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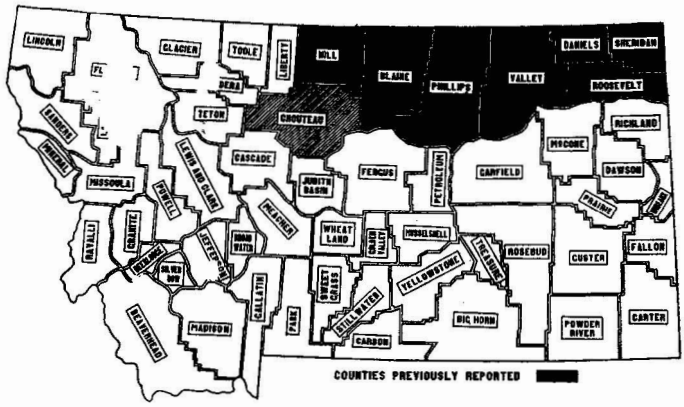
SOILS OF CHOUTEAU COUNTY



SOIL RECONNOISSANCE OF MONTANA

PRELIMINARY REPORT

BY

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MONTANA STATE COLLEGE
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BOZEMAN, MONTANA

CONTENTS

The primary purpose of this soil reconnoissance of Montana is to obtain general information in regard to (1) the soil resources of the state, (2) the adaptability of the topography to agriculture, and (3) the carrying capacity of the different soil areas for live stock. Such a survey is of a general nature and the areas shown on the soil and topographical maps simply represent the prevailing character of the soil and topography.

The Chouteau County report is the eighth to be issued. Reports on Sheridan, Daniels, Roosevelt, Valley, Phillips, Blaine, and Hill counties are also available and may be obtained from the Montana Experiment Station, Bozeman, Montana.

SOILS OF CHOUTEAU COUNTY

LOCATION

Chouteau County lies in a fairly compact body south of Hill and Liberty counties in the north-central part of the state of Montana. The county was organized during territorial times and up to 1893 was the largest county in the State and second largest in the United States. It embraced the greater part of north-central Montana, which is now included in nine counties, six of which touch the international boundary for more than one-third the distance across the State. It was named after Pierre Chouteau, who was one of the prominent members of the American Fur Trading Company during the late thirties and forties of the past century.

Since 1919 the county has included an area of 3957 square miles lying between Townships 20 and 27 north of the Base Line Montana and Ranges 3 and 17 east of the Principal Meridian Montana. Its boundaries enclose an irregular area which has an extreme length east and west of 87 miles and a maximum width north and south of 60 miles. Missouri River, which enters the county, forms a part of the southern boundary, as do also Belt and Arrow creeks. The Bear Paw Mountains rise in the northeastern corner and the Highwood Mountains in the south-central part. The more rugged and broken portion of the Highwood Mountains is included in the Jefferson National Forest.

PHYSIOGRAPHIC FEATURES

The greater part of Chouteau County lies in the glaciated portion of the Great Plains and is characterized by broad rolling to broken divides, sloping gently in the direction of Missouri River. The larger streams are deeply entrenched and bordered by rugged breaks which are locally eroded into bad lands. The physical features of the county are modified by the Bear Paw and Highwood mountains, Goosebill Dome, and by sandstone-capped buttes known as the "Knees" in the western part. Volcanic and ancient stream deposits cap the high table-lands around the mountains and along Arrow Creek. Erosion has not greatly changed the surface features of the drift-covered area since the time of glaciation.

Wisconsin Glaciation.—The Keewatin ice sheet which developed in central Canada during the Late Wisconsin Glaciation spread over the greater part of north-central Montana. It covered the plains of Chou-

teau County, the high bench lands, and extended well up the slopes of the Bear Paw and Highwood mountains. The extreme eastern part of the county, south of the Bear Paw mountains, was not glaciated.

The drift-covered plains have rolling billowy relief except on some of the more broken divides. Shallow lake depressions and low mounds and ridges are characteristic features of the more intensely glaciated sections. Deposits of drift exceeding 30 feet in depth are found in the preglacial valleys and in the Lonesome Prairie area. The more shallow deposits are found in the western part of the county and in the basin along Flat Creek south of Missouri River. Stony, hummocky ridges, knows as moraines, occur along Birch and Eagle Creeks, on the slopes of the high bench along Arrow Creek, in the preglacial valley of Missouri River above Virgelle, and on the Marias-Teton divide.

The drift-covered plains have an elevation of from 2700 to 3000 feet along Missouri River to 3600 feet on the higher divides in the western and south-central parts of the county. Lonesome Prairie area has a comparatively low elevation of 3000 to 3100 feet. South of Missouri River the land rises in the direction of the Highwood Mountains and the bench lands along Arrow Creek. Elevations of 3000 feet are recorded on the bench lands above Square Butte and 3300 feet along Shonkin Sag. East of the preglacial valley of Missouri River the land rises steeply in the direction of the Bear Paw Mountains. Most of the land on the slopes of the mountains is more than 3000 feet in elevation.

Bear Paw Mountains.—The Bear Paw Mountains rise in Chouteau and Hill counties and extend east into Blaine as two fairly well-defined ridges separated by a broad basin. The mountains tower several thousand feet above the plains in the northeastern corner of the county and their higher peaks, such as Mount Centennial, have elevations of 7000 feet. The peaks and ridges of the Bear Paw Mountains are well rounded. Dikes of ancient trap rock occur on the mountain slopes, and about Warrick the low ridges are often eroded into conical buttes, separated by broken basins.

Highwood Mountains.—The Highwood Mountains rise as an isolated group in the south-central part and extend across the county line into Judith Basin County. These mountains, which are more rugged than the Bear Paws, also tower above the plains and their higher peaks attain elevations of 7000 feet along Highwood Creek. The eastern part is broken by large basaltic dikes and by high buttes,

such as Square and Round. East of Missouri River and south of Eagle Creek are several igneous buttes rising above the breaks of the stream.

Goosebill Dome.—Goosebill Dome is a shaly butte in the north-central part of the county, west of Marias River. It stands out very prominently above the drift-covered plains. Its slopes are broken with cut-bank coulees, and along Sheep Creek are eroded into bad lands.

The Knees.—Small isolated sandstone buttes, known locally as Knees, rise above the glaciated plains in the northwestern part of the county around Genou. The buttes located on the Marias-Teton divide rise 100 feet or more and are among the more prominent landmarks in the western part of the county.

Isolated benches.—An isolated bench lying north of Missouri River, just east of the mouth of Arrow Creek, rises 500 to 800 feet above the stream and is capped with a massive sandstone, which is well covered with drift. A more broken bench, known as Last Chance, is located across the river above the bad lands north of Flat Creek. It is also capped with sandstone and has a shallow covering of drift on the surface. Its slopes are eroded into barren, gullied clay hills and ridges. Farther south along Arrow Creek, the high benches are capped with an ancient stream deposit of quartzite gravel and its western slopes are well covered with hummocky drift. The gravel deposit is semicemented with lime and is approximately 15 feet thick. The higher benches about the Highwood Mountains are capped with breccia, a rock composed of angular fragments cemented together. Some of the lower benches on the northern slopes of these mountains have a fair covering of drift on the surface.

Shonkin Sag.—Shonkin Sag is an ancient stream course at the base of the Highwood Mountains. It is probably the outlet of the Great Falls glacial lake formed by the damming of Missouri River during glacial times. The sag averages one-half mile in width and is bordered by steep walls, rising several hundred feet. North of Round and Square buttes the sag cuts through dikes, and the columnar basaltic walls are very attractive. The sag is poorly drained and several large alkali lakes are found in it. During the summer months these lakes are bordered by a broad band of alkali.

Preglacial valleys.—A well-defined stream course, northeast of Virgelle, is said to be the preglacial valley of Missouri River. This valley averages several miles in width and is bordered by gently rising bench lands. Its bottom is well covered with drift, and above Virgelle has a morainic relief or topography. In the north-central part of

the county a large undulating basin extends east from the breaks of Marias River to the preglacial valley of Missouri River above Big Sandy. It covers most of the area known as Lonesome Prairie. In the southeastern part of the county another wide basin extends northwest from Kabo through Iliad and Hopp and enters the preglacial valley of Missouri River southeast of Verona. According to some geologists this basin is the preglacial valley of Judith River. It is well covered with drift and along Eagle Creek is crossed by several morainic ridges. In the northwestern part of the county smaller basins covered with glacial lake and stream deposits occupy preglacial stream valleys on the Marias-Teton divide. Deep narrow stream courses of preglacial origin also cut through the divide south of Teton River. South of Waltham, a wide gap or basin, supposedly the preglacial valley of Belt Creek. cuts through the Highwood-Belt divide and extends northeast across Highwood Creek, entering Missouri River southwest of Fort Benton.

Bad lands and sand dunes.—The breaks of Marias River and Arrow Creek and Missouri River in the eastern part of the county are eroded into bad lands. The Virgelle sandstones of the Eagle formation, outcropping in Deer Park along Arrow Creek and forming Cathedral Spires and other scenic sections along Missouri River, are carved into fantastic mushroom rocks and pinnacles. The Colorado, Claggett, and Bear Paw shales exposed in the breaks along the Marias and Missouri rivers and Arrow Creek are eroded into barren, gullied, clay hills and ridges. These breaks are among the more desolate sections in the county. Sand dunes having a fair grass cover occupy a small area north of Missouri River along Little Sandy Creek.

DRAINAGE

Missouri River is the principal stream in north-central Montana. It enters the county in the southwestern part and after making a large loop in the central part turns to the southeast and forms a portion of the southern boundary. The Teton and Marias rivers, among other important streams in north-central Montana, drain the western part of the county. The Teton unites with Marias River a few miles above its entrance into Missouri River in the central part. Big Sandy Creek, flowing northeast through the preglacial Missouri River valley, is a tributary of Milk River.

The continental ice sheet which covered the greater part of north-central Montana did not greatly influence the drainage of the area.

The larger streams in the path of the glacier were temporarily diverted and their valleys partly filled with drift. One of the more important changes made in the drainage of this part of the State was the diversion of Missouri River from its preglacial course. Geologists claim that before the time of glaciation Missouri River occupied the basin through which Big Sandy Creek flows, and Milk River, east of Havre. Its present course south of the Bear Paw Mountains is said to have been developed during the time its waters were impounded in the central part of Chouteau County. The change in course of the stream intercepted several of its branches, such as Arrow Creek and Judith River. The present course of the Missouri east of Virgelle probably follows the preglacial valley of Arrow Creek as far south as the mouth of this stream. Other streams, such as the Teton and Marias rivers, are locally displaced from their preglacial valleys.

MISSOURI RIVER DRAINAGE BASIN

The main forks of Missouri River head in Yellowstone National Park. The river receives the drainage from the greater part of the eastern slopes of the Rocky Mountains in the State and is a navigable stream as far west as Fort Benton. The larger streams entering Missouri River from the north in Chouteau County, aside from Marias River, are Little Sandy, Eagle, Chip, and Birch creeks, while those from the south include Belt, Highwood, Shonkin, Crow, and Arrow creeks. Flat Creek drains a large basin in the southeastern part of the county and joins Arrow Creek a few miles south of its entrance into Missouri River. Cowboy and Cottonwood creeks are the larger perennial branches of Arrow Creek in the extreme southern part of the county.

Missouri River enters the county at an elevation of approximately 2800 feet and leaves it in the southeastern corner at 300 feet lower. It averages 100 yards wide and in this part of the State flows on a gravelly bottom. The stream is at flood stage during the spring run-off and again in May and June when the snows melt in the mountains.

