22				10		5,863	Qa			K9-30-65
B4-3-30acb	G. Pennoyer	H	15	4		P	7.61	10-1-65	5,940	Qa			K 10-1-65
31baa	J. Pogue	H	70	6	48	X	25.2	10-1-65	6,070	Tw	8		
32ada	J. Frank	H	36			P			5,955	Qt			K 9-30-65
32baa	C. Smith	H	41						6,005	Qt			C, K 9-30-65
32dcd	V. Frank	S	100	8	21	X	40	2-64	6,050	Tw	20	40	LD
33cac	H. White	H, S	42	7			20		5,955	Qt			K 9-30-65
34bcb	A. Nipper, Sr	H, S	50	8	45	X	21		5,905	Tw			Cemented at 45 ft.
34cdd	A. Nipper, Jr	H, S	40	6	35	X	18		5,895	Tw			K 9-30-65
B4-4-2cda	USGS	T	33	4	32	P10-32	.88	8-20-66	5,932.0	Qa	65M	1M	C, K 6-16-66, LT
2dcb	B. O'Neil	H								Qa(?)			C, K 4-28-66
5acd	Jack & Lee's Cafe	C	22	30	22		5	6-5-63	6,180	Qt			
14ccb	Crowheart School	P	400	6	319	X	31.01	11-4-65	6,125	Kf	10	100	C, LD
16ada	R. Urbigkit	H	130	6	58	X	60		6,170	Tw(?)	7	10	LD
22aba	USGS	T	33	4	33	P11-33	10.61	6-15-66	6,160.8	Qt	42M	2.1M	C, K 6-14-66, LT
23adc	D. Rice	C	30	48	30		4.15	6-5-63	6,090	Qt			C, K 4-28-66
24cbc	St. Helen's Church	H	50	8	35	P			6,080	Qt	20		LD
25 dac	R. Burnett	H	212	6	58	X			6,010	Kf(?)	4		
26abb	USGS	T	46	4	0				6,136.0	Qt			LT
B5-3-12dcc		U	98	6			84.02	6-25-66	6,316	Tw			
31cbd	J. Brown	H	70	5					6,040	Tw			K 4-27-65
32dda	USGS	T	91	4	0	X	22.06	8-22-66	6,151.6	Tw			K 6-22-66, LT
B5-4-10abc	do	T	92	4	0	X	65.53	8-22-66	6,481.7	Tw	5M		Do.
10acd	F. Swallow	H	10	24	10		9.5	4-24-65	6,415	Qa			K 4-24-65
17bdd	USGS	T	317	4	0	X	101.1	8-22-66	6,285	Tw			LT
30acd	L. Bradford	H, S	50	8		O	20		6,070	Qa			K 3-4-65
31adc	C. Deshaw	H	12	1	12	T	7.47	3-4-65	6,110	Qa			
31cbb	J. Le Clair	H	100	6	100	S	+		6,230	(?)			
32bbb	H. Stall	H	82	4			12.80	3-4-65	6,070	Tw(?)			
32caa	E. Bonatsie	H	65	6					6,190	Tw(?)			
34bdc	W. Hitshew	S	10	36			3.60	9-30-64	5,975	Qa			K 9-30-64
B5-5-10bca	L. Miller	H	Spring						6,195	Qa			K 3-4-65
13bcd	B. Lowe	H	180	7		O	33.02	9-30-64	6,140	Tw			K 9-30-64

TABLE 3.—*Records of wells and springs, Wind River Indian Reservation, Wyo.*—Continued

Well	Owner or tenant	Use	Depth of well (feet)	Well construction: Diameter (inches)	Well construction: Depth of casing (feet)	Well construction: Finish (depth interval, in feet)	Water level: Distance above(+) or below land surface (feet)	Water level: Date of measurement	Altitude of land surface (feet)	Geologic source of water	Well tests: Discharge or flow (gallons per minute)	Well tests: Drawdown (feet below nonpumping water level)	Remarks
B5-6-13bbd	Red Lodge Motel	C	25	7	20	P17-20	7.1	9-28-64	6,310	Qa			K 9-28-64
14dad	do	U	980	7	120	X	+		6,440	Pu(?)			C, K 9-30-64
14ddb	do	U	Spring						6,480	Qsa(?)			K 9-28-64
35ada	H. Stall	S	200	5	127	P107-127	27	3-26-64	7,640	Pu(?)	3		C, K 10-1-64, LD
B6-2-22cba		U	Spring						6,690	J₹u			K 9-17-64
26dba		U					+	9-17-64	6,570	₱Mu(?)			
B6-3-2bcb	J. Fike	H	138	3	138		19		6,950	Kf(?)			K 4-24-65
21cad		S		8			+	4-24-65	6,580	(?)			Do.
27cbd		S		6			+	4-27-65	6,622	(?)			K 4-27-65
33ccd	USGS	T	96	4	0	X	42.9	10-31-66	6,625	Tw	30M		C, K 10-31-66, LT
36cba	Skelly Oil	U					+	4-28-65	6,460	(?)	F6M		K 4-28-65
B6-4-20add	D. Roberts	H	12	36	12		5	4-24-65	6,840	Qa			K 4-24-65
36cdb	USGS	T	212	4	0	X			6,940	Tw			LT, destroyed
B7-1-1cad	Arapahoe Ranch	S	Spring						8,280	(?)	F15M		K 8-23-65
2aab	do	S	Spring						7,930	(?)			K 9-15-64
26cdb	Bargee School	P	200	6	45	P9-34	20	6-65	6,390	Qsa	6		K 4-28-65
27dad	L. Boller	H	50	8	40	X	12	4-28-65	6,347	Qsa(?)			K 4-28-65
C1-1-2aad	Indian tribes	C	Spring						5,475	₱Mu(?)	Fl,230		C
3ccb	L. Chavez	H	26	6	24	P16-19	4	5-21-63	5,550	Qa	20	4	K 6-22-66
4abd	B. Brown	H	23	6	23	P16-19	10	5-22-63	5,545	Qa	15	8	K 6-22-66, LD
4adc	V. Herford	H	24	6	24	O	4	5-63	5,563	Qa	15	8	C, LD
4bcb	G. Henan	H	21	6	21	P17-18	6	5 -63	5,590	Qa	20	5	K 6-22-66
4cbb	L. McAdams	H	33	6	33	P	9	5-4-63	5,600	Qa	20	6	Do.
4ccc	G. Hill	H	42	6	41	X	24.5	5-3-63	5,595	Qa	12		C, K 6-23-66
4cdb	Fort Washakie	P	25	6	21	P	6	7-11-63	5,580	Qa	10	7	K 6-23-66
4dac	USGS	T	46	1	36	P	5.36	7-25-66	5,560.7	Qa			LT
4dad	G. Twitchell	H	26	6		P17-20	4	5-24-63	5,562	Qa	15	5	K 6-22-66
5dab	P. Padia	H	150	6	28		7	4-28-63	5,620	Qa	12	3	K 6-22-66, LD
5dba	F. Nicol	H	42	6	29	X	14		5,620	Qa	6	3	C, LD

6ada	C. Soonup	H	58	6	57	P29–32	5	6–3–63	5,660	(?)	10	15	K 6–22–66
6cad	N. Engavo	H	20	6	20	P11–15	8	4–20–63	5,700	Qa	10	4	Do.
6cdd	R. Murphy	H	62	6	50	X	5.5	----------	5,695	(?)	5	34	C, LD
6ddc	T. Gould	H	23	6	23	P20–23	6	4–22–63	5,675	Qa	10	4	C, K 6–22–66, LD
7dcb	M. Tyler	H	43	6	40	P35–40	18	4–5–63	5,720	Qa	10	5	K 6–22–66, LD
7dda	P. Meyers	H	31	6	27	P15–20	8.5	4–8–63	5,690	Qa	12	----------	K 6–23–66
8aab	E. St. Clair	H	66	6	53	X	3	----------	5,612	(?)	20	5	C, LD
8aba	R. Burnett	H	31	6	31	P	10	5–20–63	5,620	Qa	10	2	K 6–22–66
8ada	G. Day	H	20	6	18	P9–12	4	----------	5,610	Qa	10	1	C, LD
8ccb	Robert's Mission	H	548	6	452	X	+	1945	5,675	Kf	----------	----------	C, LD
8daa	A. Washakie	H	100	6	43	P10–16	3	4–9–63	5,620	Qa	40	1	K 6–23–66
8dca	J. Pogoree	H	40	6	32	P11–16	11.5	4–6–63	5,635	Qa	25	3	Do.
8dda	M. Lebeau	H	43	6	41	P 8–10	7	----------	5,617	Qa	7	1	C, LD
9aab	H. Clairmont	H	30	4	----------	----------	7	----------	5,560	Qa	----------	----------	C, K 5–31–66
9bdc	F. Chingman	H	36	6	36	P26–29	5	7–2–63	5,590	Qa	10	10	C, K 6–23–66, LD
9dac	W. Cashen	H	40	6	21	P 8–11	5	5–20–63	5,570	Qa	15	3	K 6–23–66
10bcd	F. Wise	H	40	6	34	P25–28	9	5–15–63	5,550	Qa	20	7	K 6–22–66, LD
10cbd1	M. Moon	H	60	6	60	P33–37	6	5–63	5,550	Qa	20	6	C, LD
10cbd2	L. Coulston	H	60	6	53	P19–22	4	----------	5,550	Qa	10	5	LD
10cda	S. Weed	H	48	6	45	P20–23	7	7–1–63	5,542	Qa	15	8	K 6–22–66, LD
16bcb	A. Ute	H	23	6	23	P16–19	11	4–10–63	5,620	Qa	12	1	K 6–23–66, LD
C1–1–18bab	S. Wagon	H	32	6	32	P23–26	8	----------	5,738	Qa	15	11	C, LD
18bcc	T. Robertson	H	33	6	33	P20–24	12	4–13–63	5,770	(?)	10	10	C, K 6–23–66, LD
19bbb	M. Posey	H	21	6	21	P15–20	5.5	4–1–63	5,795	Qa	20	10	K 6–23–66
25dcd	D. Hollings	S	10	24	10	----------	1.06	7–20–65	5,555	Qsa	6M	----------	K 7–20–65
26ddb	W. Moats	H	81	6	----------	----------	6.61	7–20–65	5,610	Kf	----------	----------	Do.
26ddc	do	S	15	----------	----------	----------	7.0	7–20–65	5,605	Qsa	----------	----------	
C1–2–1ccd	W. Hugo	H	37	6	37	----------	20	4–16–63	5,800	Qa	15	1	K 6–22–66, LD
1dba	H. Shoyo	U	56	6	48	X	8	6–6–63	5,762	Kf(?)	5	32	Do.
1dbd	D. Shoyo	H	57	6	55	P21–24	6	6–8–63	5,760	Qa	20	4	Do.
1dca	J. Wagon	H	25	6	25	----------	10	4–18–63	5,735	Qa	12	2	K 6–22–66
1dcd	D. Tillman	H	20	6	20	P12–16	10	----------	5,780	Qa	6	3	C, LD
13ddd	L. Perry	U	70	6	68	P12–15	9	4–3–63	5,805	Qa	7	31	K 6–23–66, LD
24ada	H. Hill	H	41	6	41	P36–40	8.5	----------	5,827	(?)	15	4	C, LD
24dab	C. Pingree	H	90	----------	----------	----------	----------	----------	5,845	(?)	----------	----------	C
24dcb	H. Weed	H	40	6	34	X	17.5	3–29–63	5,885	J₹u	10	3	K 6–23–66, LD
26ada	J. Lafferty	H	56	6	56	P48–55	32	3–30–63	5,980	₹u	9	2	Do.
C2–1–1ddd	L. Twitchell	H, S	71	5	----------	----------	37.7	7–20 65	5,645	Qt(?)	----------	----------	K 7–20 65

TABLE 3.—*Records of wells and springs, Wind River Indian Reservation, Wyo.*—Continued

Well	Owner or tenant	Use	Depth of well (feet)	Well construction: Diameter (inches)	Well construction: Depth of casing (feet)	Well construction: Finish (depth interval, in feet)	Water level: Distance above(+) or below land surface (feet)	Water level: Date of measurement	Altitude of land surface (feet)	Geologic source of water	Well tests: Discharge or flow (gallons per minute)	Well tests: Drawdown (feet below nonpumping water level)	Remarks
D1-1-1ddc	K. Hansen	H	40	6	34	P	5		5,255	Qsa			K 8-16-65
12bcb	C. Harris	H, S	29	4	29	P	6.65	8-13-65	5,290	Qsa	6		K 8-13-65, LD
13bbb	F. Nicol	H	15	18	15	P			5,285	Qsa			K 8-16-65
13ccb	T. Armajo	U	33	4	33	P28-33	13.10	8-13-65	5,345.9	Qsa			LD
14aaa	USGS	T	26	1	18	P	4.66	7-25-66	5,289.2	Qsa			LT
14bab	C. O'Neal	H	26	4	26	P21-26	7.95	8-13-65	5,317	Qsa	7		LD
14ddd	E. Armajo	H	98	4	98	P15-25	4.29	8-13-65	5,355.6	Qsa	4		LD
15abb1	R. Van Hees	H	45	8			5.60	8-13-65	5,370	Kf(?)			K 8-13-65
15abb2	do	S	45	8			10		5,350	Qsa			Do.
15add	M. Underwood	H	31	4	31	P26-31	14.5	5-10-61	5,340	Qsa	6		K 8-13-65, LD
15ccc	USGS	T	38	4	38	P16-38	5.71	7-25-66	5,377.1	Qsa	40M	1.2M	C, LD
16acb	B. Hutchinson	H	80	4	80	P70-80			5,480	Kf			K 8-13-65, LD
16ddd	USGS	T	34	1	34	P16-34	7.58	6-28-66	5,378.5	Qsa			LT
21add	J. Arthur	H	21	4	21	P13-21	7	5- 8-61	5,382	Qsa	6		K 8-13-65, LD
21dda	USGS	T	56	1	45	P	12.87	7-25-66	5,409.9	Qsa			LT
22bba1	T. Reed	H	30				12		5,370	Qsa			C, K 8-13-65
22bba2	do	S	11	24			4.13	8-13-65	5,370	Qsa			
22bcb	USGS	T	21	1	21	S19-21	3.71	8-13-65	5,377	Qsa			C, K 10-5-65, LT
22bcc	S. Snyder	H	23	4	23	P18-23	4.5		5,379	Qsa	6		LD
22cbc	G. Hamilton	H, S					+		5,395	(?)			
23ada	USGS	T	41	1	36	P	6.86	7-25-66	5,373.7	Qt			LT
28dbb	E. Barton	H, S	26						5,460	Qsa			K 8-13-65
29ccc	G. Abeyta	H, S	14	7			2.34	8-13-65	5,490	Qsa			Do.
30bda	R. Eicholtz	H	1,015	4	295				5,498	Kc			LD
31aaa	W. Lozier	H, S	60	6					5,497	Kc(?)			K 7-20-65
31dad	M. Clark	H	685				29.40	4-27-66	5,533	Qt			Water from upper 50 ft.
31dda	do	H, S	45	5					5,533	Qt			C, K 7-20-65
32acd	C. Deshaw	H, S	45	6	45				5,493	Qsa			Do.

32dcb	USGS	T	17	1	17	S15-17	1.66	8-13-65	5,510	Qt			K 10-5-65
D1-2-5ddc	J. White Plume	H	47	6		P			5,195	Qa			K 8-16-65
6dcc	C. Nirider	H	40	10					5,235	Qsa			Do.
8aad	P. Heil	H	160	6			5.02	8-16-65	5,195	(?)			Do.
8bcb	W. Hirasawa	H	35						5,230	Qsa			Do.
9bbb1	H. Heil	H	430	4	363	X	110		5,190	Tf	1		C, K 8-16-65, LD
9bbb2	do	S	20	6		P	3.59	8-16-65	5,190	Qa			C, K 8-16-65
9cdd	do	H	25	6			1.51	8-16-65	5,210	Qsa	6		K 8-16-65
10dcc	F. Collins	H	473	7	407	X	80	10-54	5,157	Tf			C, K 8-16-65, LD, cemented at 407 ft.
11cdc	H. Fegler	H	60		60				5,130	(?)			K 8-16-65
14abc	E. Chamberlain	H	230	4					5,130	(?)			Do.
15aaa	H. Fegler	H	50	3		O	10		5,150	(?)			Do.
D1-3-1bba	H. Whitehead	S		8			4.04	6-22-65	5,005	Qa			
2aba	J. Busheyhead	H	60						5,030	Tw			
7dcd	USGS	T	130	4	25	X	73.9	11-3-66	5,175	Tw	30M		C, K 11-3-66, LT
10cca	L. Arthur	H	390	6	99	X	75	10-64	5,135	Tw	25		C, LD
11add	S. Spoonhunter	H	100			X			5,100	Tw			K 9-14-65
12cbc	S. Duran	H	80	7	51	P	32		5,055	Tw			
12dba	T. Duran	H	55						5,050	Tw			K 9-14-65, LD
12dcc	M. Haskins	H	18	1	18	T	7.65	9-20-65	5,030	Qt			K 9-20-65
13aab	H. Decoteau	H	300	4					5,025	Tw			C, K 9-14-65
13acc	J. White Plume	H							5,025	Tw			K 9-14-65
13dad	J. Blackburn	H	80	6	40	X	20	9-11-64	5,010	Tw	10	40	C, K 9-14-65, LD
14aaa	M. Eldridge	H	80	8			30		5,058	Tw			K 8-26-65
14abb	V. Bell	H	40	8	19	X	6	7-64	5,085	Tw	50	25	LD
14bbd	J. Headley	H	108	6	83	X			5,085	Tw			C, K 6-22-65
15aad1	D. Bath	H	130	6			28.01	8-26-65	5,090	Tw	10		K 8-26-65
15aad2	do	H, S	450	8			40		5,090	Tw			Do.
15cbc	L. Frazier	H	120	6	80		18		5,065	Tw	15	42	K 9-28-65
15cca	J. Gallington	H	126			X	11		5,065	Tw			K 8-26-65
15ddc	C. Hubbard	H, S							5,050	Tw			Do.
16cdd	R. Weber	H	160	6	110	X			5,065	Tw			K 8-26-65, cemented at 110 ft.
17aaa	J. Warren	H	85		65	X	24		5,130	Tw	7		K 8-26-65
17bcb	P. Moss	H	150						5,125	Tw			C, K 8-26-65
17dcd1	O. Linden	H	70			X	22		5,075	Tw	4M		K 8-26-65
17dcd2	do	S	80		25	X			5,080	Tw	5		Do.
17ddd	H. Warren	H	85		60	X	25		5,075	Tw			

TABLE 3.—*Records of wells and springs, Wind River Indian Reservation, Wyo.*—Continued

Well	Owner or tenant	Use	Depth of well (feet)	Well construction: Diameter (inches)	Well construction: Depth of casing (feet)	Well construction: Finish (depth interval, in feet)	Water level: Distance above (+) or below land surface (feet)	Water level: Date of measurement	Altitude of land surface (feet)	Geologic source of water	Well tests: Discharge or flow (gallons per minute)	Well tests: Drawdown (feet below nonpumping water level)	Remarks
D1-3-18dda	R. Mix	H	12	60	8	X	7.95	8-26-65	5,067	Qa			C, K 8-26-65
21bba	H. Linden	H	95	5	70	X	20		5,065	Tw			K 8-26-65, cemented at 70 ft.
23adc	W. Arthur	H	60	6	50		25		4,993	Tw	40		C. K 9-14-65
23bcc	Arapahoe Council	H	120	6	87	X	7		5,005	Tw	16	93	LD
23bdd1	T. Lajeunesse	H	42	10					4,997	Tw			K 9-14-65
23bdd2	Arapahoe School	P	250	6	200	X	35		5,025	Tw	25	150	LD
23cba	Wind River Agency	H	550	6			+	5-18-45		Tw			C
24cba	USGS	T	10	1	10	S, T 6-10	5.76	8-13-65	4,980.3	Qa			C, K 10-5-65
24cbb	W. Hanway	H	230	4	175	X	+		4,983	Tw	F4		LD
24cbd	W. Shangreau	H	235	5	200	X	+	6-64	4,978	Tw	15	160	C, LD
24cda	M. Large	H	265	4	190	X	+	9-14-65	4,975	Tw	F3		K 9-14-65, LD
24cdc	do	U	50	6			19.03	9-28-65	4,990	Tw	60		LD
24dcb	A. Jeffery	H	18		18	T			4,975	Qa			K 9-14-65
26aba	Wind River Bar	H	100	8	16	X	46.50	7-16-65	5,030	Tw			
29ccc	USGS	T	210	1	9	X	135.3	9-30-66	5,166.1	Tw			K 6-26-66, LT
34aba	V. Pozun	H	105	5		P, X	15		5,040	Tw			K 7-16-65
34bad	E. Wagner	H	35						5,035	Qsa			
34bcd	J. Dudley	H	29	6	29	P 21-29	28	3-65	5,043	Qa			
34bdb	E. Kerr	H	45	6		P	5		5,035	Qa			K 7-16-65
34bdc	J. Dudley	H	41	6		P	23	5-65	5,038	Qsa	10		
D1-4-2bbc	KVOW	N	205	6			+		4,910	Tw			
2bca	USGS	T	16	1	16	P	6.36	7-27-66	4,913.7	Qa			LT
2cab	F. Brown	H	65	6	28	X	8.20	9-20-65	4,913.4	Tw	10	42	K 9-14-65, LD
3dbd	USGS	T	9	1	9	T	2.18	6-18-65	4,920	Qa			K 9-20-65
3dcb	D. Brown	H	137	6	67	X	20	8-64	4,925	Tw	5	80	K 9-14-65, LD
4adc1	T. Duran	H	60	7	40	X	12		4,940	Tw			K 9-14-65
4adc2	do	U	18	3	18	T			4,940	Qa			Plugged.

