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CHARLES D. WALCOTT, DIRECTOR

FOREST CONDITIONS

IN THE

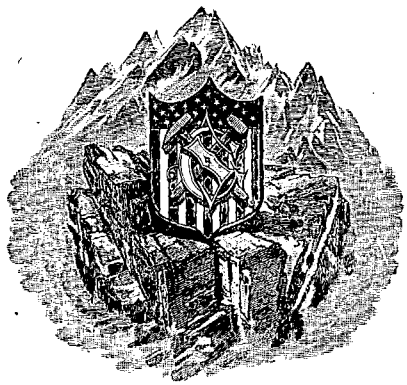
ABSAROKA DIVISION OF THE YELLOWSTONE FOREST RESERVE, MONTANA

AND THE

LIVINGSTON AND BIG TIMBER QUADRANGLES

BY

JOHN B. LEIBERG



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DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., February 10, 1904.

SIR: I have the honor to transmit for publication, as a professional paper, a report by Mr. J. B. Leiberg on the forest conditions and land classification of the Absaroka division of the Yellowstone Forest Reserve and adjacent regions.

Very respectfully,

HENRY GANNETT,
Geographer.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

FOREST CONDITIONS IN THE ABSAROKA DIVISION OF THE YELLOWSTONE FOREST RESERVE AND THE LIVINGSTON AND BIG TIMBER QUADRANGLES.

By JOHN B. LEIBERG.

ABSAROKA DIVISION OF YELLOWSTONE RESERVE.

LOCATION AND EXTENT.

The tract of land here designated the Absaroka division of the Yellowstone Forest Reserve was originally the Absaroka Forest Reserve. By proclamation of January 29, 1903, this reserve was merged with the Teton and the Yellowstone forest reserves, the whole taking the name of the Yellowstone Forest Reserve. The western, northern, and eastern boundaries, as then established and as applicable to the Absaroka division, are as follows:

"Beginning at the point where the range line between ranges nine (9) and ten (10) east, principal meridian, Montana, intersects the northern boundary of the Yellowstone National Park; thence northerly along said surveyed and unsurveyed range line, allowing for the proper offset on the first (1st) standard parallel south, to the southwest corner of section eighteen (18), township four (4) south, range ten (10) east; thence easterly to the southeast corner of said section; thence northerly to the northeast corner of section six (6), said township; thence easterly to the southeast corner of section thirty-two (32), township three (3) south, range ten (10) east; thence northerly to the northeast corner of section five (5), said township; thence easterly along the township line to the northeast corner of township three (3) south, range eleven (11) east; thence southerly to the southeast corner of said township; thence easterly along the surveyed and unsurveyed township line to the point for the southwest corner of township three (3) south, range fourteen (14) east; thence northerly along the surveyed and unsurveyed range line to the northwest corner of township two (2) south, range fourteen (14) east; thence easterly to the northeast corner of said township; thence southerly to the point for the southeast corner of said township; thence easterly to the point for the northeast corner of township three (3) south, range fifteen (15) east; thence southerly to the point for the southeast corner of said township; thence easterly along the surveyed and unsurveyed township line to the northwest corner of township four (4) south, range eighteen (18) east; thence southerly along the range line to its intersection with the first (1st) standard parallel south;

thence easterly along said parallel to the northeast corner of township six (6) south, range eighteen (18) east; thence southerly along the surveyed and unsurveyed range line to the southwest corner of township seven (7) south, range nineteen (19) east; thence easterly to the northwest corner of township eight (8) south, range twenty (20) east; thence southerly to the southwest corner of said township; thence easterly to the southeast corner of said township; thence southerly along the range line to its intersection with the boundary line between the States of Montana and Wyoming."

The southern boundary of the area discussed is west from the point where the eastern boundary of the reserve intersects the Montana-Wyoming line to the southeast corner of township 9 north, range 14 east; thence along the northern boundary line of the Yellowstone National Park to the point where said boundary line of the park intersects the range line between ranges 9 and 10 east, principal meridian. The total area, as above delineated, includes 1,334,400 acres.

CLASSIFICATION OF LANDS.

The lands in the division are classified as follows:

Classification of lands in the Absaroka division of the Yellowstone Forest Reserve.

	Acres.
Forested	442,640
Wooded	37,200
Nontimbered	854,560
Total	1,334,400

The nontimbered lands vary in character and are classified as follows:

Classification of nontimbered lands in the Absaroka division of the Yellowstone Forest Reserve.

	Acres.
Badly burned	138,410
Agricultural	34,840
Grazing	388,170
Bare rocks, high alps, and snow fields	260,640
Lakes and tarns	32,500
Total	854,560

TOPOGRAPHY.

OROGRAPHIC FEATURES.

The area discussed consists of a vast body of Archean gneisses and similar rocks carrying on its flanks upturned strata of Paleozoic and Mesozoic ages. In some localities outflows of lava rest upon the older rocks. In the northeast corner it also includes a low, terraced, undisturbed limestone area, which now constitutes a rolling foothill region. During Pleistocene times the uplift was covered with a great glacier, which, moving in various directions, but chiefly west and north, sculptured and fashioned the region much as we now find it.

The most extensive degradation of the uplift, with consequent roughness and irregularities of the contours, is found on the area situated west of Stillwater River. This portion of the reserve is scored by deep gorges with intervening narrow ridges, the crests often only a few feet wide. There are many canyons, narrow and rocky, strewn with masses of bowlders and gravel left behind by the glaciers which plowed their way to the lowlands through these valleys. In some places the glaciers left large blocks of country with broad, rolling, bowlder-strewn, plateau-like surfaces standing up massively and majestically between the larger canyons. Of this character are the so-called East and West Boulder plateaus, which represent areas of the uplift not greatly reduced from the height to which they had been elevated when the ice age began. The altitude of the region varies from 4,000 feet in the lowest canyon bottoms to 11,000 feet on the summit of the highest peaks, the average elevation being probably not far from 8,000 feet.

East of the canyon of Stillwater River the region has a considerably higher mean elevation, probably not less than 9,800 feet, excluding the foothill region. The glacier, in its northward movement to lower levels, cut its way down through the uplift for thousands of feet, leaving a series of stupendous cliff-bound gorges, producing some of the wildest and grandest scenery imaginable. At the head of these gorges are numerous peaks and pinnacles, some of them rising to altitudes of 13,000 feet, while beyond the line of canyon erosion a high, plateau-like area remains, pitted with numerous depressions, intersected by ridges and cones, furrowed by shallow ravines, and studded with low buttes and occasionally dome-like elevations. This elevated tract is named Beartooth Plateau, and is a prominent feature in the orography of the southeast quarter of the reserve.

The plateau varies from 10,000 to 12,000 feet in altitude; much of it is rolling, and in a few localities is almost a level tract with a moor-like aspect, but the greater portion presents a decidedly rugged surface. Most of the depressions hold lakelets or tarns. The plateau has a gradual slope southward to Clark Fork Valley. On the west it is bounded by the canyon of the Stillwater, while along the east line of the reserve the tract breaks off to the level of the plain with steep, almost perpendicular, fronts, in some places over 3,000 feet in height.

The general character of the canyons has been mentioned above. The canyons of the two Rosebuds in their upper areas are mere narrow rifts between nearly perpendicular rock walls, 1,500 to 2,000 feet in height, while along Stillwater Canyon the cliffs in some places tower over 3,000 feet above the floor of the canyon. Here and there the canyon floors are littered with glacial débris, which occasionally has dammed the streams and formed lakes.

The highest point in the reserve is Granite Peak, which reaches nearly 13,000 feet (12,900 feet, as obtained by aneroid). There are scores of other elevations throughout the reserve varying from 10,000 to 12,000 feet. Notwithstanding these

considerable altitudes, far above timber line, there is not a single snow peak in the reserve. Permanent snowfields occur in many localities in the high areas, but they are simply the result of heavy winds piling up great banks of snow in gullies, ravines, and on the lee side of the higher peaks, too deep to melt during the short summer season, but yearly waxing and waning according to the severity of the winter's downfall of snow.

DRAINAGE.

Primarily the area discussed is situated wholly within the Yellowstone River drainage. The run-off from its areas is carried into this river by a large number of creeks and streams, which head mostly in the alpine and subalpine tracts. Some of the streams form the heads of rivers of considerable size, others are mere alpine rivulets. The larger and more important of the drainage basins and streams are as follows: (1) The Boulder River drainage, composed of (*a*) the heads and central areas of West Boulder River; (*b*) the head and central areas of Boulder River; (*c*) the head, middle, and most of the lower portions of East Boulder River. (2) The upper half, including all the heads, of Stillwater River. (3) The Rosebud drainage, composed of (*a*) the head and central areas of West Rosebud Creek; (*b*) the head and central areas of East Rosebud Creek. (4) The head of Red Lodge Creek Basin. (5) The Rocky Fork drainage, composed of (*a*) all of West Rocky Fork, and (*b*) the head and upper central areas of East Rocky Fork. (6) The northern heads of Clark Fork drainage. (7) The head and central areas of Slough Creek drainage. (8) The head and central areas of Hell Roaring Creek Basin. (9) The head and central areas of Mill Creek.

With the exception of Clark Fork, more than 99 per cent of the water which these streams carry represents run-off originating within the reserve. The tract is thus a huge reservoir, furnishing a very large part of the annual flow in Yellowstone River, and is therefore of very great importance to the irrigation interests dependent on the waters of that stream. Excepting Slough and Hell Roaring creeks, all the streams noted above are more or less utilized for irrigation purposes above their confluences with Yellowstone River.

The volume of water discharged by these streams during the summer season can be greatly augmented by the construction of reservoirs in the alpine and subalpine areas at their heads.

ROCK FORMATIONS AND SOIL.

Three-fourths of the area discussed consists of a great Archean uplift, cut and seamed by dikes of various kinds of igneous rocks. The remainder consists of lavas of various composition, limestones, and sandstones of Paleozoic age. The limestones occur chiefly in the northern areas, flanking the first rises of the mountains along

the foothill region. They stretch northward and form most of the foothills, but are there commonly deeply buried under gravel and bowlder drift. They also occur along Boulder River, as far up as the central areas, and at the head of Stillwater River in the Cooke City region. There are also outcropping strata of limestones in the southwestern portion of the reserve, in Slough Creek Valley, on Buffalo Plateau, and farther westward. The lavas occur throughout all the areas west and northwest from Cooke City. For the most part they have been ejected from vents or craters in the region around Haystack Peak at the head of Boulder River. In part they are brecciated lavas and probably ejected through fissures. There is also a large field of these lavas in the northern part of the reserve, beginning on the left bank of Stillwater River, in the southeast corner of T. 4 N., R. 15 E., whence it stretches northward and eastward 10 to 25 miles.

The soil in the area is of two principal varieties, a siliceous loam derived from the disintegration of the prevailing granitic rocks with admixtures of mold and vegetable débris, and gumbo soils derived from the decomposition of the modern lavas. The former soils are more common and occur throughout the reserve; the latter are confined to the areas where they are underlain by rocks from which they were derived.

The siliceous soils are generally poor, except in swales and depressions, where large accumulations of vegetable mold have been washed in from the surrounding high ground. In most places the surface of the soil is strewn with bowlders. The substratum or basement is always composed of sand and gravel with bowlders freely interspersed, the whole easily displaced and gullied when the turf or forest on its surface is from any cause destroyed or removed.

The gumbo soils are hard and tough when dry, but when wet dissolve almost like soap and are easily gullied and washed. Wherever these soils occur in the nontimbered or woodland areas of the foothills and have been denuded by excessive pasturing, gullying is taking place. They possess a much greater degree of fertility than the siliceous soils, and in the forested areas bear the heaviest stands of timber in the reserve.

MINING AREAS AND MINERALS.

The area discussed contains several mineralized areas and mining camps, in some of which more or less activity is displayed in the extraction of ore, while in others no mining operations are now being carried on. The principal mining districts are as follows: Boulder River, to its head in the region around Haystack Peak; the divides at the head of Stillwater River; the southern and main tributaries of Clark Fork and Soda Butte Creek, a district with Cooke City as its center; Horseshoe Mountain, a small tract between upper Slough Creek and Stillwater River; the central areas of the Stillwater Valley around Nye and the

region along and at the head of Crevice Creek. Lesser and little known or prospected mineralized areas occur in the canyons of East and West Boulder rivers. The great mass of the reserve, all the granite areas of the Absaroka Range west of Boulder River and the vast granite uplift east of Stillwater River are, so far as known, devoid of mineralized areas.

The mineral areas embrace both quartz and placer mining. Most of the placer districts are confined to the Boulder drainage. Cooke City and Horseshoe Mountain districts are chiefly mining in quartz. The Horseshoe Mountain camp and Cowles, at the head of the Boulder, were the only camps in which active mining operations were in progress at the time this examination was made. In the foothills in T. 6 S., R. 18 E., indications of petroleum are believed to have been found, and prospecting has been in progress for some years without any very definite results.

AGRICULTURAL LANDS.

The areas actually under cultivation or susceptible of tillage without special irrigation works comprise 34,840 acres. Of this amount, 4,000 acres exist in small scattered tracts, forming bench lands, swales, reclaimed or drained wet meadows, in the various canyon bottoms, chiefly in those of Boulder and West and East Boulder rivers, in Stillwater Valley, and in the lower portions of Rocky Fork Canyon. The remainder of the agricultural areas lie in the foothill region, especially in Tps. 4 and 5 S., Rs. 16 and 17 E., and in T. 6 S., R. 18 E. The amount actually under cultivation on areas situated within the mountain region amounts to 1,200 acres, approximately, while in the foothill areas, chiefly in the townships enumerated, there are possibly a total of 8,000 or 9,000 acres under more or less complete tillage. The altitudinal limit of the arable lands lies between 5,000 and 6,000 feet. The large tracts of subalpine meadow lands lie at altitudes too high for the successful raising of crops of any sort. The agricultural lands in the foothills actually under tillage usually occupy swales and bottoms along the different creeks. They have a deep and rich soil, while the lands under tillage in the various canyons consist of shallow strata of loam spread over a clear gravel, pebble, or bowlder basement, and, therefore, have only a small and passing value for farming purposes. Most of the lands require irrigation for the production of crops.

GRAZING LANDS.

The nontimbered lands in the reserve available for range or pasture purposes comprise 388,170 acres. To these should be added grassed woodlands of 37,200 acres, making a total of 425,370 acres of grazing lands. These tracts are of different values for range purposes, depending on their general character and their situation

as regards accessibility and water supply. They may conveniently be divided into five classes, as follows: (1) Nontimbered foothills; (2) woodlands; (3) open slopes, generally southern, and nontimbered canyon bottoms; (4) wet meadows and fire glades in the subalpine forest zone; (5) summits of the high plateau areas and ridges above timber line.

The nontimbered foothills comprise 100,000 acres. They lie along the northern and northeastern edges of the area, in the northwest corner, forming a narrow and interrupted belt, gradually widening toward the east until they occupy most of Tps. 4 and 5 S., Rs. 16 and 17 E. and T. 6 S., R. 18 E. The tracts have a mean altitude of 5,600 feet. The surface is marked, in part, by long, rolling swells and low ridges alternating with shallow canyons, and, in part, is extensively cut up and intersected by a multitude of ravines. The soil is generally thin and stony, most of the areas being overlain with deep deposits of glacial bowlder and gravel drift, but, where the soil has been derived from disintegration of the brecciated lavas, it is of a gumbo-like character. The lands are generally well watered by small springs, runs, and streams, although many of the smaller ravines are dry through the latter part of summer and fall.

Originally these tracts bore a moderately close sward of various species of grasses. They have long been pastured, and, where uninclosed and only moderately well watered, have now a very low grazing value.

The lands are of little value for forestry purposes, although they are by no means incapable of supporting arborescent vegetation. They are situated within the altitudinal limits of timber growth, and were they not pastured would, in course of time, produce stands of aspen, cottonwood, limber and yellow pines. Their present treeless character is primarily due to repeated fires during the Indian occupancy of the region.

The woodlands comprise 37,200 acres. They occupy narrow and irregular tracts throughout the foothill areas, generally at altitudes not much above nor below 6,000 or 6,200 feet, following streams and gullies, or occupying crests and northern slopes or combs of ridges, or scattered over the rolling surface of the higher foothills. Portions of the areas are rocky in character, with projecting ledges of limestone and brecciated lava. Portions of the tracts consist of deep deposits of glacial bowlder and gravel drift. Most of the tracts are poorly watered, springs being scarce and the different runs and ravines mostly dry during the summer season. They are sparsely stocked with limber pine, yellow pine, red fir, aspen, and cottonwood, set in small copses, thin lines, or standing as isolated trees. Their grazing value lies in the abundant growth which forms most of the ground cover where not overpastured. Where the tracts have been too closely grazed they are bare or overgrown with coarse weeds. In some localities the creeping juniper, *Juniperus procumbens*, spreads over the ground in close and dense mats. In

general the woodlands have not been badly pastured, chiefly owing to lack of water, and, being situated at easily accessible points, they are still of considerable grazing value.

Most of the area of this class of lands is capable of bearing forests, probably not in uniform and heavily stocked stands, but in moderate volumes, 1,200 to 1,800 cubic feet per acre for mature growths. Their present thin and scattered stockage is entirely due to often repeated fires during the Indian occupancy of the country. In places where grazing for various reasons has been kept at a minimum, and where no fires have run during the past two or three decades, heavily stocked stands of sapling red fir are pushing out into the previously nontimbered or sparsely timbered areas, conclusively proving that under proper conditions the tracts will bear forests.

The pasturing of the woodlands is inimical to rapid extension or closer stockage of the timber growth. Any sheeping of the areas will practically destroy whatever seedling growth may be springing up on such grazed-over tracts. The pasturing of horses and cattle, while destructive in a less degree, is yet likely, if carried to excess, to have the same effect on the seedling growth as the sheeping.

The woodlands do not give rise to any notable quantities of run-off. They are of no particular importance in this region as adding to or conserving the water flow, and extensions or additions to their present stockage would be chiefly beneficial in giving easily accessible wood supplies to agricultural settlements in the adjacent timberless valleys.

The third class of grazing lands, consisting of open slopes and nontimbered canyon bottoms, comprises 25,000 acres. These exist throughout all parts of the reserve at altitudes ranging from 6,000 to 8,000 feet. In part they comprise slopes generally with a southern exposure, but not infrequently an eastern or western, rarely a northern. In part they are made up of meadows and swales fringing the creeks and canyon bottoms. The slopes chiefly represent ancient fire glades which, before the advent of the white man, were covered with forest. They were burned over by the aborigines, and owing to ensuing soil aridity have never restocked. In most localities the soil cover on these tracts is thin, the underlying rough talus stratum or solid rock comes near the surface, there is a rapid-drainage ratio, and little reserve moisture is stored in the shallow subsoil. Hence when denuded of forest cover restockage is an extremely slow process and the land remains grass-covered for an indefinite time. They commonly bear an abundance of grass, but owing to steepness of slope are rarely pastured to any extent. If left undisturbed, the forest will eventually cover them again. Of the total area in this class of grazing lands 15,000 acres consist of open slopes, as described.

The remainder of the lands in this class, 10,000 acres, is made up of many small glades and meadows. Their timberless character is due to the prevailing swampy nature of the ground—the soil-moisture ratio being too high for coniferous growth.

In part the glades bear close swards of paludose grasses and sedges; in part they are covered with a more or less open tangle of willow brush. The clean grassy or sedgy portions are occasionally used as natural hay meadows. The willow-covered tracts are pastured by cattle and horses.

At higher altitudes, 7,500 to 9,500 feet, is found the fourth class of grazing lands. They consist of wet meadows of very ancient fire glades in the subalpine forest and of ground thinly stocked with open stands of that type of forest. In the aggregate, 70,000 acres belong to this type of grazing lands.

The meadow portion consists of swampy, marshy tracts at the heads of streams and of narrow, springy margins fringing lakelets and tarns. They occur throughout the reserve along all the main divides, but are more abundant and contain a larger acreage than elsewhere in the following localities: Summit of Buffalo Plateau in T. 9 S., R. 11 E.; at the head of Stillwater River in T. 9 S., Rs. 14 and 15 E.; and at the head of Clark Fork in T. 9 S., R. 15 E. These tracts, as well as the rest of the class of lands to which they belong, are of great importance in conserving and regulating the water conditions of the region. They are, in effect, vast sponges, absorbing and holding back surplus flood waters early in the season, and gradually releasing the stored-up volumes as summer advances.

The swampy areas are devoid of arborescent growth except for scattered willows here and there. The dry tracts are either bare or thinly stocked with trees. When timberless it is owing to past fires and deficient restockage, largely caused by the prevailing low seed-producing capacity of the high subalpine forest. Few of the tracts are pastured at the present time. Many of them are inaccessible except to sheep, which were formerly ranged in a few localities; but the marks of such sheeping are now nearly obliterated. During the Indian occupancy the areas accessible from the National Park were used by the buffalo as summer ranges. They are dotted with the wallows and marked by the deep, well-worn trails of these animals. The tough, close sward of grass and sedge which covers these tracts will bear a considerable amount of hard usage before becoming overgrazed; but owing to the important part they occupy in the conservation and regulation of the outflow from the region only a very limited amount of stock should be permitted, while the regulations excluding sheep should be continued in full force, as at present.

The largest area of available pasture lands in the reserve is included in the 5th class and comprises the summits of the different plateaus and the true alpine regions generally. In the aggregate, the class covers 156,000 acres. Most of the lands are situated in that part of the reserve which lies east of Boulder River, and particularly in Tps. 6 and 7 S., Rs. 13 and 14 E., Tps. 8 and 9 S., Rs. 18, 19, and 20 E., embracing tracts belonging to Lake and Beartooth plateaus. Other large tracts of this class of lands occur in Tps. 4 and 5 S., Rs. 11 and 13 E., on the summits of West and East Boulder plateaus. Smaller tracts are scattered along the crests of the higher divides.

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As a rule, lands of this class are difficult of access from the plains, from the foothill regions, and from the bottom of the canyons which bound or cut into them. They lie at altitudes varying from 9,500 to 12,000 feet, and the grazing season on them is short. The various plateau areas which so largely compose them are broad summits of the great Archean uplift of the region, smoothed in some localities, eroded and roughened in others. They are bordered by enormous, cliff-bound canyons on most of their sides, and when they front directly on the plains, as in the southeast corner of Beartooth Plateau, present extremely steep slopes. In some places the surface is rolling, as on the summits of East Boulder and the northern areas of the Beartooth Plateau; at other places it is pitted with bowl-like or elongated depressions commonly partly filled with water; at other points there are combs, ridges, and dome-like elevations of solid rock or heaped-up masses of bowlder drift, resembling the "nunataks" described as projecting above the surface of the arctic continental glaciers. Streams head in the various tarns or in the springs with which the tracts are liberally supplied, and become important feeders of the rivers and creeks in the reserve.

Where not too closely sheeped in the past and where sufficient soil overlies the rock or bowlder basement the land is covered with a close and very tough sward of alpine and subalpine grasses and sedges, and in the height of the summer is brilliantly bespecked with multitudes of many-hued flowers. Around the springs and points of seepage and in crevices of rocks grow tangled thickets of frutescent willows, while on the more level and drier ground the herbaceous arctic willow, rising scarcely 2 or, at the most, 3 inches above the surface of the soil, spreads its thin mats and twigs along the grassy sward.

All the larger and more easily accessible of these tracts have been pastured, none very closely except the Beartooth Plateau areas in Tps. 8 and 9 S., Rs. 18, 19, and 20 E., which have for many years been favorite sheeping grounds for flocks owned in the vicinity of Red Lodge and in adjacent townships across the Wyoming line. Everywhere throughout these sheep runs the land has been overgrazed, and coarse alpine plants, worthless for pasturage, have either wholly or in part supplanted the former grassy turf, or where other species of vegetation have not usurped the ground the grass remaining has been eaten so close that only mere stubs remain.

Situated above timber line lands of this class are, of course, of no particular importance in the forest economics of the reserve. They have, however, a large and far-reaching value as conservators and retainers of the precipitation on the region and as regulators of the run-off. Their lakelets and tarns are effective natural reservoirs, and are so situated that by means of low embankments across their outlets their storage capacity can readily be increased tenfold or more. Where lakelets and tarns are lacking, or where they have been drained by the erosion of the natural dams at their outlets, marshes and springy ground have taken their place and serve

the same function in the regimen of the streams at their sources. The grassy turf on the uplands and around the margins of the lakelets and tarns, and the tangle of willows and heavy sward which spreads over the swampy and marshy tracts have the same beneficent influence and action on the water conservation in these alpine areas that the forest cover has on the regions at middle elevations. The grass cover effectually prevents gullying and excessive evaporation. If the grass is destroyed gullying begins, the loosened material silts the hollows and depressions that hold the lakelets, the water level is raised without corresponding elevation of the natural embankments at their outlets, and finally the lakelets are levelled and drained. In order that the grass cover of these tracts may remain intact and serve the important purpose it now does, grazing will have to be closely watched and regulated. Sheeping, whether in large or small bands, should be entirely prohibited, and the number of cattle and horses allowed on the tracts should be restricted to the lowest possible number. On the lands included in Beartooth Plateau and situated within the area discussed, gullying is apparent as yet only in isolated localities and has not proceeded to any alarming extent. But on the lands of the plateau across the Wyoming line and in the region surrounding Beartooth Lake, the evil effects of overgrazing, as displayed in the formation of gullies, are abundantly in evidence. Great gullies are opening out in the slopes of the ridges hemming in this lake on the west, the gullying following exactly the lines of excessive sheeping. On this particular tract a large band of cattle was pastured during the summer of 1903. They were rather closely herded, and to escape flies and other insect pests were accustomed to bunch up on comparatively small tracts near the lake. Where this bunching occurred, as well as on adjacent areas which were being overgrazed in consequence, the turf was quite as completely destroyed as ever it was on bedding places of sheep, showing that there are no essential differences in the effects following overgrazing, whether accomplished by cattle or sheep.

LAKES AND TARNS.

Bodies of standing water, other than marshes and swamps, cover 32,500 acres of the reserve. Without exception they owe their existence to past glacial action. Some occupy shallow basins and glacial cirques in the alpine areas, dammed and held back by ledges of rock, or by walls of morainic débris across their outlets. Others are situated in the bottoms of canyons and are formed and held back by the remains of terminal moraines stretching across the valley. Most of them are shallow and of small area. The largest in the reserve is Mystic Lake in T. 7 S., R. 16 E., covering 1,500 acres, situated in the canyon of West Rosebud Creek. The lakelets are most numerous in the southern portions of the reserve, in the high, extensively glaciated alpine areas east of upper Stillwater River, where they are found by the hundreds, occupying shallow depressions in the great granite uplift

of the region. Rarely they lie singly; usually they are in groups of 4 to 7 or more, connected by little rivulets. Sometimes they are fringed by narrow belts of timber or lines of brush, but more frequently their surroundings are bare rocks, or steeply sloping tracts of alpine meadow down to the water's edge. They are gradually disappearing, in part by silting from adjacent slopes, and in part by deepening of their outlets and consequent drainage. A large number have disappeared in this way and now form tracts of merely marshy ground.

The lakes of the reserve are of great importance, in view of future plans for water storage. Scores of the small ones could be turned into large lakes by moderate and not costly embankments across their outlets. All the streams heading in them are feeders to rivers whose waters are utilized for irrigation in the agricultural districts in the lowlands, and there can scarcely be any doubt that in course of time these natural reservoirs will be enlarged and utilized to the utmost.

FOREST CONDITIONS.

COMPOSITION AND RANGE.

The forest in the reserve is almost wholly coniferous, and is made up of the following species:

Limber pine	Pinus flexilis
Lodgepole pine	Pinus murrayana
Yellow pine	Pinus ponderosa
White pine	Pinus monticola
White-bark pine	Pinus albicaulis
Red fir	Pseudostuga taxifolia
Subalpine fir	Abies lasiocarpa
Engelmann spruce	Picea engelmanni

The deciduous trees are represented by aspen, cottonwoods, various species of arborescent willows, hawthorn, wild cherry, and service berry. The species of trees with diameters exceeding 3 inches at the base occur in the following proportions:

Composition of forest in Absaroka division of Yellowstone Reserve, including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	2.3
Lodgepole pine	45.6
Yellow pine	.005
White pine	.0002
White-bark pine	5.3
Red fir	12.2
Subalpine fir	11.1
Engelmann spruce	21.8
Aspen and cottonwood	1.6
Other species of broad-leafed trees, less than	.05

The general arrangement and distribution of these species is simple. At elevations of 5,500 to 6,000 feet limber pine, small proportions of yellow pine, and scattered copses of red fir form thin fringes of forest, or, on northern slopes, fairly well-stocked stands. From 6,000 to 8,000 feet lodgepole pine forms the great mass of the forest. It occurs either in practically pure growths, generally closely stocked, or mixed with red fir and Engelmann spruce; the red fir is particularly abundant on dry, rocky slopes; the Engelmann spruce is most common along the canyon bottoms, in places with considerable seepage or where the lodgepole pine has attained an age of 150 years and upwards. Above the 7,800-foot level the lodgepole pine thins out and is replaced by white-bark pine, subalpine fir, and Engelmann spruce, which together constitute the subalpine forest zone. The broad-leafed trees—aspen, cottonwood, and arborescent willows—are mostly confined to the canyon bottoms, and are seldom found above the 7,500-foot level.

The timber line is at an elevation of about from 9,300 feet on northern and western slopes to 9,800 feet on southern exposures. It rises, however, as the eastern edge of the reserve is approached, until in some places along the eastern verge of Beartooth Plateau it reaches 11,000 feet. Near the timber line Engelmann spruce is found in greater abundance and vigor than any other species. Next comes the white-bark pine, while the subalpine fir generally occurs at lower altitudes. Both the spruce and white-bark pine dwindle rapidly in stature as elevation is attained, until at their uppermost limits they are mere depressed shrubs.

Within their altitudinal limits the species, except the white pine, are found in the timbered area in all parts of the reserve. Their relative abundance, however, varies greatly. The limber and yellow pines are most common in the foothills in the northern townships; the yellow pine, however, forms in all cases a very small ratio of the timber in any locality and is practically lacking in all of the interior areas. The white pine occurs chiefly in the bottoms of Davis Creek, an affluent of West Boulder River, and in the Slough Creek bottoms in T. 10 S., R. 12 E. It is a very rare species in either locality, only scattered trees occurring, set in mixed stands of lodgepole pine, red fir, and Engelmann spruce. The white-bark pine is found throughout the subalpine zone. Usually it forms only a small proportion of the forest, but occasionally, as in the eastern portion of Hell Roaring Creek Basin, it becomes so abundant as to constitute 75 to 85 per cent of the stands.

The lodgepole pine is very plentiful; it forms fully 75 per cent of the forests below the subalpine zone, and, excluding the lower areas bearing red fir and limber pine, will amount to 90 per cent. It frequently forms nearly or quite pure growths, especially while in the sapling stage, and in mature stands where the forest is beginning to assume its normal composition seldom falls below 35 to 50 per cent. Its relative abundance and preponderance are wholly the result of past fires.

The red fir extends throughout the lower areas of the reserve. It occurs in

small stands of pure growth while in the sapling stage, and in more or less mixed stands as mature age is reached. Lodgepole pine is its most common associate in the mixed stands, with lesser proportions of Engelmann spruce, the red fir in such situations forming from 15 to 30 per cent of the stand.

The subalpine fir occurs most abundantly in the lower areas of the subalpine forest. It is always set in mixed stands where it seldom or never exceeds 15 to 28 per cent.

The Engelmann spruce is found abundantly throughout the reserve. While the species here properly belongs to the subalpine-forest type, it occurs lower than 6,000 feet, following the streams in their downward course almost into the plains. In the subalpine forest the spruce commonly occurs in mixed stands and forms from 15 to 45 per cent, occasionally rising to 75 per cent, of the growth, as in the lowest areas of the subalpine forest in the eastern tracts of Hell Roaring Creek Basin. Where the percentage of the species runs high it is always set in old-growth stands.

The composition of the forest is neither normal nor ultimate, but represents a transitional phase due to the numerous fires which have devastated the region for centuries, particularly during the last 200 years. The lodgepole pine is most numerous because here it is a more abundant seed producer, and is better able to adapt itself to the changes in soil and moisture ratio, and probably in chemical composition of the soil caused by the fires. Burned stands, composed in part of red fir and in part of Engelmann spruce, have been replaced by lodgepole pine in areas where it originally formed only a comparatively small percentage. As the lodgepole pine reaches maturity and the stands become more open through natural thinning it will, in course of time, be largely displaced by red fir and spruce.

