DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

WATER-SUPPLY PAPER 221

GEOLOGY AND WATER RESOURCES

OF THE

GREAT FALLS REGION

MONTANA

BY

CASSIUS A. FISHER

WASHINGTON

GOVERNMENT PRINTING OFFICE

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GEOLOGY AND WATER RESOURCES OF THE GREAT FALLS REGION, MONTANA.

By Cassius A. Fisher.

INTRODUCTION.

This report is based on field work done during the season of 1906 in connection with a detailed investigation of the geology and coal resources of the Great Falls coal field. It is designed mainly to furnish information regarding the general geology of the region and the prospects for underground water. A brief description of the different geologic formations is given, with statements concerning their structure, general distribution, and water capacity. The surface waters are also described, including their present and proposed uses for irrigation, water power, etc., and the agricultural interests of different parts of the district are briefly discussed.

The region considered comprises that portion of the Great Plains bordering the Rocky Mountain Front Range, which extends from about longitude 110° W. to about 112° 30′ W., and from about latitude 47° N. to about 48° N. It includes the lowlands lying between the Little Belt and Highwood mountains, and extends to the west and north with increasing width to a point about 10 miles north of Teton River. The area comprises about 3,600 square miles, the location of which is shown in the key map in Pl. I (pocket). It is situated in north-central Montana, mainly in Cascade and Teton counties, but includes portions of Fergus, Chouteau, and Lewis and Clark counties. It is bounded on the south and west by the Little Belt, Big Belt, and Lewis mountain ranges, and on the east and north by the Great Plains and Highwood Mountains.

The topographic map used as a base for the geologic map, and also for the water-resources and other maps presented in the report, was, for the eastern part of the district, taken mainly from detailed reconnaissance surveys of the Great Falls coal field, made from a land-subdivision standpoint by the author and his party. Topographic data for the marginal portions of the east half of the map were also taken from atlas sheets of the Fort Benton and Great Falls quadrangles surveyed in 1896. The map of the western portion of the field was made in greater part from rapid reconnaissance surveys carried on while the underground-water investigation was being made.

Throughout the work valuable assistance was rendered by W. R. Calvert and D. E. Winchester. These gentlemen mapped portions of the area, collected much of the well and spring data, and made field assays of the water. In the areal geologic mapping assistance was given by H. M. Eakin, who measured numerous sections and collected structural data. Much valuable information was furnished by S. B. Robbins, engineer of the Sun River reclamation project, regarding both underground and surface waters of the Great Falls region, and aid was also given by O. C. Mortson and John French.

LITERATURE.

GENERAL STATEMENTS.

Previous observers have given but little information regarding the underground water resources of the Great Falls region. The surface waters, particularly the Great Falls of Missouri River and the Giant Springs, are phenomena that have attracted widespread attention since the earliest explorers followed up the course of Missouri River to the westward. Captain Lewis, of the Lewis and Clark expedition, who visited this region in 1804, was the first to give an accurate account of the Great Falls and Giant Springs, and doubtless other early explorers had been attracted by them and made brief mention of their occurrence in describing the Northwest Territory. The work of the geologists of the Hayden and transcontinental surveys was confined mainly to the region lying east of Great Falls, and with one or two exceptions did not extend into this district. With the development of water power at the Black Eagle Falls, which took place in 1893, a number of articles appeared in the engineering journals describing the power which could be generated in this vicinity by the development of all the large waterfalls. In the Fort Benton folio, published in 1899, which includes a portion of the Little Belt Mountains, the Highwood Mountains, and adjoining plains, attention is called to the favorable prospects for artesian water in a portion of the quadrangle. Since the Government irrigation project has been undertaken in Sun and Teton River valleys, a number of scientific and popular articles have been published dealing principally with the surface waters of the region. Following is a chronological list of the more important papers published on the surface-water resources of the Great Falls region, one of which sets forth the prospects for artesian water in the eastern part of the district.

BIBLIOGRAPHY OF THE MORE IMPORTANT PAPERS RELATING TO THE WATER RESOURCES OF THE GREAT FALLS REGION, MONTANA.[a]

LEWIS AND CLARK EXPEDITION, 1804–6. (Coues, 4 vols., 1893.) An account of the journey up the Missouri from St. Louis to the Rocky Mountains, thence to the Pacific coast.

Contains description of the region bordering on the Missouri in the vicinity of Great Falls, Mont. The falls of the Missouri were measured and described.

NEWBERRY, J. S. Surface geology of the country bordering the Northern Pacific Railroad. In Am. Jour. Sci., vol. 30, pp. 337–347. 1885.

Includes a brief description of the surface geology in the vicinity of Great Falls, Mont., with special reference to glacial drift.

NEWELL, F. H. Thirteenth Annual Report U. S. Geological Survey, pt. 3. 1892.

The proposed irrigation system of the Sun River valley and the adjacent region is fully described, pp. 371–386, and the rainfall, topography, and amount of reclaimable land are discussed.

NETTLETON, E. S. Artesian and underflow investigation: Senate Ex. Doc. 41, pt. 2, 52d Cong., 1st sess., pp–78. 1892.

Discusses the surface and underground water of Great Falls district in connection with an explanation of the source of artesian water in eastern South Dakota.

PARKER, M. S. Water power of the falls of the Missouri, Great Falls, Mont. In Engineering News, vol. 32, p. 44. 1894.

The several falls of the Missouri are described, and estimates are made of available power. Reference is made to the Giant Springs.

PARKER, M. S. The Great Falls water power. In Engineering Record, vol. 31, No. 16, pp. 274–275. 1895.

Gives brief description of the various falls of the Missouri at Great Falls, Mont., and detailed illustrations of the power plant at Black Eagle Falls.

WEED, W. H. Fort Benton folio, Montana. Geologic Atlas, U. S., folio No. 55, U. S. Geol. Survey. 1899.

Discusses the general geology and mineral resources of the region, also the probability of obtaining artesian water in the area east of Otter Creek.

WILLIS, BAILEY. Stratigraphy and structure, Lewis and Livingstone ranges, Montana. In Geol. Soc. America, vol. 13, pp. 305–352. 1902.

Describes the physiography of the Lewis and Livingstone mountain ranges and adjoining plains, also character and structural relations of the Algonkian, Carboniferous, Cretaceous, and Quaternary rocks.

NEWELL, F. H. Second Annual Report of the Reclamation Service. 1904.

An abstract of a reconnaissance in Sun River valley, Montana, is included.

NEWELL, F. H. Third Annual Report of the Reclamation Service. 1905.

The proposed irrigation project of the Sun and Teton rivers district is discussed. The water supply of the streams, the storage reservoirs available, and the territory subject to irrigation are described.

UPHAM, WARREN. Outer glacial drift. In Am. Geologist, vol. 34, pp. 151–160. 1904.

The glacial drift of the Northwestern States, including Montana, is discussed. Reference is made to its effect upon the drainage of the Missouri River system.

LEIBERG, J. C. Forest conditions in the Little Belt Mountains Forest Reserve, Montana, and the Little Belt Mountains quadrangle. Prof. Paper No. 30, U. S. Geol. Survey. 1904.

[a] Compiled by W. R. Calvert.

The surface waters of the region and their relation to agricultural, grazing, and forest lands, are included in the discussion.

CALHOUN, F. H. The Montana lobe of the Keewatin ice sheet. Prof. Paper No. 50, U. S. Geol. Survey. 1906.

The glacial history of the Great Falls region is given, with a discussion of the effect of glaciation on the drainage system of the Missouri in that area. Reference is made to artesian conditions near Chouteau.

GEOGRAPHY.

GENERAL FEATURES.

The area treated in this report presents a variety of surface features. It lies in a region which is transitional between plain and mountainous topography and includes portions characteristic of both. Its salient features are broad, gently sloping plateaus bordering the adjacent mountain ranges. These plateaus are traversed by numerous mountain streams, which flow through deep and relatively narrow valleys throughout the eastern portion of the district, but toward the west, where the valleys have been developed in softer rocks, they are usually wide and open. Along the southern margin of the area, from Smith River to the eastern end, the surface of the plains rises gradually by sloping plateaus, culminating in a zone of high, hilly country bordering the Little Belt Mountains, which lie farther to the south. East of Belt Creek and north of the area described the Highwood Mountains rise abruptly above the plains as a cluster of high isolated peaks, reaching an altitude of over 7,000 feet. Between the Highwood and Little Belt mountains is the Otter Creek divide, having at its lowest point an altitude of 4,300 feet. To the east of this divide the country is drained by Arrow Creek and its tributaries and to the west by Belt Creek and its most important branch, Otter Creek, from which the above-described divide derives its name.

PLAINS PROVINCE.

Thoughout the region which lies to the west of Missouri River the country presents topographic features characteristic of the Great Plains, of which it forms the western margin. It is a region of long, gently sloping plateaus traversed by streams having relatively wide valleys. On the summit of this table-land at many places remnants of higher plateaus occur in the form of isolated buttes or long irregular ridges, of which Teton Ridge forms a notable example. Westward the surface rises by successive plateaus toward the base of the Lewis Mountains; the surface features become more diversified; and there are a number of high isolated buttes south of Sun River which form some of the most conspicuous topographic features of the region. There is a moderate range of altitude in the district. The highest points examined occur along the base of the Little Belt

Mountains, where the more prominent summits rise to an altitude of over 5,000 feet. The lowest point in the district is along Missouri River below Big Falls, where the altitude is 2,900 feet above sea level. The average altitude of the region is between 3,500 and 4,000 feet. The greatest variation in altitude for any locality is about 1,300 feet in a horizontal distance of 1½ miles. This occurs between Belt Creek and the summit of Belt Butte at the town of Belt. In the Plains province the relative altitudes of the summits of the plateaus bordering the valley bottoms range from 300 to 600 feet.

DRAINAGE.

The Great Falls region is drained by Missouri River, which crosses its central portion flowing in a northeasterly direction. Its flow varies greatly at different seasons of the year. High water occurs in the late spring and early summer months, when the greatest amount of snow is melted in the mountains, and the low-water mark is usually reached in the month of September. The principal tributary of Missouri River from the north is Sun River, which rises in the Lewis Mountains and, flowing eastward, joins the Missouri at Great Falls. From the south the most important tributaries are Smith River and Belt Creek, the former entering the Missouri about 7 miles above Great Falls and the latter 10 miles below, outside of the area to which this report relates. Smith River drains an extensive country lying between Big Belt and Little Belt mountains, and Belt Creek drains the northern slope of the Little Belt Range (Pl. II, *A*). Teton River crosses the northern part of the area, flowing in an easterly direction. Its principal tributaries are Deep and Muddy creeks, both of which carry considerable water. Throughout the Plains province many of the smaller streams are intermittent, but those draining the northern slope of the Little Belt Mountains always have more or less water, especially in their upper courses.

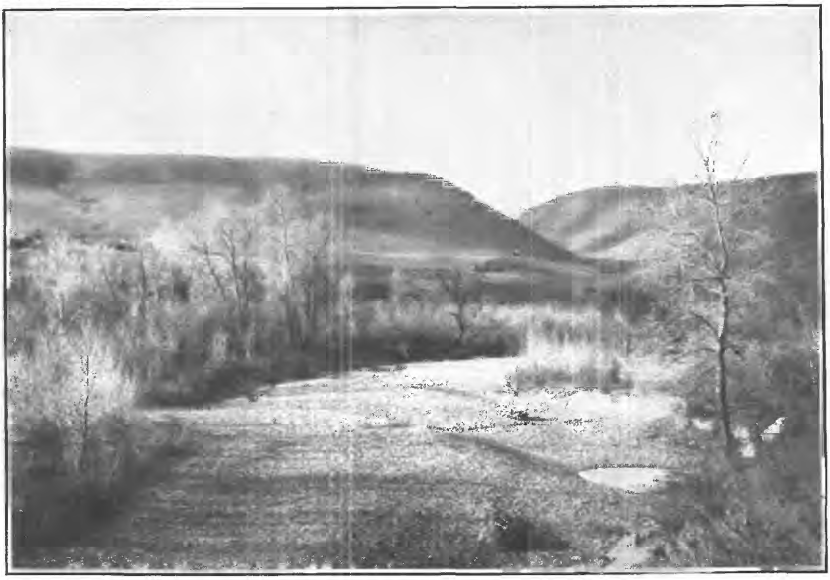
DETAILED DESCRIPTIONS OF DISTRICTS.

East of the low divide between the Highwood and Little Belt mountains the country slopes gradually northeastward toward Missouri River. It is traversed by several streams draining the slopes of the adjoining mountains. These streams flow through relatively wide valleys that are bordered by gravel-capped terraces of different elevations. Stanford Buttes, a prominent ridge lying between Running Wolf and Surprise creeks, is flat topped, being a remnant of an ancient terrace. To the north and east of this ridge gravel-capped plateaus of lower levels occupy interstream spaces. Toward the Little Belt Mountains the gravel-capped terraces give way to prominent hog-back ridges formed by the sandstone members of the Ellis and

Kootenai formations, which extend in an irregular line of outcrop along the base of the mountains. Skull Butte, a low dome-shaped uplift situated about 6 miles south of Stanford, rises about 200 feet above the surrounding region. South of Skull Butte there are a number of prominent ridges with long gradual slopes to the north and bold escarpments to the south, which overlook valleys excavated in the soft Quadrant shale. In the southwest corner of T. 16 N, R. 10 E., is located Wolf Butte, a very prominent topographic feature in this part of the area.

Broadly viewed, the district lying between the Otter Creek divide and Missouri River is a high plateau sloping northward and deeply dissected by numerous canyons. Belt and Box Elder creeks, Sand Coulee, and Smith River are the principal streams traversing this region. They all flow through deep, narrow valleys. The altitude of the plateau varies from 3,500 feet along Missouri River to 4,500 feet or more along the southern border of the field. The difference in altitude between valley bottom and plateau summit in the northern part of the area is 300 to 400 feet, but toward the mountains this difference increases to over 600 feet. The streams of this district all flow in a northerly direction, except three of the larger tributaries of Smith River—Boston, Ming, and Goodwin coulees—which flow nearly west. Sand Coulee, which is formed by the confluence of a number of canyon tributaries southeast of Stockett, flows northward for about 10 miles, then turns sharply to the west, and for the remainder of its course meanders through a wide, flat-bottomed valley formed by preglacial erosion of Missouri River.

West of the Missouri and south of Sun River the surface rises westward in successive plateaus. The lowest of these plateaus, which lies north of Ulm station and comprises what is locally known as Ulm Bench, has an altitude of about 3,650 feet. West of Ulm Bench is a low saddle separating it from a higher plateau, which in its western extension is surmounted by two isolated buttes forming two of the most conspicuous topographic features of the Plains province. Square Butte, the smaller of the two, is a flat-topped, rectangular-shaped butte, rising abruptly to a height of 500 feet above the surrounding plain (Pl. II, *B*). Fort Shaw Butte, which is in reality a ridge trending northwest, is of equal prominence, but has less precipitous sides. It is less than 1 mile wide, is 2½ miles long, and is located about 2 miles west of Square Butte and almost directly south of Fort Shaw. It has an altitude of about 4,500 feet, rising several hundred feet above the surrounding country. About 3 miles southwest of Shaw Butte is a third, known as Crown Butte, which is also very prominent but somewhat smaller than the two above described. Between Shaw and Crown buttes there is a wide, open valley drained by Little Muddy Creek, a large intermittent stream joining the Mis-



A. DRY BED OF BELT CREEK, NEAR BELT, MONT.

B. NORTHWEST SIDE OF SQUARE BUTTE, SHOWING EAGLE SANDSTONE OVERLAIN BY IGNEOUS ROCK.

souri near Riverdale. South of Little Muddy Creek the surface rises rapidly toward the mountains. Between Sun River and Sims Creek a high gravel-capped plateau of irregular outline occurs, which extends 6 to 7 miles westward. It has an altitude of 3,600 feet and is bordered on the south by the wide, open valleys of Sims Creek and its tributaries. To the west the region consists of prominent ridges and detached buttes, presenting bold escarpments to the north overlooking Sun River valley and long gradual slopes to the south.

Between Sun and Teton River valleys there is a high, gravel-capped, sloping plateau, which continues from the western margin of the district in a more or less modified form to Muddy Creek of Sun River. The southern edge of this plateau is very irregular from the west boundary of the district to a point about 3 miles north of Lowry, but from this point eastward it becomes sharply defined by a line of bluffs about 200 feet high. In its western extension this plateau increases in altitude and culminates in a high crescent-shaped ridge with a bold north-facing escarpment overlooking Deep Creek valley. Eastward the ridge terminates in a number of isolated hills, the larger of which are locally known as Priest Buttes. From Priest Buttes southward to Freezeout Lake the east face of the plateau is deeply serrated by numerous canyons. Bordering this plateau on the east is a belt of level country, imperfectly drained, which is locally known as Freezeout Basin. Near the middle of this basin and at the base of Freezeout Butte is Freezeout Lake, 1½ miles wide and about 3 miles long, which contains water only a small portion of the year. East of Freezeout Basin the surface rises slightly to a level table-land or plateau, which is locally known as the Freezeout Bench. The elevation of this plateau varies from 3,900 to 4,000 feet.

The area between Teton River and its principal tributary from the north, Muddy Creek, is in its central portion a level plateau or bench having an altitude of 3,900 feet. It is locally known as Burton Bench. On the east, where this plateau is crossed by the terminal moraine of the Keewatin ice sheet, its surface is hilly, such as is characteristic of a morainal district, but to the west the surface rises gradually toward the base of the high bluffs occurring on either side of Ralston Gap. West of this prominent line of bluffs the country, which is crossed in its northern part by Muddy Creek, is rolling. North of Muddy Creek there is a low line of bluffs 100 to 200 feet high, the margin of which is included within the area described. Between Teton River and its most important tributary, Deep Creek, is an area containing in its central portion typical badlands topography, with long, irregular ridges culminating in sharp peaks, the most prominent of which are Teton Buttes. On the north side of this high ridge the surface slopes away to Teton River, while to the south there is a wide, gravel-capped terrace which borders Deep Creek on the north.

GEOLOGY.[a]

STRATIGRAPHY.

GENERAL OUTLINE.

The formations occurring at the surface throughout the area to which this report relates consist mainly of sedimentary rocks with igneous intrusions in the form of dikes or laccoliths. The latter occur especially in the regions bordering the adjacent mountain ranges. The strata in general lie nearly horizontal or dip at a relatively small angle to the northeast away from the mountains. They are representative of Carboniferous, Jurassic, Cretaceous, Tertiary, and Quaternary systems. The distribution of these formations, except the Tertiary and certain members of the Quaternary, is shown on the geologic map (Pl. I), and their structural relations, particularly those affecting the occurrence of underground water, are illustrated in the cross sections. The table on pages 15–16 sets forth the order, age, characteristic features, thickness, and water capacity of the formations.

[a] A detailed report of the geology of the Great Falls region will appear in Bulletin No. 356 of the Geological Survey.

Geologic formations in the Great Falls region, Montana.

System.	Formation.	Character of deposit.	Average thickness.	Water capacity.	Quality of water.	Areal distribution.
			Feet.			
Quaternary and Tertiary.	Alluvium	Light-colored silt, sand, and clay with local gravel beds.	20 to 40	Water bearing	Generally good; varies with character of formation from which alluvium is derived.	Occupies valleys throughout the district.
Quaternary and Tertiary.	Lacustrine deposits	Fine-grained, light-colored silt and clay.	Not determined.	Water bearing	Good	Occur as a valley filling in all the larger valleys in front of the terminal moraine.
Quaternary and Tertiary.	Morainal deposits	Unassorted mixture of sand and gravel in which bowlders of varying size are irregularly scattered, consisting mainly of gneiss, quartzite, granite, and limestone.	Not determined.	Contain some water	Variable	Occupy the area lying south of Missouri River between Great Falls and Belt Creek; also the area north of that stream across the east side of Fort Benton Bench, along the north side of Teton Ridge, and across the east end of Burton Bench.
Quaternary and Tertiary.	Bench gravels	Sand, gravel, sandy clay, and conglomerate.	25 to 40	Generally contain water, although not a large amount; often source of small marginal springs.	Water generally hard, owing to abundance of calcareous cementing material in gravel.	On extensive areas lying east of Otter Creek divide; also highlands between Sun and Teton rivers.
Cretaceous.	Montana. Claggett	Dull-green and gray sandy shale, clay, and impure sandstone; also massive light-gray and very dark-green, iron-stained conglomeratic sandstone.	*a* 670	Probably contains more or less water.	Good	On area south of Sun River and west of Crown Butte, also north of Sun River over a part of the district lying west of a line connecting Lowry with Bas Christian's ranch. Areal distribution not shown on map.
Cretaceous.	Montana. Eagle	Massive gray sandstone containing large iron-stained concretions 3 to 10 feet in diameter, which are fossiliferous. Sandstone layers alternating with sandy shale in lower part.	90	Water bearing. Source of springs around Square and Shaw buttes.	Good	Exposed underneath the igneous rock capping Square, Shaw, and Crown buttes. Occupies summit of bluffs at Lowry; caps Freezeout and Priest buttes and gives rise to a conspicuous line of bluffs extending northward west of Chouteau past Ralston Gap to the northern margin of the area. Distribution not shown on map.
Cretaceous.	Colorado	Upper part composed of dark-colored shale with a few thin sandstone layers. Lower part consists of massive gray sandstone, often concretionary, iron-stained, containing thin layers of pebbly conglomerate.	1,600 to 1,800	Shale of upper part of formation generally not water bearing. Basal sandstone members contain large amount of water.	Water from shale highly mineralized. Sandstone contains good water.	Exposed along south side of Highwood Mountains from Belt Creek to the east border of the district. Basal sandstones cap the plateau region between Red Buttes and Missouri River. Occupies an extensive area lying between Missouri River and line of bluffs formed by Eagle sandstone above described. Not differentiated from Montana on geologic map.

a Upper limit of formation not determined.

Geologic formations in the Great Falls region, Montana—Continued.

System.	Formation.	Character of deposit.	Average thickness.	Water capacity.	Quality of water.	Areal distribution.
			Feet.			
Cretaceous.	Kootenai	Massive gray sandstone, red sandy shale and clay with an occasional bed of white limestone. The sandstone predominates throughout the lower portion while red shale, clay, and limestone constitute the upper members. About 60 feet above the base there is a bed of workable coal.	400 to 500	Sandstone members containing large amount of water.	Very good	Occupies surface area over a great part of the district lying between Smith River and Belt Creek and is the surface formation of high plateaus south of Otter Creek. East of Otter Creek extends as a narrowing outcrop along northern side of Little Belt Mountains.
Jurassic.	Morrison	Variegated shale and clay containing sandstone layers one above middle of formation, cinnamon brown in color and bone-bearing. Limestone layers sometimes present in lower part.	75 to 120	Sandstone members may contain small amount of water.	Probably would be more or less mineralized.	Outcrops as a narrow band below Kootenai rocks in sides of canyons bordering streams draining northern slope of Little Belt and Big Belt mountains from Smith River to Otter Creek. East of Otter Creek its outcrop zone, which is of varying width, generally occupies the inner face of low hogback ridges of Kootenai rocks bordering the Little Belt Mountains.
	Ellis	Dove-colored limestone comprising basal member overlain by reddish-brown, coarse-grained sandstone coarsely conglomeratic at base.	80 to 120	Sandstone member probably contains water.	Water probably hard, for sandstone is bound together by calcareous cement.	Between Smith River and Otter Creek outcrop area limited to canyons traversing the plateau region bordering the Little Belt Mountains.
Carboniferous.	Quadrant	Sandstone, red and green shale and clay, and limestone with an occasional bed of gypsum in lower part.	400 to 500	Contains some water	Water generally impure; several sulphur springs issue from this formation.	In the upper part of Belt Creek valley and extending eastward throughout a zone of varying width along the base of the Little Belt Mountains to east end of district.
	Madison	Massive light-gray limestone, white limestone, and more or less argillaceous shale.	100 exposed.	Upper part not water bearing.		In Smith River valley in T. 17 N., R. 3 E., in Sand Coulee and its tributary canyons, in the vicinity of Stockett, and along the northern base of Little Belt Mountains from Belt Creek to east end of district.

CARBONIFEROUS SYSTEM.

MADISON LIMESTONE.

The Madison limestone is very conspicuous, bordering the north side of the Little Belt Mountains, but in the greater part it lies outside of the area here described. The only exposures in the district are found along East Fork of Sand Coulee and its tributaries, where a local doming of the beds exposes about 100 feet of the formation. The distribution of the limestone is shown on the geologic map (Pl. I). Along the flanks of the Little Belt Mountains, outside of the area to which this report relates, the limestone has a thickness of about 1,000 feet, and three members have been recognized by previous workers. The lower member, which is more or less argillaceous, has been called the Paine shale, the more massive limestone of the middle part of the formation the Woodhurst limestone, and the top member the Castle limestone. The Castle limestone forms the "sluicebox canyon," the lower end of which is at Riceville. It is a part of the upper division of Madison limestone, which is exposed at numerous places in the vicinity of Stockett.

That portion of the formation exposed in the area here described consists mainly of limestone, interbedded with calcareous clay. The limestone is usually massive and compact, and is of medium to dark gray color, weathering light. It occurs in beds 10 to 12 feet thick, and is generally relatively pure. At Stockett, 15 feet of oolitic limestone was observed, and at another locality on Ming Coulee, where about 140 feet of the limestone was exposed, the lowest member contains bands of dark-colored chert. Fossils were collected from the limestone at Stockett, also on the head of Ming Coulee, outside the area described.

These fossils have been examined by Dr. G. H. Girty, who regards them as of Mississippian age. In the Little Belt Mountains the Madison limestone is said to carry a typical Mississippian fauna.

The Madison limestone is believed not to be water-bearing, especially that portion which outcrops within this area. Several wells have penetrated the limestone in the vicinity of Stockett and Sand Coulee, and have invariably failed to obtain water.

QUADRANT FORMATION.

The Quadrant formation consists of sandstone, shale, and limestone, with beds of gypsum in the lower part. It lies outside of the area studied except in a few localities, notably on Belt Creek, near Riceville, on Little Otter Creek, 2½ miles above its mouth, along the base of the Little Belt Mountains from Otter Creek to near the southeast corner of the area described, and in the central part of Skull Butte.

In the exposure near Riceville, the basal member of the Quadrant consists of reddish sandy shale with an occasional layer of gypsum. Overlying this member, to which Weed [a] has applied the term Kibbey sandstone, the deposits consist largely of shale with interbedded limestone and some sandstone, designated the Otter shale by the same author. The total thickness of the formation as exposed near Riceville is less than 500 feet.

The formation is not important as a water bearer, for throughout the greater part of the district it lies too deep to be reached by ordinary well borings, and as the upper member is shale and limestone and the lower gypsum-bearing soft sandstone, it is highly probable that if water were obtained it would be considerably mineralized. In the vicinity of Wolf Butte a number of sulphur springs issue from the shale members of this formation, and wherever springs are found in it the water contains a large amount of objectionable salts.

JURASSIC SYSTEM.

ELLIS FORMATION.

The Ellis formation is composed of a basal limestone of variable thickness ranging from 20 to 60 feet, above which lies a coarse conglomerate that passes upward into a medium-grained sandstone, light brown in color and more or less thin bedded. The limestone and conglomerate contain Jurassic fossils. Those in the conglomerate are sometimes fragmentary, but more often combined with pebbles of limestone and quartzite several inches in diameter. The component parts of the conglomerate are bound together by a calcareous cement. The total thickness of the formation is about 125 feet, and it rests unconformably upon the Quadrant and Madison formations. Though no practical tests have been made of the water capacity of the formation, it is probable that the sandstone of the upper part would readily absorb water under favorable conditions.

MORRISON FORMATION.

The Morrison formation, which is extensively exposed along the Rocky Mountain Front Range in southern Montana and Wyoming, is also believed to occur along the northern base of the Little Belt Mountains. In previous investigations in this field the Morrison formation has not been recognized, and the beds comprising it have been included in the " Cascade " formation. During the field season of 1906 dinosaur bones, believed by C. H. Gilmore to be of Jurassic age, were found at one horizon in many different localities, and at one exposure,

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[a] Weed, W. H., Geologic Atlas U. S., folio 55, U. S. Geol. Survey, 1899, p. 2.

about 30 feet below the bone-bearing horizon, a green shale was seen containing a distinctly fresh-water fauna later than the Ellis formation. These sediments, which are here provisionally regarded as constituting the Morrison formation, consist of sandstone and bright-colored sandy shale, with an occasional layer of impure limestone, generally in lenticular form. It lies with apparent conformity on the Ellis, and is overlain conformably by the Kootenai. The thickness varies from 60 to 120 feet, but the exact limits of the formation are often difficult to determine. Fragments of bones have been found at different horizons throughout the overlying Kootenai formation, but thus far none have been discovered in this region sufficiently well preserved for specific determination. It is possible that future investigation may prove that the sediments here tentatively regarded as belonging to the Morrison formation are in reality a basal member of the Kootenai.

The formation is generally exposed in a narrow band on the inner rim of a low ridge formed by the harder overlying rocks of the Kootenai formation. It outcrops all along the base of the Little Belt Mountains from the east end of the district to Smith River. Good exposures occur along the upper courses of Sage, Skull, Running Wolf, Hazlett, Surprise, Geyser, and Otter creeks, and in the bluffs for some distance back from the mountains along Belt Creek, Sand Coulee, Smith River and its principal tributary, Ming Coulee. The following section will show the succession of the beds:

Section of the Morrison formation on the east side of Belt Creek, Montana, in NE. ¼ sec. 30, T. 18 N., R. 7 E.