4ccd	Susquehanna Western.	N	63	10	63	P	7.46	10-22-58	4,948	Tw	100	7	LD
4cdd	do	N	450	10	450	P 320-338 385-420 435-438	+	10-58	4,948	Tw	350	236	C, LD
4ddd	C. Mayland	H, S	265	6	125	X	+		4,935	Tw			LD
5bbb	F. Blake	S	60	6	35	X			4,969	Tw	50		LD
7bbb	Griffin Bros.	H, S	390	8	390	P 163-180 367-382	100	11-59	5,075	Tw	20	50	LD
7bdd	G. Bartlett	H, S	80						5,072	Tw			K 9-14-65
7dcb	J. Miller	H	85	6	54	X	12		5,008	Tw	5	58	K 9-14-65, LD
8acb	R. Brown	H	70	8			10.37	9-14-65	4,970	Tw			K 9-14-65
8dad	Stradley	H	400	6			+		4,955	Tw	F1		
8dcd	Biddle	H	400				+		4,955	Tw	F6		
9aad	C. Westlake	H	267	6	118				4,935	Tw	3		LD
9cdc1	St. Stephens' Mission.	H	180				14	10-58	4,940	Tw			
9cdc2	do	H	515	6	515	P	20		4,940	Tw	30	140	LD
9cdc3	do	I	57	8	22	P, X	8		4,940	Qa, Tw	50	2	LD
10add		H	60				10	10-65	4,910	Tw			K 10-65
10bba1	H. Blomberg	H, S	274	6	118	X	+14	10-58	4,925	Tw	F2		
10bba2	do	S	100	6			6.10	10-22-58	4,925	Tw			
11bba	USGS	T	16	1	12	P	7.23	7-27-66	4,913	Qa			LT
11cac	do	T	83	4	0	X	22.4	6- 7-66	4,952	Tw			LT, destroyed
17acd	G. Griffin	S	20						4,938	Qa			K 10-65
17dba	do	H	280				30	10-65	4,938	Tw			Do.
18baa	A. Eagle	H	320	5	213	X	30	11-64	5,003	Tw	10	120	K 9-14-65, LD
18bba	R. Littleshield	H	330	6	233	X	35	10-64	5,013	Tw	25		C, LD
18bbd	A. Duran	H	60	7	38	X	1	11-60	5,010	Tw	20	35	LD
18daa	R. Yellowplume	H	270	7	159	X	+	1957	4,958	Tw	F9		K 9-14-65, LD
20cad	USGS	T	102	4	0	X	33.81	5-27-65	4,985	Tw			Destroyed
25dc	Atlantic Refining Co.	N	620	6	604	P			5,264	Tw	130		
28ccc	G. Griffin	S	46	5			7.94	9-28-65	5,005	Qsa(?)			K 9-28-65
33daa	USGS	T	22	1	22	T	1.99	9-27-65	5,025	Qsa			C, K 9-28-65, LT
D1-5-11acc	Gilpatrick Construction.	N	225	9	217	P	21.20	5-10-65	5,075	Tw	3.6M	2.4M	C, K 11-5-65, LD
11bdd	USGS	T	34	1	34	P 32-34	20.52	5-27-65	5,060	Qsa			C, K 10-6-65, LT

TABLE 3.—*Records of wells and springs, Wind River Indian Reservation, Wyo.*—Continued

Well	Owner or tenant	Use	Depth of well (feet)	Well construction: Diameter (inches)	Well construction: Depth of casing (feet)	Well construction: Finish (depth interval, in feet)	Water level: Distance above(+) or below land surface (feet)	Water level: Date of measurement	Altitude of land surface (feet)	Geologic source of water	Well tests: Discharge or flow (gallons per minute)	Well tests: Draw-down (feet below nonpumping water level)	Remarks
D1-5-12db	Continental Oil	N	800	7	600	P 300-600 X 600-800			5,197	Tw			C, K 12-3-65
13db	do	N	800	7	754	P 304-754 X 754-800			5,190	Tw	33		
17dbd	Brinkerhoff	N	612	5	612	P			5,287	Tw	15		
D1-6-7bcd	Humble Oil	N	960	7	960	P 284-955	220	12-22-65	5,275	Tw	15	137	LD, cemented at 264 ft.
29ddc	Atlantic Refining Co.	N	107	5	107	P			5,332	Tw	10		
D2-1-6ddd1	I. Seamands	U	39	6			1.55	7-19-65	5,580	Qt			
6ddd2	do	H	48	5			2.33	7-19-65	5,580	Qt			K 7-19-65
7aad	S. Clark	H	11	36	11		4.25	7-19-65	5,583	Qt			Do.
7daa	M. Meyers	H	350						5,610	Kf			C
7ddd	E. Meyers	H, S	250	7	230				5,600	Kf			K 7-19-65
17cdb1	W. Carstens	H	12				6	1965	5,506	Qsa			Do.
17cdb2	Bain and McKiernan.	H	13	30	13		2.2	7-19-65	5,510	Qsa			Do.
17cdb3	P. Bramman	H	22				+	7-19-65	5,515	Qsa			Do.
18dba	F. Harvard	S	15				4.40	7-19-65	5,550	Qsa			
D2-3-3bbc	E-Y Cattle Co.	H, S	140						5,095	Tw			K 7-16-65
4bbb	D. Booth	H, S							5,030	(?)			Do.
4cab	H. Titus	U	150	7	105	X	65		5,110	Tw	5	55	LD
5dac	G. Doughty	H, S	60		40	X	40		5,070	Tw			K 7-16-65
5dba	do	H	40						5,050	Qa			Do.
7aaa	J. Majdac	H, S	140	8	140	P	15	1953	5,070	Tw			K 7-16-65, LD
7aab	do	H	408	8	408	P	+		5,070	Tw(?)	4		LD
11aca	G. Griffin	S	123						5,235	Tw			
D2-4-7ac	do	S	300						5,240	Tw			

TABLE 4.—*Drillers' logs of wells*

[Yields in gallons per minute, and dissolved solids, in parts per million, are given in parentheses where available]

Material	Thickness (feet)	Depth (feet)
Well A1-1-27ddd		
Sand, gravel, and boulders	20	20
Shale, dark, soft	5	25
Shale, light-gray, sticky	10	35
Shale, sandy, medium-dark (1½ gpm sulfur water at 40 ft)	10	45
Shale, sandy, dark	5	50
Sandstone, dark (water)	4	54
Well A1-1-33bbb		
Soil, heavy clay	2	2
Sand, gravel (alakali water)	20	22
Shale, sandy, dark-gray (3 gpm at 30 ft, 6 gpm at 60 ft)	366	388
Shale, black (gas)	12	400
Shale, sandy, gray	30	430
Shale, dark, sticky	30	460
Shale, dark, hard	10	470
Bentonite and sandstone	5	475
Shale, dark, hard	65	540
Mud, dark, soft (with bad odor)	3	543
Sand, soft, black and white (with sulfur water)	7	550
Sandstone, hard and soft layers	50	600
Limestone, hard (5 hr drilling)	2	602
Sandstone, gray	18	620
Shell, hard	1	621
Bentonite	1	622
Rock, hard	2	624
Shale, sandy, gray, hard	88	712
Well A1-1-35adc		
Surface	2	2
Gravel and sand	16	18
Shale, dark-gray	3	21
Well A1-1-35ccb		
Silt, sandy	20	20
Gravel and sand	10	30
Mud, blue	2	32
Well A1-3-11bcd		
Soil	3	3
Sandstone, soft	4	7
Shale, sandy	25	32
Sandstone, hard	3	35
Shale, hard, blue	423	458
Sandstone, hard	10	468
Shale	287	755
Water sand, coarse	15	770
Well A1-3-34dac		
Topsoil, sandy	4	4
Gravel	18	22
Shale, gray	6	28
Shale, gray, sandy	55	83
Sandrock, gray	7	90
Shale, sandy, hard, blue	10	100
Shale, sandy, gray	2	102
Sand, gray	5	107
Shale, sandy, hard, blue	8	115

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well A1-4-21ddd					
Topsoil, sandy	6	6	Shale, sandy, gray	10	111
Sand and gravel	20	26	Shale, sandy, blue	3	114
Shale, yellowish-gray	12	38	Shale, sandy, gray	21	135
Sandrock, yellow (hard water)	14	52	Shale, sandy. blue	11	146
Shale, sandy, gray	16	68	Shale, sandy, gray	32	178
Shale, sandy, blue	5	73	Sand, gray (water)	12	190
Shale, sandy, gray	19	92	Shale, sandy, blue, hard	10	200
Shale, blue, hard	9	101			
Well A1-4-26caa					
Soil, sandy	3	3	Shale, brown and blue, hard and sticky	69	424
Gravel	17	20	Hard-rock layer	3	427
Shale, cavey, blue	10	30	Water sand	10	437
Shale, sandy, gray	5	35	Shale, hard, blue and dark-gray	18	455
Shale, sandy, blue	10	45	Shale, hard, dark-gray	23	478
Shale, blue and brown	25	70	Water sand	12	490
Shale, sandy, blue	10	80	Shale, dark-brown, sticky	20	510
Shale, sandy, gray	3	83	Water sand	15	525
Water sand	7	90	Shale, blue and brown	15	540
Shale, brown	28	118	Shale, red-brown	15	555
Shale, sandy, blue	17	135	Shale, sandy, blue	12	567
Water sand	10	145	Shale, red-brown	13	580
Shale, sandy, blue and brown	15	160	Shale, sandy, gray	10	590
Shale, sandy, gray	8	168	Water sand	7	597
Water sand	25	193	Shale, sandy, gray, hard	9	606
Shale, sandy, blue	3	196	Sand	1	607
Water sand	24	220	Shale, sandy, hard, gray	12	619
Shale, sandy, blue	5	225	Shale, brown	15	634
Water sand	30	255	Shale, sandy, blue	10	644
Shale, brown and blue	25	280	Water sand	12	656
Shale, sandy, gray, very hard	10	290	Shale, sandy, hard, blue	14	670
Shale, cavey, brown, yellow, gray	30	320	Shale, sandy, hard, gray	10	680
Shale, blue, sandy	15	335	Shale, dark-gray	5	685
Shale, gray, and hard shells	20	355	Shale, brown	15	700
Well A1-4-27aca					
Soil, sandy (surface water)	18	18	Shale, gray, and hard shells of rock	5	110
Gravel (hard water)	9	27	Shale, gray, sticky, hard	5	115
Sandstone, light-brown and yellow	34	61	Shale, sandy, hard, gray	6	121
Sandstone, blue and gray	13	74	Shale, blue and gray, sticky, soft	4	125
Shale, gray	9	83	Shale, gray, with blue streaks	50	175
Sandrock, hard	2	85	Shale, sandy, gray	10	185
Shale, gray	1	86	Shale, blue, sticky	5	190
Sandstone, hard	4	90	Shale, hard, gray	18	208
Shale, sandy, hard, gray	6	96	Sand (water)	4	212
Shale, gray, sticky	4	100	Shale, sandy, blue, hard	3	215
Shale, sandy, hard, gray	5	105			

TABLE 4.—*Drillers' logs of wells*—Continued

Well A1-4-27aca—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Sand (water)	7	222	Shale, sticky, brown	11	460
Shale, gray, sticky	3	225	Shale, sandy, gray	5	465
Shale, brown	5	230	Shale, brown, and hard shells	47	512
Shale, gray	12	242	Shale, brown and blue	13	525
Shale, blue	8	250	Shale, sandy, gray, hard	10	535
Shale, brown	10	260	Shale, sticky, brown and blue	7	542
Shale, gray	5	265	Shale, sandy, gray, hard	3	545
Water sand and hard shells	20	285	Sand (water)	5	550
Shale, gray, hard	15	300	Shale, gray, hard	5	555
Sand (water)	5	305	Shale, sticky, brown and blue	5	560
Shale, sandy, hard, gray	9	314	Shale, gray, hard	5	565
Shale, blue, hard	2	316	Shale, sticky, light-brown	25	590
Shale, gray, and hard shells	19	335	Shale, gray, hard	10	600
Shale, brown and blue	5	340	Shale, sticky, blue and brown	18	618
Shale, sandy, light-brown	10	350	Sand (water)	22	640
Sand and hard shells	15	365	Shale, brown	10	650
Shale, gray and blue, hard	30	395	Sandstone, brown	5	655
Shale, brown and blue, sticky and hard	5	400	Sandstone, gray, hard	5	660
Shale, medium-gray	15	415	Shale, brown and blue	20	680
Shale, blue and brown	25	440	Sand (water)	45	725
Shale, sandy, hard, gray	9	449	Shale, yellow	5	730

Well A1-4-29dcb

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Soil, sandy, and gravel	10	10	Shale, very sandy, gray, hard	7	257
Sand, fine	3	13	Shale, sandy, blue, hard	3	260
Gravel	5	18	Shale, gray, sandy, hard	25	285
Sand and gravel	6	24	Shale, gray; some gray sandrock	8	293
Sand, fine	7	31	Sandrock, gray; trace of shale; red and black specks	53	346
Sand and gravel	9	40	Shale, sandy, gray, hard, sticky	64	410
Shale and sand	3	43	Shale, blue, sticky	3	413
Sand, fine	7	50	Shale, dark-gray, sticky	7	420
Gravel	25	75	Shale, sandy, blue, sticky	1	421
Shale, variegated yellow and blue	5	80	Shale, sandy, gray, sticky	9	430
Shale, sandy, blue	7	87	Shale, blue; some purple and brown	17	447
Shale, sandy, gray	6	93	Sand, white, sharp (water, 445 ppm)	13	460
Shale, blue and green	11	104	Shale, brown; some yellow and gray; hard, sticky	40	500
Shale, blue, red, brown	5	109	Sand shell, hard	4	504
Shale, sandy, blue	8	117	Shale, brown and blue	41	545
Shale, sandy, gray, hard	9	126	Sand, grayish-white (water)	15	560
Shale, soft, gray	3	129	Shale, gray	5	565
Shale, gray, hard	17	146	Sand, fine, white and flecked (water)	20	585
Sandstone, gray, soft	2	148	Shale, blue	6	591
Sandrock, gray, hard	3	151	Sand, white and flecked (water)	17	608
Shale, gray, hard	8	159	Shale, brown and light-blue	22	630
Shale, sandy, gray, medium-hard	12	171	Sand, flecked (water)	10	640
Sandrock, gray, soft	9	180			
Shale, sandy, gray, medium-soft	22	202			
Shale, sandy, blue and gray, sticky	48	250			

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well A1-4-29dcb—Continued					
Shale, blue-gray, hard	12	652	Shale, dark-brown, hard (drilled 1 ft per hr)	7	825
Sand, white and flecked (water)	3	655	Sand shells, hard	18	843
Shale, blue and brown, sticky	15	670	Shale, brown, sticky, hard, some blue shale	10	853
Sand (water, gas bubbles)	4	674	Sand shells, hard	17	870
Shale, blue and brown	11	685	Shale, brown; some blue (gas, oily)	17	887
Sand (water)	10	695	Shale, sandy, dark-gray (drilled 2 ft per hr)	11	898
Shale, blue	3	698	Shale, dark-gray, sticky	17	915
Sand (water)	6	704	Shale, gray, hard	13	928
Sand shells, hard	19	723	Sandstone, very soft	12	940
Sand (water)	10	733	Sand shells, hard	20	960
Hard rock and sand (drilled 1 ft per hr)	5	738	Sandstone, soft	4	964
Shale, blue and brown, hard, sticky	17	755	Shale, gray, hard	6	970
Sand shells, gray, hard	21	776	Sandstone	12	982
Shale, light-brown, sticky	24	800	Shale, brown and blue	12	994
Shale, light-gray (gas, oily rancid odor)	18	818			
Well A1-4-31ad					
Gravel	30	30	Sandstone	10	250
Shale	170	200	Shale	105	355
Shale and sandstone	10	210	Sandstone (water)	30	385
Shale	30	240	Shale, red, brown, green	15	400
Well A1-4-33aab					
Soil	7	7	Sandstone, coarse, hard	13	233
Sand and gravel	10	17	Shale, gray	42	275
Sandstone, yellow	27	44	Sandstone, red and white (coarse 295-300)	35	310
Shale, yellow, gray, green	21	65	Shale, gray, brown, and blue	56	366
Sandstone, gray and red	21	86	Sandstone, hard	19	385
Shale, blue and gray	87	173	Shale, blue, gray, brown	85	470
Sandstone, gray, black, red	30	203	Sandstone and hard shells	28	498
Shale	5	208	Shale, sandy, gray	2	500
Sandstone, coarse, hard	7	215			
Shale, gray	5	220			
Well A1-4-34ac					
Topsoil, sandy	1	1	Shale, sandy, gray	29	112
Gravel	4	5	Water sand (15 gpm, 3,540 ppm)	14	126
Shale, yellow-blue	19	24	Shale, blue	12	138
Sandstone, yellow	26	50	Shale, sandy, gray	11	149
Shale, sandy, blue (seep of water at 60 ft, 2,240 ppm)	17	67	Shale, blue	3	152
Shale, sandy, gray	11	78	Shale, sandy, dark-gray	6	158
Shale, sandy, blue	5	83	Shale, sticky, blue	6	164

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well A1-4-34ac—Continued					
Shale, brown; with coal streak	6	170	Shale, sandy, light-blue	13	365
Shale, blue	11	181	Shale, sandy, gray	5	370
Shale, sandy, gray	97	278	Sandstone, very coarse	25	395
Shale, sandy, light-blue	9	287	Water sand, coarse (10 gpm, 910 ppm)	8	403
Shale, gray, and hard shells	43	330	Shale, sandy, hard, blue	3	406
Shale, sandy, gray	22	352			
Well A2-2-4ddd					
Shale, sandy, blue and yellow-brown	12	12	Shale, sticky, blue	4	242
Shale, sandy, blue; mixed with light-green shale (water at 18-30 ft)	28	40	Shale, sticky, gray	24	266
Shale, sandy, gray, hard	48	88	Shale, sticky, blue; mixed with brown shale	9	275
Shale, sandy, blue	12	100	Sandstone, bluish-red	25	300
Shale, sandy; gray with red specks	30	130	Shale, sandy, gray	18	318
Shale, sandy, gray, sticky	10	140	Shale, sandy, blue	8	326
Shale, sandy; gray with red specks	36	176	Shale, sandy; gray with red specks	38	364
Shale, sandy, sticky, gray	24	200	Shale, sandy, dark-gray	2	366
Shale, sandy; gray with red sand	6	206	Shale, sticky, hard, blue	7	373
Shale, sticky, blue	3	209	Sandrock, hard, gray	1	374
Shale, sandy, gray, hard	5	214	Shale, sandy, gray	12	386
Shale, sticky, blue	3	217	Shale, brown and blue, hard	3	389
Shale, sandy, gray	21	238	Water sand, white (12 gpm)	11	400
			Shale, sticky, blue; mixed with brown shale	30	430
			Water sand, white	20	450
			Shale, sandy, blue	10	460
Well A2-2-16cdb					
Soil	2	2	Sandstone, reddish-brown (water, 4 gpm)	33	75
Sandstone	28	30	Shale, sandy, gray	5	80
Shale, light-gray and yellow	12	42			
Well A2-2-18ada2					
Soil	6	6	Sandstone, gray	19	381
Sandstone, yellow and blue	44	50	Shale, blue	31	412
Shale, sandy, gray	26	76	Sandstone, white (water)	18	430
Sandstone, gray (little water)	14	90	Shale	5	435
Shale, gray and blue	272	362			

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well A2-2-31addl					
Sand, gravel (hard water)	25	25	Shale, blue	5	135
Shale, blue	10	35	Sand with blue shale, very streaked (water)	25	160
Sandstone, soft, blue (hard water)	15	50	Shale, blue	3	163
Shale, blue	17	67	Sand (hard water)	12	175
Sand (hard water)	6	73	Shale, blue and gray	22	197
Shale, blue	9	82	Sand and blue shale	4	201
Shale, brown	8	90	Shale, blue	11	212
Shale, gray and blue	14	104	Sandstone, coarse	4	216
Sand, white (hard water)	21	125	Shale, brown; sandy blue shale	9	225
Shale, blue	3	128	Water sand (385 ppm)	5	230
Shale, brown	2	130			
Well A3-1-24cca					
No log	105	105	Sandstone	25	381
Shale, blue and gray	69	174	Shale, blue and gray	108	489
Sandstone, gray	51	225	Sandstone, silty, gray	25	514
Shale, sandy, gray	19	244	Shale, gray, blue and brown (no water)	46	560
Sandstone, gray	36	280			
Shale, blue and gray	76	356			
Well A3-2-3bdb					
Topsoil	3	3	Shale, sandy, gray	2	143
Sand and gravel	5	8	Shale, blue, light-green and brown	14	157
Shale, sandy, gray	12	20	Shale, sandy, gray (smells like crude oil)	20	177
Shale, sandy, blue	7	27	Sandstone, gray	9	186
Shale, sandy, gray	11	38	Shale, sandy, gray	21	207
Shale, blue and yellow	7	45	Sandstone, gray	9	216
Water sand (15 gpm, 5,200 ppm)	1	46	Water sand (5 gpm, 700 ppm)	20	236
Sandstone, yellow	21	67	Shale, sandy, blue	2	238
Shale, sandy, gray	28	95			
Water sand (10 gpm, 3,850 ppm)	16	111			
Shale, blue	30	141			
Well A3-2-7cda					
Topsoil, sandy (water)	27	27	Shale, sandy, hard, gray	2	164
Sandrock, soft, yellow	6	33	Shale, sandy, soft, blue; with brown shale	12	176
Shale, sandy, soft, gray	4	37	Rock, hard, gray	18	194
Sandstone, soft, yellow	37	74	Shale, sandy, medium-gray	20	214
Shale, sticky, blue	12	86	Shale, sandy, soft, blue	12	226
Shale, sandy, hard, light-blue	5	91	Shale, sandy, hard, gray	28	254
Shale, sandy, soft, gray	6	97	Shale, blue, soft	6	260
Shale, sandy, soft, blue	6	103	Shale, sandy, medium-blue	19	279
Shale, sandy, gray, medium-hard	14	117	Shale, sandy, blue, coarse and muddy	3	282
Shale, sandy, soft, blue	2	119	Shale, sandy, sticky, blue	5	287
Shale, sandy, soft, gray	7	126	Shale, soft, blue and brown	15	302
Shale, sandy, gray, hard	30	156	Shale, soft, gray	5	307
Shale, sandy, soft, blue	6	162			