In the subalpine zone the composition of the forest is more nearly normal than in the areas in which lodgepole pine prevails. The fires have here reduced the percentage of Engelmann spruce, but have not favored the increase of other species, as the burned areas are either grassy or unforested, and the spruce is slowly spreading and eventually, when fully established, will greatly exceed its present percentage in the subalpine forest.

AGE AND SIZE OF TREES.

The greatest diversity prevails in the ages of the trees. Stands 15 to 20 years old are associated with growths 75 to 100 years of age and with veteran stands 200 to 300 years old. This condition has been brought about by fire, the different ages marking burns of different periods. Of the entire forest below the subalpine zone 10 per cent is less than 50 years old, 50 per cent more than 50 and less than 120 years, while the remaining 40 per cent comprises veteran stands from 120 to 300 years of age.

Except in perpetually moist and rich soil the growth of the trees is slow. Limber pine requires one hundred and twenty to one hundred and fifty years to reach heights of 30 to 40 feet, with breast-high diameters of 16 to 18 inches and clear trunks 12 to 15 feet in length. Lodgepole pine in close-set stands averages 70 to 90 feet in length, with breast-high diameters varying from 8 to 12 inches after one hundred to one hundred and fifty years of growth. White-bark pine and other trees of the subalpine forest at high elevations are slow growing. To reach a breast-high diameter of from 10 to 16 inches, and a length of bole from 25 to 45 feet requires one hundred and eighty to two hundred and fifty years. In similar situations Engelmann spruce requires from one hundred to one hundred and twenty years to attain equal dimensions. In moist situations at low or middle elevations Engelmann spruce will reach heights of 50 to 60 feet, with breast-high diameters varying from 16 to 24 inches in one hundred and twenty to one hundred and forty years. The red fir is likewise a slow growing tree, owing to its habitat on dry and rocky soils. It requires from one hundred and twenty to one hundred and fifty years to attain breast-high diameters of 12 to 18 inches, with lengths of bole varying from 60 to 80 feet. With the exception of the lodgepole pine very little timber in the reserve develops any considerable length of clear trunk. Limby and knobby boles with rapid taper and large crowns are the common characteristics. The lodgepole pine, set in close-stocked stands from the first, generally develops long, symmetrical, columnar trunks, although it rarely has a large diameter.

CHARACTER AND VOLUME OF MERCHANTABLE TIMBER.

The timber in the reserve, valuable for commercial purposes, may be divided into two classes: (1) Timber of sufficient dimensions and quality to furnish saw logs, and (2) timber fit only for fuel, fencing, pole, railroad ties, and mine props. The mill timber is present in much the smaller proportion, owing to the preponderance of the lodgepole pine, with its slender, pole-like growth, and the generally low, stocky stature of the other species of trees.

More mill timber is obtained from the lodgepole pine than from any other species, owing to its accessibility and abundance, and to its uniform distribution in areas having the most favorable climatic and soil conditions.

Next in volume comes Engelmann spruce. Although the total volume of the species is less than one-half that of the lodgepole pine the volume of mill timber is nearly 87 per cent of that of the pine, owing to the fact that the spruce of mill-timber dimensions is chiefly an old growth and its yield of saw logs is much greater proportionally than that of the lodgepole pine. Inversely its yield of fuel and pole timber is much less, amounting to only 33 per cent of that of the pine. The spruce is but little used either for mill timber, fuel, or fencing material because the heaviest and best stands of the species occur in localities remote from transportation or demand.

The red fir ranks next in volume. Its mill-timber yield is only 40 per cent of that of the spruce, while its total volume is 55 per cent. Its volume of fuel and pole timber is still more disproportionate, being only 14 per cent of that of lodgepole pine, while its total volume is almost 40 per cent. These variations are due to the fact that only a small quantity of the red fir is found in veteran or middle-aged stands, most of it being very young and unfit for commercial purposes. The red fir is little utilized. Most of it is difficult of access, growing on rocky, steep slopes or remote from transportation, and owing to the stringy and tough character of its timber is not very well liked.

The whitebark pine grows to mill-timber dimensions only in Slough Creek and Hell Roaring Creek bottoms. It has not, so far as is known, been utilized in the region for any purpose, but is included in the estimates because in the localities mentioned it grows to the size required for saw logs.

The white pine forms only an inconsiderable portion of the mill timber. In the Davis Creek region it is easy of access, and would probably have been cut out long ago had the loggers in the West Boulder Valley been able to distinguish the tree from the limber pine, which also occurs nearby and which, in close-set stands, much resembles the white pine.

The yellow pine is of still less volume than the white pine. Owing to its occurrence in the foothills only, it has been logged wherever found, and most of it has been cut out. The climatic conditions and its general altitude are inimical to the growth and extensions of the yellow-pine stands.

The yield of the mill timber varies from less than 1,000 feet B. M. per acre in the higher areas and in the tracts adjacent to the foothills to 10,000 feet B. M. on the tracts embraced in the bottoms of Davis Creek and middle West Boulder River, the Slough Creek bottoms, and portions of Buffalo Creek Valley. The highest yield observed anywhere was in the lower subalpine areas on the east side of Hell Roaring Creek Basin, where small tracts with veteran stands of nearly pure growth Engelmann spruce carry from 20,000 to 25,000 feet per acre. The diametral dimensions of the mill timber are small unless the logs are cut from Engelmann spruce, which will yield logs from 14 inches to 2 feet in diameter when squared. Logs from other species are much smaller, the average for the reserve being scarcely above 10¼ inches squared, and running from 10 to 15 logs per 1,000 feet B. M.

The yield of pole and fuel timber is comparatively large, owing to the close-set character of the lodgepole-pine stands, which furnish more than 50 per cent of the total volume. The yield of the subalpine forest zone is also considerable, when the generally open character of much of the growth on these areas is considered. This is owing to the preponderance of old growth in this type of forest, which often gives a larger volume of wood on an equal area than do the closer set but less advanced stands at lower elevations. The quantity per acre of pole and fuel timber varies

from 500 to 900 cubic feet for the thinnest and most scattered subalpine stands to 3,000 and 4,000 cubic feet for the closely stocked, middle-aged lodgepole-pine forest. In some of the very heavily stocked areas in Slough Creek and Hell Roaring Creek basins the amount rises to 10,000 cubic feet per acre. With the exception of Slough Creek and Hell Roaring Creek basins little of the area carries fully stocked stands. Notwithstanding rocky and comparatively barren soil, the region will be capable of sustaining at least twice the volume of timber it now does, if fires are totally suppressed, grazing and cutting restricted, and sheeping absolutely prohibited.

The total volume of mill timber in the Absaroka division, estimated on the minimum basis of 8 inches in diameter, breast high, and 10 feet of available bole, with the proportions furnished by each species, is as follows:

Volume of mill timber in Absaroka division of Yellowstone Forest Reserve.

	Feet B. M.
Limber pine	1,000,000
Lodgepole pine	434,000,000
Yellow pine	980,000
White pine	3,550,000
White-bark pine	8,000,000
Red fir	147,950,000
Subalpine fir	1,000,000
Engelmann spruce	376,200,000
Total	972,680,000

This gives an average stand slightly in excess of 2,190 feet B. M., per forested acre.

The volume of pole and fuel timber in the Absaroka division of the reserve, including the woodlands, is as follows, basing the estimates on diameters not less than 4 inches, breast high:

Volume of pole and fuel timber in the Absaroka division of the Yellowstone Forest Reserve.

	Cubic feet.
Limber pine	11,235,000
Lodgepole pine	511,900,000
Yellow pine	1,440,000
White pine	300,000
White-bark pine	82,230,000
Red fir	76,200,000
Subalpine fir	112,050,000
Engelmann spruce	155,100,000
Aspen and cottonwood	2,100,000
Total	952,555,000

The average volume of pole and fuel timber is nearly 2,000 cubic feet per acre. Counting 180 cubic feet of timber equal to 1,000 feet B. M., the average stand is raised to 2,390 cubic feet per timbered acre.

CUTTING.

The logged and culled areas comprise 41,650 acres, of which 22,000 acres are forested tracts and 19,650 acres are woodland. Probably all or a greater portion of the woodlands, 37,200 acres, have been more or less culled during the last thirty or thirty-five years, but many of the traces of the early cutting are now obliterated. Except in the areas adjacent to upper Boulder River the cutting is confined to the north, east, and south edges of the area discussed. Most of the cutting has been for the purpose of obtaining mine props, fuel, and fencing material. A smaller quantity has been used for railroad ties and burned for charcoal.

In the valleys of Boulder and West Boulder rivers, 50 to 90 per cent of the sizable red fir, spruce, and lodgepole pine was cut in 1882 or 1883, or possibly in 1881. The cutting extended south from the north line of the reserve up the West Boulder 2 or 3 miles and up the Boulder 10 or 12 miles, while comparatively little timber appears to have been taken out of the valley of the East Boulder. Cutting also took place on Boulder River near its head and is still actively carried on. In addition to this, a small sawmill is now established a few miles below the former camp of Independence. A small sawmill is established in the valley of the East Boulder, about 3 miles south of the north line of the reserve, and another in the middle Stillwater drainage in T. 5 N., R. 15 E. These mills are small and as yet have made little inroads on the forests in their respective localities. From the East Boulder, skirting the foot of the range around to the Rocky Fork drainage the forest has been cut and culled from 10 per cent to total. The cutting has been confined to a narrow strip and is not in a continuous belt. A large portion of the timber taken here within the past six or seven years had been fire killed. In the Rocky Fork Creek drainage the cutting area extends 3 to 4 miles up the two forks of the stream. A great deal of timber has been taken for mine props in the coal mines at Red Lodge, for fencing and fuel for the ranchers, and for cordwood for the lime burners in T. 8 S., Rs., 19 and 20 E. Here much of the timber cut had been fire killed.

Around Cooke City in T. 9 S., Rs. 14 and 15 E. 7,000 acres have been logged or culled, the cut varying from 10 per cent to total. The cutting was for the purpose of supplying mining timber to the various properties around Cooke City, fuel to stamp mills which formerly milled the ores of that region, and charcoal to one or two small smelters which have long since ceased operations. Very little cutting is going on there at present, merely enough to supply fuel to Cooke City and timber to the few miners doing assessment work. In the southwest corner of the area discussed, in the Crevice district, there has been some cutting for mining timbers and fuel, but the cut has been small. Various other tracts in the reserve have been cut over and culled, but the total amount removed has been insignificant. The large body of the forest at middle elevations and nearly all of the subalpine stands have not been touched by the ax.

No attempt has been made to leave the cut-over area in clean condition. There has been no piling of tops, except on the areas cut over since the ranger patrol of the General Land Office was established. However, much of the cut-over area, in the Boulder drainage especially, has been burned over and the tops and limbs thus removed. In general the cutting itself has caused no particular damage to the forest floor nor to the young growth. Most of the cut timber consisted of lodgepole pine, and owing to its abundant and rapid reproduction the logged tracts, where not run over by fire, are promptly restocking. There is one exception to the rule noted, namely, at Cowles mining camp near Haystack Peak. This camp is only 700 or 800 feet below timber line. The supply of timber in the immediate vicinity is limited, while the consumption, although not rapid, is constant. Here the steep hillsides are being totally denuded by the choppers and, with the limited and slow restockage of the subalpine forest, a long time must elapse before new stands replace those now being cut.

Most of the timber is exceedingly difficult of access and can only be taken out of the reserve with much labor and expense. Except for local use, or unless means of transportation through the National Park are provided, so as to reach the heavy stands in Slough Creek and adjacent basins, the bulk of the forest will remain uncut for a century or more. Boulder and Stillwater rivers and Rocky Fork Creek are drivable during high water, but these streams are sunk in deep, rocky canyons, and the amount of timber accessible by way of them is small.

BURNS.

The areas burned over during the last thirty-five or forty years aggregate 138,410 acres. The tracts are of varying extent and occur in all portions of the area, but more particularly in the northwest quarter, in the Boulder, Rosebud, and Rocky Fork drainage basins. They are of smaller extent in the southern third of the area, although by no means wholly lacking.

As far back as its history can be traced the forest has been more or less devastated by fires, its age and composition proving that these were very common and of wide extent during the Indian occupancy of the region. The large preponderance of lodgepole pine, is wholly the result of these fires, the great complexity and variation in the age of the stands indicating successive ones during centuries. Not less than 70 per cent of the forest land has been burned over within the last one hundred and twenty years, showing that since the coming of the white man there have been more fires than when the Indian held possession. In the last twenty-two years 24 per cent of the forest area has been burned, while during the one hundred and thirty years preceding about 45 per cent was swept by fire.

The forest fires in this region are remarkable for their destructive force and intensity. Here and there are uneven aged stands, where extremes in age and a

mixed composition prove that occasionally the fires did not consume or kill the entire stand. But as a rule most of the older fires made a clean sweep, and in nearly every instance the fires of modern date have done the same.

The destructiveness of the fires is due to the great quantities of litter which accumulate during the process of natural thinning, and also, to a lesser extent, to the character of the ground cover. Duff, or humus, is nearly lacking, except on a few of the northern slopes, and plays no particular part in the spread and intensity of the fires. The general ground cover consists of moss, usually a thin layer 2 or 3 inches in depth, a slight sprinkling of pine needles, low shrubs, mostly species of huckleberry, and more or less of a grassy turf or sward. During the dry season all this material burns readily, but does not make a hot or high flaming fire. It is different with the litter. The great mass of dry or partly dry wood of which it is composed makes hot and flaming fires, consuming or killing all live timber. The litter is derived in part from unconsumed débris left behind after previous fires, and in part from trees killed by excessive stockage and consequent overcrowding. The dense stockage is a sequel to fires and one of the phases of reforestation. When a tract of forest situated below the upper subalpine areas between the 8,000 and 6,500 foot levels is destroyed by fire lodgepole pine almost always follows as the primary restockage in at least 98 per cent of the cases. It is always set exceedingly close, having 10 to 20 seedlings to a square foot of ground in favorable situations. The close-set trees develop long, slender shafts, and as the stand becomes older the natural process of thinning begins. The final result is that when the stand reaches 80 to 100 years in age it is filled with long, slender dead trees, and is a veritable tinder box. Most of the stands of the ages mentioned are choked with such accumulations of dead and fallen timber. Further additions to the inflammable material are furnished by the wreckage of the former forest, as often in a forest through which fire has run there is left standing a mass of seasoning timber, although every tree may be killed. Gradually the fire-killed trees are thrown down by the wind, forming great tangled masses of kindling wood for future fires to feed on. All of the destructive fires of recent years appear to have originated, or at least to have gained headway, in the débris that litters the close-set lodgepole-pine stands, and as these constitute the great mass and hence the most valuable portions of the forest, they need to be particularly guarded.

RESTOCKAGE.

In the subalpine areas young growth is almost everywhere scanty, whether as restockage after fires or as the ordinary renewals in the growing forest. The grassy openings made by fires during the Indian occupancy are very slowly giving way to a young growth of spruce and white-bark pine. A potent cause for the

scantiness of the young growth in the subalpine forest is the low ratio of cone and seed production, characteristic of all subalpine trees when growing at high elevations. Some of the species, as the white-bark pine and subalpine fir, do not readily bear cones nor mature their seeds at any altitude in this region, and as most of the subalpine tracts are situated well above the limits of growth for the lodgepole pine, this tree, with its abundant seed production, does not become a factor in the restockage. The most prolific of the subalpine trees is the spruce, which in time is bound to form the larger proportion of this type of forest, and will be followed by the subalpine fir as taking second rank. The great snow banks, which each season pile up at these altitudes, likewise hinder restockage, as they bend and break multitudes of young trees beyond recovery.

The uppermost line of forest presents a ragged and wavy line, apparently advancing and receding from time to time, but there are no very definite indications of any change in the altitudinal limits of the general timber line within the life of the present forest. If any changes are now taking place they are wholly in the direction of an upward movement—that is, there is a tendency toward higher mean temperatures and less precipitation in the subalpine and alpine areas, with corresponding elevation of the timber line.

In the great mass of the forest between the low levels occupied by the woodlands and the subalpine zone reproduction is abundant where not interrupted by repeated fires over the same area. In the veteran stands where the composition of the forest approaches normal—that is, a preponderance of Engelmann spruce at the upper and intermediate levels and of red fir at the lower, young growth is present in sufficient quantities to maintain the density of the stands and their present composition. In the veteran stands composed of lodgepole pine young spruce and red fir are gradually regaining ground that they formerly occupied. In young and middle-aged stands the lodgepole pines are set so close that there practically can be no additions of any other species. The restockage on ground denuded by fire is nearly always composed of lodgepole pine, unless the tract is situated at low elevations where well-advanced growths of red fir prevailed on adjacent areas and lodgepole pine formed but a small percentage. In such cases the young growth is chiefly red fir. On tracts denuded by logging operations mixed stands composed of red fir, spruce, and lodgepole pine are apt to come in from the first, even if the pine forms the larger proportion of the surrounding forest. In some cases, at the lowest altitudes, aspen comes in and forms extensive and long persistent growths, whether the tract was denuded by fire or cut. The general rule, however, is that where openings are made in the forest either by fire or ax between altitudes of 6,400 and 7,900 feet, the species of inferior value, here the lodgepole pine, will form by far the largest percentage of the restockage, and will

continue to occupy the ground until, in the process of natural pruning and thinning, the more valuable and less tolerant red fir and spruce succeed in reestablishing themselves.

Openings made by fire are always more favorable to a larger per cent of lodgepole pine in the restockage than is the case where cutting has thinned or destroyed the stands. The cause for this is principally the destruction of the cover in the former case and its conservation in the latter, affording a proper germinating layer or seed bed for the seeds of the red fir and spruce, which in this region apparently need some such cover. Where fire destroys a restockage growing on a tract burned over fifteen or twenty years previously, some changes occur in the soil extremely inimical to any subsequent reforestation. Tracts of this sort are likely to become brush covered, and a decade or two may pass before forest growth again appears on them. Burns of this sort occur in the northwest and northeast quarters of the area. The common brush growth in such cases is composed of *Ceanothus velutinus* and *Shepherdia canadensis.*

Reproduction in the woodland areas is slow and sparse as a rule. The heavy grass cover more or less prevents germination of seeds of the coniferous trees composing the stands, and none of these species is at all prolific in seed production in this region. Exceptions to the general scarcity of seedling and sapling growth in the woodlands occur in T. 7 S., R. 18 E. Here tracts, formerly grass covered and aggregating 9,000 or 10,000 acres, have within the last thirty or thirty-five years been transformed from woodland to forest, with close-set stands of lodgepole pine and aspen, which have spread out from the forested mountain region in the township adjoining on the south.

TOWNSHIP DESCRIPTIONS.

IN THE ABSAROKA DIVISION.

Township 2 South, Range 14 East.

Topography.—The central and eastern portions of this township comprise masses of very steep and broken ridges, with an altitudinal range between the 5,000-foot and the 6,000-foot contours. In the extreme northern and in the western areas the ridges sink into a rolling foothill country intersected by numerous shallow ravines. The township forms the extreme northern end of the Yellowstone Forest Reserve, and its system of ridges and spurs represent the northern termination of the great mountain masses which constitute the eastern portion of the Boulder drainage in the central areas of the Absaroka division.

Mining.—None.

Soil.—Here and there in the valleys the soil is a gravelly loam. In some places it consists of clay and gumbo.

Agricultural adaptability.—Along the west line of the township in the Deer Creek drainage there are small tracts of tillable land. In general the region is much too rough and rolling to be cultivable, and lacks water for irrigation.

Grazing capacity.—The western and northeastern areas, composed chiefly of thinly stocked woodlands or of tracts devoid of trees, are suitable for stock ranges. Portions have long been used as sheep runs and have been more or less badly overgrazed

Drainage conditions.—The outflow originating in the township is of small volume, and is carried by upper Deer Creek. Most of the runs and ravines are dry during summer and fall.

Towns and settlements.—None.

Forest conditions.—The forest is composed of red fir, limber pine, and lodgepole pine, red fir being the prevailing species. On the northern slopes the stands are set close; elsewhere they are thin and scattering. Fifty per cent of the forest consists of young sapling stands—reforestations after fires that burned thirty to fifty years ago. The timber is difficult of access.

Woodlands.—The woodlands comprising the foothill region or tracts below the 5,500-foot contour carry a thin and scattering growth of limber pine, yellow pine, red fir, aspen, and cottonwood. The growth possesses only a fuel value.

Cutting.—Small quantities have been culled for farm use in various places along the north and west lines.

Burns.—Six or eight years ago extensive fires in the central portion of the township laid waste large blocks of red fir and lodgepole pine, and destroyed most of the standing timber on the tracts burned over.

Reproduction.—Reforestation is scanty on the more recent burns. The tendency is toward brush growth instead of timber. Red fir is the prevailing species in the restockage. On tracts burned over thirty or forty years ago close-set stands of red fir are coming in abundantly.

Undergrowth.—Light.

Litter.—On the burned-over tracts litter of dead and fallen and partly consumed timber is abundant; elsewhere there is little of this material.

Humus.—None.

Classification of lands in T. 2 S., R. 14 E.

	Acres.
Forested	9,540
Wooded	5,700
Nontimbered	7,800
Badly burned	3,800
Logged	None.
Agricultural	1,000
Grazing (including woodlands)	8,700
Bare rocks	1,000

Total stand of timber in T. 2 S., R. 14 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B.M.	*Cubic feet.*	*Cubic feet.*
Limber pine		3,000,000	3,000,000
Lodgepole pine		3,000,000	3,000,000
Yellow pine	800,000	500,000	644,000
Red fir	9,000,000	5,000,000	6,620,000
Engelmann spruce	550,000	400,000	499,000
Total	10,350,000	11,900,000	13,763,000

Composition of forest in T. 2 S., R. 14 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	15
Lodgepole pine	25
Yellow pine	.3
Red fir	56.7
Engelmann spruce	3

Township 3 South, Range 10 East.

Topography.—The portion of this township within the limits of the reserve has an area of 15,360 acres, consisting mostly of extremely steep, rough, and rocky crests, peaks, and slopes with deep and narrow intervening canyons. On the north and west the township is bordered by the levels of the Yellowstone Valley, from which, beyond an intermediate narrow strip of broken foothill region, the mountainous areas rise with steep, bold fronts to elevations of 10,000 feet. The summits of the ridges generally are narrow, and together with the upper slopes and their numerous precipitous rock escarpments, show everywhere deeply fissured, rapidly crumbling strata.

Mining.—None.

Grazing capacity.—The grazing areas of the township at the lower elevations consist of small parks and openings, scattered glades at the heads of the canyons, bare grass or sedge-covered ridges at or above timber line, and tracts temporarily deforested by recent fires; in all, 800 acres.

Agricultural adaptability.—No portion of the township is suitable for agricultural operations. The valleys are too narrow and stony, the slopes too high and steep, and, in general, the elevation too high.

Soil.—Generally thin, stony, and bowlder-strewn throughout.

Drainage and watershedding capacity.—The higher areas of the township shed large quantities of water, many of the high northern slopes carrying snow throughout

the summer. Much of the precipitation, however, is lost in the talus and débris which litters the valley bottoms and the slopes. The chief drainage channels are Deep, Suce, and Mission creeks, the waters of which are more or less utilized for irrigation purposes.

Towns and settlements.—None.

Forest conditions.—The forest generally is thinly stocked, with the exceptions of lodgepole-pine stands at middle elevations and small tracts of mixed growth along northern slopes bordering Mission Creek in its upper and western portions. Fifty per cent of the forest is composed of young growth 30 to 50 years old—reforestations after fires which burned that long since. All the slopes directly fronting on the Yellowstone Valley up to 7,000 feet bear stands composed of red fir to the extent of 95 per cent, mostly of the common, slender, eastern Montana type. The forest in the upper portions of the canyons and on the higher slopes is composed of stands of lodgepole pine, often 95 per cent pure, alternating with mixed stands of subalpine fir and Engelmann spruce, all of small size, even when of mature growth. The forest along the high crests and near timber line consists of more or less scattered trees of subalpine fir, white-bark pine, and Engelmann spruce, stocky and stunted in growth. As a whole the forest in the township is too small for mill timber, and is valuable chiefly for fuel, and most of all for the stability it imparts to the steep, loose, crumbling, and sliding mountain slopes that make up the larger portion of the township. All of the timbered areas are difficult of access.

Cutting.—Small quantities have been cut here and there on upper Suce and along the middle areas of Mission Creek.

Burns.—Burns have been frequent and extensive, both in past and in present times. All the young growth 30 to 50 years old, both of lodgepole pine and of red fir, as well as the old and mature, pure-stand, lodgepole-pine growths, mark clean-burning fires of various ages. The burns of recent times, swept clean of forest and not yet restocking, aggregate 3,800 acres.

Reproduction.—Reproduction is slow and deficient on all the recently burned-over ground and also throughout the thin and scattered subalpine forest. On areas burned over forty to sixty years ago young growth is abundant and is composed of red fir and lodgepole pine, set close and fully stocking the ground. In the mature, or partly mature, forest young growth is present in moderate quantities, sufficient to maintain the present density of stands.

Undergrowth.—On the burned-over slopes, which are not yet reforesting, brush growths composed chiefly of *Ceanothus velutinus* are abundant. In the close set sapling stands of red fir and lodgepole pine undergrowth is practically lacking. Throughout the older forest there is a moderate amount of scattered undergrowth composed of juniper scrub, alders, willows, and mountain ash.

Litter.—Abundant except in the subalpine areas. It consists of dead and down timber, in part the unconsumed débris remaining after fires and in part trees killed by crowding in the close-set lodgepole pine stands.

Humus.—None, or at the most a thin topping of moss and pine needles in the older forest.

Snow and rock slides.—Frequent throughout all of the higher areas of the township, as shown by the accumulations of débris in the bottom of the canyons.

Classification of lands in T. 3 S., R. 10 E

	Acres.
Forested	6,560
Nonforested	8,800
Badly burned	3,800
Logged (culled)	250
Agricultural	None.
Grazing	1,000
Bare rocks	4,000

Total stand of timber in T. 3 S., R. 10 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	1,600,000	4,500,000	4,788,000
White-bark pine		800,000	800,000
Red fir	1,200,000	2,000,000	2,216,000
Subalpine fir		800,000	800,000
Engelmann spruce	2,600,000	550,000	1,018.000
Total	5,400,000	8,650,000	9,622,000

Composition of forest in T. 3 S., R. 10 E., including trees of all species with basal diameters of 8 inches and upward.

	Per cent.
Lodgepole pine	60
White-bark pine	2
Red fir	28
Subalpine fir	5
Engelmann spruce	5

Township 3 South, Range 11 East.

Topography.—All of the township with the exception of the northeast quarter and a portion of the southeast quarter consists of a rough, deeply sculptured mass of mountains, which in the most elevated portions attains altitudes of nearly 10,000 feet. The ridges and spurs are narrow, rocky, steep, and precipitous, crowned with serrated and pinnacled crests. The canyons, generally contracted and cliff-bound, are littered with great accumulations of bowlders. The northeast quarter of the township comprises a rolling foothill region, in which narrow creek val-

leys and swales separate long easterly and westerly combs and ridges. The southeast corner of the tract is chiefly comprised in the valley of West Boulder River, a depression 600 to 700 feet below the summits of the inclosing ridges, here broad and open, but near the south line of the township contracting into a canyon.

Mining.—None.

Soil.—Throughout the mountain areas the soil is thin and stony, and the surface is littered with bowlders. In the foothill region in the northeast quarter of the township the swales and creek bottoms have a deep, rich, loamy soil, while the ridges generally are stony and strewn with great masses of bowlder drift. The bottom lands in West Boulder River have a thin, loamy soil, resting on clear gravel and boulder drift.

Agricultural adaptability.—The swales and creek bottoms in the foothill region and the bottom lands in West Boulder Valley are agricultural in character and are occupied and in cultivation wherever irrigation is possible. The mountain areas contain no agricultural lands.

Grazing capacity.—All of the northeast quarter of the township that is not susceptible of tillage and that does not bear forest is grazing land. Small tracts of grass land also occur in the valley of the West Boulder and as scattered glades along the creek bottoms throughout the mountain areas. In the aggregate the grazing lands comprise 3,500 acres.

Drainage conditions.—The run-off is abundant. Small pools and springs are numerous at the heads of the canyons. Many of the high northern slopes hold banks of snow throughout the year. Much of the run-off sinks and is lost in the steeply upturned and deeply fissured limestone strata of the region, and in the vast morainic accumulations in the larger canyons. Where conditions are favorable the streams are utilized for irrigation purposes.

Snow and rock slides.—Common and frequent at all seasons. Enormous masses of overhang, mostly fissured and rapidly crumbling, occur all along the higher summits, while the talus slopes are loose and sliding on substrata of wet, clayey mud.

Towns and settlements.—There are no towns. Settlers are living on the cultivated areas in the northeast quarter of the township and in the West Boulder Valley up to the south line of the township.

Forest conditions.—With the exception of the lower areas in the canyon of Davis Creek, a tributary of the West Boulder entering along the south line of the township, the forest is composed of stands thinly stocked, in so far as relates to the mature forest. Small tracts of the slopes adjacent to the foothill region carry moderately well-stocked stands of sapling red fir, which is the prevailing species in all the lower areas of the northern portion of the township. The foothill region is sparsely stocked with scattering stands of this species along the creek bottoms and on northern

slopes of the combs and ridges. In the interior portions of the township lodgepole pine, Engelmann spruce, and subalpine fir form the forest in the valley bottoms and at middle elevations. At higher altitudes the lodgepole pine thins out and is replaced by white-bark pine. The forest is much broken and irregular, owing to the many small burns and bare rocky expanses devoid of soil that occur everywhere in the region. All ages of growth are represented, from pole stands 30 to 40 years old to mature stands 150 to 200 years old. One-fourth of the forest is less than 100 years old. The heaviest stand, and the most prolific in mill-timber dimensions, occurs in the Davis Creek bottoms along the south line of the township. It yields from 5,000 to 10,000 feet B. M. to the acre and is composed principally of red fir 120 to 175 years old, with small proportions of spruce and the western white pine (*Pinus monticola*).

Cutting.—The stands in West Boulder Valley were cut and culled 75 per cent at the time of the Northern Pacific Railroad construction to furnish tie timber. Small areas in the foothills have also been cut over to supply local demands for fuel and poles.

Burns.—Small areas of burns, 6 to 20 years old, are scattered throughout the forest. The largest tracts of burned forest are situated in and contiguous to West Boulder Valley. They comprise in the aggregate 3,200 acres, and are practically clean burns, all the timber having been either consumed or killed.

Reproduction.—Reproduction is slow and deficient on all the higher slopes and summits. It is moderate at middle elevations except on the burns, where, outside of West Boulder Valley, there is little or no young growth. On the burns where restockage has begun lodgepole pine is the leading species. In the foothill region and on the slopes fronting on those areas red fir is the predominating species. In the mature forest there is a moderate amount of young growth composed of the same species which form the old growth.

Undergrowth.—The undergrowth is scanty. It is composed of willows, alders, juniper scrub, and the like.

Litter.—Litter is abundant in the more vigorous and close-set stands; elsewhere there is little. It is chiefly composed of the unconsumed débris from former fires and of trees killed by overcrowding.

Humus.—On northern slopes a thin cover of moss and pine needles.

Classification of lands in T. 3 S., R. 11 E.

	Acres.
Forested	10,160
Nonforested	12,880
Badly burned	3,200
Logged	1,600
Agricultural	1,800
Grazing	3,500
Bare rocks	4,380

Total stand of timber in T. 3 S., R. 11 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Limber pine		80,000	80,000
Lodgepole pine	1,500,000	1,800,000	2,070,000
White pine	500,000	300,000	390,000
White-bark pine		500,000	500,000
Red fir	21,000,000	12,000,000	15,780,000
Subalpine fir		4,000,000	4,000,000
Engelmann spruce	6,500,000	5,000,000	6,170,000
Total	29,500,000	23,680,000	28,990,000

Composition of forest in T. 3 S., R. 11 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	0.2
Lodgepole pine	10.8
White pine	.1
White-bark pine	3.9
Red fir	62
Subalpine fir	15
Engelmann spruce	10

Township 3 South, Range 14 East.

Topography.—This township comprises a mass of steep, precipitous spurs and ridges rising to altitudes of 7,200 feet, which mark the northern terminations of the mountains of the Boulder drainage. It is drained partly by Deer Creek, and partly by East Boulder River.

Mining.—None.

Soil.—Gravelly loam, clayey and gumbo-like in places.

Agricultural adaptability.—None.

Grazing capacity.—Small tracts in the western areas, chiefly deforested hillside, are grassed over and furnish limited areas of pasturage.

Drainage conditions.—The run-off at the time of the spring break-up is large, but, owing to the very steep and broken character of the region, does not last long. During the summer the creeks and rivulets heading in the tract are either dry or carry only an insignificant amount of water.

