Ground-Water Resources and Geology of the Lyman-Mountain View Area Uinta County, Wyoming

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1669-E

Prepared in cooperation with the Wyoming State Engineer and the Wyoming Natural Resource Board

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By CHARLES J. ROBINOVE *and* T. R. CUMMINGS

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

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GROUND-WATER RESOURCES AND GEOLOGY OF THE LYMAN-MOUNTAIN VIEW AREA, UINTA COUNTY, WYOMING

By CHARLES J. ROBINOVE and T. R. CUMMINGS

ABSTRACT

The Lyman-Mountain View area is adjacent to the northern flank of the Uinta Mountains. Northward- and eastward-dipping strata of Precambrian to Late Cretaceous age are unconformably overlain by deposits of Tertiary age that have a maximum thickness of at least 1,850 feet in the vicinity of Lyman. Because the pre-Tertiary rocks are not considered to be potential sources of ground water for most uses, only the Tertiary and Quaternary deposits are discussed in detail in the report.

Ground water in the permeable strata of Tertiary age is under artesian head. The principal artesian aquifers are sandstone beds in the Wasatch, Green River, and Bridger Formations. Flowing wells have been drilled only in the Wasatch Formation, but artesian pressure in the other formations is sufficient to raise the water levels in wells to near the land surface in some localities.

Ground water in the alluvial and terrace deposits of Quaternary age occurs under water-table conditions; that is, unconfined. The major stream valleys and much of the uplands within the report area are underlain by deposits of sand, gravel, and silt that are more than 40 feet thick in some localities. These deposits are the most permeable in the area and, where saturated, are capable of yielding moderate quantities of water to wells and springs. The water table is generally close to the land surface in topographically low areas and is as much as 50 feet below the land surface in higher areas; however, the water table stands near the surface of the terraces between Blacks Fork and Smith Fork because of recharge from heavy application of irrigation water.

The formations of Tertiary age are generally capable of yielding only relatively small quantities of water to wells. Yields may be expected to increase with depth, however, and moderate quantities of water may be obtained from deep wells in some localities.

Small to moderate quantities of water may be obtained from wells drilled in the terrace and alluvial deposits in many localities. Wells capable of producing as much as a few hundred gallons per minute might be constructed where the saturated thickness of the terrace and alluvial deposits is relatively great and the permeability is high. The sustained yield of individual wells will depend on the areal extent of the aquifer and the rate of recharge to it.

Ground water from the terrace and alluvial deposits is generally suitable for most uses, although water from some of the alluvial deposits may contain objectionable concentrations of iron. Water from the Wasatch and Bridger Formations differs considerably in character and degree of mineralization and, therefore, in suitability for various uses.

In the upper reaches of Blacks Fork and Smith Fork the surface water is a calcium bicarbonate water of low mineral content and is suitable for most domestic, irrigation, and industrial uses. Farther downstream, however, highly mineralized return flows from irrigation cause the water to be unsuitable for domestic use.

INTRODUCTION

A program of ground-water investigation was begun in Wyoming in November 1940 by the U.S. Geological Survey in cooperation with the State of Wyoming. As part of this program, the investigation of the Lyman-Mountain View area was made during 1957–59 by the U.S. Geological Survey in cooperation with the Wyoming State Engineer and the Wyoming Natural Resource Board.

PURPOSE AND SCOPE OF THE INVESTIGATION

The study was made to determine the origin, occurrence, availability, and quality of ground water for domestic, stock, irrigation, and municipal uses. Detailed studies were limited to areas of moderate to large water use, principally the irrigated areas.

A base map of the area was prepared from township plats of the Bureau of Land Management and from recent aerial photographs. The geologic formations were mapped on the photographs and transferred to the base map by the use of a reflected-image projector. Information on the depth of wells, depth to water, and character of the water-bearing formations was collected in the field for 106 wells and 7 springs. Drillers' logs of 18 wells were obtained.

The ground-water studies were directed by H. M. Babcock and E. D. Gordon, successive district supervisors of the Ground Water Branch for Wyoming. The quality-of-water studies were directed by T. F. Hanly, district supervisor for the Quality of Water Branch for Wyoming.

LOCATION AND EXTENT OF THE AREA

The Lyman-Mountain View area is in east-central Uinta County near the southwestern corner of Wyoming. Its southwest corner is about 22 miles east and about 7 miles north of the southwest corner of Wyoming. The area, which measures 18 miles east to west and a maximum of 22 miles north to south, covers about 300 square miles. Figure 1 shows the location of the report area.

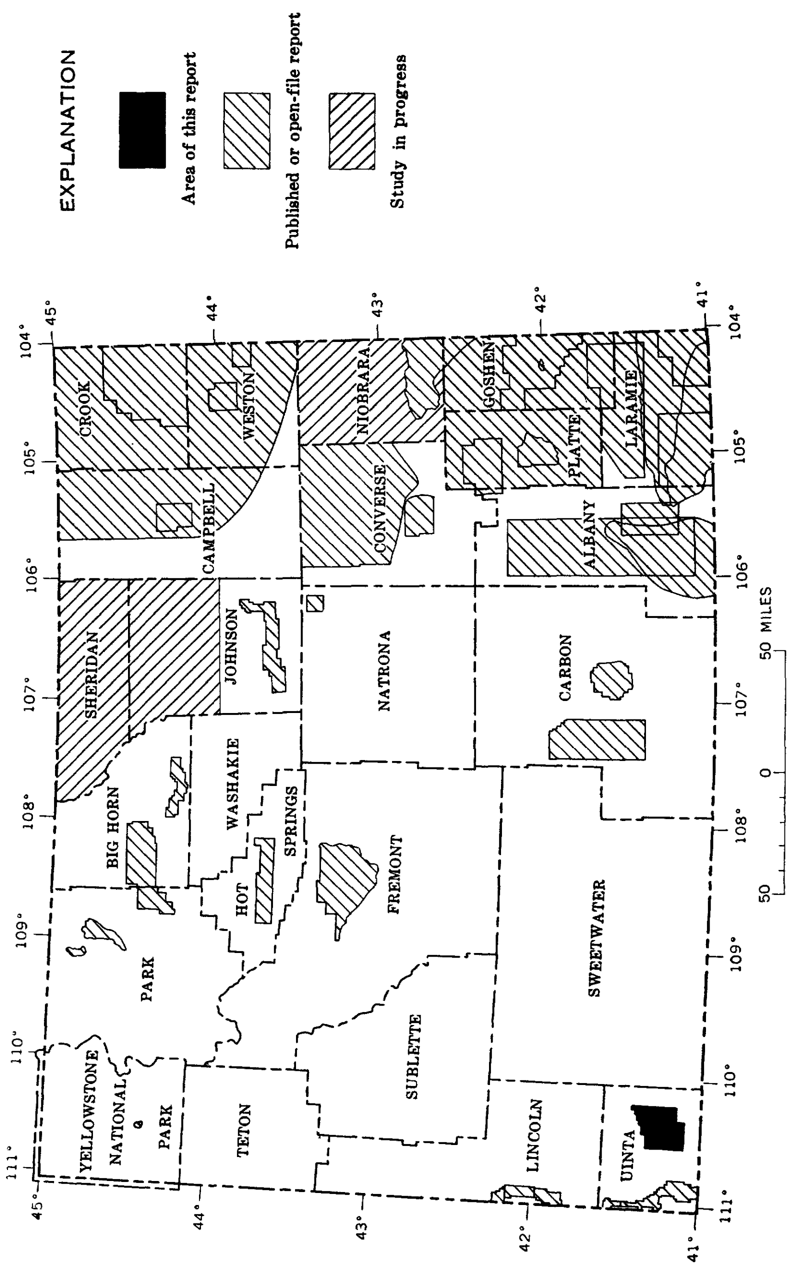

FIGURE 1.—Map of Wyoming showing the area described in this report and other areas for which ground-water reports have been released or are in preparation.

PREVIOUS INVESTIGATIONS

Bradley (1936) discussed the geology and geomorphology of the north flank of the Uinta Mountains and the adjacent Green River basin, which includes the area of this report. Later geologic investigations have been limited mainly to the study of the stratigraphy and structure of the bedrock formations, and little additional work has been done on the Quaternary deposits.

Hydrologic investigations in the area have been concerned primarily with the collection of streamflow data for the major streams draining the southwestern part of the Green River structural basin. The records of streamflow are published in the annual series of U.S. Geological Survey water-supply papers entitled "Surface-water supply of the United States, part 9" (issued annually). The location of the gaging stations for which records are available are shown as follows:

Stream and location	*Period of record*
Blacks Fork 15 miles southwest of Millburne.	July 1939 to October 1958.
Blacks Fork near Urie	August 1913 to September 1924, October 1937 to September 1955.
East Fork of Smith Fork near Robertson.	July 1939 to October 1958.
West Fork of Smith Fork near Robertson.	July 1939 to October 1958.
Smith Fork at Mountain View	May 1941 to December 1957.
Blacks Fork near Lyman	October 1937 to December 1957.

ACKNOWLEDGMENTS

The cooperation of several people has aided greatly in the preparation of this report. Mayor Desmond Phillips of Lyman gave information on the Lyman municipal water supply. The late Emil Gradert of Fort Bridger, Superintendent of Wyoming Water Division No. 4, gave information on surface-water irrigation in the area. Well drillers and well owners supplied data on wells and the water-bearing formations.

WELL-NUMBERING SYSTEM

The wells are numbered according to the Federal system of land subdivisions. All wells are in the sixth principal meridian and baseline system. The well number indicates the location of the well by township, range, section, and position within the section, as shown on figure 2. The first numeral of a well number indicates the township, the second the range, and the third the section in which the well is located. The lowercase letters following the section number indicate the position of the well within the section. The first letter denotes the quarter section, the second the quarter-quarter section,

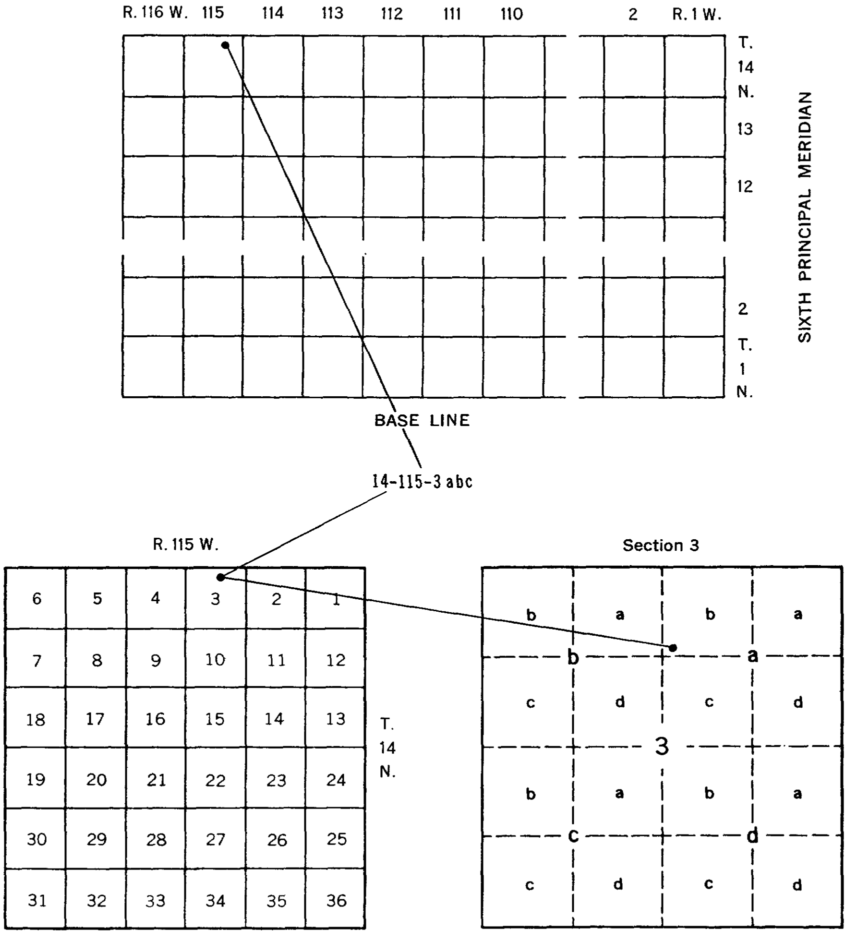

FIGURE 2.—Sketch showing well-numbering system.

and the third the quarter-quarter-quarter section (10-acre tract). The subdivisions of the section are lettered a, b, c, and d in a counterclockwise direction, beginning in the northeast quarter. Where more than one well is in a 10-acre tract, consecutive numbers beginning with one are added to the well numbers. This numbering system is used also to designate the location of springs and sites where surface-water samples were collected for analysis.

GEOGRAPHY

The Lyman-Mountain View area is in the southwestern part of the Green River basin; the area is drained by Blacks Fork and its major tributary, Smith Fork. The lowest point in the area is about 6,500 feet above sea level at the junction of Blacks and Smith Forks; the highest altitudes, about 8,000 feet, are along the southern border in the foothills of the Uinta Mountains. The land slopes generally northeastward, parallel to Blacks and Smith Forks. Flat-topped interstream divides, which are irrigated and farmed, contrast sharply with the badlands along Little Dry and Cottonwood Creeks.