TABLE 4.—*Drillers' logs of wells*—Continued

Well A3-2-7cda—Continued

Material	Thickness (feet)	Depth (feet)
Shale, sandy, hard, gray	11	318
Shale, sandy, medium-hard, gray	32	350
Sandstone, soft, red and gray	48	398
Shale, sandy, sticky, soft, gray	2	400
Sandstone, soft, gray and red (small amount of water)	11	411
Shale, sandy, medium-hard gray	38	449
Shale, sandy, hard, blue	3	452
Sand, coarse, gray (water)	11	463
Sandstone, fine	9	472
Sand, coarse, and hard shells	22	494
Rock, hard, gray	2	496
Shale, sticky, gray	4	500

Well A3-2-32cbb

Material	Thickness (feet)	Depth (feet)
Clay, sandy	10	10
Sandstone and shale	25	35
Sandstone	30	65
Shale	15	80
Sandstone and shale	45	125
Sandstone	40	165
Shale, hard, with hard stringers	150	315
Shale, hard	140	455
Sandstone (water)	18	473
Shale	12	485

Well A3-6-15bcb

Material	Thickness (feet)	Depth (feet)
Clay, fine gravel, and cobbles	12	12
Sandstone, broken	15	27
Siltstone, sandstone, and shale	20	47
Sandstone, brown	30	77
Shale, siltstone, fine sandstone	18	95
Sandstone, gray	53	148
Siltstone, sandstone, and shale	60	208
Sandstone, gray	7	215
Siltstone, very hard and bluish	83	298
Sandstone, gray	8	306
Sandstone, siltstone, and shale	40	346
Sandstone, gray, coarse, white	14	360
Sandstone, medium, white	25	385
Siltstone, sandstone, and shale	28	413
Sandstone and blue shale	22	435
Sandstone, medium, white	16	451
Sandstone, coarse, white (water)	44	495

Well A4-2-12ddd

Material	Thickness (feet)	Depth (feet)
Topsoil, sandy	2	2
Shale, sandy, gray	2	4
Shale, sandy, dark-gray	11	15
Shale, sandy, gray (10 gpm at 40 ft, 5,950 ppm at 50 ft)	46	61
Sandstone, yellow (90 gpm at 61–73 ft)	12	73
Shale, sandy, gray (4,200 ppm at 80 ft)	53	126
Shale, sandy, blue	6	132
Shale, sandy, gray (12 gal/hr, 132 ft–150 ft)	18	150
Shale, sandy, brown	10	160
Shale, sandy, gray	3	163
Shale, sandy, red-brown	5	168
Shale, sandy, gray	35	203
Shale, blue and brown	4	207
Shale, sandy, gray	8	215
Shale, brown	5	220
Shale, sandy, red-brown	8	228
Shale, sandy, gray, hard	67	295
Shale, brown	3	298
Shale, sandy, gray, hard	20	318
Shale, sandy, dark-gray	14	332
Shale, sandy, gray, medium-gray	26	358
Shale, blue and brown, cavey	6	364
Shale, sandy, brown	11	375
Shale, brown	6	381
Shale, sandy, gray, hard	5	386
Shale, brown and blue	12	398
Shale, sandy, gray, hard	2	400

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well A4-3-5dcb					
Sandstone, yellow and gray (hard water)	41	41	Shale, gray	10	150
Shale, gray, brown, green, yellow	22	63	Sandstone, soft (water, 2 gpm)	40	190
Sandstone, gray	32	95	Shale, gray	5	195
Shale, gray	25	120	Sandstone, gray	12	207
Sandstone with lime shells	20	140	Shale, gray and brown	63	270
			Sandstone, gray	5	275
			Shale, gray and brown	50	325
Well A4-3-11acd					
Sand and gravel	10	10	Sandstone, soft	16	178
Shale, sandy, gray	30	40	Coal shale	2	180
Sandstone	20	60	Shale, blue	9	189
Shale, gray, sandy	27	87	Shale, brown	8	197
Sandstone, gray	3	90	Shale, sticky, light-gray	18	215
Shale, gray	21	111	Sandstone, gray (water, 2,300 ppm)	75	290
Hard shell of rock	2	113	Sand, soft (water, 1,890 ppm)	34	324
Sandstone, gray, soft	17	130	Limestone, hard	3	327
Shale, gray, hard	2	132	Shale, very sandy (water)	18	345
Water sand (2,800 ppm)	8	140	Shale, sandy, gray	2	347
Sandstone, hard	22	162			
Well A4-3-20abc					
Soil, sandy	25	25	Shale, sandy, gray	8	98
Sandstone, yellow	32	57	Hard rock	1	99
Sandstone, gray	11	68	Shale, sandy, blue and gray	2	101
Shale, brown	5	73	Sandstone, gray	4	105
Shale, sandy, gray	13	86	Shale, sandy, gray	9	114
Shale, brown	4	90	Water sand	8	122
Well A4-3-21bbc					
Soil	7	7	Shale, sandy, gray, blue, brown	57	348
Shale, sandy, gray	24	31	Sandstone, gray	23	371
Sandstone, yellow	55	86	Shale, sandy, gray, blue, brown	64	435
Shale, sandy, gray, blue, brown	32	118	Sandstone, coarse	4	439
Sandstone (water)	6	124	Shale, sandy, gray, blue, brown	351	790
Shale, sandy, gray, blue, brown	159	283			
Sandstone, gray	8	291			
Well A4-3-35adc					
Soil, sandy	6	6	Sandstone, gray	23	195
Sand and gravel	5	11	Shale, blue	19	214
Shale, sandy, blue	29	40	Sandstone (softer water)	9	223
Sandstone, yellow	30	70	Shale, gray, blue and brown	64	287
Shale, sandy, gray and blue	30	100	Sandstone (water)	25	312
Sandstone (water)	12	112	Shale, sandy, gray	3	315
Shale, sandy, blue and gray	60	172			

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well B1-1-5acb1					
Surface	7	7	Sand and gravel	1	35
Quicksand	13	20	Shale	5	40
Clay, broken	14	34			
Well B1-1-31add					
Surface	2	2	Broken shale (water)	13	50
Rock and clay	10	12	Shale	32	82
Shale	25	37	Broken shale	8	90
Well B1-2-26add					
Surface	1	1	Sand and boulders (water)	13	28
Boulders	14	15			
Well B1-2-26cbd					
Surface	1	1	Quicksand	5	26
Rock and clay	20	21	Gravel (water)	2	28
Well B1-2-35baa					
Surface	1	1	Sand and gravel	3	22
Rock and clay	16	17	Clay, brown	2	24
Rock and gravel	2	19	Shale	10	34
Well B1-2-36cbb					
Surface	3	3	Clay, yellow	13	31
Clay, brown	12	15	Boulders	2	33
Boulders	3	18	Gravel (water)	3	36
Well B2-2-26aca					
Gravel	12	12	Sand (water)	10	35
Clay, yellow	3	15	Sand, muddy	5	40
Sandstone	10	25			
Well B2-2-28bca					
Surface	3	3	Shale, brown	4	64
Gravel	7	10	Sand rock (water)	4	68
Clay, yellow	25	35	Shale, blue	49	117
Sand rock	6	41	Sand (water)	10	127
Shale, blue	19	60			

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well B2-2-31cda2					
Surface	2	2	Gravel (water)	6	36
Clay, brown	18	20	Shale	3	39
Clay, yellow	10	30			
Well B4-3-32dcd					
Topsoil with a few rocks	12	12	Shale, sandy, gray	25	75
Shale, sandy, light-blue	6	18	Shale, sandy, light-blue	5	80
Shale, sandy, gray	29	47	Sand	15	95
Shale, sandy, light-brown	3	50	Shale, sandy, gray	5	100
Well B4-4-14ccb					
Gravel	54	54	Shale, sandy, light-blue	15	226
Shale, sandy, light-brown	33	87	Shale, sandy, gray	22	248
Shale, sandy, gray (2 gpm at 95 ft)	13	100	Water sand (4 gpm)	8	256
Shale, sandy, brown	10	110	Shale, sandy, gray	27	283
Shale, sandy, gray	19	129	Shale, blue and brown	32	315
Water sand (2 gpm)	19	148	Shale, sandy, gray	7	322
Shale, blue and brown	29	177	Water sand (main water, soft)	7	329
Shale, sandy, blue	7	184	Shale, sandy, hard, gray	30	359
Shale, sandy, gray	22	206	Shale, light-brown	6	365
Shale, brown and blue	5	211	Shale, sandy, hard, gray; with lime mixed	35	400
Well B4-4-16ada					
Soil, sandy, and rocks	30	30	Shale, gray	8	65
Boulders, sand (small amount of water)	12	42	Shale, blue and brown	15	80
Shale, blue	3	45	Sandstone, gray	30	110
Sandstone, light-brown	12	57	Water sand, coarse	20	130
Well B4-4-24cbc					
Rocks, sand, and gravel (water from 20-30 ft)	30	30	Sandrock, red-brown	6	46
Sandrock, brown	10	40	Sandrock, light-brown	4	50
Well B5-6-35ada					
Gravel, boulders, sandy clay, with streaks of shale; very unconsolidated material	75	75	Sandstone with hard stringers (water increased slightly on hard stringers)	125	200

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well C1-1-4abd					
Surface	1	1	Sand and gravel (water)	3	20
Boulders	13	14	Shale	3	23
Sand	3	17			
Well C1-1-4adc					
Surface	1	1	Quicksand	1	21
Gravel and clay	19	20	Gravel (water)	3	24
Well C1-1-5dab					
Surface	2	2	Shale	13	41
Clay and rock	20	22	Shale, sandy (1 gpm)	2	43
Quicksand (water)	6	28	Shale	107	150
Well C1-1-5dba					
Surface	1	1	Boulders, hard	3	27
Rock	17	18	Sand (water)	3	30
Quicksand	4	22	Shale	12	42
Gravel and clay	2	24			
Well C1-1-6cdd					
Surface	3	3	Shale and gravel	2	27
Rock and clay	15	18	Shale, black	11	38
Gravel (dry)	7	25	Shale, sandy, blue (water)	24	62
Well C1-1-6ddc					
Surface	3	3	Clay and gravel	7	20
Rock and gravel	7	10	Sand and gravel (water)	3	23
Gravel	3	13			
Well C1-1-7dcb					
Clay, brown	20	20	Sand and gravel	7	40
Gravel and clay	13	33	Shale	3	43
Well C1-1-8aab					
Surface	2	2	Shale	21	54
Rock and clay	20	22	Shale (water)	12	66
Quicksand	11	33			

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well Cl-1-8ada					
Surface	1	1	Clay, red, and rock (water)	8	13
Clay	4	5	Gravel	7	20
Well Cl-1-8ccb					
Topsoil	3	3	Shale, gray	19	260
Gravel	31.5	34.5	Shale, black	35	295
Shale, dark	29.5	64	Shale, sandy, gray	5	300
Sand, soft	13	77	Limestone, hard, white	5	305
Sand (carrying water)	6	83	Shale, gray	17	322
Sand	20	103	Shale, hard, gray	28	350
Shale, blue	67	170	Shale, hard, light-gray	50	400
Shale, gray	31	201	Shale, hard, black	92	492
Bentonite	1	202	Shale, sandy, gray	5	497
Shale, blue	2	204	Sand, gray, fine (water)	17	514
Coal and sand	3	207	Sand, gray	29	543
Shale, gray	20	227	Shale, gray	5	548
Shale, black	14	241			

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well Cl-2-13ddd					
Clay	5	5	Shale, blue	21	56
Rock and gravel	15	20	Shale, red	6	62
Clay, pink	15	35	Shale, blue	8	70
Well Cl-2-24ada					
Rock and clay	7	7	Shale, sandy (water, 2 gpm)	5	26
Shale, brown	11	18	Shale, gray	10	36
Shale, gray	3	21	Shale, sandy (water, 40 gpm)	5	41
Well Cl-2-24dcb					
Rock and clay	17	17	Rock, sandy, red (water)	15	40
Rock, red	8	25			
Well Cl-2-26ada					

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well D1-1-15add					
Clay	20	20	Gravel and sand	5	28
Clay, sandy	3	23	Shale, blue	3	31
Well D1-1-15ccc					
Clay, brown	13	13	Shale, black	1	39
Sand and gravel	25	38			
Well D1-1-16acb					
Surface	5	5	Shale, light-gray	25	60
Clay	20	25	Shale, blue	20	80
Shale, sandy	10	35			
Well D1-1-21add					
Surface	3	3	Gravel and sand	18	21
Well D1-1-22bce					
Surface	8	8	Gravel and sand	15	23
Well D1-1-30dba					
Clay	10	10	Shale	330	715
Sand and gravel	10	20	Shale with bentonite	140	855
Shale	185	205	Shale with sandstone stringers	160	1,015
Shale with sandstone stringers	180	385			
Well D1-2-9bbb1					
No log	160	160	Coal and dark sandy shale	7	349
Shale, sandy, brown, soft	25	185	Shale, sandy, gray, soft	13	362
Shale, sandy, gray, soft	55	240	Hard layer of rock	3	365
Shale, sandy, brown	47	287	Sandstone, gray, with red specks (soft water)	47	412
Coal	1	288	Shale, sandy, brown, soft	8	420
Shale, sandy, brown, dark	7	295	Shale, sandy, gray, soft	10	430
Shale, sandy, gray, soft	38	333			
Shale, sandy, coarse (no water)	9	342			

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well D1-2-10-dcc					
Soil, sandy	4	4	Shale, soft, light-gray	40	291
Sand, gravel (water)	26	30	Shale, brown	4	295
Sandstone, yellow	35	65	Shale, yellow	5	300
Shale, yellow	6	71	Shale, soft, light-gray	14	314
Shale, gray	12	83	Shale, yellow	8	322
Shale, blue	5	88	Shale, sandy, light-gray	14	336
Shale, gray	30	118	Shale, brown	11	347
Shale, brown and blue	7	125	Shale, sandy, light-gray (seep of water)	36	383
Shale, soft, light-gray	10	135	Sandstone, hard	6	389
Shale, sandy, soft, gray	10	145	Shale, yellow-gray	17	406
Shale, soft, light-gray	15	160	Sandstone, gray	6	412
Shale, sandy, hard, gray	20	180	Water sand (very soft water but a very small amount, 1 gpm)	6	418
Shale, soft, brown and gray	20	200	Shale, sandy, gray	37	455
Shale, soft, brown and blue	9	209	Shale, soft, gray, very cavey	18	473
Shale, sandy, gray	5	214			
Shale, brown	2	216			
Shale, sandy, soft, gray	32	248			
Shale, brown	3	251			
Well D1-3-10cca					
Topsoil, sandy	20	20	Shale, sandy, blue	8	244
Gravel	10	30	Sand, gray (water, 20 gpm, 446 ppm)	9	253
Shale, sandy, yellowish-gray (water, 4 gpm at 47 ft, 542 ppm)	28	58	Shale, sandy, blue and brown	11	264
Shale, sandy, gray	68	126	Shale, sandy, bluish-gray	36	300
Shale, sandy, blue	30	156	Shale, sandy, blue	14	314
Shale, sandy, gray	6	162	Shale, sandy, bluish-gray	16	330
Shale, sandy, blue	10	172	Sandstone, gray, very fine sand	20	350
Shale, sandy, gray	11	183	Shale, sandy, blue and brown	25	375
Shale, sandy, blue	21	204	Sand, gray (principal water bed, 434 ppm)	15	390
Shale, sandy, gray	32	236			
Well D1-3-12dba					
Topsoil and dirt, rocks	6	6	Sand, brown	5	40
Shale, blue	9	15	Shale, sandy, brown	5	45
Sandstone, yellow, very shaly	8	23	Shale, sandy, gray	5	50
Sandstone, brown	12	35	Shale, gray, and bentonite	5	55
Well D1-3-13dad					
Topsoil, sandy	3	3	Shale, sandy, gray	29	55
Gravel and water	8	11	Sand, fine, gray (water)	10	65
Shale, red-brown	9	20	Shale, sandy, gray	15	80
Bentonite	6	26			

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well D1-3-14abb					
Soil, sandy, and gravel	5	5	Sand	10	30
Shale, yellowish-gray	15	20	Shale, reddish-gray	10	40
Well D1-3-23bcc					
Topsoil, sandy	6	6	Shale, sandy, gray	16	97
Sand, gravel (hard water)	14	20	Sand, gray (good water)	20	117
Shale, sandy, gray	40	60	Shale, sticky, brown and gray	3	120
Shale, blue	21	81			
Well D1-3-23bdd2					
Soil, sandy	8	8	Shale, sandy, gray	10	100
Gravel	5	13	Shale, sticky, gray	50	150
Shale, gray, soft	5	18	Shale, brown	10	160
Sandstone, yellow	4	22	Shale, sticky, gray	15	175
Shale, gray	8	30	Shale, sandy, gray, hard	31	206
Sandstone, gray	60	90	Water sand and hard shells	44	250
Well D1-3-24cbb					
Soil	5	5	Sandstone, gray	19	212
Gravel (water)	11	16	Shale, sandy, blue	6	218
Shale, sandy, blue, gray, brown	154	170	Sandstone, white (water)	12	230
Sandstone, gray	15	185	Shale, blue	2	232
Shale, sandy, blue	8	193			
Well 1-3-24cbd					
Topsoil, sandy	4	4	Shale, sandy, gray	6	131
Gravel	8	12	Shale, sandy, blue	11	142
Sandrock, yellow (veins of hard water)	12	24	Shale, blue and brown	2	144
Shale, blue	3	27	Shale, sandy, gray	5	149
Shale, sandy, gray (water at 55 ft. Fairly hard and tastes bitter)	58	85	Shale, blue and brown	31	180
Shale, blue	6	91	Shale, sandy, gray	20	200
Shale, gray	31	122	Sandrock, gray; with hard shells	20	220
Shale, blue	3	125	Sand, white (water)	10	230
			Shale, sandy, blue	5	235
Well D1-3-24cda					
Soil, sandy	8	8	Shale, blue	6	238
Gravel	9	17	Sandstone, bluish-white	8	246
Shale, sandy; alternating gray, blue, brown, yellow	200	217	Sandstone, brown	8	254
Sandstone, coarse (small flow)	15	232	Sandstone, white (main flow)	11	265
			Shale, brown	2	267

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well D1-3-24cdc					
Topsoil, sandy	23	23	Water sand (good for 60 gpm or better)	10	50
Gravel (no water)	3	26			
Shale, sandy, gray	14	40			
Well D1-4-2cab					
Topsoil, sandy	6	6	Sand, fine, white	12	49
Gravel	10	16	Shale, blue	4	53
Shale, gray	15	31	Shale, sandy, gray	12	65
Shale, sandy, gray	6	37			
Well D1-4-3dcb					
Topsoil, sandy	3	3	Shale, sandy, blue	15	98
Gravel	11	14	Shale, sandy, gray	14	112
Shale, sandy, blue	9	23	Shale, sandy, blue, very hard	8	120
Shale, sandy, gray, hard	30	53	Sand (water)	10	130
Shale, blue	4	57	Shale, sandy, gray	7	137
Shale, sandy, gray	26	83			
Well D1-4-4ccd					
Gravel	9	9	Shale, sandy, blue	3	41
Sandstone, hard layers	3	12	Sandstone, gray (water)	14	55
Shale, bluish-gray	8	20	Shale, sandy, gray	8	63
Sandstone, gray (water)	18	38			
Well D1-4-4cdd					
Topsoil, sandy	6	6	Shale, gray, sandy	18	198
Gravel (water bearing)	9	15	Shale, sandy, blue	2	200
Sandstone, hard	1	16	Shale, sandy, gray	3	203
Shale, sandy, soft, gray	1	17	Shale, soft, blue	6	209
Sandstone, hard	1	18	Shale, sandy, gray	9	218
Shale, sandy, gray	14	32	Shale, sandy gray, red and brown sand	18	236
Shale, blue	5	37	Shale, soft, blue	4	240
Shale, sandy, gray	8	45	Shale, sandy, soft, gray	8	248
Sand (water bearing)	12	57	Shale, very sandy, gray	7	255
Shale, sandy, gray	30	87	Shale, soft, blue	4	259
Shale, sandy, sticky, gray	21	108	Shale, sandy, soft, gray	7	266
Shale, sandy, gray	12	120	Shale, soft, blue	2	268
Rock, hard, white	2	122	Shale, sandy, gray	5	273
Shale, sandy, gray	23	145	Shale, sandy, blue	8	281
Shale, sandy, blue	8	153	Shale, soft, dark-brownish-blue	2	283
Shale, sandy, gray	3	156	Shale, soft, reddish-brown	9	292
Shale, soft, sticky, blue	3	159	Shale, sandy, blue	5	297
Shale, sandy, gray	18	177	Shale, soft, reddish-brown	13	310
Shale, soft, blue	3	180			

TABLE 4.—*Drillers' logs of wells*—Continued

Well D1-4-4cdd—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Shale, sandy, blue	4	314	Shale, sandy, hard, blue	5	385
Shale, sandy, gray	6	320	Sand, gray (water bearing, flow increased to 100 gpm)	35	420
Sand, gray (water bearing, well flowed 9 gpm)	18	338	Shale, sandy, hard, blue	3	423
Shale, hard, brown	8	346	Sand, gray (water bearing)	7	430
Sandstone, hard, brown	5	351	Shale, sandy, hard, blue	5	435
Shale, hard, reddish-brown	9	360	Sand, gray (water bearing)	3	438
Shale, hard, blue	4	364	Sandstone, gray	8	446
Shale, hard, reddish-brown	14	378	Sand and blue medium-hard shale	4	450
Shale, blue and brown mixed	2	380			

Well D1-4-4ddd

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Topsoil, sandy	3	3	Sandrock (water at 150 ft, 2 gpm)	50	170
Gravel	14	17	Shale, sandy, gray	20	190
Shale, sandy, gray	63	80	Sandrock	58	248
Shale, sticky, gray	40	120	Water sand (flow)	17	265