Snow and rock slides.—Frequent in the central areas of the tract.

Towns and settlements.—None.

Forest conditions.—The stands are very much broken and scattered owing to the rocky ground and the extensive fires that have invaded the region. The

higher areas bear stands of lodgepole pine, mostly in the sapling stage. At middle and lower elevations red fir is the leading species, 50 per cent of the timber being sapling growth.

Woodlands.—The southeast and the northwest corners of the township are lightly stocked with timber and constitute woodland. The growth consists of limber pine, scattered yellow pine, and copses of red fir.

Cutting.—None.

Burns.—Extensive fires have run throughout the central and western areas. They date back six or seven years, and have destroyed all of the timber on the areas where they burned.

Reproduction.—Deficient on the burned-over areas; abundant elsewhere. Red fir predominates in all the young growth.

Undergrowth.—Scanty.

Litter.—Abundant on the burned-over ground.

Humus.—None.

Classification of lands in T. 3 S., R. 14 E.

	Acres.
Forested	7,060
Wooded	2,800
Nontimbered	13,180
Badly burned	9,500
Logged	None.
Agricultural	None.
Grazing	1,680
Bare rocks	2,000

Total stand of timber in T. 3 S., R. 14 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Limber pine		1,300,000	1,300,000
Lodgepole pine		1,500,000	1,500,000
White-bark pine		300,000	300,000
Red fir	12,000,000	4,000,000	6,160,000
Engelmann spruce	300,000	100,000	154,000
Total	12,300,000	7,200,000	9,414,000

Composition of forest in T. 3 S., R. 14 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	8
Lodgepole pine	35
White-bark pine	1
Yellow pine	Scattered trees.
Red fir	53
Subalpine fir	.2
Engelmann spruce	2.5
Aspen and cottonwood	.3

Township 3 South, Range 15 East.

Topography.—This township comprises a tract of country situated at the head of Bridger and lower Deer creeks and forms the termination of one of the long northerly spurs which stretch out from the great mountain masses in the Boulder drainage to the south. It possesses a very rough relief, the entire township, with the exception of a narrow strip along the east line, being a succession of steep, rocky ridges and narrow, cliff-bound canyons. The altitude varies from 5,600 to 7,000 feet.

Mining.—None.

Soil.—Gravelly and clayey loam.

Agricultural adaptability.—The township contains no tillable land owing to its exceedingly rough surface.

Grazing capacity.—The southeastern and northern areas are in part well grassed and have long been used as pasture grounds, chiefly for cattle, and, to a lesser extent, for sheep. The pasturage is mostly bunch grass and has not been seriously overgrazed in any locality.

Drainage conditions.—The outflow from the township is carried by Bridger and lower, or East Deer, creeks. The multitude of runs and ravines which intersect the tract are mostly dry throughout the greater part of the year. The total run-off on the areas embraced within the tract is of insignificant volume.

Snow and rock slides.—Not infrequent in the central portions of the tract along the steep slopes of lower Deer Creek.

Town and settlements.—None.

Forest conditions.—The forest consists of red fir and limber pine at lower elevations with tracts of lodgepole pine at the highest altitudes. In general the stands are thin, and are scattered as copses of varying extent over the rocky slopes. Here and there at the head of Bridger Creek and in the middle areas of the Deer Creek drainage are a few close-set stands of red fir. The red fir growth is largely composed of mature stands, while the lodgepole pine is chiefly in the pole and sapling stage.

Woodlands.—The extreme eastern and parts of the northern areas are thinly stocked with red fir and limber and yellow pine, and constitute woodlands. Climatic conditions in part, but chiefly often repeated fires during the Indian occupancy of the region, are the causes of the thinly stocked conditions of the woodlands. Most of the area is capable of supporting moderate stands of forest.

Cutting.—Small areas along Deer Creek in the northern portion of the township have been cut over to supply local demands.

Burns.—The burned-over tracts are mostly confined to the southwest quarter of the township in the lodgepole pine stands, and are eight to ten years old. The destruction of timber on them has been complete.

Reproduction.—Scanty in the woodlands and in the lodgepole pine growths as well as on the burned-over areas. Young growth is abundant in the red-fir stands, and is composed almost wholly of this species.

Undergrowth.—Very light.

Litter.—Abundant on the burned-over tracts; little in other localities.

Humus.—None.

Classification of lands in T. 3 S., R. 15 E.

	Acres.
Forested	11,040
Wooded	3,800
Nontimbered	8,200
Badly burned	3,000
Logged (culled)	600
Agricultural	None.
Grazing	4,200
Bare rocks	1,000

Total stand of timber in T. 3 S., R. 15 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Limber pine	1,000,000	3,000,000	3,180,000
Lodgepole pine	2,000,000	6,000,000	6,360,000
Red fir	10,800,000	5,500,000	7,444,000
Engelmann spruce	500,000	.....	90,000
Total	14,300,000	14,500,000	17,074,000

Composition of forest in T. 3 S., R. 15 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	10
Lodgepole pine	35
Red fir	53
Engelmann spruce	2

Township 4 South, Range 10 East.

Topography.—This township comprises high, rough mountains rising to elevations of 10,000 feet, abounding with precipices and sharp declivities. The summits are rocky, fissured, and crumbling, and the canyons are narrow and littered with talus accumulations and débris swept down from the mountain sides by avalanches and landslips. Only 21,120 acres of this township are within the reserve, three sections, or 1,920 acres, in the northwest corner being excluded.

Mining.—None.

Soil.—All of the soil, except a thin top-dressing of loam, is derived from hard, granitic rocks and is highly siliceous and sterile. It rests on gravel and bowlders.

Agricultural adaptability.—The steep slopes, rocky and sterile soil, and high altitude render the land unfit for agriculture.

Grazing capacity.—The township has no grazing value.

Drainage conditions.—There is a large run-off from the high areas of the township, but most of it is absorbed or sunk in the talus and morainic débris of the lower slopes and valleys, and comparatively little reaches the levels of the Yellowstone Valley. The waters of the streams flowing from the western areas of the township are used to some extent for irrigation in the Yellowstone Valley.

Snow and rock slides.—Avalanches of snow and rock are of frequent occurrence throughout all the higher areas.

Towns and settlements.—The township is uninhabited.

Forest conditions.—The forest consists of thin stands of white-bark pine, Engelmann spruce, and subalpine fir, scattered among the breaks of the slopes and around the heads of the canyons, while in the valley bottoms lodgepole pine, chiefly a sapling growth thirty to forty years old, forms the prevailing timber. Red fir occurs on the lower and warmer slopes of the western areas. Most of the timber is situated in inaccessible places and has only a fuel value.

Cutting.—Small quantities have been cut in the western areas for farm use in the Yellowstone Valley.

Burns.—The burns are confined to the western areas and aggregate 1,800 acres.

Reproduction.—The reproductive capacity of the subalpine forest is low. In the lodgepole pine stands at middle and lowest elevations young growth is abundant and vigorous. The burns are restocking chiefly with lodgepole pine in place of the former red fir and spruce.

Undergrowth.—Brush growth is moderately abundant except in the subalpine forest, where it is light or lacking. It consists of cherry, juniper, juneberry, *Ceanothus*, and huckleberry of several different species.

Litter.—In the lodgepole-pine stands litter is abundant. It consists of dead and

down timber, partly the result of past fires, and partly of trees killed by overcrowding in the too close-set stands.

Humus.—Lacking, or a thin moss cover, on the northern slopes.

Classification of lands in T. 4 S., R. 10 E.

	Acres.
Forested	8,900
Nonforested	12,220
Badly burned	1,800
Logged	None.
Agricultural	None.
Grazing	None.
Bare rocks and alpine	10,420

Total stand of timber in T. 4 S., R. 10 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	2,000,000	6,000,000	6,360,000
White-bark pine		430,000	430,000
Red fir	2,000,000	3,000,000	3,360,000
Subalpine fir		1,800,000	1,800,000
Engelmann spruce	500,000	2,000,000	2,090,000
Total	4,500,000	13,230,000	14,040,000

Composition of forest in T. 4 S., R. 10 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	65
White-bark pine	2
Red fir	20
Subalpine fir	9
Engelmann spruce	4

Township 4 South, Range 11 East.

Topography.—The western part of the township comprises a rugged mass of mountains—a portion of the main divide of the Absaroka Range. The central areas are cut by the narrow and cliff-bound trough of West Boulder Canyon, while the eastern portion consists of an elevated block of granite known as West Boulder Plateau, which rises to an altitude of nearly 11,000 feet, and has a broad undulating surface littered with great fields of bowlders. The plateau breaks off on the east and west by sheer descents, 1,000 to 1,500 feet in depth, while short, bowlder-littered canyons cut into its sides between immense, precipitous walls of rock.

Mining.—None.

Soil.—Stony and gravelly glacial débris, with thin top-dressings of loam.

Agricultural adaptability.—None; the mountainous and elevated character of the region makes agriculture an impossibility.

Grazing capacity.—A number of wet meadows and glades in the West Boulder Canyon are adapted to grazing purposes. The summit of West Boulder Plateau is covered with alpine sedges and grass and can be pastured, although access is difficult.

Drainage conditions.—The tract has a large outflow. Springs, marshy tracts, rivulets, and creeks are numerous. Small ponds occur here and there. A large quantity of the outflow sinks in the talus slopes and glacial litter that lie in the valley of the West Boulder, and does not reappear either in the township or outside.

Towns and settlements.—The township contains no settlements.

Forest conditions.—The eastern areas carry no forest on the summit of West Boulder Plateau and only a thin subalpine growth along the upper line of breaks. In the valley the stands are composed of thickset lodgepole pine, with spruce and red fir, the latter reaching a height of 100 feet and a diameter of 3 feet. The stands in the extreme northeast corner consist chiefly of 25 to 30 years old lodgepole pine. The western areas of the township are in part situated above timber line, and in part bear thin, scattering stands of subalpine species. The bottoms of the West Boulder are not difficult of access and much of the timber standing there can be floated down the stream during high water. The timber on the higher slopes can not readily be reached.

Cutting.—In the West Boulder Valley, near the north line of the township, the timber on 1,800 acres was culled 60 per cent by tie cutters in 1882–83.

Burns.—Severe burns visited portions of the tract in 1882–83 and at intervals since that time. The burns are confined chiefly to the northern portion of the township, where they occur on the slopes of West Boulder Plateau, near the outlet of Davis Creek and along the west bank of Boulder River.

Reproduction.—There is as yet no restocking of the burned-over areas near Davis Creek nor on the higher slopes of West Boulder Plateau. Elsewhere in the township sapling growth is exceedingly abundant outside the subalpine areas, lodgepole pine everywhere replacing the burned red fir. Large tracts of the burns have restocked with close-set stands of aspen, which here and there is giving way to lodgepole pine.

Undergrowth.—Abundant throughout, except at subalpine elevations.

Litter.—Abundant almost everywhere. On the burned-over areas the litter is enormous in quantity. The fire ran through exceedingly close-set lodgepole pine stands without consuming the trees, merely killing them, and the dead timber, now falling, forms almost impenetrable masses of woody débris.

Humus.—In the unburned forest, especially in the bottoms of West Boulder Valley, a layer of moss 6 to 8 inches deep forms the humus. In the drier situations this layer is only an inch or two in depth.

Classification of lands in T. 4 S., R. 11 E.

	Acres.
Forested	10,240
Nonforested	12,800
Badly burned	2,400
Logged	1,800
Agricultural	None.
Grazing	4,500
Bare rocks	5,100
Ponds and streams	800

Total stand of timber in T. 4 S., R. 11 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	10,000,000	14,000,000	15,800,000
White-bark pine	----------	3,000,000	3,000,000
Red fir	18,000,000	6,000,000	9,240,000
Subalpine fir	----------	3,000,000	3,000,000
Engelmann spruce	12,000,000	5,000,000	7,160,000
Total	40,000,000	31,000,000	38,200,000

Composition of forest in T. 4 S., R. 11 E., including trees of all species with basal diameters of 8 inches and upward.

	Per cent.
Lodgepole pine	40
White-bark pine	2.2
Red fir	35
Subalpine fir	2
Engelmann spruce	20
Aspen and cottonwood	.8

Township 4 South, Range 12 East.

Topography.—The western and central areas of the township consist of high, rocky spurs stretching eastward from the so-called West Boulder Plateau. They attain elevations of 10,000 feet and end with steep, bowlder-strewn fronts on the valley of Boulder River, which cuts through the eastern part of the township. The bottoms of this valley, one-fourth mile or less in width, consist of two or three low terraces. The valley is hemmed in on the west and east by steep, cliff-lined,

talus-covered slopes rising 2,500 to 3,000 feet before merging with the summit levels of the inclosing ridges.

Mining.—Placer claims and prospects on quartz leads of uncertain value are located along Boulder Valley. None are ore producing, and the placers are not now worked for their mineral contents, but have mostly been turned into hay meadows and pastures.

Minerals.—Gold.

Soil.—Thin and gravelly, consisting almost wholly of detritus derived from hard, siliceous granite rocks, with a slight top-dressing of loamy matter. Much of the levels and terraced slopes in the Boulder Valley are thickly strewn with bowlders.

Agricultural adaptability:—Small tracts of land on the lowest terraces in the Boulder Valley are utilized for agriculture. In the aggregate 1,200 acres are cultivable. The slopes and summits of the ridges and spurs are too steep and rocky, and situated at too high altitudes to be available for farming.

Grazing capacity.—The tracts at present utilized for pasture comprise 4,500 acres, and consist of temporarily deforested fire glades in the Boulder Valley and of alpine and subalpine meadows on the high summits bordering the valley.

Drainage conditions.—A large volume of run-off originates in the township. The district contains no lakes nor tarns, but the high areas in the western and central portions give rise to numerous creeks. The drainage is carried by Boulder River, which here is from 25 to 35 feet wide, with a depth varying from 14 to 25 inches at medium stage of water. The stream along its lower courses in the townships north of the reserve is of great importance in irrigation work.

Snow and rock slides.—Of frequent occurrence along the steep breaks of Boulder Valley.

Towns and settlements.—The district contains no towns. Farmsteads are scattered along Boulder Valley on the agricultural lands. Near the north line of the township, in the valley, is a small collection of houses, or a sort of hamlet, named Contact. Miners' cabins are scattered throughout the mineral-bearing areas.

Forest conditions.—The forest is thinly stocked. At low altitudes it consists of small stands of lodgepole pine and red fir, surrounded by extensive burns, while at higher elevations thin lines of trees and copses of small extent are scattered among the rocky breaks and grassy glades. Most of the timber grows in inaccessible places and has only a fuel value.

Cutting.—The timber in the accessible portions of the Boulder Valley was culled by tie makers in 1882–83. Since then most of the cutting has been to supply the local demand of the farmers in the region. Small quantities have been cut here and there by prospectors and miners. In all, 2,500 acres have been cut over, and 60 per cent of the timber on these tracts removed.

Burns.—The region has been visited by severe and extensive fires, mostly during 1882–83. The immediate valley of Boulder River has suffered most severely, and many of the fires have been clean burning, consuming everything. In the aggregate, 7,600 acres have been burned over.

Reproduction.—The restocking processes throughout the district are slow and deficient. In the subalpine areas young growth is scanty. The burned-over tracts are reforesting tardily, lodgepole pine at low and middle elevations everywhere replacing the former stands of red fir.

Undergrowth.—The brush growth is scanty except here and there on the burned-over tracts, where close growths of *Ceanothus* are occupying the ground and preventing reforestation.

Litter.—In portions of the burned-over ground and in lodgepole-pine stands 75 to 90 years old are large accumulations of dead and fallen pole timber in various stages of decay.

Humus.—None.

Classification of lands in T. 4 S., R. 12 E.

	Acres.
Forested	6,000
Nonforested	17,040
Badly burned	7,600
Logged and culled over	2,500
Agricultural	1,200
Grazing	3,000
Bare rocks and alpine	5,240

Total stand of timber in T. 4 S., R. 12 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B.M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine		4,000,000	4,000,000
White-bark pine		200,000	200,000
Red fir	2,800,000	2,500,000	3,004,000
Subalpine fir		350,000	350,000
Engelmann spruce	800,000	500,000	644,000
Total	3,600,000	7,550,000	8,198,000

Composition of forest in T. 4 S., R. 12 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	50
White-bark pine	.5
Red fir	45
Subalpine fir	1.5
Engelmann spruce	3

Township 4 South, Range 13 East.

Topography.—The western and central areas comprise high, subalpine tracts rising to altitudes of 10,000 feet. In the eastern areas the narrow, rocky canyon of the East Boulder cuts through the mountains, which, on the eastern side of the canyon, again rise steeply to subalpine heights.

Mining.—None.

Soil.—Gravelly loam, mostly stony and strewn with bowlders.

Agricultural adaptability.—Small tracts, in all 500 acres, situated in the canyon of the East Boulder are tillable. The remainder of the township is too high and rocky for agriculture.

Grazing capacity.—The township contains no proper grazing lands. Small glades and temporarily deforested burns are used as pasture ground by the few settlers in Boulder Valley.

Drainage conditions.—The high subalpine areas, from which snow is never absent any great length of time, discharge a large amount of water, most of which runs off by way of East Boulder Canyon. The tract as a whole is an important natural reservoir for maintaining the flow in the main Boulder River, the water of which is largely used for irrigation purposes on the agricultural lands adjoining the Yellowstone Valley.

Snow and rock slides.—Frequent in the high areas in the southeast corner of the township.

Towns and settlements.—Six settlers live on the agricultural lands in East Boulder Canyon. Outside this area the township is not inhabited.

Forest conditions.—The lower portions of East Boulder Canyon bear close-set stands of red fir, lodgepole pine, and spruce, one-third of which is sapling growth, representing reforestations after fires which burned a half century ago. The old growth varies from 120 to 175 years of age. The red fir is mostly of the tall, slender type, the spruce of the low, stocky, limby form. The subalpine species are scattered, some as small copses or thin lines, others in compact stands of larger extent. This township at its lower and middle elevations, and particularly in the East Boulder canyons, has been one of the best stocked townships in the reserve, but owing to fires has lost most of its timber during the last twenty or twenty-five years.

Cutting.—The cutting has been confined to the lower portions of Boulder Canyon. Part of the cut has been for local and farm use, part for sawmill purposes. The cut and culled areas aggregate 1,500 acres.

Burns.—Extensive burns have devastated the township, chiefly in the southern and eastern areas, destroying the forest on 5,700 acres.

Reproduction.—Restocking of the recent burns has not yet begun. On the older burns a close-set young growth of lodgepole pine is replacing the former

stands of spruce and red fir. In the subalpine stands young growth is moderately abundant, and is sufficient to maintain the present density of the forest. It is chiefly composed of Engelmann spruce.

Undergrowth.—Dense willow and alder brush are abundant in the canyon bottoms and on the lower slopes. In the subalpine stands there is little underbrush.

Litter.—Throughout the burns and in the sapling stands there is a great deal of litter consisting of dead and fallen fire-killed timber in various stages of decay.

Humus.—The humus on northern slopes consists of a thin moss cover, and elsewhere of light layers of pine needles.

Classification of lands in T. 4 S., R. 13 E.

	Acres.
Forested	14,440
Nonforested	8,600
Badly burned	5,700
Logged	1,500
Agricultural	500
Grazing	None.
Bare rocks	2,000
Lakelets, tarns, and streams	400

Total stand of timber in T. 4 S., R. 13 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	10,000,000	16,000,000	17,800,000
White-bark pine		2,000,000	2,000,000
Red fir	8,000,000	5,000,000	6,440,000
Subalpine fir		4,000,000	4,000,000
Engelmann spruce	6,000,000	2,000,000	3,080,000
Total	24,000,000	29,000,000	33,320,000

Composition of forest in T. 4 S., R. 13 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	60
White-bark pine	4
Red fir	10
Subalpine fir	10
Engelmann spruce	16

Township 4 South, Range 14 East.

Topography.—The western and central areas of the township comprise steep, rough mountains rising to elevations of 10,000 feet. In the eastern areas the slopes gradually spread out and form long and comparatively low ridges and spurs.

Mining.—None.

Soil.—Stony, gravelly, and strewn with bowlders.

Agricultural adaptability.—The region is worthless for agriculture, owing partly to its thin and stony soil, but chiefly to its high altitude.

Grazing capacity.—No portion of the region is a proper grazing tract, but the woodlands in the northeast corner of the township, comprising 2,000 acres, have a grass and sedge cover, and would serve for pasturage purposes.

Drainage conditions.—The run-off is small in volume, and is mostly confined to the western slope, whence it flows into East Boulder River. On the eastern areas of the township most of the water channels are dry runs during the larger portion of the year.

Snow and rock slides.—Infrequent.

Towns and settlements.—None.

Forest conditions.—The forest is of the subalpine type. Along creeks and on northern slopes of ridges where it has not been destroyed by fire it is generally low and scrubby, and consists of scattered patches and isolated stands. It has only a fuel value. Much of it forms the timber-line fringe of arborescent growth, and is depressed to the stature of shrubs.

Woodlands.—The timber growth in the northeast corner of the township consists of scattered trees and small copses, chiefly limber pine, with small proportions of red fir, and constitutes woodlands. The tract contains 2,000 acres, and the timber on the same has only a fuel value.

Cutting.—None.

Burns.—Extensive burns occur throughout the forested areas. They date back seven or eight years, and have destroyed the timber on over 14,000 acres.

Reproduction.—Scanty throughout and on the burned areas mostly lacking. The woodlands have scarcely any young growth. Lodgepole pine forms the bulk of the restockage at the higher elevations, red fir at lower altitudes.

Undergrowth.—Very light.

Litter.—The burned-over areas are encumbered with large quantities of partly consumed woody débris. In the woodlands litter is lacking.

Humus.—None.

Classification of lands in T. 4 S., R. 14 E.

	Acres.
Forested	3,900
Wooded	2,000
Nontimbered	17,140
Badly burned	14,530
Logged	None.
Agricultural	None.
Grazing	None.
Bare rocks and alpine	2,610

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Total stand of timber (pole and fuel) in T. 4 S., R. 14 E.

	Cubic feet.
Limber pine	1,000,000
Lodgepole pine	2,000,000
White-bark pine	500,000
Red fir	500,000
Subalpine fir	850,000
Engelmann spruce	600,000
Total	5,450,000

Composition of forest in T. 4 S., R. 14 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	75
White-bark pine	4
Subalpine fir	10
Engelmann spruce	11

Composition of the woodland growth in T. 4 S., R. 14 E.

	Per cent.
Limber pine	80
Red fir	20

Township 4 South, Range 15 East.

Topography.—The relief of the region is made up of numerous low ridges and combs, separated by comparatively broad and shallow canyons; the whole forms a sort of rolling plateau region constituting foothill country on the western slopes of the East Boulder-Stillwater divide.

Mining.—None.

Soil.—Gravelly loam is found in the southwestern areas. In the remainder of the township the soil is clayey and gumbo-like.

Agricultural adaptability.—The rolling character of the region and the impossibility of irrigation in the district preclude agricultural operations.

Grazing capacity.—Practically the entire township is a grazing area. In the northwest corner of the township fire has destroyed the forest cover on a small tract and made it temporarily available for grazing. With the exception of this area, all of the woodlands and the nontimbered tracts, separating the different stands of arborescent growth, are covered with a thick and close sward of bunch grasses, not yet very closely pastured.

Drainage conditions.—The outflow from the township is insignificant in volume. Most of the creeks and canyons are mere dry runs. The lack of water is probably the reason for the small amount of pasturing to which the tract has been subjected.

Snow and rock slides.—None.

Towns and settlements.—None.

Forest conditions.—The township contains no forest.

Woodlands.—The woodlands comprise 60 per cent of the tract. The timber occurs as small copses, thin lines, and single trees scattered over the entire tract. The growth is composed of limber pine, red fir, and yellow pine. The pines are mostly old growths, while of the red fir 50 per cent are sapling stands.

Cutting.—None.

Burns.—In the northwest corner 1,500 acres of land formerly forest covered have been burned over within the past six or eight years.

Reproduction.—Red fir is reproducing freely, and in many places along the west line of the township this species is encroaching on the woodland area. The reproduction of the limber and yellow pine is slow and deficient.

Undergrowth.—Very sparse; in most places lacking.

Litter.—None.

Humus.—None.

Classification of lands in T. 4 S., R. 15 E.

	Acres.
Forested	None.
Wooded	13,000
Nontimbered	10,040
Badly burned	1,500
Logged	None.
Agricultural	None.
Grazing	8,540

Total stand of timber in T. 4 S., R. 15 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Limber pine		850,000	850,000
Yellow pine	100,000	50,000	68,000
Red fir	400,000	900,000	972,000
Total	500,000	1,800,000	1,890,000

Composition of forest in T. 4 S., R. 15 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	37
Yellow pine	2
Red fir	60
Aspen and cottonwood	1

TOWNSHIP 4 SOUTH, RANGE 16 EAST.

Topography.—The township consists of a rolling table-land varying in elevation from 5,500 to 6,000 feet. It is cut and furrowed by numerous shallow canyons, ravines, and gullies, and in its eastern portion by the valley of Stillwater River.

Mining.—None.

Soil.—Clayey loam. Sandy, gravelly, and bowlder-strewn tracts are of common occurrence in the valleys.

Agricultural adaptability.—The valleys are agricultural where not too stony. In some localities the uplands are tillable without irrigation, but in general the higher ground can not be cultivated successfully without irrigation.

Grazing capacity.—The entire township, outside the tracts actually in cultivation, is essentially a grazing area.

Drainage conditions.—Very little drainage originates in the township. Water for irrigation is obtained from the streams, chiefly from Stillwater River, that head in the mountain regions to the south.

Snow and rock slides.—None.

Towns and settlements.—Farmsteads are scattered throughout the township on the agricultural lands. There are no villages or towns.

Forest conditions.—The township contains no forested areas.

Woodlands.—Scattered trees and small copses of aspen, red fir, and limber pine occur over most of the township. The growth is too thin to classify the tract even as woodland, in the strict sense of the word.

Cutting.—The timber has been culled over throughout for farm uses.

Burns.—None.

Reproduction.—There is a moderate amount of young growth in the southern portions of the township, where stands of red fir are springing up on many of the northern slopes and show a marked tendency to spread into the adjoining grassy, nontimbered areas. Most of the district is capable of supporting moderately well-stocked stands of red fir and limber pine. Its present grassy, lightly timbered condition is wholly due to repeated fires during centuries of Indian occupancy, with the consequent suppression of seedling growth.

Undergrowth.—None.

Litter.—None.

Humus.—None.

Classification of lands in T. 4 S., R. 16 E.

	Acres.
Woodland grazing	20,500
Agricultural	2,540

Total stand of timber (pole and fuel) in T. 4 S., R. 16 E.

	Cubic feet.
Limber pine, yellow pine, red fir	900,000

Composition of the woodland stands in T. 4 S., R. 16 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	30
Yellow pine	20
Red fir	50

Township 4 South, Range 17 East.

Topography.—This township consists of rolling plains intersected by small draws and creek bottoms and, in the western areas, cut by the comparatively level and shallow valley of Stillwater River. Bluffs and steep escarpments of rock border most of the larger creek valleys.

Mining.—None.

Soil.—Sandy and gravelly loam, here and there bowlder strewn; the loam is deep and rich.

Agricultural adaptability.—The lands are agricultural wherever irrigation is possible.

Grazing capacity.—The tract is grass covered throughout where not cultivated. It has been badly overgrazed in all localities.

Drainage conditions.—Small springs occur here and there. Very little drainage originates on the tract. Most of the runs and creeks heading in the township are dry during the greater part of the year.

Towns and settlements.—There are no towns in the region; farmsteads occur wherever agriculture is possible, particularly in Stillwater Valley.

Forest and woodland conditions.—The township contains no forested areas. The woodlands consist of scattered limber pine and occasional yellow pines, small aspen groves and cottonwood along the creek bottoms and around springy places—practically merely small wood lots.

Township 5 South, Range 10 East.

Topography.—This township comprises a portion of the main Absaroka range situated between the drainage of West Boulder River and Yellowstone River on the west. It is a rough bed of mountains, chiefly situated above the 9,000-foot contour, a few of the peaks rising to elevations of 11,200 feet. It is deeply and boldly sculptured, and bristles with jagged summits, overhangs, and pinnacles.

Mining.—None.

Soil.—Thin, stony, and bowlder strewn. Much of the higher areas are entirely devoid of soil.

Agricultural adaptibility.—The altitude of the township prevents agriculture.

Grazing capacity.—In all places in the alpine and higher subalpine areas where a soil cover exists the ground is covered with a grassy or sedgy turf. All of these tracts are inaccessible for stock.

Drainage conditions.—The volume of water flowing from the township is large. Part of it drains into West Boulder River and part into the Yellowstone on the west through various small creeks, the waters of which are used for irrigation purposes in Yellowstone Valley.

Snow and rock slides.—Favored by the steep slopes, precipices, and unstable conditions of the talus slopes, snowslides and rock slips are of frequent occurrence.

Towns and settlements.—The township is uninhabited.

Forest conditions.—The high elevation of the region is prohibitive to an extensive development of the forest. Most of the tract is situated above timber line. The forest is largely of the pure subalpine type, scattered thinly over the slopes, growing in small copses in the hollows among outjutting ledges, and forming more or less continuous stands in the bottoms of the larger canyons. The heaviest stands of timber in the township occur in the main canyons of West Boulder River and on the slopes facing Yellowstone Valley. They are composed of lodgepole pine and Engelmann spruce, and in the southwest corner of the township are chiefly made up of sapling stands. Small tracts fronting on Yellowstone Valley are accessible for logging operations; most parts can not be reached.

Cutting.—None.

Burns.—In the aggregate, 450 acres in the western areas.

Reproduction.—Scanty in the subalpine forest; abundant on the western areas, where the lodgepole pine predominates in all the young growth.

Undergrowth.—Willows, alders, and mountain ash along the streams. The subalpine forest has little brush growth.

Litter.—Abundant in the western areas and consisting of dead and down timber.

Humus.—Thin cover of moss on northern slopes.

Classification of lands in T. 5 S., R. 10 E.

	Acres.
Forested	8,000
Nonforested	15,040
Badly burned	450
Logged	None.
Agricultural	None.
Grazing	None.
Bare rocks and alpine	14,590

Total stand of timber in T. 5 S., R. 10 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	3,000,000	4,000,000	4,540,000
White-bark pine	----------	500,000	500,000
White pine	50,000	----------	9,000
Red fir	1,200,000	400,000	616,000
Subalpine fir	----------	900,000	900,000
Engelmann spruce	2,500,000	2,000,000	2,450,000
Total	6,750,000	7,800,000	9,015,000

Composition of forest in T. 5 S., R. 10 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	60
White-bark pine	4
White pine	Scattered trees.
Red fir	8
Subalpine fir	15
Engelmann spruce	13

Township 5 South, Range 11 East.

Topography.—The township consists of an extremely rough mass of mountains rising to altitudes of nearly 11,000 feet, bristling with peaks, pinnacles, crags, and overhang, cut by rocky, cliff-bound canyons, the bottoms of which are littered with masses of gravel and bowlders.

Mining.—None.

Soil.—The soil is thin and barren and is chiefly made up of sand and gravel with a thin cover of loam. Large tracts of the alpine and subalpine areas are entirely devoid of soil cover.

Agricultural adaptability.—There is no tillable land in the township; the entire district is nonagricultural.

Grazing capacity.—A limited amount of pasturage is furnished by small glades along the bottoms of the different canyons, and by high alpine and subalpine meadows on the summits of the ridges. However, most of the high-lying glades and meadows are practically inaccessible for stock and can not be utilized for range purposes.

Drainage conditions.—The run-off from the township is large, the discharge being chiefly by way of West Boulder River. Springs, small creeks, and alpine rivulets abound, and the higher peaks retain large banks of snow on their northern slopes throughout the summer.

Snow and rock slides.—These are frequent in all parts of the township. Few of the slopes have as yet acquired stability; the crests of the ridges are deeply fissured, broken, and crumbling, and with the vast amount of overhang existing in many places rockslides and landslips are of common occurrence.

Towns and settlements.—The region is uninhabited.

Forest conditions.—Most of the forest is of subalpine type and consists of old-growth stands. Up to timber line the ridges bear scattered copses and lightly stocked stands of lodgepole pine, spruce, subalpine fir, and white-bark pine, all low and limby and, near the timber line, depressed to the stature of shrubs. The heaviest stands occur in the valley of the West Boulder and are composed of lodgepole pine and spruce, with red fir on the drier and warmer exposures. The timber

in West Boulder Valley is accessible for logging, although with some difficulty owing to the bowlder-strewn condition of the valley bottom. The timber on the slopes is inaccessible. West Boulder River can probably be utilized for driving purposes early in the season.