The communities in the area are primarily local trading centers for the people who live on nearby farms and ranches. Fort Bridger, the earliest settlement in the area, was established in 1842 as a trading post by Jim Bridger, the frontier scout, and later became an army post, the second in Wyoming. Today the remains of the fort are an historical site in the town of Fort Bridger. The population of Fort Bridger was about 150 in 1960.

The first agricultural settlement in Wyoming was established in 1853 on Smith Fork about 9 miles south of Fort Bridger in the vicinity of Fort Supply. Fort Supply was burned in 1857 and was never rebuilt. Fort Bridger was burned at the same time but was rebuilt in 1858 and became a military post. The town of Mountain View was established in 1891, and the town of Lyman (originally called Owen) was founded in 1898. The population of Lyman in 1960 was 425; Mountain View's population in 1960 was about 400.

A canal was constructed to divert water from Blacks Fork in 1891, and irrigated farming was begun along the valleys of Blacks Fork and Smith Fork. Canals were later built to divert water into the terraces. At the present time most of the terraces are irrigated and farmed; Bridger Bench is the major exception.

Records of precipitation have been kept at the Fort Bridger airport, about 6 miles north of Fort Bridger, for the years 1940–56 and at Lyman for 1922–30 and 1956 to the present (1959). The average annual precipitation at the Fort Bridger airport (1940–56) was 10.94 inches and ranged from 6.52 inches in 1948 to 16.79 in 1945. The average annual precipitation at Lyman for the period 1922–30 was 11.92 inches. The average was not computed for the recent short period of record. These records are representative of precipitation in the Green River basin at altitudes of about 6,700 to about 7,000 feet. In the southern part of the area, where altitudes may exceed 8,000 feet, the amount of precipitation probably is somewhat greater. Water from melting snow provides much of the flow of Blacks and Smith Forks, which is diverted for irrigation.

Precipitation in the Lyman-Mountain View area generally is greatest in the summer and fall; however, more than 1 inch may fall during any month of the year. The greatest monthly precipitation on record was 3.84 inches in August 1945.

The mean annual temperature at the Fort Bridger airport is 41.2° F. Temperatures ranged from −20° F to 107° F during the period of record. The average frost-free season is about 110 days but varies with altitude.

GEOLOGY

The Green River basin is a broad structural depression that occupies about 15,000 square miles of southwestern Wyoming. The basin is bounded on the south by the east-trending anticlinal fold that forms the Uinta Mountains of Utah and on the west by a broad overthrust belt that marks the eastern border of the Central Rocky Mountains. The northern and eastern boundaries are formed by the Wind River arch and the Rawlins and Miller Hill uplifts. Lyman and Mountain View are in the Bridger basin, which is the western part of the Green River basin.

The Lyman-Mountain View area is adjacent to the northern flank of the Uinta uplift. The Uinta Mountains, which rise sharply a few miles to the south, are carved from rocks ranging from Precambrian to Late Cretaceous in age. The strata dip northward near the mountains and eastward near Lyman, where they are unconformably overlain by deposits of Tertiary age. The Tertiary deposits reach a thickness of at least 1,850 feet in the vicinity of Lyman and a thickness of several thousand feet near the center of the Green River basin.

SUMMARY OF STRATIGRAPHY

Because pre-Tertiary rocks lie at great depths throughout much of the Lyman-Mountain View area, they are not considered to be potential sources of ground water for most uses. Only Tertiary and Quaternary deposits are discussed in detail in this report. A summary of the stratigraphic section and comments on the water-bearing characteristics of the rocks are given in table 1. The areas of outcrop of the geologic formations and their stratigraphic relations are shown in plate 1.

TABLE 1.—*Summary of stratigraphic units, their water-bearing properties, and chemical quality of ground water*

System	Series	Stratigraphic unit	Symbol used in plate 1	Thickness (feet)	Physical character and areal extent	Ground-water supply	Chemical quality of water
Quaternary	Recent and Pleistocene	Alluvium	Qal	0–43+(?)	Poorly sorted sand, gravel, and silt containing boulders as much as 2 ft in diameter. Predominantly sand, but a large percentage of material is 2 in. to 1 ft in diameter. Underlies major stream valleys.	Yields small quantities of water to stock and domestic wells. Moderate quantities may be available in some areas.	Water is of the calcium or sodium bicarbonate type, soft to very hard, and may contain iron in concentrations capable of causing objectionable taste and staining. Dissolved solids may be expected to range from 200 to 400 ppm.
		Moraine deposits of the Blacks Fork glacial stage	Qmb	0–(?)	Poorly sorted silt, sand, and gravel; contain boulders as much as 2 ft in diameter. Small areal extent.	No wells have been drilled in moraine deposits. Water-bearing properties not known.	Quality of water not known.
		Moraine deposits of the Little Dry glacial stage	Qml				
		Terrace deposits along Cottonwood Creek	Qtc	0–40	Physical character similar to alluvium. Terrace deposits are principally between Blacks Fork and Smith Fork, but remnants of Qtt and Qtc lie east and west of the two streams.	Yield small quantities of water to many stock and domestic wells. Moderate quantities may be available in some areas. Recharge to terrace deposits is principally from downward seepage of applied irrigation water.	Waters from terrace deposits differ considerably in chemical character. Deposits of Tipperary Bench seem to yield very hard sodium chloride sulfate waters with dissolved solids in excess of 2,500 ppm. Deposits in Nebraska Flat seem to yield calcium bicarbonate waters with less than 400 ppm. Deposits of Lyman terrace are expected to yield waters of mixed type with dissolved solids ranging between 500 and 1,000 ppm.
		Terrace deposits along Blacks Fork	Qtb				
		Terrace deposits underlying Lyman Bench and adjacent terraces	Qtl_1, Qtl_2, Qtl_3 — Qtl				
		Terrace deposits underlying Tipperary Bench and Nebraska Flat	Qtt				

Tertiary	Miocene (?)	Browns Park Formation	Tbp	0–(?)	Conglomerate and sandstone. Formation underlies Bridger Bench, Bridger Butte, Cottonwood Bench, and some areas between Blacks Fork and Smith Fork in the southern part of the area.	Probably capable of yielding small quantities of water where saturated.	Quality of water not known.
		Bishop Conglomerate	Tbi	0-100±	Conglomerate and sandstone. Unit underlies a small area in the southwestern corner of the report area.	May be capable of yielding small quantities of water where saturated.	
	Eocene	Bridger Formation	Tb	0–1,000(?)	Green to gray shale and siltstone, tuffaceous sandstone, and some limestone. Formation underlies major part of report area.	Yields small quantities of water to many stock and domestic wells.	Water of lower mineralization (500 ppm) is of the calcium sodium bicarbonate type and suitable for most domestic uses. Water of higher mineralization (5,000 ppm) is of the sodium sulfate type and unsuitable for most uses.
		Green River Formation: Laney Shale and Wilkins Peak Members undifferentiated	Tgr	[1] 700±	Thin-bedded drab sandstone, siltstone, and mudstone, paper shale, and some thin limestone beds. Members underlie surface in northern part of report area; covered by Bridger formation in southern part.	Yield small quantities of water to a few stock and domestic wells. Moderate quantities might be obtained from deep wells in some areas.	Quality of water not known; reported poor to fair.
		Wasatch Formation	----------------	[1] 1,200+	Shale and sandstone, and some limestone. Formation not exposed but probably underlies entire area at depth. Deepest formation reached by drilling in the area.	Supplies moderate quantities of water to two flowing wells in the vicinity of Lyman.	Water is of the sodium sulfate type and of moderate to high mineralization. It generally is acceptable for domestic use, although concentrations of iron may cause objectionable taste and staining.

[1] Thickness measurement applies to northern part of area; thickness is probably somewhat less in southern part.

GROUND WATER

PRINCIPLES OF OCCURRENCE

The following discussion on the occurrence of ground water is adapted in part from Meinzer (1923), and the reader is referred to his report for a more detailed discussion of the subject.

The rocks that form the outer crust of the earth generally contain open spaces called voids or interstices. These open spaces are the receptacles that hold the water that is found below the surface of the land and is recovered, in part, through wells and springs. The amount of water that can be stored in any rock depends upon the volume of the rock that is occupied by open spaces—that is, the "porosity" of the rock. The capacity of a rock to hold water is determined by its porosity, but its capacity to yield water is determined by its permeability. The "permeability" of a rock may be defined as its capacity for transmitting water under hydraulic head, and it is measured by the rate at which the rock will transmit water through a given cross section under a given difference of head per unit of distance. Rocks that will not transmit water are said to be impermeable. Some deposits, such as dense silt or clay, may have a high porosity but, because of the small size of the pores, transmit water slowly. Other deposits, such as well-sorted gravel containing large openings that are freely interconnected, transmit water readily. Part of the water in any deposit is not available to wells, because it is held against the force of gravity by molecular attraction.

Rocks that are saturated with water are said to be in the "zone of saturation," and the upper surface of the zone is called the "water table." In the Lyman-Mountain View area the depth to the water table ranges from 0 to 50 feet below the land surface. The pressure at the water table is atmospheric. Below the water table the pressure is greater than atmospheric; that is, hydrostatic pressure exists. Just above the water table the pressure is less than atmospheric, and water is held up by capillary force, forming a zone known as the "capillary fringe."

The capillary fringe, and the unsaturated zone above it, make up the "zone of aeration." Interstices in the lower part of the capillary fringe may be full of water, but this is not a part of the zone of saturation as defined. Water in the zone of aeration is not available to wells but may be withdrawn by plants and by evaporation from the soil.

WATER-TABLE CONDITIONS

Ground water in the alluvial and terrace deposits in the Lyman-Mountain View area is under water-table conditions; that is, it is not confined by impermeable beds. The water table is not a plane surface but has irregularities comparable with and related to those of the land surface, although it is less uneven. The water table is generally closer to the surface in topographically low areas and is deeper under topographically high areas. Exceptions to this, however, are the terraces between Blacks and Smith Forks, where the water table is maintained at a high level because of recharge resulting from the application of large amounts of irrigation water.

When a well is constructed in a water-table aquifer, such as the alluvium and terrace gravels, the water level in the well will stand at the same level as the water in the aquifer. When the well is pumped, water will be removed from the water-bearing material in the vicinity of the well by gravity drainage, and the water level in the aquifer will decline as the water moves toward the well from all directions. When the pump is shut off, the water in the aquifer will continue to flow into the space dewatered by the pumping until the water level in the well and in the aquifer returns to its normal level.

The major stream valleys and much of the uplands in the Lyman-Mountain View area are underlain by deposits of sand, gravel, and silt that are more than 40 feet thick in some localities. These deposits are the most permeable in the area and, when saturated, are capable of yielding moderate quantities of water to wells and springs.

ARTESIAN CONDITIONS

Ground water in the permeable bedrock strata in the Lyman-Mountain View area is under artesian pressure; that is, it is confined in permeable sandstone beds between relatively impermeable beds of siltstone or claystone. When a well is drilled into an artesian aquifer, the water will rise in the well above the top of the aquifer to a height dependent upon the pressure in the aquifer. A well of this type is termed an "artesian well." If the pressure is great enough to raise the water above the land surface, the well is termed a "flowing artesian well."

Shale, siltstone, and sandstone constitute the bulk of the bedrock formations in the area from the surface to the lowest depths reached by drilling. The shale and siltstone are relatively impermeable and where tapped by wells generally transmit only enough water for domestic or stock use. The more permeable sandstone beds may yield moderate quantities of water to wells in some areas.

The principal artesian aquifers are sandstone beds in the Wasatch, Green River, and Bridger Formations. Flowing wells, however, have been drilled only in the Wasatch Formation. Artesian pressure in the overlying formations is sufficient in some localities to raise the water to within a few feet of the land surface, but not above it.

RECHARGE

Recharge is the addition of water to the ground-water reservoir. It may be accomplished in several ways. The terrace and alluvial deposits are recharged by precipitation that falls directly on them, by downward seepage of irrigation water from ditches and irrigated fields, and by seepage of water from stream channels. The bedrock formations are recharged principally by precipitation as rain and snow and also by the seepage of water from the channels of intermittent streams.

DISCHARGE

Discharge is the withdrawal of water from the ground-water reservoir by natural or artificial means. Water in the ground-water reservoir is continually moving toward points of discharge at a very slow rate. The water may be discharged through springs and seeps, by transpiration of plants, by evaporation, or by pumping from wells.

Springs in the Lyman-Mountain View area generally are at the base of terrace gravels, along the contact with the underlying bedrock. Roberts Spring (15-115-16c) is an example of such contact springs. Because the water is moving through the highly permeable terrace gravels at a faster rate than it can enter the underlying bedrock, it emerges as springs at points where the contact is incised by streams or gullies.