Well D1-4-5bbb

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Topsoil, sandy	6	6	Sand, gray (water)	10	50
Gravel	8	14	Shale, sandy, blue	10	60
Shale, sandy, gray	26	40			

Well D1-4-7bbb

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Gravel	15	15	Sandstone, gray (water, 3 gpm)	17	180
Sandstone, reddish-brown (seep of hard water at 29 ft)	35	50	Shale, alternating gray and blue	50	230
Shale, gray and blue	76	126	Sandstone, gray	16	246
Sandstone, gray, very coarse	17	143	Shale, alternating gray and blue	121	367
Shale, sandy, gray	20	163	Sandstone, gray (water)	15	382
			Shale, blue	8	390

Well D1-4-7dcb

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Topsoil, sandy	1	1	Shale, sandy, gray (water at 40 ft, 5 gpm)	22	65
Gravel	14	15	Sandrock, gray (water at 75 ft, 5 gpm, very hard)	10	75
Shale, yellow-brown	8	23	Shale, sandy, gray	7	82
Shale, sandy, brown	17	40	Shale, blue	3	85
Shale, pink	3	43			

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well D1-4-9aad					
Gravel and water	14	14	Shale, sandy, hard, gray	45	180
Shale, sandy, gray, very coarse	43	57	Sandstone, gray (small amount of water at 185 ft)	32	212
Shale, sandy, blue	6	63	Shale, sandy, blue	6	218
Shale, gray	32	95	Shale, sandy, gray	17	235
Shale, blue	22	117	Sandrock, gray	15	250
Sandstone, gray, with red streaks	13	130	Water sand	15	265
Shale, sandy, hard, blue	5	135	Shale, brown and blue	2	267
Well D1-4-9cdc2					
Sand and gravel (water)	17	17	Sandstone (soft water)	13	339
Sand, yellow (water)	13	30	Shale, gray and blue	136	475
Sandstone, gray, soft	30	60	Sandstone (soft water)	39	514
Sandstone, gray, hard	18	78	Shale, brown	1	515
Shale, blue and gray	248	326			
Well D1-4-9cdc3					
Soil	3	3	Sandstone, yellow (water)	39	57
Gravel (water)	15	18			
Well D1-4-18baa					
Sand, yellowish, and gravel	8	8	Shale, sandy, blue	25	190
Shale, brown and blue	24	32	Shale, blue	10	200
Bentonite	8	40	Shale, sandy, blue	40	240
Shale, sandy, blue	8	48	Sandstone, light-gray	25	265
Shale, sandy, gray (water at 60 ft, hard)	49	97	Shale, sandy, light-blue	17	282
Shale, sandy, blue	5	102	Shale, sandy, light-gray	11	293
Shale, sandy, gray	30	132	Shale, sandy, blue, hard	13	306
Sand, blue, and coal shale	3	135	Sand (main water)	10	316
Shale, blue	30	165	Shale, sandy, blue	4	320
Well D1-4-18bba					
Topsoil, sandy	2	2	Shale, streaks of blue and brown	5	119
Gravel	11	13	Shale, sandy, gray	13	132
Shale, brown	11	24	Shale, gray	12	144
Shale, sandy, gray	5	29	Shale, blue, and coal	3	147
Bentonite (0-35 very soft and cavey)	6	35	Shale, sandy, gray	19	166
Shale, sandy, gray	22	57	Shale, sandy, blue	11	177
Shale, sandy, coarse, gray (water at 57 ft, 3,312 ppm)	19	76	Shale, sandy, gray	6	183
Shale, sandy, blue	7	83	Shale, sandy, blue	6	189
Shale, sandy, gray	19	102	Shale, sandy, gray	3	192
Shale, sandy, blue	7	109	Shale, sandy, gray (114-198 ft, soft and sticky)	6	198
Shale, sandy, gray	5	114	Shale, sandy, hard, gray	11	209

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well D1-4-18bba—Continued					
Shale, blue	11	220	Shale, sandy, gray, hard	5	311
Shale, sandy, gray	17	237	Shale, sandy, blue, hard	3	314
Shale, sandy, blue	5	242	Sand, gray (378 ppm)	10	324
Shale, sandy, gray	47	289	Shale, sandy, blue, hard	6	330
Shale, sandy, blue	17	306			
Well D1-4-18bbd					
Topsoil, sandy	8	8	Shale, sandy, gray	4	40
Gravel	10	18	Sand, gray (hard water)	5	45
Shale, sandy, brown, very soft	6	24	Shale, sandy, gray	15	60
Shale, yellowish-gray, very soft	12	36			
Well D1-4-18daa					
Soil	1	1	Shale, gray, blue and green	129	217
Gravel	15	16	Sandstone (water, 2 gpm)	18	235
Shale, yellow and gray	56	72	Shale, sandy, gray	15	250
Sandstone (bad water)	16	88	Sandstone (water)	20	270
Well D1-5-11acc					
Topsoil	3	3	Sand, good, coarse (third water at 146 ft)	4	153
Sand	2	5	Clay, blue	1	154
Clay, red	15	20	Sand (fourth water at 154 ft)	2	156
Sandstone	7	27	Clay, blue	2	158
Clay, blue	32	59	Sand (fifth water)	8	166
Clay, red and blue	59	118	Clay, red and blue	25	191
Shale, sandy (first water at 118 ft)	7	125	Clay, sandy	10	201
Sandstone	1	126	Sand (sixth water at 191 ft)	7	208
Sand, good, coarse (second water at 126 ft)	6	132	Clay, blue	2	210
Clay, blue	14	146	Sand (seventh water at 210 ft)	1	211
Clay, sandy (carries water)	3	149	Clay, blue	1	212
			Sand (eighth water at 212 ft)	3	215
			Clay, blue	10	225
Well D1-6-7bcd					
No log	60	60	Sandstone, fine to coarse, light-gray, greenish-gray, unconsolidated, soft (water)	120	680
Sandstone, fine to coarse, green to olive, soft	60	120	Claystone, sandy, greenish-gray	10	690
Claystone, sandy, green, yellow, red	100	220	Sandstone, medium to coarse, light-gray, soft (water)	10	700
Sandstone, fine to coarse, green to light-gray, soft (water)	120	340	Claystone, sandy, greenish-gray	20	720
Claystone, sandy, greenish-gray; bentonite	220	560			

TABLE 4.—*Drillers' logs of wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Well D1-6-7bcd—Continued					
Sand and claystone, greenish-gray	20	740	Claystone, sandy, green, yellow, red	60	830
Sandstone, very fine to medium, light-gray, clayey, soft (water)	30	770	Siltstone, light-gray, clayey	70	900
			Shale, variegated, silty, sandy; some chert	60	960
Well D2-3-4cab					
Shale, blue and brown	14	14	Shale, sandy, blue	32	120
Shale, sandy, reddish-brown	34	48	Sand, coarse (water)	22	142
Sandrock, yellow (bad water)	40	88	Shale, sandy, gray	8	150
Well D2-3-7aaa					
Soil	20	20	Shale, blue, gray, yellow, brown	31	116
Sand and gravel	18	38	Sandstone, coarse, with shale	9	125
Sandstone, yellow	8	46	Sandstone, dirty	5	130
Shale, blue, gray, pink	23	69	Sandstone (soft water, 2 gpm)	8	138
Sandstone (water, soft, 5 gpm)	11	80	Shale, sandy, gray	2	140
Shale, gray and pink	4	84			
Sandstone (no water)	1	85			
Well D2-3-7aab					
Soil, sandy	17	17	Sandstone, coarse (water, 1 gpm)	3	298
Sand and gravel (water)	23	40	Shale, variegated	20	318
Shale, sandy, blue, pink, gray, yellow	68	108	Sandrock, gray (water, 1 gpm)	9	327
Sandstone (good water, 1½ gpm)	14	122	Shale, sandy, gray	43	370
Shale, blue	1	123	Shale, blue and brown	4	374
Sandstone, silty, coarse	12	135	Shale, sandy, sticky, gray	23	397
Shale, variegated	160	295	Sand, white (water, 3 gpm)	7	404
			Shale, sandy, gray	4	408

TABLE 5.—*Logs of test holes and test wells*

[Altitudes given in table of well records (table 3)]

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
A1-1-34bcb					
Alluvium:			Alluvium—Continued		
Clay and silt, dark-brown to black	6	6	some finer sand and coarser gravel	22	28
Sand and gravel; mostly coarse sand to fine gravel:			Cody Shale:		
			Shale, dark-gray	3	31
A1-2-6aaa					
Slope wash and alluvium:			Wind River Formation:		
Clay, silt, and sand, tan; very fine to coarse sand and some very fine gravel	37	37	Conglomerate and very coarse sandstone, loosely cemented (takes drilling mud, no returns)	6	50
Gravel and sand	7	44			
A1-2-6adb					
Slope wash:			Wind River Formation—Con.		
Sand and silt, clayey; some very fine gravel; brown	5	5	Sandstone, medium-grained to very coarse grained, dark-brown, loosely cemented; thin interbeds of siltstone	5	81
Sand, very fine, and silt, tan	5	10	Siltstone, dark-gray	5	86
Wind River Formation:			Sandstone, coarse-grained to very coarse grained, very well sorted, light-gray, loosely cemented, clean (damp)	5	91
Siltstone, dark-gray	10	20	Sandstone, very coarse grained, to very fine grained conglomerate; very well sorted, light-gray, loosely cemented (damp, water at 101 ft)	15	106
Sandstone, very fine grained to medium-grained, slightly silty, light-brown, fairly well sorted, loosely cemented	12	32	Siltstone(?), poor samples	5	111
Siltstone, dark-greenish-gray	6	38	Conglomerate, very fine grained, and very coarse grained sandstone; well-sorted, loosely cemented (water, specific conductance 1,200 micromhos)	21	132
Sandstone, very fine grained to medium-grained, light-bluish-gray, loosely cemented	4	42	Sandstone, very fine grained, tan, and green and gray siltstone; interbedded	4	136
Siltstone, dark-gray	4	46	Sandstone, very fine grained to coarse-grained, poorly sorted, tan, loosely cemented	6	142
Sandstone, very fine grained to fine-grained, light-bluish-gray, cemented	5	51			
Siltstone, dark-gray	10	61			
Sandstone, very fine grained to medium-grained, light-bluish-gray, loosely cemented	9	70			
Siltstone, dark-brownish-gray, and dark-brown medium- to coarse-grained sandstone, loosely cemented; interbedded	6	76			

TABLE 5.—*Logs of test holes and test wells*—Continued

A1-2-6adb—Continued

	Thickness (feet)	Depth (feet)
Wind River Formation—Con.		
Siltstone, red	1	143
Siltstone(?), light color, poor samples	3	146
Sandstone(?), poorly sorted, poor samples	5	151
Sandstone, very fine grained to coarse-grained, tan and brown, loosely cemented (specific conductance of water jetted from hole, when at total depth, was 1,300 micromhos)	10	161

A1-2-21bbb

	Thickness (feet)	Depth (feet)
Slope wash and alluvium (not mapped):		
Sand and silt, brown	7	7
Gravel, very fine, and brown sand	3	10
Wind River Formation:		
Siltstone, greenish-gray	5	15
Marlstone(?), grayish-white, very hard; powdery returns	1	16
Siltstone, tan	4	20
Siltstone, very fine grained sandy, greenish-gray	15	35
Siltstone, purplish-gray and olive	23	58
Siltstone, bluish-gray	3	61
Sandstone, very fine grained to medium-grained, bluish-gray (damp)	9	70
Siltstone, very fine grained, sandy, bluish-gray	5	75
Sandstone, very fine grained to medium-grained, silty, bluish-gray	5	80
Siltstone, very fine grained, sandy, bluish-gray; hard streaks at 84, 88, and 91 ft	11	91
Sandstone, very fine grained, silty, bluish-gray (damp)	9	100
Sandstone, very fine grained to medium-grained, bluish-gray	10	110
Siltstone, very fine grained, sandy, bluish-gray	5	115
Sandstone, very fine grained to medium-grained, bluish-gray and gray (dry)	15	130
Wind River Formation—Con		
Sandstone, medium- to coarse-grained, light-gray, clean (dry)	5	135
Siltstone, sandy, and very fine grained to medium-grained sandstone; bluish-gray and gray; some coarser sand	55	190
Sandstone, very fine grained to medium-grained, silty, gray; some coarser sand	20	210
Sandstone, coarse-grained to very coarse grained, well-sorted, light-gray, clean (dry)	10	220
Sandstone, medium-grained to very coarse grained, silty, gray (dry)	20	240
Sandstone, very fine grained to coarse grained, silty, gray (dry)	15	255
Siltstone, sandy, brown	5	260
Sandstone, very fine grained to coarse-grained, silty, gray (water)	10	270
Sandstone and very fine conglomerate; poor samples (water, noticeable increase in water 280-285 ft; specific conductance 730 micromhos)	27	297
Siltstone, sandy, gray	3	300

TABLE 5.—*Logs of test holes and test wells*—Continued

A1-2-26cbb

	Thickness (feet)	Depth (feet)
Slope wash (not mapped):		
Sand, silty, clayey, brown	3	3
Wind River Formation:		
Sandstone, medium to very coarse grained; mostly fair sorting; tan and yellow; rusty zones; loosely cemented; thin streak of very fine grained and fine-grained conglomerate at 17 ft	17	20
Siltstone, very fine grained, sandy, green	5	25
Sandstone, very fine grained to coarse-grained, green, poorly sorted; green siltstone	5	30
Sandstone, medium-grained, yellow, well-sorted	13	43
Siltstone, very fine grained, sandy, green	5	48
Sandstone, very fine grained to medium-grained, bluish-gray, poorly sorted; few hard streaks	32	80
Sandstone, mostly fine- to medium-grained, bluish-gray; fair sorting	55	135
Siltstone, very fine grained, sandy, dark-gray	5	140
Sandstone, mostly fine- to medium-grained, bluish-gray; fair sorting	10	150
Siltstone, dark-gray, and bluish-gray very fine grained sandstone	5	155
Siltstone, dark-gray	9	164
Marlstone(?), grayish-white, vary hard; powdery returns	2	166
Wind River Formation—Con.		
Siltstone, sandy, and very fine-grained silty sandstone; dark-gray (slightly damp about 205 ft)	44	210
Siltstone or shale, dark-reddish-brown	10	220
Siltstone, very fine grained sandy, greenish-gray	5	225
Siltstone, dark-gray	10	235
Marlstone(?), grayish-white, very hard; powdery returns	2	237
Sandstone, very fine grained to medium-grained, silty, light-gray	3	240
Siltstone, dark-gray	15	255
Siltstone and silty very fine grained to fine-grained sandstone, dark-brownish-gray	10	265
Sandstone, medium- to coarse-grained; some finer sand and silt; fair sorting; dark brownish gray	10	275
Sandstone, very fine grained to medium-grained; some coarse sand and silt; dark brownish gray	10	285
Siltstone, dark-gray; some sandy siltstone	20	305
Sandstone, coarse-grained to fine-grained conglomerate (water, specific conductance 750 micromhos)	30	335
Siltstone, dark-gray	10	345

A1-5-15aab

	Thickness (feet)	Depth (feet)
Slope wash and alluvium:		
Silt and very fine sand, tan	5	5
Clay, silty, sand, tan	6	11
Sand, very fine and fine, and clay, tan (damp)	4	15
Sand, mostly fine, tan (wet)	10	25
Sand, mostly coarse, and clay, tan (wet)	17	42
Slope wash and alluvium—Con.		
Sand, mostly coarse; fair sorting; tan (water increased at 42 ft)	8	50
Wind River Formation:		
Sandstone, fine- to medium-grained, bluish-gray	5	55

TABLE 5.—*Logs of test holes and test wells*—Continued

A2-1-27bcb

	Thickness (feet)	Depth (feet)
Wind River Formation:		
Sandstone, coarse-grained, and very fine grained conglomerate; yellow, clean	22	22
Siltstone, very fine grained, sandy, bluish-gray	5	27
Sandstone, medium-grained to very coarse grained; some fine sand and very fine gravel; yellow	18	45
Sandstone, very fine to very coarse grained, yellow and rusty-brown	16	61
Sandstone, very fine grained to coarse-grained, very silty; sandy siltstone; bluish-gray	14	75
Sandstone, fine to very coarse grained, yellow and very light brown	11	86
Siltstone, sandy, bluish-gray	6	92
Sandstone, very fine to very coarse grained, bluish-gray (damp at 92 ft)	3	95
Sandstone, medium-grained to very coarse grained, well-sorted, bluish-gray	10	105
Wind River Formation—Con.		
Sandstone, very fine to medium, bluish-gray	7	112
Siltstone, dark-brownish-red	8	120
Sandstone, fine to very coarse grained, bluish-gray	10	130
Siltstone, dark-brownish-red, partly sandy	15	145
Sandstone, mostly very fine to fine-grained, silty; sandy siltstone; brown and gray (little water 150 to 170 ft)	54	199
Sandstone, very fine grained to medium-grained, silty; some sandy siltstone; hard (little water at 210 ft)	16	215
Sandstone, very fine to very coarse grained, silty, gray and light-gray, partly hard; poor samples (little water 255 to 329 ft)	114	329
Sandstone; no sample, no circulation with water or air, probably well-sorted permeable sandstone (water)	3	332

A2-2-32cbc

	Thickness (feet)	Depth (feet)
Alluvium:		
Clay or silt, sandy, tan	4	4
Sand, mostly very fine; clay and silt; dark brown	4	8
Sand and gravel; mostly coarse sand to fine gravel; mostly dark-colored grains	9	17
Sand, very fine to coarse; mostly dark-colored grains	3	20
Sand and gravel; some cobbles or boulders; mostly medium sand to very fine gravel in samples; mostly dark-colored grains; better sorting 26-30 ft	10	30
Wind River Formation:		
Sandstone, very fine grained, silty, dark-olive-green	3	33
Siltstone, light-bluish-gray	3	36

TABLE 5.—*Logs of test holes and test wells*—Continued

A3-1-9cda

	Thickness (feet)	Depth (feet)
Slope wash and alluvium:		
Sand, very fine to coarse, tan	5	5
Gravel, very fine to fine; coarse to very coarse sand; very well sorted; tan	3	8
Wind River Formation:		
Siltstone, green and tan, and very fine grained sandy siltstone	7	15
Sandstone, very fine grained, very silty, tan and light-gray	5	20
Siltstone or shale, olive-brown and green	20	40
Siltstone, very fine grained and fine-grained, sandy; silty sandstone; gray and green	7	47
Siltstone, dark-gray	18	65
Sandstone, fine- to medium-grained; some coarser sand; fair sorting; greenish tan and gray	18	83
Siltstone, very fine grained, sandy, dark-gray	3	86
Sandstone, fine- to coarse-grained, yellow; hard cemented zones interbedded with loose mostly medium- to coarse-grained sandstone	12	98
Siltstone, dark-gray	7	105
Sandstone, very fine grained and fine-grained, dark-gray	5	110
Wind River Formation—Con.		
Sandstone, very fine grained to coarse-grained, gray; layer of dark-gray siltstone at 120 ft (damp 125–130 ft)	20	130
Siltstone, dark-gray	2	132
Sandstone, very fine grained to coarse-grained, silty, dark-gray; some sandy siltstone	13	145
Sandstone, mostly medium-grained to very coarse grained (little water at 150 ft)	9	154
Siltstone, dark-gray	3	157
Sandstone, fine- to coarse-grained, gray; less finer grains 157–160 ft (water)	13	170
Bentonite streak		170
Sandstone, medium-grained to very coarse grained; some very fine grained conglomerate (water)	12	182
Sandstone, very fine grained to coarse-grained; sandy gray siltstone	5	187
Sandstone, medium grained to very coarse grained (water)	19	206
Siltstone, very fine grained, sandy, dark-gray	1	207

A4-1-11bbd

	Thickness (feet)	Depth (feet)
Dune(?) sand or alluvium (not mapped):		
Sand, very fine to coarse, silty; contains a little gravel, poorly sorted; tan	5	5
Wind River Formation:		
Sandstone, very fine grained to coarse-grained, very silty; some sandy siltstone; poorly sorted, greenish-tan	13	18
Sandstone, mostly fine- to coarse-grained; fair sorting; tan	7	25
Wind River Formation—Con.		
Siltstone or shale, greenish-gray	5	30
Siltstone or shale, dark-reddish-brown, green, and dark-gray	10	40
Sandstone, very fine grained to medium-grained, silty, gray (damp)	10	50
Sandstone, very fine grained to fine-grained, well-cemented, light-whitish-gray, very hard	1	51

TABLE 5.—*Logs of test holes and test wells*—Continued

A4-1-11bbd—Continued

	Thickness (feet)	Depth (feet)
Wind River Formation—Con.		
Sandstone, fine-to coarse-grained, gray; thin layer of dark-gray siltstone at about 60 ft; well sorted 65–80 ft (damp, little water at 79 ft)	29	80
Siltstone, gray, hard, and sandy siltstone	10	90
Sandstone; mostly very coarse grained to very fine grained conglomerate; very silty and clayey; fairly tight (little water at 110 ft)	20	110
Wind River Formation—Con.		
Sandstone, very fine grained to medium-grained, very silty; very fine grained sandy siltstone; gray	40	150
Sandstone, very fine grained to medium-grained gray; stringers of very coarse grained sandstone containing fine gravel; streaks of light-gray shale (probably a little water)	25	175
Shale, dark-gray	10	185