Cutting.—None.

Burns.—Scattered patches of forest here and there in the valley of West Boulder have been damaged by fires of recent date.

Reproduction.—At the lower elevations there is enough young growth to maintain the present average density of the stands. In the higher subalpine areas the reproductive capacity of the forest is low, and the trees show little tendency toward spreading into the various grassy, nontimbered glades that break the continuity of the stands.

Undergrowth.—The bottoms of the West Boulder and its larger laterals bear thick and tangled masses of willows, alders, etc. There is little brush growth in the stands on the ridges.

Litter.—The forest in West Boulder Valley is littered with large quantities of dead and fallen timber. Elsewhere in the township the litter is light.

Humus.—The forest floor on the western slopes of West Boulder Valley is covered with a 3 to 4 inch layer of moss and pine needles. In the subalpine stands humus is very light or mostly lacking.

Classification of lands in T. 5 S., R. 11 E.

	Acres.
Forested	7,040
Nonforested	16,000
Badly burned	200
Logged	None.
Agricultural	None.
Grazing	None.
Bare rocks and alpine	15,600
Streams and tarns	200

Total stand of timber in T. 5 S., R. 11 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	5,800,000	7,000,000	8,044,000
White-bark pine	-------	1,000,000	1,000,000
Red fir	4,000,000	2,000,000	2,720,000
Subalpine fir	-------	2,000,000	2,000,000
Engelmann spruce	4,000,000	2,800,000	3,520,000
Total	13,800,000	14,800,000	17,284,000

Composition of forest in T. 5 S., R. 11 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	60
White-bark pine	3
Red fir	25
Subalpine fir	7
Engelmann spruce	5

Township 5 South, Range 12 East.

Topography.—The western and central areas comprise high, rough mountain summits, and spurs varying in elevation from 9,000 to 11,000 feet. The spurs are long lobes or eastward extensions from the so-called West Boulder Plateau in the township adjoining on the west. They are gashed in their fronts by extremely precipitous, narrow, rocky canyons, and where they terminate in the valley of Boulder River present enormous cliffs and rough, boulder-strewn slopes. The eastern part of the township contains a portion of the valley of Boulder River, a narrow, cliff-bound trough, its eastern declivities consisting of steep talus slopes, its bottoms terraced with morainic gravel and bowlder débris.

Mining.—Here and there in the valley and lateral canyons of Boulder River small placers were formerly worked. There are prospects on quartz leads in various localities throughout the township. No active mining is carried on.

Minerals.—Gold and copper.

Soil.—Thin, gravelly, and rocky.

Agricultural adaptability.—Small tracts in Boulder Valley, in the aggregate 300 acres, largely patented placer ground, are tillable and are under cultivation. Outside this valley none of the lands are tillable, by reason of their rocky character and altitude.

Grazing capacity.—The grazing lands in the township consist of small glades along Boulder River, fire glades on the rocky slopes fronting this valley, and alpine sedge and grass-covered summits of the high spurs in the western areas, in the aggregate 8,000 acres. Most of the high areas are accessible only for sheep.

Drainage conditions.—Large volumes of water originate in the high alpine and subalpine regions in the western and central areas and discharge into Boulder River. The eastern areas of the township shed little water.

Snow and rock slide.—Frequent in all of the western and central areas.

Towns and settlements.—No towns; five or six farmsteads in Boulder Valley.

Forest conditions.—The western and much of the central areas are situated above timber line and carry no forest. In the Boulder Valley the timber is mostly scattered over the rocky western slopes; small, compact bodies of red fir, mixed with lodgepole pine, occur here and there where the lateral canyons

enter the valley. In the bottom of the valley the forest was badly burned in 1882–83, and the present stands consist largely of sapling lodgepole pine, which has replaced the former growth of red fir. In the extreme eastern portion of the township is a burned-over area with occasional patches of very young sapling growth of lodgepole pine, and irregular, thin lines of red fir and lodgepole pine, which mark the remains of the former old growth. Most of the timber is inaccessible for logging operations. It is low, limby, and scrubby, but is valuable for its effect in imparting stability to the slopes and their talus accumulations.

Cutting.—The tie makers cutting for the Northern Pacific Railroad in 1882–83 culled 75 per cent of the accessible timber in Boulder Valley.

Burns.—Fires dating from 1882–83 have run over most of the forested areas, destroying the timber on 8,900 acres.

Reproduction.—In Boulder Valley lodgepole-pine stands are slowly reforesting the burned-over areas. On the southern slopes of the valley reproduction is generally scanty and deficient, most of the burns being bare of young growth. The red-fir stands on the western slope are gradually gaining in density, while along the subalpine areas the young growth is thin or altogether wanting.

Undergrowth.—Moderate throughout, largely composed of *Ceanothus velutinus.*

Litter.—Abundant throughout the burned areas, and consisting of dead and fallen timber partly consumed by fire or merely fire killed and thrown down by wind. There are only small quantities of litter in the green stands.

Humus.—None.

Classification of lands in T. 5 S., R. 12 E.

	Acres.
Forested	3,440
Nonforested	19,600
Badly burned	8,900
Logged	1,800
Agricultural	300
Grazing	8,000
Bare rocks and alpine	2,400

Total stand of timber in T. 5 S., R. 12 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine		1,000,000	1,000,000
White-bark pine		300,000	300,000
Red fir	2,900,000	3,000,000	3,522,000
Subalpine fir		400,000	400,000
Engelmann spruce	600,000	500,000	608,000
Total	3,500,000	5,200,000	5,830,000

Composition of forest in T. 5 S., R. 12 E., including trees of all species with basal diameters of 8 inches and upward.

	Per cent.
Lodgepole pine	30
White-bark pine	2
Red fir	60
Subalpine fir	3
Engelmann spruce	5

TOWNSHIP 5 SOUTH, RANGE 13 EAST.

Topography.—An elevated plateau-like area known as East Boulder Plateau occupies the central areas of the township. Its altitude varies from 10,000 to 11,000 feet. Its summit is intersected by numerous ridges and depressions, and by the shallow canyon heads of great gorges that cut into its sides. In the eastern and western portions of the township the plateau breaks off in great cliffs and escarpments to the canyons of Boulder and East Boulder rivers, rising again on the east bank of the latter stream in ridges 10,000 feet in altitude.

Mining.—None.

Soil.—Thin, gravelly loam underlaid and mixed with vast masses of bowlders.

Agricultural adaptability.—The township, owing to its great altitude, contains no arable land.

Grazing capacity.—The summit of East Boulder Plateau, where not too rocky, is covered with a sward of alpine sedges and grasses. The tract is extremely difficult of access, but has been utilized for sheep pasture in former years. Outside of the plateau the township has no grazing areas.

Drainage conditions.—The run-off is large. The tract contains no lakes, but springs and creeks are numerous and furnish large additions to the volume of water in East Boulder and Boulder rivers.

Snow and rock slides.—Avalanches and landslips are of frequent occurrence along the edges and steep slopes of the plateau.

Towns and settlements.—The township is not inhabited.

Forest conditions.—The forest is confined to the eastern areas of the township in East Boulder Valley. It consists of lodgepole pine and Engelmann spruce in moderately close-set stands, largely old growths. At the brinks of the plateau and following the canyon heads into the more level tracts of the table-land are thin scattered stands of subalpine forest, mostly composed of spruce and white-bark pine.

Cutting.—None.

Burns.—Scattered tracts in East Boulder Valley.

Reproduction.—Moderate and composed of the same species and in nearly the same proportions as prevail in the old stands. In the high subalpine forest young growth is scanty.

Undergrowth.—Sparse.

Litter.—In the bottoms of the East Boulder, litter is abundant. In the subalpine forest it is light or altogether lacking.

Humus.—Light.

Classification of lands in T. 5 S., R. 13 E.

	Acres.
Forested	10,000
Nonforested	13,040
Badly burned	3,200
Logged	None.
Agricultural	None.
Grazing	5,800
Bare rocks and alpine	4,040

Total stand of timber in T. 5 S., R. 13 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	8,000,000	10,000,000	11,440,000
White-bark pine		900,000	900,000
Subalpine fir		4,000,000	4,000,000
Engelmann spruce	15,000,000	6,000,000	8,700,000
Total	23,000,000	20,900,000	25,040,000

Composition of forest in T. 5 S., R. 13 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	40
White-bark pine	6
Subalpine fir	10
Engelmann spruce	44

Township 5 South, Range 14 East.

Topography.—The township is situated on the summits and slopes of the divide between East Boulder River and the West Fork of the Stillwater drainage. It comprises high, rocky ridges, the central summits attaining altitudes of nearly 10,000 feet. It is cut into by numerous rocky, precipitous canyons, and intersected by the West Fork of the Stillwater from southwest to northeast.

Mining.—None.

Soil.—Gravelly and stony.

Agricultural adaptability.—The tract is essentially a mass of mountains, and contains no arable land.

Grazing capacity.—None.

Drainage conditions.—Owing to the altitude and position of the township it receives large quantities of snow, and the run-off is large. There are no lakes nor tarns, but numerous springs and creeks. The tract supplies important feeders to East Boulder River and to the Stillwater drainage.

Snow and rock slides.—Infrequent.

Towns and settlements.—None.

Forest conditions.—The forest of the township consists chiefly of lodgepole pine in the sapling stage, mixed, at high elevations, with stocky white-bark pine, Engelmann spruce, and subalpine fir. With the possible exception of a small tract in the southeast corner in the West Fork of Stillwater Valley, it is practically inaccessible to logging operations.

Cutting.—None.

Burns.—Very extensive burns dot the township in all directions, but more particularly in the northern areas. The fires date back seven or eight years, and have made a clean sweep of the timber wherever they burned.

Reproduction.—The young growth is insufficient to fully stock the forest to its ultimate capacity. The burned-over areas are not freely restocking. Lodgepole pine is the chief species in the reforestations.

Undergrowth.—Scanty.

Litter.—There is a large amount of litter, both in the green stands and on the burned-over areas. Most of it is composed of fire-killed and unconsumed timber.

Humus.—None.

Classification of lands in T. 5 S., R. 14 E.

	Acres.
Forested	11,240
Nonforested	11,800
Badly burned	9,000
Logged	None.
Agricultural	None.
Grazing	None.
Bare rocks	2,800

Total stand of timber in T. 5 S., R. 14 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	5,000,000	8,800,000	9,700,000
White-bark pine	.....	1,000,000	1,000,000
Subalpine fir	.....	4,800,000	4,800,000
Engelmann spruce	3,500,000	2,000,000	2,630,000
Total	8,500,000	16,600,000	18,130,000

Composition of forest in T. 5 S., R. 14 E., including trees of all species having basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	70
White-bark pine	5
Subalpine fir	10
Engelmann spruce	15

Township 5 South, Range 15 East.

Topography.—The northern portions of the township consist of a rolling table-land, with numerous small canyons, ravines, and gullies intersecting it in various directions. Its altitude varies from 5,000 to 5,500 feet. The central and the southern areas comprise rough, steep mountains which reach altitudes of 9,000 feet, and through which Stillwater River, West Fork, and Lime Creek have cut narrow, terraced canyons and valleys.

Mining.—There are numerous mineral prospects throughout the central portions of the township.

Minerals.—Silver, gold, copper, and lead.

Soil.—The soil is gravelly loam, generally shallow and bowlder strewn. The lowest terraces of Stillwater Valley and of Lime Creek are covered with deeper loam, resting on barren gravel deposits. The middle and upper terraces of Stillwater Valley are made up of coarse and heavy gravel and bowlder drift.

Agricultural adaptability.—Where the soil is not too stony and irrigation is possible the valley terraces are under cultivation. The mountain slopes and the table-land in the northern portion of the district are not arable.

Grazing capacity.—The northern and central areas contain a large acreage of nontimbered slopes and bowlder terraces suitable for grazing purposes, and so used. Most of this land is more or less completely inclosed with fences and therefore is not overgrazed.

Drainage conditions.—The outflow originating in the township is of small volume. A large amount originating elsewhere flows through it and is extensively drawn on for irrigation purposes.

Snow and rock slides.—Infrequent.

Towns and settlements.—The farming lands are settled and permanently occupied. At the junction of Stillwater River with West Fork is the small village of Nye, composed of half a dozen houses.

Forest conditions.—Most of the forest is composed of low, subalpine species. Nearly one-fourth consists of sapling lodgepole pine. The forest is chiefly confined to the western areas of the township, and its most valuable portions are comparatively easy of access.

Woodlands.—The woodlands are limited to the northern portion and comprise 1,500 acres. The stands are thin and scattering, mostly mere lines, small groups, or isolated trees, and consist of limber pine, red fir, and a few yellow pines.

Cutting.—More than 1,500 acres have been cut and culled, mostly in the southwest quarter, where a sawmill has been in operation for a number of years. The cut amounts to 50 per cent of the original stand.

Burns.—Extensive and mostly clean-burning fires have destroyed the forest on 8,000 acres. The fires date back seven or eight years.

Reproduction.—Restocking of the burned-over areas has, in most localities, not yet fairly begun. The coming growth will be lodgepole pine. In the unburned timber reproduction is sufficient to maintain the present stands. In the woodlands young growth is gradually extending into the grassy areas and will, in course of time, cover them with stands of forest.

Undergrowth.—Scanty throughout; none in the woodlands.

Litter.—In some of the burns the fire-killed timber is now beginning to fall and the litter is rapidly increasing. In the green timber there is only a moderate quantity.

Humus.—None.

Classification of lands in T. 5 S., R. 15 E.

	Acres.
Forested	5,500
Wooded	1,500
Nontimbered	16,040
Badly burned	8,000
Logged and culled	1,500
Agricultural	2,000
Grazing	5,200
Bare rocks	840

Total stand of timber in T. 5 S., R. 15 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Limber pine		250,000	250,000
Lodgepole pine	3,500,000	5,500,000	6,130,000
White-bark pine		300,000	300,000
Red fir	300,000	200,000	254,000
Subalpine fir		450,000	450,000
Engelmann spruce	550,000	2,000,000	2,099,000
Total	4,350,000	8,700,000	9,483,000

Composition of forest in T. 5 S., R. 15 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	1
Lodgepole pine	79
White-bark pine	2
Yellow pine	Scattered trees.
Red fir	1
Subalpine fir	8
Engelmann spruce	9

Township 5 South, Range 16 East.

Topography.—This township consists of a rolling plateau region 5,000 to 6,000 feet in altitude, cut by numerous shallow canyons and draws, and, in the northeast corner, by the valley of Stillwater River. It is intersected by low combs and ridges, and with precipitous scarps along some of the larger canyons. In the southwest corner are steep mountain spurs.

Mining.—The mining is limited to a few prospects of uncertain value, located in the southern areas.

Soil.—The soil is gravelly and clayey loam.

Agricultural adaptability.—Wherever water for irrigation is obtainable and steepness of slope or roll does not interpose obstacles the region is arable. The tillable land in the township may be taken in the aggregate at 4,000 acres.

Grazing capacity.—Outside the tillable lands the larger portion is essentially a grazing area. Where not fenced the grass-producing capacity of the land is, for the present, practically exhausted, owing to overgrazing.

Drainage conditions.—The drainage originating on the tract is limited to small springs.

Towns and settlements.—Most of the agricultural lands in the central areas of the township are occupied by farmers. There are no towns or villages.

Forest conditions.—The forested lands are situated in the southern areas and bear stands principally composed of sapling lodgepole pine and aspen.

Woodlands.—Woodlands occur in small tracts throughout the township, the growths consisting, on the lowlands, of willows, aspens, and cottonwoods, in thin lines fringing the streams and creek bottoms, and, on the uplands, of limber pine, yellow pine, and red fir as small groups, copses, and scattered trees.

Cutting.—The tract has been culled over for fuel and fencing material; 25 to 35 per cent of the original stand has been taken.

Burns.—In the southwest quarter of the township 2,000 acres, chiefly covered with sapling lodgepole-pine stands, have been burned over within recent years.

Reproduction.—Scanty throughout. The burns are scarcely reforesting.

Undergrowth.—Willows, etc., along the streams; none on the uplands.

Litter.—None, or but trifling amounts.

Humus.—None.

Classification of lands in T. 5 S., R. 16 E.

	Acres.
Forested	1,000
Wooded	3,000
Nontimbered	19,040
Badly burned	2,000
Logged and culled	4,000
Agricultural grazing	17,040

Total stand of timber (pole and fuel) in T. 5 S., R. 16 E.

	Cubic feet.
Limber pine	200,000
Lodgepole pine	120,000
Yellow pine	100,000
Total	420,000

Composition of forest in T. 5 S., R. 16 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	1
Lodgepole pine	70
Yellow pine	Scattered trees.
Red fir	10
Aspen and cottonwood	19

Composition of the woodland growth in T. 5 S., R. 16 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	60
Yellow pine	10
Red fir	30

Township 5 South, Range 17 East.

Topography.—This township consists of a rolling, upland region, with long ridges and swells, irregular hillocks of bowlder drift, and broad levels intersected by shallow creek bottoms.

Mining.—None.

Soil.—Deep, clayey loam in the valleys and creek bottoms, thin on the ridges and steeper slopes. Much of the southern portion is covered with coarse gravel and bowlders.

Agricultural adaptability.—Most of the creek bottoms are tillable. The uplands could be cultivated in many localities were water for irrigation obtainable.

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Grazing capacity.—All of the region not under cultivation has a grazing value. Most of it has been badly overgrazed in the past, and its present pasturage value is low.

Drainage conditions.—The run-off which originates on the tract is insignificant in volume. West Rosebud and Fishtail creeks flow across portions of the township. These streams and a number of smaller creeks are utilized for irrigation purposes.

Towns and settlements.—Farmsteads are scattered throughout the township on the agricultural lands, mostly in the western areas. There are no towns.

Forest and woodland conditions.—The township contains no forested areas. The woodlands are mostly confined to the western areas and are found along creeks and here and there on the northern slopes of the ridges. Limber pine, yellow pine, aspen, cottonwood, and willow make up the growth, which is thin and scattering.

Cutting.—All of the woodland area has been cut and culled over for local farm uses. The cutting has extended over a period of twenty to twenty-five years or longer, and, as nearly as now can be determined, amounts to 50 per cent of the original stand.

Burns.—None.

Reproduction.—Aspen and cottonwood abundant. Seedling and sapling growths of coniferous species are nearly lacking.

Classification of lands in T. 5 S., R. 17 E.

	Acres.
Forested	None.
Wooded	3,200
Nontimbered	19,840
Badly burned	None.
Logged and culled	3,200
Agricultural grazing	19,840

Total stand of timber (pole and fuel) in T. 5 S., R. 17 E.

	Cubic feet.
Limber pine	1,000,000
Yellow pine	380,000
Aspen and cottonwood	400,000
Total	1,780,000

Composition of the woodland arborescent growth in T. 5 S., R. 17 E., including trees of all species with basal diameters of 8 inches and upward.

	Per cent.
Limber pine	8
Yellow pine	1
Aspen and cottonwood	91

Township 6 South, Range 10 East.

Topography.—The township lies almost entirely in the Mill Creek drainage. The northern areas comprise high ridges, with elevations up to 10,000 feet, cutting off the Mill Creek drainage from the tracts which slope into Elbow Creek Basin. The remainder of the township is composed of the wide canyons of North, Middle, and Mill creeks, and of the divides separating the two streams.

Mining.—Portions of the lower areas of Mill Creek Basin are mineral bearing and contain scattered prospect holes. No active mining is carried on.

Minerals.—Said to be gold and copper.

Soil.—Usually thin and of no great fertility. The surface is covered with a loamy mixture.

Agricultural adaptability.—The township contains no tillable land, being too stony and mountainous for agriculture.

Grazing capacity.—The grazing areas consist wholly of small glades along Mill Creek forks, not properly grazing lands.

Drainage conditions.—The township contains the principal waterheads of the Mill Creek drainage, and the outflow is large and continuous. The water is used in the Yellowstone Valley to some extent for irrigation.

Snow and rock slides.—Most of the slopes in the basin have acquired a certain degree of stability, and slides either of snow or rock are not frequent.

Towns and settlements.—None.

Forest conditions.—The Mill Creek basins are well stocked with forest, chiefly lodgepole pine of middle age or large sapling stands. On the southern slopes along the main canyons the stands are rather open and scattered, with red fir as the leading species in their composition. At the highest altitudes the growth is largely composed of spruce, with young sapling stands of lodgepole pine marking burns of recent years. As a rule, most of the growth is too small for mill timber, and is difficult of access owing to the narrow and rocky character of the main canyon of Mill Creek in the township adjoining on the west.

Cutting.—None.

Burns.—None.

Reproduction.—Young growth is abundant in most places. As a rule the lodgepole-pine stands and those chiefly composed of spruce are stocked so closely that further additions to the density of the stands are impossible.

Undergrowth.—Sparse.

Litter.—Litter, composed of timber killed by overcrowding, is abundant in all the closely stocked stands. In the subalpine stands there is a scarcity of such material, and the forest is clean and open.

Humus.—In the canyons and on the northern slopes a thin moss cover on the forest floor constitutes the humus. On the southern slopes this cover is lacking.

Classification of lands in T. 6 S., R. 10 E.

	Acres.
Forested	16,540
Nonforested	6,500
Badly burned	None.
Logged	None.
Agricultural	None.
Grazing	None.
Bare rocks and alpine	6,500

Total stand of timber in T. 6 S., R. 10 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	30,000,000	35,000,000	40,400,000
White-bark pine		2,000,000	2,000,000
Red fir	6,000,000	5,200,000	6,280,000
Subalpine fir		5,500,000	5,500,000
Engelmann spruce	10,800,000	6,000,000	7,944,000
Total	46,800,000	53,700,000	62,124,000

Composition of forest in T. 6 S., R. 10 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	60
White-bark pine	5
Red fir	7
Subalpine fir	10
Engelmann spruce	18

Township 6 South, Range 11 East.

Topography.— The central areas of the township consist of a section of the main range of the Absaroka Mountains, forming the divide between Mill Creek and Boulder River basins. The ridges attain altitudes of 11,000 feet, and abound with peaked and craggy crests. The eastern area comprises bowlder-littered canyons, opening into the main valley of Boulder River, and separated by rough-crested, narrow, and precipitous ridges. The western area is of similar character, the canyons forming in part the northern and central water heads of the Mill Creek drainage.

Mining.—None.

Soil.—The soil is thin and rocky. In the forested areas it is enriched by a topping of loam and mold. Most of the tract is thickly strewn with bowlders.

Agricultural adaptability.—None of the lands are tillable. They are too stony and are situated at too high altitudes to be available for agriculture.

Grazing capacity.—The tracts which lie above timber line have a small grazing value. They are inaccessible except to sheep.

Drainage conditions.—The tract sheds a large volume of water, owing to its extensive areas of alpine and subalpine country. Springs, marshy tracts, and rivulets are numerous throughout.

Snow and rock slides.—In the central areas avalanches of snow and rock are of frequent occurrence. In other parts they are uncommon, or are altogether absent.

Towns and settlements.—The township is not inhabited.

Forest conditions.—The central areas, lying mostly above timber line, contain no forest. In the eastern areas stands of the subalpine type, well stocked, form most of the timber on the slopes, while lodgepole pine, 100 to 175 years old, mixed with a small proportion of spruce and subalpine fir, cover the bottoms of canyons where not too rocky for timber growth. In the western areas the stands are wholly of the subalpine type, spruce being the leading species.

Cutting.—None of the tract has been cut over.

Burns.—None.

Reproduction.—Scanty in the forest of the pure subalpine type. Young growth in the lodgepole pine stands at the lower elevations is of moderate volume, sufficient to maintain a full stocking of the forest. Most of the young growth consists of spruce; the lodgepole pine, which represents reforestation after ancient fires, is evidently giving way to that species.

Undergrowth.—Huckleberry bushes and honeysuckle form most of the brush growth at lower altitudes. In the subalpine stands underbrush is scanty.

Litter.—The lodgepole pine stands are littered with large quantities of dead and fallen timber, killed by crowding. The subalpine stands contain little dead timber.

Humus.—A thin layer of moss and pine needles forms the humus in the lodgepole-pine forest. The subalpine stands have no humus cover.

Classification of lands in T. 6 S., R. 11 E.

	Acres.
Forested	10,000
Nonforested	13,040
Badly burned	None.
Logged	None.
Agricultural	None.
Grazing	8,000
Bare rocks	5,040

Total stand of timber in T. 6 S., R. 11 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	20,000,000	15,000,000	18,600,000
White-bark pine	----------	1,000,000	1,000,000
Subalpine fir	----------	3,000,000	3,000,000
Engelmann spruce	8,500,000	5,000,000	6,530,000
Total	28,500,000	24,000,000	29,130,000

Composition of forest in T. 6 S., R. 11 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	80
White-bark pine	2
Subalpine fir	6
Engelmann spruce	12

Township 6 South, Range 12 East.

Topography.—The eastern half of the township consists of a barren, rocky mass of mountains attaining elevations of 11,500 feet; the western half comprises long spurs projecting westward from the main range of the Absaroka Mountains. Between the spurs lie deep canyons littered with glacial gravel and bowlder drift. Through the center of the tract runs Boulder River in a deep, rocky canyon.

Mining.—Here and there in the valley of Boulder River are placer locations. None are worked at present.

Soil.—Gravelly loam, with the surface littered with bowlders.

Agricultural adaptability.—None of the lands are arable.

Grazing capacity.—The grazing areas are limited to small glades and wet meadows along Boulder River and to summits of the ridges in the east half of the township. They are mostly above timber line and are not easily accessible.

Drainage conditions.—The outflow from the township is large and supplies one-half or more of the volume of water in Boulder River at this point.

Towns and settlements.—Near the south end of the township, in Boulder Valley, is a sort of summer resort—Hicks Park, by name—occupying a small glade on the east side of the river. There is no other settlement in the township.

Snow and rock slides.—Avalanches are common along the steep slopes which border Boulder Valley.

Forest conditions.—Boulder Valley and the canyons entering from the east are, as a rule, lightly forested. The valleys on the west side of the Boulder carry close-set stands of forest. Lodgepole pine and Engelmann spruce form the bulk of

the stands. All ages between 50 and 200 years are represented. At the higher elevations subalpine fir and spruce constitute the forest. On the rocky slopes of Boulder Canyon red fir, mostly of short, limby growth, is abundant.

Cutting.—Tie cutters of the Northern Pacific Railroad cut and culled 50 per cent of the timber in the valley in 1882–83, since which time miners have cut an additional 10 or 15 per cent.

Burns.—The eastern portion of the valley has experienced severe and extensive burns in the last twenty years. The western has very nearly escaped.

Reproduction.—Restocking of the burned-over areas is as yet slow and deficient. Most of the forest in the bottoms of the canyons and on the lowest slopes outside of Boulder Valley is composed of fully stocked stands, and the young growth in these localities is scanty.

Undergrowth.—The growth is light and consists chiefly of huckleberry and *Ceanothus*.

Litter.—There is a very large amount of dead and fallen timber throughout the forest—partly unconsumed débris from former fires, partly trees killed by crowding.

Humus.—A thin layer of moss and decaying pine needles covers the forest floor in most of the older stands, especially in the canyons on the west side of Boulder River. In other localities humus is lacking.

Classification of lands in T. 6 S., R. 12 E.

	Acres
Forested	12,540
Nonforested	10,500
Badly burned	3,000
Logged	1,500
Agricultural	None.
Grazing	2,500
Bare rocks	5,000

Total stand of timber in T. 6 S., R. 12 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	16,000,000	15,000,000	17,880,000
White-bark pine		2,000,000	2,000,000
Red fir	6,000,000	8,000,000	9,080,000
Subalpine fir		5,000,000	5,000,000
Engelmann spruce	10,000,000	5,000,000	6,800,000
Total	32,000,000	35,000,000	40,760,000

Composition of forest in T. 6 S., R. 12 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	60
White-bark pine	2
Red fir	15
Subalpine fir	8
Engelmann spruce	15

Township 6 South, Range 13 East.

Topography.—The township comprises alpine and subalpine areas, mostly above the 10,000-foot contour. It is rocky and barren throughout, cut by numerous creeks and canyons and dotted with lakelets and tarns.

Mining.—None.

Soil.—Gravelly, stony, and the surface excessively rocky and bowlder strewn. Much of the tract, especially in the central areas and along the west line, has no soil cover.

Agricultural adaptability.—The township contains no tillable land.

Grazing capacity.—All of the alpine and subalpine areas are covered with grass and sedge wherever a soil cover exists, and are capable of furnishing a small amount of pasturage. The tract is, however, practically inaccessible to any kind of stock except sheep.

Drainage conditions.—Lakelets, tarns, and marshy areas, with which the tract is liberally supplied, act as natural reservoirs and regulate the flow of Boulder and East Boulder rivers, the streams that carry most of the outflow from the township.

Snow and rock slides.—Common in the central areas along the canyon of East Boulder River.

Towns and settlements.—None.

Forest conditions.—Most of the tract is situated above timber line and therefore carries no arborescent growth. Small areas of forest are situated in the bottoms and on the lower slopes of East Boulder Canyon and in ravines along the west line of the township. The trees are strictly a high subalpine type, of no value except for fuel, and are practically inaccessible from the outside.

Cutting.—None.

Burns.—Along the west line of the township 600 acres have been burned over in recent years and the timber totally destroyed.

Reproduction.—Reproduction is deficient throughout the township and is scarcely heavy enough to maintain the present density of stands. There is no restockage in the burns.

Undergrowth.—Light.

Litter.—In the burned-over areas there is a small amount of unburned woody débris of the former forest; elsewhere litter is light or wholly lacking.

Humus.—None.

Classification of lands in T. 6 S., R. 13 E.

	Acres.
Forested	3,000
Nonforested	20,040
Badly burned	600
Logged	None.
Agricultural	None.
Grazing	12,600
Bare rocks	4,800
Tarns and streams	2,040

Total stand of timber (pole and fuel) in T. 6 S., R. 13 E.

	Cubic feet.
Lodgepole pine	1,000,000
White-bark pine	500,000
Subalpine fir	1,500,000
Engelmann spruce	2,800,000
Total	5,800,000

Composition of forest in T. 6 S., R. 13 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	10
White-bark pine	9
Subalpine fir	30
Engelmann spruce	51

Township 6 South, Range 14 East.

Topography.—The township consists chiefly of high mountains, rising to altitudes of above 11,000 feet, breaking off along the east line with steep slopes and scarps to the canyon of Stillwater River, and broadening on the west into the wide summit of Lake Plateau in the adjoining township.

Mining.—Prospects merely, situated along Stillwater Valley.

Minerals.—Copper is said to occur.

Soil.—Stony and gravelly throughout.

Agricultural adaptability.—None of the lands in the township are tillable.

Grazing capacity.—Portions of the high western areas of the township, in all 12,000 acres, are covered with a more or less continuous turf of low alpine sedges and grasses suitable for pasturage. The tracts are difficult of access and are not pastured.

Drainage conditions.—Small creeks, rivulets, and springs are abundant. Tarns and lakelets occur here and there at the head of the creeks in the western portions

of the township, and snow remains on a few of the high northern slopes through the summer.

Snow and rock slides.—Frequent along the steep breaks to the Stillwater Canyon.

Towns and settlements.—None.

Forest conditions.—Wholly subalpine. The stands occur in scattered bodies of small extent along the breaks to Stillwater Canyon and as narrow fringes bordering the creeks. Most of the areas in the township are situated at or well above timber line and carry no arborescent growth.

Cutting.—None.

Burns.—None.

Reproduction.—Owing to the high altitude the reproductive capacity of the forest is low, and the young growth is insufficient in amount to stock fully the stands.

Undergrowth.—Willows, alders, and the like, small in amount.

Litter.—Light.

Humus.—None.

Classification of lands in T. 6 S., R. 14 E.

	Acres.
Forested	5,600
Nonforested	17,440
Badly burned	None.
Logged	None.
Agricultural	None.
Grazing	12,000
Bare rocks	5,000
Tarns and streams	440

Total stand of timber (pole and fuel) in T. 6 S., R. 14 E.

	Cubic feet.
Lodgepole pine	1,000,000
White-bark pine	1,500,000
Subalpine fir	800,000
Engelmann spruce	2,000,000
Total	5,300,000

Composition of forest in T. 6 S., R. 14 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	25
White-bark pine	25
Subalpine fir	20
Engelmann spruce	30

Township 6 South, Range 15 East.