Large amounts of water are discharged directly to the atmosphere as transpiration by native plants and irrigated crops. Where the water table is at, or close to, the land surface, ground water is discharged by evaporation from water surfaces and the capillary fringe in the soil.

Water obtained from wells is used mainly for domestic and stock use. The amount of water discharged from the ground-water reservoir was not determined during this study.

WATER-LEVEL FLUCTUATIONS

Water-level measurements record the amount of fluctuation of water level during the period of measurement. Because the amount of water in storage in a water-table aquifer is related to the height of the water table in the same manner as the amount of water stored behind a dam is related to the altitude of the water surface in the reservoir, the fluctuations of water levels in wells reflect changes in the amount of water stored in the aquifers. Thus, high water levels in wells indicate that more water is in storage than when water levels are low. The estimate of differences in amount of stored water that can be made from the measurements are only comparative values; it was not feasible in this study to determine quantitatively the relation of water-table altitude to storage.

The water levels in wells in alluvial and terrace deposits generally stand within a few feet of the land surface and fluctuate in response to changes in the amount and rate of recharge and discharge. Table 2 shows that during the irrigation season (usually April through September), when large amounts of water are applied to the soil, the water levels are high. During fall and winter the water levels gradually decline until irrigation is resumed in the spring.

Water levels in the consolidated bedrock where irrigation water is a source of recharge may be expected to fluctuate in the same general patterns as wells in the terrace deposits but probably not as widely.

The depths to water have been measured periodically from April 1957 to October 1960 in nine observation wells in the Lyman-Mountain View area. Eight of the wells tap alluvial and terrace deposits, and one taps the Bridger Formation. Table 2 shows the depths to water and dates of measurement.

TABLE 2.—*Depths to water (feet below land surface) in observation wells in the Lyman-Mountain View area*

[Symbols for aquifers are those used in pl. 1]

Well	Aquifer	Apr. 24, 1957	May 7, 1957	June 13, 1957	Aug. 13, 1957	Oct. 11, 1957	Apr. 12, 1958	Sept. 29, 1958	Apr. 9, 1959	Sept. 18, 1959	June 4, 1960	Oct. 10, 1960
15-114-3cbc	Tb	22.13	21.32	14.81	17.22	19.68	20.50	22.30	23.45	20.68	16.66	22.92
15-114-4daa2	Qtl_2	2.54	2.28	.00	1.61	3.89	1.57	5.83	6.54	3.80	1.20	3.65
15-114-10ccc	Qtl_1	-------	.40	.00	1.85	1.28	1.17	2.30	.00	3.35	.00	3.05
15-115-20cba	Qtb	10.30	9.93	+.04	4.21	6.70	9.09	7.62	8.70	6.96	4.44	8.44
15-115-21cdb2	Qtl	-------	1.80	1.02	.96	3.68	.54	5.60	4.05	5.60	.34	6.45
15-115-23bdd	Qal	2.65	2.78	.00	3.74	4.17	2.87	4.81	1.60	3.82	2.82	2.94
15-115-24bad	Qal	1.20	1.22	-------	3.68	4.14	2.20	5.25	2.55	4.65	2.22	3.66
16-114-27ddd2	Qtl_2	8.47	7.97	1.32	2.99	2.03	8.22	6.46	11.02	3.72	2.24	9.77
16-114-32bcb	Qtl_3	7.51	6.85	1.34	1.24	5.15	4.62	9.04	8.20	8.28	3.85	14.42

WELL AND SPRING INVENTORY

During the course of the investigation, information on the depth of wells, depth to water, and character of the water-bearing formations was collected for 106 wells and 7 springs. The depths were measured by means of a steel tape, when possible; depths that could not be measured are as reported by well owners, tenants, and drillers. Table 3 contains records of wells and springs that were inventoried during the investigation. Their locations are shown on plate 1. Information on the character of the water-bearing formations was obtained from field examination of rock outcrops, well-drillers' logs, and drillers' memories when logs were not available. The well logs given in table 4 were extracted from drillers' records. Some of the stratigraphic interpretations are those of the senior author.

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TABLE 3.—*Records of wells and springs in the Lyman-Mountain View area*

Well or spring number: See text for description of well-numbering system.
Type of supply: B, bored well; Dn, driven well; Dr, drilled well; Du, dug well; Sp, spring.
Depth of well: Measured depths are given in feet and tenths below land surface; reported depths are given in feet.
Type of casing: C, concrete; P, metal pipe; R, rock; T, tile; W, wood.
Character of material: Cl, clay; G, gravel; Ls, limestone; S, sand; Sh, shale; Ss, sandstone.
Geologic source (in alphabetical order): Qal, alluvium; Qtb, minor terrace deposits along Blacks Fork; Qtl, deposits of Lyman terrace numbered in ascending order of elevation; Qtt, deposits of Tipperary terrace; Tb, Bridger Formation; Tbp, Brown Park Formation; Tgr, Green River Formation; Tw, Wasatch Formation.
Method of lift: C, centrifugal; Cy, cylinder; F, flows; J, jet; N, none; T, turbine.
Type of power: E, electric; H, hand; W, windmill.
Use of water: D, domestic; I, irrigation; In, industrial; O, observation; P, public supply; S, stock; U, unused.
Depth to water: Measured depths are given in feet and hundredths; reported depths are given in feet.
Remarks: Ca, chemical analysis in table 5; D, discharge in gallons per minute (E, estimated; R, reported); L, log of well in table 4; T, temperature of water in degrees Fahrenheit.

Well or spring	Owner or tenant	Year drilled	Type of supply	Depth of well (feet)	Diameter of well (inches)	Type of casing	Principal water-bearing bed		Method of lift and type of power	Use of water	Thickness of alluvial or terrace deposits at well site (feet)	Depth to water above (+) or below land surface (feet)	Date of measurement	Remarks
							Character of material	Geologic source						
13-115- 9dbd			Dr	28.0	4	P		Tb (?)	N	U		22.16	May 3, 1957	Seismograph shot holes.
17bab			Dr	36.0	6	P	G	Tbp	N	U		29.67	do	Do.
14-115- 1baa	W. S. Tanner		Dr	65	8	P		Tb	Cy, H	S		50	May 1957	
2cbc1	Katy Vehar	1911	Du	15	48	W	G	Qtt	C, E	D, S		9.11	May 3, 1957	Well can be pumped dry. Water reported to be salty, D 20 R, Ca.
2cbc2	do		Dr	65	6	P			N	U				
3abc	Lyle Slagowski		Du	24.0	48×48	W	G	Qtt	J, E	D		9.24	Apr. 27, 1957	Water reported hard.
5aac	C. D. Hamilton		Dr	56.8	6	P			N	U		6.79	Apr. 26, 1957	Do.
5ccd			B	9.0	6	P	G	Qal	N	U		4.18	do	
9dad	H. O. Jackman		Du	17.0	11	P	G	Qtt	Cy, H	D				Well can be pumped dry.
11bcb1	R. L. McCulloch.		Du	26.0	24	T	S, G	Qtt	Cy, H	S	25	18.10	Apr. 27, 1957	Water reported to be high in sulfate and hard, L.

11bcb2	do	1954	Dr	62.0	6	P		Tb	J, E	D, S		25.41	do	Depth to water measured while pumping. Water reported to be of very poor quality.
16ddd	Clifford F. Graham		Du	30.0	8	R, T	Ss	Tb	J, E	D	18	26.31	do	Original depth 32 ft., D 3 E, L, Ca.
19aba	Ralph W. Jenkins.		Dr	44.0	6	P	G	Qal	J, E	D	43	1.50	do	Well reported to be dry in summer of 1956, D 4 E, L, Ca.
19dcd1	Larry Johnson	1951	Dr	60.0	6	P			N	U		4.19	do	
19dcd2	do	1940 (?)	Du	12.0	36×36	C	G	Qal	J, E	D		3.28	do	L.
20bbb	David D. Graham		Du	10	5	T	G	Qal	J, E	D		1.37	do	Water reported to be high in iron.
21baa	Frank Murray		Du	33			Ss	Tb	Cy, W	S	16	18	Apr. 1957	L.
30abc	Lucille B. Johnson.		Du	17.0	12	T	G	Qal	N	U		1.74	May 3, 1957	
33aab			Du	25.0	36	W	G	Qtt	N	U		19.78	Apr. 27, 1957	
14-116-14cdc	B. M. Greene		Du	11	60	T	G	Qtl	J, E	D				
16daa1	Iona W. Clifford		Dr	35	6	P			J, E	D, S				
16daa2	do		Du	12	36		G	Tb				5.77	Apr. 26, 1957	
22caa	Helen Goodrick		Du	12	36		G	Qtl	J, E	D		7.32	do	Well can be pumped dry, L.
23cad1	Sieverts Bros	1945	Du	12	12	T	G, S	Qtl	J, E	D				
23cad2	do	1953	Dr	99	8	P		Tb	N			1.71	Apr. 27, 1957	
24cac	Bern Whittaker	1951	Dr	30.0	6	P	Ss	Tb	J, E	D		3.47	do	Well flowed until 1955. Original depth 34 ft., L.
25aad	Lloyd Wall		Du	12	14	T	G, S	Qal	J, E	D				
15-114-3aaa1	L. D. S. Church		Du	13.4			G	Qtl_1	N	U				
3aaa2	do		Dr	35.3	6	P	G	Qtl_1	Cy, H	U		10.78	Apr. 20, 1957	
3cbc	David Peterson		Dr	45	6	P		Tb	Cy, H	O		22.13	Apr. 24, 1957	Water reported to be of poor quality.
3dcc	do		Du	12.2			G	Qtl_1	N	O		7.05	do	
4add	Wilson McDaniels		Dr	33	6	P	G	Qtl_2	J, E	D		26	Apr. 1957	
4daa1	John C. Peterson		Dr	41.1	6	P		Tb	J, E	D		18.59	Apr. 24, 1957	Water reported to contain sulfate.
4daa2	do		Du	24.8			G	Qtl_2	N	O		2.54	do	
4dcc1	T. E. Dearden		Dr	37	6	P	G	Qtl_2	T, E	D		17	Apr. 1957	
4dcc2	do		Du	13.5			G	Qtl_2	C, E	S		3.72	Apr. 22, 1957	
5ccc	John Noble		Dr	24.0	6	P	G	Qtl_2	Cy, H	D		2.62	Apr. 24, 1957	Original depth 80 feet.
5ddd1	Howard Walker		Du	11.0	48	W	G	Qtl_2	N	U		0.74	May 6, 1957	
5ddd2	do		Dr	125	8	P		Tb	J, E	D		15	May 1957	
5ddd3	do		Dr	200	4	P		Tb, Tgr	C, E	S		5	do	
10ccc	Gus Becker		Du	17.0	48		G	Qtl_1	C	S, O		0.40	May 7, 1957	Ca.
15-115-1ddd	Uinta Livestock Corp.		Dr	30	5	P	G	Qtl_2	J, E	D		5.50	Apr. 24, 1957	Well went dry in 1956.
2dda	Clyde Walker		Du	13	48		G	Qtl_2	N	O		4.32	do	
4cab	Walter Eardley		Du	9	16	P	G	Qal	J, E	D		5	Apr. 1957	L.
4daa	Micheli Bros		Dr	572	11	P	Ss	Tgr	F	D, S			May 7, 1957	Water reported slightly salty, L.