Missouri River flows through a valley averaging one mile wide and its flood plains are cut into irregular tracts by the meandering of the stream between the steep colluvial slopes. The valley is entrenched in a broad basin covered with drift, below which dark-colored shales outcrop as far east as Virgelle. South of Virgelle it is bordered by bold sandstone cliffs and bad lands, which increase in height to the mouth of Arrow Creek. East of Arrow Creek the valley

is bordered by several high sandstone-capped benches, below which the land is very broken.

The preglacial basin averages 5 to 6 miles wide and is bordered by gently rising uplands, except where the present stream flows below the drift-covered breaks of the old valley. The river follows the south side of its preglacial valley as far east as Loma where it swings over to the north side. The intermittent streams entering the river are deeply entrenched in the basin. South of Carter and Floweree the bottom of the basin is rather hummocky, and east of Loma low gravelly mounds and ridges are numerous. The land between the Teton and Missouri rivers is very sandy and south of Loma grades into rolling sand-hills. The basin has fair drainage except in the more hummocky sections.

Eagle Creek and its eastern branch, *Dog Creek,* are perennial streams which head in the Bear Paw Mountains and drain a broken glaciated area below the mountains. The stream flows through a hummocky basin between two high morainic ridges, which extend across the preglacial valley of Judith River. West of Eagleton the stream enters a sandstone canyon and joins Missouri River in the east-central part of the county.

Little Sandy Creek, a small perennial stream, rises on the lower slopes of the Bear Paw Mountains north of Eagle Creek and drains a rolling glaciated section below a high drift-covered ridge. Alkali Creek is an intermittent stream paralleling Little Sandy Creek and draining a rather scabby, rolling section. South of Eagle Creek, Chip Creek is an intermittent stream having its source on a morainic ridge east of Birch Creek. It flows through a deeply entrenched narrow valley along most of its course and drains a sharply rolling glaciated section north of the preglacial valley of Judith River. South of Iliad the stream enters a sunken basin, bordered by a bold sandstone escarpment. North of Kabo shaly mounds and ridges rise in the bottom of the basin. Northwest of Iliad the bottom of the preglacial valley is locally poorly drained.

Birch Creek is a perennial stream heading on the southern slopes of Mount Bear Paw in Hill County. It flows south and enters Missouri River in the southeastern corner of the county. Birch Creek and its eastern branch, Sand Creek, drain a broken bad-land area south of the mountains. The gullied clay hills and ridges are quite barren and broken with deep cut-bank coulees. Farther south sandstone breaks and bad lands rise above the stream, and the uplands are cut into

irregular tracts by deep coulees. A narrow sandstone-capped bench rising 300 to 400 feet lies above the breaks of Missouri River in the bend of the stream. Little Birch is a small perennial stream flowing below a high morainic ridge on the west.

Belt Creek is one of the larger streams entering Missouri River from the south. It rises in the Belt Mountains and forms a portion of the southern boundary of the county. The valley of the stream, averaging less than one-half mile wide, is bordered by rugged drift-covered breaks in which dark-colored shales outcrop. The land along the stream is broken with deep coulees.

Highwood Creek is one of the larger streams heading in the Highwood Mountains. It flows northwest and enters Missouri River about 6 miles west of the mouth of Belt Creek. Below an open mountain basin the stream enters an enclosed narrow valley similar to that of Belt Creek. The Belt-Highwood divide is quite broken in the vicinity of the mountains but lower down it has more of a bench-like form. North of the Milwaukee Railway the divide has a gentle slope above the breaks of the streams and coulees. Waltham is located in a preglacial depression, west of which rises a high shaly butte above the breaks of Belt Creek.

Shonkin Creek also heads in the Highwood Mountains and flows almost due north, emptying into Missouri River east of Fort Benton. The upper course of the stream lies in a narrow basin, which becomes more enclosed to the north. Below the mountains it cuts across Shonkin Sag and meanders through a valley averaging one-third mile wide and bordered by rugged breaks. The northern slopes of the mountains above the sag are cut into irregular tracts by deep coulees. The Shonkin-Highwood divide has a gently rolling relief, except for a few sharply rolling tracts. Frenchman's Ridge rises east of Shonkin Creek, and terminates near an ancient stream valley entering Shonkin Sag from the north. The western slope of Frenchman's Ridge is very hummocky and stony above the breaks of Shonkin Creek, while to the north it slopes rather steeply in the direction of Missouri River.

Crow and Rowe coulees, heading on a low morainic ridge extending east from Harwood Lake, drain the central part of the county. South of Missouri River the land has typical glacial characters, including low gravelly mounds, ridges, and shallow lake depressions, especially around Clear Lake Post Office. Along the upper course of Rowe Coulee, the Eagle sandstones are eroded into fantastic mushroom rocks. The covering of drift on the shaly slopes of the preglacial

valley of Missouri River is rather shallow and the land is broken with deep coulees.

Arrow Creek heads in the Belt Mountains and flows northeast, forming a portion of the southeastern boundary of the county. The stream has a continuous flow most of the year, but during the late summer months shrinks into a number of stagnant, alkaline waterholes. West of the mouth of Cowboy Coulee the stream flows through a narrow canyon bordered by high rugged breaks, but east of the mouth of the coulee its valley widens out to one-half mile and is a continuation of Shonkin Sag, through which Cowboy Coulee enters the stream. A high breccia-capped bench slopes steeply but gently down to the breaks of the stream south of Square Butte. East of Cowboy Coulee lies a high hilly divide, the southern slopes of which are entrenched with deep coulees. Farther east rise high, gravel-capped benches above the bad lands along the stream, which give way on the north to barren, gullied clay hills and ridges.

Cowboy Coulee is a small perennial stream heading in the Highwood Mountains west of Square Butte and entering Shonkin Sag south of the town of Square Butte. The northern and eastern slopes of the butte are broken with deep coulees between the high sandstone-capped ridges. South of Square Butte, Shonkin Sag is bordered with bold sandstone cliffs rising 100 feet or more. Cottonwood Creek is a perennial stream flowing through a small basin and draining a rough mountain area.

Flat Creek rises in the Highwood Mountains, west of Round Butte, and follows a circuitous route through the southeastern part of the county before turning east and entering Arrow Creek a few miles south of its mouth. North of Round Butte the stream enters Shonkin Sag for four or five miles and then turns north into a wide flat, above which rise rugged sandstone breaks. North of the flat the stream passes through a rolling glaciated area before turning east and entering an enclosed valley bordered by barren clay hills and ridges. South of the sag the lower slopes of the mountains are cut into irregular tracts by deep coulees. Square Butte bench lies below the stony moraines on the western slope of Arrow Creek divide above the breaks of the flat. It is drained by Panton Coulee, which is deeply entrenched above the flat. A similar bench lies west of the flat, but grades into a rolling hummocky section within a few miles of it. Spring Creek is a perennial stream heading in White Lake and draining a rolling glaciated area. East of White Lake the sag is poorly

drained and several large alkali lakes are located in its bottom. The land north of Flat Creek is characterized by low, gravelly hillocks and ridges. Along Cut Bank Creek the land is undulating and rather scabby.

MARIAS RIVER DRAINAGE BASIN

Marias River and its forks drain a broken foothill and plains area in north-central Montana. The stream follows an easterly course as far as the county line, where it turns south and joins Missouri River in the central part of the county. Teton River unites with it a few miles above its mouth. The larger branches of Marias River having their source in Chouteau County are Skit Creek, and Dug Out and Dead Indian coulees.

The valley of Marias River in Liberty and Toole counties is entrenched in a wide basin, similar to that found along Missouri River, but in Chouteau County it is bordered by high rugged breaks and bad lands. The steam meanders through a valley averaging one-half mile wide and its flood plains are fringed with cottonwoods and willows below the barren colluvial slopes. The stream is about 60 feet wide and flows on a gravelly sandy bottom. It is at flood stage when the snows melt in the mountains during May and June.

Skit Creek is an intermittent stream heading on Goosebill Dome and paralleling the river for some distance before uniting with it. The stream flows through a deep narrow valley bordered with drift-covered slopes along most of its course. The divide between the creek and the river has a gently rolling relief but is locally broken with deep coulees. The land west of the stream is characterized by high rolling ridges and wide hollows, and north of Pleasant Valley it grades into a stony morainic ridge. Embleton's Coulee drains a wide sandy basin. It becomes very deeply entrenched in the eastern part of the basin and enters Skit Creek in a broken sandstone section. The divide south of the basin along Teton River is broken with deep coulees, above which rise bold sandstone cliffs.

Pondera Coulee is an intermittent stream in the northwestern corner of the county with a few water-holes along its course. It drains an undulating hummocky section north of the Knees and several large basins around Ashmoor. Dug Out Coulee is another intermittent, deeply entrenched stream draining a rolling hilly area east and south of Hervin Post Office and a high stony morainic section to the west. The larger branches of the stream head in a large basin, known as Sample Flat, northeast of Genou. A bold sandstone escarpment

borders the basin on the south and drift-covered sandstones on the east and west. Dead Indian Coulee drains a scabby undulating section west of Goosebill Dome, and is very deeply entrenched. Marias River has no large branches entering it from the east. Black Coulee enters the stream from the north through a deep coulee. The land above the breaks has a rolling relief, sloping gently to the east and northeast in the direction of Lonesome Prairie. Colony Bay is located in an undulating basin bordered by sharply rolling and broken land on the divides above the Marias and Missouri rivers.

TETON RIVER DRAINAGE BASIN

Teton River rises in the main range of the Rocky Mountains, enters the county in the west-central part and flows east, emptying into Marias River a few miles above its mouth. The Teton River valley is entrenched 75 to 100 feet or more in a wide basin. The valley is somewhat wider than that of Marias River and is bordered with drift-covered breaks in which shales outcrop near the bottom. Its sandy gravelly terraced flood plains are cut into irregular tracts by the meandering of the stream and are locally covered with wash from the shaly breaks.

The preglacial valley of Teton River averages 5 to 8 miles wide and lies chiefly on the north side of the stream. At the mouth of Chimney Rock Coulee the stream cuts through a broken ridge into the basin above Missouri River and does not follow its former valley to the east. The preglacial valley is bordered on the north by a bold sandstone escarpment as far east as Chimney Rock Coulee, where it gives way to a stony morainic ridge above the drift-covered slopes of Pleasant Valley. The bottom of the basin is rather hummocky south of the Knees, but farther east has a gently sloping relief, except for a few small lake beds west of Dry Fork. A narrow strip of rolling sand hills lies above the breaks of the stream, between the deeply entrenched coulees west of Chimney Rock Coulee. The preglacial valley is bordered on the south by a high rolling divide rising west of Carter. The northern slope of the divide has a gentle billowy relief, except for a few sharply rolling tracts along the coulees. Weatherwax Coulee is deeply entrenched in the basin at the foot of the slope. Several gaps cut through the divide west of Floweree and their drift-covered slopes are very stony. The southern slope of the divide is quite rolling near Lake Creek and in the vicinity of Hunters' Coulee. Timber Creek is an intermittent stream heading on

the divide in Teton County. Its valley is deeply entrenched along most of its course.

Chimney Rock Coulee, an intermittent stream, heads on the Marias-Teton divide in the northwestern part of the county. It drains a rolling area characterized by stony hills and ridges and flows through a narrow valley bordered by rugged breaks.

MILK RIVER DRAINAGE BASIN

A small area in the northeastern part of the county lies in the drainage basin of Milk River. Big Sandy Creek, the most important tributary of this river in Chouteau County, rises in the Bear Paw Mountains and after following a circuitous route enters the preglacial valley of Missouri River, southeast of Big Sandy, and flows northeast, emptying into Milk River west of Havre. Below the mountains it flows through a narrow valley between high drift-covered ridges. In the preglacial valley it is entrenched 10 to 15 feet deep in a wide flood plain.