Topography.—The central and southern areas of the township comprise high, rocky slopes and summits varying from 9,000 to 11,000 feet, abounding in precipices

and steep declivities. The western quarter of the township is cut by the canyon of Stillwater River, which is 3,000 to 3,500 feet below the summits of the inclosing ridges, whose slopes rise steep and precipitous from the narrow cliff-bound valley of the stream. The eastern areas are traversed by Rock Creek Canyon, a narrow rift between towering walls of rock.

Mining.—None.

Soil.—Thin, stony, and gravelly, with small admixtures of loam.

Agricultural adaptability.—None except a few small tracts in the Stillwater bottoms, 350 acres in all.

Grazing capacity.—None.

Drainage conditions.—The run-off is of moderate volume and is carried by Stillwater River and Rock Creek, both of which are utilized for irrigation purposes on lands situated in townships adjoining on the north. Many of the high northern slopes carry banks of snow throughout the summer.

Snow and rock slides.—Frequent along the steep breaks of Stillwater River and Rock Creek.

Towns and settlements.—No towns exist in the region. There are two or three farmsteads in Stillwater Valley.

Forest conditions.—The forest is chiefly of the subalpine type. It occurs in thin, scattering stands on the rocky slopes and in small compact bodies here and there on the summits of the lower and broader ridges. It contains little mill timber, all of very inferior quality and mostly inaccessible. It is chiefly valuable as a factor in insuring stability of slope.

Cutting.—Small quantities in Stillwater Valley have been cut for farm uses.

Burns.—Tracts in the northern areas (400 acres) have been burned over within the past seven or eight years.

Reproduction.—Low throughout, generally insufficient to maintain or increase the present stands.

Undergrowth.—Scanty; mostly composed of low-growing huckleberry shrubs.

Litter.—On the burned-over areas the litter, consisting chiefly of the unconsumed trees, is moderately abundant; elsewhere its amount is trifling.

Humus.—None.

Classification of lands in T. 6 S., R. 15 E.

	Acres.
Forested	9,100
Nonforested	13,940
Badly burned	400
Logged	None.
Agricultural	350
Grazing	None.
Bare rocks and alpine areas	13,100
Lakes, tarns, and streams	90

Total stand of timber in T. 6 S., R. 15 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	1,000,000	2,500,000	2,680,000
White-bark pine		1,500,000	1,500,000
Subalpine fir		1,400,000	1,400,000
Engelmann spruce	500,000	600,000	690,000
Total	1,500,000	6,000,000	6,270,000

Composition of forest in T. 6 S., R. 15 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	34
White-bark pine	28
Subalpine fir	30
Engelmann spruce	8

Township 6 South, Range 16 East.

Topography.—The southern areas of the district comprise rough mountains rising to altitudes of 12,500 feet, bristling with crags and rocky, inaccessible heights. In the central areas are the northern fronts and spurs of this mass of mountains, which, in the northern end of the township, sink into a narrow fringe of foothill country.

Mining.—None.

Soil.—Sand, gravel, and bowlders, with thin toppings of loam.

Agricultural adaptability.—None; the land is too stony, its slopes too steep, and its altitude too great for agriculture.

Grazing capacity.—The grazing lands consist of ancient fire glades situated in the northern part of the township that have failed to restock.

Drainage conditions.—The township in part forms the water head of Fishtail Creek, besides giving rise to numerous smaller streams. A large amount of run-off originates in its high southern areas. The northern slopes situated above the 10,500-foot level carry banks of snow throughout the summer.

Snow and rock slides.—Not infrequent in the upper portions of Fishtail Canyon.

Towns and settlements.—None.

Forest conditions.—The foothills and lower portions of the central areas are stocked with exceedingly close-set sapling stands of aspen and lodgepole pine—reforestations after fires that occurred thirty to fifty years ago. The higher slopes bear low and scrubby stands of subalpine species, and scattered patches of old-growth lodgepole pine at middle elevations.

Cutting.—For domestic use, fuel and fencing, the dead and fallen timber on 1,500 acres has been more or less completely removed.

Burns.—A large tract in the southeast and another in the northwest corner of the township have been burned over and the timber thereon entirely destroyed.

Reproduction.—The sapling stands of lodgepole and aspen at the lower elevations are fully stocked, and any further seedling growth there is impossible. The burned-over areas are not reforesting, or but very scantily. In the subalpine stands young growth is sparse.

Undergrowth.—In the forested areas there is very little underbrush. On the burns *Ceanothus* and other shrubs are springing up profusely.

Litter.—Light.

Humus.—None.

Classification of lands in T. 6 S., R. 16 E.

	Acres.
Forested (sapling stands, 9,000 acres)	13,040
Nonforested	10,000
Badly burned	3,000
Logged	None.
Agricultural	None.
Grazing	2,000
Bare rocks	5,000

Total stand of timber in T. 6 S., R. 16 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	2,500,000	3,000,000	3,450,000
White-bark pine		500,000	500,000
Subalpine fir		2,300,000	2,300,000
Engelmann spruce	1,200,000	1,000,000	1,216,000
Total	3,700,000	6,800,000	7,466,000

Composition of forest in T. 6 S., R. 16 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	62
White-bark pine	8
Subalpine fir	14
Engelmann spruce	14
Aspen and cottonwood	2

TOWNSHIP 6 SOUTH, RANGE 17 EAST.

Topography.—The township consists of a rolling foothill region in the northern and east-central areas, having an altitude of 5,500 to 6,000 feet, and of rough, rocky mountain spurs in the remainder. The more northern and eastern foothills are low and gently rolling; the western rise to long combs and swells separated by wide canyons with gentle slopes.

Mining.—None.

Soil.—Deep loam in the creek bottoms; thin, gravelly, and excessively strewn with bowlders on the uplands. The central areas throughout, and the lower slopes and valleys in the southern, are deeply buried under a mantle of bowlders.

Agricultural adaptability.—The creek bottoms in the central and northern areas are arable and generally cultivated. The uplands are mostly too stony for agriculture.

Grazing capacity.—The uplands in the central and northern areas are grazing lands. Where not under fence they have been excessively overgrazed.

Drainage conditions.—The outflow originating in the township is of small volume and has its rise in various small springs. West Rosebud Creek carries most of the drainage of the township. Its waters are used for irrigation.

Snow and rock slides.—These occur only in the southwest corner of the township and are not of frequent occurrence.

Towns and settlements.—The agricultural lands are occupied. There are no towns or villages in the township.

Forest conditions.—Formerly the extreme southern and most of the western areas were forested. Fires have swept the timber out of existence, with the exception of 1,000 acres in the valley of West Rosebud Creek. The stands on this tract consist of thin lines of scrubby yellow pine and red fir, with small proportions of limber pine and a low growth of aspen.

Woodlands.—Before the advent of white settlers about one-half of the township was covered with a scattering growth of lodgepole pine, limber and yellow pine, and large, compact aspen stands. Cutting has diminished the woodland area and thinned the stands, until only 2,000 acres remain that bear timber enough to be classed as woodland. The growth is everywhere thin and scrubby.

Cutting.—The entire township, with the exception of small tracts along the south line, has been culled over. Systematic cutting is confined to the lower foothills and to the valley of the West Rosebud, where 50 per cent has been cut out. Most of the timber taken has been fuel and pole stuff; the valley has, however, supplied saw timber.

Burns.—The foothills in the central areas and all of the southern tracts have been badly burned over and the timber on them almost totally destroyed. The

foothills carried stands chiefly composed of aspen; the mountain areas were clothed with lodgepole pine.

Reproduction.—The burned-over forest lands are reforesting very slowly, and the young growth is largely composed of aspen at the lower elevations, and of lodgepole pine at the middle and the highest altitudes. In the woodlands aspen is almost the sole component in the young growth.

Undergrowth.—Thin and low.

Litter.—Light.

Humus.—None.

Classification of lands in T. 6 S., R. 17 E.

	Acres.
Forested area	1,000
Woodland area	2,000
Nontimbered area	20,040
Badly burned	7,000
Logged	1,500
Agricultural (grazing)	13,040

Total stand of timber in T. 6 S., R. 17 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Limber pine		225,000	225,000
Lodgepole pine		330,000	330,000
Yellow pine	80,000	90,000	104,400
Red fir		60,000	60,000
Aspen and cottonwood		50,000	50,000
Total	80,000	755,000	769,400

Composition of forest and woodland in T. 6 S., R. 17 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	45
Lodgepole pine	10
Yellow pine	38
Red fir	.5
Aspen and cottonwood	6.5

TOWNSHIP 6 SOUTH, RANGE 18 EAST.

This township consists of a rolling tract of country; low swells and ridges alternate with shallow draws and canyons. It contains no forest land. Aspen

and willow groves line the streams. The uplands are utilized for grazing purposes, and the creek bottoms and swales for agriculture. It is distinctly a grazing and agricultural tract and is of no value for forestry purposes.

Township 7 South, Range 10 East.

Topography.—With the exception of a small area in the central portion, the township consists of narrow-crested and precipitous ridges and divides attaining altitudes of nearly 11,000 feet. The exception to the high relief is a broad canyon, a tributary of the Middle Fork of Mill Creek, cutting into the central areas of the township from the north.

Mining.—None.

Soil.—Gravel, with thin surface layers of loam; very stony and bowlder-strewn on the slopes and in the bottoms of the canyons.

Agricultural adaptability.—No portion is fit for agriculture; the tract is too stony and the altitude too great.

Grazing capacity.—The subalpine and alpine areas are mostly grassy and suitable for sheep pasture, but are practically inaccessible.

Drainage conditions.—The run-off is large and is carried by tributaries of Mill Creek. Lakelets and tarns are lacking, but the tract is well supplied with springs, marshy tracts, and creeks, and forms a natural reservoir for much of the Mill Creek flow.

Snow and rock slides.—Infrequent.

Towns and settlements.—None.

Forest conditions.—The forested areas are confined to the canyons in the central portions of the township, the high areas on the north, east, and south being situated above timber line. The stands are of medium density, thinning out near the 9,500-foot contour to small copses and narrow lines. In the lower areas lodgepole pine and Engelmann spruce are the prevailing species, largely in old growth stands. At higher altitudes the typical subalpine forest constitutes the stands. The timber is accessible by way of Mill Creek, but only with great difficulty and expense.

Cutting.—None.

Burns.—None.

Reproduction.—Deficient in the subalpine areas but abundant in the stands on the lower elevations. Most of the young growth is composed of spruce.

Undergrowth.—Light.

Litter.—There is a small amount in the stands in the canyon bottoms: very little in the stands on the subalpine areas.

Humus.—There is a thin layer of moss and pine needles.

Classification of lands in T. 7 S., R. 10 E.

	Acres.
Forested	8,320
Nonforested	14,720
Badly burned	None.
Logged	None.
Agricultural	None.
Grazing (alpine tracts)	14,720

Total stand of timber in T. 7 S., R. 10 E.

Species.	Mill timber.	Pole and fuel timber.	Total stand of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	8,000,000	10,000,000	11,440,000
White bark pine	----------	3,000,000	3,000,000
Subalpine fir	----------	2,000,000	2,000,000
Engelmann spruce	6,500,000	5,000,000	6,170,000
Total	14,500,000	20,000,000	22,610,000

Composition of forest in T. 7 S., R. 10 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	55
White bark pine	7
Subalpine fir	10
Engelmann spruce	28

Township 7 South, Range 11 East.

Topography.—The eastern, northern, and western areas of this township lie wholly on the summit of the main divide of the Absaroka Range, and consist of alpine and subalpine tracts rising to elevations of nearly 11,000 feet. The region is one of narrow, sharp-crested ridges, steep slopes, and bold precipitous breaks and escarpments. The central areas of the tract form the head of Hell Roaring Creek and consist of open canyons, with slopes of comparatively easy gradients in most localities..

Mining.—None.

Soil.—Gravelly and stony, with thin surface dressings of loam.

Agricultural adaptability.—The township has no arable land.

Grazing capacity.—The pasture areas of the township are limited to the summits and high slopes of the ridges, which carry a more or less close and continuous sward of alpine sedges and grasses. The tracts are difficult of access and are not now pastured, although formerly, it is said, sheep were grazed on them.

Drainage conditions.—The run-off from the township is large and is carried in part by Boulder River and in part by Hell Roaring Creek. The township contains

few tarns and lakelets, but abounds in springs and rivulets. Snow lies on the high northern slopes throughout the summer.

Snow and rock slides.—Near the crests of the mountains avalanches are common.

Towns and settlements.—None.

Forest conditions.—The forest consists of thin subalpine stands of white-bark pine and spruce at the higher and the middle elevations. In the canyon of Hell Roaring Creek the forest is mostly made up of old-growth stands of lodgepole pine mixed with spruce.

Cutting.—None.

Burns.—None.

Reproduction.—Reproduction is generally deficient in the subalpine stands. The lodgepole-pine stands in the lower portions of the canyons are mostly stocked too close for any further additions.

Undergrowth.—Light.

Litter.—The subalpine forest contains very little litter. In the lodgepole-pine stands it is abundant, and is composed of trees killed by overcrowding.

Humus.—None.

Classification of lands in T. 7 S., R. 11 E.

	Acres.
Forested	10,040
Nonforested	13,000
Badly burned	None.
Logged	None.
Agricultural	None.
Grazing and alpine	10,000
Bare rocks	3,000

Total stand of timber in T. 7 S., R. 11 E.

Species.	Mill timber.	Pole and fuel timber.	Total stand of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	6,600,000	9,000,000	10,188,000
White-bark pine	----------	1,200,000	1,200,000
Subalpine fir	----------	2,700,000	2,700,000
Engelmann spruce	4,000,000	3,500,000	4,220,000
Total	10,600,000	16,400,000	18,308,000

Composition of forest in T. 7 S., R. 11 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	58
White-bark pine	4
Subalpine fir	8
Engelmann spruce	30

Township 7 South, Range 12 East.

Topography.—High, steep, precipitous mountains reaching elevations of 11,200 feet, a part of the main range of the Absarokas, are found in the southern and in most of the central areas of the township. The remainder consists of portions of the narrow and rocky upper canyon of Boulder River, of steep spurs abutting on this canyon, and, in the northeast quarter, of terraces or small plateau-like areas lying at the head of the West Boulder at altitudes of 9,000 to 9,500 feet.

Mining.—Boulder Valley in this township contains two mining camps—Independence and Cowles. Independence is abandoned, but Cowles is in active operation. The gravels in the central areas of the township are auriferous, and hundreds of placer claims have been located on them, a few of which are being worked.

Minerals.—Gold.

Soil.—Gravelly loam, mostly stony and mixed with bowlder drift. In places the soil is clayey or gumbo-like.

Agricultural adaptability.—No portion of the township is cultivable. The stony soil and the high altitude of the region are prohibitive of agriculture.

Grazing capacity.—Numerous alpine and subalpine glades occur throughout the township. They bear close swards of sedge and grass. Accessible in most places, they are pastured only by the animals of prospectors and by small bands of stock.

Drainage conditions.—The principal water head of Boulder River is in this township, and as such its watershedding capacity is of great importance. The run-off is large. Tarns, rivulets, and creeks are numerous. Most of the feeders to the different creeks head in glacial cirques, which commonly hold one or more tarns, forming extensive series of natural reservoirs.

Snow and rock slides.—Avalanches of rock and snow are frequent throughout, more particularly on the eastern slopes of Boulder Canyon.

Towns and settlements.—Cowles mining camp in Boulder Valley, near Haystack Peak, a stamp mill working the auriferous ores of the region, with the necessary buildings for employees clustered around it, and one small sawmill near the north line of the township in Boulder Canyon, comprise the settlements. Numerous miners' cabins are scattered over the mineral-bearing areas.

Forest conditions.—At the higher elevations the forest consists of thin subalpine stands very much scattered among the grassy glades. The timber is low and scrubby, fit chiefly for fuel and mine props. The canyon of the Boulder, and especially the tributary canyons coming in from the west, contains close-set stands of lodgepole pine and spruce varying in age from 100 to 200 years.

Cutting.—A great quantity of timber has been cut in Boulder Valley, particularly around the deserted mining camp of Independence and at Cowles camp. At the latter place the subalpine slopes are being completely stripped of every vestige of

timber large enough to supply fuel to the mines and to the stamp mill, where steam is used for motive power.

Burns.—Large tracts in the valley of the Boulder and in the northeast quarter have been burned over during the past eight or ten years. The timber on the burned tracts has in most cases been totally destroyed.

Reproduction.—The young growth throughout is scanty and scattered. There is little restockage in the burns.

Undergrowth.—Light.

Litter.—In the stands on the west of Boulder Canyon the litter, composed of fallen timber killed by overcrowding, is abundant. Elsewhere litter is light.

Humus.—On most of the slopes with northern exposures there is usually a thin moss cover. Elsewhere humus is lacking.

Classification of lands in T. 7 S., R. 12 E.

	Acres.
Forested	10,540
Nonforested	12,500
Badly burned	3,000
Logged	4,000
Agricultural	None.
Grazing	4,500
Bare rocks	3,800
Tarns	1,200

Total stand of timber in T. 7 S., R. 12 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	10,000,000	12,000,000	13,800,000
White-bark pine		2,000,000	2,000,000
Red fir	1,000,000	500,000	680,000
Subalpine fir		4,000,000	4,000,000
Engelmann spruce	9,000,000	15,000,000	16,620,000
Total	20,000,000	33,500,000	37,100,000

Composition of forest in T. 7 S., R. 12 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	60
White-bark pine	4
Red fir	1.5
Subalpine fir	9.5
Engelmann spruce	25

Township 7 South, Range 13 East.

Topography.—This township is a plateau-like area situated mostly above timber line, cut by shallow canyons and dotted with numerous tarns.

Mining.—None.

Soil.—Thin gravelly loam.

Agricultural adaptability.—The township contains no tillable land.

Grazing capacity.—Most of the township is covered with a thin sward of alpine grasses and sedges which might afford a scanty pasturage during three or four months of each year.

Drainage conditions.—Owing to its elevated position the region receives a large amount of snow and rain, and the run-off is large. The tract abounds in tarns, springs, and creeks, and constitutes an important water head of Boulder and Stillwater rivers.

Snow and rock slides.—Infrequent.

Towns and settlements.—None.

Forest conditions.—The forest is of subalpine composition throughout, and consists of white-bark pine, spruce, and subalpine fir, with lodgepole pine in the southwest corner. On a small tract in this corner, the forest is set in a close, well-stocked stand; elsewhere the stands are thin, and scattered over the rough surface and slopes in narrow lines and small copses. It is chiefly an old and middle-aged growth. Except for local use the forest is inaccessible.

Cutting.—None.

Burns.—Along the west line of the township the timber on 1,200 acres has been killed by recent fires.

Reproduction.—Scanty throughout. The young growth is composed of the same species, in the same proportions as the mature forest.

Undergrowth.—There is only a very low and thin growth of underbrush in the district.

Litter.—Abundant in the southwest corner of the township, consisting of dead and fallen pole growths, killed by overcrowding.

Humus.—Thin or entirely lacking.

Classification of lands in T. 7 S., R. 13 E.

	Acres.
Forested	3,500
Nonforested	19,540
Badly burned	1,200
Logged	None.
Agricultural	None.
Grazing	12,000
Bare rocks	3,840
Lakelets and tarns	2,500

Total stand of timber in T. 7 S., R. 13 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	3,000,000	3,000,000	3,540,000
White-bark pine		300,000	300,000
Subalpine fir		600,000	600,000
Engelmann spruce	2,200,000	1,000,000	1,396,000
Total	5,200,000	4,900,000	5,836,000

Composition of forest in T. 7 S., R. 13 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	30
White-bark pine	5
Subalpine fir	15
Engelmann spruce	50

Township 7 South, Range 14 East.

Topography.—The eastern and western areas comprise steep, rocky spurs rising to elevations of 10,000 to 11,000 feet. The central areas consist of the canyon of Stillwater River and its immediate slopes. The canyon is a rocky gorge hemmed in by steep slopes, which in the southeast portion become immense, towering cliffs rising sheer from the valley 2,000 to 2,500 feet.

Mining.—None.

Soil.—Gravelly and stony, with light surface admixtures of loamy matter.

Agricultural adaptability.—None of the areas are tillable.

Grazing capacity.—The summits of the spurs are covered with a thin sward of alpine and subalpine sedge and grass. The eastern areas are practically inaccessible. The western areas can be reached, but probably only by sheep.

Drainage conditions.—The tract gives rise to numerous springs and creeks, but owing to the broken character of the region holds no lakelets.

Snow and rock slides.—Very frequent along the canyon of the Stillwater, owing to the excessively steep slopes.

Towns and settlements.—There are no settlements in the township.

Forest conditions.—The timber is confined to the canyon of Stillwater River, its larger western tributaries, and a few of the lower and less rocky slopes. The stands are composed of lodgepole pine in nearly pure growths or with large proportions of spruce and subalpine fir, and vary in age from 60 to 200 years, depending on the time that has elapsed since the last fire. The forest is practically inaccessible, except for local use.

Cutting.—None.

Burns.—None.

Reproduction.—Young growth is everywhere scanty or of only moderate volume. The proportion of the different species composing it is the same as in the old or mature growth.

Undergrowth.—Light.

Litter.—Small quantities in the younger lodgepole stands.

Humus.—A thin moss cover in the canyons comprises all the humus layer.

Classification of lands in T. 7 S., R. 14 E.

	Acres.
Forested	7,040
Nonforested	16,000
Badly burned	None.
Logged	None.
Agricultural	None.
Grazing	8,000
Bare rocks and alpine	8,000

Total stand of timber in T. 7 S., R. 14 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	6,000,000	3,000,000	4,080,000
White-bark pine	----------	1,000,000	1,000,000
Subalpine fir	----------	6,000,000	6,000,000
Engelmann spruce	4,000,000	6,000,000	6,720,000
Total	10,000,000	16,000,000	17,800,000

Composition of forest in T. 7 S., R. 14 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	12
White-bark pine	8
Subalpine fir	20
Engelmann spruce	60

TOWNSHIP 7 SOUTH, RANGE 15 EAST.

The township comprises a high, mostly alpine region, abounding with crags, precipices, and bare rocky peaks rising to altitudes of 12,500 feet, and deep, cliff-bound canyons. None of the areas are agricultural; none have a grazing value; none are forested; scattered trees of subalpine species grow here and there in the lower and more sheltered ravines, but as most of the region is situated above timber line, there never can be any extensions of the present amount of arborescent

growth. Small tarns and ponds form heads to various creeks, and the region is of importance by reason of these natural reservoirs.

Classification of lands in T. 7 S., R. 15 E.

	Acres.
Forested	None.
Nonforested	23,040
Bare rocks and alpine	20,000
Lakelets, tarns, and streams	3,040

Township 7 South, Range 16 East.

Topography.—This township is in a high, mostly alpine region—a mass of crags, precipices and pinnacled ridges, which, in the northwest corner of the township, culminate in peaks rising to elevations of 12,500 feet. Winding among the steep, rocky spurs lie deep, cliff-lined canyons littered with talus and morainic débris, which here and there dams the streams and causes them to spread out and form lakes of considerable size.

Mining.—None.

Soil.—The soil is sterile and rocky. A large proportion of the tract has no soil cover.

Agricultural adaptability.—There is no tillable land in the township.

Grazing capacity.—The summits of the ridges bear, hear and there, thin swards of alpine sedges and grasses and some of the larger lakes have wet glades fringing them. None of them are accessible to stock.

Drainage conditions.—There is a large and continuous outflow, all by way of West Rosebud Creek. The township constitutes a great natural reservoir to this stream, and as such is of importance notwithstanding its rough and rocky character.

Snow and rock slides.—Frequent throughout.

Towns and settlements.—No part of the township is inhabited.

Forest conditions.—Most of the township lies above timber line, and the forest is confined to the lower slopes and the bottoms of a few canyons in the northern portion. The stands are composed of lodgepole pine and spruce at the lowest elevations, and of the subalpine type of forest at the upper.

Cutting.—None.

Burns.—Tracts in the northeast corner of the township have been burned over within the past seven or eight years and the timber on 400 acres destroyed.

Reproduction.—Young growth is not abundant. Lodgepole pine and Engelmann spruce are the leading species in the restockage. The burned-over tracts are not reforesting.

Undergrowth.—Low shrubs, of huckleberry, wild raspberry, gooseberry, etc.

Litter.—In the lodgepole-pine stands and on the burned-over areas litter of

dead and fallen pole timber is abundant. In the subalpine stands the amount is small.

Humus.—None.

Classification of lands in T. 7 S., R. 16 E.

	Acres.
Forested	2,400
Nonforested	20,640
Badly burned	400
Logged	None.
Agricultural	None.
Grazing	None.
Bare rocks and high alpine	17,140
Lakes and tarns	3,100

Total stand of timber (pole and fuel) in T. 7 S., R. 16. E.

	Cubic feet.
Lodgepole pine	950,000
White-bark pine	350,000
Subalpine fir	800,000
Engelmann spruce	800,000
Total	2,900,000

Composition of forest in T. 7 S., R. 16 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	50
White-bark pine	12
Subalpine fir	20
Engelmann spruce	18

TOWNSHIP 7 SOUTH, RANGE 17 EAST.

Topography.—The township consists of the divide lying betweet East and West Rosebud creeks, with the steep breaks leading into the canyons of these streams. It is a high, rugged mass of mountains, some portions rising to nearly 12,000 feet while comparatively little lies below the 9,000-foot contour.

Mining.—None.

Soil.—Very thin, gravelly loam, stony, and strewn with huge bowlders in most places. Large areas, particularly on the breaks to the Rosebud canyons, are entirely devoid of soil cover.

Agricultural adaptability.—The township contains no arable land.

Grazing capacity.—In the Rosebud canyons small glades and burned-over tracts not reforesting furnish pasture and are so utilized. The summits of the spurs are covered with alpine sedges and grasses, but are inaccessible to domestic grazing animals.

Drainage conditions.—The run-off is large and continuous, and as the tract serves as a natural reservoir for the two Rosebud creeks it is of great importance.

Snow and rock slides.—These are common, especially in East Rosebud Canyon. Enormous masses of overhang line the brinks of the canyons and frequently send down vast masses of rock and gravelly débris.

Towns and settlements.—There are no towns on the tract. At the north end of East Rosebud Lake, a sheet of water covering 750 acres in the canyon of the same name, is a summer cottage belonging to a Major Armstrong, who occupies a tract of surveyed land in the heart of the mountains far from all other surveys.

Forest conditions.—The forest consists of thin stands of lodgepole pine, red fir, white-bark pine, and spruce in the canyons and on the declivities where the slope is not too steep to permit soil to accumulate. Small stands of aspen and cottonwood occur in the bottoms of East Rosebud Canyon, while a few copses of yellow pine occupy tracts at the mouth of the canyon. Formerly the bottoms and slopes of East Rosebud Canyon were closely stocked with timber in most places, but very little has escaped the fires during the last four or five years.

Cutting.—Small quantities here and there for local use.

Burns.—During the past six or seven years most of the township has been burned over. Complete destruction of the timber has followed.

Reproduction.—There is little young growth. The burned tracts show practically no evidence of reforestation. Especially is such the case on the southern and western exposures. Since the fires many of the slopes show extensive gullying, while on most of them the loamy surface is being washed into the streams and carried away, a process which will indefinitely retard reforestation.

Undergrowth.—Moderate in quantity. A few of the burns are growing up to various sorts of brush, mostly *Ceanothus.*

Litter.—There are large quantities of dead and fallen timber on the burned-over tracts. Most of the dead timber is still standing, and when it falls the amount of litter will be very large.

Humus.—None.

Classification of lands in T. 7 S., R. 17 E.

	Acres.
Forested	3,600
Nonforested	19,440
Badly burned	11,440
Logged	None.
Agricultural	None.
Grazing	3,000
Bare rocks	4,000
Lakes and tarns	1,000

Total stand of timber (pole and fuel) in T. 7 S., R. 17 E.

	Cubic feet.
Lodgepole pine	1,200,000
White-bark pine	800,000
Yellow pine	20,000
Red fir	40,000
Subalpine fir	500,000
Engelmann spruce	500,000
Aspen and cottonwood	200,000
Total	3,260,000

Composition of forest in T. 7 S., R. 17 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	50
White-bark pine	15
Yellow pine	.2
Red fir	.8
Subalpine fir	10
Engelmann spruce	20
Aspen and cottonwood	4

TOWNSHIP 7 SOUTH, RANGE 18 EAST.

Topography.—The western half of the township consists of steep, rocky spurs forming the divide between Red Lodge and West Rocky Fork creeks, and between Red Lodge and East Rosebud drainage. Their eastern terminations lie in the central portion of the tract where they break with sharp descents to a rolling foothill region, which fills the remainder of the areas of the township with low, long ridges and a multitude of shallow ravines and gullies. The general elevation of the foothill region is about 5,600 feet, while the ridges in the western areas reach altitudes of 9,000 feet.

Mining.—No mineral is mined. Petroleum is thought to occur in the northwest quarter of the township, where borings have been made intermittently for several years, but without definite results.

Soil.—Gravelly loam. The entire foothill region is covered with a deep blanket of extremely heavy bowlder drift, partly overlain with a thin top-dressing of loamy matter.

Agricultural adaptability.—The western areas contain no tillable land. Tracts in the eastern portion, in the aggregate 800 or 1,000 acres, are susceptible of cultivation.

Grazing capacity.—The foothill region, where not wooded, has a grass cover, and has long been utilized as cattle and sheep ranges. Where not fenced it has been badly overgrazed.

Drainage conditions.—The run-off is of moderate volume, and is carried by Red Lodge, West Rocky Fork, and numerous smaller creeks, which have their rise in the fronts of the spurs. Their waters are more or less used for irrigating agricultural lands outside the township.

Snow and rock slides.—Infrequent, and limited to the high western portions.

Towns and settlements.—One or two farmsteads near the north line of the township comprise the settlements.

Forest conditions.—The mountain areas bear nearly pure-growth stands of lodgepole pine at middle elevations, giving way to stands of the ordinary subalpine type at the highest altitudes. The foothill region is dotted with extensive and extraordinarily closely set stands of sapling lodgepole pine and aspen, this young growth covering fully 60 per cent of the forested area of the township. Most of the timber in the district has only a fuel or pole value. With the exception of the summits of the spurs the different tracts are not particularly difficult of access.

Cutting.—The foothills and lower slopes of the mountains were culled many years ago. In some of the more readily accessible portions the cutting has amounted to 80 or 90 per cent. Much fire-killed timber has been taken out. In the aggregate 5,000 acres have been culled.

Burns.—Extensive forest fires, originating five or six years ago in East Rosebud Canyon, burned the timber on large tracts of the mountain spurs, but the killed trees are still standing.

Reproduction.—In the high areas there is little young growth. Parts of the burns are restocking; parts are still without any seedling growth. Lodgepole pine is the chief species in the restockage. The foothills are becoming covered with extremely close-set stands of lodgepole pine and aspen. It is impossible to determine with absolute certainty whether these stands are reforestations direct after fires, or whether they occupy ground formerly grassed over as the result of repeated fires while the Indian had control of the region. However this may be, the forest is now extending into foothill tracts which do not show a vestige of former timber growth. These heavily stocked stands of young lodgepole and aspen are the most conspicuous features of the forest.

Undergrowth.—In the stands of green timber there is very little underbrush present. On the burned-over areas which are not restocking, dense growths of shrubs, chiefly *Ceanothus*, are covering the ground.

Litter.—In the growing forest the litter generally is light. In the burned districts dead and down timber is accumulating in great quantities.

Humus.—None.

Classification of lands in T. 7 S., R. 18 E.

	Acres.
Forested	12,040
Nonforested	11,000
Badly burned	6,000
Logged (culled)	8,000
Agricultural	1,000
Grazing	3,200
Bare rocks	800

Total stand of timber in T. 7 S., R. 18 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet, B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	2,000,000	9,000,000	9,360,000
White-bark pine	----------	1,200,000	1,200,000
Subalpine fir	----------	900,000	900,000
Engelmann spruce	800,000	900,000	1,044,000
Aspen and cottonwood	----------	1,000,000	1,000,000
Total	2,800,000	13,000,000	13,504,000

Composition of forest in T. 7 S., R. 18 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	Scattered trees.
Lodgepole pine	70
White-bark pine	3
Red fir	Scattered trees.
Subalpine fir	1
Engelmann spruce	6
Aspen and cottonwood	20

Township 8 South, Range 10 East.

Topography.—The township consists of high, rocky, alpine and subalpine ridges reaching altitudes of 10,000 feet, with deep and narrow intervening canyons belonging to the drainage basin of Hell Roaring Creek.

Mining.—None.

Soil.—Thin, gravelly, stony, and bowlder-strewn throughout.

Agricultural adaptability.—There are no lands capable of tillage in the township.

Grazing capacity.—None.

Drainage conditions.—Numerous springs, rivulets, and creeks have their rise in the township.