TABLE 3.—*Records of wells and springs in the Lyman-Mountain View area*—Continued

Well or spring	Owner or tenant	Year drilled	Type of supply	Depth of well (feet)	Diameter of well (inches)	Type of casing	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift and type of power	Use of water	Thickness of alluvial or terrace deposits at well site (feet)	Depth to water above (+) or below land surface (feet)	Date of measurement	Remarks
15-115-7add	Aimone Bros.		Dr	170	4	P		Tgr	J, E	S				Water reported to contain much iron.
9ddd	Edward Davidson.		Du	14.0			G	Qtl_3	J, E	S		2.45	Apr. 26, 1957	L.
11aaa1	Ernest Hopkinson.		Dr	18.5	12	T	G	Qtl_2	J, E	D				Water reported to contain sulfate.
11aaa2	do		Du	12.8	48		G	Qtl_2	Cy, H	S, O		6.59	Apr. 24, 1957	
11ddd	Kenneth Fackrell.		Du	13	4½	P	G	Qtl_1	J, E	D, S		3.87	do	
12add	Vernon J. Walker.		Du	10	24	C	G	Qtl_1	C, E	D, S		2.95	do	D 3 E, Ca.
12daa	Don Walker		Du	6.8	30	T	G	Qtl_1	N	U		3.48	do	
13aad	Oscar W. Dahlquist.		Dr	55.0	6	P		Tb	J, E	D		7.23	do	
13cbc	Myron Stringer.		Dr	70	6	P	Cl	Tb	T, E	D		2	Apr. 1957	
13dcb	Anna M. Tripp.		Dn	14	2	P	G	Qal	J, E	D		4	do	
16c	Town of Lyman (Roberts Spring).		Sp				G	Qtl_3		P				Water carried by gravity pipeline 5.95 miles to Lyman, D 212 R, Ca.
20caa	John Cross		Dr	50	6	P		Tb	J, E	D		7	May 1957	
20cba			Du	16.5	24	T	G	Qtb	Cy, H	O		10.30	Apr. 24, 1957	
21abb	Curtis W. Bird.		Dr	50	12	P	G	Qtl_3	T, E	I		3.89	do	Well inadequate for irrigation supply; can be pumped dry in one minute at estimated discharge of 500-600 gpm.
21cdb1	E. R. Hamblin.		Dr	83	6	P	G	Qtl	J, E	D		5	May 1957	

21cdb2	do		Du	10.3	60	W	G	Qtl	N	O		1.80	May 7, 1957	
22ccb	Lawayne Hurdsman.		Du	10.0	48	C	G	Qtl_1	J, E	D		5.25	May 4, 1957	
23aac	Mountain View Schools.	1956	Dr	80	12	P		Qal, Tb(?)	C, E	P		18.12	Apr. 24, 1957	Water level measurement made while pumping, Ca.
23bdd			Du	5.4	24	P	G	Qal	N	O		2.65	do	
24bad			Du	6.5	12	T	G	Qal	Cy, H	O		1.20	do	D 2 E, Ca.
24bbd	U.S. Forest Service.		Dr	50	6	P			J, E	D				
29cca	Daniel X. and John D. Watson.		Du	9.3	36	P	G	Qal	N	S		4.48	Apr. 26, 1957	
33bca	John Hamilton		Du	7	12	T	G	Qal	C, E	D		4	May 1957	Water level depends on stream level.
36ada	W. S. Tanner		Du	35	18	T	Ss	Tb	F	S			May 6, 1957	
36ddb	do		Du	35	12–10	T	Ls	Tb	J, E	D, S		15	do	
15-116-27cdd	Mr. and Mrs. Clarence A. Taylor.		Du	29.5	60	R	S, G	Qtt	J, E	D, S		24.39	Apr. 26, 1957	L.
35dda	George Bugas		Du	9.0	36	R	G	Qtt	J, E	D, S		3.85	do	D 3 E, Ca.
16-114-20bbb	Wayne Shelton		Dr	65	6	P		Tgr	J, E	D		9.18	Apr. 25, 1957	Water reported highly mineralized.
20cda	John and Howard Brinton.		Dr	55	8	P	Ss	Tb(?)	J, E	D, S		15	Apr. 1957	
23dca	Dewey Hoopes		Du	18.4	48	W	Ss, G	Qtl_2, Tb	J, E	D, S		12.25	Apr. 24, 1957	
27ddd1	Keith Maxfield		Dr	95	6–4	P	Ls(?)	Tb	J, E	D, S		41.25	do	
27ddd2	do		Du	13			S, G	Qtl_2	C, H	S, O		8.47	do	
28cdd	Univ. of Wyoming.		Dr	130	6	P		Tb(?)	J, E	D, O		19.45	do	
30abc	Porter Rollins	1911	Dr	1865	9⅝	P	Ss	Tw	F	D	27±	+100	do	D 20 R, L, Ca.
30add	John Brinton		Dr	80	8	P	Ss	Tb		D, S				
31ab	Town of Lyman		Sp				G	Qtl_3	F					D 10–20 E, Ca.
31add1	do	1934	Dr	1200	6¼	P	Ss	Tw	T, E	U	17	+	May 2, 1957	D 2.5 E, L, Ca.
31add2	do	1955	Dr	350	8	P	Ss	Tb, Tgr	N	U	40	4.03	do	L.
31dda1	Mrs. Marian H. Larson.	1955	Dr	42	12	P	G	Qtl_3	J, E	D		12	March 1955	Water reported slightly mineralized and hard.
31dda2	do		Du	13.8	48	R	G	Qtl_3	Cy, H	U		8.26	May 7, 1957	Well goes dry periodically.
32aba	Wyoming Highway Dept.		Dr	100.0	6	P		Tb	J, E	In		7.69	Apr. 25, 1957	Water very salty, unfit for drinking; D 3 E, Ca.
32bcb	Frank Blackner		Du	12.0	36	R	G	Qtl_3	N	O		7.51	Apr. 24, 1957	
32dbc1	Leland Bluemel		Dr	64	6	P	G	Qtl_3	J, E	D		17.72	Apr. 20, 1957	
32dbc2	do		Du	20.0			G	Qtl_3	C, E	S		12.90	Apr. 29, 1957	
33baa	Univ. of Wyoming.		Dr	118.0				Tb	J, E	D		22.08	Apr. 25, 1957	Water reported to be of poor quality.
33cbc1	Ross Reed		Dr	60	8	P		Tb	J, E	D		33	Apr. 1957	
33cbc2	do		Du	16.7			G	Qtl_3	J, E	S		9.66	Apr. 20, 1957	
33dcb	John Platts		Sp				G	Qtl_2		D				D 5 E, T 43.
33ddb1	do		Sp				G	Qtl_2		S				D 1 E, T 45.
33ddb2	do		Sp				G	Qtl_2		I				D 10 E, T 43.
34bbb	Lee Jarman		Du	11.5	48	P	G	Qtl_3	J, E	D	10	3.33	Apr. 25, 1957	L.
34cbc	L. O. Walker		Dr	13.6			G	Qtl_2	Cy, H	D		4.85	Apr. 20, 1957	

TABLE 3.—*Records of well and springs in the Lyman-Mountain View area*—Continued

Well or spring	Owner or tenant	Year drilled	Type of supply	Depth of well (feet)	Diameter of well (inches)	Type of casing	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift and type of power	Use of water	Thickness of alluvial or terrace deposits at well site (feet)	Depth to water above (+) or below land surface (feet)	Date of measurement	Remarks
16-114-34ccb	Mike Vercimak		Sp				G	Qtl$_2$		D				D 5 E, T 46.
35ccc1	L. D. S. Church		Du	13.0			G	Qtl$_1$	N	U		5.61	Apr. 20, 1957	Water reported to be contaminated.
35ccc2	do	1956	Dr	60	6	P		Tb	J, E	D, S				Well flows during spring season, D 8 R.
16-115-24ccc	Elmer Saxton		Dr	110	6	P	Sh	Tgr	J, E	D, S	11	41.36	Apr. 25, 1957	Water reported unfit for drinking; L.
25bcc	Steve Vercimak		Dr	65	6	P		Tgr	J, E	D, S		30	Apr. 1957	Water reported unfit for drinking.
25caa	Lester St. Jeor		Du	9.0	24	T	G	Tb	J, E	D		0.73	Apr. 25, 1957	
25cbb	Kenneth Ellsworth.		Dr	105				Tgr	J, E	D		43.61	do	Water reported unfit for drinking.
26bcb	Louis Zanolli		Sp				G	Qtb		D				Discharge fluctuates slightly in response to irrigation. D 5-10 E, T 47.
26bcc1	do		Du	17			G, S		N			1.00	Apr. 25, 1957	
26bcc2	do		Dr	134	12	P		Tgr	J, E	D	11			L.
33ccd	J. M. Sharp		Dr	53.5	8	P	Cl, G	Qal, Tgr(?)	J, E	D	13	2.08	Apr. 25, 1957	D 3 E, L, Ca.
34dba	Micheli Bros		Du	25.6	48		G	Qtb	Cy, H	S, O		1.50	Apr. 24, 1957	
35bab	Ray R. Wright		Dr	74	6	P		Tgr	J, E	S		15	Apr. 1957	
35daa	do		Dr	60	6	P		Tgr	J, E	D, S		15	do	Water reported to be of good quality.
35ddd	Allan Sellers		Du	16	36	P	G	Qtl$_3$	C, E	D, S		5.92	Apr. 25, 1957	
36cdd	Andy Motichka		Du	13.0	60	C	G	Tb	J, E	D, S		8.39	May 7, 1957	

TABLE 4.—*Drillers' logs of wells in the Lyman-Mountain View area*

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
14-115-11bcb1 [Owner or tenant, R. L. McCulloch]					
Terrace deposits:			Bridger Formation:		
Rock and red sand	25	25	Shale or clay	1	26
14-115-16ddd [Owner or tenant, Clifford F. Graham]					
Terrace deposits:			Bridger Formation:		
Gravel and sand	18	18	Clay	10	28
			Sandstone	4	32
14-115-19aba [Owner or tenant, Ralph W. Jenkins]					
Alluvium:			Bridger Formation:		
Gravel	43	43	Sandstone, gray	1	44
14-115-19dcd2 [Owner or tenant, Larry Johnson]					
Alluvium:			Clay	3	6
Gravel	3	3	Gravel	8	[1] 14
14-115-21baa [Owner or tenant, Frank Murray]					
Terrace deposits:			Bridger Formation:		
Gravel	16	16	Sandstone, blue	17	33
14-116-22caa [Owner or tenant, Helen Goodrick]					
Terrace deposits:					
Gravel	12	12			
14-116-24cac [Owner or tenant, Bern Whittaker]					
Bridger Formation:			Shale, blue	13	30
Gumbo	6	6	Sandstone	4	34
Hardpan	11	17			
15-115-4cab [Owner or tenant, Walter Eardley]					
Alluvium:					
Gravel	9	9			

See footnotes at end of table.

TABLE 4.—*Drillers' logs of wells in the Lyman-Mountain View area*—Continued

15-115-4daa

[Owner, Micheli Bros.]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
No record—log was made while deepening well from original depth of 415 feet. Top of Green River formation near land surface	415	415	Shale, red	2	532
Green River Formation:			Sandstone, gray, water-bearing. Well bailed at rate of 6 gpm; water reported good, soft	7	539
Shale, gray. Gas odor	62	477	Sandstone, gray, water-bearing. Well flowed 1.2 gpm	3	542
Shale, brown. Gas odor	3	480	No record	8	550
Shale, variegated, very hard	5	485	Sandstone, gray, very hard, water-bearing. Well flowed 1.6 gpm	10	560
Oil shale, brown. Strong gas odor	25	510	Shale, red	12	572
Shale, gray. Gas odor	20	530			

15-115-9ddd

[Owner or tenant, Edward Davidson]

Material	Thickness (feet)	Depth (feet)
Terrace deposits:		
Gravel	16	16
Clay	------	[2] 16

15-116-27cdd

[Owner or tenant, Mr. & Mrs. Clarence A. Taylor]

Material	Thickness (feet)	Depth (feet)
Soil	3	3
Terrace deposits:		
Sand and gravel	29	[3] 32

16-114-30abc

[Owner or tenant, Porter Rollins]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Terrace deposits	27	27	Wasatch Formation—Continued		
Incomplete record indicates water-bearing shale at 30 ft, inflammable gas at 165 ft, water-bearing sandstone at 640 ft	618	645	Shale, gray	35	775
Wasatch Formation:			Shale, red (water-bearing sandstone at 1,009 ft, well flowed)	234	1,009
Shale, red	50	695	Sandstone, fractured	181	1,190
Sandstone (water and show of oil)	10	705	Limestone	45	1,235
Shale, red	35	740	Sandstone (water)	45	1,280
			Shale, white	15	1,295
			Sandstone (water)	10	1,305
			Shale, white	10	1,315

See footnotes at end of table.

TABLE 4.—*Drillers' logs of wells in the Lyman-Mountain View area*—Continued

Material	Thickness (feet)	Depth (feet)
16-114-30abc—Continued [Owner or tenant, Porter Rollins]		
Wasatch Formation—Continued		
Sandstone (water)	10	1,325
Sandstone, fractured	140	1,465
Limestone	15	1,480
Sandstone, fractured	10	1,490
Shale, green	10	1,500
Sandstone (water; well flowed)	65	1,565
Sandstone, fractured	36	1,601
Sandstone, white (water, largest flow encountered)	24	1,625
Shale, blue	20	1,645
Wasatch Formation—Continued		
Limestone (water?)	10	1,655
Shale, white, sandy	30	1,685
Sandstone, white and buff	25	1,710
Shale, white	50	1,760
Shale, black	5	1,765
Shale, brown	15	1,780
Shale, gray	53	1,833
Limestone	2	1,835
Sandstone (water)	15	1,850
Shale, black	15	1,865
16-114-31add1 [Owner, town of Lyman]		
Terrace deposits:		
Sand and gravel	17	17
Bridger and Green River Formations:		
Shale, gray	35	52
Limestone, blue(?)	138	190
Shale, brown, hard (water)	20	210
Shale, blue	5	215
Shale, white	5	220
Shale, white, with bentonite	5	225
Shale, sandy	20	245
Shale, gray, sandy	10	255
Shale, brown	5	260
Shale, gray	10	270
Shale, brown	10	280
Shale, gray	5	285
Shale, blue	5	290
Shale, brown	5	295
Shale, buff	10	305
Shale, gray	14	319
Limestone, hard	32	351
Shale, brown	7	358
Limestone, gray	14	372
Shale, brown	13	385
Limestone, gray	18	403
Sandstone, tuffaceous(?). (Driller logged "talc")	22	425
Sandstone	3	428
Limestone	22	450
Shale, brown	5	455
Limestone	45	500
Shale, brown	5	505
Shale, white, calcareous	19	524
Shale, blue	13	537
Shale, gray	18	555
Shale, blue	8	563
Sand, soft (Driller logged "quicksand")	29	592
Shale, blue	13	605
Shale, gray	17	622
Shale, brown	6	628
Shale, gray	47	675
Shale, brown	10	685
Shale, gray	20	705
Limestone, white	10	715
Shale, blue	44	759
Sandstone	1	760
Shale, brown	5	765
Rock, hard	5	770
Shale, gray	10	780
Limestone	5	785
Limestone, blue	10	795
Limestone	15	810
Wasatch Formation:		
Shale, red	50	860
Shale, red calcareous	------	860
The well is 1,200 ft deep. No log is available from 860 to 1,200 ft but the chief water-bearing beds are reported to have been penetrated at 900, 1,050, and 1,150 ft.		