A4-1-18dbc

	Thickness (feet)	Depth (feet)
Terrace deposits (not mapped):		
Sand and some gravel, poorly sorted	18	18
Wind River Formation:		
Sandstone, mostly medium- to coarse-grained, rusty-yellow	49	67
Siltstone or shale, olive-green and dark-gray	21	88
Sandstone, very fine grained to medium-grained, very silty, gray	2	90
Siltstone, dark-gray	4	94
Sandstone, very fine grained to medium-grained, silty, gray	16	110
Siltstone, dark-gray	8	118
Sandstone, very fine grained to medium-grained, silty, gray; streak of very hard whitish-gray marlstone(?) at 122 ft; powdery returns	7	125
Bentonite(?) streak, gray		125
Sandstone, fine grained to very coarse grained, fairly well sorted, gray and dark-gray	10	135
Sandstone, medium- to coarse-grained, well-sorted, dark-gray	7	142
Shale, dark-gray	10	152
Siltstone, very fine grained, sandy, gray, hard; streak of silty coarse-grained sandstone at 160 ft	8	160
Wind River Fomation—Con.		
Siltstone, dark-gray, green, and dark-reddish-brown; streak of very hard light-gray marlstone(?) at about 166 ft	13	173
Sandstone, mostly very fine grained to medium-grained, very silty, dark-gray; streaks of dark-gray siltstone; thin bed of hard greenish-gray shale at about 197 ft	27	200
Siltstone, dark-gray	5	205
Sandstone, very fine grained to coarse grained, partly silty, gray and dark-gray; fair sorting 215–225 ft (damp)	20	225
Siltstone, sandy, gray	1	226
Sandstone, mostly coarse grained to very coarse grained, very well sorted, light-gray (water at 230 ft)	4	230
Sandstone, fine- to coarse-grained; fair sorting; light-gray; hard streak at 247 ft (water)	17	247
Sandstone, medium grained to very coarse grained, well-sorted, light-gray (water)	24	271
Shale, dark-gray	1	272

TABLE 5.—*Logs of test holes and test wells*—Continued

A5-3-32bcb

	Thickness (feet)	Depth (feet)
Wind River Formation:		
Siltstone, dark-gray and green; contains some very fine grained sand	25	25
Siltstone, very fine grained, sandy; silty very fine to fine-grained sandstone; gray; streak of very hard white material at 40 ft	35	60
Siltstone or shale, dark-reddish-brown	12	72
Siltstone, and very fine grained silty sandstone, gray	11	83
Siltstone, dark-brown and green	7	90
Sandstone, very fine-grained to fine-grained, silty; sandy siltstone; gray	9	99
Sandstone, fine- to medium-grained, silty; fair shorting; gray	6	105
Siltstone, dark-gray	5	110
Siltstone, dark-brown and green	5	115
Siltstone, very fine grained, sandy, dark-gray and green, hard	15	130
Siltstone or shale, dark-reddish-brown, green, and dark-gray	15	145
Sandstone, very fine grained to medium-grained, silty; poor sorting; gray	5	150
Siltstone, dark-gray and green	10	160
Sandstone, very fine grained to medium-grained, silty, gray; some coarse sand and less silt 180–187 ft	27	187
Siltstone, dark-gray; some gray very fine grained sandy siltstone	13	200
Sandstone, very fine grained to medium-grained, very silty, gray and dark-brown	15	215
Siltstone, dark-gray	5	220
Sandstone, very fine grained and fine-grained, very silty, gray	10	230
Sandstone, very fine grained to coarse-grained, gray	10	240
Wind River Formation—Con.		
Siltstone, very sandy, and silty; very fine grained to fine-grained sandstone; gray	5	245
Siltstone, dark-gray; some very fine grained sandy siltstone	15	260
Sandstone, very fine grained, very silty, gray and light-gray	14	274
Siltstone, reddish-brown	1	275
Siltstone, very fine grained, sandy, gray and dark-gray	15	290
Siltstone, dark-reddish-brown, dark-gray, and green	17	307
Siltstone, very fine grained, sandy, and very silty; very fine grained sandstone; light-gray and gray	8	315
Siltstone or shale, dark-reddish-brown, green, and dark-gray; some very fine grained sandy siltstone	10	325
Siltstone, very fine grained, sandy; silty sandstone; gray	7	332
Siltstone or shale, dark-reddish-brown, green and dark-gray	13	345
Siltstone, sandy, light-gray very hard	3	348
Limestone, very hard (or very fine grained calcareous well-cemented sandstone), mostly gray, some tan; some cherty(?) material of other colors	6	354
Siltstone or shale, dark-reddish-brown, green, and dark-gray	11	365
Siltstone, very fine grained, sandy, gray and light-gray; streak of reddish-brown shale at 368 ft	9	374
Siltstone, dark-gray; some brown	6	380
Siltstone, very fine grained, sandy, light-gray	5	385
Sandstone, very fine grained to fine-grained, silty, light-gray	4	389

TABLE 5.—*Logs of test holes and test wells*—Continued

A5-3-32bcb—Continued

	Thickness (feet)	Depth (feet)
Wind River Formation—Con.		
Siltstone or shale, dark-reddish-brown, green, and dark-gray; some gray very fine grained sandy siltstone below 395 ft	41	430
Siltstone or shale, dark-reddish-brown, green, and dark-gray; thin beds of gray very fine grained sandy siltstone and silty sandstone at about 432, 448, 469, and 482 ft	60	490
Sandstone, very fine grained to medium-grained, slightly silty; fair sorting; light-gray	5	495
Siltstone or shale, dark-reddish-brown, green, and dark-gray; hard streak at 512 ft	20	515
Wind River Formation—Con.		
Sandstone, very fine to fine-grained, silty, light-gray	5	520
Siltstone or shale, dark-reddish-brown; some green	13	533
Sandstone, very fine grained to medium-grained, silty, light-gray, hard	3	536
Siltstone or shale, dark-reddish-brown; some green	9	545
Siltstone, very fine grained, sandy, light-gray, hard	7	552
Siltstone or shale, dark-reddish-brown; some green (dry hole to total depth)	8	560

A5-4-21ccd

	Thickness (feet)	Depth (feet)
Terrace deposits:		
Gravel and sand, angular fragments, silty, poorly sorted	5	5
Wind River Formation:		
Sandstone, very fine grained to fine-grained, silty, fairly well sorted, olive-tan, soft, loosely cemented	22	27
Siltstone, black, rusty-brown, and green	3	30
Siltstone, green, few streaks of green; rusty very fine grained silty sandstone	12	42
Sandstone, very fine grained and fine-grained, rusty, olive-tan	7	49
Marlstone(?), white, very hard	2	51
Siltstone, gray and green; contains very fine sand	6	57
Sandstone, very fine grained to medium-grained, olive-tan	5	62
Siltstone, bluish-gray and green; layers of very fine grained silty sandstone	28	90
Wind River Formation—Con.		
Sandstone, fine- to medium-grained, well-sorted, blue-gray; streak of very hard white material at 94 ft	6	96
Siltstone or shale, dark-gray and dark-reddish-brown	4	100
Siltstone or shale, dark-gray; streaks of light-gray very fine grained to fine-grained silty sandstone at 120, 140, and 150 ft	55	155
Sandstone, very fine grained to medium-grained, silty, gray; coarser and better sorted 160-165 ft	15	170
Siltstone, very fine grained, sandy; some silty sandstone; gray	12	182
Marlstone(?), white, very hard; powdery returns	3	185
Siltstone, dark-gray	38	223
Sandstone, very fine grained to fine-grained, silty, gray	12	235

TABLE 5.—*Logs of test holes and test wells*—Continued

A5-4-21ced

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Wind River Formation—Con.			Wind River Formation—Con.		
Siltstone, dark-gray	10	245	Sandstone, coarse-grained to very coarse grained, very well sorted (water started at 279 ft; specific conductance 3,900 micromhos)	20	295
Sandstone, very fine grained to fine-grained, silty, gray	5	250	Siltstone, very fine grained, sandy, dark-gray	1	296
Siltstone, dark-gray	5	255			
Sandstone, very fine grained to medium-grained, gray	5	260			
Sandstone, medium-grained, very well sorted, gray; hard streak at 266 ft (damp)	15	275			

A5-5-33aba

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Terrace deposits:			Wind River Formation—Con.		
Gravel, sand, and clay, poorly sorted; gravel is angular and largely of sedimentary rocks	7	7	Siltstone, dark-gray and green, partly sandy	17	112
Wind River Formation:			Siltstone, sandy, and very fine to fine-grained silty sandstone; gray	8	120
Siltstone, very fine grained, sandy; silty very fine to medium-grained sandstone; green	28	35	Sandstone, very fine grained to medium-grained; fair sorting; dark-gray (dry)	10	130
Siltstone, green and olive	15	50	Siltstone, dark-gray, streak of very fine to fine-grained silty sandstone at 150 ft	30	160
Sandstone, very fine grained, light-gray and green; hard cemented streaks	5	55	Sandstone, very fine to fine-grained; siltstone; dark-gray; streaks of hard white material	7	167
Sandstone, fine to coarse-grained, very well sorted, light-gray and green (damp)	12	67	Siltstone, dark-gray	4	171
Siltstone or shale, dark-gray	8	75	Marlstone(?), white, very hard	2	173
Sandstone, very fine grained, silty, dark-gray; dark-gray and green sandy siltstone	5	80	Sandstone, fine to medium-grained, well-sorted, gray (water at 182 ft)	13	186
Siltstone or shale, dark-gray and green	10	90	Shale, dark-gray, oil stain	1	187
Sandstone, very fine grained to medium-grained, silty, gray	5	95	Sandstone, very fine grained, silty, gray	1	188
			Shale, very dark gray	2	190

TABLE 5.—*Logs of test holes and test wells*—Continued

B4-1-4cbb

	Thickness (feet)	Depth (feet)
Wind River Formation:		
Siltstone, partly sandy, and silty very fine grained to medium-grained sandstone; olive and gray	80	80
Sandstone, very fine grained to medium-grained, silty, gray	15	95
Sandstone, very fine grained to coarse-grained, silty, gray	20	115
Sandstone, very fine to very coarse, gray; contains some very fine gravel	5	120
Wind River Formation—Con.		
Sandstone, fine- to coarse-grained, silty, gray; streaks of olive-gray siltstone	15	135
Siltstone, olive-gray	5	140
Sandstone, medium-grained to very coarse grained, gray	15	155
Sandstone, very coarse grained, and very fine grained conglomerate; very well sorted (water, specific conductance 1,350 micromhos)	10	165
Siltstone or shale, reddish-brown	1	166

B4-2-6add

	Thickness (feet)	Depth (feet)
Wind River Formation:		
Siltstone, sandy, and very fine grained silty sandstone; light-gray	13	13
Sandstone, fine- to coarse-grained; fair sorting; tan and light-gray; mostly firmly cemented	37	50
Sandstone, very fine grained to fine-grained, silty, tan, loosely cemented	10	60
Sandstone, medium- to coarse-grained, well-sorted, tan, loosely cemented	7	67
Marlstone(?), very light gray, very hard	2	69
Sandstone, coarse-grained and very coarse grained; very fine grained conglomerate	6	75
Sandstone, medium- to coarse-grained, cemented, very hard	2	77
Conglomerate, mostly very fine to fine gravel	9	86
Siltstone, green and tan	4	90
Marlstone(?), light-gray, very hard	1	91
Conglomerate, mostly very fine to fine gravel, light-gray and tan	17	108
Wind River Formation—Con.		
Sandstone, fine- to coarse-grained; fair sorting; gray; some very coarse sand 115-120 ft	12	120
Siltstone, sandy, dark-gray	5	125
Conglomerate, very fine grained, and very coarse sand, very well sorted, gray (still dry)	6	131
Sandstone, mostly coarse-grained to very coarse grained, well-sorted, gray (wet at 136 ft)	5	136
Siltstone, sandy, gray	3	139
Sandstone, mostly medium- to coarse-grained; fair sorting; gray (dry)	16	155
Sandstone, mostly very fine grained to medium-grained, well-sorted, gray	10	165
Siltstone, gray, partly sandy, very fine grained	55	220
Sandstone, very fine grained to medium-grained, silty, light-gray	13	233
Siltstone, reddish-brown	24	257
Sandstone, very fine grained to fine-grained, silty, light-gray	18	275
Siltstone, red and green, and some very fine grained silty sandstone	26	301

TABLE 5.—*Logs of test holes and test wells*—Continued

B4–2–33daa

	Thickness (feet)	Depth (feet)
Slope wash and alluvium:		
Sand, very fine and fine, silty, brown	4	4
Wind River Formation:		
Siltstone, sandy, brown	7	11
Sandstone, very fine grained to medium-grained, tan, loosely cemented	4	15
Sandstone, very fine grained to fine-grained, silty, green, and reddish-brown; green siltstone	5	20
Siltstone, reddish-brown	5	25
Siltstone, reddish-brown and greenish-gray	5	30
Siltstone, and very fine grained to medium-grained silty sandstone; green	12	42
Sandstone, very fine grained to medium-grained, well-sorted, olive, clean (damp)	13	55
Sandstone, medium- to coarse-grained, well-sorted, olive, clean (water at about 60 ft)	7	62
Sandstone, very fine grained to coarse-grained, silty, green	6	68
Siltstone, very fine grained, sandy, greenish-gray	16	84
Sandstone, very fine grained to fine-grained, well-sorted, gray (water)	24	108
Siltstone, sandy, gray and green	9	117
Sandstone, fine- to medium-grained, well-sorted, gray, loosely cemented (water)	5	122
Siltstone, greenish-gray	2	124
Sandstone, as above	1	125
Siltstone, gray and greenish-gray, partly sandy	6	131

B4–4–2cda

[Log of test hole 50 ft west of well]

	Thickness (feet)	Depth (feet)
Alluvium:		
Clay and silt, dark-brown and tan	6	6
Sand and gravel; some cobbles	20	26
Sand, gravel, and cobbles; some boulders	10	36
Sand and gravel	4	40
Clay	1	41
Gravel	3	44
Wind River Formation:		
Siltstone, gray	2	46
Sandstone	1	47

B4–4–22aba

	Thickness (feet)	Depth (feet)
Terrace deposits:		
Soil, dark-brown, sandy, gravelly	1	1
Sand and silt, clayey, gravelly, tan	7	8
Sand, gravel, and cobbles	12	20
Sand and gravel	7	27
Sand, gravel, and cobbles; some boulders	8	35
Wind River Formation:		
Siltstone or shale, reddish-brown	2	37

TABLE 5.—*Logs of test holes and test wells*—Continued

B4-4-26abb

	Thickness (feet)	Depth (feet)
Terrace deposits:		
Cobbles, gravel, and sand, clayey, soily, brown	1	1
Cobbles, gravel, and sand; poorly cemented with white calcareous cement	5	6
Cobbles, gravel, and coarse sand, angular; boulder at 8 ft	3	9
Sand and fine gravel; some coarser rock	3	12
Sand, clay, and fine gravel; some coarser rock; rusty-yellow water	4	16
Terrace deposits—Con.		
Sand and fine gravel; some coarser gravel	10	26
Sand, very fine to coarse; streaks of brown clay	5	31
Sand and fine gravel; streaks of brown clay and coarser gravel	7	38
Wind River Formation:		
Siltstone, and very fine grained sandstone; blue gray; poor samples	6	44
Siltstone(?), red; water color changed to reddish-orange; no samples	2	46

B5-3-32dda

	Thickness (feet)	Depth (feet)
Slope wash and alluvium:		
Gravel veneer on surface		
Silt, sandy, clayey, brown	7	7
Wind River Formation:		
Siltstone, greenish-gray	8	15
Siltstone, reddish-brown and greenish-gray	20	35
Siltstone, very fine grained, sandy, greenish-gray and brownish-gray (wet at 35 ft)	5	40
Sandstone, very fine grained, silty, greenish-gray (little water)	5	45
Sandstone, mostly very fine grained to fine-		
Wind River Formation—Con.		
grained, silty; siltstone; greenish-gray and reddish-brown (water)	15	60
Siltstone, greenish-gray and light-purple	5	65
Sandstone and siltstone, gray and light-purple (water from 70–75 ft)	10	75
Sandstone, fine- to medium-grained, well-sorted, balck and white grains, clean (water)	14	89
Siltstone, gray	2	91

B5-4-10abc

	Thickness (feet)	Depth (feet)
Alluvium:		
Sand, clayey, poorly sorted, brown	4	4
Wind River Formation:		
Siltstone, dark-greenish-gray, light-gray, and very light maroon	11	15
Siltstone, and some very fine grained silty sandstone; greenish-gray	10	25
Sandstone, mostly very fine grained to medium-grained, greenish-gray	9	34
Wind River Formation—Con.		
Siltstone, red; some green; some greenish-gray very fine grained silty sandstone 45–50 ft	16	50
Siltstone, red	15	65
Siltstone, greenish-gray and dark-gray; some very fine grained silty sandstone	15	80
Sandstone, very fine grained to medium-grained, greenish-gray; very hard material at 92 ft (water at 83 ft)	12	92

TABLE 5.—*Logs of test holes and test wells*—Continued

B5-4-17bdd

	Thickness (feet)	Depth (feet)
Wind River Formation:		
Sandstone, very fine grained to medium-grained, very silty, light-gray; layer of reddish-brown sandy siltstone at 10 ft	12	12
Conglomerate, very fine grained; contains coarse to very coarse sand	6	18
Siltstone, red, dark-gray, and brown	8	26
Sandstone, silty, light-red	4	30
Conglomerate, very fine grained; contains sand	3	33
Siltstone, reddish-brown and gray, partly sandy	23	56
Conglomerate, very fine grained; contains sand	1	57
Siltstone, gray and brown, partly sandy	11	68
Marlstone(?), light-gray, calcareous, very hard	4	72
Siltstone, dark-reddish-brown	28	100
Siltstone, dark-gray	10	110
Sandstone, very fine to very coarse grained, silty	5	115
Siltstone, sandy, light-gray	5	120
Sandstone, very fine grained, very silty, light-brown	5	125
Siltstone, dark-reddish-brown	10	135
Sandstone, mostly very fine to medium-grained, silty	10	145
Sandstone, coarse-grained to very coarse grained, well-sorted, loosely cemented (wet at 150 ft)	5	150
Wind River Formation—Con.		
Siltstone, sandy, light-gray; poor samples	10	160
Marlstone(?), light-gray, very hard; poor samples	2	162
Siltstone, and silty sandstone(?), red; hard drilling 170–180, 185–195, 210–217; poor samples (possibly a little water 185–210 ft)	65	227
[Began drilling with water instead of air]		
Siltstone or shale, red and green	13	240
Siltstone, red, green, and purple	12	252
Sandstone, fine- to coarse-grained in white clay matrix	5	257
Siltstone, red, green, and purple; white clayey sandstone (as above)	5	262
Marlstone(?), light-gray, very hard	1	263
Siltstone, red and green; some returns of soft light-gray sandy clay	4	267
Siltstone, red and green, sandy, soft	20	287
Siltstone, sandy, and very fine to coarse-grained silty sandstone; green, gray, and white	10	297
Siltstone, sandy, red, and green	10	307
Sandstone, silty, green and white, partly clayey; red siltstone; streaks of very hard material 312–317 ft	10	317

B6-3-33ccd

	Thickness (feet)	Depth (feet)
Wind River Formation:		
Siltstone, dark-reddish-brown and grayish green	7	7
Sandstone, very fine grained to coarse-grained, very silty, very poorly sorted, reddish-brown	3	10
Wind River Formation—Con.		
Siltstone, dark-reddish-brown and brick-red, partly sandy	15	25
Siltstone, light-gray, greenish-gray; some brown	15	40

TABLE 5.—*Logs of test holes and test wells*—Continued

	Thickness (feet)	Depth (feet)
B6-3-33ccd—Continued		
Wind River Formation—Con.		
Siltstone, reddish-brown, dark-gray and green, partly hard	21	61
Sandstone, very fine grained to coarse-grained, very silty, poorly sorted; some sandy siltstone; green and gray (little water)	4	65
Sandstone, coarse grained to very coarse grained, well-sorted (little water)	6	71
Sandstone, very fine grained to coarse-grained, silty, very poorly sorted	19	90
Sandstone, fine to coarse, gray (water)	5	95
Siltstone, reddish-brown and green	1	96
B6-4-36cdb		
Aycross and Wind River Formations:		
Sandstone, fine- to coarse-grained, green and greenish-tan; hard cemented layers and streaks of very fine grained and fine-grained conglomerate	35	35
Sandstone, fine- to coarse-grained, blue-gray and olive-brown; streak of green siltstone at about 40 ft	25	60
Siltstone, very fine grained, sandy, dark-green and dark greenish-gray, very hard	5	65
Sandstone, medium- to coarse-grained; fair sorting (damp)	10	75
Siltstone, dark-gray and greenish-gray	32	107
Sandstone, very fine grained to fine-grained, silty, gray	8	115
Siltstone, gray	4	119
Aycross and Wind River Formation:—Con.		
Sandstone, fine- to coarse-grained, very light gray	21	140
Sandstone, coarse-grained to very coarse grained, very light gray	5	145
Sandstone, very fine grained to medium-grained, very light gray and brown	10	155
Siltstone, dark-reddish-brown	5	160
Sandstone, mostly very fine grained to medium-grained, gray	12	172
Siltstone, dark-reddish-brown, and some brown sandstone	3	175
Sandstone, very fine grained to medium-grained, gray (trace of water 195–200 ft)	25	200
Sandstone, fine- to coarse-grained, gray (damp)	10	210
Siltstone(?); no samples	2	212
C1-1-4dac		
Alluvium:		
Soil, sand, gravel, and cobbles	1	1
Cobbles, gravel, and sand; contains some tan and light-brown clay	7	8
Alluvium—Continued		
Cobbles, gravel, sand, and some boulders; contains streaks of light-brown clay	30	38
Cody Shale:		
Shale, dark-gray; oil odor	8	46

TABLE 5.—*Logs of test holes and test wells*—Continued

D1-1-14aaa

	Thickness (feet)	Depth (feet)
Slope wash and alluvium:		
Silt, slightly sandy, brown	7	7
Gravel and coarse sand	3	10
Gravel, fine to medium, clean	4	14
Slope wash and alluvium—Con.		
Gravel, fine to medium, and coarse sand	3	17
Cody Shale:		
Shale, dark-gray	9	26

D1-1-16ddd

	Thickness (feet)	Depth (feet)
Slope wash and alluvium:		
Silt, sandy, tan	3	3
Silt, heavy, tan	12	15
Gravel, fine to medium, and coarse sand	7	22
Slope wash and alluvium—Con.		
Gravel, fine to coarse	9	31
Sand, fine to coarse	7	38
Frontier(?) Formation:		
Shale, dark-gray	3	41