Snow and rock slides.—Infrequent.

Towns and settlements.—None.

Forest conditions.—The lower areas are covered with large and continuous stands of lodgepole pine, with small admixtures of spruce and red fir. The stands average 100 years old. The subalpine forest consists of white-bark pine, spruce, and subalpine fir and is thin and scattering.

Cutting.—None.

Burns.—Along the east line small patches of burns, in the aggregate 500 acres, extend into the township from the large burns in Hell Roaring Basin.

Reproduction.—Scanty, but sufficient to maintain the present density of stands. The greater portion of the sapling and seedling growth is composed of lodgepole pine.

Undergrowth.—Sparse.

Litter.—There is a moderate amount of dead and down timber, killed by overcrowding, in the lodgepole pine stands. In the subalpine forest the amount of litter is small.

Humus.—None.

Classification of lands in T. 8 S., R. 10 E.

	Acres.
Forested	16,000
Nonforested	7,040
Badly burned	500
Logged	None.
Agricultural	None.
Grazing	None.
Bare rocks and high alpine	6,540

Total stand of timber in T. 8 S., R. 10 E.

Species.	Mill timber.	Pole and fuel timber.	Total stand of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	20,000,000	25,000,000	28,600,000
White-bark pine	----------	8,000,000	8,000,000
Red fir	1,000,000	----------	180,000
Subalpine fir	----------	3,000,000	3,000,000
Engelmann spruce	5,000,000	2,000,000	2,900,000
Total	26,000,000	38,000,000	42,680,000

Composition of forest in T. 8 S., R. 10 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	72
White-bark pine	10
Red fir	.3
Subalpine fir	5.7
Engelmann spruce	12

Township 8 South, Range 11 East.

Topography.—The tract chiefly consists of the upper basin of Hell Roaring Creek, a broad, semicircular depression between ridges having altitudes of 9,000 to 10,000 feet. The depression forms a sort of valley with low ridges, gullies, and ravines intersecting its bottom in various directions. Hell Roaring Creek is in a rift in the solid granite, 50 to 60 feet wide and 40 to 60 feet deep, with nearly perpendicular walls. The east side of the valley rises to the summit of the inclosing ridges through a series of broad terraces; the north and west sides mount on the steep fronts of high spurs stretching out from divides in the townships adjoining, while the south side forms the entrance to the canyon portion of Hell Roaring Creek Valley.

Mining.—None.

Soil.—Thin, gravelly loam, stony; many of the slopes are covered with talus devoid of soil. The surface of the central part of the depression consists of a sheet of bowlder and gravel drift.

Agricultural adaptability.—None of the lands in the township are tillable.

Grazing capacity.—The grazing areas of the township are mostly fire glades slowly reforesting. A few marshy meadows occur in the central areas, and some small subalpine glades on the ridges inclosing the valley on the east.

Drainage conditions.—A large amount of water flows from the township. The tract abounds in large springs, points of seepage, subalpine rivulets, and small ponds. It is practically the water head of Hell Roaring Creek.

Snow and rock slides.—Infrequent or altogether lacking.

Towns and settlements.—None.

Forest conditions.—The forest conditions are the results of fires during the past one hundred and fifty years. The central areas are covered chiefly with lodgepole pine, varying in age from 50 to 100 years. The younger stands are reforestations after fires in modern times; the older growths are stands that escaped the last great fires, and are scattered throughout the sapling growths. The subalpine forest, covering 30 per cent of the township, consists of spruce, white-bark pine, and subalpine fir, with occasionally some lodgepole pine. The white-bark pine is very abundant, and at the highest levels forms 75 per cent of the forest. Along the lower edge of the subalpine stands Engelmann spruce constitutes 60 to 80 per cent of the timber. The timber on the high eastern slopes of the valley is chiefly an old growth, varying from 150 to 200 years in age. Poplar and aspen groves are common in the central parts and form thick fringes around the tarns and ponds, or entirely cover the more seepy areas where coniferous growth is not possible.

Cutting.—None.

Burns.—The recent burns, not yet reforesting, or only very tardily, amount

in the aggregate to 2,000 acres. Most of the central areas, about 10,000 acres, were burned over sixty or seventy years ago.

Reproduction.—There is a moderate amount of young growth throughout the central portions, but nowhere is the restockage at all dense. The grassy fire glades that came into existence sixty or seventy years ago show a tendency to become permanent. Some of them are covered with dense brush growths in which the seeds of coniferous trees obtain lodgement with extreme difficulty. Lodgepole pine prevails as young growth at all the lower altitudes. Seedling and sapling growth are scanty in the subalpine forest.

Undergrowth.—There is little brush growth in the subalpine forest or in the well-stocked stands of lodgepole pine at the lower elevations. Dense brush covers many of the old fire glades. It is composed of *Shepherdia*, *Canadensis*, *Ceanothus velutinus*, juneberry, wild rose and the like.

Litter.—In the lodgepole pine stands the amount of litter is small. In the subalpine forest, particularly where Engelmann spruce is abundant, there is an immense amount of uprooted timber, due to heavy winds and to the springy character of the ground.

Humus.—In the spruce stands on the east side of the valley the humus or duff, composed of moss, is 3 to 6 inches in depth. Elsewhere in the township it is lacking.

Classification of lands in T. 8 S., R. 11 E.

	Acres.
Forested	17,640
Nonforested	5,400
Badly burned	2,000
Logged	None.
Agricultural	None.
Grazing	1,900
Bare rocks	500
Ponds and marshes	1,000

Total stand of timber in T. 8 S., R. 11 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	30,000,000	21,000,000	26,400,000
White-bark pine	----------	7,000,000	7,000,000
Red fir	2,000,000	----------	360,000
Subalpine fir	----------	3,800,000	3,800,000
Engelmann spruce	23,000,000	7,000,000	11,140,000
Total	55,000,000	38,800,000	48,700,000

Composition of forest in T. 8 S., R. 11 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	68
White-bark pine	8
Red fir	.5
Subalpine fir	3.5
Engelmann spruce	20

Township 8 South, Range 12 East.

Topography.—The northern areas comprise rough ridges and crests rising to altitudes of 11,000 feet. The central areas are formed by the basin-like valley of upper Buffalo Creek, which is bordered on the west by a plateau-like ridge, forming the divide against Hell Roaring Creek; and on the east by narrow, rocky crests sloping into Buffalo and Slough creeks with a succession of long terraces.

Mining.—None.

Soil.—Clayey and gravelly loam, stony and bowlder strewn in places.

Agricultural adaptability.—The tract is too stony, too mountainous, and situated at too high altitudes for agriculture.

Grazing capacity.—The plateau-like portion of the spurs inclosing Buffalo Creek on the west, and the upper areas of the basin of that stream, contain large areas of grassy glades and uplands suitable for pasture. No stock were pastured on these tracts during the past season.

Drainage conditions.—The township is well supplied with springs and rivulets and small ponds here and there in the western areas. It forms the water head of the Buffalo Creek drainage.

Snow and rock slides.—Infrequent.

Towns and settlements.—None.

Forest conditions.—The forest in the east half of the township consists of lodgepole pine to the extent of 80 per cent. In Buffalo Creek Basin the stands are chiefly composed of Engelmann spruce. On the summit of the ridges the forest, wholly of the subalpine type, consists mostly of white-bark pine and spruce. The forest is composed of old growth stands varying in age from 150 to 200 years and over. There is very little forest in the sapling stage throughout the township. Portions of the timber in the extreme eastern sections of the township are accessible by way of Slough Creek Valley. The remainder can be reached only for local use.

Cutting.—None.

Burns.—A small tract, 100 acres, along the western edge of the township has been burned over by fires of recent date.

Reproduction.—Most of the forest has reached the period when its stands are

fully stocked, and young growth is nearly impossible owing to lack of light. In consequence there is little seedling and sapling growth.

Undergrowth.—Light.

Litter.—The forest in the east half contains immense quantities of dead and fallen timber, killed by overcrowding. The western half has only a moderate quantity of litter.

Humus.—Generally abundant in the east half of the township; scanty or wholly lacking in the west half and on the summit of the higher ridges.

Classification of lands in T. 8 S., R. 12 E.

	Acres.
Forested	12,040
Nonforested	11,000
Badly burned	100
Logged	None.
Agricultural	None.
Grazing	8,000
Bare rocks	2,600
Ponds and streams	300

Total stand of timber in T. 8 S., R. 12 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	15,000,000	20,000,000	22,700,000
White-bark pine	1,000,000	3,000,000	3,180,000
Red fir	3,000,000	1,000,000	1,540,000
Subalpine fir		2,000,000	2,000,000
Engelmann spruce	17,000,000	6,000,000	9,060,000
Total	36,000,000	32,000,000	38,480,000

Composition of forest in T. 8 S., R. 12 E., including trees of all species with basal diameters of 8 inches and upward.

	Per cent.
Lodgepole pine	68
White-bark pine	3
Red fir	1
Subalpine fir	8
Engelmann spruce	20

Township 8 South, Range 13 East.

Topography.—The township comprises the northern portion of Slough Creek drainage, the stream running through the center of the tract. In its bottoms is a terraced flood valley. Ridges, with long, easy slopes, for the most part, border the

valley on the west and on the east, the northeast corner being an exception. Here the spurs rise to altitudes of 10,000 feet and form Horseshoe Mountain.

Mining.—The summit and upper slopes of Horseshoe Mountain are mineral bearing.

Minerals.—Gold, both quartz and placer.

Soil.—Thin, gravelly loam, generally very much littered with bowlders.

Agricultural adaptability.—The region is situated at a too high altitude for agriculture.

Grazing capacity.—Small glades on Horseshoe Mountain and in Slough Creek; in the latter several ancient fire glades afford pasturage.

Drainage conditions.—The township is abundantly supplied with springs, marshy areas, and places of seepage, besides giving rise to several large creeks. The outflow is carried by Slough Creek, which evidently has a great underflow through the vast mass of glacial débris littering the valley.

Snow and rock slides.—Snow and rock avalanches are common along the west slopes of Horseshoe Mountain where it abuts on the valley of Slough Creek.

Towns and settlements.—There are two permanent mining camps, both small, on Horseshoe Mountain. Outside this area the tract is not inhabited.

Forest conditions.—With the exception of the summit of Horseshoe Mountain the township is well stocked with forest, carrying the greatest quantity of timber of any of the townships in the Absaroka division of the Yellowstone Forest Reserve. In the valley of Slough Creek and in the bottoms and middle slopes of the tributary creeks entering from the east the stands are chiefly composed of lodgepole pine, varying in age from 50 to 200 years. Some of the stands carry timber, mostly of logging dimensions; others have nothing but slender pole growths. At the middle elevations on the west slopes spruce largely replaces the lodgepole pine of the valley. In stands where it is the dominant species it attains diameters up to 3 feet with trunks 100 feet in height. At subalpine elevations the usual thin and scattering stands of white-bark pine, spruce, and subalpine fir form the forest. With the exception of the lodgepole pine the trees are limby and knotty throughout, rarely showing any clear trunk. The tract is easily accessible by way of Yellowstone National Park and the lower portion of Slough Creek Valley.

Cutting.—None, except a small amount on Horseshoe Mountain, culled out for local use by the miners.

Burns.—There are two small burns, amounting to 100 acres, in the Slough Creek bottoms near the south line of the township.

Reproduction.—Young growth is abundant in the stands where the forest is not too closely set. In the young and close-set lodgepole-pine forest seedling and young-sapling growth are almost entirely lacking. In most of the older and open

lodgepole-pine the young growth is chiefly spruce. Nearly all the forest in the township is in a very active stage of natural thinning.

Undergrowth.—The brush growth is scanty throughout.

Litter.—Here and there along Slough Creek and on Horseshoe Mountain the forest is quite free from litter, and presents, in the older stands, a clean, park-like appearance. Elsewhere in the township the forest is littered with an immense amount of dead and down pole timber, the result of overstockage.

Humus.—In the stands bordering the valley on the west a layer of humus or duff, 3 to 6 inches in depth, covers the forest floor. In the stands on the eastern side of the valley it is very thin or altogether lacking.

Classification of lands in T. 8 S., R. 13 E.

	Acres.
Forested	20,640
Nonforested	2,400
Badly burned	100
Logged	None.
Agricultural	None.
Grazing	1,800
Bare rocks	500

Total stand of timber in T. 8 S., R. 13 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	65,000,000	64,000,000	75,700,000
White pine	3,000,000	----------	540,000
White-bark pine	----------	4,000,000	4,000,000
Red fir	5,000,000	----------	900,000
Subalpine fir	----------	5,500,000	5,500,000
Engelmann spruce	52,000,000	10,000,000	19,360,000
Total	125,000,000	83,500,000	106,000,000

Composition of forest in T. 8 S., R. 13 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	62
White pine	.8
White-bark pine	7.2
Red fir	.2
Subalpine fir	9.8
Engelmann spruce	20

Township 8 South, Range 14 East.

Topography.—The eastern areas of the township comprise a high, rocky, glaciated tract abounding in shallow depressions, small flats, short escarpments, steep serrated peaks, and narrow crevice-like canyons. The central areas are cut by the trough-like canyon of Stillwater River, with sheer, rock walls in most places. The western tracts consist of broad spurs and ridges stretching eastward from the main divides in the township on the west.

Mining.—None.

Soil.—Thin and gravelly; most of the nontimbered areas of the township have no soil cover.

Agricultural adaptability.—The township contains no tillable land.

Grazing capacity.—None.

Drainage conditions.—The run-off is large. The eastern half is very abundantly supplied with springs, tarns, alpine rivulets, and creeks, while several large creeks have their rise in the western areas. The township is one of the principal water heads of Stillwater River.

Snow and rock slides.—Slides are of frequent occurrence, especially in the eastern areas along the breaks to the Stillwater Canyon.

Towns and settlements.—The township is uninhabited.

Forest conditions.—The bottoms of the Stillwater canyons are forested with moderately close-set stands of lodgepole pine and Engelmann spruce, mostly old growth. The ridges west of the canyon carry stands of subalpine type, thin and scattered at the higher elevations, close set in the canyons. The eastern areas of the township are mostly bare of forest, or have thin lines of trees and small copses set here and there in the sheltered hollows of the spurs. The timber is inaccessible except for local use.

Cutting.—None.

Burns.—None.

Reproduction.—In the stands in Stillwater Valley the young growth, consisting chiefly of lodgepole pine, is sufficient to maintain the present volume. There is little young growth in the subalpine stands.

Undergrowth.—Light.

Litter.—A small quantity of dead and down timber is scattered through the forest in Stillwater Valley, a large proportion of this being due to the crushing effects of snow and rock slides descending the steep slopes. Elsewhere the litter is small in quantity.

Humus.—A light cover of moss occurs in the valley and on the lower slopes. At the higher elevations the forest floor is bare.

Classification of lands in T. 8 S., R. 14 E.

	Acres.
Forested	9,000
Nonforested	14,040
Badly burned	None.
Logged	None.
Agricultural	None.
Grazing	None.
Bare rocks and alpine	13,000
Tarns and streams	1,040

Total stand of timber in T. 8 S., R. 14 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	8,000,000	10,000,000	11,440,000
White-bark pine		1,000,000	1,000,000
Subalpine fir		3,000,000	3,000,000
Engelmann spruce	20,000,000	2,000,000	5,600,000
Total	28,000,000	16,000,000	21,040,000

Composition of forest in T. 8 S., R. 14 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	20
White-bark pine	6
Subalpine fir	9
Engelmann spruce	65

Township 8 South, Range 15 East.

Topography.—The township consists of a high alpine and subalpine area, in the southern and central portions comprising a mass of short, irregular ridges with a maze of ravines, shallow canyons, and runs cutting the ridges in all directions, and a large number of depressions holding one or more lakelets and tarns. The northern areas rise into towering peaks, several of them 12,000 feet in height, surrounding which are rock-bound canyons almost crevice-like in their narrowness.

Mining.—None; the region is mineralized, however.

Minerals.—Gold and copper.

Soil.—Thin and gravelly, in most localities strewn with immense bowlders and masses of talus. Most of the areas are entirely devoid of soil, presenting nothing but the smooth, bare rock.

Agricultural adaptability.—The township contains no arable land.

Grazing capacity.—A few hundred acres of alpine meadow land exist in the southern and central areas. The tracts are not pastured.

Drainage conditions.—The township is of importance by reason of the large volumes of water constantly discharged from its areas. The tarns and lakelets constitute natural reservoirs, and great banks of snow or incipient glaciers lie on the northern slopes of most of the higher elevations. The drainage flows partly into Stillwater River and partly into Clark Fork.

Snow and rock slides.—Of frequent occurrence, especially in the northern areas. Mud slides carrying vast quantities of bowlders line many of the tarns and are common on the slopes of the peaks. The ragged and serrated crests of the ridges have enormous masses of overhang, from which avalanches of stones and bowlders are continually descending into the canyons and building up the talus slopes.

Towns and settlements.—None.

Forest conditions.—The tract carries no forest. There are a few trees of white-bark pine and Engelmann spruce scattered through the hollows or lining the tarns in the southern areas. Most of the township lies at altitudes above timber line, where low growths of willows replace arborescent vegetation.

Reproduction.—Climatic conditions are such that much young growth is impossible. In the sheltered hollows and ravines, up to elevations of 9,800 feet, there will always be a few seedlings and saplings. Very rarely will one of them grow to maturity, being broken off or uprooted by heavy snows and fierce gales as soon as any considerable size and spread of limbs are attained.

Classification of lands in T. 8 S., R. 15 E.

	Acres.
Forested	None.
Nonforested	23,040
Agricultural	None.
Grazing	3,000
Bare rocks, alpine snowbanks, and incipient glaciers	18,000
Lakelets, tarns, and streams	2,040

Township 8 South, Range 16 East.

The township consists of a high, rugged mass of mountains, mostly situated above the 9,500-foot contour, with peaks and ridges rising to 12,900 feet. It abounds with peaks, serrated and pinnacled crests and ridges, canyons, precipices, and alpine lakelets and tarns.

The township is uninhabited. The surface consists chiefly of bare rock. None of the areas are agricultural in character. Swampy meadows, fringing the alpine tarns, are met with here and there, but they are practically inaccessible to stock.

None of the lands are mineral bearing. No forest exists in the township, but a few narrow lines of spruce and white-bark pine fringe tarns situated at or near the 9,500-foot contour line. The greater portion of the tract lies above timber line. The township has a large run-off, and is of importance by reason of the large natural storage capacity afforded by its many lakelets and tarns.

Classification of lands in T. 8 S., R. 16 E.

	Acres.
Forested	None.
Nonforested	23,040
Bare rocks	17,000
Alpine meadows and glades	2,540
Lakelets, tarns, and streams	3,500

Township 8 South, Range 17 East.

Topography.—The eastern area comprises high spurs with broadening or plateau-like summits, which in the central portion break off to the canyon of the East Rosebud. The portion of this canyon situated within the township is a mere rift through the mountains, bounded on either side by great, bare, almost perpendicular walls of rock. The southwest corner of the township rises in a vast mass of jagged cliffs. The average altitude of the township is about 10,800 feet, while many isolated tracts attain elevations of 12,000 feet.

Mining.—None.

Soil.—Thin gravelly loam, with the surface strewn with bowlders, usually of large size. The slopes leading to the different canyons are mostly bare of soil, presenting either naked rock or talus.

Agricultural adaptability.—No portion of the township has any arable land.

Grazing capacity.—The summits of the ridges are covered with a thin sward of alpine sedges and grasses. They are extremely difficult of access, probably beyond the reach of any kind of stock except sheep. There are no grazing areas in the canyons.

Drainage conditions.—The township is the water head of East Rosebud Creek. The run-off is large. Springs abound, while numerous tarns and ponds in the southern part serve as natural reservoirs and more or less regulate the outflow. The waters of East Rosebud Creek are largely utilized for irrigation purposes in the agricultural sections north of this township.

Snow and rock slides.—Of common occurrence.

Towns and settlements.—The tract is entirely uninhabited.

Forest conditions.—Light stands of lodgepole pine, spruce, and subalpine fir occur in the bottom of East Rosebud Canyon for a distance of 3 miles south from the north line of the township. Small copses and thin lines of spruce and white-bark pine cling to the rocky slopes of the different canyons or nestle in

the deeper and more sheltered hollows to which projecting spur or excavated glacial cirque give rise. There is no mill timber; the growth has only a fuel value and is practically inaccessible except for local use. Most of it is a pole growth.

Cutting.—None.

Burns.—None.

Reproduction.—Reproduction is sufficient to maintain present stands. Climatic conditions forbid any considerable additions to the present timbered area, but more closely stocked stands, particularly in the East Rosebud bottoms, are possible. Lodgepole pine and spruce are the leading species of the young growth.

Undergrowth.—Very thin and scattering.

Litter.—A small amount in the lodgepole-pine stands.

Humus.—Lacking.

Classification of lands in T. 8 S., R. 17 E.

	Acres.
Forested	3,000
Nonforested	20,040
Badly burned	None.
Logged	None.
Agricultural	None.
Grazing	11,000
Bare rocks	7,300
Tarns and streams	1,740

Total stand of timber in T. 8 S., R. 17 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine		1,000,000	000,000
White-bark pine		250,000	250,000
Subalpine fir		350,000	350,000
Engelmann spruce		1,000,000	1,000,000
Total		2,600,000	2,600,000

Composition of forest in T. 8 S., R. 17 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	30
White-bark pine	5
Subalpine fir	30
Engelmann spruce	35

TOWNSHIP 8 SOUTH, RANGE 18 EAST.

Topography.—The township consists of a moor-like plateau nearly 11,000 feet above sea level. Its surface is elevated in long swells and depressed in broad, shal-

low swales. It is intersected from southwest to northeast by the extremely rocky and precipitous canyon of Rocky Fork, from which several lateral gorges cut deep into the plateau.

Mining.—None.

Soil.—Thin, gravelly loam with masses of bowlder drift scattered over the surface.

Agricultural adaptability.—The township contains no arable land.

Grazing capacity.—Except the breaks to the various canyons the entire township is a grazing area. It has been closely sheeped in former years, and its present grazing value is low in consequence.

Drainage conditions.—There is a moderate outflow from the tract. A few small tarns occur on the summit of the plateau, and numerous springs and small creeks along its slopes. Many of the ravines which intersect the summit hold large banks of snow on their northern slopes throughout the summer, which supply various runs and rivulets with moderate volumes of water.

Snow and rock slides.—Avalanches of rock and snow, and landslips, are of frequent occurrence along the breaks of Rocky Fork Canyon and its lateral gorges.

Towns and settlements.—None.

Forest conditions.—Most of the tract is situated above timber line, and the small amount of forest is confined to the lower breaks and bottoms of the canyons. It is almost wholly of the subalpine type. The stands are thin and scattering, and are chiefly valuable for fuel. They are generally inaccessible except for local use.

Cutting.—None.

Burns.—Burned-over tracts occur in Rocky Fork Canyon and in the northwest corner of the township. The fires in Rocky Fork Canyon apparently burned six or seven years ago, and practically wiped out all the timber in the central portion of the canyon and in its northern laterals.

Reproduction.—Very scanty throughout. The burns are not yet restocking.

Undergrowth.—Scarcely any.

Litter.—Abundant on the burned-over tracts; light in other plaees.

Humus.—None.

Classification of lands in T. 8 S., R. 18 E.

	Acres.
Forested	2,000
Nonforested	21,040
Badly burned	4,000
Logged	None.
Agricultural	None.
Grazing	13,800
Bare rocks	3,100
Tarns and streams	140

Total stand of timber in T. 8 S., R. 18 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
White-bark pine		1,500,000	1,500,000
Subalpine fir		500,000	500,000
Engelmann spruce	500,000	800,000	890,000
Total	500,000	2,800,000	2,890,000

Composition of forest in T. 8 S., R. 18 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	10
White-bark pine	40
Subalpine fir	20
Engelmann spruce	30

Township 8 South, Range 19 East.

Topography.—The southern portion of the township is situated on the summit of Beartooth Plateau, and comprises a rolling tract of country at an average altitude of 9,800 feet. The central areas are made up of steep slopes and narrow, short spurs stretching north from the rim of the Beartooth Plateau into the canyon of Rocky Fork, which occupies the northern part of the township and marks the termination of the plateau in this direction. The canyon is a narrow valley, sunk nearly 4,000 feet below the summit of the plateau level on the south, and nearly 3,000 feet below the crest of the inclosing ridge on the north. The sides rise steeply, but not precipitously, to the crests, on the south making access possible to the summit of Beartooth Plateau. The valley is littered with great accumulations of heavy, glacial, bowlder drift.

Mining.—None.

Soil.—Gravelly loam, stony, and bowlder strewn.

Agricultural adaptability.—The tillable land is confined to 150 acres in Rocky Fork Canyon.

Grazing capacity.—The southern areas, situated on the summit of the plateau, and small glades in the Rocky Fork bottoms, comprise the grazing areas. They have been closely sheeped in former years and their present pasturage value is small.

Drainage conditions.—The outflow originating in the township is comparatively small. It is carried by Rocky Fork Creek, and is used for irrigation enterprises and for domestic supply in the town of Red Lodge, in the township adjoining on the east.

Snow and rock slides.—Most of the slopes in the district having long ago acquired stability and a forest cover, avalanches either of snow or of rock are infrequent.

Towns and settlements.—The district has no towns. Two or three small farmsteads in Rocky Fork Canyon comprise all of the settlements.

Forest conditions.—Most of the northern slopes, where not burned over, carry close-set stands of timber, 80 per cent of which is in the sapling stage and represents restockage after burns thirty-five to fifty years ago. At the higher elevations 75 per cent of this young growth is composed of white-bark pine, the balance being lodgepole pine and spruce. The southern slopes have been nearly deforested by fires in recent years, and carry only scattered stands of lodgepole pine, mostly in the sapling stage. At the lowest elevations on all slopes lodgepole pine is the prevailing species, red fir and limber pine constituting only a small proportion.

Cutting.—Small tracts bordering Rocky Fork Canyon have been cut over for fencing, mine timber, and fuel.

Burns.—Most of the southern, and some small tracts on the northern, slopes have been burned over, apparently six or seven years ago.

Reproduction.—The sapling stands are generally so fully stocked that further additions are impossible. In the mature stands there is a moderate amount of young growth. The recent burns are restocking scantily. Lodgepole pine predominates in all of the young growth, seedling and sapling, at low and middle elevations; white-bark pine prevails at the highest altitudes.

Undergrowth.—Light.

Litter.—There is a very great amount of dead and fallen pole timber, both in the green and in the burned stands. The accumulations are constantly increasing by further downfalls of the fire-killed trees.

Humus.—None.

Classification of lands in T. 8 S., R. 19 E.

	Acres.
Forested	10,240
Nonforested	12,800
Badly burned	5,400
Logged	900
Agricultural	150
Grazing	7,250

Total stand of timber in T. 8 S., R. 19 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Limber pine		30,000	30,000
Lodgepole pine	3,500,000	10,000,000	10,630,000
White-bark pine		2,600,000	2,600,000
Red fir	350,000	600,000	663,000
Subalpine fir		250,000	250,000
Engelmann spruce	800,000	1,200,000	1,344,000
Total	4,650,000	14,680,000	15,517,000

Composition of forest in T. 8 S., R. 19 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	0.1
Lodgepole pine	52
White-bark pine	18
Red fir	.3
Subalpine fir	15.5
Engelmann spruce	14.1

Township 9 South, Range 10 East.

Topography.—Of this township only the northern and central areas, in the aggregate 15,360 acres, belong to the reserve, the southern portion lying within the boundaries of Yellowstone National Park. The eastern part consists of the central, or canyon, portion of Hell Roaring Creek Basin, here a narrow valley, 200 to 300 yards wide at the bottom, sunk 1,500 to 2,000 feet below the summits of the inclosing ridges. The eastern wall rises steep and rocky, with long talus slopes devoid of soil, the western wall less abruptly, precipitous only here and there, and more or less terraced. The western half comprises high, rough ridges sloping into Crevice Gulch along the western line of the township.

Mining.—Placer and quartz in Crevice Gulch.

Minerals.—Gold.

Soil.—Stony and gravelly throughout; top dressing of loam thin, except around marshy places in Hell Roaring Canyon. In Hell Roaring Canyon are two lower terraces, 75 to 110 feet in height above the stream level, chiefly composed of coarse, heavy, bowlder drift.

Agricultural adaptability.—The township contains no tillable land.

Grazing capacity.—Small, and limited to wet glades in the bottom of Hell Roaring Canyon.

Drainage conditions.—The run-off of Hell Roaring Creek Basin is large. The valley is well supplied with springs and points of seepage. The flow in Crevice

Gulch is small and intermittent. None of the streams supply water for irrigation purposes.

Snow and rock slides.—Frequent in Hell Roaring Canyon.

Towns and settlements.—Miners' cabins along Crevice Gulch; no towns.

Forest conditions.—The western portion of the township is well stocked with close-set lodgepole-pine stands 75 to 150 years old, except the lower areas of Crevice Gulch, where young or middle-aged red-fir stands predominate. The forest in Hell Roaring Canyon consists of red fir, with stands of nearly pure-growth lodgepole pine 75 to 90 years old, these lodgepole-pine stands representing burns of that age. The red fir is of small dimensions, limby and stocky, 16 to 24 inches in diameter, 50 to 75 feet in height. Engelmann spruce occurs in small quantities throughout. Close-set aspen groves cover most of the swampy and springy tracts in Hell Roaring Canyon.

Cutting.—Small quantities in Crevice Gulch for local use.

Burns.—Small burns, aggregating 200 acres, occur in the northeast corner of the township on the slopes of Hell Roaring Canyon.

Reproduction.—Sufficient to maintain the present density and composition of the forest.

Undergrowth.—Small in quantity, consisting of the common low-growing shrubs of the region, chiefly huckleberry and *Shepherdia.*

Litter.—Moderate, consisting of dead and fallen timber.

Humus.—A thin layer of decaying pine needles.

Classification of lands in T. 9 S., R. 10 E.

	Acres.
Forested	13,240
Nonforested	2,120
Badly burned	200
Logged	None.
Agricultural	None.
Grazing	None.
Bare rocks	1,920

Total stand of timber in T. 9 S., R. 10 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	12,000,000	26,000,000	28,160,000
White-bark pine	1,000,000	1,000,000	1,180,000
Red fir	30,000,000	8,000,000	13,400,000
Subalpine fir	----------	1,300,000	1,300,000
Engelmann spruce	3,500,000	1,500,000	2,130,000
Aspen and cottonwood	----------	450,000	450,000
Total	46,500,000	38,250,000	46,620,000

Composition of forest in T. 9 S., R. 10 E., including trees of all species with basal diameters of 8 inches and upward.

	Per cent.
Lodgepole pine	25
White-bark pine	1.5
Red fir	65
Subalpine fir	2
Engelmann spruce	6
Aspen and cottonwood	.5

Township 9 South, Range 11 East.

Topography.—The portion of the township within the forest reserve comprises 15,360 acres, the two southern tiers of sections being situated within the Yellowstone National Park. The eastern areas of the township consist of terraced breaks and slopes leading into the valley of Buffalo Creek. The central portions comprise tracts situated on the summit of Buffalo Plateau—a narrow, undulating table-land intersected with numerous low combs and ridges of rock and dotted by lakelets and tarns. The western portion is formed by terraces and slopes leading from the summit of Buffalo Plateau into Hell Roaring Canyon, sharp, precipitous breaks marking the last descent to the bottom of that valley. The altitudinal range varies from 7,200 to 9,500 feet.

Mining.—None.

Soil.—Gravelly loam, stony, with much bowlder drift throughout.

Agricultural adaptability.—None of the lands in the township are tillable, being too stony and at too high altitude for agricultural purposes.

Grazing capacity.—The grazing lands of the township comprise 4,000 acres and consist of grassy glades, in part swampy, in Buffalo Canyon and on its terraced western slopes, of level and rolling grass- and sedge-covered summits of the plateau area, and of fire glades, scantily reforesting, on the western slope of the plateau. The grazing areas have been moderately sheeped in the past, but were not used by any kind of stock in the summer of 1903.

Drainage conditions.—The run-off is large. The township is a sort of natural reservoir to the lower portions of Hell Roaring and Buffalo creeks. Pools, ponds, marshy tracts, springs, and rivulets abound throughout its area. The summit of Buffalo Plateau is remarkably well supplied with springs and ponds.

Snow and rock slides.—Apparently not frequent.

Towns and settlements.—None.