TABLE 4.—*Drillers' logs of wells in the Lyman-Mountain View area*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
16-114-31add2 [Owner, town of Lyman]					
Terrace deposits:			Clay, blue, sticky	16	240
Clay and boulders	40	40	Clay, brown, sticky	20	260
Bridger and Green River Formations:			Clay, blue, sticky	22	280
Clay, blue (little water at bottom)	150	190	Shale, gray	23	305
Sandstone, hard	10	200	Clay, blue, sticky	10	315
Sand, muddy (little water)	24	224	Shale, gray, hard	5	320
			Clay, blue, sticky	28	348
			Shale, brown (gas odor)	2	350
16-114-34bbb [Owner or tenant, Lee Jarman]					
Terrace deposits:			Bridger Formation:		
Gravel	10.5	10.5	Clay	1	11.5
16-115-24ccc [Owner or tenant, Elmer Saxton]					
Terrace deposits:			Clay, blue	5	63
Sand and boulders	11	11	Shale, blue, flaky (Reported hard water)	2	65
Green River Formation:			Clay, blue (water level 25 ft below land surface)	2	67
Clay, yellow and brown	5	16	Shale, blue-green	23	90
Rock	2	18	Clay, gray	10	100
Clay, brown	16	34	Clay and shale	5	105
Clay, brown, sandy	4	38	Rock	1	106
Clay, blue	12	50	Clay and flaky shale	4	110
Shale, blue	2	52			
Clay, blue	4	56			
Shale, blue, flaky	2	58			
16-115-26bcc2 [Owner or tenant, Louis Zanolli]					
Terrace deposits:			Rock	1	29
Boulders	11	11	Clay, blue	27	56
Green River Formation:			Rock	3	59
Clay, blue-gray	2	13	Clay, blue	35	94
Rock	3	16	Shale, blue, flaky	2	96
Clay, brown	7	23	Sandstone, gray	28	124
Clay, brown, sandy	4	27	Clay, blue	9	133
Clay, brown	1	28	Rock	1	134
16-115-33ccd [Owner or tenant, J. M. Sharp]					
Alluvium:			Clay, sandy	12	[4] 55
Gravel	13	13			
Green River Formation:					
Clay, blue	30	43			

[1] Original depth 14 ft; measured depth 12 ft.
[2] Reported depth 16 ft; measured depth 14.0 ft.
[3] Reported depth 32 ft; measured depth 29.5 ft.
[4] Reported depth 55 ft; measured depth 53.5 ft.

STRATIGRAPHIC UNITS AND THEIR WATER-BEARING PROPERTIES

TERTIARY SYSTEM

The Tertiary System in the Lyman-Mountain View area is represented by rocks of Eocene and Miocene(?) age. Strata of Paleocene, Oligocene, and Pliocene age either were not deposited or were removed by erosion.

WASATCH FORMATION

The Wasatch Formation of early Eocene age does not crop out in the area, but its top is penetrated at a depth of 810 feet in a deep well (16–114–31add1) at Lyman and at a depth of 645 feet in a well (16–114–30abc) at the Porter Rollins ranch 1 mile north of Lyman. The driller's log of the Rollins well (table 4) describes the Wasatch Formation as a sequence of predominantly red, white, and green shale with some interbedded sandstone and limestone. Darker shale was penetrated near the bottom of the well. The thickness of the formation is estimated to be at least 1,200 feet at the Rollins ranch and greater in the northern part of the area.

Only the two wells just mentioned are known to yield water from the Wasatch Formation in the Lyman-Mountain View area. The Lyman well is 1,200 feet deep and formerly was used for a municipal supply. The well flowed an estimated 2.5 gpm (gallons per minute) in 1959; previously, it reportedly produced 250 gpm by pumping. There is no record of the artesian pressure or of the drawdown at a discharge rate of 250 gpm.

The well at the Rollins ranch is 1,865 feet deep and flows at a reported artesian pressure of 45 pounds per square inch, which corresponds to a head of about 100 feet above the land surface. The flow could not be measured, but it is sufficient for domestic and stock use.

GREEN RIVER FORMATION

The Green River Formation of Eocene age comprises two members in the Lyman-Mountain View area, the Wilkins Peak Member (lower) and the Laney Shale Member (upper). The members have not been differentiated in this report. The formation consists of gray to black and drab-yellow thin-bedded sandstone, siltstone, and mudstone, gray fissile shale, and gray to green limestone. Beds of fibrous calcite from ¼ to 2 inches thick are common. The thickness of the formation is about 700 feet in the vicinity of Lyman; it probably is somewhat less in the southern part of the area owing to the progressive thinning of Tertiary deposits toward the margins of the Green River basin.

Nine wells in the Lyman-Mountain View area obtain water entirely from the Green River Formation. The depths of the wells range from 60 to 572 feet, and water levels range from about 9 feet to more than 40 feet below the land surface. All are domestic or stock wells, and most are reported to be adequate for their use. The quality of the water is reported to be generally fair to poor, though some supplies are reported to be unfit for human consumption.

BRIDGER FORMATION

The Bridger Formation of middle and late(?) Eocene age overlies the Laney Shale Member of the Green River Formation with a gradational and apparently conformable contact in the Lyman-Mountain View area. The rocks composing the formation are light-green to gray shale, siltstone, and tuffaceous sandstone containing some thin hard buff limestone beds.

Many stock and domestic wells obtain water from the Bridger Formation in the Lyman-Mountain View area. Wells range in depth from about 10 to 130 feet with the exception of one well (16–114–31add2), 350 feet deep, that is owned but not used by the town of Lyman. The water level in most wells is less than 20 feet below the surface and the quantities of water obtained generally are reported to be adequate for small-scale use. A number of water supplies were reported to be highly mineralized and unfit for drinking.

BISHOP CONGLOMERATE AND BROWNS PARK FORMATION

The Bishop Conglomerate of Miocene(?) age unconformably overlies older rocks and extends from the Uinta Mountains into the Green River basin. It was deposited on the Gilbert Peak erosion surface, which truncates both hard and soft rocks in the basin, and it overlies the Bridger and Green River Formations in the report area. The conglomerate is characteristically poorly sorted, moderately to firmly cemented, and ranges in grain size from fine gravel to small boulders as much as 1 foot in diameter. Its matrix consists of sandstone. In the report area the rocks were derived for the most part from the Uinta Mountain Group of Precambrian age, which forms the core of the Uinta Mountains.

The Browns Park Formation of Miocene(?) age lies upon the Bear Mountain erosion surface. It consists of a basal conglomerate overlain by sandstone; only the basal conglomerate is present in the report area. The most prominent exposures of the conglomerate are in Bridger Bench, Bridger Butte, Cottonwood Bench, and a few areas south of Robertson between Little Dry Creek and Blacks Fork.

Only one well in the area (13–115–17bab) taps the Browns Park Formation; no wells are known to obtain water from the Bishop Conglomerate. Both formations underlie areas that are on drainage divides, and they are dissected by streams which have cut into the underlying formations. The rocks making up the formations have favorable water-bearing characteristics, but, because of their high topographic position and consequent good drainage, they probably do not contain large amounts of ground water. It is likely that small supplies of ground water could be developed in localities where the formations are partly saturated. No chemical analyses of water from either formation were made.

QUATERNARY SYSTEM

TERRACE DEPOSITS

Terrace deposits of Quaternary age, which were formerly flood plains of Blacks Fork and Smith Fork, underlie a large part of the report area. Most of them are between Blacks Fork and Smith Fork, but Nebraska Flat and Tipperary Bench lie west and east, respectively, of the main streams. Minor terraces have been formed along Cottonwood Creek.

The senior author does not intend to propose formal names for the various terrace deposits in the area, but, for convenience in this report, the names Tipperary terrace and terrace deposit, Lyman terraces and terrace deposits, Blacks Fork terraces and terrace deposits, and Cottonwood Creek terrace and terrace deposit will be used.

ORIGIN OF TERRACE DEPOSITS

The origin and formation of the terraces and the evolution of the present landscape have been ably treated by Bradley (1936), and the reader is referred to that publication for detailed information. Only a cursory treatment of the subject will be given here.

The Bear Mountain erosion surface, which is regarded by Bradley (1936, p. 180) as a pediment, covered a large area in the Green River basin. The Browns Park Formation was deposited on the erosion surface. Streams flowing on the Browns Park Formation cut deep valleys that were subsequently filled with sand and gravel as the streams became graded and gradually lost the ability to transport the heavier material. Broad flood plains were formed as the meandering streams swung laterally across the valley floors. A resumption of stream downcutting left remnants of the former flood plains as terraces bordering the new lower flood plains. Repetitions of the cycle produced increasingly lower levels of terraces.

The highest of these terraces in the Lyman-Mountain View area is the Tipperary terrace which underlies Tipperary Bench, Nebraska Flat, and two small areas—one east and one west of Lyman. The next lower terrace is the Lyman terrace which occupies much of the area between Blacks and Smith Forks. It consists of one level east and south of Millburne, but farther downstream it diverges into three levels—the lowest near Smith Fork, the highest near Blacks Fork. The highest of these three levels, on which the town of Lyman is located, is called the Lyman Bench. The three levels of the Lyman terrace were formed by successive southward migration and downcutting of Smith Fork, possibly aided by piracy by small intermittent streams flowing into Little Dry Creek from near the north end of Tipperary Bench (Bradley, 1936, p. 191–193).

The two small remnants of the Tipperary terrace on the north edge of the Lyman Bench are all that is left of a low escarpment at the north edge of the Lyman terrace that forced Smith Fork to migrate southward instead of northward. North of these remnants, Blacks Fork cut downward after the formation of the Lyman terrace and formed lower terraces in its valley while migrating to its present position. Probably during the formation of the terraces, a similar terrace was formed along Cottonwood Creek in the eastern part of the area.

CHARACTER OF TERRACE DEPOSITS

The terrace deposits in the Lyman-Mountain View area are all of very similar lithology. The material ranges from silt to small boulders; it generally is only loosely consolidated and very permeable but may be rather firmly cemented in some places. No mechanical analyses have been made of the material, but field inspection indicates that the bulk of the material ranges from coarse sand to coarse gravel.

Little detailed data are available on the thickness of the terrace deposits because few logs of wells were obtainable and no test drilling was done for this study. Mr. Alvin Stewart (oral communication), a well driller at Lyman, states that the terrace deposits generally are about 17 feet thick throughout most of the Lyman Bench. Logs of six wells penetrating terrace deposits (table 4) showed thicknesses of 17 and 40 feet at Lyman (wells 16–114–31add1 and –31add2), 27 feet on a terrace of Blacks Fork (well 16–114–30abc), and 16, 18, and 25 feet on the Tipperary Bench (wells 14–115–21baa, –16ddd, and –11bcb1).

The terrace deposits probably do not exceed 40 feet in thickness anywhere in the area and are commonly less than 10 feet. More accurate data on the thickness of the deposits can be obtained only by drilling test holes.

GROUND WATER IN TERRACE DEPOSITS

Terrace deposits underlie a large part of the Lyman-Mountain View area and are a major source of domestic and stock water. Most wells are shallow, because water levels generally are within a few feet of the surface and drilling or digging is usually discontinued when "enough water" is obtained. Two springs, one near the town of Lyman (16–114–31ab) and one at the Roberts ranch (15–115–16c), discharge water from terrace deposits at the contact with the underlying bedrock. In some areas water levels in the terrace deposits are so near the land surface as to waterlog the soil in the spring and early summer.

Six wells in terrace deposits were selected for periodic measurements of the depth to water, and the measurements are tabulated in table 2. In general, the water levels are nearest the land surface in late spring and early summer, at the height of the irrigation season, and are at their lowest levels in early spring, before irrigation begins. The rate and magnitude of the fluctuations of water levels are primarily due to recharge dependent on the rate and amount of application of irrigation water; the fluctuations are on the order of a few feet during a given year. Rises of water level are caused by the seepage of irrigation water and precipitation into the ground-water reservoir. Downward fluctuations are caused by loss of water from the ground-water reservoir by drainage through springs and seeps at the edges of the terrace deposits, withdrawal of water by wells, and consumptive use of water by plants.