	Feet.
Gray, thin-bedded sandstone	17
Pebbly conglomerate occurring in lenses	5
Maroon and green shale	52
Green shale capped by 1½ feet of gray sandstone	5
Calcareous sandstone, weathering light brown	5
Green shale	20
Massive sandstone, weathering light brown	7
Dark-green shale containing thin limestone layers	9
Ellis formation.	
	120

The so-called Morrison formation is believed not to be an important water-bearing formation in this general district. It is composed largely of shale and clay, which are apparently not sufficiently porous to absorb or transmit underground water freely. It is possible, however, that some of its sandy members may contain water; but it is inferred from their lithologic character and the absence of springs throughout their exposed areas that they are not water bearing.

CRETACEOUS SYSTEM.

KOOTENAI FORMATION.

The Kootenai formation includes the upper third of the "Cascade," the Dakota, and the basal red shale included in the Colorado formation as described by W. H. Weed[a] in the Fort Benton folio. The name Cascade, as referring to a Cretaceous formation, was first used by that author in his description of the rocks of the Fort Benton quadrangle to apply to a series of beds ranging in thickness from 225 to 500 feet. The lower part of the formation, as originally described, consisted of lavender-tinted sandstone and highly colored shale and clay with massive gray sandstone above containing at its base a workable bed of coal.

During the present investigation, as previously stated, saurian bones, believed by some geologists to be of Jurassic age, were discovered in the lower half of the so-called "Cascade" formation, which indicates that these beds are probably of Morrison age, although vertebrate remains continue to occur to the top of the Kootenai. Between a horizon 45 feet below the coal bed and the top of the "Cascade" formation, as above defined, fossil plants of Kootenai age were collected at four different horizons, which establishes the lower Cretaceous age of this portion of the formation. On the east side of Spanish Coulee, a tributary of Smith River, at a horizon about 150 feet above the "Cascade" formation, in beds the stratigraphic equivalent of which near Belt are regarded provisionally by Weed as of Dakota age, a large collection of Kootenai plants were secured from dark coaly shale associated with red and green shale and clay. Overlying this plant-bearing bed there is about 200 feet of sediment consisting of red shale and sandstone, not differing materially in stratigraphy from beds immediately underlying the plant horizon. For this reason, together with the apparent absence of the Dakota flora in these beds, this member is provisionally regarded as of lower Cretaceous age and included in the Kootenai formation. It is overlain by dark-colored shale and sandstone of the Colorado formation, in the lower part of which were discovered marine saurian remains.

In this report it is not regarded as advisable to employ the name Cascade for the following reasons: The term has not been as extensively used in the literature as the older term Kootenai; its usage would necessitate redefining the term in order to separate its lower member, which is now believed to be Morrison; and the beds immediately overlying the formation can not be differentiated paleontologically from the "Cascade," both being of lower Cretaceous age,

[a] Weed, W. H., Geologic Atlas U. S., folio 55, U. S. Geol. Survey, 1899.

rendering it necessary to base the upper limit of the formation in question purely on lithologic grounds.

The Kootenai formation is about 450 feet thick and consists of alternating layers of sandstone and shale with the former predominating, especially in the lower half. The sandstone varies in thickness from 10 to 80 feet and is more or less massive in character. In the upper part shale predominates and is interbedded with thin layers of impure sandstone. At Belt, on the east side of Belt Creek, where a complete section was measured, the basal member of the formation consists of a sandy shale interbedded with sandstone, the latter predominating, and the whole having a thickness of about 60 feet. This member sometimes consists of firm, massive sandstone, with only a small percentage of shale. It is overlain by coal, which here has a thickness of 6 feet, including a few thin partings. Above the coal there is a dark, coaly shale 5 to 6 feet thick, covered by 38 feet of massive light-gray sandstone. This sandstone is followed in ascending order by 138 feet of beds consisting mainly of alternating layers of sandstone, red shale, and clay, with an occasional limestone lens in the lower part. Above this alternating series of sandstone, red shale, and limestone there is about 200 feet of red shale, which constitutes the topmost member of the formation. On the north side of Skull Butte the base of the Kootenai consists of a soft, light-gray, massive sandstone, but in other respects the portion of the formation exposed in this locality agrees closely with the beds exhibited at Belt Butte. A section of the Kootenai on the north side of Skull Butte is given below:

Section of the Kootenai formation on the north side of Skull Butte, Mont.

	Feet.
Reddish sandy shale.	
Gray thin-bedded sandstone	1½
Reddish sandy shale with layers of sandstone in the lower part	21
Greenish-gray sandstone, weathering dark, thin-bedded above, clay-ball conglomerate below	4
Reddish sandy shale, with layers of sandstone in lower part	27
Gray cross-bedded sandstone, clay-ball conglomerate in lower part	5½
Reddish sandy shale	30
Soft, thin-bedded sandstone	20
Gray, massive sandstone, clay-ball conglomerate	3½
Red sandy shale	38
Gray, massive sandstone, clay-ball conglomerate	5
Red sandy shale	24
Calcareous sandstone, alternating with sandy shale	20
Light and dark gray, fine-grained, massive sandstone	86
Coal and coaly shale (estimated)	6
Soft, massive, gray sandstone	62
	353½

Next to the Colorado the Kootenai has the greatest areal distribution of all the formations outcropping within the area. It occupies the surface over a great part of the district lying between Smith River and Belt Creek and is the surface formation of the high plateaus south of Otter Creek. Beyond Otter Creek it is exposed as a band of varying width, which narrows eastward.

The Kootenai is the principal water-bearing formation of the Great Falls region. As above stated, it consists mainly of sandstone and sandy shale. The sandstone is medium to coarse-grained and porous so that it readily absorbs water when the structural conditions are favorable. Along each side of Otter Creek and its tributaries from the south, also in Sand Coulee and its tributaries, the various sandstone members of the Kootenai formation are the source of numerous springs, and in the eastern part of the territory, where this sandstone is overlain by impervious Colorado shale, it contains artesian water.

COLORADO FORMATION.

The Colorado formation is well developed in this general region, being represented by about 1,600 feet of beds. In its type locality in the vicinity of Fort Benton, only a few miles to the north, it is essentially a shale formation, but throughout this region the lower part contains a number of prominent sandstone members. West of Great Falls, where the formation is typically developed, its basal member consists of a soft, massive sandstone somewhat concretionary, which is about 30 feet thick. Above this sandstone there is approximately 35 feet of sediment composed largely of dark-colored shale, with a few sandstone beds. This dark-colored shale is overlain by gray, coarse-grained, massive sandstone, containing concretionary layers and an occasional thin bed of soft, sandy shale, the whole having a thickness of about 80 feet. Above the sandstone for about 300 feet the beds consist mainly of alternating layers of sandstone and shale. These are followed by 700 feet of beds composed largely of uniformly dark-colored shale, which constitutes the uppermost member of the Colorado.

The Colorado formation is exposed throughout a wide area extending along the south side of the Highwood Mountains from Belt Creek southeastward to the east border of the district. Its basal sandstone members occupy the summit of Red Buttes and continue westward as a plateau capping to the Missouri River valley. Smith River and its tributaries cut the basal sandstone of the Colorado, exposing the underlying Kootenai rocks. The Colorado formation occupies the surface of the highland lying between Missouri and Sun rivers, also north and west of these streams to beyond the Teton. Its areal distribution is larger than any other formation within the district.

The shale of the Colorado formation, which constitutes nearly two-thirds of its entire thickness, is not water bearing, but the sandstone comprising its basal portion, which is medium to coarse grained and porous, carries an abundance of water. Throughout Ulm Bench, which is capped by basal Colorado sandstone, a number of wells have been sunk that furnish a large supply of excellent water derived from this formation. It is also the source of well-water supply on the highlands between Smith and Missouri rivers. East of Smith River there are a number of small springs situated along the margin of the detached plateaus which issue from the base of the Colorado sandstone. A typical spring of this character is shown in Pl. V, *A*.

MONTANA GROUP.

The Montana is extensively developed in the western part of the Great Falls region. It is represented within the area examined by the Eagle and Claggett formations. West of the district fossils were obtained from it which are believed to be of Judith River age. No Pierre shale was recognized in this general vicinity, although the formation is probably represented in the steeply dipping beds that skirt the base of the Lewis Mountains. While no careful examination was made of the Cretaceous formations bordering the base of the Lewis Mountains, it is believed that the various members that constitute the Montana group in the Judith River basin are here represented.

EAGLE SANDSTONE.

The Eagle sandstone consists of massive gray sandstone containing large iron-stained concretions 3 to 10 feet in diameter, which are fossiliferous. Sandstone layers alternate with sandy shale in the lower part. It has a thickness of about 90 feet and is exposed in places underneath the igneous rock capping Square, Fort Shaw, and Crown buttes (see Pl. II, *B*). It occupies the summits of the bluffs at Lowry where fossils characteristic of the formation were collected. Farther north it caps Freezeout and Priest buttes and gives rise to a conspicuous line of bluffs extending northward west of Chouteau and past Ralston Gap to the northern margin of the district. The distribution of the formation is not shown on the geologic map. The Eagle sandstone is a water-bearing formation, as is shown by the numerous small springs which issue from its base around Fort Shaw and Square buttes.

CLAGGETT FORMATION.

Overlying the Eagle sandstone is the Claggett formation, which consists of dull green and gray sandy shale, clay, and impure sandstone; also massive, light-gray and very dark-green, iron-stained, conglomeratic sandstone. In the upper part of that portion of the formation exposed in the area examined there is an erosional unconformity, which may be local, exhibiting a marked change in the character of the beds immediately above and below the contact. This apparent unconformity is well exposed on the north face of a high bluff on the south side of Sun River about 7 miles below Augusta, where the following section was taken:

Section of a portion of the Claggett formation on the south side of Sun River, Mont.[a]

	Feet.
Sandstone, dark green, conglomeratic, interbedded with sandy, leaf-bearing shale	50
Unconformity?	
Sandstone, massive, gray, and sandy shale, fossiliferous throughout	125
Sandstone, soft greenish gray	95
Shale, sandy and dark green, interbedded with sandstone layers which are concretionary	100

The Claggett formation occupies the surface south of Sun River and west of Crown Butte, also north of Sun River throughout a part of the district lying west of a line connecting Lowry with Bas Christian's ranch. The areal distribution of the formation is not shown on the geologic map. The sandstone members of the Claggett formation probably contain more or less water, although as far as could be ascertained no wells have been sunk in them.

QUATERNARY SYSTEM.

TERRACE DEPOSITS.

Throughout a great part of the territory lying east of Otter Creek divide and north of Sun River most of the interstream spaces are capped by bench gravel. This deposit consists of gravel and sand ranging in thickness from 10 to 40 feet and having smooth surfaces sloping gently away from the uplift. The component parts of the gravel, especially in the terraces north of Sun River which have their source to the west in the Lewis Mountains, are mainly sandstone, limestone, and chert, with a small per cent of igneous rock, the whole being sometimes bound together by calcareous cement. In the eastern part of the area the gravel of the terraces is more diversified, containing a larger percentage of igneous rock derived from the Little Belt Mountains to the south.

[a] Fossils collected from the locality where the above section was measured are regarded by T. W. Stanton as of the same age as forms collected from the Claggett formation in Judith River basin.

Gravel deposits of four different periods have been recognized. The earlier gravel, which is often cemented into conglomerate, occurs only in limited areas, capping some of the more prominent buttes and ridges, while the later is widely distributed, especially throughout the eastern part of the field. This bench gravel probably ranges in age from Tertiary to later Quaternary age, having been brought down by streams from the Little Belt Mountains and spread by them over the lower plain country as their courses were shifted from time to time. The distribution of the terrace deposits is not shown on the geologic map.

The gravel terraces of the Great Falls district usually contain some water. The amount, however, is not large, and a well sunk in them rarely obtains a sufficient quantity for both stock and domestic purposes of an average-sized ranch. That these gravels contain water, however, is shown by the fact that wherever they occupy extensive areas they are the source of numerous small marginal springs. The water contained in them is derived from rainfall.

GLACIAL DEPOSITS.

Glacial deposits of late Wisconsin age occupy a considerable area throughout the Great Falls region. The terminal moraine of the Keewatin ice sheet enters the district at the east end of Burton Bench, extending south to Teton River, where it turns to the east and follows along the northern side of Teton Ridge to the vicinity of Dutton. From here it extends diagonally southeastward past Benton Lake, across Missouri River to Sand Coulee near Gerber station, where it makes a sharp bend eastward and continues thus past the head of Red Coulee, thence northeastward to Belt Creek, where it passes off the northeast margin of the area. Its location and extent, as worked out by Calhoun,[a] are shown on the geologic map. The Keewatin ice sheet, extending into the region from the northeast, dammed up Missouri River and its tributaries, forcing the former to abandon its channel in many places, some of which were not reoccupied on the retreat of the ice. The abandoned channel, a portion of which is shown on the accompanying map, extends from the mouth of Sand Coulee, 4 miles south of Great Falls, northeastward in meandering course to the mouth of Belt Creek, where it unites with the present Missouri. In addition to the morainal deposits described above, there was deposited during the occupation of this general region by the ice extensive lake sediments in front of the terminal moraine. Much of this material has been removed by post glacial erosion on the higher lands,

[a] Calhoun, F. H. H., Montana lobe of the Keewatin ice sheet: Prof. Paper U. S. Geol. Survey No. 50, 1906.

but all the larger valleys in front of the moraine are filled with these sediments. Lake deposits of two different periods have been recognized by glaciologists in this region—an earlier and a later deposit. The limits of the earlier lake sediments can be ascertained only by bowlders lodged on the summits of the plateaus, while much of the deposits of the more recent lake still remains as a filling in the larger valleys. The distribution of the lake sediments is not shown separately, but is included with the valley wash.

The glacial deposits—especially the more recent lake sediments filling the valleys—are water bearing, and in some places in front of the terminal moraine they are the source of artesian water. The artesian water of Burton Bench is derived from granitic gravels overlain by impervious glacial clays deposited in front of the terminal moraine, and in Box Elder Creek valley is a flowing well, which is believed to have a similar source.

ALLUVIUM.

The alluvial deposits of this general region exhibit the usual diversified character, especially along the larger streams, such as Missouri, Sun, and Teton rivers, the deposits varying in width from one-fourth to 1 mile. The material is composed of fine silt, sand, clay, and gravel, which have been transported by streams in times of high water and deposited at different places along their courses. Along Missouri River from the base of the Big Belt Mountains northeastward to the vicinity of Great Falls the river flows in a meandering course through a wide plateau plain of alluvium, but east of that point it flows through a narrow canyon in which only small detached areas of alluvium are found.

The alluvial deposits generally contain a large amount of water and are the source of well water along nearly all the valleys in this region. The water in this formation is generally relatively pure, although the alluvium of some of the smaller valleys, especially in the Colorado shale areas, contains highly mineralized water.

STRUCTURE.

As the movement of water underground is governed to a certain extent by the structure of the formations, a brief description of the structural relations of the rocks of different parts of the district is here given, attention being called to the manner in which these structures affect the prospects for artesian water. Throughout the Plains portion of the region described the structure is relatively simple and the rocks lie nearly horizontal, dipping with a small angle to the north and east away from the mountains; but in the mountainous portion the structure is more complex.

LITTLE BELT MOUNTAINS.

The general structure of the Little Belt Mountains, which border this area on the south, is that of an anticlinal uplift with sharply dipping sides and a flat summit. In the central portion of the range the stratified rocks lie nearly horizontal, while along the northern flanks of the uplift, as shown on the head of Avoca Creek, the limestone dips at an angle of 15° to 20° toward the lower Plains country. The simple structure of the northern part of the uplift has been considerably modified by the intrusion of igneous rocks in the form of laccoliths, which have caused local doming of the strata in many places. Only one of these laccolithic domes occurs within the area described, but there are others, such as are found east of Kibbey and in the head of Dry Wolf Creek, whose marginal structure extends into this area. In the vicinity of the larger intruded masses of igneous rock the dips are often steep and variable, but in that portion of the mountain front where local intrusions have not disturbed the strata they dip away normally from the uplift at angles of 6° to 12°, lessening gradually toward the lower Plains country, thus producing ideal structural conditions for the occurrence of artesian water on the plains.

HIGHWOOD MOUNTAINS.

The Highwood Mountains, which border on the north the eastern end of the area described, are structurally different from the Little Belt Range. They consist of a group of isolated peaks which have been formed by igneous intrusion in Cretaceous rocks which were horizontally bedded or slightly inclined eastward. Subsequent to this intrusion stream erosion has removed much of the softer rock, leaving the harder rock standing as a cluster of peaks above the surrounding plain.

LEWIS AND BIG BELT RANGES

The Lewis and Big Belt ranges, being more remote from the field investigated, were not examined, but their broader structural features, as worked out by previous investigators, are given below.

The Lewis Mountains, lying to the west of the district and constituting the Rocky Mountain Front Range of northern Montana, have been formed by an overthrust fault of considerable magnitude, extending along the east side of the range, which superimposes Algonkian strata on upper Cretaceous rocks. The extent of the thrust in the vicinity of Chief Mountain, which lies to the north, is said to be 7 miles in a horizontal direction. Under these conditions it is apparent that rocks occupying the surface throughout the adjoining plains on the east will in their westward extension pass under the higher portions of the mountains instead of extending normally up their flanks, thus producing structural relations not favorable to the occurrence of artesian water in the western part of the Great Falls region. From observations made in the vicinity of Cascade, the northern end of the Big Belt Mountains is formed by extensive masses of igneous rock penetrating upper Cretaceous sediments, which are in some places horizontally bedded and in others sharply folded. It is possible that the overthrust fault which extends along the face of the Lewis Range turns eastward along the northern side of the Big Belt Mountains, but this point was not ascertained in the field.

WATER RESOURCES.

SOURCE.

The source of water supply of the Great Falls region is found mainly in the adjoining mountain ranges. These mountains rise to altitudes of 8,000 to 10,000 feet, where there is a relatively large precipitation and a heavy snowfall. They are covered to a greater or less extent by coniferous forests, and thus serve as natural reservoirs regulating the run-off of the district. The numerous streams traversing the Great Falls region head high in the slopes of the adjoining mountains. Here they gather a large amount of water from melting snow, which is carried out of the mountains into the plains or is absorbed by the upturned edges of the porous rocks over which the streams pass, thus becoming available as artesian water lower down on the plains when the overlying impervious strata are penetrated by well borings. Extensive fires have denuded much of the mountainous land which was formerly densely forested, leaving bare rocks and dead timber and causing the run-off to be more rapid.

SURFACE WATERS.

STREAMS.

MISSOURI RIVER.

The principal stream of the district is Missouri River. It enters the area near Cascade and flows in a northerly direction to the vicinity of Great Falls, where it changes to a more easterly course, continuing thus to the border of the field. That portion of the stream lying above Great Falls flows in a meandering course through a wide valley, but below this point it enters a narrow valley with precipitous bluffs, passing over a number of cataracts collectively known as the Great Falls of the Missouri River (Pl. III, *A* and *B*, and Pl. IV, *A* and *B*). The drainage area of Missouri River at Cascade, Mont., is estimated at 18,295 square miles. Its largest tributaries from the south are Smith River and Belt Creek, and from the west and north Sun and Teton rivers, the latter entering the Missouri in the vicinity of Fort Benton outside of the area to which this report relates.

A. DAM AT BLACK EAGLE FALLS AND THE ANACONDA CONSOLIDATED COPPER AND MINING COMPANY'S SMELTERS, GREAT FALLS, MONT.

B. RAINBOW FALLS OF MISSOURI RIVER, 4 MILES BELOW THE TOWN OF GREAT FALLS, MONT.

There are a number of medium to large size intermittent streams with relatively large drainage areas entering the river from either side. Those from the south are Bird Creek, Castner Coulee, Sand Coulee, Box Elder Creek, and Red Coulee, and from the west Little Muddy Creek. The flow of Missouri River is by no means constant, but varies greatly with the season. According to discharge measurements made at Cascade, Mont., during four consecutive years from 1902 to 1905, inclusive, it had a maximum flow of over 22,000 second-feet and a minimum of about 1,800 second-feet, the mean varying from about 2,000 to 18,000 second-feet. As previously stated, the greatest volume of water is carried by the stream during the months of June and July, and the low-water mark is generally reached in the month of September. The results of observations made on the flow of Missouri River at Cascade are given in the following table:

Estimated rate of discharge of Missouri River at Cascade, Mont., 1902–1905, by months.

[Measurements made by W. W. Schlecht and L. V. Branch.]

Date.	Discharge in second-feet.			Date.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.		Maximum.	Minimum.	Mean.
1902.				1904.			
July 17-31	6,900	3,170	4,847	April	12,830	5,150	8,409
August	2,950	1,810	2,171	May	21,710	12,090	14,925
September	2,305	1,915	2,057	June	20,600	11,350	16,660
October	2,950	2,380	2,720	July	11,350	3,600	7,436
November	4,030	2,550	3,176	August	3,480	2,305	2,898
				September	2,380	1,915	2,167
1903.				October	3,600	2,465	2,979
April	9,300	4,730	6,536	November	3,600	3,260	3,416
May	12,700	7,700	9,958	December	4,490	2,740	3,597
June	22,700	12,100	17,953				
July	12,700	2,845	7,302	1905.			
August	3,420	2,090	2,372	March	3,930	3,340	3,721
September	2,550	1,970	2,274	April	4,320	3,120	3,635
October	3,170	2,645	3,056	May	4,320	3,450	3,944
November	6,300	3,170	4,470	June	10,410	4,060	8,081
December	9,900	2,740	6,083	July	10,070	2,600	4,518
				August	2,900	1,800	2,147
1904.				September	2,020	1,720	1,929
January			[a] 6,000	October	2,600	1,720	2,159
February			[a] 6,000	November 1-27	3,930	2,600	3,158
March			[a] 6,000				

[a] Estimated.

Discharge measurements of Missouri River at Cascade, Mont., in 1902 and 1906.

[Drainage area, 18,295 square miles.]

Date.	Hydrographer.	Second-feet.
1902.		
July 21		5,537
September 9		1,891
November 6		3,131
1906.		
April 24	G. Edson	6,190
May 12	do	7,880
June 3	do	14,400
June 25	Edson and Richards	10,400
August 20	R. Richards	2,300
September 17	Grover and Richards	2,620
October 31	R. Richards	3,480

According to measurements of the flow of Missouri River, made by E. T. Nettleton [a] in September, 1891, this stream loses 834 second-feet of water between the town of Great Falls and Fort Benton, a distance of about 45 miles. These measurements are supposed to have taken into account the amount added to Missouri River by Belt and Highwood creeks and by Giant Springs. That from the former two is inconsiderable, but the latter adds materially to the total flow.

SUN RIVER.

Sun River, the largest tributary of Missouri River in this district, rises high in the Lewis Mountains. The main stream is formed by the junction of North and South forks of Sun River, which takes place about 3 miles northeast of Augusta in the northwest corner of T. 8 N., R. 5 W. From this point the stream pursues an easterly course through an open valley to Great Falls, where it joins Missouri River. The area drained by Sun River comprises the greater portion of that part of the high eastern slope of the Rocky Mountain Front Range extending from parallel 47° 30′ to 48° and a portion of the adjoining Plains province 25 to 30 miles wide extending from the base of the mountains eastward to the vicinity of Great Falls. The high mountainous portion of its drainage area is covered with snow throughout the greater part of the year, while on the adjoining plains more arid conditions prevail. The principal tributary of Sun River from the north is Muddy Creek, which drains the high plateau between Sun and Teton rivers, emptying into the Sun near Vaughn. It is an intermittent stream of minor importance. From the south Sims Creek joins Sun River near the town of Sims, and a few miles farther west Spring and Dry creeks come in from the same side. Sun River has a large flow of water, the maximum being reached during the early summer months when the largest amount of snow is melted on the mountains. By far the greater part of the water of this stream comes from North Fork of Sun River, which is several times larger than South Fork, having its drainage area higher on the slopes of the Lewis Mountains. Discharge measurements of Sun River at the town of Sun River, about 20 miles above its mouth, are given below:

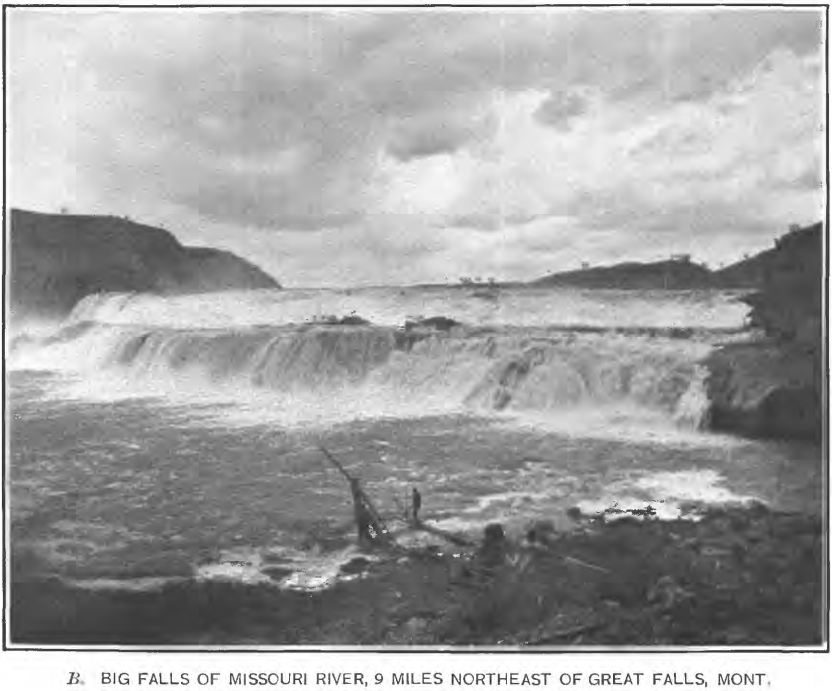
Discharge measurements of Sun River at Sun River, Mont., 1906.

Date.	Hydrographer.	Second-feet.
April 10	Morse and Edson	344
April 15	H. M. Morse	359
May 3	G. Edson	684
May 21	do	1,240
May 22	do	1,160
May 30	do	2,140
June 19	Edson and Richards	1,510
July 16	R. Richards	506
August 17	do	74
October 6	do	204
November 6	Follansbee and Richards	396
November 16	do	[b] 1,440

[a] See Bibliography, p. 9.

[b] Ice running; value doubtful.

A. CROOKED FALLS OF MISSOURI RIVER, NEAR GREAT FALLS, MONT.



B. BIG FALLS OF MISSOURI RIVER, 9 MILES NORTHEAST OF GREAT FALLS, MONT.

SMITH RIVER.

Smith River has its source far to the southeast in the vicinity of the Castle Mountains, and flowing northwest drains the highland area between the Big Belt and Little Belt mountains. It enters the area described near the center of the south line of T. 17 N., R. 3 E., and flowing in a northeasterly direction joins Missouri River at a point near Ulm. Within the area described the stream flows in a meandering course through a deep but narrow valley. The gradient of the lower course of the stream is about 7 feet to the mile. The largest tributary of Smith River is Hound Creek, entering from the west, near Orr. It drains the northern end of the Big Belt Mountains, some of its tributaries extending high up the slopes of that range. From the east three intermittent streams enter Smith River—Boston, Ming, and Goodwin coulees. Smith River has a flow of nearly 400 second-feet during the months of May and June, but in the late fall its flow is very much smaller, as is shown by the following discharge measurements:

Discharge measurements of Smith River at Truly, Mont., 1905–6.

Date.	Hydrographer.	Second-feet.
1905.		
March 7	Porter and Bird	163
May 11	Stockman and Porter	125
September 1	A. P. Porter	31
1906.		
April 9	Morse and Edson	423
May 11	G. Edson	397
July 12	R. Richards	317
November 28	do	[a]79.9

[a] Wading section.

TETON RIVER.

The northern portion of the area treated in this report is drained by Teton River. This stream has its source on the eastern slope of the Lewis Mountains, but it does not extend far back into the uplift. After leaving the mountains it pursues a southeasterly course to the vicinity of Chouteau, where it makes a pronounced bend and flows northeastward past Collins and joins Missouri River in the vicinity of Fort Benton. Its largest affluents are Muddy and Deep creeks, the former entering from the northwest below Collins, and the latter from the south near Chouteau. These streams both rise in the foothills of the mountains and have a continuous flow throughout the year. The flow of Teton River is not large, especially in the vicinity of Chouteau, but near the mountains the amount is greater. At a point about 7 miles above Chouteau the stream bed is often dry throughout the late summer months, but, while the surface flow of this portion of the stream is small, there is apparently a very strong underflow. Spring Creek, a tributary of this stream, is formed by a number of springs having their source in the valley wash. It rises in Teton Valley in the northwest part of T. 24 N., R. 5 W., and flows roughly parallel to Teton River at a distance of one-half to three-fourths of a mile from it for about 10 or 12 miles to where it enters the main stream. Discharge measurements of Teton River have been made near Belleview and in the vicinity of Chouteau. These are given in the following tables:

Discharge measurements of Teton River near Belleview, Mont., 1904–1906.

Date.	Hydrographer.	Second-feet.
1904.		
November 27	A. P. Porter	58
1905.		
May 8	Stockman and Porter	48
October 12	Gordon Edson	56
November 4	do	51
1906.		
April 12	G. Edson	25.2
May 9	do	43.1
June 22	Edson and Richards	17

Discharge measurements of Teton River near Chouteau, Mont., 1904–5.