The preglacial valley of Missouri River averages 5 to 6 miles wide and is bordered by gently rising uplands which are locally broken with deep coulees. The valley is poorly drained south of Big Sandy and in the northern part approaches an alkali greasewood flat. Low terraces rise above the flood plains of Big Sandy Creek in the eastern part of the valley and also west of Verona. West of Big Sandy Creek and north of Big Sandy the drift-covered basin is characterized by high mounds and other glacial features.

SETTLEMENT

Settlement of this part of Montana began soon after 1842 when the American Fur Trading Company established a permanent post at Fort Benton. After the discovery of gold in western Montana, this post became the terminus of steamboat traffic from St. Louis and during the sixties and seventies of the last century was one of the more important places in the State. Other local centers developed along the routes of travel to accomodate the overland passenger and freight trains moving in and out of Fort Benton. Stockmen settled about the Highwood Mountains during the late seventies and in the plains during the early eighties. The boundaries of the Indian Reservation in northern Montana were established about 1885 and the area north of Marias and Missouri rivers was thrown open for settlement after 1887. Most of the land in the county was sectionized during the early nineties.

History.—The Lewis and Clark Expedition passed up Missouri River in 1805 on its way to the Pacific Northwest. On the return of the party the following year, Lewis ascended Marias River to discover its source but was turned back by Indians on Cut Bank Creek in Glacier County. The tribes composing the Blackfoot Nation, such as the Piegans and Bloods, were in possession of the area east of the main range of mountains and along Marias River; and the Gros Ventres, an allied tribe, controlled the Bear Paw Mountains. Fur-trading companies began to exploit the territory soon after the Lewis and Clark Expedition returned to St. Louis. The Blackfoot Indians were hostile to American trappers and traders. After several unsuccessful attempts a permanent post in the Blackfoot territory was established in 1842 by Alexander Culbertson for the American Fur Trading Company. This was at the present site of Fort Benton and later became the head of navigation on Missouri River. Steamboats made regular trips between this town and St. Louis during the sixties and seventies and much of the freight and passenger traffic passed through Fort Benton on its way to the gold fields at Virginia City and other mining centers, and also to the agricultural districts in the intermountain sections.

The Stevens Expedition, organized to investigate the feasibility of building a railway through Northwest Territory, passed through this part of the State in 1854. It left behind a small party in charge of Lieutenant Mullen to survey the area south of Missouri River and also the mountain passes to the west during the following fall and winter. Other expeditions were organized later to study the resources of the area. The information thus obtained finally resulted in the construction of the transcontinental railways through the State in 1883 and 1888. The Havre-Butte branch of the Great Northern Railway was completed in 1887.

Boats were withdrawn from the upper Missouri River soon after the completion of the Northern Pacific Railway through the southern part of the State in 1883. By this time the Indians were confined to the reservations, and stock raising increased rapidly and was the chief industry for many years. About 1908 the public range lands were settled and fenced by the "dry-land farmer," and since that time stock raising has given way to farming in the more favorable agricultural sections.

Time of settlement.—The early stockmen of this county settled largely in the Highwood Mountains and along the larger streams such

as Teton River. The Bear Paw Mountains and the valley of Marias River became the headquarters of large cattle companies soon after the Blackfoot Indian reservation was thrown open for settlement in 1887. The land taken up by the early stockmen was chiefly bottom lands along the streams and water-holes and winter grazing lands, the possession of which largely controlled the grazing of live stock in the area. The public range land which was suitable for agriculture was homesteaded in tracts of 160 and 320 acres between 1908 and 1914. The southern part of the county was thinly populated until 1912 when the branch line of the Milwaukee Railway between Lewistown and Great Falls was constructed.

Settlers.—The early trappers and traders were largely of French ancestry and their descendants form a small percentage of the present population. The early stockmen were mostly English and Scotch, many of whom have remained in the county. The people attracted to the free lands during the "dry-land movement" came chiefly from the industrial centers and agricultural districts of the Central West. They were largely native born, although in a few localities foreign-born nationalities predominate, such as the Bohemians around Iliad and Scandinavians west of Big Sandy. A few Chinese, Japanese, and Negroes are found in the larger towns.

Population.—Chouteau County was thinly populated when stock raising was the chief industry, but between 1908 and 1914 the farm and urban populations grew very rapidly. Before the drought, 1917 to 1920, the population of the county was estimated at 17,600 but when the 1920 census was taken the total population was 11,051. The agricultural census for 1925 places the farm population at 5285. The present estimate of the total population is approximately 8500.

Towns.—Fort Benton, the county seat and one of the historic places in the State, is located on the Havre-Great Falls branch of the Great Northern Railway in the central part of the county. It has a population of approximately 1000 and serves a large farming and stock raising section. Loma, Virgelle, Floweree, and Carter are small distributing points on the Great Northern Railway. Big Sandy, located in the northeastern part of the county, serves a large area, devoted chiefly to stock raising. It has a population of approximately 400 and is second in size. Geraldine, located on the Great Falls-Lewistown branch of the Chicago, Milwaukee, St. Paul and Pacific Railway, is the largest and most important town in the southern part of the county. Waltham, Highwood, Montague, Geraldine, and Square Butte

are small but important grain centers along the Milwaukee road. Iliad is a local inland trading point in the southeastern part of the county. The larger towns have most of the modern improvements, such as electric lights, water, and sewers. The accredited schools are among the best in the State. In the more sparsely settled rural districts, the school year ranges from three to seven months.

Transportation.—The Havre-Great Falls branch of the Great Northern Railway runs diagonally through the county. It connects at Havre with the main line and at Great Falls with branches running to Butte, Billings, and Shelby. The Great Falls-Lewistown branch of the Chicago, Milwaukee, St. Paul and Pacific Railway skirts the base of the Highwood Mountains in the southern part of the county. At Lewistown it joins another branch connecting with the main line at Harlowton. The railways permit the direct shipment of grains, live stock, and live stock products, which make up most of the exportable surplus, to eastern and western markets. Local markets for perishable farm products include Great Falls, Helena, and Butte, which are the largest industrial centers in the State.

The more important highways out of Fort Benton run to Great Falls, Chester, Havre, and Lewistown, while those out of Big Sandy are the Winifred road and the Cow Island trail. The latter extends east through Warwick, south of the Bear Paw Mountains. Most of the improved roads are maintained in fair condition and are passable during the greater part of the year.

STATE LANDS

There are 181,848 acres of state land in Chouteau County, of which 144,721 acres are state school land. The sale and lease of these lands are under the direction of the Register of State Lands, located in the capitol at Helena. A minimum price of $10 per acre has been placed upon these lands by legislative enactment.

CLIMATE

The climate of this part of Montana is characterized by a moderately low rainfall, a dry atmosphere, hot summers, cold winters, and a large proportion of sunny days. The midsummer temperatures are not oppressive because of the low humidity, and the winter extremes usually are not severe as the cold waves are not often accompanied by strong winds.

Tables 1 and 2 give the normal monthly, seasonal, and annual precipitation and temperature at Havre, Fort Benton, Geraldine,

TABLE I.—PRECIPITATION

Months	Mean				Total amount driest year				Total amount wettest year				Snow, average in inches			
	Havre 1880-1929	Fort Benton 1869-1913	Geraldine 1911-1929	Lytle 1912-1928	Havre 1905	Fort Benton 1870	Geraldine 1921	Lytle 1919	Havre 1884	Fort Benton 1876	Geraldine 1909	Lytle 1911	Havre	Fort Benton	Geraldine	Lytle
December	0.63	0.55	0.64	0.50	0.12	0.22	0.55	0.49	0.72	0.09	1.30	0.51	7.7	5.4	5.5	6.1
January	0.69	0.74	0.83	0.60	0.85	1.00	0.49	T	0.16	0.71	0.83	1.14	7.9	7.4	12.4	8.8
February	0.47	0.45	0.71	0.56	0.14	0.42	0.25	0.95	0.44	0.28	0.32	1.34	5.4	4.7	8.5	6.9
Winter	**1.79**	**1.74**	**2.18**	**1.66**	**1.11**	**1.64**	**1.29**	**1.44**	**1.32**	**1.08**	**2.45**	**2.99**	**19.0**	**17.5**	**26.4**	**21.8**
March	0.48	0.57	0.91	0.54	0.15	0.15	1.21	0.38	0.53	1.53	1.10	0.31	5.0	5.6	6.6	4.6
April	1.01	1.15	1.49	0.91	0.70	0.06	0.88	0.09	0.25	1.25	2.41	1.56	3.2	1.3	6.4	5.1
May	2.09	2.66	2.70	1.85	0.83	2.41	0.93	1.95	3.05	11.06	2.24	3.42	1.8	0.8	1.4	1.9
Spring	**3.58**	**4.38**	**5.10**	**3.30**	**1.68**	**2.62**	**3.02**	**2.42**	**3.83**	**13.84**	**5.75**	**5.29**	**10.0**	**8.7**	**14.4**	**11.6**
June	2.82	2.45	3.25	2.24	1.72	0.63	3.27	0.95	4.72	1.45	5.80	2.07	T	0	0	T
July	1.92	1.59	2.00	1.41	0.86	0.80	0.50	0.01	9.67	2.31	8.75	1.01	0	0	0	0
August	1.26	1.00	1.27	1.37	0.30	0.71	1.25	0.84	2.61	1.46	0.85	2.98	0	0	0	0
Summer	**6.00**	**5.04**	**6.52**	**5.02**	**2.88**	**2.14**	**5.02**	**1.80**	**17.00**	**5.22**	**15.40**	**6.06**	**T**	**0**	**0**	**T**
September	1.03	1.10	1.50	1.06	0.12	0.32	1.91	1.62	2.69	0.39	3.08	2.94	0.5	T	0.8	1.7
October	0.50	0.64	0.88	0.74	0.37	0.41	0.28	0.93	0.41	0.24	0.20	1.71	2.2	1.2	4.8	6.8
November	0.77	0.55	0.34	0.41	0.60	0.14	0.52	0.32	0.42	0.33	0.90	0.78	4.6	4.1	5.9	2.8
Fall	**2.30**	**2.29**	**2.72**	**2.21**	**1.09**	**0.87**	**2.71**	**2.87**	**3.52**	**0.96**	**4.18**	**5.43**	**7.3**	**5.3**	**11.5**	**11.3**
Year	**13.67**	**13.44**	**15.16**	**12.26**	**6.76**	**7.27**	**12.04**	**8.53**	**25.67**	**21.10**	**27.78**	**19.77**	**36.3**	**30.5**	**52.3**	**44.7**

TABLE 2.—TEMPERATURE

Months	Mean				Absolute Maximum				Absolute Minimum			
	Havre 1880-1929	Fort Benton 1869-1913	Geraldine 1911-1928	Lytle 1912-1928	Havre	Fort Benton	Geraldine	Lytle	Havre	Fort Benton	Geraldine	Lytle
December	20.4	26.0	26.3	23.1	63	73	66	57	–35	–59	–32	–28
January	12.9	20.6	21.6	12.1	61	72	65	69	–57	–58	–36	–39
February	13.6	21.2	24.4	19.4	63	69	67	54	–45	–45	–33	–29
Winter	**15.6**	**22.6**	**24.1**	**18.2**	**63**	**73**	**67**	**69**	**–57**	**–59**	**–36**	**–39**
March	27.1	30.6	32.0	30.0	77	82	77	71	–26	–42	–26	–32
April	43.7	45.2	44.4	43.0	94	90	93	82	–4	–6	–2	–1
May	53.4	53.6	52.5	52.0	96	94	89	102	20	16	22	18
Spring	**41.4**	**43.1**	**42.6**	**41.6**	**96**	**94**	**93**	**102**	**–26**	**–42**	**–26**	**–32**
June	62.0	61.6	61.3	60.9	108	108	99	102	29	27	28	27
July	69.3	67.8	68.5	67.7	103	111	102	105	37	31	41	34
August	65.4	65.6	67.0	65.7	106	108	104	100	27	27	28	35
Summer	**65.6**	**64.9**	**65.6**	**64.8**	**108**	**111**	**104**	**105**	**27**	**27**	**28**	**27**
September	53.4	56.2	57.2	56.8	94	101	96	94	19	9	22	21
October	44.5	47.8	46.8	45.4	89	87	90	92	–7	–6	–15	5
November	31.2	33.2	35.5	33.9	75	77	74	70	–30	–36	–20	–20
Fall	**43.0**	**45.7**	**46.5**	**45.4**	**94**	**77**	**96**	**94**	**–30**	**–36**	**–20**	**–20**
Year	**41.1**	**44.1**	**44.8**	**42.9**	**108**	**111**	**104**	**105**	**–57**	**–59**	**–36**	**–39**

and Lytle. Havre has the longest weather record in north-central Montana, dating from 1880. Fort Benton has an incomplete record between 1869 and 1913. Geraldine's record dates from 1905 and Lytle, located across the county line in Pondera County, has a record from 1912.