Forest conditions.—Most of the stands in the township consist of old growths, 100 to 150 years old. The eastern areas are forested with close-set stands of lodgepole pine, pure or mixed with spruce, or occasionally, at the lower elevations, with red fir. The forest on the summit of Buffalo Plateau is chiefly of the subalpine type—white-bark pine, Engelmann spruce, and subalpine fir, the spruce predominating. It occurs in thin lines and scattered groups with tracts of grassy glades or

meadow intervening. On the slopes of Buffalo Plateau, in the western part of the township, the forest at the upper elevations consists of 75 per cent white-bark pine and 25 per cent Engelmann spruce, much of the white-bark pine forming trees 20 to 30 inches basal diameter and 20 to 35 feet clear trunk. At middle elevations the forest is chiefly made up of close-set stands of Engelmann spruce, the trees being 2 to 4 feet in diameter and 30 to 50 feet clear trunk, while the lowest terraces bear uneven-aged stands of lodgepole pine, from 50 to 150 years old, thinly set or in more closely stocked, scattered stands separated by old fire glades. All of the timber in the township is difficult of access for logging operations.

Cutting.—None.

Burns.—Recent burns amount to only 350 acres. Burns sixty to eighty years ago laid waste 4,000 acres, now partly reforesting.

Reproduction.—The reproductive capacity of the subalpine forest on the summit of Buffalo Plateau is low. The wide grassy tracts which occur here are wholly due to past fires, and as no portion of the plateau is above timber line the forest will slowly advance and eventually reoccupy the ground, provided fires are prevented. Elsewhere in the township young growth is sufficient to maintain the present stocking of the stands, and where abnormally thin, old growths prevail abundantly enough to insure more close-set stands in the future.

Undergrowth.—Undergrowth is scanty at high elevations and in the close-set lodgepole-pine stands throughout, as well as in the old, heavy, spruce growths on the middle terraces of the western slopes of Buffalo Plateau. It is thick and abundant in the young lodgepole-pine stands on the lower western slopes of the plateau, consisting chiefly of *Shepherdia*, with small percentages of willows.

Litter.—Light, except in the spruce growths on the western slopes of the plateau, where vast quantities of uprooted trees block the forest in all directions.

Humus.—In the spruce growths above mentioned the humus layer varies from 3 to 6 inches in depth; elsewhere in the township it is light or altogether lacking.

Classification of lands in T. 9 S., R. 11 E.

	Acres.
Forested	10,360
Nonforested	5,000
Badly burned	350
Logged	None.
Agricultural	None.
Grazing	3,800
Bare rocks	100
Lakes, ponds, and streams	750

Total stand of timber in T. 9 S., R. 11 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	8,000,000	7,500,000	8,940,000
White-bark pine	3,000,000	12,000,000	12,540,000
Subalpine fir		2,000,000	2,000,000
Engelmann spruce	27,000,000	3,500,000	8,360,000
Total	38,000,000	25,000,000	31,840,000

Composition of forest in T. 9 S., R. 11 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	55
White-bark pine	15
Subalpine fir	10
Engelmann spruce	20

Township 9 South, Range 12 East.

Topography.—The western portions of the township comprise a part of the lower valley of Buffalo Creek, a depression with bottoms one-third mile wide and slopes rising in a succession of terraces to the summits of the inclosing ridges, which reach altitudes of 9,600 feet. The central regions comprise narrow, plateau-like areas, forming the divide between Buffalo and Slough creeks and breaking off to the latter in a succession of narrow rocky terraces. The township contains 15,360 acres, the two southern tiers of sections belonging to Yellowstone National Park.

Soil.—Gravelly loam, or clayey where derived from the lavas.

Agricultural adaptability.—The township contains no arable land.

Grazing capacity.—The grazing lands consist of swales and glades on the summit of the divides in the central areas and on its slopes; in all, 500 acres.

Drainage conditions.—The tract is well supplied with springs and points of seepage, but gives rise to no creeks of notable size.

Snow and rock slides.—The declivities are too gentle and the stability of the slopes too well established for slides of any sort.

Towns and settlements.—The region is uninhabited.

Forest conditions.—The township is fairly well stocked with continuous stands of old-growth lodgepole pine, spruce, and small proportions of red fir in the lower and middle areas. Above the 9,000-foot contour the forest consists of the subalpine type, and the stands are more or less separated by small grassy glades. The tract is easily accessible from the south, or from the National Park.

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Cutting.—None.

Burns.—None.

Reproduction.—There is sufficient young growth to maintain the present stands. The more aged lodgepole pine is gradually giving way to spruce.

Undergrowth.—The underbrush, composed of willows, huckleberry, *Shepherdia*, and serviceberry, is of moderate amount in the less closely stocked stands. In the old and thickset lodgepole pine it is nearly lacking.

Litter.—In the eastern areas the forest is littered with great quantities of dead and fallen timber, killed by overcrowding. The stands in the western portions of the township contain only small quantities.

Humus.—The forest floor in the eastern parts is covered with a layer of moss and pine needles 3 to 4 inches in depth. In the western areas the humus layer is thin or altogether lacking.

Classification of lands in T. 9 S., R. 12 E.

	Acres.
Forested	14,220
Nonforested	1,140
Badly burned	None.
Logged	None.
Agricultural	None.
Grazing	500
Bare rocks	640

Total stand of timber in T. 9 S., R. 12 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	25,000,000	30,000,000	34,500,000
White-bark pine		1,500,000	1,500,000
Red fir	2,000,000	500,000	860,000
Subalpine fir	1,000.000	3,500,000	3,680,000
Engelmann spruce	10,000,000	5,000,000	6,800,000
Total	38,000,000	40,500,000	47,340,000

Composition of forest in T. 9 S., R. 12 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	65
White-bark pine	1
Red fir	1
Subalpine fir	4
Engelmann spruce	29

Township 9 South, Range 13 East.

Topography.—The eastern areas comprise high spurs radiating westward from the mountains at the head of Stillwater River, with the intervening canyons wide and having comparatively gentle slopes. The central areas consist of the valley of Slough Creek, which, in the northern part of the township, forms a wide level bottom, and, in the southern, contracts to a narrow pass, 400 to 500 yards wide. The western areas of the township are made up of long slopes, with low escarpments here and there forming narrow terraces, rising to the divide between Slough and Buffalo creeks.

Mining.—None.

Soil.—Gravelly loam, mixed with coarse bowlder drift.

Agricultural adaptability.—The level bottoms of Slough Creek, comprising 1,100 acres, are adapted to the raising of hay. There are three ranch locations on this tract. The entire area actually under cultivation amounts to 2 acres, on which timothy has been sown. The land is occupied mainly for the facilities such occupation affords for poaching on the areas of the Yellowstone National Park and for killing elk and beaver that may stray across the line into the middle Slough Creek Basin.

Grazing capacity.—Grassy glades in the Slough Creek bottom and along the larger lateral canyons, in the aggregate 2,000 acres, serve as pasture grounds. The lands are not grazed, however, except by prospectors' horses and by a dozen head of cattle owned by the three ranchers in Slough Creek Valley.

Drainage conditions.—While the tract is well supplied with springs and small creeks, the outflow originating within the boundaries of the township is not large. There are no lakelets or tarns.

Snow and rock slides.—Infrequent.

Towns and settlements.—The tract has no towns.

Forest conditions.—Thickset stands of lodgepole pine, in almost all parts of the entire township, comprise the forest. All ages, from 40 up to 200 years, are represented in the stands. In the younger growths the stands of lodgepole pine are nearly pure; in the more aged stands spruce and white-bark pine are present in considerable quantities. The timber is accessible only from the south by way of the Yellowstone National Park.

Cutting.—Small quantities have been cut for local use by the ranchers of Slough Creek Valley.

Burns.—A small area, comprising 40 acres and situated in the north-central portion, has been burned over recently.

Reproduction.—Young growth is abundant throughout all of the stands. The more aged lodgepole-pine growths are gradually being supplanted by spruce and subalpine fir.

Undergrowth.—Underbrush is light at the higher elevations. In the bottoms and along the lower slopes it is abundant.

Litter.—The forest in all directions is littered with large quantities of dead and fallen timber. The timber has been killed in part by overcrowding and in part by fires dating back fifty years or more.

Humus.—Generally thin in all parts of the township, and composed mostly of a light laver of moss and pine needles.

Classification of lands in T. 9 S., R. 13 E.[a]

	Acres.
Forested	11,320
Nonforested	4,040
Badly burned	40
Logged	None.
Agricultural	None.
Grazing	3,100
Bare rocks	900

Total stand of timber in T. 9 S., R. 13 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	32,000,000	34,000,000	39,760,000
White-bark pine	1,000,000	1,000,000	1,180,000
Subalpine fir	----------	5,000,000	5,000,000
Engelmann spruce	24,000,000	5,000,000	9,320,000
Total	57,000,000	45,000,000	55,260,000

Composition of forest in T. 9 S., R. 13 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	60
White-bark pine	3
Red fir	.2
Subalpine fir	7
Engelmann spruce	29.8

Township 9 South, Range 14 East.

Topography.—Of this township only 15,360 acres are in the area discussed, the two southern tiers of sections, or 7,680 acres, being in Yellowstone National Park. The western, southern, and eastern portions of the township consist of steep, rough mountains from 8,000 to 10,000 feet in altitude, abounding in precipitous

[a] Twelve sections of this township, or 7,680 acres, are in the Yellowstone National Park, and are not included in the land classification or the timber estimates.

slopes and craggy crests; the central areas comprise low, broad, swampy, and terraced tracts around the head of Stillwater River.

Mining.—The region is mineral bearing throughout.

Minerals.—Gold, silver, copper, lead.

Soil.—Thin top-dressings of loam here and there, generally gravelly and bowlder strewn; many of the steeper slopes entirely bare of soil. Deep, loamy soil exists in the more swampy areas of the central sections.

Agricultural adaptability.—The altitude of the region is too great for agriculture.

Grazing capacity.—In the aggregate, 6,000 acres of the tract are grass lands. They comprise glades, open, nonforested mountain slopes, swampy alpine meadows, especially at the head of Stillwater River, sedge, and grass-covered crests above timber line.

Drainage conditions.—The region abounds in springs, alpine and subalpine rivulets, and marshy tracts. It contains the ultimate heads of Stillwater River, several of the southern heads of Clark Fork, and the heads of numerous creeks flowing south into the Yellowstone. The volume of run-off is large and continuous, and the tract is of great importance by reason of its water-shedding capacity.

Snow and rock slides.—Frequent along all the steeper slopes.

Towns and settlements.—Miner's claims and cabins are numerous in the eastern part of the township. Cooke City, an old and nearly dead mining camp, is said to be situated in the southeast corner of the township, an assertion the correctness of which depends on the accuracy of certain surveys.

Forest conditions.—The subalpine type of forest prevails throughout the township. Engelmann spruce is the leading species. The timber generally is small, limby, and knotty, scattered in small stands, copses, and lines. The heaviest growths are in the eastern sections. There is little young or sapling growth, most of the timber running from 100 to 175 years in age. As a source of local timber supply the forest is of great importance, although the quality of its products ranges low.

Cutting.—Most of the forest in the east half of the township has been culled and cut over by prospectors and miners, the cut amounting to 10 per cent.

Burns.—A few recent burns are scattered throughout the east half of the township, in the aggregate amounting to 200 acres.

Reproduction.—Slow and scanty throughout, as is usually the condition in the higher subalpine forest in this region.

Undergrowth.—Small in quantity and composed of low-growing huckleberry shrubs to the extent of 75 per cent.

Litter.—Trifling in amount in the lower portions, almost lacking in the upper areas of the forest.

Humus.—None.

Classification of lands in T. 9 S., R. 14 E.

	Acres.
Forested	5,360
Nonforested	10,000
Badly burned	200
Logged and culled	4,000
Agricultural	None.
Grazing	6,000
Bare rocks	3,000
Lakelets and tarns	800

Total stand of timber in T. 9 S., R. 14 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	3,000,000	4,000,000	4,540,000
White-bark pine	.....	800,000	800,000
Subalpine fir	.....	4,500,000	4,500,000
Engelmann spruce	18,500,000	5,000,000	8,330,000
Total	21,500,000	14,300,000	18,170,000

Composition of forest in T. 9 S., R. 14 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	5
White-bark pine	5
Subalpine fir	30
Engelmann spruce	60

Township 9 South, Range 15 East.

Topography.—With the exception of the southeast quarter, which is a region of low relief, this township comprises a mass of rugged mountains rising to elevations of 11,000 feet in the southwest corner and along the west line. The northeast quarter has an altitude of from 8,000 to 9,000 feet, and comprises steep, rocky ridges and dome-like hillocks more or less isolated by the interposition of ravines and glacial cirques. The upper portion of Clark Fork and the Broadwater cut the township from northwest to southeast.

Mining.—The southwest quarter of the township is mineral bearing, and in it many claims, as yet chiefly prospects, have been located. It forms part of Cooke City district.

Minerals.—Gold, silver, copper, lead.

Soil.—Gravelly loam, mostly thin and stony.

Agricultural adaptability.—None of the lands in the township are agricultural in character.

Grazing capacity.—The township contains many marshy glades along its streams and tarns; large areas of the northern portions are situated at or above timber line and present grass- or sedge-covered slopes. These tracts are suitable for pasturage, but are not utilized.

Drainage conditions.—The outflow from this township is very large and continuous. The chief water heads of Clark Fork rise in it; of these there are two, the main Clark Fork and the Broadwater. The former is a small stream 12 to 15 feet wide and 10 to 18 inches deep at medium stage; it flows in a wide canyon which in the southeast corner of the township ends in a broad flat. The Broadwater tributary is sunk in a deep, rocky canyon, the central portion of which has a remarkably level floor, the total fall in a distance of nearly 3 miles probably not exceeding 5 feet. The stream varies from 40 to 500 feet in width and from 15 inches to 8 feet in depth. Here and there it expands into lakelets, some of which are one mile long and nearly one-half mile wide. A short distance above its junction with Clark Fork, in the southeast corner of the township, the stream leaves its canyon through a narrow gorge, affording an excellent site for a storage dam. The hydrographic features of this township are of the greatest importance to the maintenance of the flow in Clark Fork.

Snow and rock slides.—In the high areas of the township avalanches are not uncommon.

Forest conditions.—The central areas of the township are covered with close-set stands of lodgepole pine and Engelmann spruce, mostly old growths. On the high-lying tracts the forest, subalpine in type, is low and scrubby, and is scattered around the margins of tarns and in the more sheltered localities in the hollows and ravines.

Cutting.—Near the junction of Clark Fork and its Broadwater tributary 60 per cent of the timber has been cut on 3,000 acres. The timber was used partly for fuel and mill timber and partly in the burning of charcoal for use of a former smelter in Cooke City.

Burns.—A few small burns occur in the southeast quarter of the tract.

Reproduction.—Abundant, except in the high subalpine areas. The young growth is composed of the same species and in nearly the same ratio as the old stands.

Undergrowth.—Light.

Litter.—Litter, composed of timber killed by overcrowding, is of moderate volume in the stands at the lower elevations. In the subalpine forest it is nearly lacking.

Humus.—Light, mostly totally lacking.

Classification of lands in T. 9 S., R. 15 E.

	Acres.
Forested	11,840
Nonforested	11,200
Badly burned	300
Logged	3,000
Agricultural	None.
Grazing	4,000
Bare rocks	4,700
Lakes and tarns	2,200

Total stand of timber in T. 9 S., R. 15 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	35,000,000	20,000,000	26,300,000
White-bark pine		3,000,000	3,000,000
Subalpine fir		7,000,000	7,000,000
Engelmann spruce	40,000,000	5,000,000	12,200,000
Total	75,000,000	35,000,000	48,500,000

Composition of forest in T. 9 S., R. 15 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	40
White-bark pine	6
Subalpine fir	10
Engelmann spruce	44

Township 9 South, Range 16 East.

Topography.—The southern and central areas comprise a tract of plateau-like country, with hillocks, irregular ridges and shallow depressions scattered over its surface. In the northern portion of the township the plateau rises in steep and deeply sculptured ridges which attain altitudes of nearly 12,000 feet.

Mining.—None.

Soil.—Rocky and gravelly. In the northern areas many of the higher slopes are entirely bare of soil, and present stretches of naked rock or slopes strewn with immense talus accumulations.

Agricultural adaptability.—The township contains no arable land.

Grazing capacity.—Most of the tarns and lakelets in the region have small grassy glades fringing their margins, while the high-lying northern areas, where the soil cover is not lacking, bear thin swards of alpine sedges and grasses. The pasturage is on the whole, however, insignificant in extent.

Drainage conditions.—The region is dotted with a large number of lakes and tarns, all of great importance as constituting a series of natural reservoirs for Clark Fork. The run-off is steady and of considerable volume.

Snow and rock slides.—Not infrequent in the high and precipitous northern areas.

Towns and settlements.—The township is not inhabited.

Forest conditions.—The southern and central areas are covered with fairly uniform old-growth stands of lodgepole pine and Engelmann spruce. The northern areas bear thin stands of white-bark pine and spruce, or are wholly without forest cover. The timber in the southern and central areas is comparatively easy of access.

Cutting.—None.

Burns.—None.

Reproduction.—Good and abundant, except in the high northern areas. The prevailing species in the sapling and seedling growth is lodgepole pine, followed by Engelmann spruce.

Undergrowth.—The underbrush is sparse and scattering, particularly in the pure-growth lodgepole-pine stands, or where this species predominates.

Litter.—Abundant along the streams and margins of tarns, and in general where seepage prevails. It consists largely of spruce uprooted and overthrown by wind.

Humus.—There is commonly a thin layer of moss and decaying pine needles in the close-set stands, especially where the ground is swampy. In the more open forest on the uplands and at subalpine elevations the humus is lacking.

Classification of lands in T. 9 S., R. 16 E.

	Acres.
Forested	15,000
Nonforested	8,040
Badly burned	None.
Logged	None.
Agricultural	None.
Grazing	1,000
Bare rocks	3,040
Lakes, tarns, and streams	4,000

Total stand of timber in T. 9 S., R. 16 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine	20,000,000	22,000,000	25,600,000
White-bark pine		2,000,000	2,000,000
Subalpine fir		4,000,000	4,000,000
Engelmann spruce	17,000,000	10,000,000	13,060,000
Total	37,000,000	38,000,000	44,660,000

Composition of forest in T. 9 S., R. 16 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	60
White-bark pine	2
Subalpine fir	6
Engelmann spruce	32

Township 9 South, Range 17 East.

Topography.—The southeast quarter of the township comprises rolling tracts of plateau land—portions of the so-called Beartooth Plateau. The rest of the township consists of mountains 10,000 to 12,000 feet high and of immense rocky and bowlder-littered canyons. The entire region, with the exception of a few areas, is high and alpine in character.

Mining.—None.

Soil.—Thin, gravelly, bowlder strewn, except around the margins of tarns and lakelets, where loamy constituents are more or less mixed with the gravelly substrata.

Agricultural adaptability.—The township contains no arable land. Its altitude would in any event preclude agricultural operations.

Grazing capacity.—The region is covered with a low growth of alpine sedges or grass wherever any soil cover exists. In past years it has been extensively used for sheep pasture, but, with the exclusion of sheep from the reserve, cattle were the only kind of stock on the tract last year. About one-half shows marks of excessive sheeping in the partial destruction of the grass cover.

Drainage capacity.—The western and central areas abound in lakelets and tarns, springs, and small marshes, and form important natural reservoirs, in part to Rocky Fork Creek and in part to Clark Fork. The northern areas carry snow throughout the summer in many localities, and the total run-off from the tract is large and continuous.

Snow and rock slides.—Rock and snow slides are of frequent occurrence throughout the northern areas. Mud slips, carrying vast masses of bowlder talus and drift, are common around the higher-lying tarns and on many of the steeper slopes.

Forest conditions.—The township contains no forested areas. In the southern portions small copses and thin lines of white-bark pine and spruce, with an undergrowth of willows, border the tarns and rivulets.

Classification of lands in T. 9 S., R. 17 E.

	Acres.
Forested	None.
Nonforested	23,040
Agricultural	None.
Grazing	15,000
Bare rocks	5,500
Lakelets and tarns	2,540

TOWNSHIP 9 SOUTH, RANGE 18 EAST.

Topography.—This township is included in what is known as Beartooth Plateau, a rolling tract of country, situated mostly at elevations of 10,000 to 11,500 feet, on the east stretching into adjoining township, and on the west breaking off with vast cliffs and precipices to the depths of Rocky Fork Canyon. The summit of the plateau is intersected with combs, ridges of rock, and heaped-up masses of bowlders, while shallow draws, gullies, and ravines break the levels in various directions.

Mining.—None.

Soil.—Gravelly loam, with the surface in most localities strewn with bowlder drift.

Agricultural adaptability.—No portion of the township contains any arable land.

Grazing capacity.—With the exception of precipitous slopes, mostly confined to the western areas, the entire tract is covered with a close turf or sward of alpine sedges, grasses, and low herbaceous plants of other orders. The tract has heretofore been excessively sheeped, and much of the former grass growth has been eaten out.

Drainage conditions.—The run-off from the tract is comparatively small. There are, however, numerous small springs and points of marshy seepage, with occasionally a group of tarns, while many of the shallow draws hold banks of snow throughout the summer.

Snow and rock slides.—Avalanches of snow and rock are not infrequent in the western areas, falling from the summit of the plateau to the bottom of Rocky Fork Canyon. Mud slips, sometimes nearly a half mile in length, exist in many of the shallow draws on the summit of the plateau, and are slowly sliding toward its breaks.

Towns and settlements.—The district is uninhabited.

Forest conditions.—The forested areas are small. They dot the plateau in various directions up to altitudes of 10,000 feet, and line the canyons in the southern portions of the township and the bottoms in Rocky Fork Canyon with sparse and thin groups of trees and copses. Most of the forest has a precarious existence, owing to its position at or near timber line. It consists wholly of the subalpine type, chiefly white-bark pine and Engelmann spruce. The trees are low, stunted, and scrubby, and are valuable only for fuel.

Cutting.—None.

Burns.—None.

Reproduction.—Young growth is sparse, barely sufficient to insure the continuance of the present thin stockage of the stands.

Undergrowth.—In the timber the underbrush consists of scattered willows. The springy and swampy areas on the summit of the plateau at alpine elevations

are invariably covered with a dense matting of willows wherever sheep have not destroyed the growth by browsing and trampling.

Litter.—None.

Humus.—None.

Classification of lands in T. 9 S., R. 18 E.

	Acres.
Forested	1,800
Nonforested	21,240
Badly burned	None.
Logged	None.
Agricultural	None.
Grazing	17,500
Bare rocks	3,000
Lakelets and tarns	740

Total stand of timber in T. 9 S., R. 18 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
White-bark pine		650,000	650,000
Subalpine fir		200,000	200,000
Engelmann spruce	1,000,000	550,000	730,000
Total	1,000,000	1,400,000	1,580,000

Composition of forest in T. 9 S., R. 18 E., including trees of all species with basal diameters of 8 inches and upward.

	Per cent.
White-bark pine	15
Subalpine fir	25
Engelmann spruce	60

Township 9 South, Range 19 East.

Topography.—The township consists of a plateau-like area—a portion of Beartooth Plateau—varying in altitude from 10,000 to 11,000 feet. The surface is rolling and intersected with low combs, ridges, and shallow canyons, the latter of which develop immense rocky gorges along the east and west lines of the township.

Mining.—None.

Soil.—Gravelly loam, the surface stony and bowlder strewn.

Agricultural adaptability.—Owing to the high altitude of all portions of the district none are cultivable.

Grazing capacity.—With the exception of 3,000 acres the township consists of open land, covered with alpine grasses and sedges. The tract has been excessively sheeped during periods covering many years up to the past summer of 1903, and the better part of the herbage has been eaten and trampled out.

Drainage capacity.—Only a very small outflow originates in the township. Springs, places of seepage, and one or two tarns occur on the summit of the plateau.

Snow and rock slides.—Apparently infrequent.

Towns and settlements.—The township is not inhabited.

Forest conditions.—The forest is limited to a few small stands of subalpine type occurring in the southern areas of the district. It is inaccessible except for local use, and has chiefly a fuel value.

Cutting.—None.

Burns.—A small tract comprising 100 acres has been burned over.

Reproduction.—Reproduction is exceedingly scanty. Apparently the forest occupies less ground now than in former times, owing probably to repeated burnings of the grassy tracts and destruction of the forest fringing them, and subsequent lack of reforestation.

Undergrowth.—Chiefly low-growing willows.

Litter.—Very light.

Humus.—None.

Classification of lands in T. 9 S., R. 19 E.

	Acres.
Forested	2,500
Nonforested	20,540
Badly burned	100
Logged	None.
Agricultural	None.
Grazing	20,000
Bare rocks	440

Total stand of timber in T. 9 S., R. 19 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine		200,000	200,000
White-bark pine		350,000	350,000
Subalpine fir		800,000	800,000
Engelmann spruce	2,000,000	1,000,000	1,360,000
Total	2,000,000	2,350,000	2,710,000

Composition of forest in T. 9 S., R. 19 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	4
White-bark pine	26
Subalpine fir	40
Engelmann spruce	30

TOWNSHIP 9 SOUTH, RANGE 20 EAST.

Topography.—The western and central areas of the township consist of a plateau-like region varying in elevation from 10,000 to nearly 11,000 feet. The surface is broken into long, low swells, short combs of rock 200 to 400 feet high, broad levels, and intersecting shallow draws or ravines that form the water heads of various creeks. The eastern areas consist of excessively steep and precipitous breaks to the levels which border Clark Fork, forming a front to the plateau nearly 5,000 feet in height, and of a narrow strip of level or rolling desert land fringing the foot of the plateau.

Mining.—None.

Soil.—The soil is gravelly, except along the foot of the plateau, where it is more or less loamy. The summit of the plateau is mostly bowlder strewn.

Agricultural adaptability.—The plateau areas are situated far above the altitudinal limits for agriculture; the desert strip at the eastern foot of the plateau is without water for irrigation.

Grazing capacity.—The summit of the plateau and the level areas at its foot are grass or sedge covered. Up to the present the tracts have been closely and excessively sheeped and have therefore only a very low grazing value.

Drainage conditions.—The run-off is small. Springs and points of seepage occur in many localities on the summit of the plateau, but the small creeks to which they give rise are mostly dry runs before they reach the levels at the foot of the plateau.

Snow and rock slides.—Frequent along the steep declivities of the eastern front of the plateau.

Towns and settlements.—None.

Forest conditions.—The forest is thin and scattered. It consists wholly of the subalpine type, white-bark pine and Engelmann spruce being the dominant species. It is chiefly an old growth, and is mostly confined to the slopes and breaks of the eastern front of the plateau. Its value is principally for fuel and the stability it imparts to the loose talus slopes where it grows. Most of it is inaccessible. The summit of the plateau lies for the most part above timber line.

Cutting.—None.

Burns.—A tract in the east-central area, amounting to 500 acres, has been burned over within the last six or eight years.

Reproduction.—Young and sapling growth is scanty throughout; the burned-over tracts are reforesting tardily.

Undergrowth.—Sparce throughout; mostly willows and *Shepherdia.*

Litter.—In the burned-over districts there are moderate quantities of dead and down timber. Elsewhere the litter is light or lacking.

Humus.—None.

Classification of lands in T. 9 S., R. 20 E.

	Acres.
Forested	3,880
Nonforested	19,160
Badly burned	500
Logged	None.
Agricultural	None.
Grazing	18,000
Bare rocks	660

Total stand of timber in T. 9 S., R. 20 E.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Lodgepole pine		1,000,000	1,000,000
White-bark pine		2,000,000	2,000,000
Subalpine fir		1,000,000	1,000,000
Engelmann spruce	1,500,000	2,000,000	2,270,000
Total	1,500,000	6,000,000	6,270,000

Composition of forest in T. 9 S., R. 20 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	30
White-bark pine	35
Subalpine fir	10
Engelmann spruce	25

TOWNSHIPS ADJOINING THE ABSAROKA DIVISION.

The following-described tracts, to wit, T. 7 S., R. 19 E.; T. 7 S., R. 20 E.; T. 8 S., R. 20 E., adjoin the Absaroka division on the east. As they are partly forested from the termination of the timbered areas stretching west, and may in the future be included in the forest reserve, the estimates and detailed descriptions have been extended to cover them.

Township 7 South, Range 19 East.

Topography.—The central and southern areas comprise steep, rocky spurs, rising to form divides between West Rocky Fork and the Red Lodge Creek drainage and reaching elevations of 9,800 feet. The northern portion of the township consists of rolling foothill areas intersected by many shallow ravines and gulches.

Mining.—None.

Agricultural adaptability.—The mountainous areas are too rough for tillage, and the foothill region is so stony and so cut up with ravines and gulches that farming is practically impossible.

Grazing capacity.—The foothill areas are grassy and serve as pasture lands.

Drainage conditions.—The run-off originating in the township is insignificant in volume and consists wholly of the outflow from small springs.

Snow and rock slides.—Along the steep fronts of the spurs in the central areas rock slides are not uncommon.

Towns and settlements.—None.

Forest conditions.—The bases of the mountains in the northern areas are fringed with close-set stands of lodgepole pine and aspen 20 to 35 years old. The middle elevations are temporarily deforested through the agency of extensive forest fires. The upper areas carry thin and scattered stands of subalpine growth, low, scrubby, and only valuable for fuel and for the stability they impart to the steep slopes.

Cutting.—In the southeast quarter of the township practically all the timber on 1,500 acres has been cut, chiefly as fire-killed timber.

Burns.—Extensive fires have laid waste much of the forest. The front of the spurs, where they abut on the foothill areas, have been swept nearly clean of living forest. Most of the fires date back six or seven years.

Reproduction.—The restocking on the burned-over tracts is progressing slowly. About 50 per cent are covered with growths 4 to 6 years old. On the others no reforesting process has yet begun. In the foothills young growth is exceedingly abundant, and the aspen and lodgepole-pine stands are slowly pushing out into the hitherto nontimbered lands in the north part of the township. In the subalpine areas the young growth is scanty.

Undergrowth.—In the green timber underbrush is sparsely represented; on the burned-over areas not reforesting, a brush growth, chiefly composed of *Ceanothus*, thickly covers the ground.

Litter.—Moderate quantities of fire-killed timber litter the forest in the foothills and at medium altitudes.

Humus.—None.

Classification of lands in T. 7 S., R. 19 E.

	Acres.
Forested	12,040
Nonforested	11,000
Badly burned	6,000
Logged	1,500
Agricultural	None.
Grazing	3,000
Bare rocks	2,000

Total stand of timber (pole and fuel), in T. 7 S., R. 19 E.

	Cubic feet.
Lodgepole pine	1,000,000
White-bark pine	.....
Subalpine fir	900,000
Engelmann spruce	.....
Total	1,900,000

Composition of forest in T. 7 S., R. 19 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lodgepole pine	82
White-bark pine	8
Subalpine fir	4
Engelmann spruce	3
Aspen and cottonwood	3

Of the very young growth, comprising trees 2 inches to 2½ inches in basal diameter, aspen forms 20 per cent.

Township 7 South, Range 20 East.

Topography.—With the exception of six sections in the southwest portion the township consists of level and rolling tracts of agricultural and grazing lands. The mountain areas comprise low, broken terminations of spurs stretching eastward from high divides in the township adjoining on the west, and vary in altitude from 1,000 to 1,500 feet above the adjacent levels on the east.

Mining.—No ore deposits are known to occur. In several places in the western portion of the township limestone is quarried and burned to quicklime. Coal is mined at Red Lodge, in the eastern areas.

Soil.—Deep loam in the valley bottoms, gravelly and thin on most of the uplands; mixed with a great deal of bowlder drift along the west line.

Agricultural adaptability.—The lands are agricultural in character where the soil is not too stony nor the contours too steep, and where water for irrigation is obtainable. The mountain areas in the western portion of the district are not cultivable.

Grazing capacity.—The level and rolling tracts where not tillable are used as range ground.

Drainage conditions.—There is only an insignificant volume of run-off originating in the township. It is all comprised in the discharge issuing from a series of small springs along the base of the mountains in the district.

Snow and rock slides.—None.

Towns and settlements.—The eastern and central areas contain numerous farmsteads on the agricultural lands. The city of Red Lodge is situated in the southeast quarter of the township.

Forest conditions.—The forest consists of thin, poorly stocked stands of lodgepole pine and red fir, and is confined to the mountain areas and to a narrow strip of adjoining foothill region. Small stands of very close-set aspen and lodgepole pine push out from the foothills into the agricultural areas along the various ravines and points of seepage. Most of the forest is in the pole stage, 25 to 40 years old.

Cutting.—Forty per cent of the stands have been cut over, the cut varying from 50 per cent to total. The timber has been used for props in the coal mines at Red Lodge, and there and at other localities for fencing and fuel.

Burns.—Fires within the past ten years have destroyed the timber on tracts aggregating 1,200 acres.