Date.	Hydrographer.	Second-feet.
1904.		
November 9	A. P. Porter	7.3
1905.		
May 9	Stockman and Porter	8
October 13	Gordon Edson	3
1906.		
April 13	Morse Edson	7.2
May 9	G. Edson	4.6
June 23	Edson and Richards	7.8

BELT CREEK.

This stream rises in the northern part of the Little Belt Mountains, flows north across the east-central part of the district, draining the territory lying west of the Highwood Mountains, and entering the Missouri about 12 miles northeast of Great Falls. It is a vigorous mountain stream, which carries a large flow of water in its upper course throughout all seasons of the year, especially near the mountains, but at the town of Belt all this water sinks to an underflow (see Pl. II, *A*) during the late summer months, leaving the stream bed dry. The loss is probably due to the fact that soft porous sandstone forms the floor of Belt Creek valley. A view of the dry bed of Belt Creek is shown in Pl. II, *A*. From a short distance below the town of Belt to its mouth the stream has a small but continuous flow. Discharge measurements above the town of Belt are as follows:

Discharge measurements of Belt Creek near Belt, Mont., in 1905–6.

Date.	Hydrographer.	Second-feet.
1905.		
March 17	Porter and Bird	8.0
May 12	L. R. Stockman	7.8
June 11	A. P. Porter	578
1906.		
April 20	G. Edson	4.62
May 18	do	160
May 19	do	155
June 1	do	357
July 14	R. Richards	190
November 10	Follansbee and Richards	3.55

OTTER CREEK.

Otter Creek is one of the largest tributaries entering Belt Creek from the east. It rises on the northeastern slope of the Little Belt Mountains near Barker and flows north for about 6 miles, thence northwest, joining Belt Creek near Armington. It receives several small spring-fed tributaries from the south, including Little Otter Creek, Bundy Coulee, Swan Coulee, and Ford Creek. Its branches from the north, which have their source in the Highwood Mountains, are Williams and Cora creeks—the former entering near Spion Kop and the latter 2 miles above its mouth. No discharge measurements have been made of Otter Creek, but it has considerable water throughout all seasons of the year, which is supplied mainly by a number of large springs along its course.

OTHER SMALL STREAMS.

The area lying between Belt Creek and Smith River is drained by Box Elder Creek and Sand Coulee. Box Elder Creek rises on the high plateaus about 3 miles west of Riceville, flows northward in a direction roughly parallel to Belt Creek, and enters the Missouri about 9 miles northeast of Great Falls. This stream carries only a small flow of water. Sand Coulee, an intermittent stream with a large drainage area, is formed by the union of several small canyon tributaries southeast of Stockett. It continues northward to a point about 6 miles below Stockett, where it makes a sharp turn to the west and meanders through a wide level-floored valley for about 7 miles, entering Missouri River about 4 miles above Great Falls. That portion of its valley through which the stream flows from the point where it makes the sharp turn to the west is a part of the preglacial valley of the Missouri, which extends from the mouth of Sand Coulee eastward to Box Elder Creek and then northeastward to near the mouth of Belt Creek, where it reunites with the present channel.

East of Otter Creek there is a prominent ridge constituting a low divide between the Highwood and Little Belt mountains which has been named the Otter Creek divide. East of this divide the drainage is all to the northeast into Arrow Creek, which is a small tributary of the Missouri, entering a short distance above the mouth of Judith River. Arrow Creek, which has its source on the southern slope of the Highwood Mountains, flows eastward, passing out of this district in T. 18 N., R. 11 E. Its principal affluent is Surprise Creek, which rises at the base of Wolf Butte and pursues a northeasterly course, uniting with the main stream outside of the area here described. Running Wolf Creek rises higher up the slopes of the Little Belt Mountains farther to the southeast and flows northeasterly past Stanford Buttes, joining Judith River outside of the district. East of Running Wolf Creek there are several small creeks crossing the extreme southeast corner of the district which belong to the Judith River system. These are Skull, Willow, and Sage creeks.

LAKES AND SWAMPS.

The lakes occurring within the Great Falls district are of two kinds—those on the table-land, which hold flood water during a small portion of the year, and the artificial lakes, which are used as storage reservoirs for the most important irrigation systems. The largest of the natural lakes is Benton Lake, located on the highlands about 9 miles nearly due north of Great Falls. It is about 1 mile wide and 2½ miles long, and is said to have formerly held water all the year. At present the flood water which it receives during the spring sinks away, leaving the lake bed dry throughout the entire summer. It is situated in front of the terminal moraine of the Keewatin ice sheet and is probably of glacial origin. Freezeout Lake, situated in the center of an area of glacial lake deposits in Freezeout Basin, holds a small amount of water a portion of the year. There is also another small, dry lake on the plains about 3 miles southeast of Dutton. Northeast of Priest Buttes are two artificial lakes, known as Priest Lakes, which are formed by seepage water from the Cascade Land Company's canal, and south of Ralston Gap there is a small lake used as a storage reservoir. Lakes or reservoirs are of frequent occurrence throughout the district. One of considerable size is found on the table-land north of Lowry, and another, now abandoned, south of Square Butte, in the Little Muddy Creek valley. Many other smaller lakes of this character are found throughout the district, the locations of which are given on the geologic map. On Burton Bench, near

Teuchot home ranch, there are a number of small lagoons or lakes fed by springs which contain water throughout the year.

To the west of the area treated in this report and along the base of the Lewis Mountains there is a zone in which local mountain glaciers have deposited morainal material over wide districts bordering the larger streams. Throughout these glaciated areas there are innumerable small lakes and swamps which furnish water to the mountain streams crossing them.

UNDERGROUND WATERS.

GENERAL STATEMENTS.

The water-bearing rocks of the Great Falls region are confined mainly to the basal Colorado and the Kootenai formations, where a number of sandstone beds occur which are porous and imbibe water freely when conditions are favorable. There are other formations within the district that have sandstones that probably contain more or less water. These are the Eagle and Claggett sandstones of the Montana formation and the coarse-grained conglomeratic sandstone of the Ellis formation. Around the sides of Square and Fort Shaw buttes a number of small springs issue from the base of the Eagle sandstone. In the Kootenai formation several water-bearing horizons are found. The massive gray sandstone overlying the coal, which ranges in thickness from 25 to 80 feet, is the source of a number of springs along Otter Creek, and wherever the coal is mined, especially where the sandstone forms the roof, considerable difficulty is encountered with water from this formation. Above the sandstone overlying the coal there are a number of massive sandstones interbedded with red shale, which, when they occupy summits of plateaus, have numerous small springs issuing from their base. These Kootenai sandstone beds are the sources of numerous small springs wherever they are exposed from the eastern margin of the field to Smith River. West of Stockett, however, they are overlain by basal sandstones of the Colorado, which cap the plateau summits west and south of Sand Coulee, extending to beyond Missouri River and including the bench land north of Ulm. Throughout this area springs are of frequent occurrence at the base of the Colorado sandstone, and wherever well borings on the summits of the plateau have entered this sandstone a good supply of water has usually been obtained.

SPRINGS.

DISTRIBUTION.

One of the most valuable sources of domestic and stock water supply in the Great Falls district is found in the numerous springs which occur along the upper courses of the smaller mountain streams and in the valleys of the larger streams throughout the lower Plains country. Along the northern slope of the Little Belt Mountains springs are very abundant. The zone bordering the mountains is essentially a plateau region traversed by numerous mountain streams which flow through deeply cut valleys. In the bottom of these valleys and along their sides at different elevations above the streams springs of moderate flow occur at frequent intervals. Their source is the various water-bearing sandstones of the Kootenai formation, which extend southward far up the slopes to the high hilly zone bordering the mountains where there is an increased precipitation, and the sandstones absorb a large amount of water. Lower down on the plains the mountain streams cut and expose these sandstones, leaving the water free to escape as springs in the sides of the plateaus and in the lower portions of the valleys. Springs of this character are most abundant along Otter and Belt creeks, Sand Coulee, Smith River, and their principal tributaries (see Pl. V, *A*). They are usually not large, but afford a steady supply of good water when properly developed. West of Missouri River springs are less numerous. Several are found issuing from the base of the Eagle sandstone on the sides of Square and Fort Shaw buttes. At one locality on the west side of Square Butte water from a number of these small springs which have been developed is piped 2 miles to the Toman stock ranch, where it is utilized for domestic purposes (see Pl. II; *B*). On the north side of Sun River the high gravel-capped plateau is more or less dissected by canyons leading southward. In these canyons and in the heads of coulees tributary to them springs are frequent. They have their source in the gravel terrace which caps the plateau, or in the underlying Eagle sandstone. The flow, though not large, is continuous, the water being used mainly for stock purposes by the Flowerree Cattle Company. A few small springs are found along Muddy Creek of Sun River northwest of Vaughn and along the base of the bluffs at the upper end of Burton Bench.

In Sun and Teton River valleys there are a few large springs which derive their water from the underflow of these streams. Probably the largest spring of this character is found in Teton Valley about 7 miles above Chouteau, where a sufficient amount of water issues from the valley wash to supply a stream of considerable size, known as Spring Creek. In Sun River valley at Lowry is a spring of similar size, which is utilized for both irrigation and stock purposes. This spring has a large flow of excellent water, which enters Sun River a short distance below Lowry. Another spring, somewhat smaller, is found on the opposite side of the river at Skinner and Heikie's ranch, and farther down the river, a short distance above the intrusive dike which crosses Sun River valley about 1 mile west of Fort Shaw, there is a small area where numerous springs issue

A. SPRING AT BASE OF COLORADO SANDSTONE, 12 MILES SOUTH OF GREAT FALLS, MONT.

B. GIANT SPRINGS, NEAR GREAT FALLS, MONT.

from the valley wash. Springs are not infrequent in Sun River valley between Lowry and Augusta. At Sam Larkin's ranch, 6 miles below Augusta, a spring issues from the base of a low gravel-capped terrace, and has a strong flow of water throughout the year. Other springs of a similar character examined in this part of Sun River valley are given in the table on pages 42–50, with their source, quality, and approximate yield.

A few springs are found along Missouri River between Cascade and Great Falls which are used for domestic and stock purposes, although in the majority of cases in this vicinity the water supply is derived from shallow wells. Along the base of the Big Belt Mountains on the east side of the river springs are more numerous, and in many instances they have been given the chief consideration in locating ranches.

GIANT SPRINGS.

Near Great Falls are some very large springs which present unique geologic features and an interesting question as to the source of the water (see Pl. V, *B*). These springs, locally known as Giant Springs, are located on the south bank of Missouri River about 3 miles below Great Falls. They have a very large flow of relatively pure water, which appears at the surface through large joints in a medium to coarse-grained sandstone belonging to the Kootenai or lower Cretaceous rocks. On either side of the main spring for a short distance are smaller springs flowing from the joints, and directly opposite it in the bed of the river there is a large spring, which is apparent during low water. The Giant Springs were discovered by Captain Lewis, of the Lewis and Clark Expedition, in 1804, and in his description were spoken of as the "largest fountain in the United States."

According to measurements made by E. T. Nettleton[a] the flow of these springs is approximately 638 cubic feet per second, an amount which, converted into gallons, is the equivalent of over 400,000,000 gallons every twenty-four hours—a veritable underground river. The fact that the water of Giant Springs issues from rocks at the water's edge and in the bed of the river renders it difficult to measure their exact flow. In order to ascertain this amount, measurements were taken of the total flow of Missouri River above and below the springs; the difference between these two measurements is assumed to be the quantity furnished to the river by the springs. It is readily seen from the above figures that these springs rank among the largest in the United States. The water, which boils up with considerable force, is clear, blue, and relatively pure, containing no more dissolved salts than the average well water of the region. It has a temperature of about 50° F.

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[a] See Bibliography, p. 9.

No spring deposits occur in the immediate vicinity of Giant Springs, and the water is not generally regarded as possessing therapeutic value. It is not utilized at present, but is allowed to flow into the river. There are, however, a few improvements, such as sidewalks, etc., which make it possible for tourists to view the springs from the most advantageous points.

A chemical analysis of the water was made several years ago by James A. Dodge, of the University of Wisconsin, and a field analysis of the water was made during the past field season by W. R. Calvert. These analyses are given below.

Analyses of water of Giant Springs near Great Falls, Mont.

MINERAL ANALYSIS.

[Grains per gallon.]

$CaSO_4$	14.04
$CaCO_3$	4.38
$MgCO_3$	4.98
NaCl	.56

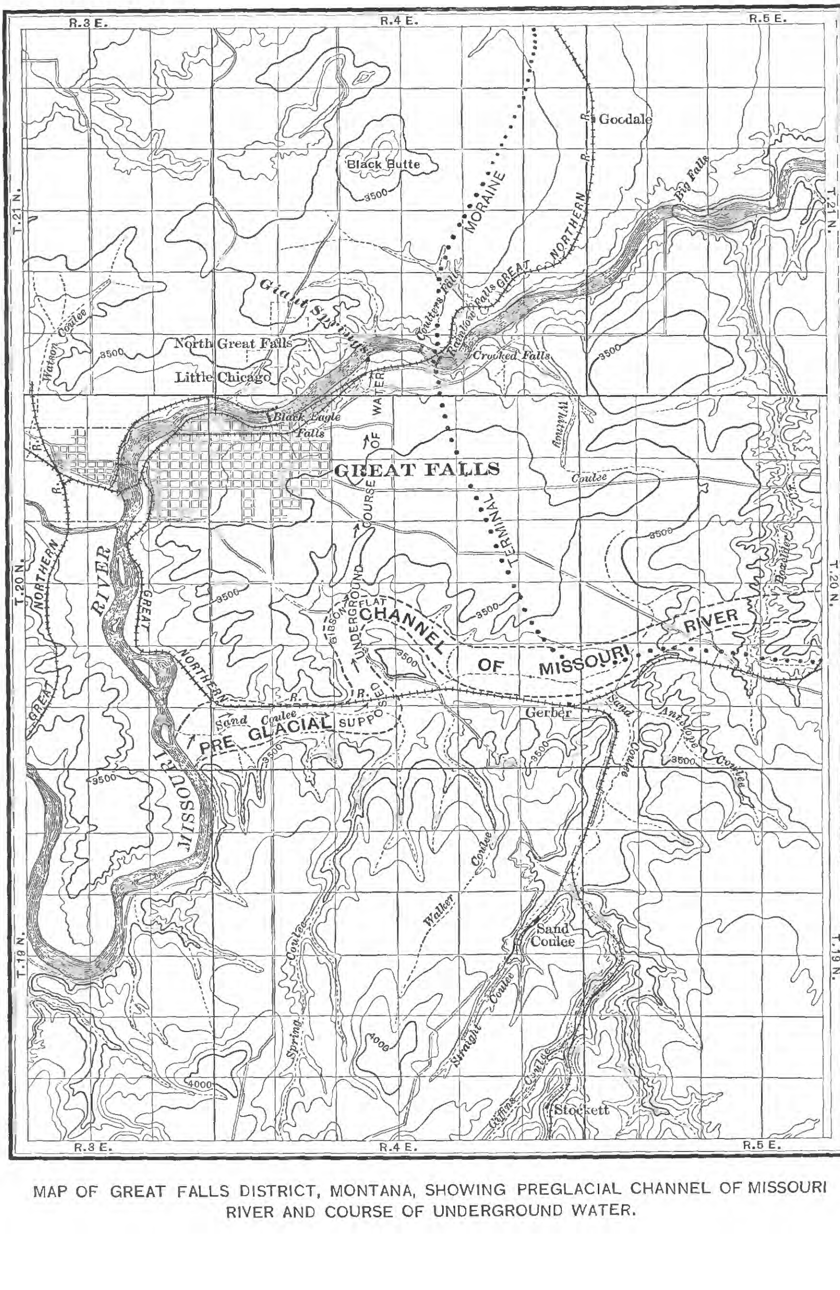
Traces of borates and potassium and lithium.

FIELD ANALYSIS.

[Parts per million.]

Turbidity	0
Color	0
Iron	0
Calcium	Moderate.
Total hardness	97
Total alkalinity	340
Alkaline carbonates	0
Alkaline-earth carbonates	339
Sulphates	300
Chlorides	10

From a careful study of the geologic relations in the vicinity of Great Falls, it is believed by the writer that the water of Giant Springs is derived from the subriver flow of the Missouri which leaves the valley of that stream near the mouth of Sand Coulee as an underflow and passes down its preglacial channel, which extends up Sand Coulee, into Gibson Flat, an oxbow in the old river channel. From here by a subterranean passage through porous Cretaceous sandstone and sandy shale, which dip in a favorable direction for its transmission, it makes its escape to the present Missouri River, where it appears in the form of Giant Springs (see Pls. V, *B*, and VI). It is further believed by the writer that the jointing, which is here well developed with the major joint planes extending in a north-south direction, is an important factor in the underground movement of the water. It is also possible that a fault in this vicinity further facilitates the underground passage of the water, but no positive



MAP OF GREAT FALLS DISTRICT, MONTANA, SHOWING PREGLACIAL CHANNEL OF MISSOURI RIVER AND COURSE OF UNDERGROUND WATER.

evidence of this was seen. Well borings in lower Sand Coulee and Gibson Flat demonstrate that the materials filling the old valley are largely coarse river sediments, well adapted for rapid percolation of water.

From the above it is readily seen that along the supposed underground course of the water from the mouth of Sand Coulee to where it appears at the surface as springs, the physical conditions are such as to permit the passage of a large volume of water, an amount believed to be equivalent to that furnished by the Giant Springs.

WELLS.

While springs are the principal source of domestic water supply in the Great Falls region, there are a number of localities, especially in the larger valleys, where the greater part of such water is derived from shallow wells rarely exceeding 20 feet in depth. On the summits of some of the plateaus bordering the Little Belt Mountains, where dry farming is successfully practiced, wells obtain water at depths varying from 100 to 300 feet, depending on the locality. To the west and north of Great Falls, throughout the highland districts, wells are usually shallow, rarely being sunk below the base of the gravel terraces, which vary from 25 to 40 feet in thickness and cover extensive areas. In the larger valleys traversing the western part of the district wells are usually shallower than those on the highland, and water is more abundant. Throughout Burton Bench, north of Teton River, they vary from 20 to 100 feet, the deeper ones being artesian. A few deep wells have been dug in the vicinity of Great Falls, three by the Great Falls Meat Company on the table-land east of Great Falls, two by the Copeland Brothers near the south end of Sun River bridge, and others farther up Missouri River, one on Odell ranch and another at Ulm. The deepest boring in this portion of Montana occurs about 6 miles east of Dutton, where an oil prospect hole, known as the Banatyne well, has been sunk to a depth of 1,500 feet. Records of the Copeland Brothers, Banatyne, and Odell wells are given below, and on subsequent pages occur well tables giving the location, depth, quantity, and quality of water of a number of representative wells in the Great Falls district.

Records of Copeland Brothers' wells near the south end of Sun River bridge, Great Falls, Mont.

WELL NO. 1.

	Feet.
Fine sand	0– 4
Gumbo	4–15
Blue clay	15–31
Sand and gravel, water bearing	31–33
Red sandstone	33–43

Records of Copeland Brothers' wells near the south end of Sun River bridge, Great Falls, Mont—Continued.

WELL NO. 1—Continued.

	Feet.
Ferruginous sandstone	43– 47
Blue shale	47– 59
Gray shale	59– 85
Gray sandy rock	85–100
Light-red rock	100–105
Dark-red rock	105–112
Gray compact sandstone	112–122
Blue shale	122–134
Red rock	134–144
Sandstone with shaly layers	144–147
Light-red rock	147–157
Soapstone	157–227
Impure sandstone	227–229
Gray shale	229–244
Impure sandstone	244–247
Gray shale	247–252
Impure sandstone	252–255
Gray shale	255–263
Impure sandstone	263–265
Gray shale	265–277
Sandstone and shale	277–282

WELL NO. 2.

Fine sand	0– 8
Medium fine sand	8– 25
Gumbo	25– 36
Blue clay	36– 52
Red rock	52– 62
Ferruginous sandstone	62– 66
Blue shale	66– 81
Red rock	81–103
Fine gray sandstone	103–107
Light-red rock	107–123
Blue shale	123–131
Gray sandstone	131–143
Brown shale	143–157
Gray shale	157–167
Soapstone	167–207
Light-red rock	207–219
Impure sandstone	219–223
Dark-red rock	223–233
Black shale	233–247
Light-red rock	247–250
Gray shale	250–260
Impure sandstone	260–263
Gray shale	263–265
Impure sandstone	265–266
Blue shale	266–274
Impure sandstone	274–276

Records of Copeland Brothers' wells near the south end of Sun River bridge, Great Falls, Mont—Continued.

WELL NO. 2—Continued.

	Feet.
Dark shale	276–280
Impure sandstone	280–283
Gray shale	283–289
Blue sandstone	289–297
Brown shale	297–300
Blue sandstone	300–310
Impure limestone	310–318
White limestone	318–370
Brown limestone	370–417
White limestone	417–459
Blue limestone	459–519
Impure limestone	519–541
Brown limestone	541–569
Blue limestone	569–581
White limestone	581–643

Record of Banatyne well, 6 miles east of Dutton, Mont.

	Feet.
Yellow clay	0– 74
Shale	74– 280
Sand, containing salt water and gas	280– 285
Sandy shale	285– 358
Black sand	358– 365
Shale	365– 500
Sand, containing salt water	500– 509
Sand and gritty shale	509– 605
Soft, white conglomerate	605– 780
Hard conglomerate	780– 870
Fine blue sand	870– 880
Hard blue shale	880– 900
Hard shale in thin layers	900– 950
Dark-blue shale	950– 975
Black shale	975–1,040
Hard bluish sandstone	1,040–1,130
Black shale	1,130–1,160
Red limestone	1,160–1,200
Red sandstone	1,200–1,240

It is believed that the so-called red limestone encountered at a depth of 1,160 feet below the surface represents the upper part of the Kootenai formation.

Record of Odell well in Missouri River, south of Great Falls, Mont.

	Feet.
Alluvium	0– 20
Sand	20–145
Clay	145–205
Gravel	205–212

Partial list of springs of Great Falls region, Montana.

No.	County.	Locality.	Township, etc.	Owner.	Temperature.	Quantity.	Material from which spring issues.	Approximate elevation.	Is supply continuous?	Use.
					°F.			Feet.		
1	Teton	Chouteau	SW. ¼ sec. 30, T. 25 N., R. 5 W.	On Government land		Small	Blue shale	4,100		Stock.
2	do	do	NE. ¼ sec. 18, T. 25 N., R. 5 W.	Frank Ralston	52	do		4,100	Yes	Domestic and stock.
3	do	do	SW. ¼ sec. 28, T. 24 N., R. 5 W.	On Government land		do	Sandstone	4,050		Stock.
4	do	do	SW. ¼ sec. 1, T. 24 N., R. 4 W.	H. R. Thompson	50	do	Alluvium	3,800	Yes	Domestic and stock.
5	do	do	SE. ¼ sec. 24, T. 23 N., R. 5 W.			do	Blue shale	4,200		
6	do	do	SE. ¼ SE. ¼ sec. 20, T 23 N., R. 4 W.	P. Grossen	52	Medium	Sandstone	3,900	Yes	Domestic, stock, and irrigation.
7	do	do	SW. ¼ sec. 18, T. 23 N., R. 4 W.	S. T. Cattle Co.	53	Small	do	3,950	Yes	Stock.
8	Cascade	do	NW. ¼ sec. 13, T. 22 N., R. 4 W.	J. Thorn						
9	do	Augusta	SW. ¼ sec. 28, T. 22 N., R. 4 W.	—— Flowerree	55					Do.
10	Lewis and Clark	do	NW. ¼ sec. 26, T. 21 N., R. 6 W.	Jim Lytle					Yes	
11	do	do	Sec. 13, T. 21 N., R. 6 W.	—— Flowerree				4,300		
12	do	do	NW. ¼ sec. 35, T. 21 N., R. 5 W.	Clark Lytle	48				No	
13	Cascade	do	NE. ¼ sec. 2, T. 21 N., R. 5 W.	—— Flowerree						
14	do	do	NE. ¼ sec. 6, T. 21 N., R. 4 W.	do		Small				Do.
15	Lewis and Clark	do	SE. ¼ SW. ¼ sec. 2, T. 20 N., R. 6 W.	P. Mayer	52			4,000	No	Irrigation.
16	do	do	NE. ¼ sec. 1, T. 20 N., R. 6 W.	C. C. Woods	54			4,000	Yes	
17	do	do	NW. ¼ NW. ¼ sec. 6, T. 20 N., R. 5 W.	S. Larkin	52	Small		4,100		
18	do	do	SE. ¼ NE. ¼ sec. 7, T. 20 N., R. 5 W.	J. S. Lytle				4,000	Yes	
19	do	do	SE. ¼ sec. 9, T. 20 N., R. 5 W.	P. Bickle		Small		4,000		
20	Cascade	do	NW. ¼ sec. 5, T. 20 N., R. 4 W.	—— Flowerree	54				Yes	
21	do	Hepler	NE. ¼ sec. 13, T. 21 N., R. 4 W.	do	51	Small				Domestic and stock.
22	do	do	SW. ¼ sec. 14, T. 21 N., R. 4 W.	do	52	do				Stock.
23	do	do	NW. ¼ sec. 35, T. 22 N., R. 4 W.	do	49	Medium	Blue shale		Yes	Do.
24	do	do	NE. ¼ sec. 27, T. 22 N., R. 4 W.	do	52				Yes	Do.
25	do	do	NE. ¼ sec. 2, T. 20 N., R. 4 W.	do						
26	do	do	NE. ¼ sec. 4, T. 20 N., R. 3 W.	do		Medium	Alluvium			
27	do	do	NE. ¼ sec. 10, T. 20 N., R. 3 W.	D. B. Todd		do	do		Yes	
28	do	do	NW. ¼ sec. 35, T. 20 N., R. 3 W.	Carl Meickel	48	do	Blue sandstone		Yes	Domestic and stock.
29	do	do	NW. ¼ SE. ¼ sec. 5, T. 20 N., R. 2 W.	On Government land	52	do		3,500	Yes	Stock.
30	do	do	NE. ¼ sec. 20, T. 20 N., R. 2 W.	do		Small			Yes	Do.
31	do	do	NW. ¼ sec. 20, T. 20 N., R. 2 W.	do		do			Yes	Do.
32	do	do	SE. ¼ sec. 4, T. 19 N., R. 3 W.	Carl Meickel			Sandstone			Stock and irrigation.
33	do	Sun River	SW. ¼ sec. 33, T. 22 N., R. 1 E.	Sun River Stock and Land Co.		Small				Stock.
34	do	do	SE. ¼ SE. ¼ sec. 34, T. 21 N., R. 2 W.	On Government land	50	Medium			Yes	Do.
35	do	do	NE. ¼ sec. 35, T. 20 N., R. 2 W.	Toman Bros.		do			Yes	Do.