MORAINE DEPOSITS

Moraine deposits are exposed on Bridger Bench, in two small areas south of Nebraska Flat, on the west side of Cottonwood Bench, and near the southern border of the report area on the divide between Smith Fork and Little Dry Creek. The moraines were mapped by Bradley (1936) and classified by him as belonging to three glacial stages. Moraines of two stages, the Little Dry and Blacks Fork, are shown on the geologic map (pl. 1). Moraines of the Smith Fork glacial stage have not been observed in the Lyman-Mountain View area.

The moraine deposits consist of sand, silt, and gravel derived from the Uinta Mountains and the foothill areas over which the glaciers passed. The moraines of the Blacks Fork glacial stage are conspicuously bouldery, but the moraines of the Little Dry glacial stage are not (Bradley, 1936, p. 194–195).

No wells in the Lyman-Mountain View area penetrate moraine deposits, so their water-bearing properties are not known. Because of their relatively small areal extent and generally high topographic position, which induce nearly complete drainage, they are not considered to be potential sources of ground water.

ALLUVIUM

Blacks Fork and Smith Fork flow on alluvium through the report area, and Little Dry Creek flows on alluvium from the point where it ceases to parallel the east side of Tipperary Bench to its junction with Smith Fork.

The composition of the alluvium is similar to that of the terrace deposits, but little information is available on its thickness. Mr. Alvin Stewart (oral communication) reports that the alluvium is about 30 feet thick in the vicinity of Mountain View. Well 14–115–19aba at Roberts penetrated 43 feet of alluvium; well 16–115–33ccd at Fort Bridger penetrated 13 feet of alluvium. Well 14–115–19dcd2 south of Robertson penetrated 14 feet of alluvium but did not reach bedrock (table 4).

Alluvium underlying the valleys of Blacks Fork and Smith Fork provides a source of shallow ground water for stock and domestic use. Water levels in wells in the alluvium generally are near the land surface and fluctuate in response to recharge dependent on the rate and amount of application of irrigation water and to changes in stream level.

LARGE-SCALE GROUND-WATER DEVELOPMENT

LYMAN MUNICIPAL WATER SUPPLY

The water used in the municipal system in the town of Lyman has been derived from several different sources. For many years water was diverted from the Blacks Fork Canal through a gravel-filled infiltration gallery and, after being treated, was pumped into the distribution system. Later, two wells (16–114 31add1 and –31add2) 1,200 and 350 feet deep, respectively, were drilled. Water from the 1,200-foot well has been used at times, but water from the 350-foot well has never been used. A spring (16–114–31ab) northwest of the municipal wells and at the north edge of Lyman Bench was used at one time to supplement the other supplies. The spring discharges water from the terrace deposits overlying relatively impermeable bedrock.

At the present time (1959), the water for the town of Lyman is obtained from Roberts Spring (15–115–16c) about 6 miles southwest of Lyman. (See pl. 1.) Roberts Spring issues from terrace deposits at the contact with the underlying bedrock, as does the spring at Lyman, but the flow of Roberts Spring is much greater. The water is collected in a gallery 500 feet long and is delivered to Lyman by gravity flow through an 8-inch pipeline 5.95 miles long. The pipeline is approximately parallel with Blacks Fork.

Water flowing from the spring at Lyman and Roberts Spring is derived from the infiltration of applied irrigation water and precipitation into the terrace deposits. The water moves downward until its progress is impeded by the less permeable bedrock and then moves laterally along the contact to the points of discharge.

IRRIGATION SUPPLIES

Only one well has been drilled to supply irrigation water in the Lyman-Mountain View area. Well 15–115–21abb was drilled to a depth of 50 feet and was reported to penetrate about 19 feet of terrace deposits. An attempt was made to test the well by pumping, but the pump's discharge (estimated at 500–600 gpm) caused the water level in the well to drop below the pump bowls at the end of 1 minute, and the discharge declined to zero.

It seems unlikely that large quantities of water (in excess of about 1,000 gpm) could be developed for irrigation, but moderate amounts of water (a few hundred gallons per minute) probably could be obtained from thicker saturated sections of the terrace and alluvial deposits.

THE COURSE OF WATER IN THE LYMAN-MOUNTAIN VIEW AREA

The discussion in this section traces the course of a small amount of water through various phases of the hydrologic cycle in the Lyman-Mountain View area and describes what happens to the water as it passes through various phases of use.

Consider a summer rainstorm in the Uinta Mountains near the headwaters of Blacks Fork. The rain soaks the ground and, when the soil zone is filled with water, much of the excess precipitation moves down the mountain slopes as surface runoff and eventually reaches Blacks Fork. The water we are tracing may be diverted from Blacks Fork into the Blacks Fork Canal. A part of it may seep into the sand and gravel of the terrace deposits, move slowly through them, and emerge in Roberts Spring where it then enters the pipeline carrying water to the town of Lyman. Another part of the water may be diverted from the Blacks Fork Canal into farm ditches and thence to irrigated fields to be used by the growing crops and also to enter the ground. Some is then returned to the atmosphere in the form of water vapor by evaporation and plant transpiration. The remainder of the water continues to flow in the Blacks Fork Canal. Some may seep into the sand and gravel of the terrace deposits near Lyman and subsequently emerge at the spring on the north edge of Lyman Bench near Lyman.

Some of the rainfall that does not leave the Uinta Mountains as surface runoff percolates into permeable beds in the bedrock formations some distance to the south of the report area. This water moves very slowly down the dip of the beds toward the center of the Green River basin and may be tapped by wells that penetrate deep below the terrace and alluvial deposits. It is this water that supplies the 350-foot and 1,200-foot wells at Lyman and the 1,865-foot well at the Rollins ranch.

AVAILABILITY OF GROUND WATER

Small to moderate quantities of ground water can be obtained from the terrace and alluvial deposits and the bedrock aquifers in the Lyman-Mountain View area. Wells capable of producing as much as a few hundred gallons per minute might be constructed at some places in the terrace and alluvial deposits where the saturated thickness is relatively great and the permeability is high. The sustained yield of individual wells will depend upon the areal extent of the aquifer and the rate of recharge to it.

The bedrock aquifers underlying the terrace and alluvial deposits generally are capable of yielding only relatively small quantities of water to wells in the Lyman-Mountain View area. Yields, however, may be expected to increase at greater depths and, thus, as more water-bearing strata are penetrated. Moderate quantities of water might be obtained from deep wells in some localities. The water in bedrock aquifers is under artesian pressure, and wells at low altitude may flow.

CHEMICAL QUALITY OF WATER

During April 1959 water samples were collected from 13 wells, representing 5 different water-bearing formations, and from 2 streams and 1 canal. One ground-water sample was obtained in September 1954. Surface-water samples were collected for the purpose of comparing the chemical quality of water used for irrigation with that of ground water from the terrace and alluvial deposits. The results of chemical analyses are given in tables 5 and 6. All samples were analyzed by the Quality of Water Branch of the U.S. Geological Survey. Although few in number, these analyses indicate the general chemical character of the water in the report area.

The Lyman terrace and alluvial deposits seem to yield the best quality ground water. Usable supplies also may be obtained at some places from the Wasatch and Bridger Formations and from the Tipperary terrace deposits.

In the upper reaches of Blacks Fork and Smith Fork the water is low in dissolved-solids content and is of the calcium bicarbonate type.[1] It is suitable for most domestic, irrigation, and industrial uses. Farther downstream, however, return flows from irrigation cause deterioration in chemical quality, resulting in a water unsuitable for domestic use.

[1] Water is frequently referred to as a chemical type. The following examples illustrate how these designations are arrived at: (1) "Calcium bicarbonate" designates a water in which the calcium amounts to 50 percent or more of the cations and bicarbonate to 50 percent or more of the anions, based on equivalents per million; (2) "sodium calcium bicarbonate" designates a water in which sodium and calcium are first and second, respectively, in the order of abundance among the cations but neither amounts to 50 percent of all the cations; and (3) "sodium sulfate bicarbonate" designates a water in which sulfate and bicarbonate are first and second in order of abundance among the anions, as above.

TABLE 5.—*Chemical analyses of ground waters in the Lyman-Mountain View area, Wyoming*

[Analytical results in parts per million except as indicated]

Well	Depth (feet)	Approximate yield (gpm)	Date of collection	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Calculated	Dissolved solids: Residue at 180°C	Hardness as $CaCO_3$ (Ca,Mg)	Noncarbonate hardness as $CaCO_3$	Percent sodium	Sodium-adsorption ratio	Specific conductance (micromhos at 25°C)	pH	Color
Wasatch formation																											
16-114-30abc	1,865	20	4-9-53	60	11	0.06	----	6.0	2.4	569	0.8	358	21	504	301	1.0	0.2	0.37	1,590	1,610	25	0	98	50	2,600	8.6	0
16-114-31add [1]	1,200	2.5	9-30-54	50	12	6.3	0.00	30	7.2	160	3.8	136	0	328	4.5	.2	.8	----	614	612	104	0	76	6.8	939	8.1	13
Bridger formation																											
14-115-16ddd [1]	30	3	4-8-59	46	27	0.00	----	75	27	81	2.2	346	0	140	35	0.5	4.6	0.36	563	576	297	13	37	2.0	883	7.4	2
16-114-32aba	100	3	4-9-59	53	14	.04	----	160	29	1,400	2.0	206	0	2,830	359	3.8	3.6	4.8	4,910	5,070	520	351	85	27	6,470	7.8	5
Lyman terrace deposits																											
15-114-10ccc	17	------	4-8-59	33	23	0.22	0.50	67	25	68	5.2	311	0	92	57	0.5	0.6	0.17	492	517	268	13	35	1.8	800	7.5	35
15-115-12add	10	3	4-8-59	37	36	.03	----	87	37	158	2.1	568	0	173	57	.8	.5	.30	831	847	368	0	48	3.6	1,280	7.6	7
15-115-16c [2]	------	212	4-8-59	47	18	.03	----	30	14	81	.5	247	0	90	13	1.0	2.0	.23	371	375	133	0	57	3.1	597	7.6	1
16-114-31ab [1]	------	20	4-8-59	40	16	.05	----	39	10	286	.8	322	0	301	128	2.0	7.9	.64	949	970	140	0	82	11	1,510	7.9	4
Tipperary terrace deposits																											
14-115-2cbc [1]	15	20	4-7-59	41	32	0.02	----	165	139	500	1.7	380	0	695	726	0.9	14	0.82	2,460	2,650	983	671	52	6.9	3,850	7.6	11
15-116-35dda	9	3	4-8-59	39	64	.03	----	69	29	9.4	.1	352	0	13	3.9	1.5	.2	.07	363	365	293	4	7	.2	549	7.4	5
Alluvium																											
14-115-19aba	44	4	4-7-59	44	14	7.0	0.08	44	8.8	16	0.9	154	9	17	25	0.2	0.5	0.04	209	223	146	20	19	0.6	363	6.9	75
15-115-23aac [3]	80	------	4-7-59	52	12	.05	----	7.0	.4	115	.5	194	0	25	58	.9	.2	.44	314	316	19	0	93	11	537	7.8	0
15-115-24bad	6.5	2	4-9-59	41	11	1.1	.06	69	9.2	37	.1	242	0	45	31	.2	.4	.08	323	329	210	12	28	1.1	552	7.4	1
16-115-33ccd [4]	53.5	3	4-8-59	48	7.6	.46	----	12	4.6	67	.7	177	0	30	18	.3	.2	.13	228	226	49	0	74	4.2	391	7.9	0

[1] Sandstone in Bridger Formation.
[2] Spring.
[3] Sample may contain some water from Bridger Formation.
[4] Sample may contain some water from Green River Formation.