D1-1-21dda

	Thickness (feet)	Depth (feet)
Slope wash and alluvium:		
Clay and sand, brown	5	5
Clay and sand, mostly very fine to fine, tan	16	21
Sand and gravel; mostly very coarse sand to fine gravel; layers of clay; not loose, may be lightly cemented or bound with clay	5	26
Slope wash and alluvium—Con.		
Sand and gravel; mostly coarse sand to medium gravel; some clay; layer of sand and of gravel	26	52
Wind River Formation:		
Sandstone; no sample	3	55
Siltstone, sandy, light-gray	1	56

D1-1-22bcb

	Thickness (feet)	Depth (feet)
Slope wash and alluvium:		
Clay, silty, yellow-green to tan; soil at top	8	8
Gravel, sand, and clay	7	15
Gravel and sand	14	29
Clay, sandy, brown	3	32
Cody Shale:		
Clay(?) and shale, dark-gray (clay zone may be present above Cody Shale)	15	47
Shale, dark-gray	4	51

D1-1-23ada

	Thickness (feet)	Depth (feet)
Slope wash and alluvium:		
Clay and sand; some very coarse sand; tan	5	5
Clay, sandy; mostly very fine sand; brown to tan	11	16
Sand and clay; very fine to coarse sand	10	26
Sand, clayey; mostly coarse sand	7	33
Slope wash and alluvium—Con.		
Gravel and sand; mostly coarse sand to fine gravel	3	36
Clay, sandy, tan	4	40
Cody shale:		
Shale	1	41

TABLE 5.—*Logs of test holes and test wells*—Continued

D1-3-7dcd

	Thickness (feet)	Depth (feet)
Terrace deposits:		
Soil, brown	1	1
Sand, some gravel, silty, tan	13	14
Wind River Formation:		
Siltstone, very fine grained, sandy, green	16	30
Sandstone, very fine grained to medium grained; fair sorting; tan	2	32
Siltstone, green	9	41
Sandstone, medium- to coarse-grained, well-sorted, tan	20	61
Bentonite(?) or blue-gray clay streak		61
Siltstone, gray, and very fine grained silty sandstone	19	80
Sandstone, very fine grained, silty, light-gray	3	83
Wind River Formation—Con.		
Sandstone, fine-grained, well-sorted, yellowish-green and gray (damp)	6	89
Sandstone, coarse-grained, very well sorted (water at 94 ft)	10	99
Siltstone and very fine grained silty sandstone	5	104
Sandstone, medium-grained to very coarse grained; some fine gravel (water)	17	121
Siltstone and very fine grained silty sandstone, dark-gray	3	124
Sandstone, very coarse, and very fine grained conglomerate (water)	4	128
Siltstone, and very fine grained silty sandstone; yellow and yellowish-green	2	130

D1-3-29ccc

	Thickness (feet)	Depth (feet)
Slope wash and alluvium (not mapped):		
Silt, sandy, reddish-brown	4	4
Wind River Formation:		
Siltstone, red	4	8
Sandstone, very fine to very coarse grained, silty, white to tan, loosely cemented	9	17
Siltstone, very fine grained sandy, purple and dark-gray	3	20
Siltstone, very fine grained sandy, tan and dark-gray	5	25
Sandstone, very fine grained to coarse-grained, silty; siltstone; tan, gray, and brown	10	35
Siltstone, gray, purple, and red	5	40
Sandstone, fine-grained to very coarse grained; some very fine gravel; fair sorting; tan; loosely cemented; clean	7	47
Siltstone, very fine grained, sandy, rusty and greenish-gray	6	53
Wind River Formation—Con.		
Sandstone, medium-grained to very fine grained conglomerate; tan, clean, loosely cemented	12	65
Sandstone, fine-grained to very fine grained conglomerate; tan, loosely cemented	16	81
Siltstone, sandy, and very fine-grained to medium-grained silty sandstone; greenish-gray	4	85
Sandstone, very fine grained to coarse-grained, silty, poorly sorted, greenish-gray	4	89
Siltstone, very fine grained, sandy, brown and dark brownish-gray	18	10'
Sandstone, medium-grained to very coarse grained; some very fine gravel; well-sorted; bluish-gray; loosely cemented	20	127
Siltstone, dark-gray	8	135

TABLE 5.—*Logs of test holes and test wells*—Continued

D1-3-29ccc—Continued

	Thickness (feet)	Depth (feet)
Wind River Formation—Con.		
Sandstone, fine- to coarse-grained; fair sorting; bluish-gray	8	143
Sandstone, medium-grained to very fine grained conglomerate; well-sorted; greenish-gray to 195 ft; tan below; poor returns below 150 ft; some thin siltstone layers (damp at 150 ft, no water noted above 150 ft; water at 165 ft; specific conductance 2,000 micromhos)	60	203
Siltstone, very fine grained, sandy, greenish-gray	7	210

D1-4-2bca

	Thickness (feet)	Depth (feet)
Alluvium:		
Sand, fine, silty	4	4
Sand, fine to medium	5	9
Gravel, fine to coarse	5	14
Wind River Formation:		
Siltstone, gray	2	16

D1-4-11bba

	Thickness (feet)	Depth (feet)
Alluvium:		
Soil and silt, sandy, brown	6	6
Gravel and sand; mostly coarse sand to medium gravel	7	13
Wind River Formation:		
Sandstone, very fine grained to medium-grained, tan	2	15
Siltstone, sandy, light-bluish-gray	1	16

D1-4-11cac

	Thickness (feet)	Depth (feet)
Slope wash (not mapped):		
Silt, sandy	2	2
Wind River Formation:		
Siltstone, gray	6	8
Siltstone, sandy, gray and brown	3	11
Siltstone, gray	10	21
Sandstone, fine-grained, silty	5	26
Siltstone, gray	18	44
Siltstone, sandy, gray	7	51
Siltstone, gray, hard	22	73
Siltstone, sandy, gray	2	75
Sandstone, fine- to medium-grained (water)	8	83

TABLE 5.—*Logs of test holes and test wells*—Continued

D1-4-33daa

	Thickness (feet)	Depth (feet)
Slope wash and alluvium:		
Clay and soil	2	2
Sand, mostly medium to very coarse, clayey; fair sorting; tan (water)	10	12
Sand, as above except more clay and grayer color (less water)	10	22
Slope wash and alluvium—Con.		
Sand, as above except less clay and generally coarser (water)	3	25
Wind River Formation:		
Siltstone, sandy, gray	2	27

TABLE 5.—*Logs of test holes and test wells*—Continued

D1-5-11bdd

	Thickness (feet)	Depth (feet)
Slope wash and alluvium:		
Sand, very fine to medium, tan; dune sand	12	12
Sand and silt, tan	3	15
Sand, fine to very coarse; some fine gravel; poorly sorted; some coarser gravel 22–27 ft (water at 25 ft)	12	27
Slope wash and alluvium—Con.		
Sand, very coarse, fairly well sorted (water)	9	36
Sand, mostly very coarse; some very fine gravel; very well sorted; tan (water)	7	43
Wind River Formation:		
Siltstone, bluish-gray	20	63

TABLE 6.—*Chemical analyses of ground-water*

[Analytical results in parts per million, except as indicated.

Location	Depth of well (feet)	Production interval (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)
Madison Limestone and Bighorn Dolomite												
B2-1-18ccc----	4,222	------	12-13-62	------	-------	-----	178	34	46	-------	293	-----
Tensleep Sandstone												
C1-1-2aad [1]---	Spring	-------	5-18-45	116	------	-----	162	41	49	-------	290	0
2aad [1]---	Spring	-------	8-18-53	103	34	----	-------	------	49	-------	280	0
Permian rocks and (or) Dinwoody Formation												
B5-6-14dad---	980	At 980	9-30-64	51	9.4	[2] 0.29	409	68	557	18	734	0
35ada---	200	75-200	10- 1-65	48	14	.44	447	171	469	7.6	367	0
Jurassic, Jurassic(?), and Triassic(?) rocks												
B3-1-5ba-----	5,306	-------	10-31-55	------	0.23	------	4,380	93	4,320		379	0
Frontier Formation												
A1-1-33bbb [3] -	712	543-620(?)	10-30-57	------	-------	------	0.4	0.3	772	3.5	951	117
A8-4-7 cab [1]---	440	-------	7-22-46	------	-------	0.20	10	8.1	1,510		516	33
B4-4-14ccb----	400	329-359	11- 4-65	------	7.4	.21	33	11	680	2.4	166	0
C1-1-8ccb ----	548	497-543(?)	5-19-45	------	-------	------	1.0	1.3	435	-------	430	70
D2-1-7daa [3]---	350	-------	5-10-63	------	-------	------	-------	------	680	-------	-----	------
Cody Shale												
A1-1-36cb [1,3] --	>300	-------	5-18-45	------	-------	------	15	12	598		390	23
B4-1-31dab [1]--	384	-------	11-14-51	------	7.4	0.06	71	4.1	716		138	0
Fort Union Formation												
D1-2-9bbb1 --	430	365-412	11- 6-64	------	6.9	0.60	8.3	1.8	387	3.1	561	16
10dcc [3]--	473	412-418	11-19-66	------	------	------	6	3	400	3	522	33

See footnotes at end of table.

samples, Wind River Indian Reservation, Wyo.

Analyses by U.S. Geological Survey, except as indicated]

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	Sodium-adsorption-ratio (SAR)	Specific conductance (micromhos at 25° C)	pH	Remarks
Madison Limestone and Bighorn Dolomite—Continued												
360	50	----	----	----	930	----	----	----	0.7	----	7.4	
Tensleep Sandstone—Continued												
362	41	2.6	0.1	----	----	801	573	336	0.9	1,180	----	
358	43	----	----	----	----	----	556	326	.9	1,170	7.3	
Permian rocks and (or) Dinwoody Formation—Continued												
1,560	219	2.1	0.0	0.48	3,240	3,210	1,300	698	6.7	3,920	----	
2,320	76	1.1	.1	.06	4,030	3,690	1,820	1,520	4.8	4,230	8.2	Mn 0.59 ppm.
Jurassic, Jurassic(?), and Triassic(?) rocks—Continued												
11,100	6,260	1.0	0.3	----	27,200	26,300	11,300	11,000	----	31,700	7.2	
Frontier Formation—Continued												
500	57	----	----	3.8	1,800	----	----	----	----	2,530	9.1	
2,700	52	2.8	10	----	4,600	----	58	0	----	5,660	8.4	
1,230	116	1.6	1.0	2.0	2,220	2,170	126	0	6	3,170	7.9	
430	20	3.8	.0	----	----	1,170	8	0	----	1,800	----	
----	----	.95	----	----	2,350	----	25	----	----	----	8.6	
Cody Shale—Continued												
730	182	1.2	4.3	----	----	1,750	87	0	36	2,660	----	
1,520	37	1.2	1.0	0.21	2,450	2,430	194	81	16	3,380	7.5	
Fort Union Formation—Continued												
1.5	291	2.6	0.0	0.18	1,010	995	28	0	32	1,760	8.4	Mn 0.09 ppm.
1	270	1.8	0	.10	992	----	30	----	30	1,720	8.6	

TABLE 6.—*Chemical analyses of ground-water samples,*

Location	Depth of well (feet)	Production interval (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)
Wind River Formation												
A1-1-3bbb	579	559(?)-579	8-31-66	53	1.8	------	16	9.7	96	2.5	204	0
A1-3-16cca	103	-------	10-19-48	50	15	0.02	81	8.2	171	4.0	157	0
17add	285	246-280	11- 8-65	------	11	.36	4.2	.4	148	.4	52	2
A1-4-3ddd	124	-------	10-20-48	52	26	3.0	64	15	98	.8	388	0
12ccc	64	-------	10-21-48	51	19	.32	42	14	21	.8	145	3.9
24caa	70	-------	10-21-48	50	12	1.4	5.0	2.2	226	.8	85	4.9
27cda [4]	645	255-645	10-21-60	57	13	.13	1.6	1.0	126	1.6	184	10
27ddd [4]	600	353-600	10-22-48	55	13	[2] .03	6.5	.3	142	.4	191	7
27ddd [4]	600	353-600	9-23-54	54	11	[2] .00	1.5	.1	142	1.7	185	12
27ddd [4]	600	353-600	12- 3-65	------	12	[2] .00	.8	.2	136	.9	204	0
A1-4-32bda	367	-------	10-15-48	50	9.5	2.4	8.5	.2	155	2.8	131	1
34add [4]	609	345-609	10-27-51	56	11	.01	2.9	.1	160	.5	192	9
34add [4]	609	345-609	12- 2-65	50	7.5	.00	1.2	1.7	165	1.4	187	10
34bac [4]	535	440-535	12- 2-65	50	8.3	.00	.8	.1	132	.9	165	21
34bbd [4]	660	460-660	10-26-51	------	12	.06	23	1.1	125	.7	191	8
A2-1-24ccd	180	-------	9-15-65	55	26	.13	94	14	15	3.1	334	0
A2-2-4dcd	40	-------	9-17-49	49	10	2.0	370	70	403	6.4	236	0
15dca [1]	22	-------	10-18-48	50	14	.08	37	5.9	167	18	386	0
17aaa	500	486-500	10-18-48	50	25	2.8	34	1.5	148	1.2	186	0
18ada1	485	-------	11- 1-60	------	20	.00	59	7.8	72	2.0	190	0
A2-3-10bcc	85	60-65	10-19-48	49	11	.16	23	3.4	250	3.6	152	0
19dda	228	202-228	9-17-49	50	10	2.0	14	.6	235	4.0	35	0
26dca	80	35-55	9-17-49	49	10	2.4	62	.5	579	4.8	28	0
A2-4-2cbc	50	-------	10-20-48	50	16	1.1	13	1.7	343	2.4	561	0
10dcc	350	330-350	9-17-49	52	10	.54	16	.4	260	4.8	34	0
17ada	40	-------	10-20-48	49	12	.26	12	1.3	350	21	625	14
A2-5-2aba	306	275-300	10-20-48	50	16	.16	14	1.5	261	.8	34	0
30cdd	177	165-167	10-21-48	52	10	1.9	10	.1	248	.4	163	0
7cda	128	108-125	9-17-49	52	8.8	.96	8.0	10	235	4.8	138	0
A2-6-19dab	360	300-353	10-20-48	55	13	2.0	26	4.6	284	.8	126	6
A3-1-9cda	207	150-206	11- 1-66	------	18	------	201	20	759	2.8	445	0
21add	226	183-225	10-14-48	52	13	.60	46	2.0	458	4.4	85	0
21bab	40	-------	9-17-49	51	14	1.1	81	24	86	3.2	284	0
21ddd	75	-------	10-14-48	50	28	4.0	282	73	414	2.4	414	0
25bcd	223	66(?)	9-17-49	49	14	8.0	230	59	966	6.4	512	0
36ada	77	-------	10-14-48	50	13	2.2	450	167	748	5.6	342	0
A3-2-5bcb	100	70-100	8-14-50	58	10	------	33	.5	459	1.3	78	0
6acc	41	-------	6-18-51	50	-------	------	-------	------	253	2.6	134	0
6acc	41	-------	6-19-51	49	-------	------	-------	------	362	3.7	164	0
7cca	398	300-398	10-29-60	------	16	.30	8.0	0	210	.4	88	2
10acc	482	466-482	10-18-48	50	14	1.6	6.0	.6	174	5.2	44	0
26adc	321	296-321	10-18-48	53	13	2.0	46	.1	445	7.6	22	0

See footnotes at end of table.

Wind River Indian Reservation, Wyo.—Continued

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	Sodium-adsorption-ratio (SAR)	Specific conductance (micromhos at 25° C)	pH	Remarks
Wind River Formation—Continued												
103	20	0.6	0.2	0.19	358	350	100	0	4.7	610	8.0	
426	17	.3	1.2	.12	830	802	236	107	4.8	1,200	7.5	
251	15	2.4	0	.33	474	461	12	0	19	743	8.4	Mn 0.08 ppm.
84	7.0	.6	19	.20	500	508	221	0	2.6	784	7.9	
68	20	.4	.5	.30	247	249	162	37	.7	385	8.3	
368	39	2.0	.4	.38	698	703	22	0	21	1,090	8.3	
107	9.0	.6	.6	------	335	360	8	0	19	574	8.5	PO_4 0.04 ppm, Li 0.04 ppm.
125	9.9	.4	.8	.22	394	401	17	0	15	664	8.6	
117	9.0	.4	.0	------	378	386	4	0	31	613	8.9	
122	11	.6	.0	.10	400	384	3	0	34	627	8.2	
220	16	3.6	.2	.34	510	482	22	0	12	768	8.2	
161	13	.4	.6	.16	472	453	7	0	25	725	8.7	Pumped 22 hr 10 min.
174	11	.8	.0	.13	486	465	10	0	22	769	8.5	
99	8.9	.7	.0	.07	354	353	2	0	41	470	8.7	
96	10	.6	.5	.24	355	351	10	0	6.9	562	8.6	Pumped 32 hr 2 min.
47	3.0	.4	1.7	.05	373	368	293	19	.4	586	8.0	Mn 0.06 ppm.
1,780	20	.2	17	.30	2,930	2,790	1,210	1,020	2.6	3,140	7.3	
140	23	1.0	.6	.08	618	600	116	0	6.7	916	7.9	
232	6.5	.5	.0	.12	548	542	91	0	6.7	825	7.7	
170	4.0	.8	.7	------	448	429	179	24	2.3	658	8.0	Al 0.2 ppm.
448	7.6	1.4	.0	.25	864	824	72	0	13	1,240	7.4	
456	41	1.2	.6	.48	800	782	38	9	17	1,130	7.3	
1,250	82	1.2	41	.52	2,050	2,050	157	134	20	2,770	6.9	
3.2	258	2.8	.4	.66	933	926	40	0	24	1,610	7.9	
456	92	1.2	.3	.46	878	858	42	14	15	1,280	6.8	
224	20	1.0	4.4	.24	984	972	36	0	25	1,470	8.3	
444	97	2.8	.2	.43	872	854	41	13	18	1,360	7.7	
376	28	1.2	.8	.40	734	756	25	0	------	1,210	8.0	
400	18	.8	.3	.24	752	754	61	0	13	1,090	7.2	
440	94	1.6	1.4	.22	953	934	84	0	13	1,480	8.2	
1,770	67	.4	.1	.16	2,980	3,060	582	217	12	3,800	7.9	
1,000	12	.7	.3	.08	1,590	1,580	123	53	18	2,060	7.5	
196	21	1.2	34	.28	606	601	301	68	2.6	867	7.8	
1,380	46	1.4	9.8	.22	2,570	2,440	1,000	661	18	3,030	7.2	
2,120	163	2.4	92	.33	4,090	3,910	817	397	15	4,840	7.8	
2,760	158	.7	.3	.18	4,700	4,470	1,810	1,530	7.6	4,790	7.7	
990	8.5	.8	.8	.10	1,550	1,540	85	21	22	2,180	7.5	
400	290	------	------	.12	1,220	------	391	281	------	1,830	7.8	Pumped 36 min.
945	330	------	------	.30	2,150	------	808	674	------	2,810	7.7	Pumped 23 hr 50 min.
345	21	2.0	0	------	608	647	20	0	20	974	8.5	
320	26	1.4	.4	.10	612	570	18	0	18	913	7.5	
988	18	.7	.2	.22	1,560	1,530	116	98	18	2,160	7.1	

TABLE 6.—*Chemical analyses of ground-water samples,*

Location	Depth of well (feet)	Production interval (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)
Wind River Formation—Continued												
A3-2-27baa	57	-------	12- 5-50	49	12	0.08	488	167	282	5.3	256	0
30ddb	582	215-230	10-18-48	52	15	.03	70	2.6	579	7.2	119	0
A3-3-6ccc	270	240-270	10-26-51	52	21	------	.9	.1	97	.2	74	33
16cbc	360	340-360	10-18-48	50	17	.60	12	.1	217	1.2	34	0
24ccc	50	37-50	10-20-48	48	16	2.1	460	179	714	10	175	0
26aba	244	228-244	10-19-48	49	11	.28	27	.1	332	4.0	23	0
A3-4-29cdd	76	-------	9-17-49	49	9.2	3.0	74	7.9	473	4.8	416	0
A3-5-33dcc	35	-------	10-16-48	47	19	.06	206	41	735	3.2	330	0
A3-6-15bcb	495	451-495	10-27-60	------	10	.08	4.8	1.0	179	.6	168	2
A4-1-11bbd	185	110-175	11- 2-66	------	6.9	------	149	15	1,500	6.3	212	0
18dbc	272	230-271	11- 2-66	------	11	------	36	2.9	582	.2	131	0
A4-2-29dba	266	248-258	8-14-50	50	12	------	31	.1	548	1.8	64	0
A4-3-13dcb	465	425-436	10-26-51	51	10	.25	5.5	.1	256	.6	32	16
34ada	305	278-302	10-26-51	50	12	------	7.5	.1	264	.2	43	0
36dbb	120	-------	10-29-60	------	28	.13	320	224	520	8.2	254	0
A4-4-20dad	234	170-210	10-26-51	52	8.0	1.6	31	.9	556	.9	34	0
23dbd1	621	411-590	6-26-51	53	6.8	.08	14	.7	380	.6	78	0
28cdc	>87	-------	10-19-48	48	13	.30	186	69	354	6.0	285	0
A5-4-21ccd	296	279-295	10-26-66	------	5.7	------	34	8.0	819	3.0	72	0
A5-5-33aba	190	182-188	10-26-66	------	4.9	------	52	7.9	1,070	3.0	76	0
B3-1-24cda [1]	40	-------	9-17-49	------	32	.01	70	29	124	3.2	405	15
B3-3-4aba	55	30-55	11- 4-65	------	23	.05	39	17	66	.8	190	0
B4-1-4cbb	166	155-165	10-31-66	------	5.4	------	9.6	1.9	261	1.0	140	2
25daa	487	-------	12-19-66	------	1.8	------	32	3.2	342	1.8	50	4
B6-3-33ccd	96	90-95	10-31-66	------	6.2	------	11	.1	294	.4	90	0
D1-3-2aba [3]	60	-------	11- 4-64	------	-------	------	27	5	80	1	211	0
7dcd	130	94-128	11- 3-66	------	12	------	102	15	56	2.0	180	0
10cca [3]	390	244-253	10-29-64	------	-------	------	1	2	175	1	211	21
10cca [3]	390	375-390	10-27-64	------	-------	------	3	3	155	0	153	24
13aab [3]	300	-------	11-12-64	------	-------	------	28	4	190	1	211	6
13dad [3]	80	55-65	11-19-64	------	-------	------	148	16	310	3	241	0
14bbd [3]	108	91-108	11-19-64	------	-------	------	163	5	580	1	85	0
D1-3-17bcb	150	95-140	11- 3-65	------	17	.17	59	12	73	2.1	162	0
23adc [3]	60	-------	11-19-64	------	-------	------	146	39	130	1	226	0
23cba	550	-------	5-18-45	------	-------	------	1.5	2.2	150		166	12
24cbd [3]	235	220-230	11-19-64	------	-------	------	5	2	175	1	122	15
D1-4-4cdd	450	320-450	9-30-64	------	7.0	.06	2.0	1.0	139	1.0	223	
18bba [3]	330	At 57	10-16-64	------	-------	------	424	58	521	3	305	0
18bba [3]	330	314-325	10-26-64	------	-------	------	4	2	150	1	156	18
D1-5-11acc	225	118-215	11- 5-65	55	16	.26	150	39	340	7.4	469	0
12db	800	300-800	12- 3-65	------	19	[2] .03	51	22	92	5.4	177	0
Glacial deposits												
B3-2-17acb	45	At 45	11- 4-65	------	19	0.10	46	10	18	2.4	170	0

See footnotes at end of table.