36	do	Cascade	NW. ¼ SE. ¼ sec. 5, T. 19 N., R. 1 W.	do		do		4,000	Yes	Domestic and stock.
37	do	do	SW. ¼ NE. ¼ sec. 9, T. 19 N., R. 1 W.		57	Small		4,000		
38	do	do	SW. ¼ SE. ¼ sec. 9, T. 19 N., R. 1 W.		54	Medium		3,800	Yes	Do.
39	do	Truly	Sec. 29, T. 19 N., R. 2 E.	J. Ferguson		do	Sandstone	3,400		Domestic.
40	do	do	Sec. 28, T. 19 N., R. 2 E.	G. L. Ferguson		Small				Domestic and stock.
41	do	do	Sec. 30, T. 19 N., R. 3 E.	Erison Dent		Medium	Sandstone			Irrigation.
42	do	do	Sec. 28, T. 19 N., R. 3 E.	M. Coy		do	do			
43	do	do	Sec. 32, T. 19 N., R. 3 E.	—— Wood					No.	
44	do	do	SE ¼ sec. 31, T. 19 N., R. 3 E.	Shaw & Le Pon		Small				
45	do	do	NW. ¼ sec. 32, T. 19 N., R. 3 E.	do		Medium				
46	do	do	E. ½ sec. 25, T. 18 N., R. 2 E.	—— Johnson			Sandstone	3,400		
47	do	do	SE. ¼ sec. 17, T. 18 N., R. 2 E.	J. A. Perrine				3,600		
48	do	do	Sec. 32, T. 18 N., R. 2 E.	—— Misolf		Small				
49	do	do	Sec. 25, T. 18 N., R. 2 E.	J. J. Patterson			Clay			Domestic.
50	do	do	NW. ¼ sec. 8, T. 18 N., R. 3 E.							
51	do	do	E. ½ sec. 10, T. 18 N., R. 3 E.	—— Bisson		Small				
52	do	do	Sec. 15, T. 18 N., R. 3 E.	—— Hensler		Medium	Sandstone		No.	
53	do	do	SW. ¼ sec. 4, T. 18 N., R. 3 E.				do			
54	do	do	Sec. 23, T. 18 N., R. 3 E.	—— Kinsey			do			
55	do	do	Sec. 21, T. 18 N., R. 3 E.	P. Linquist		Small	do			Do.
56	do	do	S. ½ sec. 21, T. 18 N., R. 3 E.			do	do			
57	do	do	SW. ¼ sec. 20, T. 18 N., R. 3 E.	—— Steele		do				
58	do	do	S. ½ sec. 29, T. 18 N., R. 3 E.	A. Engstrom		do				
59	do	do	Sec. 2, T. 17 N., R. 2 E.	H. E. Wood		do	Sandstone		Yes	Do.
60	do	do	do	T. J. S. Wingley		do	do			
61	do	do	NW. ¼ NE. ¼ sec. 29, T. 17 N., R. 2 E.	Sutton Bros		Medium	Alluvium		Yes	
62	do	do	NE. ¼ sec. 34, T. 17 N., R. 2 E.	—— Hansen		do	Sandstone		Yes	
63	do	do	do	do		Small	do		Yes	
64	do	do	SW. ¼ sec. 8, T. 17 N., R. 3 E.	Huntsbarger Bros.			do			Stock.
65	do	do	NE. ¼ sec. 6, T. 17 N., R. 3 E.	M. E. Bruneau			do		Yes	Domestic.
66	do	do	SW. ¼ NW. ¼ sec. 2, T. 17 N., R. 3 E.	T. Splain		Medium		3,500		Irrigation and stock.
67	do	do	NW. ¼ sec. 11, T. 17 N., R. 3 E.	—— Ryane		Small	Sandstone			Domestic.
68	do	do	NE. ¼ sec. 14, T. 17 N., R. 3 E.	J. Cocren		Large		3,500	Yes	Domestic and stock.
69	do	do	Sec. 26, T. 17 N., R. 3 E.	B. Marxer		do	Sandstone	3,600	Yes	
70	do	do	Sec. 21, T. 17 N., R. 3 E.	W. R. Goodell		Medium	do		Yes	
71	do	Great Falls	SW. ¼ sec. 33, T. 22 N., R. 2 E.	Sun River Stock and Land Co.		Small	Shale		Yes	
72	do	do	NE. ¼ sec. 11, T. 20 N., R. 2 E.	—— Sindblade		Large	Alluvium	3,350	Yes	
73	do	do	NE. ¼ sec. 7, T. 20 N., R. 3 E.	K. B. McIver		do	do		Yes	Domestic and stock.
74	do	do	SW. ¼ sec. 9, T. 19 N., R. 4 E.	C. Jaeckel		Small				Stock.
75	do	do	Sec. 12, T. 19 N., R. 4 E.	H. J. Clark		Medium	Sandstone	3,500	Yes	Do.
76	do	do	NW. ¼ sec. 12 T. 19 N., R. 4 E.	J. A. Walker		do	do	3,500	Yes	Domestic and stock.
77	do	do	NE. ¼ sec. 4, T. 19 N., R. 4 E.	F. E. Goon		Small	do	3,400	Yes	Do.
78	do	do	SE. ¼ sec. 4, T. 19 N., R. 4 E.	I. O. Proctor		do	do	3,400	Yes	Do.
79	do	do	Sec. 8, T. 19 N., R. 4 E.	Jas. Belcher		do		3,400	Yes	Do.
80	do	do	Sec. 17, T. 19 N., R. 4 E.	do		Large		3,400	Yes	Do.
81	do	do	Sec. 6, T. 19 N., R. 4 E.	Jas. D. Young		do	Limestone	3,500	Yes	Do.

Partial list of springs of Great Falls region, Montana—Continued.

No.	County.	Locality.	Township, etc.	Owner.	Temperature.	Quantity.	Material from which spring issues.	Approximate elevation.	Is supply continuous?	Use.
					°*F.*			*Feet.*		
82	Cascade	Great Falls	SW. ¼ sec. 7, T. 19 N., R. 4 E.	Dudley Crothers			Sandstone		Yes	Domestic and stock.
83	do	do	S. ½ sec. 14, T. 19 N., R. 5 E.	M. E. Abernathy			Shale			
84	do	do	Sec. 11, T. 19 N., R. 5 E.	—— Johnston		Medium		4,000	Yes	Do.
85	do	do	NW. ¼ sec. 12, T. 19 N., R. 5 E.	D. E. Johnston		Small			Yes	Stock.
86	do	do	NW. ¼ sec. 7, T. 19 N., R. 5 E.	J. G. Ernst		Medium				Do.
87	do	Stockett	Sec. 36, T. 19 N., R. 4 E.	Eric Erickson		Small		3,700	Yes	Domestic.
88	do	do	SW. ¼ sec. 27, T. 19 N., R. 4 E.	T. Littlejohn		do	Shale	3,900		
89	do	do	SW. ¼ sec. 33, T. 19 N., R. 4 E.	John Edstrom			do	3,900		Stock.
90	do	do	NE. ¼ sec. 31, T. 19 N., R. 4 E.	L. R. Howard		Small			Yes	Domestic and stock.
91	do	do	Sec. 25, T. 19 N., R. 5 E.	T. E. Kent		Medium	Sandstone		Yes	Do.
92	do	do	NW. ¼ sec. 36, T. 19 N., R. 5 E.	W. Turner			do			Do.
93	do	do	SE. ¼ sec. 35, T. 19 N., R. 5 E.	A. Santschi		Medium			Yes	Do.
94	do	do	Sec. 24, T. 19 N., R. 5 E.	S. C. King					Yes	Stock.
95	do	do	NE. ¼ sec. 27, T. 19 N., R. 5 E.	D. Lane		Medium			Yes	
96	do	do	SW. ¼ sec. 22, T. 19 N., R. 5 E.	do						
97	do	do	NE. ¼ sec. 2, T. 18 N., R. 4 E.	Benj. Stephens		Medium				Domestic and stock.
98	do	do	NE. ¼ sec. 22, T. 18 N., R. 4 E.	G. H. Lindh		Small	Sandstone	3,800	Yes	Do.
99	do	do	Sec. 28, T. 18 N., R. 4 E.	N. Frank		Medium	do	3,850	Yes	Do.
100	do	do	SE. ¼ sec. 26, T. 18 N., R. 4 E.	John Gillis		Small	do	4,750	Yes	Domestic.
101	do	do	do	do		Medium	do	4,750	Yes	Stock.
102	do	do	NW. ¼ sec. 15, T. 18 N, R. 4 E.	Ed. Connelly		Small	do	3,800		Domestic and stock.
103	do	do	Sec. 25, T. 18 N., R. 4 E.	C. Cavanaugh		do	do		Yes	Stock.
104	do	do	SE. ¼ sec. 14, T. 18 N., R. 4 E.	Davale Culberson		Medium	Alluvium	4,450	Yes	Domestic and stock.
105	do	do	NE. ¼ sec. 25, T. 18 N., R. 5 E.	Eric Lindquist		do			Yes	Domestic.
106	do	do	SW. ¼ sec. 6, T. 18 N., R. 5 E.	Cottonwood Coal Co.		do		3,600	Yes	
107	do	do	Sec. 7, T. 18 N., R. 5 E.	Joe Sarzin		do		3,700	Yes	Domestic and stock.
108	do	do	Sec. 19, T. 18 N., R. 5 E.	Joe Kornowski		do				Do.
109	do	do	NE. ¼ sec. 2, T. 18 N., R. 5 E.	A. Keels		Small	Sandstone		Yes	Do.
110	do	do	SW. ¼ sec. 2, T. 17 N., R. 4 E.	J. H. Betts		Medium	do	4,950	Yes	Do.
111	do	do	SE. ¼ sec. 2, T. 17 N., R. 4 E.	J. P. Heber		Large		5,000	Yes	
112	do	do	Sec. 1, T. 17 N., R. 4 E.	J. O. Selstrom		Small		5,000	No	Domestic.
113	do	do	do	do		Large		5,000	Yes	Stock.
114	do	do	Sec. 17, T. 17 N., R. 4 E.	L. Herbolsheimer		Small		4,925	Yes	Domestic and stock.
115	do	do	NE. ¼ sec. 21, T. 17 N., R. 4 E.	Herman Johnson		Medium		5,000	Yes	Do.
116	do	do	NW. ¼ sec. 29, T. 17 N., R. 4 E.	John Pilgrim		Small		5,000	Yes	Do.
117	do	do	Sec. 17, T. 17 N., R. 4 E.	Edwin Meisenbach		do		5,000	Yes	Do.
118	do	do	SW. ¼ sec. 4, T. 17 N., R. 4 E.	Wm. Kirby		do	Sandstone		Yes	Do.
119	do	do	Sec. 9, T. 17 N., R. 4 E.	do		do	do		Yes	Do.
120	do	do	NE. ¼ sec. 35, T. 21 N., R. 6 E.	P. P. Buchanan		do			No	Domestic.
121	do	do	Sec. 2, T. 20 N., R. 6 E.	V. P. Carr		Large			Yes	Stock.
122	do	do	Sec. 35, T. 20 N., R. 6 E.	P. P. Buchanan						
123	do	do	NW. ¼ sec. 33, T. 20 N., R. 6 E.	Mack Depew	55	Small	Sandstone		Yes	

124	do	do	Sec. 32, T. 19 N., R. 6 E.	E. Turner						Domestic and stock.
125	do	do	NW. ¼ sec. 14, T. 19 N., R. 6 E.	John Wright		Medium			Yes	Domestic.
126	do	do	SW. ¼ sec. 1, T. 19 N., R. 6 E.	W. S. Sifford		do			Yes	Domestic and stock.
127	do	do	NW. ¼ sec. 8, T. 19 N., R. 6 E.	—— Erickson					Yes	Domestic.
128	do	do	NE. ¼ sec. 32, T. 19 N., R. 6 E.	C. Turner		Small			Yes	Do.
129	do	do	SE. ¼ sec. 22, T. 19 N., R. 6 E.	—— Rush		Medium		3,700	Yes	Domestic and stock.
130	do	do	Sec. 5, T. 19 N., R. 6 E.	W. H. Porter		do	Sandstone		Yes	Do.
131	do	do	Sec. 8, T. 19 N., R. 6 E.	G. Erickson		Large		3,800	Yes	Do.
132	do	do	SW. ¼ sec. 3, T. 19 N., R. 6 E.	Joe Bogner		Medium		4,300(?)		Do.
133	do	do	NW. ¼ sec. 5, T. 19 N., R. 6 E.	J. B. Burrows		Small		3,900	Yes	Domestic.
134	do	do	NW. ¼ sec. 1, T. 19 N., R. 6 E.	A. Bloom		Medium	Alluvium		Yes	Domestic and stock.
135	do	do	NW. ¼ sec. 36, T. 19 N., R. 6 E.	A. H. McMillan		Small			Yes	Do.
136	do	do	NE. ¼ sec. 35, T. 19 N., R. 6 E.	Edgar Mann		do			Yes	Stock.
137	do	do	Sec. 36, T. 18 N., R. 6 E.	G. Siegling		Medium				
138	do	do	NW. ¼ sec. 19, T. 18 N., R. 6 E.	J. Eckerson						
139	do	do	NW. ¼ sec. 19, T. 18 N., R. 6 E.	J. Shannon		Small				
140	do	do	Sec. 19, T. 18 N., R. 6 E.	J. F. Irwin		Medium			Yes	Domestic and stock.
141	do	do	Sec. 2, T. 18 N., R. 6 E.	S. S. Crane	54		Sandstone		No.	Stock.
142	do	do	SW. ¼ sec. 3, T. 18 N., R. 6 E.	do	55	Small	Alluvium			
143	do	do	NE. ¼ SE. ¼ sec. 22, T. 18 N., R. 6 E.	Neel Creek Cattle Co.	52				Yes	Stock, domestic, and irrigation.
144	do	do	NE. ¼ NE. ¼ sec. 27, T. 18 N., R. 6 E.	do			Sandstone			
145	do	do	NE. ¼ NE. ¼ sec. 33, T. 18 N., R. 6 E.	O. V. Jacobs	46		do			
146	do	do	do	do	46					
147	do	do	SE. ¼ sec. 13, T. 18 N., R. 6 E.	J. Wiegand			Sandstone			Domestic and stock.
148	do	do	do	do		Small				Irrigation.
149	do	do	SE. ¼ sec. 24, T. 18 N., R. 6 E.	N. Neumeyer	47	Medium				Domestic.
150	do	do	NW. ¼ sec. 18, T. 18 N., R. 7 E.	C. Ashewert		do	Sandstone	3,700	Yes	Domestic and stock.
151	do	do	SE. ¼ SE. ¼ sec. 30, T. 18 N., R. 7 E.	F. J. Ober		do	do	3,800	Yes	Stock.
152	do	do	SW. ¼ sec. 31, T. 18 N., R. 7 E.	A. Albright		do				Do.
153	do	do	Sec. 27, T. 18 N., R. 7 E.	J. W. Blythe						Irrigation.
154	do	do	NE. ¼ sec. 6, T. 18 N., R. 7 E.	John Hunter					Yes	Domestic.
155	do	do	NW. ¼ SW. ¼ sec. 8, T. 18 N. R. 7 E.	T. D. Joscelyn		Medium		3,800	Yes	Domestic and stock.
156	do	do	do	do		do			Yes	Stock.
157	do	do	SW. ¼ SW. ¼ sec. 8, T. 18 N., R. 7 E.	do		Small			Yes	Do.
158	do	do	SE. ¼ SW. ¼ sec. 8, T. 18 N., R. 7 E.	do		do			Yes	Do.
159	do	do	NW. ¼ SW. ¼ sec. 16, T. 18 N., R. 7 E.	W. B. S. Armstrong		do			Yes	Do.
160	do	do	SW. ¼ SW. ¼ sec. 16, T. 18 N., R. 7 E.	do		do			Yes	Do.
161	do	do	SE. ¼ sec. 16, T. 18 N., R. 7 E.	do		Medium			Yes	Do
162	do	do	NW. ¼ SW. ¼ sec. 22, T. 18 N., R. 7 E.	do		do			Yes	Do.
163	do	do	NE. ¼ SW. ¼ sec. 22, T. 18 N., R. 7 E.	P. P. Rector		do			Yes	Domestic, stock, and garden.
164	do	do	NE. ¼ SE. ¼ sec. 34, T. 18 N., R. 7 E.	J. W. Blythe		do			Yes	Stock.

Partial list of springs of Great Falls region, Montana—Continued.

No.	County.	Locality.	Township, etc.	Owner.	Temperature.	Quantity.	Material from which spring issues.	Approximate elevation.	Is supply continuous?	Use.
					°*F.*			*Feet.*		
165	Cascade	Stockett	SE. ¼ SE. ¼ sec. 34, T. 18 N., R. 7 E.	J. W. Blythe		Medium			Yes	Stock.
166	do	do	NE. ¼ NE. ¼ sec. 34, T. 18 N., R. 7 E.	do		do			Yes	Domestic and stock.
167	do	do	NW. ¼ SW. ¼ sec. 27, T. 18 N., R. 7 E.	do		do			Yes	Domestic.
168	do	do	NW. ¼ sec. 21, T. 18 N., R. 7 E.	T. Armstrong		do	Sandstone	3,900	Yes	Domestic and stock.
169	do	do	NW. ¼ NW. ¼ sec. 10, T. 18 N., R. 7 E.	G. W. Blake		Small		4,050	Yes	Domestic.
170	do	do	SE. ¼ NW. ¼ sec. 10, T. 18 N., R. 7 E.	do		do		4,050	Yes	Do.
171	do	do	SW. ¼ SE. ¼ sec. 4, T. 18 N., R. 7 E.	F. Falls		Medium		4,025	Yes	Stock.
172	do	do	SW. ¼ SW. ¼ sec. 4, T. 18 N., R. 7 E.	do		Small			Yes	Domestic and stock.
173	do	do	SW ¼ NW. ¼ sec. 4, T. 18 N., R. 7 E.	J. Ham		Medium			Yes	Domestic and irrigation.
174	do	do	SE. ¼ NW. ¼ sec. 4, T. 18 N., R. 7 E.	do		Small			Yes	Stock.
175	do	do	NW. ¼ NE. ¼ sec. 4, T. 18 N., R. 7 E.	do		do			Yes	Do.
176	do	do	NW. ¼ sec. 6. T. 18 N., R. 7 E.	Chas. Ashwort		do		3,800	Yes	Domestic and stock.
177	do	do	do	do		do		3,800	Yes	Stock.
178	do	do	do	do		do		3,800	Yes	Do.
179	do	do	NE ¼ sec. 6, T. 18 N., R. 7 E.	L. Bain		Medium		4,000	Yes	Domestic.
180	do	do	do	do		do		4,000	Yes	Stock.
181	do	do	SW. ¼ sec. 5, T. 18 N., R. 7 E.	D. Maussa		Large			Yes	Do.
182	do	do	SE. ¼ sec. 34, T. 18 N., R. 8 E.	S. Colarchik	48	Medium			Yes	Domestic and stock.
183	do	do	NE. ¼ sec. 34, T. 18 N., R. 8 E.	J. H. Vaskey	50	Small			Yes	Do.
184	do	do	NW. ¼ sec. 35, T. 18 N., R. 8 E.	J. Morrison	47	Large			Yes	Do.
185	do	do	SW. ¼ sec. 23, T. 18 N., R. 8 E.	R. Johnson	51	Medium			Yes	Do.
186	do	do	NW. ¼ sec. 23, T. 18 N., R. 8 E.	A. A. Dawson		Small			No	Stock.
187	do	do	NE. ¼ sec. 22, T. 18 N., R. 8 E.	do	61	do			Yes	Domestic.
188	do	do	SW. ¼ sec. 14, T. 18 N., R. 8 E.	J. Magnuson	51	do			Yes	Stock.
189	do	do	NW. ¼ sec. 14, T. 18 N., R. 8 E.	do		do			Yes	Do.
190	do	do	SW. ¼ sec. 10, T. 18 N., R. 8 E.	W. McGinnis		do			Yes	Do.
191	do	do	NE. ¼ sec. 11, T. 18 N., R. 8 E.	M. Owen		do			Yes	Do.
192	do	do	NE. ¼ sec. 16, T. 18 N., R. 8 E.	P. Brown	49	Medium			Yes	Domestic and stock.
193	do	do	NE. ¼ sec. 13, T. 18 N., R. 8 E.	I. Cameron		Small			No	Stock.
194	do	do	NW. ¼ sec. 26, T. 18 N., R. 8 E.	R. Johnson		Medium			Yes	Do.
195	do	do	NW. ¼ NW. ¼ sec. 21, T. 18 N., R. 8 E.	S. Anderson					Yes	Domestic and stock

196	do	do	NE. ¼ NW. ¼ sec. 21, T. 18 N., R. 8 E.	do					Yes	Do.
197	do	do	SW. ¼ NE. ¼ sec. 28, T. 18 N., R. 8 E.	R. Williamson		Medium			No	Do.
198	do	do	NE. ¼ SE. ¼ sec. 7, T. 18 N., R. 8 E.	—— Klein		Small				Stock.
199	do	do	Sec. 31, T. 18 N., R. 8 E.	A. Owen					Yes	
200	do	do	NW. ¼ sec. 16, T. 18 N., R. 8 E.	P. Brown	50					Domestic and stock
201	do	do	SE. ¼ NE. ¼ sec. 16, T. 18 N., R. 8 E.	do	49	Medium				Do.
202	do	do	SW. ¼ SW. ¼ sec. 29, T. 18 N., R. 8 E.	F. J. Ober		do			Yes	Stock.
203	do	do	NW. ¼ sec. 21, T. 18 N., R. 8 E.	S. Anderson					Yes	Domestic and stock.
204	do	do	NW. ¼ NE. ¼ sec. 31, T. 18 N., R. 8 E.	A. Owen		Small				Domestic.
205	do	do	SE. ¼ NE. ¼ sec. 16, T. 18 N., R. 8 E.	P. Brown	49	Large			Yes	Domestic and stock.
206	do	do	NE. ¼ sec. 2, T. 17 N., R. 7 E.	McConkey Bros		Small			Yes	Stock.
207	do	do	SW. ¼ sec. 1, T. 17 N., R. 7 E.	do		do			Yes	Do.
208	do	do	NW. ¼ sec. 12, T. 17 N., R. 7 E.	do		do			Yes	Do.
209	do	do	SW. ¼ sec. 1, T. 17 N., R. 6 E.	G. W. Goodman						
210	do	do	NW. ¼ NE. ¼ sec. 16, T. 17 N., R. 6 E.	Peter Johnson		Medium				Garden irrigation.
211	do	do	SW. ¼ SE. ¼ sec. 16, T. 17 N., R. 6 E.	do						
212	do	do	SE. ¼ sec. 9, T. 17 N., R. 6 E.	F. Skelton		Medium				
213	do	do	SW. ¼ sec. 31, T. 17 N., R. 7 E.	C. P. Neisman						
214	do	do	SW. ¼ sec. 24, T. 17 N., R. 7 E.	Peterson & Johnson					Yes	
215	do	do	Sec. 22, T. 17 N., R. 7 E.	B. W. Armstrong		Medium	Limestone	5,000		Domestic and stock.
216	do	do	Sec. 15, T. 17 N., R. 7 E.	N. Montag		do				
217	do	do	SW. ¼ sec. 15, T. 17 N., R. 7 E.	J. Holmberg		do				
218	do	do	SE. ¼ sec. 36, T. 17 N., R. 7 E.	Bundy & Henderliden		Small	Shale			
219	do	do	NE. ¼ sec. 36, T. 17 N., R. 7 E.	do		Medium	do			
220	do	do	Sec. 25, T. 17 N., R. 7 E.	do			Limestone			Stock.
221	do	do	Sec. 19, T. 17 N., R. 8 E.	do						
222	do	do	SW. ¼ sec. 36, T. 17 N., R. 7 E.	P. McFee						
223	do	do	SE. ¼ sec. 25, T. 17 N., R. 7 E.	Bundy & Henderliden		Large	Limestone	4,900	Yes	Do.
224	do	do	SE. ¼ sec. 29, T. 17 N., R. 8 E.	Hanson Bros					Yes	
225	do	do	NE. ¼ sec. 32, T. 17 N., R. 8 E.	P. Dotseth			Shale		Yes	
226	do	do	NE. ¼ sec. 19, T. 17 N., R. 8 E.	Bundy & Henderliden		Small		4,500		Do.
227	do	do	NW. ¼ sec. 4, T. 17 N., R. 8 E.	—— Peterson	50	Medium	Sandstone		Yes	Do.
228	do	do	Sec. 5, T. 17 N., R. 8 E.	E. R. Huggins					No	
229	do	do	SE. ¼ SE. ¼ sec. 18, T. 17 N., R. 8 E.	McConkey Bros		Medium			Yes	Do.
230	do	do	NE. ¼ sec. 18, T. 17 N., R. 8 E.	Ed. Landy						
231	do	Geyser	SE. ¼ sec. 34, T. 18 N., R. 8 E.	S. Colarchik	49				Yes	
232	do	do	NE. ¼ sec. 34, T. 18 N., R. 8 E.	J. H. Vaskey	52				Yes	
233	do	do	NW. ¼ sec. 35, T. 18 N., R. 8 E.	J. Morrison	47	Large	Sandstone			
234	do	do	SW. ¼ sec. 23, T. 18 N., R. 8 E.	R. Johnson	52		do		Yes	
235	do	do	N. E. ¼ sec. 22, T. 18 N., R. 8 E.	A. A. Dawson		Small				Domestic and stock.
236	do	do	do	do	61	do		4,000	Yes	Do.
237	do	do	SW ¼ sec. 3, T. 18 N., R. 8 E.	C. W. McClay	50	Large			Yes	Not used.

Partial list of springs of Great Falls region, Montana—Continued.

No.	County.	Locality.	Township, etc.	Owner.	Temperature.	Quantity.	Material from which spring issues.	Approximate elevation.	Is supply continuous?	Use.
					°*F.*			*Feet.*		
238	Cascade	Geyser	NE. $\frac{1}{4}$ sec. 11, T. 18 N., R. 8 E.	M. Owen		Small				Stock.
239	do	do	NW. $\frac{1}{4}$ sec. 14, T. 18 N., R. 8 E.	J. Magnuson	52				Yes.	
240	do	do	NE. $\frac{1}{4}$ sec. 11, T. 18 N., R. 8 E.	Martin Owen		Small	Fine sand			Do.
241	do	do	NW. $\frac{1}{4}$ sec 13, T. 18 N., R. 8 E.	Geo. Hay		Medium	Sand rock			
242	do	do	SW. $\frac{1}{4}$ sec. 10, T. 18 N., R. 8 E.	W. McGinnis		Small			Yes.	Do.
243	do	do	SE. $\frac{1}{4}$ sec. 14, T. 18 N., R. 9 E.	W. Kernaghan	52		Shale		Yes.	
244	do	do	NW. $\frac{1}{4}$ sec. 26, T. 18 N., R. 9 E.	J. Kernaghan		Medium	Sandstone			Do.
245	do	do	SE. $\frac{1}{4}$ sec. 9, T. 18 N., R. 9 E.	C. J. Ellis	46	do				
246	do	do	SE. $\frac{1}{4}$ sec. 13, T. 18 N., R. 9 E.	J. Strong		Small			Yes.	
247	do	do	SE. $\frac{1}{4}$ sec. 13, T. 18 N., R. 9 E.	J. Armstrong		do			Yes.	Do.
248	do	do	SE. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 9, T. 18 N., R. 9 E.	C. J. Ellis	46	Medium		4,100	Yes.	Domestic, stock, and irrigation.
249	do	do	Sec. 12, T. 18 N., R. 9 E.	S. C. Philbrick	48	do		4,200	Yes.	Do.
250	do	do	SE. $\frac{1}{4}$ sec. 20, T. 18 N., R. 9 E.	D. Rankin						
251	do	do	NW. $\frac{1}{4}$ sec. 36, T. 18 N., R. 9 E.	School section		Medium			Yes.	Stock.
252	do	do	SE. $\frac{1}{4}$ sec. 16, T. 18 N., R. 9 E.	J. B. Lone		do			Yes.	Do.
253	do	do	SE. $\frac{1}{4}$ sec. 15, T. 18 N., R. 9 E.	J. Kernaghan		Small			Yes.	Domestic and stock.
254	do	do	SW. $\frac{1}{4}$ sec. 13, T. 18 N., R. 9 E.	do		do			Yes.	Stock.
255	do	do	Sec. 32, T. 18 N., R. 10 E.	J. R. Long						
256	do	do	SW. $\frac{1}{4}$ sec. 17, T. 18 N., R. 10 E.	J. Keto	15	Small			Yes.	Domestic.
257	do	do	NE. $\frac{1}{4}$ sec. 3, T. 17 N., R. 8 E.	—— Larson		Medium		3,800	Yes.	Stock and garden.
258	do	do	SW. $\frac{1}{4}$ sec. 3, T. 17 N., R. 8 E.	C. W. McClay	48	do	Sandstone	3,700	Yes.	
259	do	do	SE. $\frac{1}{4}$ sec. 11, T. 17 N., R. 8 E.	W. A. Nelson	54		do			Stock.
260	do	do	NE. $\frac{1}{4}$ sec. 14, T. 17 N., R. 8 E.	do	55	Medium				
261	do	do	NE. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 18, T. 17 N., R. 9 E.	G. L. Lee	54	Small			No.	Do.
262	do	do	NW. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 18, T. 17 N., R. 9 E.	do	54	do			No.	Do.
263	do	do	SW. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 18, T. 17 N., R. 9 E.	do	54	do			No.	Do.
264	do	do	NE. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 27, T. 17 N., R. 9 E.	S. McAllister	49	Medium			Yes.	Do.
265	do	do	NE. $\frac{1}{4}$ SW. $\frac{1}{4}$ sec. 26, T. 17 N., R. 9 E.	do	47	do			Yes.	Do.
266	do	do	SW. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 35, T. 17 N., R. 9 E.	G. Okerman	45	Large			Yes.	Domestic and stock.
267	do	do	NW. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 25, T. 17 N., R. 9 E.	S. McAllister	44	Medium			Yes.	Do.
268	do	do	NW. $\frac{1}{4}$ sec. 10, T. 17 N., R. 9 E.	H. P. Schumacher		Small			No.	Stock.
269	do	do	do	do	52	do			Yes.	Do.
270	do	do	SE. $\frac{1}{4}$ sec. 27, T. 17 N., R. 9 E.	S. McAllister	49	Medium				Do.
271	do	do	NE. $\frac{1}{4}$ sec. 35, T. 17 N., R. 9 E.	G. Okerman	47	do			Yes.	Domestic and stock.