Precipitation.—The average annual precipitation at the different stations ranges from 12.26 to 15.16 inches. The longer records show averages of approximately 13.5 inches. The rainfall increases with the elevation and in the mountains exceeds 15 to 16 inches. The lowest amount received at Fort Benton was 7.27 inches and the highest, 21.10 inches. Over 70 per cent of the total rainfall is received between March 1 and September 1. May and June are the months of greatest rainfall, each averaging between 2 and 3 inches. The rainfall of the summer months is characterized by local dashing showers. The fall and winter months are usually open with light snowfall. The records at Lytle and Geraldine indicate a heavier snowfall in the western part of the county and in the mountains.

Temperature.—The average annual temperature in Chouteau County ranges from 41.1° F. to 44.8° F. The temperature extremes at Fort Benton for the winter and summer months are –59° F. and 111° F., respectively. January with averages of 12.1° to 20.6° and

July with 67.7° to 68.5° are the coldest and hottest months, respectively. During the summer months the daily range is great, and the nights are usually cool. The frost-free period dates from the middle of May to the latter part of September, averaging 135 days in the lower plains to less than 100 days on the mountain slopes. Killing frosts have occurred in every month of the year except July. Late spring frosts rarely damage early seeded small grains, but early frosts in the fall may injure the more tender crops, such as corn and potatoes. Small grains are usually seeded during late April and early May.

Winds.—Chouteau County is subject to strong, persistent winds which usually are more noticeable during the early spring months. Chinooks or warm winds are common during the winter months, hence snow rarely accumulates to any great depth in the plains. Hot winds may occur during dry seasons and have caused serious crop losses. Hailstorms occur locally as in other parts of the State and of the Great Plains.

MAPS

The four maps accompanying this report show (1) the location and extent of the different soils; (2) the main physiographic and geographic features; (3) the location and percentage of each section under cultivation; and (4) the United States geological land classification, which shows the adaptation of the land to agriculture.

Soil map.—The soil map shows the relationship of the soils in different parts of the county. A soil section, such as is found in road cuts and coulees, shows distinct layers or horizons which can not be attributed to the origin or manner in which the parent material was deposited. The number, arrangement, and stage of development of these layers are largely the result of the common soil-forming processes which have varied in intensity under the climatic conditions prevailing in the different localities. Their physical properties, such as color, structure, thickness, and relative position, depend upon the length of time the soil material has been subject to weathering and other influencing factors, such as topography, drainage, and vegetation. These layers are the means of dividing the soils into large groups, known as the soil series, which are further divided into soil types on the basis of variation in texture, that is, the proportion of sand, silt, and clay in the surface layers. The soils of each series have the same general profile, in which the number, arrangement, and general character of the layers are the same. Reconnoissance surveys deal primarily with the identification and isolation or mapping of

the larger soil groups and less attention is given the soil type. On the soil map the types most prevalent in each series are shown as loams, sandy loams, etc., but each type may contain tracts of heavier or lighter soils and in some cases small areas of other soil series. Physiographic features, such as mountains and bad lands, are shown separately and are not included in any of the soil series.

Topographic map.—The chief physiographic and geographic features of the county are shown on the topographic map. The location and extent of physiographic features such as mountains, lakes, and bad lands, and such geographic features as towns, post offices, railways, and the more important stream courses are shown on the map. The general relief of the land is divided into three phases or classes—(1)level, (2) rolling, and (3) sharply rolling, or land too steep or broken for cultivation.

Map of area under cultivation.—A record of the approximate acreage under cultivation was made at the time of the survey for the purpose of locating the more intensely cropped lands and for studying the conditions under which certain parts of the county appeared to be more favorably adapted to agriculture than others. The approximate percentage of each section in crop, fallow, and tame pasture is shown on the map.

Land classification map.—The Sixteenth Legislative Assembly of Montana provided for a classification of all lands in the State for taxation purposes. The manner of carrying out the provisions of the act was left to the county authorities. In 1916 the United States Geological Survey undertook a classification of the public lands in the Western States for the purpose of designating those areas in which 640-acre homesteads could be taken up under the Stock Raising Act. The state and government classifications were based largely upon topographic and vegetative features and in no instances was any information obtained in regard to the soil relationships occuring in any one county or between two or more counties.

The land classification map supplements the soil and topographic maps by showing the general adaptation of the land to agriculture. Under this classification the agricultural land is classified as (1) farm lands, (2) farming-grazing land, (3) grazing forage land, and (4) non-agricultural land, as grazing land and non-tillable grazing land. The non-agricultural land includes both soil and physiographic features. For example, heavy alkaline stream bottoms and stony and very sandy lands are shown as non-agricultural, as well as mountains,

sharply rolling land, and breaks along streams. In Chouteau County most of the land is classified as grazing forage land and non-tillable grazing land. The larger tracts of irrigated land and the area covered by the proposed Marias Irrigation Project are also shown on the land classification map.

GENERAL DESCRIPTION OF THE SOILS

The soils of the northern part of the Great Plains are characterized by rather dark-colored surface soils and by a gray carbonate zone, consisting chiefly of lime, in the lower soil depths. In north-central Montana the soils have developed under a moderately low rainfall, great temperature extremes, and a short grass cover. In the mountainous sections the rainfall is greater, the temperature lower and more uniform, and the vegetative cover consists largely of timber and shrubs. The oldest agricultural soils in the area are found on the gravel-capped bench lands and on the plateaus around the mountains. The deposits of gravel and rock fragments on these high table-lands are supposed to have been laid down during late Tertiary times. Erosion has been active and the drainage is good, except locally in the glaciated area.

The soil profiles in Chouteau County vary with the age and elevation, and locally with the drainage and erosion. In the mountains more than 5500 feet in elevation, the surface soils are almost black and the lime-free heavy subsoils are dull reddish brown. On the gravel-capped bench lands the surface soils are usually reddish brown and the gravelly subsoils are often semicemented with lime. The bench lands about the mountains are in various stages of erosion, and their lime-coated stony subsoils often occur near the surface. The younger soils of the drift-covered area are brown to dark brown with friable corbonate zones below 7 to 15 inches. The soils developed over sedimentary rock are usually immature and are often without distinct soil horizons.

The soils developed over drift in the more intensely glaciated sections of Chouteau County are grouped in three series—Williams, Scobey, and Joplin. The Williams series, which includes the darker-colored soils with carbonate zones below 15 inches, are confined to the high glaciated slopes of the mountains. The Joplin series includes the lighter-colored soils, with carbonate zones often within 7 to 10 inches of the surface. The Scobey series includes a group of soils intermediate in color and in depth of the carbonate zone, between the

Williams and Joplin series. The soils of the Scobey series cover the greater part of the county, except for the light-colored soils on the slopes of the divides in the western part, which are grouped in the Joplin series.

Scab lands occupy isolated tracts in the more feebly glaciated sections. These are often underlain at comparatively shallow depths with dark-colored non-calcareous marine shales. This land is characterized by irregular depressed bare spots locally called "blowouts" and "slick spots." The bare spots range in depth from 1 to 3 inches on the heavier soils to 8 inches or more where the soils are lighter, and in some localities cover more than 50 per cent of the total surface of the land. Slick spots are rather common on the more level phases of the drift-covered area, especially at the head of drainage basins. The less scabby phases were not mapped as such unless more than 20 per cent of the total surface was occupied with bare spots. The soils of the scab land sections are grouped in the Phillips series, and are described as having developed over modified drift, containing a fair amount of residual material derived from non-calcareous shales and sandstones.

Glacial stream deposits which occur as gravelly terraces in the preglacial valley of Missouri River and other streams were grouped in the Cheyenne series. The soils developed over these stratified sandy gravelly deposits have brown surface soils and rather deep carbonate zones.

The soils of the mountainous sections are grouped in three series—Blaine, Belknap, and LeRoy. The Blaine series, which is the most extensive, includes a group of dark-brown deep stony loams on the broken, unglaciated slopes of the mountains. The Belknap soils are confined largely to small tracts within the Bear Paw Mountains, and were mapped largely because of their dull red color, derived from the parent hard red sandstones and shales. The soils of the LeRoy series are dark-colored deep stony loams found on the breccia-capped benches around the Highwood Mountains. The black soils at the higher mountain elevations were not mapped separately but are included within the area designated as rough broken land.

The soils developed over dark-colored sedimentary shales are grouped on the basis of their maturity into three series—Lismas, Pierre, and Marias. The immature soils of the Lismas series are confined to the shaly breaks of streams and the bad lands south of the Bear Paw Mountains. Soils of the Pierre series have a calcareous

mulch on the surface, and a faintly developed humus-bearing layer. The lower soil depths are olive-brown lime-free clays, containing fragments of shale below 4 feet. The Marias soils are fairly mature, and have a calcareous mulch on the surface and a well-developed brown humus-bearing layer. The subsoils are deep light olive-brown calcareous clays. The soils of the Pierre series are usually associated with those of the Lismas and are found along Arrow Creek, on Goosebill Dome, and in other sections where dark-colored shales are exposed on the surface. The soils of the Marias series cover large tracts in the basins in the northwestern part of the county.

The immature soils developed over light-colored calcareous sandstones and shales are represented in the county by one series—Bainville. These soils, confined largely to the eroded sandstone areas along the Marias and Missouri rivers and Arrow Creek, have developed light-brown shallow humus-bearing layers, and the subsoils have the structure of the parent sandstones and shales and are usually mottled with rusty iron streaks.

The Box Elder series includes a group of undifferentiated alkaline soils in the preglacial valleys. In Chouteau County the soils are chiefly greasewood, alkaline flats.

The Orman series includes a group of mature soils found in low depressions in the preglacial valleys. These soils have well-developed non-calcareous humus-bearing layers and well-defined carbonate zones.

The Lloyd series, found on the gravel-capped benches along Arrow Creek, includes a group of soils developed over ancient stream deposits. The surface soils are usually reddish brown and the subsoils are semicemented with lime.

The recent stream deposits and the wash below the breaks of streams were included in two series—Chouteau and Laurel. The Chouteau series comprises a group of dark-colored stony soils found in the high mountain basins. The Laurel group consists of gray calcareous stratified sands, silts, and clays found in the bottoms of the larger streams in the plains. These soils are usually without distinct soil horizons.