Wind River Indian Reservation, Wyo.—Continued

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	Sodium-adsorption-ratio (SAR)	Specific conductance (micromhos at 25° C)	pH	Remarks
Wind River Formation—Continued												
2,190	24	0.7	13	0.15	3,660	3,310	1,910	1,700	28	3,500	7.1	
1,290	15	.6	.3	.04	2,040	2,040	185	87	18	2,720	7.5	
42	38	1.6	.4	.21	272	270	3	0	30	446	9.7	
394	36	2.0	.0	.27	716	696	30	2	17	1,100	8.0	
2,980	69	1.2	.8	.98	4,940	4,520	1,880	1,740	------	5,160	7.9	
664	59	1.0	.3	.12	1,130	1,110	68	49	18	1,660	7.1	
848	17	1.1	.7	.28	1,670	1,640	217	0	14	2,190	7.8	
1,760	58	1.1	44	.34	3,130	3,030	682	411	------	3,830	7.6	
234	12	3.0	.7	------	565	530	16	0	19	847	8.3	Li 0.08 ppm.
3,250	77	1.2	.1	.07	5,000	5,110	435	261	31	6,300	7.8	
1,190	14	.4	.1	.05	1,870	1,910	102	0	25	2,670	8.0	
1,090	48	1.1	.3	.10	1,810	1,770	78	26	32	2,560	8.2	
435	49	2.0	.4	.35	802	791	14	0	26	1,270	9.5	
500	35	1.8	.4	.24	866	842	19	0	24	1,320	7.2	
2,510	56	1.0	0	------	4,040	3,790	1,720	1,510	------	6,180	7.7	
1,020	160	3.2	.3	.22	1,820	1,800	81	53	27	2,740	7.2	
415	260	4.0	.3	.15	1,130	1,120	38	0	27	1,870	7.5	
1,150	34	.8	.0	.14	2,050	1,960	748	514	5.6	2,490	7.5	
1,370	335	2.2	.1	.19	2,580	2,610	118	59	33	3,810	7.5	
1,800	416	3.8	.1	.23	3,310	3,390	162	100	37	4,730	7.9	
175	16	1.4	15	.31	696	680	294	0	3.1	964	8.2	
23	1.0	.5	.7	.01	203	205	168	12	.2	340	7.8	
406	51	1.4	.1	.09	828	808	32	0	20	1,280	8.3	
763	15	.5	.5	.03	1,190	1,190	93	45	15	1,770	8.5	
438	86	3.4	.1	.17	880	883	28	0	24	1,380	8.0	
58	0	------	------	2	336	------	------	------	3.5	540	7.3	
258	8.6	.7	.9	.06	550	543	315	167	1.4	797	7.8	
125	14	------	0	.12	434	------	------	------	17	569	8.8	
157	11	1	0	.18	466	------	------	------	11.4	569	8.2	
285	12	------	0	.12	644	------	88	------	8.8	983	8.2	
873	37	1.0	8	.12	1,600	------	438	------	6.5	2,210	7.9	
1,640	36	.8	.7	.09	2,560	------	430	------	12	3,380	7.8	
208	8.2	.9	.3	.10	492	461	196	63	2.3	696	7.8	
501	57	.4	0	.05	1,010	------	525	------	2.5	1,350	7.7	
155	9	.5	.0	------	------	416	12	0	19	688	----	
239	14	1.1	0	.09	540	------	23	------	12	879	8.6	
139	4.0	1.1	.04	------	388	426	------	8	20	670	8.5	Commercial analysis.
1,960	43	------	0	.36	3,310	------	2,590	------	4.5	3,730	7.6	
132	11	1.2	0	.14	378	------	19	------	10.5	697	8.8	
782	77	1.2	.3	.33	1,710	1,650	534	149	6.4	2,320	8.0	
270	7.1	1.6	.0	.10	590	555	219	74	2.7	869	8.1	
Glacial deposits—Continued												
52	4.0	0.2	0.2	0.03	240	236	157	18	0.6	380	7.7	

TABLE 6.—*Chemical analyses of ground-water samples,*

Location	Depth of well (feet)	Production interval (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)
Terrace deposits near Wind River												
A1-4-32adb	12	-------	10-15-48	54	38	0.34	87	13	56	6.4	368	0
B4-3-32baa	41	-------	4-28-66	------	30	.04	35	19	24	1.0	223	0
B4-4-22aba	33	21-33	10-26-66	50	31	------	64	12	86	1.6	392	0
23adc	30	-------	4-28-66	------	24	.00	47	42	144	2.0	566	0
Terrace deposits near Muddy Creek												
A4-4-23acd	23	11-19	6-26-51	------	-------	------	-------	------	175		334	7
23dbd2	20	8-15	10-26-51	------	-------	------	-------	------	240		294	14
Alluvium of Mill Creek valley												
D1-1-15ccc	38	16-38	10-25-66	52	17	------	358	94	258	5.4	342	0
22bba1	30	-------	8-13-65	------	17	0.05	238	121	226	4.6	313	0
22bba1	30	-------	4-28-66	------	16	.00	223	127	235	5.0	342	0
22bcb	21	19-21	10- 5-65	53	19	.45	227	156	316	6.0	329	0
31dda	45	-------	10- 6-65	49	18	.46	63	26	15	2.3	284	0
32acd [1]	45	-------	10- 5-65	------	19	.07	49	31	11	2.1	284	0
Alluvium of Kirby Draw												
A1-5-15aab	29	-------	9-28-65	51	12	0.80	42	8.0	461	1.9	417	0
D1-5-11bdd	34	32-34	10- 6-65	52	14	.34	168	55	1,100	4.7	409	0
Alluvium of Beaver Creek valley												
D1-4-33daa	22	20-22	9-28-65	52	18	1.3	184	48	169	7.4	271	0
Alluvium of Crow Creek valley												
B4-3-8bbd	30	-------	11- 4-65	50	29	0.37	104	17	89	3.6	526	0
Alluvium of Owl Creek valley												
A8-4-16aaa	50	-------	7-23-46	------	-------	0.05	114	41	445		332	------
A9-2-35aaa	47	-------	7-22-46	------	-------	.80	285	121	65		300	------

See footnotes at end of table.

Wind River Indian Reservation, Wyo.—Continued

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	Sodium-adsorption-ratio (SAR)	Specific conductance (micromhos at 25° C)	pH	Remarks
Terrace deposits near Wind River—Continued												
86	7.0	1.2	0.6	0.16	494	479	270	0	1.5	738	7.5	
20	5.3	.6	1.9	.04	268	247	165	0	.8	397	7.9	
71	7.2	1.3	.7	.34	446	468	210	0	2.6	705	7.6	
115	17	1.3	0	.02	714	670	289	0	3.7	1,100	8.0	
Terrace deposits near Muddy Creek—Continued												
122	17	------	17	------	606	------	68	0	--------	897	8.4	
273	27	------	15	------	796	------	76	0	--------	1,210	8.7	
Alluvium of Mill Creek valley—Continued												
1,470	21	1.4	8.5	0.44	2,540	2,400	1,280	1,000	3.1	2,740	7.6	
1,220	17	1.0	6.0	.47	2,230	2,010	1,090	833	3.0	2,500	8.2	
1,210	22	.9	7.1	.39	2,150	2,010	1,080	800	3.1	2,600	7.9	
1,470	24	.9	4.0	.63	2,640	2,390	1,210	940	4.0	2,890	8.0	Mn 0.45 ppm.
59	1.9	.9	1.4	.08	329	328	264	31	.4	543	8.1	Mn 0.03 ppm.
38	2.6	.9	2.5	.05	293	296	250	17	.3	492	8.1	Mn 0.03 ppm.
Alluvium of Kirby Draw—Continued												
695	31	1.5	0.00	0.27	1,490	1,460	138	0	17	2,140	8.2	Mn 0.54 ppm.
2,450	95	.8	.1	.49	4,600	4,090	646	311	19	5,650	8.2	Mn 0.12 ppm.
Alluvium of Beaver Creek valley—Continued												
648	88	1.0	0.1	0.22	1,380	1,300	656	434	2.9	1,780	8.1	Mn 1.1 ppm.
Alluvium of Crow Creek valley—Continued												
84	10	0.3	0.3	0.02	601	597	331	0	2.1	911	7.9	Mn 0.26 ppm.
Alluvium of Owl Creek valley—Continued												
1,060	30	0.8	1.6	------	1,930	------	453	181	9.1	2,440	8.0	
1,040	16	.2	.0	------	1,960	------	1,210	964	.8	2,010	7.3	

TABLE 6.—*Chemical analyses of ground-water samples,*

Location	Depth of well (feet)	Production interval (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)
Alluvium of Little Wind River valley												
A1-1-34bcb	28	0-28	11- 2-66	------	15	------	157	63	223	9.9	404	0
C1-1-4adc	24	At 24	11- 3-65	------	10	0.00	53	22	14	3.1	220	0
4ccc [3]	42	At 41	5-10-63	------	------	------	------	------	110	------	------	------
5dba [3]	42	------	5-10-63	------	------	------	------	------	36	------	------	------
6ddc [3]	23	20-23	5-10-63	------	------	------	------	------	64	------	------	------
8ada [3]	20	5-20(?)	5-10-63	------	------	------	------	------	18	------	------	------
8dda [3]	43	3-12	5-10-63	------	------	------	------	------	7	------	------	------
9aab [3]	30	28-30	5-10-63	------	------	------	------	------	93	------	------	------
9bdc [1,3]	36	26-29	5-10-63	------	------	------	------	------	115	------	------	------
10cbd1	60	33-40	11- 3-65	47	7.9	1.3	40	18	200	2.4	343	0
18bab [3]	32	23-32	5-10-63	------	------	------	------	------	24	------	------	------
C1-2-1dcd [3]	20	------	5-10-63	------	------	------	------	------	72	------	------	------
D1-2-9bbb2	20	------	11- 3-65	54	20	.01	168	80	161	4.6	395	0
9bbb2	20	------	4-28-66	45	17	.00	128	68	122	3.0	317	0
D1-3-18dda	12	------	11- 3-65	------	68	.19	162	58	226	1.0	268	0
24cba	10	5-10	10- 5-65	57	16	.18	168	73	181	3.9	344	0
Alluvium of Wind River valley												
A1-2-3daa	41	------	10-15-48	49	24	0.14	48	11	28	2.0	202	0
A1-3-35cdc [3]	40	------	11-19-64	------	------	------	69	12	28	1.5	238	0
A1-4-31dcc	9	------	11- 6-65	53	24	.50	128	33	243	3.9	488	0
A2-1-13ccc	60	------	9-15-65	------	13	.10	56	9.4	25	1.6	188	0
B4-4-2cda	33	21-33	10-26-66	------	15	------	92	14	24	2.8	286	0
2dcb [1]	------	------	4-28-66	------	16	[2] .02	74	21	19	3.5	262	0
Water-bearing formation unknown												
A5-6-21aa	600-800	------	8-23-46	65	14	0.03	76	37	19	------	275	------
A7-1-19cca	------	------	4-28-65	54	11	.00	52	28	5.0	2.2	224	0
C1-1-6cdd [3]	62	38-62	5-10-63	------	------	------	------	------	250	------	------	------
8aab [3]	66	54-66	5-10-63	------	------	------	------	------	160	------	------	------
18bcc [3]	33	20-24	5-10-63	------	------	------	------	------	16	------	------	------
C1-2-24ada [3]	41	36-41	5-10-63	------	------	------	------	------	6	------	------	------
24dab [3]	90	------	11-10-64	------	------	------	110	71	117	4	366	0

[1] Geologic source is questionable.
[2] In solution at time of analysis.
[3] Analysis by Wyoming State Department of Agriculture, Laramie, Wyo.
[4] Riverton city well.

Wind River Indian Reservation, Wyo.—Continued

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	Sodium-adsorption-ratio (SAR)	Specific conductance (micromhos at 25° C)	pH	Remarks
Alluvium of Little Wind River valley—Continued												
732	20	1.0	0.3	0.66	1,460	1,420	650	319	3.8	1,860	7.8	
63	5.7	.3	1.2	.10	292	280	222	42	.4	476	7.6	
-------	-------	.85	-------	-------	730	-------	340	-------	-------	-------	8.2	
-------	-------	.28	-------	-------	420	-------	209	-------	-------	-------	7.9	
-------	-------	.95	-------	-------	540	-------	230	-------	-------	-------	7.8	
-------	-------	.9	-------	-------	1,160	-------	655	-------	-------	-------	7.8	
-------	-------	.82	-------	-------	550	-------	347	-------	-------	-------	7.4	
-------	-------	.58	-------	-------	1,160	-------	525	-------	-------	-------	7.6	
-------	-------	.72	-------	-------	750	-------	275	-------	-------	-------	7.7	
306	7.2	.5	3.4	.96	772	757	173	0	6.6	1,170	7.8	Mn 0.16 ppm.
-------	-------	.62	-------	-------	930	-------	415	-------	-------	-------	7.7	
-------	-------	1.32	-------	-------	450	-------	195	-------	-------	-------	7.7	
694	18	.9	3.6	.32	1,450	1,340	746	422	2.6	1,780	8.2	
558	18	.8	2.7	.02	1,140	1,070	598	338	2.2	1,480	7.9	
845	13	1.6	8.5	.42	1,570	1,520	641	421	3.9	1,930	7.7	
736	28	.6	2.7	.20	1,500	1,380	720	438	2.9	1,810	8.1	Mn 0.77 ppm.
Alluvium of Wind River valley—Continued												
47	5.0	0.3	0.8	0.07	256	267	165	0	0.9	435	8.0	
99	9	.2	10	.04	354	-------	223	-------	.8	541	7.6	
495	64	.6	.1	.17	1,270	1,230	456	56	4.9	1,790	7.7	Mn 0.20 ppm.
68	6.2	.2	.0	.02	284	272	178	24	.8	447	7.8	
103	3.4	.1	1.4	.06	378	397	286	51	.6	635	7.6	
80	7.4	.2	.0	.05	392	355	272	57	.5	603	8.0	
Water-bearing formation unknown—Continued												
143	5.0	0.8	-------	-------	-------	430	342	116	14	696	7.5	Paleozoic(?) rocks.
67	5.0	.7	0.8	0.03	280	282	245	61	.1	479	6.8	Do.
-------	-------	1.15	-------	-------	780	-------	37	-------	-------	-------	8.6	Alluvium(?), Cody(?) Shale.
-------	-------	1.25	-------	-------	550	-------	35	-------	-------	-------	9	Do.
-------	-------	.95	-------	-------	1,630	-------	1,000	-------	-------	-------	7.1	Alluvium(?), Thermopolis (?) Shale.
-------	-------	.78	-------	-------	420	-------	305	-------	-------	-------	7.4	Cloverly and Morrison(?) Formations, Sundance(?) Formation.
490	11	-------	0	.46	1,070	-------	568	-------	-------	1,460	7.4	Do.

TABLE 7.—*Chemical analyses*

[Analytical results in parts per million, except as

Date of collection	Discharge (cfs) [1]	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)
INDIVIDUAL SAMPLES											
6–2185 [2] Wind River near Dubois, Wyo.											
1965											
July 19	632	20	0.11	13	1.9	2.9	1.5	57	0	0	0
Aug. 26	188	22	[3] .02	14	6.0	4.5	1.8	78	0	2.5	1.1
Sept. 27	175	26	.05	15	5.7	10	2.1	88	0	11	1.8
Nov. 1	87	24	.05	22	5.5	6.7	2.2	101	0	8.2	0
Dec. 10	86	23	.05	23	5.7	7.4	2.6	102	2	17	0
1966											
Jan. 17	63	27	[3] .00	23	7.4	9.0	2.5	113	0	13	.7
Feb. 2	65	27	.05	22	6.4	8.0	3.0	107	0	12	1.1
Mar. 23	74	27	.00	24	7.1	9.0	2.8	115	0	13	1.1
Apr. 5	61	26	.05	25	6.8	9.0	2.0	119	0	14	0
May 6	368	17	.19	13	7.2	7.0	2.5	67	0	14	5.0
June 6	328	21	-------	10	4.9	6.0	1.6	67	0	2.9	1.1
July 5	230	23	.10	16	3.2	7.3	1.9	71	0	6.4	0
Aug. 1	131	25	.11	20	3.5	7.0	2.4	88	0	8.2	.7
Sept. 6	84	24	.15	21	6.7	7.9	1.5	95	0	14	3.5
Oct. 3	73	25	.06	17	8.6	7.7	1.5	110	0	6.6	4.3
6–2310 [2] Little Wind River above Arapahoe, Wyo.											
1966											
Aug. 1	7.9	16	0.18	103	54	144	3.6	243	0	532	23
Sept. 6	15	11	.08	128	71	206	6.2	265	0	802	33
Sept. 30	36	9.6	.11	100	43	131	2.4	244	0	447	25
6–2336 [2] Pop Agie River at Hudson, Wyo.											
1966											
Aug. 1	73	12	0.18	103	43	71	3.6	267	0	346	6.4
Sept. 6	159	8.0	.00	57	52	64	2.2	204	0	302	7.1
Sept. 30	123	5.4	[3] .04	80	37	64	2.4	210	0	305	8.9

See footnotes at end of table.

of surface-water samples

indicated. Analyses by U.S. Geological Survey]

Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Calculated	Dissolved solids: Residue at 180° C: Parts per million	Dissolved solids: Residue at 180° C: Tons per acre-foot	Dissolved solids: Residue at 180° C: Tons per day	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Sodium-adsorption-ratio	Specific conductance (micromhos per cm at 25° C)	pH
INDIVIDUAL SAMPLES—Continued												
6-2185 [2] Wind River near Dubois, Wyo.—Continued												
0	0	0	67	72	0.10	--------	40	0	13	0.2	100	7.7
.2	.3	0	90	112	.15	--------	60	0	14	.3	146	7.8
.1	0	0	115	102	.14	--------	60	0	26	.6	148	7.4
.3	.1	0	119	156	.21	--------	77	0	15	.3	179	7.8
.2	.1	0	133	172	.23	--------	80	0	16	.4	195	8.3
.2	0	0	139	136	.18	--------	88	0	18	.4	208	8.2
.2	0	0	133	142	.19	--------	82	0	17	.4	197	7.6
.2	0	.04	141	164	.22	--------	88	0	17	.4	209	7.8
.2	0	.01	142	170	.23	--------	90	0	17	.4	236	7.6
.1	.6	0	100	114	.16	--------	62	7	19	.4	128	7.1
.2	0	.02	81	100	.14	--------	45	0	22	.4	117	7.5
.2	.3	.01	93	94	.13	--------	52	0	23	.4	133	7.1
.2	.0	0	110	116	.16	--------	65	0	18	.4	157	7.3
.2	.0	.01	126	122	.17	--------	81	3	17	.4	171	7.6
.2	.3	.02	125	122	.17	--------	78	0	17	.4	185	7.8
6-2310 [2] Little Wind River above Arapahoe, Wyo.—Continued												
0.9	2.1	0.19	999	1,050	1.43	--------	478	279	39	1.9	1,400	7.8
.9	.0	.24	1,390	1,420	1.93	--------	610	393	42	3.6	1,810	8.0
.7	1.9	.16	881	924	1.26	--------	425	225	40	2.7	1,260	8.0
6-2336 [2] Pop Agie River at Hudson, Wyo.—Continued												
0.6	0.9	0.12	718	764	1.04	--------	435	216	26	1.5	1,050	7.6
.5	.0	.00	593	662	.90	--------	356	189	28	1.5	881	7.7
.5	.0	.13	606	638	.87	--------	350	178	28	1.5	900	8.1