272	....do	....do	SW. ¼ sec. 26, T. 17 N., R. 9 E.	S. McAllister	47	....do				
273	....do	....do	SE. ¼ sec. 25, T. 17 N., R. 9 E.	....do	47					Do.
274	....do	....do	NE. ¼ sec. 19, T. 17 N., R. 9 E.	G. L. Lee		Medium			Yes	Do.
275	....do	....do	SW. ¼ sec. 8, T. 17 N., R. 10 E.	J. B. Long		....do			Yes	Do.
276	....do	....do	SE. ¼ sec. 19, T. 17 N., R. 10 E.	P. O'Hara	45	....do		4,300	Yes	Domestic, stock, and irrigation.
277	....do	....do	NW. ¼ sec. 20, T. 17 N., R. 10 E.	J. H. Skelton	41	....do		4,700	Yes	Do.
278	....do	....do	SE. ¼ sec 17, T. 17 N., R. 10 E.	J. Keto	59	Small		4,200	Yes	Domestic.
279	....do	....do	SE. ¼ sec. 20, T. 17 N., R. 10 E.	P. O'Hara	48	Medium		4,300		
280	....do	....do	NW. ¼ sec. 18, T. 17 N., R. 10 E.	L. Waldeland	49				Yes	
281	....do	....do	SE. ¼ sec. 3, T. 16 N., R. 9 E.	John Downey					Yes	
282	....do	....do	NE. ¼ sec. 9, T. 16 N., R. 9 E.	Peter Van	48	Small				
283	....do	....do	NE. ¼ sec. 17, T. 16 N., R. 9 E.	L. Bergeron	44	Large			Yes	
284	....do	....do	W. ½ sec. 17, T. 16 N., R. 9 E.	D. Naud					Yes	
285	....do	....do	SW. ¼ sec. 5, T. 16 N., R. 9 E.	Delphas LeBlanc			Limestone			
286	....do	....do	NE. ¼ sec. 5, T. 16 N., R. 9 E.	....do	48					Do.
287	....do	....do	NE. ¼ sec. 14, T. 16 N., R. 9 E.	Peter Van	48	Small				
288	....do	....do	SW. ¼ sec. 8, T. 16 N., R. 9 E.	O. Swanson			Sandstone		No.	
289	....do	....do	SW. ¼ sec. 9, T. 16 N., R. 9 E.	....do	48	Small	....do		Yes	Domestic and stock.
290	....do	....do	NE. ¼ sec. 2, T. 16 N., R. 9 E.	J. M. Walters		....do	....do		Yes	Do.
291	....do	....do	Sec. 4, T. 16 N., R. 10 E.	T. Shannon	52	....do				Do.
292	....do	....do	SE. ¼ NE. ¼ sec. 4, T. 16 N., R. 10 E.	....do	46	Medium	Drift			Irrigation and stock.
293	....do	....do	SW. ¼ NW. ¼ sec. 4, T. 16 N., R. 10 E.	....do	49					Irrigation.
294	....do	....do	SW. ¼ sec. 19, T. 16 N., R. 10 E.	P. O'Hara	45	Medium	Limestone			
295	....do	....do	SW. ¼ sec. 4, T. 16 N., R. 10 E.	J. H. Skelton	42	....do	....do			Do.
296	....do	....do	SW. ¼ sec. 34, T. 16 N., R. 10 E.	H. G. Burgess	46		Drift			
297	....do	....do	SW. ¼ sec. 20, T. 16 N., R. 10 E.	J. H. Skelton	42	Medium			Yes	Domestic and stock.
298	....do	Stanford	SW. ¼ sec. 25, T. 17 N., R. 10 E.	Thos. Higgins	51	....do			Yes	
299	....do	....do	....do	....do		Small				
300	....do	....do	....do	....do		....do	Limestone			
301	Fergus	....do	Sec. 11, T. 17 N., R. 11 E.	Bower Bros.		....do		4,100	Yes	Domestic.
302	....do	....do	SE. ¼ NE. ¼ sec. 33, T. 17 N., R. 11 E.	....do						
303	Cascade	....do	Secs. 1 and 2, T. 16 N., R. 10 E.	D. Butterfield	48	Small			No.	
304	....do	....do	....do	....do	45	Medium			Yes	
305	....do	....do	Secs. 1 and 2, T. 16 N., R. 10 E.	....do	44	....do			Yes	
306	....do	....do	NE. ¼ sec. 13, T. 16 N., R. 10 E.	Pool Ranch	46	Small				Do.
307	....do	....do	NW. ¼ sec. 25, T. 16 N., R. 10 E.	A. V. Cheney	52	Medium				
308	....do	....do	NE. ¼ NE. ¼ sec. 25, T. 16 N., R. 10 E.	First National Bank	50	Small			Yes	Stock.
309	....do	....do	SW. ¼ sec. 34, T. 16 N., R. 10 E.	—— Burgess	47	Medium			Yes	Domestic and stock.
310	....do	....do	NW. ¼ NW. ¼ sec. 13, T. 16 N., R. 10 E.	First National Bank		....do			Yes	Stock (?).
311	....do	....do	SW. ¼ sec. 25, T. 16 N., R. 10 E.	T. Higgins	51	....do			Yes	Stock.
312	Fergus	....do	NE. ¼ sec. 24, T. 16 N., R. 11 E.	Bower Bros.		....do			Yes	Do.
313	....do	....do	SW. ¼ sec. 13, T. 16 N., R. 11 E.	P. Westfall		Small			Yes	
314	....do	....do	NW. ¼ sec. 13, T. 16 N., R. 11 E.	R. Skelton	48	Medium		4,400		Domestic and irrigation.
315	....do	....do	SW¼ sec. 12, T. 16 N., R. 11 E.	....do	48					Do.

Partial list of springs of Great Falls region, Montana—Continued.

No.	County.	Locality.	Township, etc.	Owner.	Temperature.	Quantity.	Material from which spring issues.	Approximate elevation.	Is supply continuous?	Use.
					°*F.*			*Feet.*		
316	Fergus	Stanford	SW. ¼ NE. ¼ sec. 13, T. 16 N., R. 11 E.	E. F. Tuttle						Irrigation.
317	do	do	SE. ¼ NE. ¼ sec. 13, T. 16 N., R. 11 E.	do	52	Medium			Yes	
318	do	do	SW. ¼ sec. 25, T. 16 N., R. 11 E.	G. H. Ketchner		Large				
319	do	do	Sec. 35, T. 16 N., R. 11 E.	Fisher ranch		Medium			Yes	
320	do	do	NE. ¼ sec. 7, T. 16 N., R. 11 E.	Bower Bros.	47	do	Sandstone			
321	do	do	NE. ¼ sec. 31, T. 16 N., R. 12 E.	S. S. Hobson	55	Small				
322	Cascade	do	SE. ¼ NE. ¼ sec. 2, T. 15 N., R. 10 E.	—— Butterfield	45	do		4,900	Yes	Domestic and stock.
323	Fergus	do	Sec. 10, T. 15 N., R. 11 E.	Bower Bros.	47	Medium		2,000 (?)		Domestic, stock, and irrigation.
324	do	do	NE. ¼ sec. 3, T. 15 N., R. 11 E.	do	46	Large			Yes	Domestic and stock.
325	do	do	SE. ¼ sec. 24, T. 15 N., R. 11 E.	J. Jehnick	46	Medium			Yes	Domestic.
326	do	do	SW. ¼ sec. 24, T. 15 N., R. 11 E.	do	46	Small			Yes	Stock.
327	do	do	SW. ¼ sec. 30, T. 15 N., R. 12 E.	Sage Creek Sheep Co.		do				Do.
328	do	do	SE. ¼ sec. 30, T. 15 N., R. 12 E.	do		Medium				Do.
329	do	do	SW. ¼ sec. 31, T. 15 N., R. 12 E.	do		do				Do.
330	do	do	SE. ¼ sec. 32, T. 15 N., R. 12 E.	do		do				Do.
331	do	do	NW. ¼ sec. 26, T. 15 N., R. 12 E.	do		do				Do.
332	do	do	NW. ¼ sec. 23, T. 15 N., R. 12 E.	do		Small				Do.
333	do	do	SW. ¼ sec. 4, T. 15 N., R. 12 E.	A. T. Kach	49	Medium	Sandstone			

Partial list of wells of Great Falls region, Montana.

No.	County.	Locality.	Township, etc.	Owner.	Depth (feet).	Date completed.	Quality of water.	Is supply continuous?	How obtained at surface.	Geologic formation.	Use.
1	Teton	Chouteau	Sec. 30, T. 26 N., R. 5 W.	Nicolas Tuttle	130			Yes			Domestic and stock.
2	do	do	Sec. 20, T. 26 N. R. 5 W.	do	165	1902		Yes			Do.
3	do	do	SE. ¼ sec. 5, T. 25 N., R. 5 W.	Lewis A. Savik	40	1899	Slightly hard.	Yes			Do.
4	do	do	SE. ¼ sec. 28, T. 25 N., R. 4 W.	Bollerud Bros.	13	1898	Hard				Do.
5	do	do	SW. ¼ sec. 23, T. 25 N., R. 4 W.	Olaf Lindseth	13	1896	do				Do.
6	do	do	SE. ¼ sec. 19, T. 25 N., R. 4 W.	J. Johnson	9	1905	Slightly hard.	Yes		Gravel	Do.

7	do	do	NE. ¼ sec. 6, T. 24 N., R. 5 W.	Earl Yeager	65		Hard	Yes			Do.
8	do	do	SW. ¼ sec. 3, T. 24 N., R. 4 W.	Abrem Broere	40			No water		Shale	
9	do	do	NW. ¼ sec. 2, T. 24 N., R. 4 W.	W. N. Van Der Riet.	80			No water			
10	do	do	SW. ¼ sec. 19, T. 24 N., R. 4 W.	C. E. Moore	30		Very hard	Yes		Shale	Do.
11	do	do	SW. ¼ sec. 5, T. 24 N., R. 4 W.	W. W. Gamble	12		Slightly hard.	Yes		Gravel	Domestic.
12	do	do	NE. ¼ sec. 5, T. 24 N., R. 4 W.	—— Carlson	12	1894	Hard			Shale	Domestic and stock.
13	do	do	SW. ¼ sec. 24, T. 23 N., R. 4 W.	Chris Lindseth	47					Shale and gravel.	
14	do	do	NW. ¼ sec. 13, T. 22 N., R. 4 W.	J. Thom	9		Fair	Yes			
15	Lewis and Clark	Augusta	NE. ¼ sec. 1, T. 20 N., R. 6 W.	Mrs. C. C. Woods	24		Good	Yes			Domestic.
16	do	do	NE. ¼ sec. 7, T. 20 N., R. 5 W.	J. S. Lytle	8		Alkaline	Yes			Irrigation.
17	do	do	SE. ¼ sec. 9, T. 20 N., R. 5 W.	P. Bickel	34		do				Stock.
18	do	do	Sec. 1, T. 20 N., R. 5 W.	Mrs. Fullberg	20		Good	Yes		Alluvium	Domestic and stock.
19	do	do	Sec. 7, T. 20 N., R. 4 W.	H. C. Reilz	15		Hard	Yes		do	
20	do	do	Sec. 8, T. 20 N., R. 4 W.	H. J. Riedling	22		Alkaline	Yes		do	
21	do	do	Sec. 5, T. 20 N., R. 4 W.	S. Eder	12						
22	Teton	Hepler	SE. ¼ sec. 29, T. 22 N., R. 3 W.	Cole Bros	10		Good	Yes	Windmill		Stock.
23	do	do	NE. ¼ sec. 32, T. 22 N., R. 3 W.	do	16		do	Yes			
24	Cascade	do	NE. ¼ sec. 31, T. 22 N., R. 3 W.	E. G. Kufus	20		do	No		Shale	
25	do	do	SE. ¼ sec. 31, T. 22 N., R. 3 W.	J. C. Kufus	23		do	Yes			
26	do	do	SE. ¼ sec. 35, T. 22 N., R. 3 W.	F. C. Krucks	40		do	Yes		Shale	
27	do	do	SW. ¼ sec. 35, T. 22 N., R. 3 W.	do	35		do				
28	Teton	do	NW. ¼ sec. 30, T. 22 N., R. 2 W.	Z. Zimmerman	75	1903	Hard	Yes			
29	Cascade	do	NE. ¼ sec. 5, T. 21 N., R. 3 W.	—— Flowerree	15			Yes		Sandstone	
30	do	do	SW. ¼ sec. 20, T. 21 N., R. 2 W.	Cascade Land Co.	100			No.	Windmill		Stock.
31	do	do	SE. ¼ sec. 23, T. 20 N., R. 3 W.	J. F. Johnson	18		Alkaline			Alluvium	
32	do	do	SW. ¼ sec. 10, T. 20 N., R. 3 W.	P. B. Fox	20		Fair				Do.
33	do	do	NW. ¼ sec. 22, T. 20 N., R. 3 W.	T. Seaquist	71	1902		Yes			Domestic.
34	do	do	NW. ¼ sec. 23, T. 20 N., R. 3 W.	do	15						Do.
35	do	do	NW. ¼ sec. 21, T. 20 N., R. 3 W.	G. LaRue	11		Good				
36	do	do	SE. ¼ sec. 4, T. 20 N., R. 3 W.	H. Olson	17		do				
37	do	do	NW. ¼ sec. 4, T. 20 N., R. 3 W.	—— Flowerree	65		do				
38	do	do	NE. ¼ sec. 10, T. 20 N., R. 3 W.	D. B. Todd	20		do			Alluvium	
39	do	do	Sec. 33, T. 20 N., R. 2 W.	Sun River Land and Stock Co.	10						Domestic.
40	do	do	NE. ¼ sec. 31, T. 20 N., R. 2 W.	do					Windmill		Stock.
41	do	Dutton	Sec. 4, T. 24 N., R. 1 W.	do	108			Yes			
42	do	do	Sec. 22, T. 23 N., R. 1 W.	do	108			No.			
43	do	do	do	do	110						
44	do	Sun River	SW. ¼ sec. 29, T. 22 N., R. 1 W.	do	20			Yes	Windmill	Alluvium	
45	do	do	NE. ¼ sec. 31, T. 21 N., R. 1 W.	Noble Bros	85		Alkaline				
46	do	do	SE. ¼ sec. 30, T. 21 N., R. 1 W.	D. Davies	15		do	Yes			Do.
47	do	do	SW. ¼ sec. 30, T. 21 N., R. 1 W.	Ford ranch	25		do				Do.
48	do	do	NE. ¼ sec. 34, T. 21 N., R. 1 W.	M. L. Strong	63		Soft				
49	do	do	NW. ¼ sec. 36, T. 21 N., R. 1 W.	J. C. Adams	80		Hard				
50	do	do	NW. ¼ sec. 2, T. 20 N., R. 1 W.	E. C. Blossom	96		Alkaline				
51	do	do	NE. ¼ sec. 25, T. 21 N., R. 1 W.	Gouch Bros	15						
52	do	do	NE. ¼ sec. 27, T. 21 N., R. 1 W.	B. Thomas	10					Alluvium	
53	do	do	Sec. 12, T. 20 N., R. 1 E.	—— Hollarf	140					Sandstone	
54	do	do	Sec. 14, T. 20 N., R. 1 E.		128						
55	do	do	do	—— Swager	90					Sandstone	

Partial list of wells of Great Falls region, Montana—Continued.

No.	County.	Locality.	Township, etc.	Owner.	Depth (feet).	Date completed.	Quality of water.	Is supply continuous?	How obtained at surface.	Geologic formation.	Use.
56	Cascade	Sun River	NE. ¼ sec. 13, T. 19 N., R. 2 W.	Toman Bros	40					Sandstone	
57	do	do	NW. ¼ sec. 12, T. 19 N., R. 1 W.	Ed. Bull	35						Stock.
58	do	do	NE. ¼ sec. 22, T. 19 N., R. 1 W.	D. E. Rease	30						
59	do	do	NW. ¼ sec. 21, T. 19 N., R. 1 W.	E. A Weigand	10		Alkaline				Do.
60	do	do	SE. ¼ sec. 35, T. 18 N., R. 1 W.	H. F. Montag	15	1890	Hard	Yes			Domestic and stock.
61	do	do	Sec. 13, T. 18 N., R. 1 W	W. Bochna	18						
62	do	do	do	do	30						
63	do	do	Sec. 26, T. 18 N., R. 1 W	Cascade Waterworks.	78		Hard				Domestic.
64	do	do	Sec. 35, T. 18 N., R. 1 W	do	25		do				
65	do	do	do	H. Schrameck	18		do		Windmill	Alluvium	
66	do	do	SE. ¼ sec. 35, T. 18 N., R. 1 W.	do	17	1882	do	Yes			Domestic, stock, irrigation, and manufacturing.
67	do	do	NW. ¼ sec. 30, T. 18 N., R. 1 E.	Benj. Rumney	20	1890	do	Yes	Pump		Domestic and stock.
68	do	do	NW. ¼ sec. 1, T. 18 N., R. 1 E.	James Travis	12	1889	Iron	Yes	do		Domestic, stock, and irrigation.
69	do	do	Sec. 24, T. 18 N., R. 1 E	Sam Jones	30		Soft				Domestic.
70	do	do	Sec. 8, T. 17 N., R. 1 E	Sam Kelly	30		do	Yes	Pump		Domestic and stock.
71	do	do	SE. ¼ sec. 8, T. 17 N., R. 1 E.	G. H. Crum	65	1886	Hard		do		Do.
72	do	do	T. 17 N., R. 1 E	Aug. Wedsworth	16	1895	do	Yes	do		Domestic.
73	do	do	Sec. 29, T. 19 W., R. 2 E	J. Ferguson	276			No water			
74	do	do	Sec. 29, T. 19 N., R. 2 E	T. C. King	80			Yes			
75	do	do	Sec. 28, T. 19 N., R. 2 E	G. S. Ferguson	30			Yes			
76	do	do	Sec. 26, T. 19 N., R. 2 E	Sanden T. Hops	50		Soft		Windmill		
77	do	do	Sec. 31, T. 19 N., R. 3 E	—— Prudle	68			No.			Do.
78	do	do	Sec. 29, T. 19 N., R. 3 E	A. Hickey	72		Good				Domestic, stock, and irrigation.
79	do	Truly	Sec. 21, T. 18 N., R. 2 E	—— McLaughlin	10		Hard				
80	do	do	do	—— Cummins			do				
81	do	do	SW. ¼ sec 16, T. 18 N., R. 2 E.	—— Cranston	65		Alkaline	No.			
82	do	do	Sec. 21, T. 18 N., R. 2 E	—— Perry	8		do				
83	do	do	Sec. 17, T. 18 N., R. 2 E	J. A. Perrine	17		Hard				
84	do	do	do	do	22		do				
85	do	do	do	do	125		do		Bucket		
86	do	do	Sec. 18, T. 18 N., R. 2 E	J. W. Perrine	49	1902	do				
87	do	do	Sec. 17, T. 18 N., R. 2 E	W. G. Stone	23	1905		Yes			Domestic and stock.
88	do	do	Sec. 7, T. 18 N., R. 2 E	J. S. Ferguson	35		Hard	Yes			Stock.
89	do	do	Sec. 8, T. 18 N., R. 2 E	R. Richardson	12	1905					Domestic and stock.
90	do	do	Sec. 2, T. 18 N., R. 2 E	—— Hughes	17						
91	do	do	do	do	16			No.			
92	do	do	NE. ¼ sec. 28, T. 18 N., R. 2 E.	J. H. Daly	225			No water			
93	do	do	do	do	75		Soft	Yes			

94	do	do	Sec. 3, T. 18 N., R. 2 E.	W. Misolf	10		Hard				
95	do	do	Sec. 28, T. 18 N., R. 2 E.	F. Johnson	20						
96	do	do	Sec. 6, T. 18 N., R. 2 E.	R. Oliver	20		Hard	No			Domestic
97	do	do	NW. ¼ sec. 5, T. 18 N., R. 2 E.	D. Lynne	80			No			
98	do	do	SW ¼ sec. 5, T. 18 N., R. 2 E.	—— Patton	20		Alkali				
99	do	do	Sec. 3, T. 18 N., R. 2 E.	H. S. Curtis	108		Good			Sandstone	
100	do	do	NW. ¼ sec. 3, T. 18 N., R. 2 E.	D. Lynne	102		Hard			do	
101	do	do	Sec. 12, T. 18 N., R. 3 E.	—— Evans	20		Good	Yes			
102	do	do	NE. ¼ sec. 28, T. 18 N., R. 3 E	—— Hinsoe	222		Hard				
103	do	do	NW. ¼ sec. 23, T. 18 N., R. 3 E.	M. C. Cumber	27					Shale	
104	do	do	Sec. 21, T. 18 N., R. 3 E.	P. Linquist	60			Yes		do	
105	do	do	SE. ¼ sec. 20, T. 18 N., R. 3 E.	C. Hanson	215						
106	do	do	Sec. 9, T. 18 N., R. 3 E.	—— Bisson	14		Hard	No			
107	do	do	Sec. 10, T. 18 N., R. 3 E.	—— Hale	16				Pump		
108	do	do	Sec. 9, T. 18 N., R. 3 E.	R. Skinner	132					Sandstone	
109	do	do	SW. ¼ SW. ¼ sec. 2, T. 17 N., R. 2 E.	T. J. S. Wingley	18					Shale	
110	do	do	SE. ¼ NE. ¼ sec. 4, T. 17 N., R. 2 E.	V. P. Carr	12		Hard				
111	do	do	do	do	22		do				
112	do	do	NW. ¼ sec. 19, T. 17 N., R. 2 E.	J. Carlile	20			No water			
113	do	do	NW. ¼ sec. 28, T. 17 N., R. 2 E.	Sutton Bros	9		Good				
114	do	do	Sec. 2, T. 17 N., R. 2 E.	—— Vesley	26		do				
115	do	do	SW. ¼ sec. 4, T. 17 N., R. 3 E.	Stin Bros	24		Hard	Yes			Domestic.
116	do	do	do	T. Splain	8					Alluvium	Stock and irrigation.
117	do	do	do	J. Marxer	102			No			
118	do	do	do	do	35		Slightly hard.	Yes	Pump	Red shale and gray sandy limestone.	Domestic and stock,
119	do	do	do	do	22			Yes	Windmill		Irrigation.
120	do	do	SE ¼ sec. 14, T. 17 N., R. 3 E.	J. Cocren	27			Yes			
121	do	do	NE. ¼ sec. 24, T. 17 N., R. 3 E.	—— Knight	65		Good	Yes	Pump		Domestic and stock.
122	do	do	SE. ¼ sec. 24, T. 17 N., R. 3 E	Geo. Bell	110			Yes	do		Domestic.
123	do	do	SW. ¼ SW. ¼ sec. 24, T. 17 N., R. 3 E.	—— Milligan	125			Yes	Windmill		
124	do	do	SE. ¼ NE. ¼ sec. 26, T. 17 N., R. 3 E.	B. Marxer	75			Yes	Pump		Do.
125	do	do	SE. ¼ sec. 22, T. 17 N., R. 3 E.	G. Werl	32		Alkaline	Yes		Sandstone	
126	do	do	Sec. 30, T. 17 N., R. 3 E.	G. A. Colby	21			No water			
127	do	do	do	do	21			Yes			
128	do	do	SW. ¼ sec. 8, T. 17 N., R. 3 E.	Huntsbarger Bros.	10		Soft				
129	do	Great Falls	SW. ¼ sec. 22, T. 20 N., R. 2 E.	A. W. Craig	32	1895	Alkaline	Yes			Domestic and stock.
130	do	do	NE. ¼ sec. 29, T. 20 N., R. 2 E.	H. W. Boynton	76	1903	(?)	Yes	Pump		Domestic, stock, and irrigation.
131	do	do	SE. ¼ sec. 22, T. 20 N., R. 2 E.	do	150						
132	do	do	NW. ¼ sec. 24, T. 20 N., R. 2 E.	Eugene J. Dugas	47	1900	Fair	Yes	Pump	Shale	Domestic and stock.
133	do	do	SW. ¼ sec. 2, T. 20 N., R. 2 E.	Wm. Straling	140	1905	Hard	Yes			
134	do	do	SW. ¼ sec. 22, T. 20 N., R. 2 E.	A. W. Craig	40						
135	do	do	do	do	457			No water		Shale	
136	do	do	do	do	32			No			
137	do	do	SE. ¼ sec. 29, T. 20 N., R. 2 E.	do	40						
138	do	do	do	do						Shale	

Partial list of wells of Great Falls region, Montana—Continued.

No.	County.	Locality.	Township, etc.	Owner.	Depth (feet).	Date completed.	Quality of water.	Is supply continuous?	How obtained at surface.	Geologic formation.	Use.
139	Cascade	Great Falls	SE. ¼ sec. 29, T. 20 N., R. 2 E.	A. W. Craig	32						
140	do	do	NE. ¼ sec. 28, T. 20 N., R. 2 E.	do	15		Alkaline				
141	do	do	SE. ¼ sec. 29, T. 20 N., R. 2 E.	do	6						
142	do	do	do	do	6		Alkaline				
143	do	do	Sec. 28, T. 20 N., R. 2 E.	do	15		Hard				
144	do	do	do	—— McCloud	45		do				
145	do	do	NE. ¼ sec. 34, T. 20 N., R. 2 E.	—— Stratin	10			Yes			
146	do	do	NW. ¼ sec. 33, T. 20 N., R. 2 E.	do	525			No water			
147	do	do	do	do	90			Yes			
148	do	do	NE. ¼ sec. 23, T. 20 N., R. 2 E.	do	125			No water			
149	do	do	SE. ¼ sec. 35, T. 20 N., R. 2 E.	do	8						Domestic and stock.
150	do	do	SW. ¼ sec. 25, T. 20 N., R. 2 E.	—— Transon	94		Alkaline	Yes			
151	do	do	SE. ¼ sec. 15, T. 20 N., R. 2 E.	C. K. Giles	57		Good				
152	do	do	NE. ¼ sec. 15, T. 20 N., R. 2 E.	—— Shobert	12			Yes			
153	do	do	Sec. 19, T. 20 N., R. 2 E.	—— Cherpeski	91						
154	do	do	Sec. 29, T. 20 N., R. 2 E.	—— Stewart	76						
155	do	do	Sec. 21, T. 20 N., R. 2 E.	—— Weber	71		Good				
156	do	do	SW. ¼ sec. 23, T. 20 N., R. 2 E.	—— Arnold	133						
157	do	do	Sec. 15, T. 20 N., R. 2 E.	—— Rumbeaugh	76						
158	do	do	Sec. 13, T. 20 N., R. 2 E.	—— Geerson	51		Good				
159	do	do	Sec. 9, T. 20 N., R. 2 E.	—— Carruthers	123						
160	do	do	Sec. 22, T. 20 N., R. 2 E.	—— Boynton	320						
161	do	do	SW. ¼ sec. 17, T. 20 N., R. 3 E.	Peter Dindolad	114	1906	Good	Yes		Shale	Do.
162	do	do	NE. ¼ sec. 30, T. 20 N., R. 3 E.	G. D. Nicolai	61	1904	Hard	Yes			Do.
163	do	do	Sec. 21, T. 20 N., R. 4 E.	P. Gibson	25						
164	do	do	NW. ¼ sec. 22, T. 20 N., R. 4 E.	do	17						
165	do	do	SE. ¼ sec. 20, T. 20 N., R. 4 E.	do	14						
166	do	do	SW. ¼ sec. 27, T. 20 N., R. 4 E.	do	18						
167	do	do	NE. ¼ sec. 32, T. 20 N., R. 4 E.	John Locke	27		Hard				Do.
168	do	do	do	W. H. Mitchell	56	1906	do				Do.
169	do	do	NW. ¼ sec. 31, T. 20 N., R. 4 E.	W. F. Jenkin	9	1893	do				
170	do	do	NE. ¼ sec. 26, T. 20 N., R. 4 E.	Great Falls Meat Co.	126	1904	do	Yes	Windmill	Gravel and clay.	Stock.
171	do	do	SW. ¼ sec. 13, T. 20 N., R. 4 E.	do	300	1895	Very poor				
172	do	do	NE. ¼ sec. 4, T. 20 N., R. 4 E.	do	300	1893	Poor				
173	do	do	NW. ¼ sec. 15, T. 20 N., R. 4 E.	do	165	1893					
174	do	do	SE. ¼ sec. 25, T. 20 N., R. 4 E.	F. Yost	25		Hard		Windmill		Do.
175	do	do	SE. ¼ sec. 26, T. 20 N., R. 4 E.	Lee ranch	4		Good	Yes	do	Alluvium	
176	do	do	NE. ¼ sec. 26, T. 20 N., R. 4 E.	do					do		
177	do	do	SW. ¼ sec. 8, T. 20 N., R. 5 E.	Great Falls Meat Co	300	1904					
178	do	do	SE. ¼ sec. 32, T. 20 N., R. 5 E.	E. Grieger	10		Soft	Yes		Alluvium	
179	do	do	Sec. 32, T. 20 N., R. 5 E.	do	5						
180	do	do	SW. ¼ sec. 31, T. 20 N., R. 5 E.	do	15		Soft				

181	do	do	NE. ¼ sec. 18, T. 19 N., R. 4 E.	A. Mobray	45	1903	Hard				Domestic and stock.
182	do	do	do	do	160	1905	do				Do.
183	do	do	SE. ¼ sec. 18, T. 19 N., R. 4 E.	John R. Ross	45	1897	do				Domestic.
184	do	Stockett	SW. ¼ sec. 30, T. 19 N., R. 4 E.	R. Skinner	85		do				Domestic and stock.
185	do	Great Falls	NE. ¼ sec. 12, T. 19 N., R. 4 E.	J. G. Ernst	32		do	No			Domestic.
186	do	do	NE. ¼ sec. 12, T. 19 N., R. 5 E.	Ray & Freidrich. Sheep Co.	175		Very hard	Yes	Pump		Domestic and stock.
187	do	do	NE. ¼ sec. 9, T. 19 N., R. 5 E.	A. Farling	12		Good	Yes		Sandstone	
188	do	do	SW. ¼ sec. 6, T. 19 N., R. 5 E.	J. Dougherty	12				Pump		Do.
189	do	do	do	do	30			No			
190	do	Stockett	SE. ¼ sec. 27, T. 19 N., R. 4 E.	J. Eisenberg	32		Hard				Do.
191	do	do	NE. ¼ sec. 27, T. 19 N., R. 4 E.	Edmund Dirk	110		Very hard	No			
192	do	do	SW. ¼ sec. 33, T. 19 N., R. 4 E.	John Edstrom	30		Good	No			Domestic.
193	do	do	SW. ¼ sec. 36, T. 19 N., R. 4 E.	C. W. Peterson	40		Hard	No			Do.
194	do	do	Sec. 36, T. 19 N., R. 4 E.	Cottonwood Coal Co.	50	1904		No			
195	do	do	Sec. 23, T. 19 N., R. 5 E.	W. E. Abernathy	15			Yes		Sandstone	
196	do	do	do	do	30		Soft				Domestic and stock.
197	do	do	SW. ¼ sec. 35, T. 18 N., R. 4 E.	J. G. Martin	19		Hard				Domestic.
198	do	do	Sec. 21, T. 18 N., R. 4 E.	J. H. Connor	22						Domestic and stock.
199	do	do	Sec 33, T. 18 N., R. 4 E.	J. P. Jones	30	1902	Hard				Do.
200	do	do	NE. ¼ sec. 17, T. 18 N., R. 4 E.	C. Jaeckel	14	1889	do	Yes			Do.
201	do	do	NE ¼ sec. 31, T. 18 N., R. 4 E.	John Steyaerr	30	1905	do			Shale	Do.
202	do	do	NE. ¼ sec. 34, T. 18 N., R. 4 E.	N. J. Wagner	280	1902					
203	do	do	do	do	45		Hard				Domestic.
204	do	do	SW ¼ sec. 35, T. 18 N., R. 4 E.	Wm. Kirby	180			Yes	Windmill	Sandstone	
205	do	do	SE. ¼ sec. 25, T 18 N., R. 4 E.	Chester Cavanagh	20	1898	Soft	Yes			Domestic and stock.
206	do	do	Sec. 19, T. 18 N., R. 5 E.	A. Winkle	115	1902	Hard	No			Do.
207	do	do	SE. ¼ sec. 31, T. 18 N., R. 5 E.	Chas. Gereke	205					Shale	
208	do	do	do	J. Mettsh	120	1903	Hard	Yes		Sandstone	Do.
209	do	do	do	—— Marko	200			No			
210	do	do	Sec. 12, T. 18 N., R. 5 E.	John Ross	150	1902	Hard	No		Sandstone	Do.
211	do	do	Sec 14, T. 18 N., R. 5 E.	A. Carlson	65			Yes	Windmill		Stock.
212	do	do	do	do	20		Soft	No			
213	do	do	SW. ¼ sec 14, T. 18 N., R. 5 E.	Penn Bros	35			No			
214	do	do	Sec. 24, T. 18 N., R. 5 E.	do	11		Soft	Yes			
215	do	do	NE ¼ sec. 26, T 18 N., R. 5 E.	J. M. Mahoney	26		Slightly hard.	Yes			
216	do	do	Sec. 18, T. 18 N., R. 5 E.	J. Knabe	65		Soft	No			Domestic.
217	do	do	do	B. Goethe	15		do	Yes			Domestic and stock.
218	do	do	Sec. 21, T. 18 N., R. 5 E.	Young & Jeffries	9			No			
219	do	do	Sec. 1, T. 18 N., R. 5 E.	O. Romundstad	40	1905	Soft				
220	do	do	Sec. 12, T. 18 N., R. 5 E.	W. Shoop	200			No	Windmill		
221	do	do	Sec. 11, T. 17 N., R. 4 E.	Wellington Gates	50	1905	Soft				Do.
222	do	do	NE. ¼ sec. 2, T. 17 N., R. 4 E.	L. E. Betts	120	1905	Hard				Do.
223	do	do	Sec. 26, T. 20 N., R. 6 E.	J. B. Long	20				Windmill		Do.
224	do	do	NE. ¼ sec. 32, T. 20 N., R. 6 E.	Mack Depew						Sandstone	
225	do	do	SE. ¼ sec. 25, T. 20 N., R. 6 E.	J. A. Demuth	25		Poor				
226	do	do	do	do	50	1906				Blue limestone.	
227	do	do	NE. ¼ sec. 24, T. 20 N., R. 6 E.	J. B. Metzell	25				Steam engine.		
228	do	do	SE. ¼ sec. 13, T. 20 N., R. 6 E.	J. B. Young	12			No	Pump		
229	do	do	NE. ¼ sec. 31 T. 20 N., R. 6 E.	L. F. Leech	14		Poor	No			Do.