Table 3 gives the name and actual and relative extent of each soil mapped in the area. It also shows the topographic adaptation of each type of agriculture at the time of the survey.

TABLE 3.—SOIL AND TOPOGRAPHY OF CHOUTEAU COUNTY

Type	Soil		Topography			
			Level to sharply rolling		Sharply rolling	
	Total area in square miles	Percentage of county	Square miles	Percentage under cultivation	Square miles	Percentage under cultivation
Scobey loam	1263.9	31.9	1022.4	18.9	241.5	0.0
Scobey sandy loam	139.6	35.0	139.6	16.7	0.0	0.0
Scobey silt loam	195.2	5.0	195.2	41.8	0.0	0.0
Scobey stony loam	29.8	0.7	27.9	2.9	1.9	0.0
Joplin loam	486.7	12.3	322.0	15.3	164.7	0.0
Joplin silt loam	222.3	5.8	222.3	13.4	0.0	0.0
Joplin fine sandy loam	36.2	0.9	36.2	27.7	0.0	0.0
Joplin stony loam	6.0	0.1	4.7	0.0	1.3	0.0
Williams loam	73.9	1.8	45.3	22.9	28.6	1.2
Williams stony loam	2.9	—	2.9	0.0	0.0	0.0
Phillips loam	182.9	4.6	182.9	8.2	0.0	0.0
Bainville loam	269.6	6.8	54.1	6.6	215.5	0.6
Lismas clay loam	66.3	1.6	16.2	0.0	50.1	0.0
Pierre clay loam	197.0	5.0	50.6	7.7	146.4	0.7
Marias clay loam	92.6	2.3	92.6	16.0	0.0	0.0
Marias silt clay loam	1.3	—	1.3	76.9	0.0	0.0
Lloyd gravelly loam	2.5	—	2.5	30.0	—	—
LeRoy stony loam	15.7	0.4	15.7	13.0	—	—
Blaine stony loam	241.7	6.1	57.3	11.1	184.4	1.9
Belknap loam	7.0	0.2	1.8	11.1	5.2	0.0
Cheyenne gravelly loam	4.6	0.1	4.6	0.0	0.0	0.0
Orman clay loam	21.5	0.5	21.5	9.5	0.0	0.0
Box Elder loam	0.8	—	0.8	0.0	0.0	0.0
Laurel loam	122.3	3.1	122.3	0.0	0.0	0.0
Laurel clay loam	14.9	0.3	14.9	7.0	0.0	0.0
Chouteau loam	10.0	0.2	10.0	14.9	0.0	0.0
Bad lands	91.6	2.3	10.0	0.0	91.6	1.0
Bad-land basins	0.8	—	0.8	0.0	0.0	0.0
Sand dunes	1.0	—	0.0	0.0	1.0	0.0
Lakes	6.9	0.1	—	—	—	—
Mountains	157.3	4.0	0.0	0.0	157.3	0.0

JOPLIN LOAMS

Description.—The surface 1 to 2 inches of the Joplin loams, such as are found on the northern slopes of the divide south of Teton River and at the head of Chimney Rock and Dug Out coulees, is a light grayish-brown loose fine sandy mulch. The humus-bearing layer is a brown, fairly compact loam averaging 5 inches thick, while the lighter-colored, columnar-structured subsurface layer is somewhat more compact and slightly heavier in texture. The carbonate zone below 7 to 12 inches is a grayish-brown compact loam to silt loam, grading into structureless yellowish-brown loamy drift at 30 inches or more. The upper part of the carbonate zone has a faint columnar structure and is stained along seepage lines with organic matter. The soils are rather stony at the head of Dug Out and Chimney Rock coulees.

The lighter-colored phase of the Joplin loams, such as is found in the basins above the valleys of the Teton and Missouri rivers, has well-developed surface mulches and rather shallow humus-bearing layers. The carbonate zone is usually within 8 to 10 inches of the surface and the yellowish-brown parent drift is stratified and locally mottled with rusty iron streaks. The soils in the basins are somewhat lighter in texture than in the rolling uplands and usually less stony on the surface.

Topography.—Joplin loams occur in the western part of Chouteau County. The land has fair drainage, being rolling to broken in relief, and is characterized by low mounds, ridges, and lake depressions. The land in the preglacial depressions has a gentle relief but is usually quite hummocky.

Tillable area.—Joplin loams cover 487 square miles, of which 165 square miles are too broken for cultivation. On the land classification map the loams are classified as grazing forage land and non-tillable grazing land. The more broken and hummocky phases, amounting to 195 square miles, are shown on this map as non-tillable grazing land.

Utilization—The Joplin loams were homesteaded in tracts of 160 and 320 acres and largely broken before 1915. During the dry years between 1917 and 1921 the cropped acreage was greatly reduced and a large area abandoned. In 1925 only 15 per cent of the tillable land was under cultivation. The improved land of this type was found largely on the hummocky loams south of Ashmoor and around Egly. The more level phases on the divide between Chimney Rock and Skit coulees were under cultivation.

Before the time of the drought, exclusive grain farming predominated, but since that time stock raising has grown in importance. The farms have increased rapidly in size during the past few years, and one to two sections or more often comprise a farm. Spring wheat is the more important cash crop grown on the Joplin loams. Other small grains are grown chiefly for feed and forage. The acreage devoted to such forage crops as corn, alfalfa, sweet clover, and brome grass is small. Continuous cropping to small grains is the general practice until the land becomes foul with weeds when a clean summer fallow is introduced every second or third year. The soils drift after the root fiber is destroyed. Tractors and "big team" outfits furnish the motive power on the larger grain farms. The number of small combines has increased materially during the past few years.

The Joplin loams are classed among the important agricultural soils in Chouteau County. They are not difficult to maintain in good tilth and have a fair water-holding capacity. The surface acre-foot contains from 3000 to 4500 pounds of nitrogen, 1200 to 1600 pounds of phosphorus, and is well supplied with lime. The lowest amounts of nitrogen are found in the soils located in the preglacial valleys. Crop yields have been greatly influenced by the amount and distribution of the rainfall since the land was first broken. The average yields of spring wheat have not exceeded 10 bushels per acre but the crop should average between 15 and 20 bushels on well-prepared summer-fallowed land in favorable seasons.

Improved land is held at $15 to $25 per acre and unimproved land at $10 to $20 per acre. The value of grazing land depends largely upon its location, carrying capacity for live stock, and water-holes, but is usually priced very low.

Vegetation.—Grama grass (*Bouteloua gracilis*) and its associated species form the principal cover on the Joplin loams. The black-rooted sedge known as nigger wool (*Carex filifolia*) and slender wheat grass (*Agropyron tenerum*) are usually associated with grama on the lighter-textured loams, and western wheat grass (*Agropyron smithii*) on the heavier loams. Other grasses, such as needle grass (*Stipa comata*) and June grass (*Koeleria cristata*) are more or less prevalent and in the overgrazed sections may form the dominant type of vegetation. The grasses are all considered excellent range forage.

Mountain sage (*Artemesia frigida*) and gum weed (*Grindelia squarrosa*) are the more important shrubs. Mountain sage is abundant in the overgrazed sections and on land abandoned during the dry years. Black sage (*Artemesia tridentata*) grows on the loams in the vicinity of shaly outcrops. Prickly pear is found in large patches in the overgrazed sections. None of the shrubs is important range forage, although mountain sage is readily eaten by sheep. Native trees and large shrubs are not found on the Joplin loams except where transplanted.

The density of the grass cover is not uniform. The lighter stands occur in the preglacial valleys and on the loams above the breaks of Marias River and other streams. Thirty to 35 acres would be required to carry a 1000-pound steer through a grazing season of ten to twelve months on the better grassed sections of the Joplin loams. Some stockmen consider the Joplin loams better grazing for sheep than for cattle because of the prevalence of mountain sage.

JOPLIN FINE SANDY LOAMS

Description.—The surface 2 to 3 inches of the Joplin fine sandy loams, such as are found in Pleasant Valley, is a loose light grayish-brown fine sandy mulch. The humus-bearing layer is a friable, faintly columnar-structured, brown fine sandy loam averaging 7 inches thick. The subsurface layer is a compact yellowish-brown fine sandy loam. The carbonate zone below 14 to 24 inches is a grayish-brown compact slightly heavier-textured fine sandy loam, grading into yellowish-brown sandy drift at 40 inches or more. Boulders and gravel are not numerous on the surface or in the soil. The sandy loams are rather scabby below the morainic ridge which borders the valley on the north.

The Joplin fine sandy loams in the basin west of Chimney Rock Coulee are coarse-textured sandy loams farther back from the stream. The carbonate zone lies 20 inches or more below the surface and the lower depths are often stratified. Boulders and gravel are rather abundant on the coarse-textured sandy loams.

Topography and tillable area.—Joplin fine sandy loams have an undulating relief in the bottom of the preglacial valley of Teton River. The coarse-textured loams are more rolling and hilly above the breaks of the river and on the slopes of the divide bordering Pleasant Valley on the south. The fine sandy loams cover 36 square miles, of which 30 square miles are classified as grazing forage land and the remainder as non-tillable grazing land.

Utilization.—The Joplin fine sandy loams were well settled and broken before the time of the drought, but the coarser-textured loams were largely abandoned during the dry years and have not been reclaimed. In 1925, 28 per cent of the total area was under cultivation. Most of the cropped land was confined to Pleasant Valley. Spring wheat was the most important crop grown on the sandy loams. The acreage of corn and forage crops was small, but larger than on the Joplin loams. Continuous cropping to small grains is quite generally practiced and the soils often drift after the root fiber has been destroyed.

The fine sandy loams have an open porous character and readily absorb the summer rainfall. The nitrogen content of the surface acre-foot averages 500 pounds lower than that of the Joplin loams, while the phosphorous content is more variable and the lime content is somewhat lower. The yields of spring wheat have averaged higher

on the fine sandy loams but are likely to decline more rapidly unless the root fiber is maintained.

Vegetation.—The vegetation on the Joplin fine sandy loams consists chiefly of grama grass and nigger wool, which are usually associated with sand grass (*Calamovilfa longifolia*). Needle grass, June grass, and slender wheat grass are usually present in the overgrazed sections and may form the chief cover. The live stock carrying capacity of the fine sandy loams is between 30 and 40 acres per head.

JOPLIN SILT LOAMS

Description.—The darker-colored phases of the Joplin silt loams are found in the basin along Marias River and in the uplands above the preglacial valley of Teton River in the northwestern part of the county around Genou. The surface 1 to 2 inches of the silt loams in the basin along Marias River is a dull light grayish-brown granular silty mulch, which usually has a firm checked crust on the surface during the summer months. The humus-bearing layer is a cloddy columnar-structured granular dull brown silt loam, averaging 3 to 5 inches thick. The columnar-structured subsurface layer is rather shallow and effervesces weakly with acid in the lower part. The carbonate zone below 8 to 12 inches is a compact structureless grayish-brown silt to silty clay loam, blotched and streaked with lime and alkali. Below 24 to 30 inches the carbonate zone grades into stratified massive light yellowish-brown silty drift, which is about 30 feet in depth and overlies dark-colored shales which outcrop in the bottom of the coulees.

The Joplin silt loams around Genou also have the characteristic granular silty mulch on the surface. The humus-bearing layer is a rather friable silt loam averaging 5 to 7 inches thick. The subsurface layer is not well defined and the carbonate zone lies within 7 to 9 inches of the surface. The parent drift below 30 inches is a dull light-brown structureless silt loam modified locally with residual material derived from the sedimentary rocks outcropping in the area.