TABLE 6.—*Chemical analyses of surface waters in the Lyman-Mountain View area, Wyoming*

[Analytical results in parts per million except as indicated]

Date of collection	Discharge (cfs)	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Calculated	Dissolved solids: Residue at 180° C	Hardness as $CaCO_3$ (Ca, Mg)	Noncarbonate hardness as $CaCO_3$	Percent sodium	Sodium-adsorption ratio	Specific conductance (micromhos at 25°C)	pH	Color
Blacks Fork, northeast of Millburne, Wyo. (15-115-20bd)																								
Apr. 8, 1959	------	------	11	0.16	0.00	41	12	8.3	1.1	186	11	5.2	0.1	0.2	0.5	181	187	152	0	10	0.3	320	7.7	5
Blacks Fork, north of Urie, Wyo. (16-115-24cb)																								
Apr. 8, 1959	------	------	12	0.21	0.00	188	65	154	2.5	265	732	50	0.5	0.3	0.23	1,330	1,440	736	519	31	2.5	1,770	7.6	3
Blacks Fork, Canal, east of Millburne, Wyo. (15-115-21ca)																								
Apr. 8, 1959	------	33	6.6	0.15	------	33	7.7	3.1	0.7	129	9.5	2.6	0.0	0.3	0.03	127	131	114	8	6	0.1	230	7.8	4
Smith Fork at Mountain View, Wyo. (15-115-23ca)																								
Apr. 7, 1959	58.2	------	12	0.26	------	40	8.0	22	2.8	154	29	20	0.2	0.5	0.08	211	223	133	7	26	0.8	366	7.4	17

REPORTING OF DATA

In presenting chemical-quality data, the determined constituents are generally expressed in parts per million (ppm). A part per million is one unit weight of a constituent in 1 million unit weights of water. Frequently, it is more convenient to work with equivalents per million (epm) rather than parts per million when engaged in the study of special problems of water chemistry and when studying the effects of irrigation waters on soils. An equivalent per million is one unit chemical-combining weight of a constituent in 1 million unit weights of water and is calculated by dividing the concentration in parts per million by the chemical combining weight of the constituent or by multiplying by the reciprocal of the combining weight. For convenience in making the conversion, the reciprocals of chemical combining weights of the most commonly reported constituents (ions) are given in the following table:

Constituent	*Factor*	*Constituent*	*Factor*
Calcium (Ca^{+2})	0. 04990	Carbonate (CO_3^{-2})	0. 03333
Magnesium (Mg^{+2})	. 08224	Sulfate (SO_4^{-2})	. 02082
Sodium (Na^{+1})	. 04350	Chloride Cl^{-1})	. 02820
Potassium (K^{+1})	. 02558	Fluoride (F^{-1})	. 05263
Bicarbonate (HCO_3^{-1})	. 01639	Nitrate (NO_3^{-1})	. 01613

One equivalent per million of a positively charged ion (cation) will react with one equivalent per million of negatively charged ion (anion). Because the positive and negative charges are balanced in a solution, the total equivalents per million of the common cations (calcium, magnesium, sodium, and potassium) are approximately equal to the total of the equivalents per million of the common anions (bicarbonate, carbonate, sulfate, chloride, fluoride, and nitrate).

CHEMICAL QUALITY IN RELATION TO USE

Water for domestic use in the Lyman-Mountain View area is obtained almost entirely from ground-water supplies. Water for stock and irrigation use is derived principally from surface water of Blacks and Smith Forks. Only small amounts of ground and surface waters are used for industrial purposes.

DOMESTIC USE

Chemical-quality standards for drinking water used in interstate commerce are established by the U.S. Public Health Service (1962) and are reproduced, in part, as follows:

Constituent	*Recommended limit (ppm)*	*Constituent*	*Recommended limit (ppm)*
Iron (Fe)	0. 3	Fluoride	[1]
Manganese (Mn)	. 05	Nitrate	45
Sulfate (SO_4)	250	Total dissolved solids	500
Chloride (Cl)	250		

[1] Limits vary depending in temperature. (See U.S. Public Health Service, 1962.)

Hardness, a property of water which causes soap to form soap curds, is due principally to the presence of calcium and magnesium. Water is arbitrarily classified in the following manner with regard to hardness: 60 ppm or less, soft; 61 to 120 ppm, moderately hard; 121 to 200 ppm, hard; and more than 200 ppm, very hard.

AGRICULTURAL USE

The primary agricultural uses of water are stock watering and irrigation. Although water has many chemical constituents or properties that affect its suitability for irrigation, the two main criteria for determining a suitable supply are (1) the dissolved-solids content and (2) the sodium content and the concentration of sodium relative to the calcium and magnesium content. The concentrations of bicarbonate and boron are important under certain conditions.

The use of highly mineralized water for irrigation causes the soil solution to be highly mineralized, resulting in a retardation of plant growth. The total mineralization of water is usually referred to as the salinity, and the specific conductance is a measure of the salinity hazard of water.

Use of irrigation water containing a high concentration of sodium relative to the concentration of calcium and magnesium causes dispersion of clay in soils, which results in a soil of poor tilth and poor permeability. The sodium-adsorption ratio (SAR) frequently is used as a measure of the suitability of water for irrigation use (U.S. Salinity Laboratory Staff, 1954, p. 72). The ratio is calculated by the following relation where ion concentrations are expressed in equivalents per million:

$$\text{Sodium-adsorption ratio} = \frac{\text{Na}}{\sqrt{\frac{\text{Ca}+\text{Mg}}{2}}}$$

Figure 3 is a diagram recommended by the U.S. Salinity Laboratory Staff (1954) for the classification of irrigation water. The classification is based on the salinity and the sodium hazards of water and assumes that the water will be used under average conditions with respect to soil texture, infiltration rate, drainage, quantity of water used, climate, and salt tolerance of crops.

Bicarbonate, when present in excess of the sum of calcium and magnesium may also make a water objectionable for irrigation. The harmful effects of excessive concentrations of bicarbonate can be measured and expressed as "residual sodium carbonate" (Eaton, 1950), which is equal to the concentrations (epm) of carbonate plus bicarbonate minus the concentrations (epm) of calcium plus magnesium.

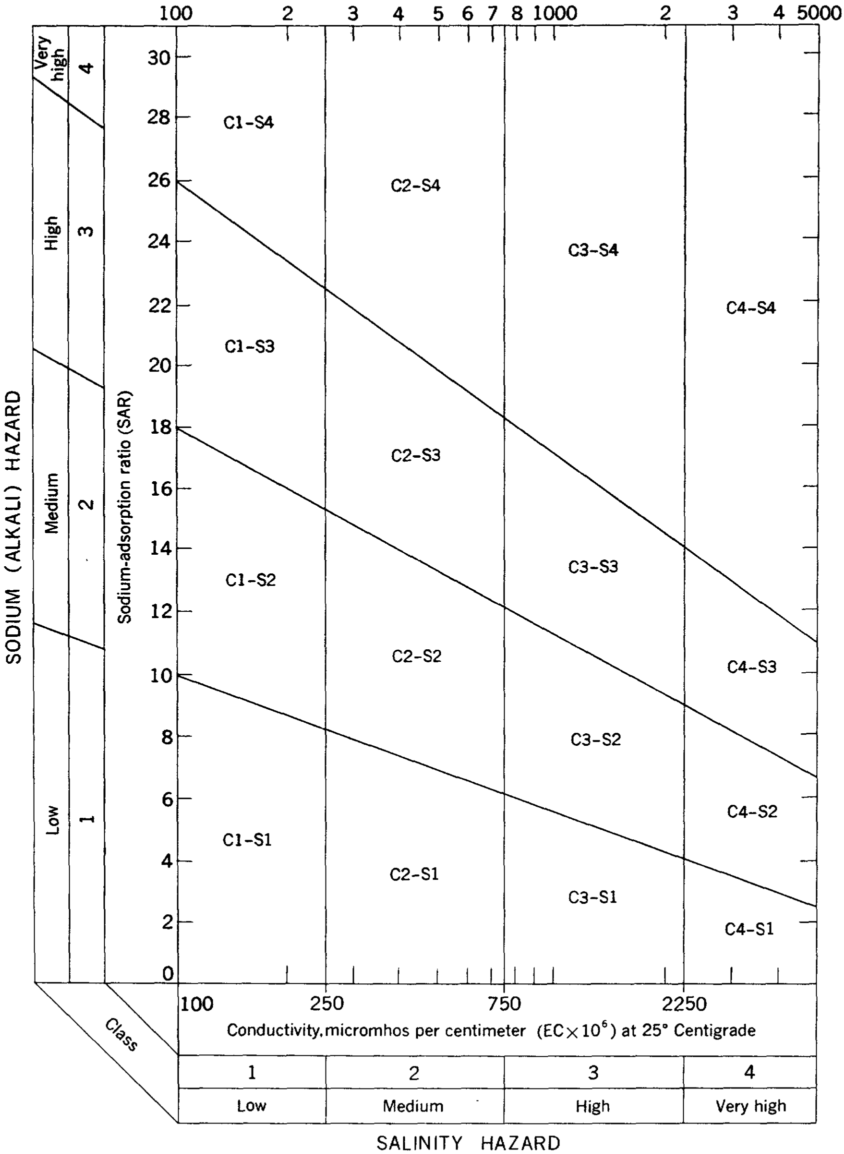

FIGURE 3.—Diagram for the classification of irrigation waters (from U.S. Salinity Laboratory Staff, 1954, p. 80).

Water whose residual sodium carbonate content is less than 1.25 epm is regarded as probably safe, 1.25 to 2.5 epm as marginal, and more than 2.5 epm as unsafe, according to studies made by the U.S. Salinity Laboratory Staff (1954, p. 81).

Studies made by Scofield (1936) indicate that a significant reduction of crop yield may occur by using water having certain boron concentrations: as low as 0.67 ppm for boron-sensitive crops, 1.33 ppm for semitolerant crops, and 2.00 ppm for tolerant crops.

The relation of the quality of water consumed to the health of livestock is not well defined, but waters of very high sodium content probably cause ill effects. The suitability differs with the kind of animal, but the following general classification has been proposed (Beath and others, 1953):

Classification	*Dissolved solids (ppm)*
Good	<1, 000
Fair (usable)	1, 000–3, 000
Poor (usable)	3, 000–5, 000
Very poor (questionable)	5, 000–7, 000
Not advised	>7, 000

CHEMICAL QUALITY IN RELATION TO SOURCE

GROUND WATER

In describing the quality of water from each geologic source, the characteristics of special significance and the suitability of the water for present and future uses are pointed out. The chemical analysis of water samples collected during the investigation suggest that ground water from the terrace and alluvial deposits is generally suitable for most uses, although water in alluvial deposits may contain objectionable amounts of iron at some places. Water samples from the Wasatch and Bridger Formations differ considerably in character and dissolved solids and, therefore, in their suitability for various uses. Because of the heterogeneous nature of the deposits, the water contained in them will probably differ in chemical character from place to place in the report area. Table 5 contains the results of chemical analyses of water samples obtained from the principal water-bearing formations in the Lyman-Mountain View area. Figures 4 and 5 illustrate the chemical character of some of these waters.

WASATCH FORMATION

Chemical analyses of two samples of water from the Wasatch Formation are given in table 5. Well 16–114–30abc, 1 mile northwest of Lyman, yields a water of the sodium sulfate chloride type containing 1,610 ppm of dissolved solids. The water is used for domestic and stock purposes. Although soft, the water contains dissolved solids and sulfate and chloride in concentrations that exceed those suggested by the standards for water used for domestic purposes. Although the water is only of fair quality, it is usable for stock. The high sodium-

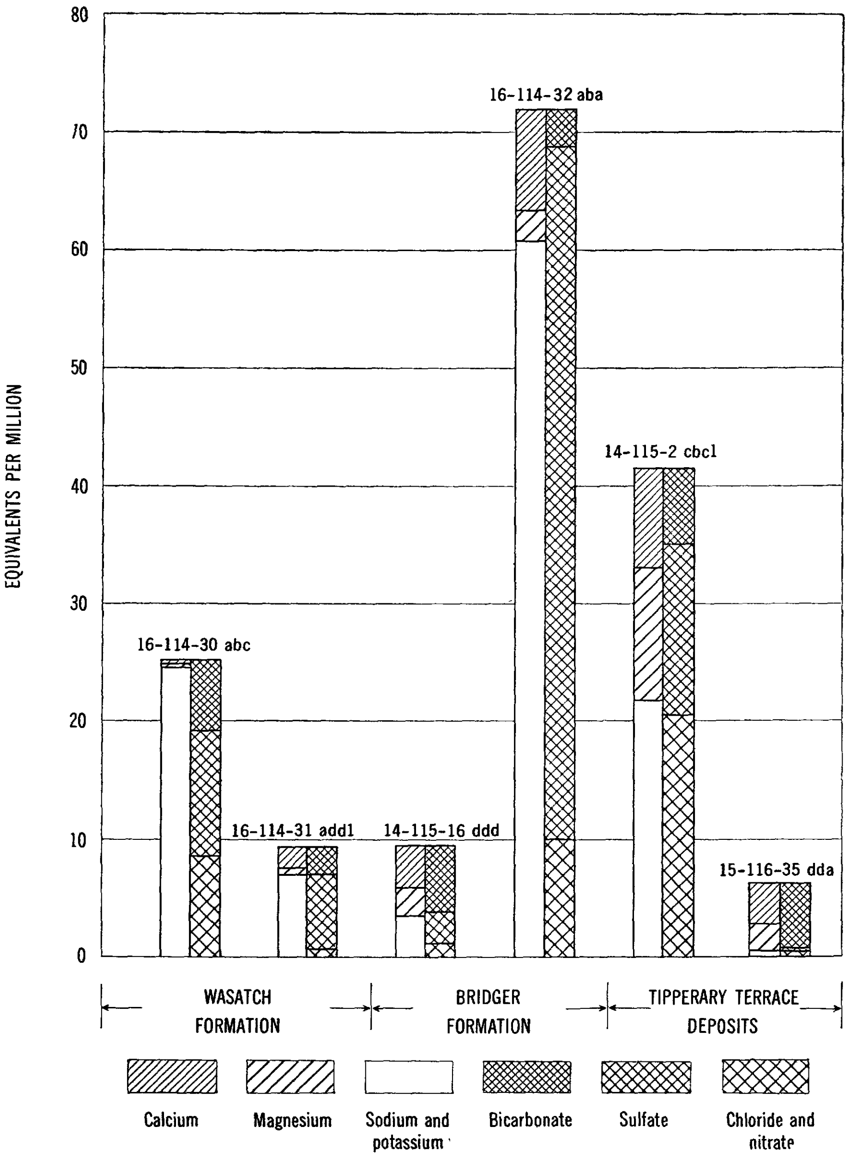

FIGURE 4.—Chemical quality of ground water in the Wasatch and Bridger Formations and deposits of Tipperary terrace in the Lyman-Mountain View area, Wyoming.

adsorption ratio of 50 (table 5) indicates that the water would be undesirable for irrigation.