Partial list of wells of Great Falls region, Montana—Continued.

No.	County.	Locality.	Township, etc.	Owner.	Depth (feet).	Date completed.	Quality of water.	Is supply continuous?	How obtained at surface.	Geologic formation.	Use.
230	Cascade	Stockett	NW. ¼ sec. 32, T. 20 N., R. 6 E.	J. Dougherty	15						Stock.
231	do	do	Sec. 32, T. 20 N., R. 6 E.	do	20						Do.
232	do	do	NW. ¼ sec. 29, T. 20 N., R. 6 E.	do	20		Soft				
233	do	do	NE. ¼ sec. 18, T. 20 N., R. 7 E.	J. Epperson	20		Hard	Yes			
234	do	do	Sec. 33, T. 20 N., R. 7 E.	—— Gillette	14	1886	Good	Yes	Pump		Domestic and stock.
235	do	do	NE. ¼ sec. 15, T. 19 N., R. 6 E.	A. H. McMillan	80	1905	do	Yes	do		Do.
236	do	do	SE. ¼ sec. 22, T. 19 N., R. 6 E.	Rush Farm	8		do	Yes	Bucket		Domestic.
237	do	do	Sec. 10, T. 19 N., R. 6 E.	—— Kupperion	20		Hard	Yes			
238	do	do	Sec. 5, T. 19 N., R. 6 E.	W. H. Porter	8		Good	Yes			
239	do	do	do	Henry Kassmier	36		do	Yes			
240	do	do	Sec. 21, T. 19 N., R. 6 E.	C. B. Pyle	35			No			Domestic and stock.
241	do	do	Sec. 14, T. 19 N., R. 6 E.	F. Polutnik	64			No	Bucket		
242	do	do	do	do	80				Windmill		Do.
243	do	do	do	John Wright	16	1900		Yes			
244	do	do	do	do	40						
245	do	do	Sec. 1, T. 19 N., R. 6 E.	W. S. Sifford	25		Poor	No			
246	do	do	Sec. 11, T. 19 N., R. 6 E.	Geo. Togden	27			No			
247	do	do	do	do	175		Good	Yes			
248	do	do	NW. ¼ sec. 3, T. 19 N., R. 6 E.	Jno and Joe Bogner	25						
249	do	do	Sec. 15, T. 19 N., R. 6 E.	Edgar Mann	14	1905	Hard	Yes	Pump		Domestic, stock, and irrigation.
250	do	do	do	do	20	1900	Soft	Yes	do		Do.
251	do	do	NE. ¼ sec. 32, T. 19 N., R. 6 E.	C. Turner	120	1897		No water.			
252	do	do	Sec. 15, T. 19 N., R. 6 E.	A. H. McMillan	80	1905	Soft	Yes	Pump		Domestic and stock.
253	do	do	NW. ¼ sec. 6, T. 19 N., R. 6 E.	S. Dean	14		Slightly hard.	Yes		Alluvium	
254	do	do	Sec. 34, T. 19 N., R. 6 E.	Cottonwood Coal Co.	100						
255	do	do	Sec. 21, T. 19 N., R. 6 E.	Chas. Lindsey	35	1902	Slightly hard.	Fairly.	Pump		Do.
256	do	do	SE. ¼ SE. ¼ sec. 2, T. 19 N., R. 7 E.	J. F. McGraw	20					Alluvium	
257	do	do	NE. ¼ sec. 33, T. 18 N., R. 6 E.	O. V. Jacobs	8						
258	do	do	NE. ¼ sec. 28, T. 18 N., R. 6 E.	Hans Johnson	4						
259	do	do	SE. ¼ sec. 20, T. 18 N., R. 6 E.	P. Nelson	217				Gasoline engine.		
260	do	do	SE. ¼ sec. 25, T. 18 N., R. 6 E.	N. Newmeyer	10						
261	do	do	Sec. 36, T. 18 N., R. 6 E.	G. Siegling	22		Soft				Do.
262	do	do	NE. ¼ sec. 15, T. 18 N., R. 6 E.	J. R. Bowen							
263	do	do	NE. ¼ sec. 14, T. 18 N., R. 6 E.	Dan Gibt	23		Hard				Stock.
264	do	do	SW. ¼ sec. 14, T. 18 N., R. 6 E.	F. Polutnik	80	1904	Good	Yes	Windmill		Domestic and stock.
265	do	do	Sec. 5, T. 18 N., R. 7 E.	S. D. Winston	35					Sandstone	
266	do	do	NE. ¼ sec. 5, T. 18 N., R. 7 E.	J. T. Bough	17		Good	No		Shale	

267	do	do	Sec. 11, T. 18 N., R. 7 E	F. Armstrong	13			No.			
268	do	do	Sec. 11, T. 18 N., R. 7 E	W. R. Cresop	22		Good	Yes			
269	do	do	Sec. 29, T. 18 N., R. 8 E	F. J. Ober	16						Domestic.
270	do	do	Sec. 20, T. 18 N., R. 8 E	J. W. Watkins	20	1904	Good	Yes	Pump	Sandstone	Domestic, stock, and garden.
271	do	do	Sec. 28, T. 18 N., R. 8 E	Rob. Williamson	14		Alkaline	No.	Bucket		Stock.
272	do	do	SW. ¼ sec. 1, T. 17 N., R. 6 E	W. Albright	10					Alluvium	
273	do	do	do	G. W. Goodwin	21						Domestic.
274	do	Geyser	SW. ¼ sec. 10, T. 18 N., R. 8 E	W. McGinnis	40	1900					
275	do	do	NE. ¼ sec. 13, T. 18 N., R. 8 E	J. Cameron	7						
276	do	do	NE. ¼ sec. 24, T. 18 N., R. 8 E	H. Koskey	10		Soft	Yes		Shale	
277	do	do	NE. ¼ SE. ¼ sec. 14, T. 18 N., R. 9 E.	W. Kernaghan	23		do	Yes		Clay	
278	do	do	SW. ¼ SW. ¼ sec. 12, T. 18 N., R. 9 E.	J. Todd	9		do	Yes			
279	do	do	NW. ¼ sec. 14, T. 18 N., R. 9 E.	R. O'Connor	15		do	Yes			
280	do	do	S. ½ sec. 2, T. 18 N., R. 9 E	F. McCliste	15			Yes			
281	do	do	SW. ¼ sec. 20, T. 18 N., R. 9 E.	D. Rankin	14	1900	Soft	Yes	Pump		Domestic and garden.
282	do	do	NE. ¼ sec. 35, T. 18 N., R. 9 E.	Gabriel Takola	5	1905	do	Yes	Bucket		Domestic.
283	do	do	NW. ¼ sec. 32, T. 18 N., R. 10 E.	J. B. Long	15			Yes	Pump		Do.
284	do	do	do	do	15			Yes	do		Do.
285	do	do	SE. ¼ sec. 32, T. 18 N., R. 10 E.	do	15			Yes	do		Do.
286	do	do	NE. ¼ sec. 3, T. 17 N., R. 8 E	—— Larson		1881	Soft	Yes			Domestic, stock, and garden.
287	do	do	NE. ¼ sec. 2, T. 17 N., R. 9 E	H. Haulfa	8		do	No.			
288	do	do	NE. ¼ sec. 29, T. 17 N., R. 9 E.	W. Nollar	25						Domestic and stock.
289	do	do	NW. ¼ sec. 10, T. 17 N., R. 9 E.	H. P. Schumacher	23						Domestic.
290	do	do	SW. ¼ sec. 5, T. 16 N., R. 9 E	Delphas Leblanc	14		Hard			Limestone	
291	do	do	SE. ¼ sec. 26, T. 16 N., R. 9 E	—— Peterson	8		Poor		Bucket		Stock.
292	do	do	SW. ¼ sec. 19, T. 16 N., R. 10 E.	P. O'Harra	8						Domestic and stock.
293	Fergus	Stanford	SE. ¼ SE. ¼ sec. 33, T. 17 N., R. 11 E.	Bower Bros	30	1890		Yes			Do.
294	do	do	NW. ¼ sec. 27, T. 17 N., R. 12 E	do	15			No	Pump		Stock.
295	do	do	NW. ¼ sec. 22, T. 17 N., R. 12 E.	do	20			Yes	do		Do.
296	do	do	SW. ¼ NW. ¼ sec. 11, T. 17 N., R. 12 E.	T. Bain	20		Soft		do		
297	do	do	Sec. 27, T. 17 N., R. 12 E	Bower Bros							Do.
298	do	do	SW. ¼ NW. ¼ sec. 27, T. 17 N., R. 12 E.	do					Pump		Do.
299	do	do	NW. ¼ sec. 11, T. 17 N., R. 12 E.	do	15				do		Do.
300	do	do	NE. ¼ NE. ¼ sec. 3, T. 17 N., R. 12 E.	do	15				Windmill		Do.
301	do	do	SW. ¼ SW. ¼ sec. 13, T. 16 N., R. 11 E.	P. Westfall	12		Hard	Yes		Drift	
302	do	do	NW. ¼ NW. ¼ sec. 13, T. 16 N., R. 11 E.	J. Skelton	10		Soft	No.			
303	do	do	NE. ¼ sec. 13, T. 16 N., R. 11 E.	E. F. Tuttle	12		Hard				
304	do	do	Sec. 24, T. 16 N., R. 11 E	W. Skelton	15		do	Yes			
305	do	do	SW. ¼ sec. 25, T. 16 N., R. 11 E.	G. H. Ketchner	18		do				
306	do	do	Sec. 35, T. 16 N., R. 11 E	Fisher ranch	12		Soft	No.			
307	do	do	NE. ¼ sec. 24, T. 16 N., R. 11 E.	W. Skelton	15	1900			Pump		Do.
308	do	do	Sec. 31, T. 16 N., R. 12 E	S. S. Hobson	12		Hard				

Partial list of wells of Great Falls region, Montana—Continued.

No.	County.	Locality.	Township, etc.	Owner.	Depth (feet).	Date completed.	Quality of water.	Is supply continuous?	How obtained at surface.	Geologic formation.	Use.
309	Fergus	Stanford	NW. ¼ NW. ¼ sec. 23, T. 15 N., R. 12 E.	Sage Sheep Creek Co.				Yes			Irrigation.
310	do	do	NE. ¼ NW. ¼ sec. 4, T. 15 N., R. 12 E.	J. Segla	9		Good	Yes		Sandstone	
311	do	do	Sec. 4, T. 15 N., R. 12 E.	do	20		do	Yes		do	
312	do	do	do	A. T. Kach	25		do	Yes		Shale	
313	do	do	SE. ¼ SW. ¼ sec. 18, T. 15 N., R. 12 E.	W. J. Hughes	18			Yes		Sandstone	

Artesian wells in the Great Falls region, Montana.

No.	County.	Locality.	Township, etc.	Owner.	Depth.	Diameter.	Date drilled.	Estimated flow per minute.	Quality of water.	Use.	Remarks.
					Ft.	*Ins.*		*Gals.*			
1	Teton	Farmington	SW. ¼ sec. 35, T. 26 N., R. 4 W.	Francois Truchot	47	2	1904	¾	Good	Not used	
2	do	do	SW. ¼ sec. 2, T. 25 N., R. 4 W.	do	50	2	1900	1	do	Stock	
3	do	do	NE. ¼ sec. 11, T. 25 N., R. 4 W.	do	50	2	1900	1	do	do	
4	do	do	SE. ¼ sec. 23, T. 26 N., R. 4 W.	do	100	2		1	do	do	
5	do	do	NW. ¼ sec. 35, T. 26 N., R. 4 W.	H. Weiske	45	2			do	Domestic and stock.	Barely rises above surface.
6	do	do	NW. ¼ sec. 2, T. 25 N., R. 4 W.	G. A. Gorum	45	2	1903	¾	do	Stock	
7	do	do	SE. ¼ sec 21 T. 26 N. R. 4 W.	B. P. Dirkson	45	2	1902	1		do	
8	do	do	SE ¼ sec. 15, T. 26 N., R. 4 W.	J. P. Schmidt	75	2		1¾		do	
9	do	do	SE ¼ sec. 11, T. 25 N., R. 4 W.	John Jackson	37½	2	1903	½		Domestic and stock.	
10	do	do	do	do	34½	2	1905	1½		Irrigation	
11	do	do	SW. ¼ sec. 11, T. 25 N., R. 4 W.	do	29	3¼	1906	1½		do	
12	do	do	do	do	35	3¼	1906				Closed.
13	do	do	NE. ¼ NW. ¼ sec. 6, T. 25 N., R. 4 W.	Peter Egraud	87	5⅞	1899	2		Domestic, stock, irrigation.	
14	do	do	Sec. 6, T. 25 N., R. 4 W.	do	87	5				Stock	
15	do	do	do	do	91	8		1		Domestic, stock, irrigation.	

16	do	do	do	do	83	8					Do.
17	do	do	SE. ¼ sec. 3, T. 25 N., R. 4 W.	Elias Rekdehl	31	3½	1905	2½		Irrigation	
18	do	do	do	do	31	3½	1905	1		do	
19	do	do	Sec. 3, T. 25 N., R. 4 W	do	31	3½	1905	3		do	
20	do	do	do	do	16	6		3		do	
21	do	do	do	do	16	2		1½		do	
22	do	do	do	do	16	6	1900	½		Not used	
23	do	do	do	do	42	2	1900	1½		Domestic and stock.	
24	do	do	do	do	16	2	1900	½		Not used	
25	do	do	do	do	36						Not cased, and caved in.
26	Fergus	Stanford	Sec. 4, T. 15 N., R. 12 E.	B. E. Stacks	321				Mineralized	Domestic, stock, and irrigation.	
27	do	do	Sec. 23, T. 15 N., R. 12 E.	Sage Creek Sheep Co.	850	2				Irrigation	
28	do	do	SW. ¼ NE. ¼, sec. 14, T. 15 N., R. 12 E.	Sage Creek Sheep Co's. home ranch.	850	2			Good	Domestic and irrigation.	
29	do	do	NW. ¼ SE. ¼, sec. 21, T. 15 N., R. 12 E.	Razor well	400	2			do		Well not flowing at present.
30	do	do	NE. ¼ NE. ¼, sec. 18, T. 15 N., R. 12 E.	McComb well	400	2			do		Well plugged; not flowing at present.
31	do	do	NW. ¼ NE. ¼, sec. 2, T. 14 N., R. 12 E.	Upper Sage Creek well.	700	2			do		
32	do	do	SW. ¼ SW. ¼, sec. 20, T. 13 N., R. 12 E.	Dry Coulee well	900	2			Mineralized	Stock	
33	Cascade	Belt	NE. ¼ SE. ¼ sec. 32, T. 19 N., R. 6 E.	E. Turner	95				do	Domestic and stock.	
34	do	Great Falls	NE. ¼ sec. 5, T. 20., N., R. 3 E.	J. F. Bryant	160			8	Contains iron.		
35	do	do	NW. ¼ sec. 9, T. 20., N., R. 3 E.	Mat Venetz	180			(a)	do	Irrigation	

a 300 barrels in 24 hours.

ARTESIAN CONDITIONS.

Throughout the eastern part of the area examined, especially that lying east of Belt Creek, the geologic conditions are in general favorable for the occurrence of artesian water. The rocks consist of medium to coarse grained massive sandstone and sandy shale overlain by impervious shale and clay. They dip gradually to the northeast away from the mountains, so that the streams passing over the upturned ends of this porous sandstone and shale lose much of their water. This water in passing underground is soon carried beneath impervious shale farther down on the plains, where it is available as artesian water when the overlying shale is penetrated by deep-well borings. These conditions obtain throughout a zone of varying width along Sage, Willow, Skull, Running Wolf, Surprise, and Arrow Creek valleys.

Throughout the area lying between Belt Creek and Smith River the general geologic and structural conditions are not favorable for the occurrence of artesian water. There is, however, a shallow flowing well of local origin in Box Elder Creek which probably derives its water from the valley filling. In this general vicinity the sandstone members of the Kootenai and the base of the Colorado formation, which are the principal artesian water-bearing beds to the east, occupy summits of more or less detached plateaus, which rise to the south toward the highland lying between the Big Belt and Little Belt mountains. As these sandstone members, which in other localities are artesian water-bearing, occupy only the summits of the higher table-lands far above the mountain streams draining the area, the only water which they can receive is that derived from rainfall. A portion of this is disposed of by run-off and evaporation, while the remainder is free to escape in the numerous marginal springs which occur along the edge of the above-described plateaus; hence the region is one where artesian water is not to be expected.

From Smith River westward along the base of the adjacent mountain ranges the geologic and structural conditions, although different from those above described, are equally unfavorable for the occurrence of artesian water in the adjoining plains region. Along the northern base of Big Belt Mountains the sedimentary rocks, which are of upper Cretaceous age, are cut by igneous rocks over extensive areas, thus preventing them from extending into the higher mountain regions where they might be free to absorb water. The same is true along the base of the Lewis Range bordering this area on the west. Cretaceous rocks, instead of dipping normally away from the uplift, owing to the overthrust fault above described dip toward the mountains, passing under the older Algonkian rocks, which form the higher portion of the range. In the region lying west of Great Falls the water-bearing sandstones of the Kootenai and the base of the

Colorado formation are not exposed, but are covered by several hundred feet of upper Cretaceous sediment, consisting mainly of impervious shale with sandstone members in the upper part. Under these conditions it is apparent that rocks which are water-bearing on the east are on the west, along the base of the Lewis Mountains, completely sealed off from a surface water supply by a great thickness of overlying impervious shale of upper Cretaceous age. The sandstone beds in the upper part of the upper Cretaceous formation also dip toward the mountains in a direction opposite to the flow of the streams which pass over them. Under the above conditions it is obvious that all the water derived from the melting snow of the Lewis Range must either be carried along the valleys of these various streams as a surface flow or an underflow, or be absorbed by the local glacial deposits which cover the formations along the base of the Lewis Range.

From the above it is apparent that the structural relations of the geologic formations in the plains region bordering the Lewis Mountains, including Sun and Teton river valleys, are unfavorable for the occurrence of deep-seated artesian water. Small areas with artesian water of local origin are, however, scattered through this district. Along Muddy Creek, a tributary of Teton River, there is a small district, comprising about 20 square miles, in which a number of successful artesian wells have been obtained. The depth of these wells varies from 16 to 100 feet. The water is relatively pure and is used for both domestic and irrigation purposes. It is obtained from a coarse gravel bed, which is overlain by glacial clay of variable thickness. This artesian area is believed to be supplied with water from the stream in Ralston Gap and upper Muddy Creek. These streams contain numerous swamps in their upper courses, but the water in passing downstream sinks to an underflow a few miles above the artesian area, where it apparently passes under the impervious glacial clay and becomes available as artesian water when this impervious overlying clay is penetrated by well borings. In the lower part of Sun River valley, between Sun River and Great Falls, there are a few shallow wells. The flow of these wells is due to local artesian conditions, which extend over only small areas. The water is obtained in each case from gravel lying in the lower part of the valley filling. This gravel is locally covered by impervious clay, thus producing artesian conditions.

WATER SUPPLY BY DISTRICTS.

GEYSER DISTRICT.

Throughout the area lying to the east of Otter Creek divide the underground water supply is derived mainly from springs, which occur at varying intervals along nearly all of the mountain streams. These springs are more or less numerous in the region adjacent to the inclosing mountain ranges, as is shown by the water-resource map (Pl. VII), but farther out on the plains they are fewer in number. Shallow wells occur here and there along the stream valleys. They vary in depth from 15 to 25 feet and afford an ample supply of good water, but owing to the large number of springs only a few wells have been sunk. Throughout this district the prospects for artesian water along Lonetree, Arrow, Surprise, Running Wolf, Skull, and Sage Creek valleys are very favorable. The region, as previously stated, is underlain by beds of porous sandstone belonging to the Kootenai formation, which in their outcrop area bordering the Little Belt Mountains absorb more or less water from mountain streams. In their extension northeastward these sandstone beds pass under impervious Colorado shale producing ideal artesian conditions. The Kootenai rocks underlying this region contain a bed of workable coal which has been prospected extensively and is mined at present at several localities. In 1901 the Sand Coulee Mining Company made extensive diamond-drill borings in search of coal along Sage Creek valley. Five holes were bored, ranging in depth from 400 to 700 feet, three in Sage Creek valley in T. 15 N., R. 12 E., one in a small tributary of Willow Creek near Hughes's ranch, and one about 3 miles east of Sage Creek Sheep Company's home ranch. A flow of good water was reported from each of these borings; the largest flow, however, was secured at Sage Creek Sheep Company's home ranch. The water from this well is stored in a small reservoir and used for irrigation purposes. According to the best information which could be obtained concerning these borings, the water in each case was derived from a gray sandstone, probably constituting one of the basal members of the Kootenai formation. The occurrence of these artesian wells in upper Sage Creek valley has a very important significance, for it demonstrates that artesian water can be secured at moderate depths throughout the upper courses of several small mountain-stream valleys in the immediate vicinity, an area comprising a considerable acreage of rich agricultural land. The prospects for artesian water are equally favorable in the upper part of the Skull Creek valley for a short distance northeast of Skull Butte, and it is possible that small flows might be obtained throughout the wide valley of Running Wolf Creek in the vicinity of Stanford. While no practical tests have been made of the artesian water capacity of the Kootenai sandstone underlying Lonetree Creek valley in the vicinity of Geyser, the geologic conditions in this district are favorable for flowing wells. The porous sandstone of the Kootenai formation dips gradually northeastward away from the Little Belt Mountains, passing under the impervious Benton shale, which in the vicinity of Geyser and along Lonetree Creek valley could be penetrated by relatively shallow borings.

MAP OF GREAT FALLS REGION, MONTANA, SHOWING IRRIGATION AND AGRICULTURAL AND WATER RESOURCES.

OTTER CREEK DISTRICT.

The Otter Creek district is arbitrarily taken to include the area between Otter Creek divide and Belt Creek. It has an abundant water supply, which is derived largely from springs. A few shallow wells are found along Belt Creek valley and its tributaries, especially in the vicinity of Belt. Shallow wells are also not infrequent on the higher slopes bordering the Highwood and Little Belt mountains. Along Otter Creek numerous springs from the Kootenai sandstone occurring at frequent intervals either in the bottom of the valleys or on the sides of the bluffs furnish an ample amount of good water and make it generally unnecessary to sink wells. The tributaries of Otter Creek from the south, which drain the high plateaus, are also well supplied with spring water from the same source. North of Otter Creek, especially on the higher slopes bordering the Highwood Mountains, there is a strong underflow in the bottom of all the coulees, which is derived from melting snow higher on the mountain slopes. The water thus absorbed in the heads of the coulees high on the slopes appears at the surface lower down in their course in the form of small springs, or it can be easily reached by shallow wells.

GREAT FALLS DISTRICT.

Under the Great Falls district is described the territory lying south of Missouri River between Belt Creek and Smith River. As stated above it is essentially a plateau region more or less dissected by canyons. Throughout the lower part of the district, on the plains east of Great Falls, water for domestic purposes is apparently difficult to obtain, excepting along Box Elder Creek valley, where a number of shallow wells furnish a large amount. Several wells have been dug by the Great Falls Meat Company immediately east of Great Falls. The depths of these vary from 150 to 300 feet, and in no instance has the quality and quantity of the water been entirely satisfactory. Farther to the south and east springs are the chief source of water supply, although a few wells have been sunk. As a rule wells in this portion of the district are not successful, and it is believed that the most satisfactory source of domestic water supply is to be found in the development of the small springs which are more or less abundant. At Stockett and Sand Coulee a few wells have been bored, which are described on page 70, and on the high plateaus southeast of these towns deep borings have been made, which usually failed to secure a satisfactory amount of water. In the vicinity of Stockett there is a local doming of the formations, which exposes the Madison limestone for a considerable distance along Sand Coulee and in Cottonwood and Straight coulees. Wells sunk in this limestone fail to find water, for the upper part of the formation is not water bearing. The Jurassic and Cretaceous formations overlying the Carboniferous limestone in this vicinity are relatively thin, but they thicken to both the east and the west. Wells bored on the plateaus penetrate the water-bearing sandstone of the Kootenai formation within a distance of 200 to 300 feet from the surface. This sandstone in the vicinity of Stockett and Sand Coulee is not heavily saturated with water, notwithstanding that it is the source of many small springs. The scarcity of water is probably due to the fact, as previously described, that in its southern extension the sandstone caps the higher hills, where the only water which it can absorb is from rainfall and melting snow. In sinking a well in this general region whenever the limestone is reached the boring should be discontinued, for it indicates that all the water-bearing rocks of the region have been penetrated. Along the west side of the district, where the plateaus are capped by the basal sandstone of the Colorado, springs are abundant along the side of the plateaus (see Pl. V, *A*), and in the valleys good water is obtained from shallow wells. Representative wells and springs in the Great Falls district are listed on pages 43–44 and 53–55.

MISSOURI RIVER VALLEY DISTRICT.

Along Missouri River valley from the base of Big Belt Mountains to a point about 2 miles above Riverdale there is a wide, open valley on the east side of the river in which an abundance of good water is obtained from wells at depths varying from 15 to 25 feet, depending on the distance from the river. A few wells in this valley have been sunk to greater depths in order to obtain a larger supply of water, but generally they have not been successful. Several unsuccessful attempts have also been made to secure artesian water in the valley. This is not practicable, owing to the adverse structural relations described on page 27. The water of shallow wells is derived from alluvial sands and gravel, which have a variable thickness. To the east, on the summit of the high plateau bordering Smith River on the west, water is secured from wells at a considerably greater depth. Here the principal water-bearing horizon is the basal sandstone of the Colorado formation. Wells along this plateau vary from 50 to 150 feet, and a sufficient quantity of water is usually obtained. The extent of the basal Colorado sandstone in this region is shown on the geologic map (Pl. I).