The lighter-colored phases of the Joplin silt loams are found in the preglacial valley of Teton River, on the divide between Skit Creek and Marias River, and locally along Marias River north of Goosebill Dome. In the basin above Teton River and locally around Goosebill Dome the granular silty mulch is 2 to 3 inches deep and the humus-bearing layer has a rather light-brown color. The blotched carbonate zone lies within 8 inches of the surface and grades into stratified

yellowish-brown silty drift, which averages 20 feet thick in the preglacial Teton Valley. On the Skit Creek-Marias River divide the surface soils are rather shallow and light colored. The carbonate zone lies within 7 to 8 inches of the surface and grades into structureless light-brown silty drift. The Joplin silt loams on the slopes of Goosebill Dome have developed over modified shaly drift, and locally are rather scabby.

Topography.—The Joplin silt loams in the preglacial valleys have a gentle relief, but in the uplands the land is more or less hummocky. These soils cover 222 square miles, of which 183 square miles are classed as grazing forage land and the remainder as nontillable grazing land.

Utilization.—The Joplin silt loams were well under cultivation up to the time of the drought, but since then the lighter-colored phases have been abandoned and used for the grazing of live stock. In 1925 only 13 per cent of the total area was under cultivation. The improved land was found largely along Black Coulee, north of Marias River, around Genou, and southwest of Goosebill Post Office. The cropped land was devoted chiefly to spring wheat. The cultural and cropping methods are the same as found on the Joplin loams.

The Joplin silt loams have good water-holding capacity but are somewhat more difficult to maintain in good tilth in wet seasons than the Joplin loams. The darker-colored phase contains about the same amount of plant food in the surface acre-foot as the better classes of the Joplin loams, but the lighter-colored phases average 300 to 500 pounds less in nitrogen. The yields of spring wheat on the darker-colored phases have been fair, with exceptionally high yields on well-prepared summer-fallowed land in favorable seasons.

Vegetation.—Grama grass forms the chief cover on the Joplin silt loams. Western wheat grass is abundant in wet seasons on the heavier phases, such as are found around the Marias clay loams. The vegetative cover is rather light in the preglacial depression of Teton River and on the divide between Skit Creek and Marias River. The carrying capacity of the silt loams is between 30 and 40 acres per head of cattle.

JOPLIN STONY LOAMS

Description.—The profiles of the Joplin stony loams are in general the same as those of the Joplin loams and sandy loams, found in the vicinity of the stony tracts, except for a greater quantity of

boulders and gravel on the surface and in the soils. The surface soils on the mounds and ridges are usually shallow.

Topography and utilization.—Joplin stony loams cover a morainic area of about 6 square miles in the northwestern part of the county, most of which is classified as grazing forage land. The type is used almost wholly for the grazing of live stock.

Vegetation.—The vegetation found on the Joplin stony loams is the same as that found on the Joplin loams and silt loams. The live stock capacity of the stony loams will not differ greatly from that of the loams and sandy loams.

SCOBEY LOAMS

Description.—The lightest-colored phase of the Scobey loams is found (1) in the north-central part of the county, north of Missouri River, (2) on the northern slopes of the Teton divide west of Carter, and (3) in the preglacial valley of Missouri River east of Loma. The surface 1 to 3 inches is a light grayish-brown loose sandy mulch, which develops a compact laminated structure in wet seasons. The humus-bearing layer is a friable brown loam averaging 5 to 7 inches thick. The subsurface layer is a lighter brown compact columnar-structured slightly heavier-textured loam. The carbonate zone below 8 to 16 inches is a compact structureless grayish-brown silt loam, grading into yellowish-brown structureless loamy drift at 30 to 40 inches.

The soils on the divide north of Missouri River have developed over modified drift, containing fragments of shale. The surface soils are rather shallow and the land is quite scabby. The soils in the basin around Colony Bay represent a heavier phase of the Scobey loams and grade into silt loams, with carbonate zones 8 to 9 inches below the surface. In the preglacial valley of Missouri River the surface soils are rather light colored and shallow. The carbonate zone lies 8 to 12 inches below the surface and grades into yellowish-brown stratified loamy drift at 24 to 30 inches.

A gravelly phase of the Scobey loams covers the central part of the county between Missouri River and Flat Creek east of a line drawn north and south through Clear Lake Post Office. A similar gravelly phase borders Little Birch Creek on the west and also covers the area between Cut Bank Creek and Flat Creek. The surface 1 to 2 inches is a loose gravelly sandy mulch. The gravelly brown humus-bearing layer averages 5 to 7 inches thick. The sub-

surface layer has a well-developed columnar structure. The gravelly carbonate zone lies 8 to 15 inches below the surface and grades into structureless brown gravelly drift at 30 inches or more.

The carbonate zone on the gravelly sandy knolls often is within 4 to 8 inches of the surface, while in the lake depressions it is 15 to 20 inches below the surface. North of Eagleton Post Office the gravelly drift is rather shallow, and dark-colored shaly material modifies the character of the soils on the slopes of the preglacial Missouri valley. South of Flat Creek the soils are not so hummocky and the mounds are not so gravelly and sandy as north of the stream. North of Eagleton, between Eagle, Dog, and Little Birch creeks, the soils have developed over glacial gravelly outwash, and the subsoils are usually loose, lime-coated sands and gravels below 10 to 14 inches.

A medium dark-colored phase of the Scobey loams occurs (1) on the Teton divide, (2) in the preglacial valley of Judith River around Hopp and Iliad, and (3) above the breaks of Missouri River west of the gravelly area. The surface mulch is well developed and the brown humus-bearing layer averages 5 to 7 inches thick. The carbonate zone lies 8 to 12 inches below the surface and grades into yellowish-brown structureless drift at 30 to 40 inches. The soils in the uplands along the preglacial valley of Judith River are several shades lighter in color, and the lime zone lies 12 to 15 inches below the surface. Boulders and gravel are more abundant on the upland phase.

The darkest-colored Scobey loams are found (1) on the slopes of the Bear Paw Mountains and Arrow Creek divide, (2) in the south-central part of the county north of Shonkin Sag, and (3) on the irregular drift-covered benches south of the sag about Montague and Geraldine. The surface 2 to 3 inches is a light grayish-brown loose sandy mulch containing a fair amount of plant fiber on the slopes of the Bear Paw Mountains. The humus-bearing layer is a brown to dark-brown friable loam averaging 5 to 7 inches thick. The columnar-structured subsurface layer is somewhat heavier in texture and usually not as compact as in the lighter-colored phase. The carbonate zone below 12 to 20 inches is a compact structureless grayish-brown silt to silty clay loam, grading into light-brown structureless loamy drift at 3 to 4 feet. Residual material derived fom sedimentary sandstones and shales and from dikes of ancient trap-rock modifies the character of the soils to some extent on the drift-covered benches south of Shonkin Sag. The darker-colored and deeper-horizoned soils are found

at the higher elevations (1) along Shonkin Gap, (2) on Frenchman's Ridge, and (3) on the slopes of the mountains and on the Arrow Creek divide.

Soils developed over drift are quite variable in texture and are rarely uniform over a large area. The lighter-textured phase is found in the north-central part, the heavier phase south of Missouri River west of Shonkin Creek, and the gravelly phase in the central and other parts of the county. The character of the soils is modified by sedimentary sandstones and shales in the more feebly glaciated and eroded sections. Sheet erosion is active on the more gentle slopes between the deeply entrenched coulees above the breaks of the stream, and the surface soils are often very shallow. Glacial boulders are sufficiently numerous on most phases to preclude farming, unless the land is cleared. The glacial and gravelly hummocks are usually very stony and the more stony phases are found (1) on the Arrow Creek divide, (2) in the central part of the county around Harwood Lake, (3) in the preglacial valleys of the Missouri and Judith rivers north of Virgelle and Hopp, and (4) west of Little Birch Creek.

Topography.—The lighter-colored phase of the Scobey loams, such as is found in the Lonesome Prairie basin, has an undulating billowy relief. The divide above the Missouri and Marias rivers is rolling and its southern and western slopes are broken with deeply entrenched coulees. The gravelly phase has a gently rolling relief characterized by numerous gravelly mounds and lake depressions. The darker-colored phase has a gentle relief west of Shonkin Creek, but east of the stream it is more rolling and on the slopes of Frenchman's Ridge and along Shonkin Gap is locally broken. A morainic area covers the western slopes of the Arrow Creek divide and high rolling drift-covered ridges extend down the Bear Paw Mountains. The land south of these mountains above the preglacial valley of Judith River is quite rolling and along the streams is quite broken. The Teton divide has a gentle relief, becoming more rolling to the west. Drainage has not been well established on the more gravelly and stony phases of the Scobey loams.

Tillable area.—Scobey loams cover 1264 square miles, of which 241 square miles are too broken for cultivation. On the land classification map the darker-colored phases (1) west of Shonkin Creek, (2) on Frenchman's Ridge, (3) at the high elevations along Shonkin Gap, east of Frenchman's Ridge, and (4) on the lower, less stony slopes of the Arrow Creek divide are classified as farming-grazing land and

the remainder of the tillable area as grazing forage land. Non-tillable grazing land to the extent of 347 square miles is confined largely to the breaks of streams and land broken with entrenched coulees.

Utilization.—Scobey loams were homesteaded in tracts of 160 and 320 acres during the dry-land movement and most of the tillable land was broken before 1915. During the dry years the cropped acreage was greatly reduced and the lighter-colored and gravelly phases were largely abandoned. In 1925, 19 per cent of the tillable land was under cultivation. The improved land was found largely on the darker-colored phase around Frenchman's Ridge and along the Shonkin Gap. A fair acreage was under cultivation around Kenilworth, Colony Bay, Hopp, Iliad, and on the Teton divide west of Carter.

Exclusive grain growing was the common practice on the Scobey loams up to the time of the drought, but since that time stock raising, often combined with grain growing, is carried on in the less desirable farming districts. The farms are large, often covering one or more sections of land. Spring wheat is the most important cash crop grown on the Scobey loams, with flax ranking second in importance. Flax is usually grown on new breaking since the yields are rather low on old land. Fall wheat winterkills too frequently at the lower elevations to be depended upon and is confined largely to the darker-colored phase on the high benches along Shonkin Sag in the vicinity of Montague and Geraldine. Other small grains, such as oats, barley, and rye, are grown chiefly for feed or forage. The corn acreage increased rapidly during the dry years but recently has declined and is confined largely to the lighter-colored phase. There is a small acreage of forage crops, such as alfalfa, sweet clover, and brome grass. On the grain-stock farms, winter feed consists largely of the native grass, small-grain hays, and straw. The winters are usually open and stock is run on the range and in the fields during the winter months. Tractors and large-type farm machinery are in general use in growing spring wheat on the Scobey loams. The land is continuously cropped until it becomes foul with weeds when a clean summer fallow is introduced every second or third year. After the root fiber has been destroyed the lighter-colored soils may drift. On the more diversified farms, corn replaces summer fallow to some extent and a greater acreage is seeded down to sweet clover and brome grass.

The Scobey loams are among the more important agricultural soils in Chouteau County. These soils have good tilth and good water-holding capacity. The surface acre-foot of the lighter-colored and

gravelly phases contains from 3000 to 4000 pounds of nitrogen, and the darker-colored phases 3500 to 4000 pounds or more. The soils average from 1200 to 1500 pounds of phosphorus and are well supplied with lime. Crop yields have been fairly consistent on the darker-colored phase since the land was broken, but on the lighter-colored phase they have been greatly influenced by the amount and distribution of seasonal rainfall. The yields of spring wheat have averaged a few bushels higher than on the Joplin loams. Yields of 20 to 30 bushels of spring wheat per acre are not uncommon on well-prepared summer-fallowed land on the darker-colored soils in wet seasons.