Well 16–114–31addl, on the edge of the town of Lyman, yields sodium sulfate water containing 612 ppm of dissolved solids. The water is of somewhat better quality than that from well 16–114–30abc.

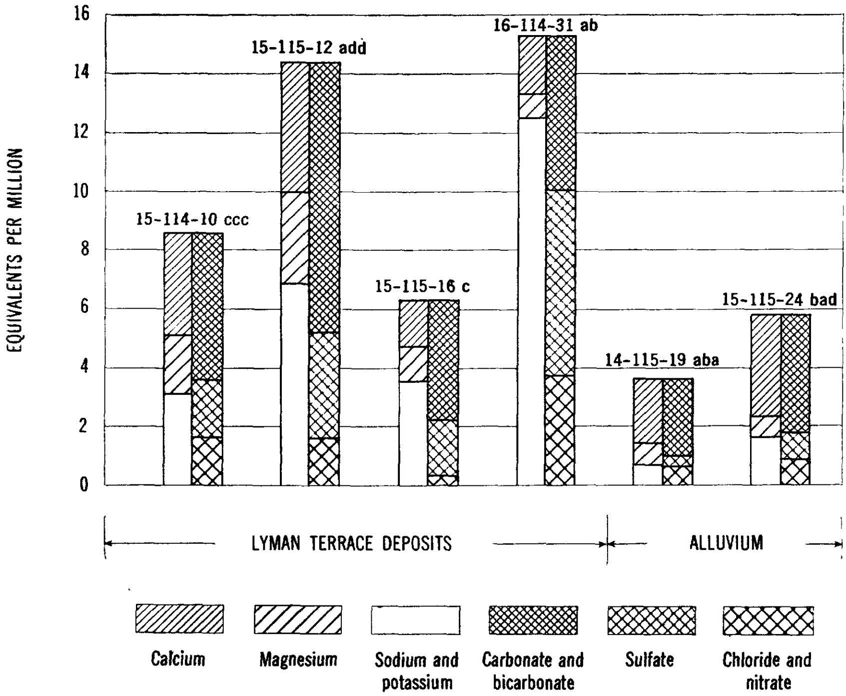

FIGURE 5.—Chemical quality of ground water in deposits of Lyman terrace and alluvium in the Lyman-Mountain View area, Wyoming.

though a high content of iron, which readily precipitates, limits its suitability for domestic and stock uses. If wells yielding adequate amounts of chemically similar water could be developed, however, they would be suitable as irrigation supplies.

Data are insufficient to determine whether the two samples collected for analysis are representative of the water in the Wasatch Formation in the area. The results of chemical analyses of water from the Wasatch in adjoining areas indicate that in other parts of the Green River basin the water may contain more or less dissolved solids than the two samples described here and may be of the sodium bicarbonate type.

BRIDGER FORMATION

Well 14–115–16ddd, 2 miles east of Robertson, is 30 feet deep and penetrates a sandstone bed in the Bridger Formation. Water from this well is of the calcium sodium bicarbonate type and has a dissolved-solids content of 576 ppm. The water is very hard but otherwise is of good quality for domestic use. The dissolved-solids content and the sodium-adsorption ratio indicate that the water would be satisfactory for irrigation, although it is unlikely that wells of sufficient yield from the Bridger Formation could be developed in this area.

Another well (16–114–32aba) tapping the Bridger Formation yields a sodium sulfate water with dissolved solids exceeding 5,000 ppm. The concentrations of boron (4.8 ppm) and fluoride (3.8 ppm) are objectionable. This water is used by the Wyoming State Highway Department garage for washing vehicles and equipment, but is unsatisfactory for most domestic, irrigation, and industrial uses.

DEPOSITS OF LYMAN TERRACE

Chemical data of four water samples obtained from the Lyman terrace deposits indicate that the character of the water differs appreciably from place to place. (See table 5 and fig. 5.) One of the samples, collected from well 15–114–10ccc (17 feet deep), contained 0.50 ppm of manganese and 0.21 ppm of iron. This water is also very hard. The concentrations of iron and manganese are sufficient to impart an unpleasant taste and to cause staining. Water from well 15–115–12add is of similar quality, although the iron content is lower. Spring 15–115–16c, which supplies the town of Lyman, is one of the best ground waters sampled in the report area. It is hard but should be satisfactory for most purposes. Spring 16–114–31ab, which was formerly the Lyman municipal supply, yields a less satisfactory water. The water is slightly harder than that from spring 15–115–16c and has a high sulfate and high dissolved-solids content. Fluoride slightly exceeds the recommended maximum concentration.

Deposits of the Lyman terrace would probably yield water of only fair quality for irrigation. The residual sodium carbonate values of waters from well 15–115–12add (1.93 epm) and spring 15–115–16c (1.40 epm) suggest that these waters should be used with caution.

Much of the water in the terrace deposits of the Lyman Bench probably is derived from Blacks Fork Canal by direct seepage from the canal and by seepage of canal water diverted for irrigation. The quality differs substantially, however, because of changes in chemical composition that occur as the water passes through the soil.

DEPOSITS OF TIPPERARY TERRACE

Analyses of water from two wells penetrating Tipperary terrace deposits are given in table 5. On Nebraska Flat, well 15–116–35dda, which is 9 feet deep, yields a calcium bicarbonate water having a dissolved-solids content of 365 ppm. Water from a 15-foot well on Tipperary Bench (14–115–2cbc1) is of sodium chloride sulfate type and has a dissolved-solids content approximately seven times greater than the water from the well on Nebraska Flat. Another significant difference in the two waters is in boron content. Water from the well on Tipperary Bench contains 0.82 ppm of boron, whereas that from the well on Nebraska Flat contains 0.07 ppm.

Although used as a domestic supply, water from the well on Tipperary Bench is unsatisfactory for most domestic purposes. The sulfate, chloride, and dissolved-solids contents exceed the suggested limits. As a stock supply, the water must be classed as poor although usable; it would be undesirable as an irrigation supply. Water from the well on Nebraska Flat should be satisfactory for most uses although it is very hard. Wells yielding water of similar chemical quality would be suitable as irrigation supplies.

ALLUVIUM

Samples were collected from two wells (14–115–19aba and 15–115–24bad) that yield water solely from the alluvium and from two wells (15–115–23aac and 16–115–33ccd) that tap the alluvium and the underlying bedrock. Analyses show that water from the wells drilled in the alluvium is of the calcium bicarbonate type, hard, and low in dissolved solids. Although water from well 14–115–19aba is of relatively good quality, the high concentration of iron, which readily precipitates, limits the utilization of this water without treatment. Water from well 15–115–24bad is somewhat harder and contains iron in excess of the suggested recommended limits for domestic use, though the iron content is considerably lower than that from well 14–115–19aba. The high iron content probably would make water from the alluvium objectionable for irrigation, although in other chemical respects it is satisfactory.

Samples collected from wells 16–115–33ccd (log, table 4) and 15–115–23aac, which penetrate both alluvium and underlying bedrock, are low in dissolved solids, have very little calcium and magnesium, and are classified as the sodium bicarbonate type. Both have somewhat higher concentrations of boron than waters derived solely from the alluvium. These wells probably obtain most of their water from the alluvium, but the lack of casing records precludes a definite determination of the source of the water.

SURFACE WATER

Surface flow in Blacks Fork and Smith Fork is a source of large supplies of irrigation water in the Lyman-Mountain View area. The analyses of samples collected at four locations are given in table 6, and graphic illustrations of their chemical character are shown in figure 6.

BLACKS FORK

Two water samples were collected from Blacks Fork, one at 15–115–20bd, about half a mile northeast of Millburne, and the other at 16–115–24cb, about 10 miles downstream, north of Urie. The downstream sampling was timed so that the collection could be made from approximately the same streamflow sampled northeast of Millburne. Table 6 and figure 6 show that the concentration of dissolved solids increased from 187 to 1,440 ppm in this relatively short reach of

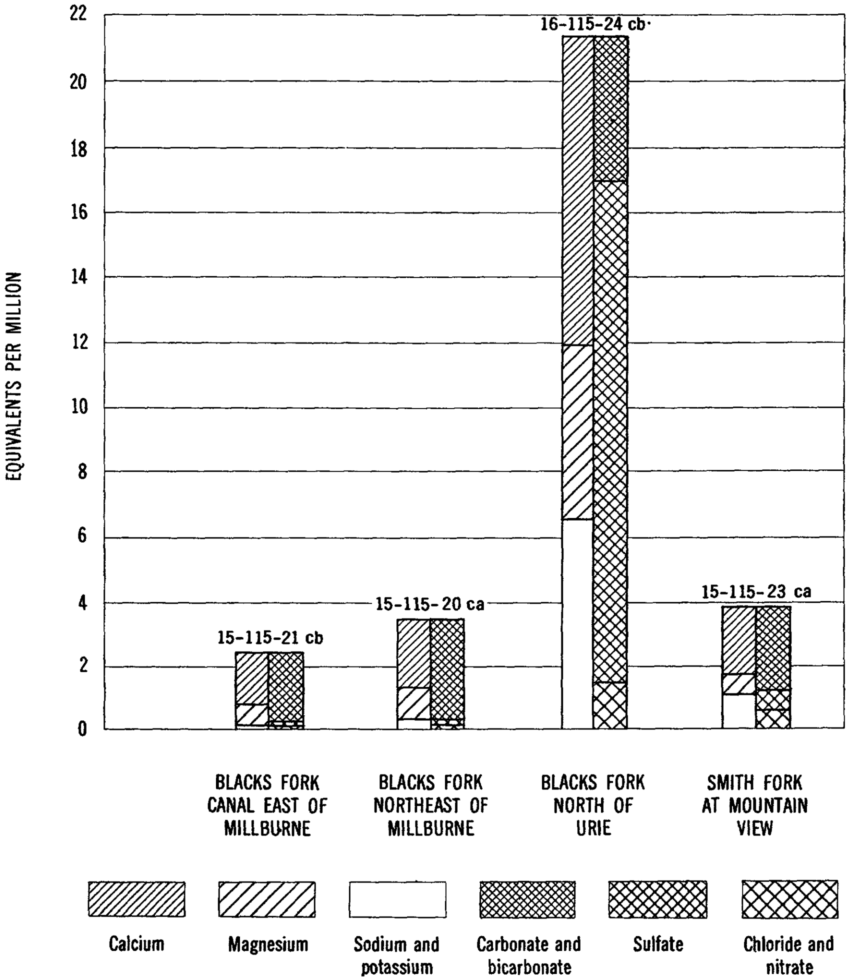

FIGURE 6.—Chemical quality of surface water in the Lyman-Mountain View area, Wyoming.

stream. Although several factors may contribute to such a change in the chemical character of the water, an inspection of the area on April 8, 1959, indicated that irrigation return flow probably is the principal cause of the change.

Figure 6 shows that the water of Blacks Fork northeast of Millburne is of calcium bicarbonate type; the sodium, sulfate, chloride, and dissolved-solids contents are in low concentration. North of Urie, however, the water is of the calcium sodium sulfate type, and the concentration of dissolved material has increased about eight times. Data from sampling of Blacks Fork, at a site 11 miles northeast of

Lyman and outside the report area, indicate that sodium is the predominant cation.

The water of the upper reaches of Blacks Fork is of good quality and satisfactory for most uses. As its quality deteriorates downstream, it becomes unsuitable for domestic use. Sulfate, hardness, and dissolved solids considerably exceed the suggested limits (table 6). In the downstream reaches, the water was still usable for irrigation at the time of sampling, but by midsummer the quality might become questionable.

BLACKS FORK CANAL

A sample collected from the Blacks Fork Canal, 6 miles downstream from the diversion on Blacks Fork, was taken on the same day as the sample from Blacks Fork 1 mile northeast of Millburne. The quality of water in the canal at the sampling point resembles closely that in Blacks Fork above the diversion (table 6).

SMITH FORK

On April 7, 1959, a sample was collected from Smith Fork at Mountain View (15–115–23ca). The chemical character of Smith Fork water was similar to that of Blacks Fork near Millburne (fig. 6). The analysis shows a calcium bicarbonate water with a dissolved-solids content of 223 ppm. No data are available regarding possible changes in chemical quality downstream from Mountain View, but, as irrigation is practiced along Smith Fork, changes similar to those along Blacks Fork can be expected.

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