ULM BENCH.

Throughout Ulm Bench, which lies southwest of Great Falls between Missouri and Sun rivers, dry farming is extensively practiced, and the district has been divided into a number of small farms. On these farms wells have been bored which invariably obtain good water at depths rarely exceeding 100 feet. The water is derived from the lower part of the basal Colorado sandstone which caps Ulm Bench. Along the western margin of Ulm Bench, where the overlying Colorado shale occupies the surface, the well water is generally more or less mineralized and unfit for domestic purposes.

AREA SOUTH OF SUN RIVER.

West of Ulm Bench throughout the district lying south of Sun River the prospects for underground water are not favorable. The formation occupying the surface in this region is the Colorado shale, which rarely if ever contains pure water. The principal drainage of the area is Little Muddy Creek, a large intermittent stream draining a considerable district south of Square and Fort Shaw buttes. From several field analyses which have been made of water from wells in this valley it has been found to contain an unusually large amount of magnesium and other harmful salts. The well water in this region is so highly mineralized that it is rendered unfit even for stock purposes. The Eagle sandstone, which with the overlying igneous rock caps the prominent buttes in this region, is the only near source of potable water supply.

West of Crown Butte throughout the lower part of the territory drained by Sims Creek prospects for underground water are more favorable. Here the Eagle sandstone underlies the surface, and, while no practical tests have been made, it is believed that wells sunk in this sandstone will probably secure good water.

SUN RIVER VALLEY.

Along the valley of Sun River water for domestic and stock purposes is derived from wells and springs or taken directly from the river. In the lower part of the valley between Sun River and Great Falls many shallow wells have been sunk which furnish a good supply. These derive their waters mainly from the valley wash. Farther up Sun River valley throughout the lower land water is obtained from shallow wells, but back from the streams the depth increases. At Fort Shaw a well was recently drilled and good water found at a depth of 101 feet. This, however, was at the mouth of a small coulee entering Sun River from the south, and it is possible the well did not penetrate the valley filling. In the vicinity of Augusta water is secured from wells at depths varying from 10 to 15 feet, but here the greater part of the domestic water supply is taken directly from Sun River, where, owing to the nearness to Lewis Mountains, it is relatively pure. The prospects for water from deep wells in Sun River valley are very poor, especially in the lower part. Between Manchester and Sims well borings extending through the valley filling will enter the nonwater-bearing Colorado shale, which has a thickness increasing from zero at Manchester to over 800 feet at Sims. Between Sims and Augusta wells sunk below the bottom of the valley filling would enter the lower part of the Montana, which consists of sandstone and shale in alternating succession. The basal sandstone, comprising the Eagle formation, probably contains water, but the shale overlying the sandstone is believed not to be water bearing.

HIGHLANDS NORTH OF SUN RIVER.

Throughout the high plateau region between Sun and Teton rivers the prospects for underground water are not generally favorable. On that portion of the region lying west of Freezeout Lake no wells, so far as could be ascertained, have been bored which would test the water capacity of the extensive gravel terraces capping the highland, but it is evident from the numerous springs along their eastern margin that they contain more or less water. Underneath the gravel of this district occur the Eagle and Claggett sandstones, which are also water bearing, so that it is believed little difficulty would be encountered in securing a good supply of water from wells in this part of the field. On Freezeout Bench, however, a number of shallow wells have been sunk, which, with one exception, do not furnish a satisfactory amount of water. At Zimmerman's ranch a well 30 feet deep supplies only a small amount of alkali water, while 3 miles to the southwest, at Kruck's ranch, a good well of potable water was secured at about the same depth. Freezeout Bench is composed geologically of a thin veneer of gravel lying on the nonwater-bearing Colorado shale, consequently the only water which can be expected from wells on this bench is at the base of this gravel, which has a thickness varying from 25 to 40 feet. The amount of water available at the base of the gravel will probably not be large, although this may vary locally, and in many cases it is apt to be hard, as the gravel carries considerable lime as a cementing material. Wells penetrating the gravel and entering the Colorado shale would probably obtain alkali water, as this shale rarely furnishes good water. North of Freezeout Bench in some of the coulees tributary to Muddy Creek of Sun River there are small springs fed by the gravel terraces, and here and there a successful shallow well.

FORT BENTON BENCH.

East of the Montana and Great Northern Railway, between Great Falls and Collins, is an area of featureless plains comprising several townships and locally known as Fort Benton Bench, in which the prospects for underground water are very poor. Although this area was not examined in detail, it is known that over a great part of the district the surface formation is Colorado shale. The results of the Banatyne boring, 6 miles east of Dutton, demonstrate that the surface formation and the formations underlying to a depth of at least 1,500 feet are not water bearing. Along Teton Valley, which crosses the northern part of the district, shallow wells can probably be obtained from the valley wash, although no detailed examination was made of this portion of the field, and it is believed that shallow wells furnishing a moderate supply of water could be secured in some of the small coulees draining northwestward into Teton River.

TETON RIVER VALLEY.

From the west margin of T. 25 N., R. 6 W., eastward as far as the investigation was carried, and especially to the mouth of Deep Creek, there is a strong underflow in Teton Valley. Wells at Chouteau obtain water at three distinct horizons, the first at 7 feet, the second at 27 feet, and the third at 48 feet beneath the surface. There is no marked dissimilarity in the chemical character of the water found at these depths, and in many respects it resembles the water of Teton River. Springs occur in abundance in Teton Valley above Chouteau.

Deep Creek Valley, a tributary of the Teton from the south, has a strong underflow, and an abundance of water is found at depths of 10 to 20 feet below the surface. At the head of Deep Creek are numerous small swamps and glacial lakes, which add materially to both the surface flow and the underflow of Deep Creek valley. North of Deep Creek there is a wide gravel-capped terrace extending toward the mountains, throughout which water could probably be secured from wells not exceeding 30 feet in depth, the water occurring at the base of the gravel. North of this broad terrace there is a badlands district surrounding Teton Buttes, in which there is a scarcity of water.

BURTON BENCH.

Springs are not abundant in the vicinity of Chouteau outside of Teton River valley, and water for domestic purposes is sometimes difficult to obtain. An exception is found in Burton Bench, an area comprising about four townships, which lies north of Chouteau. Bench gravel, loosely cemented, caps this area, thinning gradually from a depth of 30 feet on the southwest to a mere sprinkling on the northeast. Immediately beneath this cap is impervious shale, causing the gravel to act as a reservoir for surface water. Before irrigation ditches had crossed Burton Bench water was obtained at a depth corresponding to the thickness of the gravel, but the water plane has been gradually rising under the influence of irrigation until now an abundant supply is found at 10 to 12 feet beneath the surface. Outside the gravel-capped area water for stock and domestic purposes is taken directly from the ditches, although it contains a considerable quantity of undesirable mineral matter. The average well has a depth of about

60 feet, but is often too strongly impregnated with alkali to be potable. A limited artesian basin of about 20 square miles occurs in the northeastern part of Burton Bench. It is described in detail in the next section.

MUDDY CREEK ARTESIAN BASIN.[a]

General description.—Within an area extending about 6 miles west from where the terminal moraine of the Keewatin ice sheet crosses Muddy Creek valley in T. 25 N., R. 3 W., and having a width of about 3 miles, artesian water is obtained from coarse granitic gravel, overlain by impervious lacustrine clay, at moderate depths below the surface. The writer examined twenty-two flowing wells in this district, all of which furnish a good quality of water. Others that formerly flowed have become clogged by caving where the well was not cased.

The water resources of this basin have not as yet been utilized to any great extent, partly because much of the area is used only for grazing and partly because water for irrigating purposes is readily available from the ditches crossing Burton Bench. In many cases the water is allowed to flow from the wells and no use is made of it, but in many instances outside of the ditch system it is utilized for irrigation as well as for stock and domestic purposes. Two wells in sec. 6, T. 25 N., R. 3 W., water 30 acres of alfalfa, and a group of wells in sec. 11, T. 25 N., R. 4 W., irrigate 100 acres of hay land. In general the wells are 2½ or 3 inches in diameter, as it was found by experiment that a pipe of that size yielded the same flow as a larger one. The smaller size is the more advantageous, since wells of that diameter may be drilled by hand where the depth does not exceed 75 or 80 feet. The method of drilling used in this vicinity is simple. A 1-inch iron rod twisted at one end into a spiral of the diameter desired is used as an auger. The stiff clay which must be penetrated is sufficiently adhesive to allow the drill to bring up a clean core several feet in length. The wells vary in depth from 16 to 100 feet, the deeper being as a rule along Muddy Creek. The variation in depth of these wells indicates that this stream is following rather closely its preglacial channel. Although practically all the artesian wells are south of Muddy Creek, it is probable that there is likewise a considerable area north of that stream where flowing wells might be obtained if, as seems probable, the preglacial valley extends laterally in that direction as well as south. The eastern limits of the basin are defined by the moraine, and since the head of the artesian flow is in no case great, the largest reported being 35 feet, it is not probable

[a] The description of artesian conditions in the Muddy Creek artesian basin is by W. R. Calvert.

that a flow can be secured much farther west than the wells located in sec. 15, T. 6 N., R. 4 W., where the pressure is very weak.

Source.—Brief mention has already been made (p. 61) of the probable source of the artesian water of Muddy Creek basin. The geologic structure of the region and the small head of the flowing wells preclude the theory of a distant or high source. That the artesian flows of this area are due to local conditions is evident from a study of the field. Some water may be supplied by Muddy Creek in its course through T. 26 N., R. 6 W., where the water sinks to an underflow, leaving the stream bed dry for a distance of several miles during the greater part of the year. Since apparently the entire flow reappears at the surface near Bynum, and the stream has not there cut through the lacustrine clays, it is not probable that Muddy Creek contributes much of the artesian water to Muddy Creek basin. On the contrary, the evidence indicates that the artesian basin is connected more directly with the Teton through Ralston Gap. To the observer looking southwest through Ralston Gap it seems probable that the depression was once a large stream valley, and since river sand and gravel are found there the conclusion is further strengthened. From the base of the mountains until it reaches the southeast corner of T. 25 N., R. 6 W., Teton River is not intrenched, but flows in a wide gravel-filled valley. Considerable water is absorbed by this gravel, and it is believed that there is an underflow from Teton River through Ralston Gap to Muddy Creek valley. Springs in sec. 16, T. 25 N., R. 6 W., vary in their flow with the flow of Teton River, the rise in the river increasing within a short period of time the flow of the springs. This phenomenon has been observed even during the dry season of the year, hence it is difficult to attribute this increase in the flow of the springs to any other source than the increase of Teton River. A small stream north of Teton River at present flows toward Ralston Gap, but as it reaches the vicinity of the gap it sinks to an underflow and probably soon passes beneath the impervious lacustrine clay into the porous granitic gravel and becomes available as artesian water to the east when the overlying impervious clay is penetrated by well borings.

WATER SUPPLY OF TOWNS AND VILLAGES.

There are comparatively few towns in the Great Falls region. Great Falls, the largest, derives its city water supply from Missouri River about 1 mile above the business center. From the pumping station, which is located in the NW. ¼ sec. 14, T. 20 N., R. 3 E., the water is pumped directly to a standpipe, located on a prominent hill in the eastern part of town, which has a capacity of 560,000 gallons. From this point it is distributed by a system of 6-inch mains to the different parts of the city. A field assay of the water taken from one of the hydrants in the main part of the city is as follows:

Analysis of a sample of the Great Falls city water.

[Parts per million.]

Source	Missouri River.
Color	0
Iron	0
Total hardness	125
Alkalinity	180
Alkaline carbonates	32
Alkaline-earth carbonates	160
Chlorides	25

Chouteau, the next town in importance within the district and the county seat of Teton County, depends entirely upon shallow wells for its water supply. Here water is obtained from valley filling at three distinct horizons, which, as previously stated, occur at depths below the surface of 7, 27, and 48 feet, respectively. The largest supply is usually found at a depth of 7 feet below the surface, but wells are generally sunk to the lower horizons in order to obtain water less liable to surface contamination. There is no general town system.

The water supply for the town of Sand Coulee is derived from wells which show considerable variation in depth. In the valley wells are considerably over 100 feet deep. The well owned by Louis Dahn, situated in the valley in the northern part of town, is 168 feet deep. On the slope of the hills bordering the valley water has been secured at depths of 25 to 30 feet, but the supply is variable. In the sides of some of the small coulees in the vicinity of this town there are many water seeps, as previously described, which if properly developed might afford a good domestic water supply.

Considerable difficulty has been encountered in obtaining water for the town of Stockett. In the northern part of the town the people depend for water largely on small springs issuing from the base of sandstone in the sides of the coulee. It has been found by experiment that these small seeps in the hillside, when properly developed, often furnish a good steady flow of potable water. Farther up the coulee, in the main part of town, the Cottonwood Coal Company has sunk a well in the bottom of the main coulee to a depth of 50 feet. From the bottom of this well a tunnel 4 feet wide by 5½ feet high has been dug 90 feet to the east and 125 feet to the west, thus obtaining the greater part of the underflow of the coulee in which Stockett is built. During the driest season of the year the well has furnished 65,000 gallons per day, and the average capacity is over 100,000 gallons a day, most of which is used by the

Cottonwood Coal Company. Wells sunk in the sides of the coulees furnish small quantities of water at varying depths.

The present supply of water for both Sand Coulee and Stockett might be materially increased by the proper improvement of the numerous moist places occurring along the sides of many of the coulees. These moist places or seeps are generally indicated by the deeper green color of the vegetation. In many such localities if shallow excavations were made, water in considerable quantity would probably be obtained, which could easily be piped to houses situated in the valley, thus affording an excellent domestic water supply. The practicability of such a source of water has been demonstrated at a few places in the vicinity of Stockett and at many places along Otter Creek, where springs occur under similar conditions. It is believed also that on many of the small farms in the vicinity of Stockett and Sand Coulee a careful examination of the sides of the coulee might result in the location of moist or seepy places where by inexpensive development water could be procured.

CHEMICAL CHARACTER OF WATER.

During the course of the investigation of the water resources of the Great Falls region samples of water were collected from representative wells and springs for the purpose of analysis. These analyses or assays were made in the field in accordance with the method employed by the water resources branch of the United States Geological Survey. This method is fully described in Water-Supply Paper No. 151. Knowledge was also desired concerning the variation, if any existed, in the quality of waters from the several formations represented in the district. Although a complete analysis of the samples was not possible by the methods employed, the chief characteristics and chemical constituents were determined. These include physical properties, color and turbidity, and those depending more directly upon chemical quality, namely, the amount of iron, calcium, alkaline and alkaline-earth carbonates, sulphates, and chlorides present, and the hardness.

The waters throughout the district are remarkably free from turbidity, only one sample possessing more than a trace. In only a few instances was the presence of coloring matter noted, and iron is a rare constituent in the waters examined.

In the region east of Missouri River the great majority of springs issue from the sandstone or sandy shale of the Kootenai formation. In general the calcium and sulphate content of waters from this formation is high owing to the presence of gypsum in the shale. Near the southern border of the eastern portion of the district examined many springs issue from the Quadrant shale, and these are impregnated to a considerable extent with salts of magnesium and many are charged with hydrogen sulphide, which renders them unpleasant for drinking. In the district where the surface formation is Colorado shale wells and surface springs are likewise apt to contain considerable magnesium and the alkalinity is high.

In the area west of the Missouri and south of Sun River, with the exception of Ulm Bench, water is relatively scarce and is obtained chiefly from the sandy members of the Montana. As above stated, the water of this district, especially in the Colorado shale area, is characterized by an abundance of magnesium salts, and the alkalinity is often so great as to render it unfit to drink. Several samples of wells and springs from this area also indicate the presence of a large amount of chlorides. In Sun River valley water is usually obtained from alluvium and is not so highly mineralized as that in the area to the south. To the north between Sun and Teton rivers but few samples were taken. There are few wells in this region and springs are not abundant. The samples analyzed, however, indicate that the various members of the Montana group afford water containing more or less mineral matter. In the valley of the Teton, where water is obtained from alluvium, the mineral content, while not especially high, is considerable. On Burton Bench the chief water supply is from the gravel capping consisting principally of limestone pebbles. This gravel contains a large amount of soluble salts. The chlorine content is especially high. In spite of the mineralization, however, it is of better quality than that from wells or springs in the region to the east, where the gravel capping is absent and Colorado shale occupies the surface. From the artesian basin in Muddy Creek valley two samples of water were analyzed. These samples show considerable variation. No. 1, from the eastern portion of the basin, is not so highly mineralized as No. 2, obtained farther west, the difference being chiefly in the calcium and sulphate content. The following table shows the results of the analyses of waters from the various parts of the area investigated. The results are expressed in parts per million.

Analyses of waters from Great Falls region, Montana.

[Parts per million.]

No.	County.	Locality.	Township, etc.	Owner.	Source.	Quantity.[a]	Temperature.	Turbidity.	Color.	Iron.	Calcium.	Total hardness as $CaCO_3$.	Total alkalinity as $CaCO_3$.	Alkaline carbonates as Na_2CO_3.	Alkaline-earth carbonates as $CaCO_3$.	Sulphate radicle (SO_4).	Chlorine.
							°F.										
1	Teton	Chouteau	NW. ¼ NE. ¼ sec. 6, T. 25 N., R. 3 W.	P. Eyraud	Artesian well.	Large	51	0	0	0	Mod.	69	249	0	249	181	19
2	do	do	SE. ¼ sec. 15, T. 26 N., R. 4 W.	J. Schmidt	do	Medium		0	0	0	High	55	279	0	279	600+	5
3	do	do	SW. ¼ sec. 5, T. 24 N., R. 4 W.	W. W. Gamble	Well			0	0	0	Mod.	55	458	0	458	459	114
4	do	do			Teton River			0	0	0	High	111	219	0	219	181	5
5	do	do	SW. ¼ SE. ¼ sec. 25, T. 25 N., R. 5 W.	—— Hodgskiss	Well			0	0	0	Mod.	111	199	0	199	159	10
6	do	do	SW. ¼ SE. ¼ sec. 25, T. 24 N., R. 5 W.	do	do			0	0	0	Mod.	222	319	0	319	125	10
7	do	do	SW. ¼ sec. 19, T. 24 N., R. 4 W.	C. E. Moore	do			0	0	0	High	83	438	0	438	431	27
8	do	do	SW. ¼ sec 1, T. 24 N., R. 4 W.	H. R. Thompson	Spring	Small	50	0	0	0	High	55	359	0	359	573	79
9	do	do	SE. ¼ sec. 20, T. 23 N., R. 4 W.	P. Crossen	do	Medium	52	0	0	0	Mod.	111	598	0	598	150	15
10	do	Hepler	SE. ¼ SE. ¼ sec. 35, T. 22 N., R. 3 W.	F. C. Krucks	Well			0	0	0	Mod.	75	319	0	319	327	39
11	Cascade	Augusta	NE. ¼ sec. 2, T. 21 N., R. 5 W.	—— Flowerree	Spring			0	0	0	Mod.	83	279	42	239	191	19
12	do	do	Sec. 1, T. 21 N., R. 4 W.	do	do			0	226	0	Tr.	41	279	0	279	270	14
13	do	Hepler	NW. ¼ sec. 4, T. 20 N., R. 3 W.	Flowerree's ranch	Well			0	0	0	0	41	399	84	319	153	199
14	do	do	SE. ¼ sec. 4, T. 20 N., R. 3 W.		Sun River			0	0	0	Mod.	69	319	0	319	255	10
15	do	do	NE. ¼ sec. 4, T. 20 N., R. 3 W.	—— Flowerree	Spring	Large		0	0	0	Mod.		279	0	279	222	19
16	do	do	NW. ¼ sec. 35, T. 20 N., R. 3 W.	Carl Meickel	do	do	48	0	0	0	Low	69	279	0	279	300	59
17	do	Sun River	SE. ¼ sec. 34, T. 21 N., R 2 W.	On Government land	do	do	50	0	0	0	Mod.	83	199	0	199	156	10
18	do	do	NE. ¼ sec. 13, T. 19 N., R. 2 W.	Toman Bros.	Well			0	160	40	Mod.	111	319	0	319	600+	239
19	do	do	SE. ¼ sec. 4, T. 20 N., R. 2 W.		Spring	Large	52	0	0	0	Mod.	111	199	0	199	116	7
20	do	do	NE. ¼ sec. 22, T. 19 N., R. 1 W.	D. Rease	Well			24	0	10	High	69	399	0	399	600+	109
21	do	do	NE. ¼ sec. 34, T. 21 N., R. 1 W.	M. T. Strong	do			0	0	0	High	139	199	0	199	276	7
22	do	do	NW. ¼ sec. 36, T. 21 N., R. 1 W.	J. C. Adams	do			0	0	0	0	7	199	84	79	150	19
23	do	Great Falls	NE. ¼ sec. 7, T. 20 N., R. 3 E.	K. B. McIver	Spring			0	0	0	High	90	259	0	259	237	14
24	do	do	SW. ¼ NE. ¼ sec. 33, T. 21 N., R. 4 E.		Giant Springs.	638 s.-ft.		0	0	0	Mod.	97	339	0	339	300	10
25	do	do			Missouri River			0	0	0		125	179	31	159	153	24
26	do	do	NE. ¼ sec. 26, T. 20 N., R. 4 E.	Great Falls Meat Co.	Well			0	0	0	High					421	13

[a] Springs with a flow sufficiently large to fill a 2-inch pipe are regarded as large, those between three-fourths inch and 2 inches as medium, and those less than three-fourths inch as small.

Analyses of waters from Great Falls region, Montana—Continued.

No.	County.	Locality.	Township, etc.	Owner.	Source.	Quantity.	Temperature.	Turbidity.	Color.	Iron.	Calcium.	Total hardness as $CaCO_3$.	Total alkalinity as $CaCO_3$.	Alkaline carbonates as Na_2CO_3.	Alkaline-earth carbonates as $CaCO_3$.	Sulphate radicle (SO_4).	Chlorine.
							°F.										
27	Cascade	Sand Coulee	Sec. 13, T. 19 N., R. 4 E.	Louis Dahn	Well			0	0	0	Mod.	83	199	84	119	362	29
28	do	Stockett	NW. ¼ sec. 15, T. 18 N., R. 4 E.	Ed. Connelly	Spring			0	0	0	Tr.	75	279	0	279	207	19
29	do	do	SE. ¼ sec. 14, T. 18 N., R. 4 E.	Davale Culberson	do			0	0	0	High	122	279	0	279	207	19
30	Teton	do	NE. ¼ sec. 17, T. 18 N., R. 4 E.	C. Jaeckel	Well			0	0	0	Mod.	111	239	0	239	164	19
31	do	Great Falls	Sec. 11, T. 19 N., R. 5 E.	—— Johnston	Spring			0	0	0	Mod.	86	222	0	222	35	19
32	do	do	SW. ¼ sec. 12, T. 19 N., R. 5 E.	D. Johnston	do			0	0	0	Mod.	48	243	0	243	65	20
33	do	do	SE. ¼ NE. ¼ sec. 12, T 19 N., R. 5 E.	Ray & Friedrick Sheep Co.	Well			0	0	0	Tr.	48	364	429	324	28	19
34	do	Stockett	NE. ¼ sec. 31, T. 18 N., R 5 E.	J. Miltsch	do			0	0	0	Mod.	122	279	0	279	150	39
35	do	Belt	NE. ¼ sec. 16, T 17 N., R. 6 E.	P. Johnson	Spring		45	0	0	0	Mod.	41	199	0	199	327	10
36	do	do	NE. ¼ sec. 15, T. 18 N., R. 6 E.	J. R. Bowen	Well			0	0	0	High	97	239	0	239	201	14
37	do	do	SE. ¼ sec. 22, T. 19 N., R. 6 E.	Chas. Lindsey	do			0	19	0	Mod.	115	283		283	35	19
38	do	do	Sec. 21, T. 19 N., R. 6 E.	do	do			Tr.	0	Tr.	Mod.	77	283	42	243	35	14
39	do	do	SW. ¼ SW. ¼ sec. 14, T. 19 N., R. 6 E.	F. Polutnik	do			0	0	0	Mod.	48	220	0	220	202	10
40	do	do	NE. ¼ sec. 15, T. 19 N., R. 6 E.	A. H. McMillan	do			0	0	0	Mod.	77	283	0	283	Tr	14
41	do	do	Sec. 15, T. 19 N., R. 6 E.	Edgar Mann	do			0	24	0	Mod.	48	314	0	314	84	99
42	do	do	do	do	do			0	4	0	Mod.	48	202	0	202	38	159
43	do	do	Sec. 8, T. 19 N., R. 6 E.	G. Erickson	Spring			0	0	0	Mod.	48	405	0	405	62	149
44	do	do	Sec. 5, T. 19 N., R. 6 E.	W. H. Porter	do			0	0	0	Mod.	57	405	0	405	73	29
45	do	do	NW. ¼ sec. 5, T. 19 N., R. 6 E.	do	Well			0	0	0	Low	57	243	0	243	29	10
46	do	do	NW. ¼ sec. 3. T. 19 N., R. 6 E.	Joe Bogner	Spring			0	0	0	Mod.	57	324	0	324	38	16
47	do	do	SE. ¼ NE. ¼ sec. 35, T. 20 N. R 6 E.	P. P. Buchanon	do			0	47	1	High	67	141	0	141	222	29
48	do	do	SW. ¼ sec. 26, T. 20 N., R. 6 E.	J. B. Long	Well			0	0	0	Tr.	83	279	0	279	112	17
49	do	do	Sec. 33, T. 20 N., R. 7 E.	—— Gilette	do			0	47	0	Mod.	48	324	0	324	600+	19
50	do	Cora	SW. ¼ SE. ¼ sec. 3, T. 18 N., R. 7 E.	F. Armstrong	do			0	52	0	Mod.	57	191	0	191	160	19
51	do	Belt	SW. ¼ sec. 8, T 18 N., R. 7 E.	T. D. Joscelyn	Spring			0	0	0	Mod.	57	202	42	162	80	12
52	do	do	NW. ¼ sec. 10, T. 18 N., R. 7 E.	G. W. Blake	do			0	0	0	Low	48	445	21	425	38	14
53	do	do	NW. ¼ sec. 18, T. 18 N., R. 7 E.	Chas. Ashwert	do			0	47	0	Mod.	38	121	0	121	256	10
54	do	do	NW. ¼ sec. 21, T. 18 N., R. 7 E.	T. Armstrong	do			0	19	0	Mod.	57	220			54	10
55	do	do	SE. ¼ SE. ¼ sec. 30, T. 18 N., R. 7 E.	F. J. Ober	do	Medium.		Tr.	0	0	Mod.	67	222	0	222	94	10 10
56	do	do	SE. ¼ sec. 25, T. 17 N., R. 7 E.	Bundy & Henderliden	do	Large		0	0	0	Mod.	48	245	0	245	312	
57	do	do	NE. ¼ sec. 4, T. 16 N., R. 8 E.	J. Laboie	Well			0	0	0	Mod.	28	243	0	243	324	10

58	do	do	NE. ¼ sec. 19, T. 17 N., R. 8 E.	Bundy & Henderliden	Spring	Small		0	0	0	Tr.	28	405	0	40	Tr.	5
59	do	Geyser	NE. ¼ sec. 3, T. 17 N., R. 8 E.	—— Larson	do			0	0	0	High	57	283	0	283	384	10
60	do		NW. ¼ SE. ¼ sec. 28, T. 18 N., R. 8 E.	R. Williamson	Well			0	0	0	Mod.	67	139	0	139	96	14
61	do	Belt	NE. ¼ sec. 22, T. 18 N., R. 8 E.	A. A. Dawson	Spring			0	0	0	0	28	40	0	40	0	10
62	do	do	SW. ¼ NW. ¼ sec. 20, T. 18 N., R. 8 E.	J. W. Watkins	Well			0	0	0	Mod.	28	330	0	330	403	14
63	do	do	SW. ¼ sec. 6, T. 18 N., R. 8 E.		do			Tr.	24	0	Low	38	364	....	....	102	10
64	do	Geyser	SW. ¼ sec. 3, T. 18 N., R. 8 E.	C. W. McClay	Spring			0	0	....	High	77	40	0	40	492	10
65	do	do	SE. ¼ SE. ¼ sec. 9, T. 18 N., R. 9 E.	C. J. Ellis	do			0	0	0	High	111	162	0	162	64	10
66	do	do	NE. ¼ sec. 19, T. 17 N., R. 9 E.	G. L. Lee	do			0	0	0	Mod.	83	202	0	202	73	7
67	do	do	NE. ¼ sec. 12, T. 18 N., R. 9 E.	S. C. Philbrick	do			0	0	0	Mod.	83	303	0	303	256	7
68	do	do	SW. ¼ sec. 20, T. 18 N., R. 9 E.	D. Rankin	Well			0	0	....	High	67	202	0	202	600+	10
69	do	do	SE. ¼ sec. 4, T. 16 N., R. 10 E.	T. Shannon	Spring		46	0	0	0	High	83	202	0	202	384	7
70	do	do	SE. ¼ sec. 19, T. 16 N., R. 10 E.	Pat. O'Hara	do	Large	45	0	0	0	Mod.	111	202	0	202	Tr.	5
71	do	do	SW. ¼ sec. 20, T. 16 N., R. 10 E.	J. H. Skelton	do	do	41	0	0	0	Mod.	83	81	0	81	136	5
72	do	Stanford	NW. ¼ SW. ¼ sec. 13, T. 16 N., R. 10 E.	First National Bank	do	Medium		0	0	0	Mod.	134	364	0	364	.....	5
73	do	do	NE. ¼ NE. ¼ sec. 25, T. 16 N., R. 10 E.	do	do	Small	45	0	0	0	High	27	324	0	324	574	7
74	do	do	SW. ¼ sec. 34, T. 16 N., R. 10 E.	—— Burgess	do	do		0	0	0	Mod.	69	121	0	121	132	5
75	do	do	SE. ¼ NE. ¼ sec. 2, T. 15 N., R. 10 E.	—— Butterfield	do	do		0	43	0	Mod.	69	121	0	121	174	5
76	Fergus	do	NE. ¼ sec. 11, T. 17 N., R. 11 E.	Bower Bros	do	do		0	0	0	High	97	263	263	.....	362	10
77	do	do	SE. ¼ NE. ¼ sec. 33, T. 17 N., R. 11 E.	do	Well			0	0	0	Mod.	38	324	0	324	600+	17
78	do	do	NE. ¼ sec. 24, T. 16 N., R. 11 E.	W. Skelton	Spring			0	0	0	High	83	223	0	223	238	10
79	do	do	SW ¼ sec. 10, T. 15 N., R. 11 E.	Bower Bros	do			0	0	0	Mod.	139	219	10	209	154	5
80	do	do	SE. ¼ sec. 4, T. 15 N., R. 12 E.	B. E. Stacks	Well			0	0	0	High	83	259	0	259	313	7
81	do	do	NW. ¼ NW. ¼ sec. 23, T. 15 N., R. 12 E.	Sage Creek Sheep Co.	do			0	0	0	Mod.	111	159	0	159	313	10

WATER POWER.