Vegetation.—Grama grass and its associated species form the principal cover on the Scobey loams. On the heavier phases, such as are found south of Missouri River west of Shonkin Creek, western wheat grass often forms the principal cover in wet seasons. The density of the grass cover varies with the location and elevation. The lighter stands are found on the lighter-colored and gravelly phases in the north-central and central parts of the county. The live stock carrying capacity is between 30 and 35 acres per head. On the darker-colored phase, such as is found along Shonkin Gap, Teton Ridge, and on the slopes of the Bear Paw Mountains, and Arrow Creek Divide, 20 to 25 acres per animal would be required in average seasons.

SCOBEY SANDY LOAMS

Description.—The Scobey sandy loams west of Big Sandy have a loose grayish-brown sandy mulch on the surface, averaging 2 to 3 inches deep. The humus-bearing layer is a brown, slightly columnar-structured, friable medium fine sandy loam averaging 5 to 7 inches thick. The lighter-colored subsurface layer is compact and is without definite structure. The carbonate zone below 16 to 30 inches is a grayish-brown compact structureless sandy loam, grading into yellowish-brown structureless sandy drift at 36 to 42 inches. Around Kenilworth the subsoils are locally stratified sandy clays.

The soils in the preglacial valley west of Fort Benton are fine sandy loams, overlain with a shallow loose fine sandy mulch. The brown humus-bearing layer averages 5 to 8 inches thick. The carbonate zone lies 16 to 20 inches below the surface and grades into yellowish-brown stratified drift at 40 inches or more. The deposit of drift in the preglacial valley is 30 to 40 feet thick and overlies dark-colored shales.

The coarser-textured phases of the Scobey sandy loams are found (1) south of Loma, (2) north of Virgelle, (3) along the Hill County line, and (4) along Missouri River north of Eagle Creek. These soils are loose coarse-textured sandy loams, with deep carbonate zones.

Topography and tillable area.—The Scobey sandy loams have an undulating to gently rolling topography in the north-central part of the county. In the preglacial valley of Missouri River west of Fort Benton the land is level to undulating, sloping gently in the direction of the stream. The coarse sandy loams are hilly and locally have a sand dune topography. Scobey sandy loams cover 140 square miles, of which 126 square miles are classified as grazing forage land and the remainder as non-tillable grazing land.

Utilization.—The fine to medium-fine sandy loams were fairly well broken before the time of the drought, but since then a large acreage has been abandoned and devoted to the grazing of live stock. The cropped acreage in 1925 was approximately 17 per cent of the total area. The improved land was found chiefly west of Big Sandy and in the preglacial basin of Missouri River west of Fort Benton. Spring wheat was the most important crop grown on the sandy loams. Other small grains covered a small acreage, except on some of the more diversified farms, where a fair acreage is devoted to corn, for fodder and for hogging off. The Scobey sandy loams drift after the root fiber has been destroyed.

The Scobey sandy loams are open and porous and readily absorb the summer rainfall. The soils average 500 pounds lower in nitrogen than the lighter-colored phase of the Scobey loams and the phosphorous content is more variable. The soils are well supplied with lime. The yields of spring wheat on the Scobey sandy loams have averaged lower than on the darker-colored phases of the Scobey loams.

Vegetation.—The plant relationships on the Scobey sandy loams are much the same as on the Joplin fine sandy loams. The tall grasses adapted to droughty conditions are often found on the coarser-textured sandy loams. The carrying capacity of the sandy loams is from 30 to 40 acres per animal. On the coarser-textured sandy loams a few more acres would be required to run a steer through the growing season.

SCOBEY SILT LOAMS

Description.—The surface 1 to 2 inches of the Scobey silt loams, such as are found in the area south of Missouri River west of Shonkin Creek, is a dull grayish-brown granular silty mulch. The humus-

bearing layer is a fine cloddy columnar-structured granular dark-brown silt loam, averaging 5 inches thick. The subsurface layer is a columnar-structured compact brown silt to silty clay loam, having locally a slight reddish cast. The carbonate zone below 17 inches is a grayish-brown compact streaked and blotched silty clay, the upper part of which has faint columnar structure. The parent drift below 3 feet is an olive-brown structureless silt loam. Boulders are not numerous and the drainage is fair. The glacial depressions are locally quite scabby.

The heavier phase of the Scobey silt loams, such as is found on Square Butte bench, has a granular silty mulch on the surface, averaging 1 inch deep. The humus-bearing layer, averaging 7 inches deep, is brown compact granular cloddy silt to silty clay loam. The subsurface layer is shallow and poorly developed. The carbonate zone below 8 to 11 inches is a grayish-brown compact silty clay, grading into olive-brown structureless lime-blotched silt to silty clay material with depth. The greater part of Square Butte bench is underlain with gravel and sand at depths of 3 feet or more. The soils on the bench west of Flat Creek are similar to those on Square Butte bench, but the sandy gravelly substratum was not encountered at depths of 5 feet.

The Scobey silt loams on the divide south of Teton River have loose granular silty mulches on the surface, averaging 2 to 3 inches deep. The humus-bearing layers are lighter in color than those in the area west of Shonkin Creek, south of Missouri River, and the subsurface layers are somewhat more compact, especially in the lower part. The carbonate zone below 15 inches is a compact lime-blotched silt to silty clay loam, grading into more friable structureless silty light-brown drift at 38 inches. Fragments of shales are found usually in the lower soil depths and boulders are rather numerous on the surface.

Topography and tillable area.—The Scobey silt loams cover an undulating to rolling area west of Shonkin Creek and south of Missouri River. Square Butte bench has a gentle sloping relief, while the southern slope of the Teton divide is quite rolling and hilly. The silt loams cover 195 square miles, of which 171 square miles are shown as tillable on the land classification map. The soils south of Missouri River are classified as farming-grazing lands, and on the Teton divide as grazing forage land.

Utilization.—The Scobey silt loams south of Missouri River were largely taken up by the early stockmen for winter grazing. During the dry-land movement the larger stock companies were dissolved and the land converted into farms. In 1925, 41 per cent of the total area was under cultivation. Much of the tillable land south of Missouri River was under cultivation but on the Teton divide it was not so well improved. The land under cultivation at the foot of the Highwood Mountains lies at a fair elevation and is devoted chiefly to spring and fall wheat. Summer fallowing of land every other year is quite generally practiced on the heavier loams. The farms are large, often covering more than one section of land.

Scobey silt loams are among the more productive agricultural soils in Chouteau County. They are not as easily maintained in good tilth as the lighter loams but have a high water-holding capacity. The surface acre-foot contains from 4000 to 5000 pounds of nitrogen and is fairly well supplied with phosphorus and lime. The yields of spring wheat have averaged higher than on the Scobey loams; in favorable seasons yields of 30 to 35 bushels per acre are not unusual.

Vegetation.—Grama grass and western wheat grass form the principal cover on the Scobey silt loams. The live stock carrying capacity of the silt loams north of the Highwood Mountains is between 20 and 25 acres per head and on the Teton divide about 30 acres.

SCOBEY STONY LOAMS

Description.—The profiles of the Scobey stony loams are similar to those on the different phases of the Scobey loams and sandy loams, found in the vicinity of the stony tracts. Boulders and gravel are abundant on the stony loams. The surface soils are usually shallow on the tops of the mounds and ridges and fairly deep around the potholes and depressions. The darker-colored phases are found at the higher elevations, such as the slopes of the Bear Paw Mountains and the Arrow Creek divide.

Topography and tillable area.—Scobey stony loams are distributed in tracts of varying size over the more intensely glaciated portion of the county. Most of the tracts have a hummocky morainic relief. The stony loams cover 30 square miles. On the land classification map 21 square miles are shown as grazing forage land and the remainder as non-tillable grazing land.

Utilization.—Scobey stony loams generally are too stony for cultivation and are used chiefly for the grazing of live stock. Less than 2 per cent of the total area was under cultivation in 1925.

Vegetation.—The grasses and shrubs on the Scobey stony loams do not differ greatly from those on the Scobey loams and sandy loams and have about the same carrying capacity for live stock.

WILLIAMS LOAMS

Description.—The surface 1 to 2 inches of the Williams loams on the slopes of the Bear Paw Mountains is a fibrous mat of organic matter derived from a creeping moss. The humus-bearing layer, averaging 5 inches thick, is a dark-brown friable columnar-structured loam, grading into a more compact heavier-textured subsurface layer. The carbonate zone below 16 inches is a grayish-brown compact silt loam, changing at 40 inches or more into light-brown structureless loamy drift.

The Williams loams on the slopes of the Highwood Mountains east of Waltham have a dark-brown organic loamy mulch on the surface, averaging 2 to 3 inches deep. The dark-brown humus layer averages 5 to 7 inches thick and the columnar-structured subsurface layer grades from a friable brown loam in the upper part to a compact lighter-brown silt loam in the lower part. The carbonate zone lies below 18 inches and grades into rather heavy-textured parent drift at 40 inches or more.

The Williams loams on the slopes of the mountains grade into the Scobey loams without any appreciable change in the character of the soil profiles or in the contour of the land. At the higher elevations the transition between the Williams loams and the Blaine stony loams is marked by a difference in color and depth of the soil horizons, rock outcrops, and a greater quantity of rock fragments on the surface. The Williams loams on the slopes of the Bear Paw Mountains are quite stony.

Topography and tillable area.—The Williams loams are rolling and broken on the slopes of the Bear Paw Mountains, but on the slopes of the Highwoods have a more rolling bench-like form. These soils cover 74 square miles of which area 25 per cent is too broken for cultivation. On the land classification map 21 square miles are shown as farming-grazing land and the remainder as non-tillable grazing land.

Utilization.—The Williams loams are among the better grass lands in north-central Montana and were largely taken up for winter grazing by the early stockmen. In 1925, 23 per cent of the tillable area was in crops and summer-fallowed land. The cropped acreage was

found largely below Mount Centennial and on the tract east of Waltham. The Williams loams are devoted chiefly to the growing of spring and fall wheat. Other small grains, such as oats, are grown chiefly for winter feed. The tame grasses and legumes are confined largely to small irrigated tracts along the larger perennial streams.

The Williams loams are among the more productive soils in Chouteau County, but their elevation is too high to mature many of the crops grown in the lower plains. The surface acre-foot contains over 5000 pounds of nitrogen and is well supplied with lime and phosphorus. The yields of spring wheat on well-prepared summer-fallowed land have consistently averaged a few bushels higher than on the Scobey silt loams.

Vegetation.—Western wheat grass and grama grass are the principal grasses on the Williams loams at the lower elevations, giving way to a mountainous type at the higher elevations. In normal seasons the carrying capacity of the Williams loams is between 15 and 20 acres per head of cattle.

WILLIAMS STONY LOAMS

Description.—The profiles of the Williams stony loams are the same as those of the Williams loams, except for a greater quantity of boulders and rock on the surface and in the soil. The stony loams cover 3 square miles, nearly all of which is shown as non-tillable grazing land on the land classification map. The soils are too stony for cultivation and are used for grazing. The carrying capacity of the stony loams is the same as that of the loams.

PHILLIPS LOAMS

Description.—Phillips loams are characterized by numerous depressed bare spots locally called slick spots and blow outs. The character of these spots varies with the texture and probably with the stage of development of the soil. On the heavier phases the bare spots are depressed 3 to 5 inches and cover 30 to 50 per cent of the total surface of the land while on the lighter-textured phases they are often deeper but do not cover as large a portion of the surface. Slick spots are distributed over the soils composing the Scobey and Joplin loams, silt loams, and sandy loams, especially at the head of drainage basins; but the scab land was not mapped separately unless more than 20 per cent of the total land surface consisted of such spots.