Reproduction.—Very scanty on the areas burned over within recent years; abundant elsewhere and composed mostly of lodgepole pine and aspen.

Undergrowth.—Light or none in the green forest. On the burned-over ground *Ceanothus velutinus* is springing up in dense masses.

Litter.—A small quantity of dead and down pole timber remains on the burns. Most of the fire-killed timber was long ago cut off and converted into fencing, mine props, and fuel. There is not much litter in the green stands.

Humus.—None.

Classification of lands in T. 7 S., R. 20 E.

	Acres.
Forested	3,830
Nonforested	19,200
Badly burned	1,200
Logged	2,000
Agricultural-grazing	18,000

Total stand of timber (pole and fuel) in T. 7 S., R. 20 E.

	Cubic feet.
Limber pine, lodgepole pine, red fir	750,000

Composition of forest in T. 7 S., R. 20 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Limber pine	3
Lodgepole pine	75
Red fir	5
Aspen and cottonwood	17

Township 8 South, Range 20 East.

Topography.—The western portion of the township is a part of Beartooth Plateau, a level and rolling tract of alpine and subalpine country rising to altitudes of 10,000 and 11,000 feet. The central areas comprise a series of cliffs and

extremely steep and rocky descents where the plateau breaks off to the plains of Clark Fork Valley. A narrow strip of this plain, in part intersected with short, broken ridges and shallow ravines, fills the eastern areas.

Mining.—None.

Soil.—In the eastern areas clayey or gumbo soils prevail. In the western areas gravelly loam, stony and bowlder strewn, is found.

Agricultural adaptability.—Small tracts in the eastern portions of the township are tillable under irrigation. The remainder contains no arable land.

Grazing capacity.—The summit of the plateau region has long been used as sheeping ground. It carries a thin sward of alpine sedges and grasses. It has been badly overgrazed and its present pasturage value is low. The central areas, composed of steep breaks, have no grass cover. The eastern tracts were formerly used as ranges, but have been so closely pastured that their present condition is practically that of a desert.

Drainage conditions.—The outflow originating in the township is very small. It is carried by short creeks which head in the steep eastern front of the plateau. Most of the flow sinks at the foot of the plateau.

Snow and rock slides.—Infrequent, and confined to the steep scarps of the plateau.

Towns and settlements.—The settlements are limited to the eastern areas, and consist of two or three farm buildings on one of the small creeks at the foot of the plateau.

Forest conditions.—The forest is confined to the steep breaks and fronts of the plateau, and consists of stands of sapling lodgepole pine in the lower, with white-bark pine and spruce in the upper, areas. At the foot of the plateau red fir and limber pine in small proportions are mixed with the lodgepole pine. The growth has only a fuel value.

Cutting.—Small quantities here and there along the foot of the plateau.

Burns.—Small tracts in the north-central areas, and thence extending southward, have been badly burned within the past six or seven years. The largest block of burned-over ground is just south of Grove Creek, near the middle of the township.

Reproduction.—Young growth is generally abundant at the middle and upper elevations, and is chiefly composed of lodgepole pine. At the lowest levels it is scanty. In the northern areas spruce and white-bark pine prevail.

Undergrowth.—Light.

Litter.—A small amount of dead and fallen timber.

Humus.—None.

Classification of land in T. 8 S., R. 20 E.

	Acres.
Forested	7,040
Nonforested	16,000
Badly burned	1,800
Logged (culled)	800
Agricultural	500
Grazing	12,800
Bare rocks	900

Total stand of timber (pole and fuel) in T. 8 S., R. 20 E.

	Cubic feet.
Lumber pine	20,000
Lodgepole pine	3,500,000
White-bark pine	800,000
Red fir	150,000
Subalpine fir	900,000
Engelmann spruce	800,000
Total	6,170,000

Composition of forest in T. 8 S., R. 20 E., including trees of all species with basal diameters of 3 inches and upward.

	Per cent.
Lumber pine	0.1
Lodgepole pine	35
White-bark pine	25
Red fir	.4
Subalpine fir	10.5
Engelmann spruce	29

LIVINGSTON AND BIG TIMBER QUADRANGLES.

The Absaroka portion of the Yellowstone Forest Reserve, in Montana, is represented in part on the Livingston and Big Timber atlas sheets of the topographic map of the United States published by the United States Geological Survey. The Livingston quadrangle contains 30 per cent and the Big Timber quadrangle 13.5 per cent of the area discussed.

The present examination was made primarily to classify the lands and estimate the timber within the boundaries of the reserve, but the land classification and timber estimates have been made for tracts beyond the reserve boundaries in order to include all of the Livingston and Big Timber quadrangles, and the following general description of the different classes of lands has been added to the report. The accounts of sylvicultural conditions in the reserve apply equally to the forested areas in these quadrangles beyond its boundaries.

LIVINGSTON QUADRANGLE.

LOCATION, EXTENT, AND CLASSIFICATION OF LANDS.

The Livingston quadrangle is situated in Montana between 45° and 46° north latitude and between 110° and 111° west longitude, comprising an area of 2,146,664 acres. The lands consist of forest, woodland, and nontimbered tracts, with the acreage of the several classes shown in appended table:

Classification of lands in the Livingston quadrangle, Montana.

	Acres.
Forested	886,120
Woodland	54,000
Nontimbered	1,206,544
Total	2,146,664

The nontimbered lands comprise tracts of great diversity in their topographic and physical features, owing to the altitudinal differences in their position. They are here divided into four general classes, as shown in the following table:

Classification of nontimbered lands in the Livingston quadrangle, Montana.

	Acres.
Agricultural	256,356
Grazing	712,115
Bare rocks and high alpine	227,433
Lakes and tarns	10,640
Total	1,206,544

TOPOGRAPHIC FEATURES.

The quadrangle comprises two marked divisions—a southern, made up almost wholly of rough mountain areas, and a northern, consisting of rolling, semiarid plains, hemmed in by a stretch of mountain rampart along the west side and rising into a small tract of rugged and rocky heights in the north-central areas.

The high relief in the southern portions of the quadrangle is formed by portions of the Gallatin Range and by the north half of the Absaroka Range, both of them eastern extensions of the Rockies. The low relief, aside from the canyons and short valleys in the interior of the mountain regions, is formed by the valley of Yellowstone River, bisecting the district from south to north and separating the Gallatin and Absaroka ranges by a comparatively broad valley.

The portion of the Gallatin Range within the quadrangle consists, in its northern part, of a narrow, rocky crest, fronting rather abruptly on the valley of Yellowstone River and sending out short, steep spurs. With a westerly trend the crest line of the range gradually passes beyond the limits of the quadrangle until, in the southwest corner, the range is represented only by eastern termina-

tions of long and broken spurs. The canyon system consists of narrow, short troughs with rapid descents. The mean elevation of the range, including its immediate slopes, is 8,200 feet, approximately; isolated knobs on a few of the higher ridges attaining altitudes of 10,000 feet.

The Absaroka Range consists of a huge uplift of granite flanked by limestones and outflows of Tertiary lavas. It is a very rough and rugged region, deeply and extensively sculptured by the erosive power of the vast glacier field, which in times past covered its entire area. The tract is a succession of deep, cliff-lined canyons and tortuous ridges, the larger with a generally north-south trend. The crests of the ridges are mostly narrow and sharp, presenting vast masses of cracked and crumbling overhang. Occasionally they widen and are studded with peaks and pinnacles, or become broader and expand into plateau-like tracts. Their slopes, as they front on the valleys and canyons, are remarkably steep, frequently rising in scarps and precipices 1,000 to 2,000 feet in height. Vast quantities of talus extend up the slopes and deep deposits of bowlder and gravel drift litter the canyon bottoms. The mean elevation of the tract outside the immediate canyon floors is estimated at 8,500 feet. Here and there peaks reach altitudes of 11,000 to 12,000 feet; but none of the tracts reach the line of perpetual snow on all slopes.

The high relief of the north half of the quadrangle is formed by a section of the Bridger Range and the southern termination of the Crazy Mountains. The Bridger Range, a northward continuation of the Gallatin Range, consists of a narrow, serrated, extremely rocky ridge, rising sharply from the levels of the surrounding tableland, buttressed by numerous short and steep spurs and indented by a multitude of rifts, ravines, and gorge-like canyons. The average elevation is about 7,800 feet, while points along the crest attain altitudes of 9,100 feet. The section of Crazy Mountains in the north-central regions of the district covers a tract of approximately 47,000 acres, and consists of steep slopes rising directly and continuously from the plains level to altitudes of 10,400 feet.

The low areas of the quadrangle consist of a rolling, timberless plain, rising in more or less broken and continuous terraces to intersecting broad swells and ridges, falling away in long, gentle slopes to the valleys of Yellowstone and Shields rivers, which border and bisect the district, or knobbed with lines of rocky buttes and furrowed by shallow canyons and depressions.

The lowest depressions in the quadrangle are along Shields and Yellowstone rivers. The former bisects the quadrangle from north to south; the latter forms in part a dividing line between the mountainous southern areas and the plains districts of the northern part of the quadrangle. Both streams flow in broad valleys lined with low bluffs, which alternately approach and recede from the stream banks. The mean elevation of the plains regions is 5,200 feet; that of the Yellowstone flood valley, 4,200 feet.

DRAINAGE CONDITIONS.

Most of the quadrangle lies within the Yellowstone drainage, small tracts only, situated on the western slopes of the Bridger and Gallatin ranges, draining into the Missouri through other channels than the Yellowstone. The run-off is large, most of it being supplied from the 38 per cent of its area covered with the spurs, peaks, and canyons of the range. This tract, the altitude of which insures an abundance of rainfall, is, in fact, an immense natural reservoir, and as such of the greatest importance to the central regions of the Yellowstone drainage. Next in importance is the Shields River drainage, but outside its freshet period in early summer the volume carried by the stream is small. The lesser creeks and streams originating in the Gallatin and Bridger ranges are small and variable in their flow. A large number of ravines and canyons head in the small tract of the Crazy Mountains in the north-central part of the district, but the run-off carried by them is comparatively insignificant. The minor creeks, which head in the rolling areas of the plains, carry water during the spring break-up, but are dry in the summer and fall.

AGRICULTURAL LANDS.

The cultivable lands, comprising nearly 12 per cent of the quadrangle, border the streams either directly in the flood valleys or on the lower terraces not far from the main stream or its tributaries. The largest single area of cultivable land is situated within the Shields River drainage. Irrigation is required everywhere for the successful cultivation of crops. Doubtless much of the land now utilized as cattle and sheep ranges can be reclaimed by means of high-line ditches, but the generally high and rolling character of the plains region, and the lack of large volumes of water, except in the low-lying Yellowstone River, will probably preclude any extensive scheme of reclamation of lands remote from the flood valleys of the streams. The agricultural areas in the mountain districts consist of small, level pieces of bench or semimarsh land in the bottoms of the larger canyons below the 6,000-foot contour, the total comprising less than 15,000 acres. The soil on the lowest terraces in the valleys is usually rich and deep. A large amount of land situated on the upper terraces and on the swells away from the streams is covered with bowlder and gravel drift of glacial origin, and is worthless for agricultural pursuits. Grain, hay, small quantities of apples, and the ordinary northern bush fruits are produced.

GRAZING LANDS.

The grazing lands in the quadrangle comprise a trifle more than 33 per cent of its area. They consist in part of the rolling plains region in the northern part of district, and in part of tracts in the mountain region situated at or above timber line, while a large remainder is made up of fire glades, mostly in the subalpine forest,

which, from a variety of causes, have never restocked. The grazing areas in the strictly alpine regions are confined to the high tracts above the 9,200-foot contour in the Absaroka ranges. The fire glades in the subalpine forest occur in all the mountain areas.

Originally the plains were well stocked with a luxurious growth of bunch grasses. They were easy of access, sufficiently well watered for the stockman's needs, and in every way suitable for range purposes, but they have been excessively pastured, and their present grazing value is exceedingly low where not inclosed. The inclosed areas show a decided betterment, and with freedom for a few years from excessive pasturing of both cattle and sheep, would show a great improvement. As it now stands there is a small amount of grass early in the summer. In a few weeks cattle and sheep have exhausted it, and during the greater portion of the year the tracts afford only the scantiest grazing or none at all.

The alpine areas, mostly located above timber line, are closely covered with a tough sward of low alpine and subalpine grasses and sedges. All are more or less difficult of access, which fact, together with the short season, has prevented any extensive use being made of them. Most of the lands of this character in these ranges appear never to have been pastured by any domestic animals except by horses belonging to the prospectors of the region.

The subalpine areas have been grazed to a limited extent, mostly on the Bridger and Gallatin ranges, because they front directly on the plains and are therefore easy of access, while the subalpine areas in the adjoining ranges occur mostly in the interior. This class of grazing lands is as yet in a fair condition.

BARE ROCK AND HIGH ALPINE AREAS.

Extensive tracts of this character occur throughout all the mountain areas and in the aggregate they comprise nearly 10 per cent of the quadrangle. The upper slopes of Bridger Range are mostly bare rock, the crests and higher slopes contributing the larger proportion. These localities are often so steep that no soil can adhere or find lodgment, and in consequence vegetation is lacking. The alpine regions comprise snow fields on the northern slopes, sharp steep peaks, and mud slides formed of talus débris.

LAKES AND TARNS.

The lakes and tarns cover 0.5 per cent of the quadrangle. Their origin is due to the effects of glacial erosion. Most of them lie in hollows and in glacial cirques on the summit of the alpine plateau areas and near the heads of the different streams. In a few cases they are held back by rocky barriers across their outlets, but in the majority of cases by morainic accumulations. All of them are small in areal extent and of shallow depth, but nevertheless form series of natural reservoirs of marked importance in the regimen of the streams which head in them.

WOODLANDS.

The woodlands form 2.55 per cent of the quadrangle. They consist of scattered, sparsely timbered tracts in the foothills flanking the Bridger and Absaroka ranges, and of thin lines of trees fringing the larger streams. The uplands areas are stocked with limber pine, yellow pine, red fir, and a little lodgepole pine. The timber in these stands is low, stunted, and of inferior quality throughout, suitable only for fuel and fencing material. Along the streams the stands are set more closely than on the uplands. They consist of different proportions of aspen, cottonwood, and aborescent willows. As protection against wash and wear of the alluvial stream banks and terraces, and as supplying considerable quantities of fuel, they are of value.

The woodlands in the foothill region have a low restockage ratio. Climatic conditions—semiaridity—prevent abundant seed reproduction, as the grassy sward which covers the ground obstructs the proper inhumation of the seeds and their subsequent germination. Small quantities of underbrush are present, consisting mostly of sagebrush and shrubby cinquefoil.

The woodlands that border the streams restock rapidly. The cottonwoods and aspens are abundant and steady seed producers. Much dense undergrowth, formed by a mass of interlacing willows and wild-rose brush, is nearly always present, except in very old-growth cottonwood stands, where commonly a grassy sward forms the ground cover.

The average yield of timber in the woodlands of the foothill region is between 800 and 900 cubic feet per acre; in the cottonwood stands fringing the streams the yield rises to 900 or 1,000 cubic feet. Circumscribed localities occasionally yield twice the amount stated, but stands of that density are rare owing to long-continued cutting of the best and most easily reached blocks of timber.

FOREST.

The forested areas of the quadrangle comprise about 40 per cent. They lie chiefly between the 6,000 and the 9,500 foot contours, and hence belong to the mountain regions of the district. In some localities, particularly in the canyon bottoms in the interior portions of Absaroka Range, the lower limit for the forest falls to the 5,300-foot level, while in the foothills of Gallatin Range fronting on the Yellowstone Valley the lower limit stops at the 7,000-foot level in some localities.

The forest is composed of limber pine, lodgepole pine, white pine, white-bark pine, red fir, subalpine fir, Engelmann spruce, aspen, cottonwood, various species of arborescent willows, thorn, wild cherry, and serviceberry. The coniferous species form the principal part of the growth; the percentage contributed by the broad-leaved species is insignificant.

The forest appears in three general zones or strata, which blend where they meet and are not closely differentiated, though fairly well marked in their central areas. The upper zone, stretching to timber line at 9,500 to 9,800 feet, is composed of Engelmann spruce, subalpine fir, and white-bark pine, with the addition of lodgepole pine in varying proportions at the lower limits. The spruce forms the largest percentage of the zone, followed by white-bark pine and subalpine fir. Occasionally this arrangement is reversed and white-bark pine takes the lead or even subalpine fir may hold the dominant place; but in stands where a normal ratio has been established spruce always leads. The stands of this zone are open and scattered at their upper limits and are often very compact and densely stocked at their lowest. The open stands are set in grassy tracts or fire glades which have only partly restocked since they were burned over. The subalpine forest contains little mill timber. Its chief value lies in the stability it imparts to the upper slopes and in the volume of fuel and mine timber it is capable of supplying.

The central zone consists of well-stocked stands composed of red fir, lodgepole pine, and Engelmann spruce, lodgepole pine constituting the dominant species. In some localities at the lower levels of the zone red fir becomes the chief species, and occasionally along the stream margins in the lowest canyons Engelmann spruce predominates. The bulk of the forest in the quadrangle occurs in this zone, both the saw timber and the pole and fuel size.

The lowest zone in the series borders the plains, or the woodlands when woodlands are present. The forest in this zone commonly is open and more or less broken, its heaviest stands occurring on the northern slopes of ridges and canyons where the semiarid conditions of the nearby plains are less marked. It is composed of red fir, yellow pine, limber pine, and small proportions of Engelmann spruce along the streams. Red fir is always the dominant species in this zone, the other coniferous species constituting only a small percentage.

The proportion of the coniferous species in the forests of the quadrangle is shown in appended table.

Composition of the forest in the Livingston quadrangle, Montana, including trees of all species with basal diameters of 4 inches and upward.

	Per cent.
Limber pine	3
Lodgepole pine	42
White pine	less than .1
White-bark pine	5
Yellow pine	.5
Red fir	30
Subalpine fir	4
Engelmann spruce	15
Aspen and cottonwood	.4

The supply of mill timber in the forest is small. Most of the stands are composed of pole growths less than 130 years old, at which age the lodgepole pine, the chief timber tree, has not attained sufficient diametrical dimensions to become available for mill purposes, except in very favorable localities. Most of the timber is fit only for fuel, fencing, and other purposes where pole timber can be utilized. The mill timber throughout is of 3-inch grade, and on an average will not square over 10.25 inches. Most of the timber in the quadrangle grows in localities difficult of access; not over 10 per cent is so situated that it can be reached without entailing expenses almost equal to the present value of the product.

The amount of timber standing in the district is shown in the appended table:

Total stand of timber in the Livingston quadrangle, Montana.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Limber pine	5,000,000	16,380,000	17,280,000
Lodgepole pine	427,000,000	636,100,000	712,960,000
White pine	3,500,000	300,000	930,000
White-bark pine	15,050,000	77,050,000	79,759,000
Yellow pine	3,000,000	5,000,000	5,540,000
Red fir	177,100,000	220,350,000	252,228,000
Subalpine fir	3,000,000	93,200,000	93,740,000
Engelmann spruce	306,000,000	221,450,000	276,530,000
Aspen and cottonwood	.....	2,000,000	2,000,000
Total	939,650,000	1,271,830,000	1,440,967,000

The tracts more or less logged and culled comprise in the aggregate 85,000 acres. They are situated on the eastern slopes of Gallatin and Bridger ranges, in the foothills in the Boulder River drainage, in the eastern and southern edges of the Absaroka ranges, and on the lower slopes of Crazy Mountains. Most of the cutting has been for fuel and fencing material. Lesser amounts have been taken to furnish ties for railroad construction and for props in the coal mines on the eastern slopes of Gallatin Range.

Forest reproduction is good throughout the middle zone and in the higher portions of the lowest of the timber zones. It is deficient in the subalpine forest; that is, the restockage is not sufficient to reoccupy the areas which in the course of centuries have been denuded by fire. Lodgepole pine is the dominant species in the reforestations in the young growth and in the older stands at middle elevations.

Extensive forest fires have ravaged the timber within recent years. In the aggregate 90,000 acres have been laid waste. The fires have been more extensive in the Absaroka Range than elsewhere, and in all places where they have run through

the stands complete destruction has been the result. The region has always been subject to widespread and destructive forest fires, as proved by the age of the timber.

BIG TIMBER QUADRANGLE.

LOCATION, EXTENT, AND CLASSIFICATION OF LANDS.

The region embraced in the Big Timber quadrangle, Montana, is situated between 45° 30′ and 46° north latitude and between 109° 30′ and 110° west longitude, and contains an area of 534,283 acres. Forest, woodland, agricultural, and grazing areas are represented within the quadrangle, the acreage of the different classes of land being shown in subjoined table.

Classifiation of lands in the Big Timber quadrangle, Montana.

	Acres.
Forested	27,000
Woodland	206,000
Nontimbered	301,283
Total	534,283

The nontimbered lands, excluding the areas of bare rock, differ but little in their general features, except as regards their water supply and dependent irrigation facilities. They are classified as follows:

Classification of nontimbered lands in the Big Timber quadrangle, Montana.

	Acres.
Agricultural	34,300
Grazing	253,283
Bare rocks	13,700
Total	301,283

TOPOGRAPHIC FEATURES.

Excepting the southwest quarter, the quadrangle is a rolling plateau area cut by many shallow, more or less rocky, and in some cases gorge-like, canyons. Broad swells and low, rocky, irregular ridges separate the different ravines and canyons. The lowest altitude is in the valley of the Yellowstone, which bisects the quadrangle from west to east. The valley varies from 1 to 3 miles in width, and is made up of two to three low terraces, bordered by low bluffs of sedimentary rocks, which present sharp scarps to the river front and alternately approach and recede from the immediate river except in the northeast quarter of the quadrangle, where they are close to the stream for a distance of 18 miles and display a steep, solid front of rock 300 to 400 feet in height.

The southwest quarter of the quadrangle consists of mountain areas formed by the terminations of northward-projecting spurs from the Granite Mountain district

to the south. This tract is roughly sculptured, its areas being a succession of steep, narrow ridges and deep, rocky canyons.

The average altitude of the plateau region is 4,800 feet; in some localities projecting points rise 500 to 600 feet higher, while in the northeast quarter alone the average elevation slightly exceeds 5,000 feet. The average altitude of the mountain areas in the southwest quarter is 6,800 feet, with here and there points which reach elevations of 7,500 feet.

DRAINAGE CONDITIONS.

The quadrangle lies wholly within the drainage of Yellowstone River. While a large volume of water is carried by the different streams in the district, only a trifling proportion originates on its areas. Most of the different canyons and ravines are dry during summer and fall, carrying water only while the spring break-up lasts, or immediately after heavy rainstorms. Springs are not plentiful outside the mountain areas in the southwest corner of the district, and the few standing bodies of water here and there are mere pools.

AGRICULTURAL LANDS.

The agricultural lands comprise between 6 and 7 per cent of the quadrangle and are confined to the lowest terraces bordering Yellowstone River and the other larger streams. Irrigation is practically indispensable, and the lands most easily and least expensively irrigable have been reclaimed first. With high-line ditches, possible in many localities, a large portion of the area now utilized as range land can be reclaimed.

The soil in the valleys consists of a deep, rich, more or less alkaline soil, yielding good crops of grain and hay. The uplands are often stony and bowlder strewn, particularly in the southern half of the quadrangle, where a great deal of glacial bowlder and gravel drift was deposited during the glaciation of the high Absaroka ranges to the south.

GRAZING LANDS.

The range lands comprise very nearly 48 per cent of the lands in the quadrangle, and including the woodlands, utilized as pasture ground, amount to 85 per cent. Originally the lands were covered with good growths of various sorts of grasses, but for many years the region has been closely ranged by cattle and sheep. Outside inclosed tracts the condition of these range lands is now in general exceedingly bad, owing to excessive pasturing, but more particularly sheeping. In many instances, especially in the south half of the quadrangle, every vestige of gramineous vegetation has been either eaten or trampled out by sheep. Nothing remains but small patches of the common, indigenous phlox, so low and scanty that it is locally

known as "moss," scattered patches of *Chrysothamnus* and *Artemisia* shrubs, and cacti. Where not so closely grazed a thin growth of grass comes up in the spring and supplies pasturage for a month or two, after which nothing remains but close stubble. The semiarid climate naturally brings about a low recuperative power in the gramineous vegetation, and, with the excessive pasturing to which it long has been subjected, its destruction has, from the first, been a logical result.

Where the grassy turf has been at all extensive and completely destroyed there has been gullying and denudation of the surface soil. Everywhere the "ditch," as the lowest central depression in the canyon bottoms is aptly called, shows encroachment on adjoining bench land or slope. It is clear that these waterways carry larger volumes of water now during spring freshets than they formerly did, and that their gullying power has correspondingly increased. The denudation of the surface soil on the badly sheeped lands is especially marked on tracts situated in the lower Deer and Work creeks drainage. Here the gullying of the soft soil on the uplands, a sort of gumbo, is rapidly creating "bad lands." The result of the destruction of the grassy turf on these plains is the same as from the destruction of forest covers on mountain slopes—accelerated run-off, extensive and rapid gullying, and removal of the soil cover.

WOODLANDS.

A trifle more than 38 per cent of the quadrangle may be classed as woodland. The largest proportion is situated in the northeast quarter on a tract 500 to 600 feet above the average level of the nontimbered lands. Smaller tracts occur in the southwest quarter, where they occupy a foothill region having an altitude of from 5,500 to 6,000 feet. Lesser areas fringe the larger streams in more or less continuous lines.

The woodlands are generally lightly stocked with timber. Limber pine, yellow pine, red fir, and juniper, of the coniferous species, and aspen and cottonwood, of the broad-leaved trees, are represented in the stockage.

The lightly timbered conditions of these tracts are due to the many visitations of fire which they have experienced during centuries, and to a naturally scanty and defective seed production due to the arid climate. The stands are capable of closer stockage, but to insure this result absolute freedom from fire and grazing is necessary. Most of the timber has only a pole and fuel value. Less than 10 per cent is mill timber, with only a 3-inch class value. The average yield of timber is 850 cubic feet per acre.

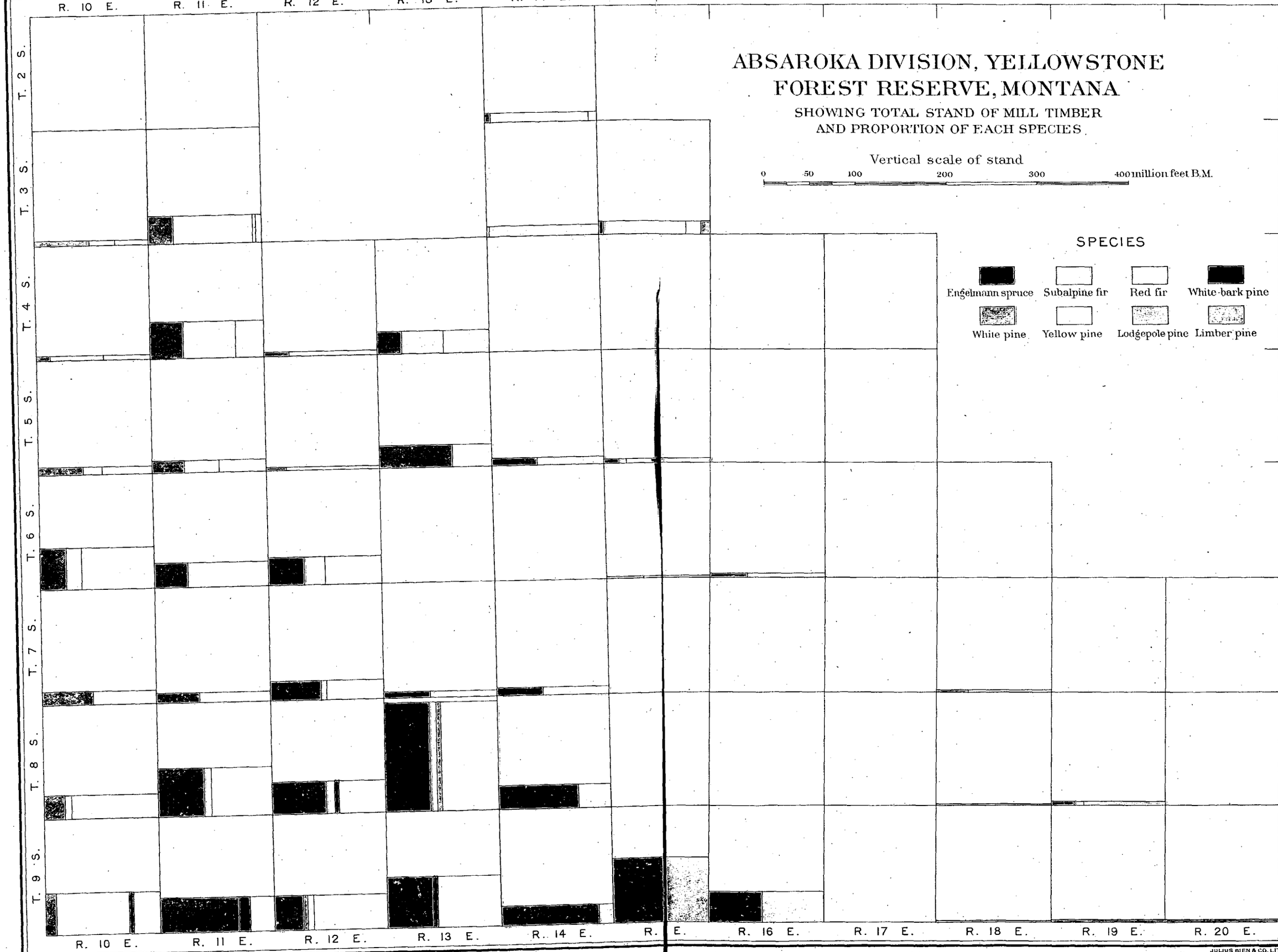
The fringes of woodland along the streams are valuable only for fuel and fencing material and, most of all, for the cohesion and waste-resisting power their widely spreading roots impart to the soft alluvium of the stream banks.

ABSAROKA DIVISION, YELLOWSTONE FOREST RESERVE, MONTANA

SHOWING TOTAL STAND OF MILL TIMBER AND PROPORTION OF EACH SPECIES

Vertical scale of stand

0 50 100 200 300 400 million feet B.M.



SPECIES

- Engelmann spruce
- Subalpine fir
- Red fir
- White-bark pine
- White pine
- Yellow pine
- Lodgepole pine
- Limber pine

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The composition of the woodland stands is as follows:

Composition of the stands of timber in the woodlands of the Big Timber quadrangle, Montana.

	Per cent.
Limber pine	30
Yellow pine	47
Red fir	20
Aspen and cottonwood	3

FOREST.

The forested areas comprise only 5 per cent of the quadrangle, and are confined to the southwest corner. They lie almost wholly within the limits of Yellowstone Forest Reserve in T. 2 S., R. 14 E.; T. 3 S., Rs. 14 and 15 E.; T. 4 S., Rs. 14 and 15 E. Where not devastated by fire, they carry well-stocked stands of red fir, limber pine, and lodgepole pine, with small proportions of Engelmann spruce in the canyons and on the northern slopes. The red fir is the dominant species, forming 65 per cent of the stands, followed by lodgepole pine with 40 per cent, while limber pine adds somewhat less than 5 per cent. The timber is extremely difficult of access, owing to the broken character of the ground where it grows. Most of the timber is either a pole growth or else so short, stocky, and knotty that it is unfit for mill timber. Fully 85 per cent is only valuable for pole and fuel timber. The total volume of timber in the quadrangle is shown in the subjoined table.

Total stand of timber in the Big Timber quadrangle, Montana.

Species.	Mill timber.	Pole and fuel timber.	Total volume of all timber.
	Feet B. M.	*Cubic feet.*	*Cubic feet.*
Limber pine	15,000,000	45,000,000	47,700,000
Lodgepole pine	1,000,000	6,250,000	6,430,000
Yellow pine	40,000,000	70,000,000	77,200,000
Red fir	34,000,000	32,000,000	38,120,000
Engelmann spruce	670,000	550,000	670,600
Aspen and cottonwood	----------	4,700,000	4,700,000
Total	90,670,000	158,500,000	174,820,600

The forested area has been cut over in the upper Deer Creek drainage on areas aggregating 200 or 300 acres. The woodlands have been culled in most of the accessible places, the cut amounting to less than 5 per cent.

Fires have swept the forest in recent years and burned up the timber on 18,000 acres. The woodlands have also been overrun by fire, but most of the damage has been confined to destruction of the young growth.

Reproduction in the forested areas is abundant, the leading species in the restockage being red fir at the lower and middle elevations and lodgepole pine at the higher.

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