DESCRIPTION OF FALLS.

The water power of the Great Falls region is undoubtedly one of its most valuable assets, although at present it is practically undeveloped. Between the Great Northern Railway bridge at Great Falls and the mouth of Belt Creek, a distance of approximately 10 miles, Missouri River has a total fall of 612 feet. Of this amount the greater part occurs at five different places, Black Eagle, Coulters, Rainbow, Crooked, and Big falls, which are collectively known as the Great Falls of Missouri River. (See Pl. III, *A*, *B*, and Pl. IV, *A*, *B*.) The remainder of the fall which takes place between the above-mentioned points is in the form of rapids occurring at varying intervals between the cataracts. Conflicting reports are current regarding the exact height of the different falls. According to the first measurements, which were made by Lewis and Clark in 1804, Black Eagle Falls have a drop of 20 feet, Coulters 14 feet 7 inches, Rainbow 47 feet 8 inches, Crooked 19 feet, and Big Falls 87 feet $\frac{3}{4}$ inch. In M. S. Parker's description of the falls, published in 1894, the following measurements are given, which are somewhat at variance with those above quoted, although in a previous article by Parker, published in 1892, favorable comment is made on the accuracy of the Lewis and Clark measurement. Parker ascribes to Black Eagle Falls a drop of 20 feet, to Coulters 14 feet, to Rainbow 37 feet, to Crooked 19 feet, and to Big Falls 75 feet 4 inches. No careful measurements of these falls were made by the author while in the field, but according to the best information which can be obtained from local engineers familiar with the region the height of Black Eagle Falls, the first of the series, located at the Boston and Montana smelters, is 41 feet, including the masonry dam, which has been built on their crest. Coulters Falls, which are about 1 mile farther downstream and just above the Great Northern Railway bridge, have a drop of 14 feet. A short distance below the railroad bridge and about one-eighth of a mile from Coulters Falls, are Rainbow Falls, which have a drop of 37 feet. Crooked Falls, so named from their irregular shape, which occur about one-fourth of a mile farther downstream, drop 20 feet, and 4 miles still farther down the Missouri the water at Big Falls plunges over a precipice 75 feet high. Views of Black Eagle, Rainbow, Crooked, and Big falls are shown in Pls. III, *A*, *B*, and IV, *A*, *B*, respectively.

UTILIZATION.

At present power from only Black Eagle Falls has been developed. The Boston and Montana Smelter Company have constructed a large masonry dam which develops sufficient power, supplemented by an auxiliary steam plant, to supply the large smelters owned by that company on the north side of Missouri River at this place. The amount of horsepower developed at Black Eagle Falls varies from 6,000 to 12,000, depending on the season. In addition to the large power plant located on the north side of the river there is also a smaller power plant on the south side, which is used as an electric station for power for street railways, electric-light plant, Royal Milling Company's flour mills, and a number of smaller factories.

UNDEVELOPED POWER.

Coulters, Rainbow, Crooked, and Big falls are wholly undeveloped, although they are apparently more favorably situated for power development than Black Eagle Falls. The following table shows the available horsepower of the different falls:

Available horsepower of the Great Falls of Missouri River.

Name.	Height.	Discharge.	Horsepower.
	Feet.	*Second-feet.*	
Black Eagle Falls	41	1,800	6,545
Coulters Falls	14	2,400	3,272
Rainbow Falls	37	2,400	8,072
Crooked Falls	20	2,400	4,333
Big Falls	75	2,400	16,363
			38,585

The above statements are based on a minimum flow of Missouri River above Black Eagle Falls of 1,800 second-feet, as shown by Government discharge measurements extending over a period of four years, from 1902 to 1905, inclusive. These measurements were taken at Cascade, where the Geological Survey has maintained a gaging station for a number of years. To the measurements of this gaging station is added an average minimum flow of Sun River, which empties into the Missouri a short distance above Great Falls and between Cascade and Black Eagle Falls. Below Black Eagle Falls Giant Springs add to the flow of the river approximately 600 cubic feet per second, which apparently does not vary at different seasons of the year. Taking this amount into consideration Coulters, Rainbow, Crooked, and Big falls would have a minimum flow of about 2,400 second-feet. This amount has been used for calculating the available horsepower at these cataracts. Of course it should be borne in mind that by the proper development of any one of these falls the amount of available horsepower could be materially increased. It is possible also that by constructing suitable dams the fall of the numerous small rapids which occur between the cataracts could be made to furnish considerable power, but as such questions depend entirely on the nature and extent of the development, no estimate as to the total horsepower which could be developed under ideal conditions of improvement in the vicinity of Great Falls is here given.

IRRIGATION.

GENERAL STATEMENTS.

Irrigation has been practiced along the valleys of the larger streams in the Great Falls region for many years, but its growth and development have been necessarily slow until recently. Prior to the building of railroad lines into the district, which was in 1886, and for some time afterwards, the inhabitants of the region were principally engaged in cattle raising and mining, and only small tracts were irrigated here and there along the valleys. With the growth in population and the increased demand for agricultural produce, irrigation began to be more generally practiced along the larger streams, resulting eventually in the construction of several large canals by private individuals or small companies organized among the ranchmen. Extensive preparations are now being made, both by the Government and by private enterprises, to reclaim larger tracts of land along Sun and Teton rivers and the highland lying between these two streams. (See Pl. VII.)

SUN RIVER VALLEY.

Sun River valley is one of the most extensively irrigated valleys in the Great Falls region. There are a large number of small ditches covering the lower lands along each side of the river from the vicinity of Great Falls to the base of the Lewis Mountains. In addition to these several large canals have been constructed by individual ranchmen and small companies organized among the farmers. The largest of these is the Flowerree Trustee ditch, which is taken out of North Fork of Sun River near the center of sec. 20, T. 21 N., R. 6 W., and extends for about 25 miles eastward, covering a large territory of table-land bordering Sun River on the north. Another and somewhat smaller ditch occurs on the same side of Sun River farther downstream, known as the Sun River canal. Its headgate is located near the east end of old Fort Shaw Reservation, and it furnishes water to an area nearly a mile in width, extending east as far as Muddy Creek of Sun River. One of the largest canals on the south side of Sun River is the Crown Butte canal, constructed by individual enterprise, which leaves the river in the southeast corner of sec. 6, T. 20 N., R. 4 W., and extending eastward crosses Sims Creek in a big loop, and passing through a low divide north of Crown Butte empties into the head of Little Muddy Creek valley. A number of smaller ditches are found along the south side of the river, including, from east to west, Campbell, Eder, and Richling Company, Bickel Burk, Butler, Clemens, Phyllip, Mayer, and others farther up South Fork of Sun River. The Government irrigation project along the south side of Sun River, known as the Fort Shaw canal, covers about 16,000 acres in the vicinity of the Fort Shaw Reservation. The larger features of irrigation along Sun River valley are shown on the map (Pl. VII).

TETON RIVER VALLEY.

Irrigation is not extensively practiced along the valley of Teton River in the vicinity of Chouteau. A few small farms are irrigated around Chouteau and near the head of Spring Creek, but, with these exceptions, irrigation is confined to Burton Bench, where a number of large canals have been constructed. Burton Bench, which is one of the largest, if not the largest, irrigation district in the area described, is supplied with water by three large canals, the Burton, Cooperative, and Eldorado canals. These canals are all taken from the Teton River 10 miles above Chouteau. Their approximate location and the land irrigated by them is shown on Pl. VII.

The Cascade Land Company's ditch, which is taken out of Deep Creek on the south side about 3 miles above its mouth, extends around the east side of Priest Buttes, crosses by siphon flume the north end of Freezeout Basin, and continues to the Cascade Land Company's home ranch, where it furnishes water for several hundred acres of land situated in the southwestern part of T. 23 N., R. 3 W. A short distance below the headgates of the Cascade Land Company's ditch there is another ditch which is owned by the S. T. Cattle Company. It extends down the river about 6 miles, where it supplies water for over a thousand acres of land in T. 24 N., Rs. 3 and 4 W. The location of the above-described ditches and the approximate limits of the land to which they supply water are shown on Pl. VII.

OTHER VALLEYS.

Along the east side of Missouri River in the vicinity of Cascade, irrigation has been practiced for many years. No large canals have been constructed in this region, but a number of small ditches carry water some distance out from the river to scattered ranches along the valley. In Smith River valley are a number of irrigated ranches, but only a relatively small portion of the valley land is now cultivated. Hound Creek, one of its principal tributaries from the west, has a few small irrigated ranches along its course. Considerable irrigation is carried on all along Belt and Otter Creek valleys. No large canals have been built along these streams, owing mainly to the fact that the valleys are narrow and the amount of irrigable land small. Short ditches which occur at frequent intervals supply water to small fields. Throughout the eastern portion of the district the streams carry only a small flow of water, all of which has been appropriated for irrigation purposes. In some cases private reservoirs have been constructed to increase the available supply by storing flood waters.

AGRICULTURE.

Throughout the lower Plains portion of the Great Falls region the aridity of the climate renders tillage without irrigation impracticable, but in the plateau region bordering Little Belt and Highwood mountains dry farming is extensively practiced far up the slopes of these ranges. The cultivated portions of the area examined comprise a relatively small part of the entire district, the remainder being utilized for pasturage of cattle—an important industry of the region, to which the upland areas are well adapted. Among the chief agricultural products are wheat, oats, barley, rye, spelt, flax, alfalfa, tame hay, potatoes, and a variety of garden vegetables, most of which are consumed by workers in the mines and smelters surrounding Great Falls. The main crop is wheat, which has a yield varying from 20 to 40 bushels per acre. Both winter and spring wheat is raised, but the preference seems to be for winter wheat at present. Oats have a large yield, ranging from 35 to 45 bushels per acre, and the yield of potatoes and other vegetables is unusually large.

Cascade County, Mont., is one of the most important grain centers in the State. Fruit raising is a growing industry, and many young, well-kept orchards are to be found throughout the district; currants, gooseberries, and strawberries are among the important fruits. The seasons are ordinarily of sufficient length to insure the maturity of all cultivated crops, except on the higher slopes bordering the inclosing mountain ranges, where the time between killing frosts is short.

The distribution and extent of the land irrigated, also the area in which dry farming is practiced, are shown on Pl. VII.

CLIMATE.

TEMPERATURE.

General statements.—The temperature records of this general region present a very wide range between extremes—a feature which is apt to cause an erroneous impression. Though the annual range is probably as large as in any other part of the United States, the periods of low temperature are of short duration and are generally attended by dry, calm atmosphere. Under these conditions the low winter temperatures are not so severe on life in general as much higher temperatures would be under less favorable conditions. Owing to this fact stock can successfully winter on the range without shelter. The summer temperatures, although high, are not so oppressive as an equivalent temperature would be in more humid atmosphere in low altitudes. The summer days are long and often very hot, but as evening approaches the air cools rapidly by radiation, and the nights are cool and comfortable.

Great Falls region.—Very few meteorological data are available regarding the mountainous districts surrounding the Great Falls region, but there are a number of places lower down on the plains where systematic observations have been carried on for a number of years. The first meteorological station was established at Chouteau in 1890, and in December of the following year a similar station was placed at Great Falls. The observations begun at Chouteau were continued for only one year, but the station was reestablished at this place in January, 1905. Climate data began to be collected in a systematic way at Sun River in March, 1895, and a station was established at Augusta in July, 1896. Records of the temperature have been collected at Cascade, Mont., since May, 1894, but observations during the first two months are not quoted below. At Great Falls, where the most systematic information has been procured, and where the results are in a measure representative of the district, the mean monthly temperatures from 1893 to 1903, inclusive, are as follows:

Mean monthly temperatures for ten years at Great Falls, Mont.

	°F.		°F.
January	26	July	68
February	26	August	67
March	32	September	56
April	45	October	49
May	55	November	33
June	62	December	30

Throughout the above-described period the mean of the maximum temperatures at Great Falls varied from 36° in January to 83° in July. The absolute maximum temperatures range from 60° in December to 106° in August, the mean of the minimum from —14° in January to 54° in July, and the absolute minimum from —38° in January to 35° in July.

Although the climatic observations made at Great Falls may be regarded as in a measure representative of the district, yet for the purpose of comparing the variations between stations located near the base of the mountains and those farther out on the plains, the following comparative table is introduced. The highest temperature ever recorded at the Great Falls station is 106°, which occurred in August, 1892. The minimum temperature recorded was —38° in January, 1893. The average date of the first killing frost in autumn is in the latter part of September, while the average date of the last killing frost in spring is about the first of May. The direction of the prevailing wind is southwest, except in June, when it is west.

Comparative temperatures (°F.) at Augusta, Great Falls, Cascade, and Chouteau for five years (1902–1906, inclusive).

	Maximum.					Minimum.					Mean.				
	1902.	1903.	1904.	1905.	1906.	1902.	1903.	1904.	1905.	1906.	1902.	1903.	1904.	1905.	1906.
January:															
Augusta	58	63	54	55	60	−30	−14	−10	−28	−26	23.9	31.0	27.4	18.2	28.2
Great Falls	60	56	52	47	53	−23	− 2	− 7	−21	−24	27.6	31.8	29.4	18.2	29.2
Cascade	.....	.....	.....	56	.....	.....	.....	.....	−21	−28	.....	.....	.....	19.4	.....
Chouteau	.....	.....	.....	.....	61	.....	.....	.....	.....	−21	.....	.....	.....	.....	28.5
February:															
Augusta	58	55	54	65	63	−19	−21	−20	−43	−14	26.6	24.0	15.8	18.6	29.2
Great Falls	60	55	52	62	55	−16	−18	−16	−30	−10	27.5	25.9	15.1	20.2	30.1
Cascade	.....	.....	.....	63	60	.....	.....	.....	−38	− 9	.....	.....	.....	22.3	33.0
Chouteau	.....	.....	.....	64	63	.....	.....	.....	−34	−10	.....	.....	.....	19.9	30.0
March:															
Augusta	55	62	58	70	70	−16	−13	−21	− 7	−35	29.2	25.7	22.8	37.0	23.2
Great Falls	56	63	45	71	68	− 6	− 7	−13	9	−24	35.0	27.2	16.6	40.8	26.2
Cascade	.....	.....	.....	75	72	.....	.....	.....	1	−31	.....	.....	.....	42.0	27.2
Chouteau	.....	.....	.....	69	71	.....	.....	.....	6	−28	.....	.....	.....	37.8	24.3
April:															
Augusta	66	72	79	73	86	15	10	16	4	14	39.8	39.5	44.8	41.2	45.6
Great Falls	68	72	72	74	82	20	20	20	19	25	43.7	43.8	48.2	44.6	49.0
Cascade	.....	.....	.....	76	86	.....	.....	.....	14	20	.....	.....	.....	45.5	50.8
Chouteau	.....	.....	.....	72	85	.....	.....	.....	11	22	.....	.....	.....	41.6	47.4
May:															
Augusta	86	84	77	78	85	25	24	20	26	19	50.8	47.2	49.5	46.6	46.6
Great Falls	86	89	82	78	87	30	27	30	31	30	56.2	51.0	54.2	50.6	50.1
Cascade	.....	.....	.....	82	88	.....	.....	.....	28	28	.....	.....	.....	51.3	51.0
Chouteau	.....	.....	.....	81	90	.....	.....	.....	25	22	.....	.....	.....	47.2	48.6
June:															
Augusta	83	86	90	83	82	27	32	32	30	30	53.2	60.0	56.4	53.8	53.0
Great Falls	86	87	94	88	80	34	40	41	35	40	57.4	65.0	62.0	58.0	57.7
Cascade	.....	.....	.....	88	85	.....	.....	.....	33	37	.....	.....	.....	58.4	59.4
Chouteau	.....	.....	.....	84	80	.....	.....	.....	31	35	.....	.....	.....	55.6	55.4
July:															
Augusta	87	93	.....	91	88	36	34	.....	31	38	59.9	60.0	.....	67	63.4
Great Falls	92	92	97	93	92	42	42	48	48	45	65.4	65.6	69.5	68.4	69.8
Cascade	.....	.....	99	95	98	.....	.....	41	44	48	.....	.....	68.6	68.5	71.4
Chouteau	.....	.....	.....	98	94	.....	.....	.....	34	38	.....	.....	.....	65.3	66.4
August:															
Augusta	86	92	91	89	93	35	32	31	31	31	61.1	60.3	60.8	62.9	60.2
Great Falls	89	94	86	93	96	43	42	17	42	44	67.0	65.5	53.6	70.2	65.4
Cascade	.....	.....	100	96	94	.....	.....	35	40	38	.....	.....	67.4	70.2	63.4
Chouteau	.....	.....	.....	95	97	.....	.....	.....	35	39	.....	.....	.....	65.6	62.5
September:															
Augusta	83	80	88	85	.....	23	20	19	27	.....	49.9	50.6	55.6	55.1	.....
Great Falls	83	80	90	86	.....	28	30	30	32	.....	56.7	56.1	57.8	59.6	.....
Cascade	.....	.....	95	.....	.....	.....	.....	26	.....	.....	.....	.....	60.4	.....	.....
Chouteau	.....	.....	.....	87	.....	.....	.....	.....	27	.....	.....	.....	.....	57.2	.....
October:															
Augusta	80	80	81	78	.....	19	20	11	− 2	.....	45.8	48.8	47.8	40.6	.....
Great Falls	77	78	80	77	.....	22	25	28	2	.....	48 8	51.8	50.6	41.0	.....
Cascade	.....	.....	86	85	.....	.....	.....	22	3	.....	.....	.....	48.4	45.0	.....
Chouteau	.....	.....	.....	78	.....	.....	.....	.....	− 4	.....	.....	.....	.....	40.6	.....
November:															
Augusta	54	72	74	74	.....	− 2	−39	10	−28	.....	28.9	27.0	43.0	35	.....
Great Falls	58	70	65	64	.....	6	−25	17	−18	.....	32.6	31.6	45.8	36.7	.....
Cascade	.....	.....	66	69	.....	.....	.....	13	−21	.....	.....	.....	47.6	.....	.....
Chouteau	.....	.....	.....	75	.....	.....	.....	.....	−24	.....	.....	.....	.....	37.1	.....
December:															
Augusta	52	61	60	56	.....	−17	−14	−26	−10	.....	24.2	33.0	29.7	32	.....
Great Falls	52	56	54	51	.....	−10	−12	−20	−16	.....	23.6	33.8	31.4	31.4	.....
Cascade	.....	.....	67	.....	.....	.....	.....	−24	.....	.....	.....	.....	33.3	.....	.....
Chouteau	.....	.....	.....	58	.....	.....	.....	.....	− 9	.....	.....	.....	.....	33.0	.....

RAINFALL.

There is only a moderate amount of rainfall throughout the Great Falls region, especially in that portion bordering the adjacent mountain ranges. On the lower lands farther out on the plains more arid conditions prevail. A characteristic of the annual precipitation in this region, as in other parts of Montana, is that a large percentage falls during the growing season. The amount of rainfall received during the four summer months nearly equals that for the remainder of the year—a feature peculiarly favorable for agriculture. The mean monthly precipitation at Great Falls for a period of ten years, 1893 to 1903, inclusive, is as follows:

Mean monthly precipitation at Great Falls, Mont.

January	0.6	July	1.6
February	.5	August	.6
March	.7	September	1.1
April	1.2	October	.4
May	2.6	November	.8
June	2.8	December	.5

During the period of ten years above described the total rainfall for the driest year was 6.7 inches, while the total for the wettest year was 17.3 inches. The average depth of snow for this period is 39.6 inches, and the heaviest snowfall in twenty-four hours is 9.3 inches.[a]

In order to show the relative precipitation of the regions adjacent to the mountains and those farther out on the plains, the following comparative table is introduced:

Relative precipitation at Augusta, Great Falls, Cascade, and Chouteau for five years (1902–1906, inclusive).

	Rain and snow (melted).					Snow.				
	1902.	1903.	1904.	1905.	1906.	1902.	1903.	1904.	1905.	1903.
January:										
Augusta	0.14	0.19	0.21	0.40	0.51	3.3	1.5	2.5	4.0	5.0
Great Falls	.16	.08	.17	.32	.32	1.6	.7	1.7		
Cascade				.23	.20				4.5	7.1
Chouteau					.12					
February:										
Augusta	.49	.18	.15	.40	.45	8.2	2.0	1.0	4.0	4.5
Great Falls	1.02	.35	.51	.17	.77	9.8	3.5	4.9		
Cascade				.31	.85				9.0	10.0
Chouteau				.12	.08				2.4	Tr.
March:										
Augusta	.76	1.00	2.18	2.27	.70	14.0	10.0	18.0	1.5	7.0
Great Falls	.19	.89	2.20	.66	.73	1.6	8.0	22.0		
Cascade				55	.63				8.5	9.1
Chouteau				.56	.31				4.6	
April:										
Augusta	.35	1.71	.50	1.78	.92		13.0	1.5	10.0	
Great Falls	.05	2.00	.62	.68	1.17			Tr.		Tr.
Cascade				.84	1.16				11.5	
Chouteau				.55	56					
May:										
Augusta	4.16	2.48	.92	1.52	6.43	2.5	8.0	6.0		
Great Falls	5.93	1.84	1.16	1.99	5.03				Tr.	
Cascade				2.30	5.79				Tr.	.1
Chouteau				1.45	4.47				2.0	
June:										
Augusta	.79	1.36	.99	4.97	.97					
Great Falls	4.02	2.19	1.06	4.23	5.59					
Cascade				5.48	2.69					
Chouteau				2.63	1.57					
July:										
Augusta		3.54		1.70	1.00					
Great Falls	2.14	2.74	.97	.67	.88					
Cascade			29	1.04	.80					
Chouteau				1.25	1.14					
August:										
Augusta	.77	1.51	.32	1.44	2.18					
Great Falls	.55	.74	1 18	.82	2.66					
Cascade			.12	2.05	3.15					
Chouteau				.70	2.75					

[a] A portion of the data above and in the statements immediately following are for the period from 1893 to 1903. The remainder is computed from the establishment of the station in 1891.

Relative precipitation at Augusta, Great Falls, Cascade, etc.—Continued.

	Rain and snow (melted.).					Snow.				
	1902.	1903.	1904.	1905.	1906.	1902.	1903.	1904.	1905.	1906.
September:										
Augusta	.36	.75	.16	.07						
Great Falls	.74	.99	.14	.18			Tr.			
Cascade			.13							
Chouteau				.27						
October:										
Augusta	Tr.	.27	.10	.47			2.2	1.0	5.0	
Great Falls	.07	.45	.44	.26			Tr.	Tr.		
Cascade			.29	.38				Tr.	4.0	
Chouteau				.10						
November:										
Augusta	.32	1.71	Tr.	.60				16.0	Tr.	6.0
Great Falls	.45	.83	.01	1.25				8.3		
Cascade			.02	1.50						10.3
Chouteau				.26						
December:										
Augusta	1.00	.69	.40	.10			6.0	4.0	1.0	
Great Falls	.39	.91	.54	.18			9.1	8.0	1.8	
Cascade			.38	.20					2.0	
Chouteau				Tr.					Tr.	

CULTURE.

Settlement here as elsewhere is determined by geologic and climatic conditions. Along all the larger stream valleys where surface water for irrigation purposes is available settlements are numerous, but much of the upland and grazing districts is thinly populated. On the higher slopes bordering the mountains in the zone of increased rainfall many small farms occur, some of which are among the best improved places found in the district.

One relatively large town, three medium-sized coal-mining towns, and a number of smaller trading points are in the district. Great Falls, a town of 18,000 inhabitants and a thriving business center, is located on Missouri River near the north-central portion of the district. Although at present none of its railroad lines are transcontinental, they are the most important connecting lines between the main lines of the Great Northern and the Northern Pacific, and when the Billings and Northern road, now being constructed between Billings and Great Falls, is completed it will open up a new transcontinental route through Great Falls to the northwest coast. At present railroad lines extend in four directions from Great Falls: The Great Northern southwestward to Helena and Butte; the Montana and Great Northern northwestward to Shelby Junction, a point on the main line of the Great Northern; the Great Northern extending northeastward to Havre, another point on the Great Northern main line; and the Neihart branch of the Great Northern connecting Great Falls with Neihart, a silver-mining town in the Little Belt Mountains about 100 miles to the southeast. This road has a short branch line leaving it at Gerber station for Stockett and Sand Coulee, two of the larger coal-mining camps. The Boston and Montana Consolidated Copper and Silver Mining Company's smelters and refineries are located at Great Falls; also the Royal Milling Company, besides a number of smaller business enterprises. The ore handled at the smelters comes from Butte and Anaconda; this, together with the coal and limestone used in the operation of the plant, makes a relatively large freight traffic for Great Falls, while it also furnishes employment for a large force of men.

Belt, one of the largest coal-mining towns in the region, has a population of about 1,000, composed mainly of employees of the Anaconda Copper Mining Company, the largest operators at this place. It is located on Belt Creek, about 20 miles southeast of Great Falls, on the Neihart branch of the Great Northern road, and is the oldest coal-mining town in this region. About 10 miles west of Belt and about 10 miles from Great Falls are the two coal-mining towns of Stockett and Sand Coulee. At Stockett, the larger of the two places, is located the Cottonwood Coal Company, which is one of the two largest coal-mining companies operating in the district. Stockett has a population of about 800, composed largely of coal miners employed by the Cottonwood Coal Company. Sand Coulee, about 2½ miles northwest of Stockett, is a smaller mining town of about 400 inhabitants. It is situated in Straight Coulee, a branch of Sand Coulee, and owes its existence mainly to the Nelson and Gerber coal companies, which are operating at this place.

The other towns in the district are mainly supported by a ranch population. Chouteau, the most important of these and the county seat of Teton County, is located on Teton River, about 40 miles northwest of Great Falls. It has a population of about 400, and is bordered on the north by one of the oldest and best-developed irrigated districts in the Great Falls region. Along Sun River there are a number of small towns and trading points. The largest of these is Augusta, in Lewis and Clark County, on South Fork of Sun River, about 3 miles above its mouth. Sun River, somewhat smaller, although one of the oldest towns in this region, is located in Sun River Valley, about 20 miles west of Great Falls. Two towns have recently been laid out in Sun River valley by the Reclamation Service engineers—one at Fort Shaw Indian School, which will be known as Shaw, and another at the mouth of Sims Creek, which is called Sims. At Flowerree home ranch there is a large company store and another at Sunnyside, owned by the Sun River Stock and Land Company. Along the Great Northern Railway line the principal town within the area described is Collins, located on the north side of Teton River. From this place stage lines connect with Chouteau through Farmington, a post-office and store in the middle of Burton Bench. Bynum, another small trading point, is located in the northwest part of Burton Bench.

There are no towns along Missouri River below Great Falls within the area described, but above that town are two small stations, Ulm and Cascade, the latter, located near the base of the Big Belt Mountains, with a population of about 200. It is supported by a large ranch trade from each side of the river.

On Smith River there is a post-office known as Truly, about 5 miles above its mouth; another, Orr, farther up the river, has recently been discontinued.

In Belt Creek valley, about 2 miles above Belt, is the small town of Armington, which is situated at the junction of the new Billings and Northern and the Neihart branch of the Great Northern. It is mainly a small railroad town, which receives a portion of the ranch trade of the surrounding country. Along the new railroad there are a few small stores, located at intervals of 12 to 15 miles; these are Spion Kop, Geyser, and Stanford, the latter being an important trading point for a large ranch district along Skull, Running Wolf, and Sage Creek valleys.

While the Great Falls region is at present a sparsely settled district, it is believed that the Government irrigation projects now under way which will reclaim millions of acres of fertile farming land, the almost unparalleled advantages for the development of water power, and the increasing railroad facilities will cause the population to increase rapidly within the next decade.

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