TABLE 7.—*Chemical analyses of*

Date of collection	Discharge (cfs) [1]	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)
COMPOSITE SAMPLES											
6-2280 [2] Wind River at Riverton, Wyo.											
1965											
Oct. 1-10	768	18	-------	33	8.3	19	2.3	135	0	46	5.7
Oct. 11-27	861	21	-------	37	10	20	2.9	156	0	51	3.5
Oct. 28-Nov. 3	1,460	10	-------	31	13	17	2.0	113	0	71	5.3
Nov. 4-16	529	14	-------	44	16	24	2.8	165	0	88	5.3
Nov. 17-30	506	17	-------	44	15	23	2.8	186	0	71	7.1
Dec. 1-9	479	16	-------	45	16	25	2.9	192	0	71	5.3
Dec. 10-18	417	15	-------	49	19	28	2.9	195	0	103	5.3
Dec. 19-31	395	15	-------	44	18	24	2.9	189	0	77	7.1
1966											
Jan. 1-15	438	16	-------	47	12	24	3.5	183	0	56	5.3
Jan. 16-31	414	15	-------	46	18	28	3.3	183	0	87	5.3
Feb. 1-12	448	14	-------	45	13	23	3.1	171	0	64	4.3
Feb. 13-19	401	15	-------	47	13	23	3.1	177	0	69	5.3
Feb. 20-28	474	15	-------	44	13	24	3.1	168	0	67	3.5
Mar. 1-13	415	18	-------	43	13	24	2.0	159	0	63	7.1
Mar. 14-31	376	15	-------	43	13	32	2.0	171	0	76	7.1
Apr. 1-7	533	15	-------	34	14	26	1.4	155	0	60	4.6
Apr. 8-14	141	14	-------	48	17	43	1.5	186	0	114	5.3
Apr. 15-30	236	13	-------	37	16	33	1.0	165	0	82	4.6
May 1-7	341	19	-------	40	13	24	2.5	165	0	68	3.5
May 8-14	1,250	15	-------	24	8.9	12	1.7	113	0	31	1.8
May 15-31	246	15	-------	26	9.8	19	1.3	122	0	45	2.8
June 1-10	280	12	-------	28	6.0	22	1.5	107	0	52	2.5
June 11-19	246	13	-------	30	6.4	23	1.5	116	1	48	4.3
June 20-30	445	14	-------	27	6.4	17	1.3	110	0	37	3.5
July 1-9	171	13	-------	36	10	38	2.3	149	0	65	14
July 10-Aug. 9	346	11	-------	27	7.8	24	1.7	122	0	38	7.1
Aug. 10-Sept. 14	190	10	-------	49	8.1	43	2.2	162	0	109	6.7
Sept. 15-30	308	16	-------	49	7.9	43	2.9	179	0	95	5.3

See footnotes at end of table.

surface-water samples—Continued

Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Calculated	Dissolved solids: Residue at 180° C: Parts per million	Dissolved solids: Residue at 180° C: Tons per acre-foot	Dissolved solids: Residue at 180° C: Tons per day	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Sodium-adsorption-ratio	Specific conductance (micromhos per cm at 25° C)	pH
COMPOSITE SAMPLES—Continued												
6-2280 [2] Wind River at Riverton, Wyo.—Continued												
0.4	0.0	0.06	199	220	0.30	457	118	7	26	0.8	320	8.1
.4	.0	.06	223	246	.33	564	135	7	24	.8	356	8.1
.3	.0	.04	206	240	.33	956	130	37	22	.6	339	7.7
.4	.0	.09	276	316	.43	451	174	39	23	.8	455	7.8
.4	.0	.06	271	316	.43	432	174	21	22	.8	444	7.6
.3	.0	.08	276	284	.39	371	178	21	23	.8	448	8.1
.4	.0	.04	319	320	.44	364	201	41	23	.9	508	8.1
.3	.0	.07	280	272	.37	290	182	27	22	.8	442	8.0
.3	.7	.04	255	242	.33	287	167	17	23	.8	434	7.6
.3	.7	.04	294	284	.39	320	188	38	24	.9	474	7.9
.4	.1	.17	251	234	.32	284	166	26	23	.8	414	8.0
.4	.4	.07	263	226	.31	247	170	25	22	.8	417	8.0
.3	.3	.10	253	232	.32	301	162	24	24	.8	411	8.1
.2	.6	.04	249	258	.35	288	160	30	24	.8	414	8.2
.3	.0	.07	272	290	.39	291	162	22	30	1.1	449	8.2
.3	.2	.11	232	232	.32	338	143	15	28	.9	386	7.2
.4	.2	.05	334	358	.49	137	190	37	33	1.4	544	7.7
.3	.2	.11	268	280	.38	178	158	23	31	1.1	446	7.7
.4	.7	.04	252	292	.40	271	152	17	25	.8	413	7.9
.3	.5	.02	151	196	.27	669	97	4	21	.5	253	7.4
.3	.0	.06	179	190	.26	127	105	5	28	.8	295	7.6
.3	.2	.04	178	186	.25	139	95	7	33	1.0	270	8.2
.5	.0	.02	185	194	.26	127	102	5	32	1.0	302	8.3
.3	.0	.00	160	156	.21	185	93	3	28	.7	258	8.2
.4	.2	.10	252	264	.36	122	130	8	38	1.4	406	8.1
.3	.1	.09	177	194	.26	178	100	0	34	1.0	300	8.0
.4	.1	.06	309	298	.41	155	156	23	37	1.5	490	7.6
.4	.0	.06	308	290	.39	238	155	8	37	1.5	470	7.8

318-228—69——10

TABLE 7.—*Chemical analyses of*

Date of collection	Discharge (cfs) [1]	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)
6-2355 [2] Little Wind River near Riverton, Wyo.											
1965											
Oct. 1-20	503	8.5	-------	62	31	50	2.8	159	0	249	9.9
Oct. 21-31	387	6.3	-------	63	35	48	2.9	171	0	253	8.5
Nov. 1-15	338	5.5	-------	74	33	55	3.5	190	0	259	9.9
Nov. 16-30	301	7.2	-------	78	36	59	3.6	196	0	293	10
Dec. 1-13	222	8.7	-------	69	37	55	3.1	186	0	267	8.9
Dec. 14-18	197	10	-------	76	36	66	3.8	210	0	283	11
Dec. 19-31	234	12	-------	74	39	61	3.2	210	0	291	8.9
1966											
Jan. 1-10	233	11	-------	68	38	58	3.3	192	0	274	11
Jan. 11-27	198	12	-------	73	32	52	3.0	192	0	249	11
Jan. 28-Feb. 5	193	11	-------	70	29	47	3.5	186	0	218	8.9
Feb. 2-20	189	11	-------	76	35	56	3.2	198	0	260	11
Feb. 21-28	214	11	-------	76	32	54	3.5	186	0	255	12
Mar. 1-10	198	11	-------	76	38	62	2.5	186	0	294	16
Mar. 11-18	272	12	-------	78	49	110	5.5	165	0	455	18
Mar. 19-31	264	11	-------	80	45	79	3.5	189	0	361	16
Apr. 1-16	298	11	-------	75	33	68	4.0	188	0	294	18
Apr. 17-30	304	9.2	-------	85	47	116	4.0	198	0	463	19
May 1-7	337	7.2	-------	61	27	54	1.4	162	0	230	13
May 8-15	805	7.8	-------	42	12	30	1.0	116	0	116	6.4
May 16-31	475	4.8	-------	46	16	33	1.1	123	0	138	6.7
June 1-10	612	8.5	-------	54	18	41	.6	128	0	183	7.1
June 11-30	659	8.0	-------	54	23	40	1.5	134	0	186	7.1
July 1-15	297	8.8	-------	77	33	68	1.4	192	6	289	11
July 16-31	115	12	-------	95	37	94	2.0	222	0	384	16
Aug. 1-20	102	12	-------	99	42	99	3.0	238	0	411	17
Aug. 21-Sept. 10	182	9.2	-------	98	40	95	2.6	226	0	397	15
Sept. 11-30	219	8.9	-------	90	36	89	2.7	203	0	363	17

[1] Discharge subject to revision.
[2] Official station number.
[3] In solution at time of analysis.

surface-water samples—Continued

Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Calculated	Dissolved solids: Residue at 180° C: Parts per million	Dissolved solids: Residue at 180° C: Tons per acre-foot	Dissolved solids: Residue at 180° C: Tons per day	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Sodium-adsorption-ratio	Specific conductance (micromhos per cm at 25° C)	pH
6-2355 [2] Little Wind River near Riverton, Wyo.—Continued												
0.6	0.0	0.12	492	544	0.74	738	284	154	27	1.3	743	8.0
.4	.7	.09	502	500	.68	522	301	161	26	1.2	762	8.2
.7	.2	.10	534	572	.78	523	320	164	27	1.3	800	7.9
.7	.6	.11	584	602	.82	490	340	179	27	1.4	862	7.9
.5	.0	.10	534	570	.78	343	322	169	27	1.3	836	7.8
.5	.1	.11	589	628	.85	332	340	168	29	1.6	897	7.9
.5	.2	.10	594	624	.85	395	344	172	28	1.4	874	7.8
.5	1.4	.04	559	600	.82	379	328	171	28	1.4	838	8.0
.5	1.0	.00	528	544	.74	291	312	155	26	1.3	804	8.0
.5	1.1	.10	480	502	.68	260	295	142	25	1.2	754	7.9
.5	1.1	.11	551	582	.79	296	331	169	27	1.3	844	7.7
.5	2.0	.10	537	564	.77	327	320	168	27	1.3	825	7.8
.5	1.1	.09	592	634	.86	338	345	193	28	1.5	894	8.0
.5	8.2	.11	817	874	1.19	642	396	261	37	2.4	1,180	7.8
.5	1.8	.10	691	762	1.04	545	386	231	31	1.7	1,040	8.0
1.0	.0	.06	596	604	.82	485	323	169	31	1.6	872	8.0
.7	2.5	.08	843	872	1.19	718	405	243	38	2.5	1,180	8.0
.5	.1	.03	474	498	.68	455	265	132	31	1.4	726	7.3
.3	.1	.05	273	290	.39	623	156	61	29	1.0	445	7.5
.3	.1	.04	307	340	.46	433	181	80	28	1.1	509	7.3
.3	.9	.07	376	394	.54	655	208	103	30	1.2	588	7.0
.3	.5	.10	386	406	.55	719	228	118	27	1.1	604	6.9
.5	.8	.12	590	616	.84	495	330	163	31	1.6	876	8.3
.6	.8	.14	751	780	1.06	242	390	208	34	2.0	1,090	8.0
.6	.5	.18	801	842	1.15	233	420	223	34	2.1	1,100	8.2
.6	.5	.20	769	716	.97	350	410	225	33	2.0	1,070	8.1
.6	.6	.18	708	748	1.02	443	372	206	34	2.0	997	8.2

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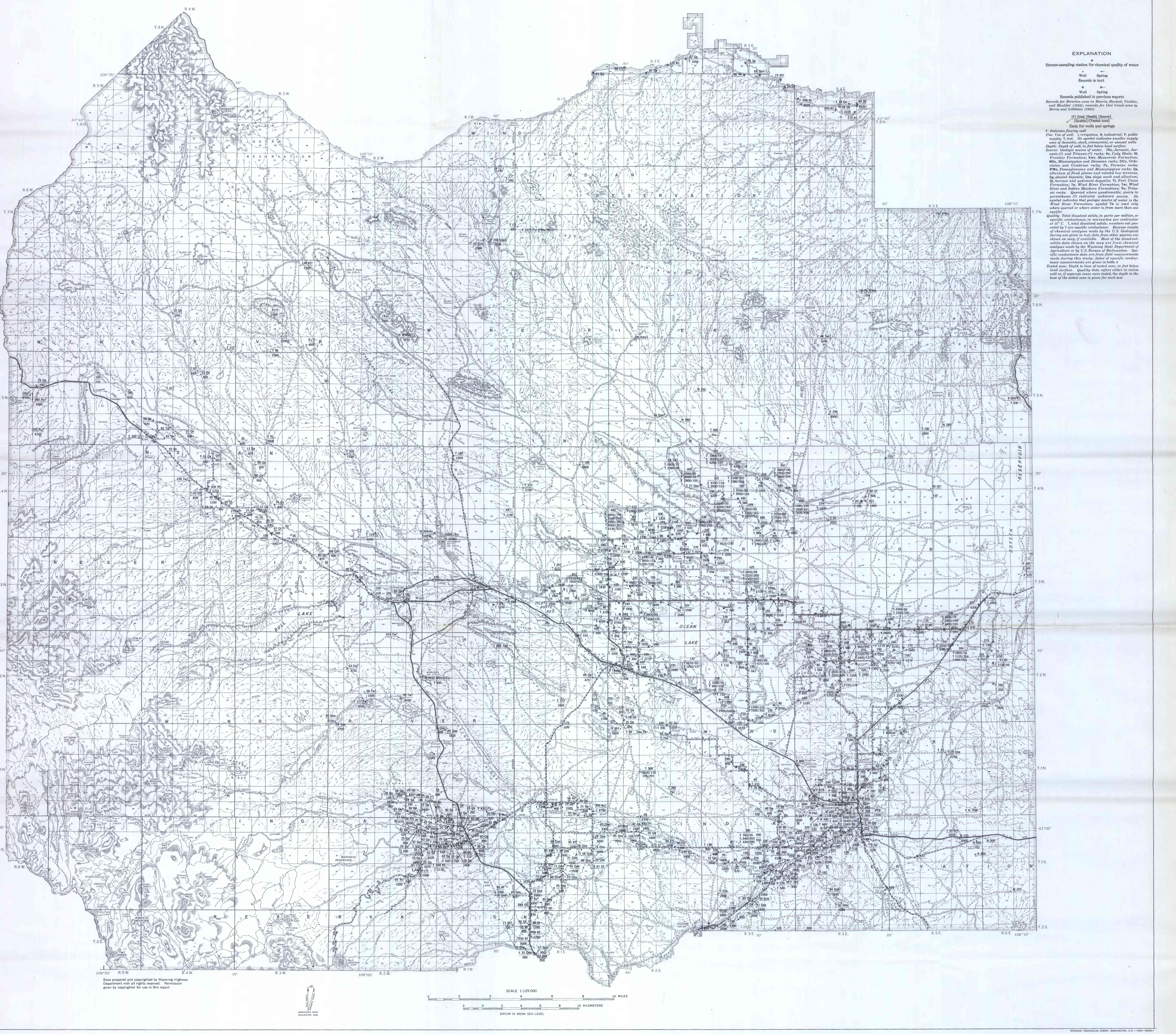
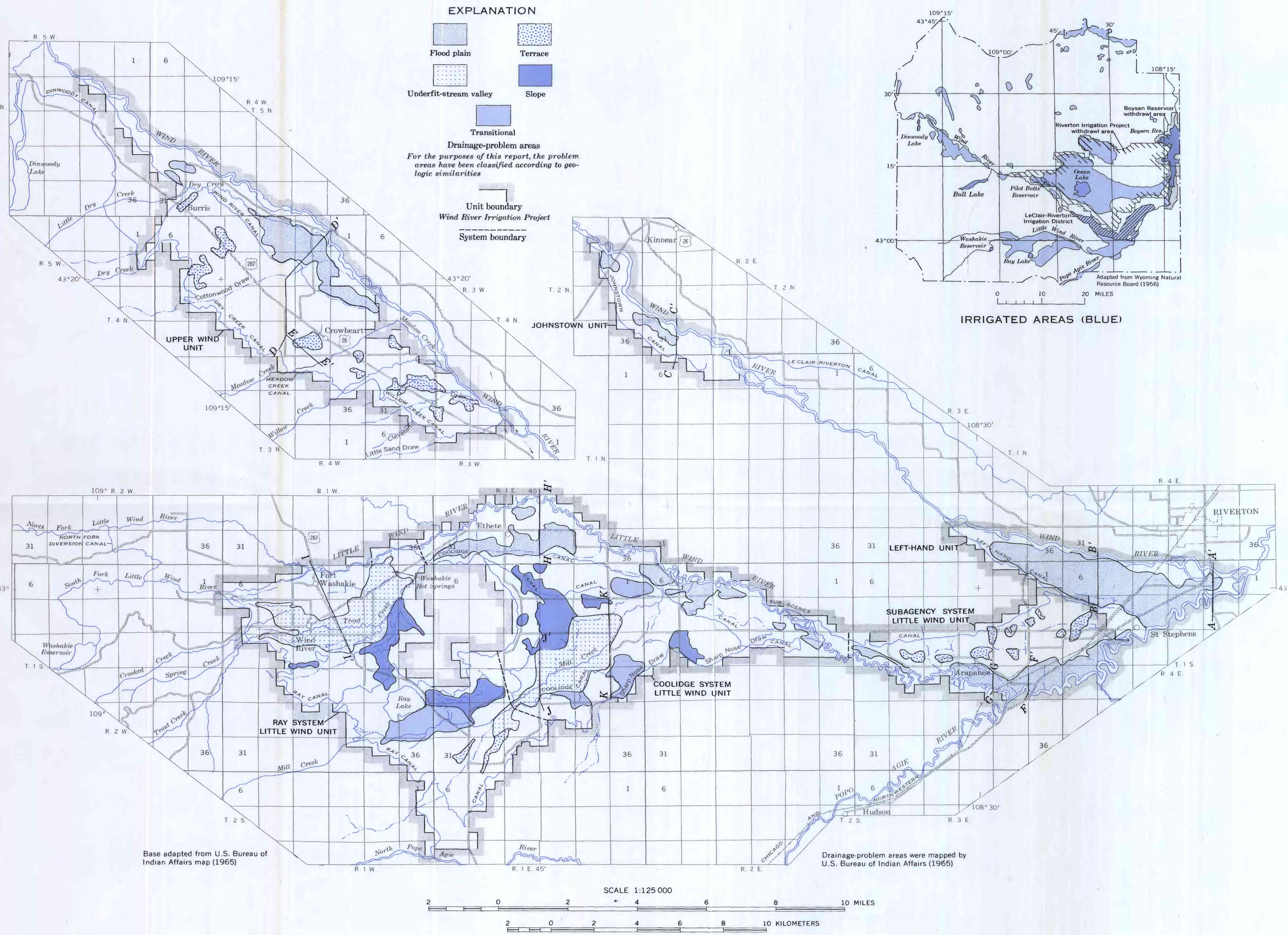
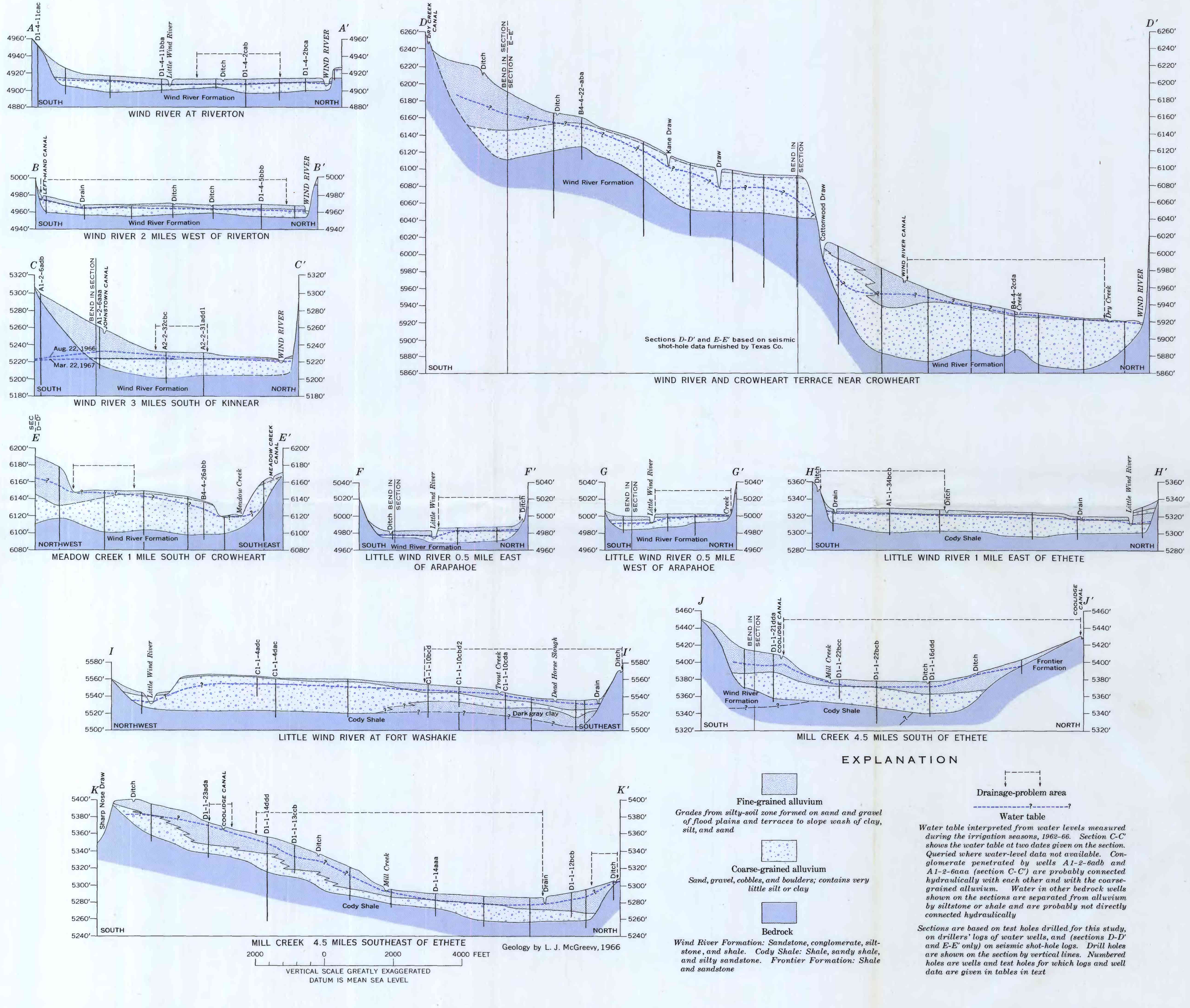


MAP SHOWING WELL LOCATIONS AND CHEMICAL QUALITY OF GROUND WATER, WIND RIVER INDIAN RESERVATION, WYOMING

PREPARED AS PART OF THE PROGRAM OF THE
DEPARTMENT OF THE INTERIOR
FOR THE DEVELOPMENT OF THE MISSOURI RIVER BASIN





INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1968—W68167

MAP AND SECTIONS SHOWING DRAINAGE-PROBLEM AREAS IN THE WIND RIVER IRRIGATION PROJECT, WIND RIVER INDIAN RESERVATION, WYOMING