The profiles of the grassed portion of the Phillips loams are in general similar to those of the Scobey and Joplin loams, silt loams,

and sandy loams found in the vicinity of the scab land. The mulch in the Phillips loams is somewhat more pronounced and the subsurface layer is usually more compact.

The bare spots on the heavier phases of the Phillips loams, such as are found in the basin above Marias River, have a glazed silty crust on the surface, averaging one-half to one inch thick. The crust is underlain with a honey-combed or vascular-structured silty layer grading into a compact impervious silt to silty clay hardpan. The hardpan averages 3 to 5 inches thick, and the low part is usually flecked with white calcareous alkaline material. In the preglacial valley the hardpan is underlain with a lighter-textured layer, but in other localities it grades directly into the carbonate zone found in the grassed section. The carbonate zone appears to be continous and underlies the general level of the land at the same depth. The bare spots on the lighter-textured phases also have the crust and vascular-structured layer on the surface, but often a compact sandy layer overlies the impervious gritty hardpan.

The soils of the scabby lake basins and alkaline stream bottoms were undifferentiated and included in the Phillips loams. The more scabby phases of the lake basins cover old shore lines. In the stream bottoms wind-blown material accumulating around the shrubs often modifies the character of the soils and the surface features.

Topography and tillable area.—Phillips loams are confined largely to the more level and undulating phases of the lightly drift-covered area in the plains of Chouteau County. Low gravelly hummocks are quite numerous on the scabby land along Flat and Little Sandy creeks. The land is poorly drained, and the scab spots are often filled with water during the spring months. The loams cover 183 square miles, of which 143 square miles are classified as grazing forage land and the remainder as non-tillable grazing land.

Utilization.—The Phillips loams were settled and broken before the drought, but during the dry years the more scabby phases were abandoned and have not been reclaimed. In 1925 less than 8 per cent of the total area was under cultivation. The cropped acreage was largely confined to the darker-colored phases south of Missouri River where less than 35 to 40 per cent of the surface of the land is covered with slick spots. The land under cultivation is devoted chiefly to spring wheat, and the non-agricultural land to the grazing of live stock.

Phillips loams are among the marginal agricultural soils in Chouteau County. The soils in the slick spots are rather retractive. In

dry seasons satisfactory stands of the small grains are difficult to obtain on these spots, and the grain that does grow is usually stunted and is the first to show signs of burning although water may have stood in the spots for several weeks in the spring. The surface acre-foot of the grassed portions of the Phillips loams contains about the same amount of plant food as is found in the Scobey and Joplin loams, sandy loams, and silt loams surrounding the scabby sections. The soils in the bare spots are usually several hundred pounds lower in nitrogen but contain about the same amount of phosphorus, and the calcium content often exceeds 30,000 pounds per acre. Crop yields have varied greatly, depending upon the seasonal rainfall. In wet seasons the yields have been fair, averaging a few bushels lower than on the Scobey and Joplin loams.

Vegetation.—The vegetation on the Phillips loams is about the same as on the Scobey and Joplin loams. Annual weeds and small shrubs are somewhat more abundant and prickly pear is prevalent. The live stock carrying capacity is quite variable, but an average of 35 to 40 acres would be required to carry a steer through the grazing season. During the time that water-holes are filled some stockmen consider the Phillips loams better adapted to the grazing of sheep than of cattle.

BAINVILLE LOAMS

Description.—The more mature phases of the Bainville loams, such as are found southeast of Square Butte, have a shallow loose sandy mulch on the surface. The humus-bearing layer is a friable yellowish-brown sandy loam averaging 4 to 6 inches thick. The subsurface layer is not well developed on the more rolling phases but in the basins or depressions it is a structureless light yellowish-brown sandy loam. The carbonate zone below 4 to 20 inches is a gray structureless sandy loam to gritty loam grading into sandy silty material having the structure of the parent sandstones and shales and usually streaked with rusty iron stains. The soils on the bench above Missouri River in the bend of Birch Creek are similar to those southeast of Square Butte, except that the subsurface layer is rather shallow.

The immature phases of the Bainville loams, such as are found south of the Bear Paw Mountains, in the breaks above the Missouri and Marias rivers, and in other sections of the county also, have a shallow sandy mulch on the surface. The humus-bearing layer, which is often not well developed, is a gray to yellowish-brown silt to sandy loam averaging 3 to 4 inches thick. The subsoils are gray to yellowish

calcareous silty and sandy loams, having the structure of the parent material and usually stained with rusty iron streaks. Fragments of the parent sandstones and shale are often found in the soils, and the parent rocks often outcrop on the more eroded phases. On the steeper slopes and in the bottom of coulees, the colluvial wash consists largely of light grayish-brown calcareous silty to fine sandy material without a distinct humus-bearing layer. In the basin above Kabo the Bainville loams have developed over dark-colored shales and the surface soils are grayish-brown calcareous silty clay loams, overlain with a well-developed granular silty clay mulch. The subsoils are massive olive-brown silty clays, containing fragments of the parent shales in the lower depths. On the slopes of the basin the soils are modified with wash from the sandstone rim-rocks. In the preglacial valley of Teton River colluvial wash also modifies the soils below the rim-rocks bordering the basin on the north.

Topography and tillable area.—The Bainville loams have a broken relief in most sections of the county. The land south of the Bear Paw Mountains and above the breaks of streams is cut into irregular tracts by deep coulees. Southeast of Square Butte the land is characterized by high hills and wide deep basins or hollows. The southern slope of the Arrow Creek divide is broken with deep coulees. The colluvial wash in the basin above Kabo and in the preglacial valley of Teton River has a gentle but rather steep slope. The loams cover 270 square miles, of which only 54 square miles are suitable for farming. Most of the area mapped as Bainville loams is classified as non-tillable grazing land.

Utilization.—Bainville loams are devoted chiefly to the grazing of live stock. In 1925, 7 per cent of the tillable land was under cultivation. The improved land was found largely southeast of Square Butte, on the slopes of the basin above Kabo, and below the rim-rocks, bordering the preglacial valley of Teton River on the north. A combination of stock raising and grain growing is a common practice in the more desirable farming sections.

The more mature phases of the Bainville loams are classed among the farm lands of Chouteau County. The soils in the basins southeast of Square Butte contain over 4000 pounds of nitrogen in the surface acre-foot and are well supplied with phosphorus and lime. The immature phases are usually low in nitrogen. The yields of spring wheat on the Bainville loams southeast of Square Butte range between 15 and

20 acres on summer fallowed land, but on the less mature phases the yields have averaged low.

Vegetation.—The principal cover on the Bainville loams consists of grama grass and nigger wool and their associated species. The density of the grass cover varies in different parts of the county. Southeast of Square Butte 30 to 35 acres would carry a steer through the grazing season, while in other sections of the county 5 to 10 acres more would be required.

LISMAS CLAY LOAMS

Description.—The surface 1 to 2 inches of the Lismas clay loams is a non-calcareous loose granular light grayish-brown silty clay mulch, which develops a compact checked crust on the surface after the spring rains. The material below the mulch is a dark olive-brown cloddy platy-structured clay, grading into a compact massive lighter olive-brown clay, having the structure of the parent shales. Fragments of shales are found below 2 to 3 feet and slabs and crystals of gypsum are distributed over the surface and in the soils in the area underlain with the Bear Paw shales. Wide cracks penetrate the soil for 10 to 15 inches below the mulch. The Lismas clay loams in the southeastern part of the county are lower in elevation than the Bainville loams, hence the colluvial wash from the sandstone breaks often modifies the character of the surface soils.

Topography and utilization.—Lismas clay loams cover the barren clay hills and ridges south of the Bear Paw Mountains along Birch Creek, and also in the southeastern part of the county along Missouri River and Arrow Creek. The land south of Missouri River along Arrow Creek is very broken, and the high hills and ridges are often capped with sandstone. The clay loams cover 66 square miles, of which 61 square miles are classed as non-tillable grazing land. The Lismas clay loams are not under cultivation but are devoted to grazing.

Vegetation.—Lismas clay loams are sparsely covered with vegetation. Black sage, isolated plants of western wheat grass, shrubs, and annual weeds, such as native sunflower and cocklebur, make up most of the cover. The live stock carrying capacity of the Lismas clay loams is very low.

PIERRE CLAY LOAMS

Description.—The surface 2 inches of the Pierre clay loams, developed over the Bear Paw and Claggett shales in the southeastern part of the county along Missouri River and Birch and Arrow creeks,

is a loose granular light grayish-brown silty clay mulch effervescing weakly with acid. The material below the mulch for 4 to 7 inches is a drab compact cloddy platy-structured clay, grading into massive non-calcareous olive-brown clays, having the structure of the parent shales below 3 to 4 feet. Pockets of brown silty material and flecks of gray ashy alkaline material occur in the soils below 12 to 15 inches. Crystals of gypsum are usually distributed through the soil and fragments of shale below 3 to 4 feet. Wide cracks penetrate the soils for 12 to 15 inches below the mulch.

The soil profiles of the Pierre clay loams developed over the Colorado shales in the western half of the county are similar to those developed over the Bear Paw and Claggett shales. The rusty dark-colored shales of the Colorado formation give the soils a slightly reddish-brown color. The sandstones of this formation carry free lime, and locally the subsoils have a grayish color and effervesce with acid. The colluvial wash in the bottom of Arrow Creek and Shonkin Sag is a barren alkali flat.

Topography and utilization.—Pierre clay loams cover rather barren gullied clay hills and ridges, which have a more subdued relief than those of the Lismas clay loams. The intermittent streams between the hills and ridges are of the cut-bank type. Pierre clay loams cover 197 square miles, of which 147 square miles are classed as non-tillable grazing forage land. In 1925 less than 8 per cent of the tillable land was under cultivation. The cropped land was largely confined to small irrigated tracts where the surface soils are modified with drift. The soils contain a fair amount of phosphorus and lime but are usually low in nitrogen, and are used chiefly for grazing since they are too retractive for dry-land farming. The irrigated tracts are devoted largely to forage crops such as alfalfa.

Vegetation.—Black sage, grama grass, and western wheat grass form the principal cover on the Pierre clay loams. Grama grass occurs chiefly in patches. The live stock carrying capacity of these loams while low is higher than that of the Lismas clay loams.

MARIAS CLAY LOAMS

Description.—The surface 2 inches of the Marias clay loams in the west-central part of the county around Aznoe is a calcareous granular light grayish-brown silty clay mulch. The humus-bearing layer is calcareous dark-brown compact cloddy silty clay to clay loam, averaging 6 to 8 inches thick. The subsoils below 8 to 10 inches

are calcareous dull olive-brown compact structureless clays. Wide cracks penetrate the soils a foot or more below the mulch. A few glaciated boulders occur on the surface of the land and a small amount of gravel in the soils.

The soils in the basin known as Sample Flat and in the basin east of Ashmoor are included in the Marias clay loams in Chouteau County, but are to be associated with the darker-colored phase of the Orman clay loams, which were mapped in the counties to the west after the soil map of this county was prepared. The surface 1 to 2 inches in the Sample Flat basin is a granular grayish-brown non-calcareous silty clay mulch, which has a firm crust on the surface in wet seasons. The humus-bearing layer is a dull-brown compact cloddy granular non-calcareous silty clay to clay loam. The carbonate zone below 8 to 10 inches is a compact drabbish-brown clay, effervescing freely with acid, and grading into stratified fine sands, silts, and clays with depth. The heavier strata are usually streaked and blotched with lime and alkali and often contain fragments of shale and sandstone. The depth and character of the stratified material are not uniform over the basin. Silty, sandy colluvial wash modifies the soils on the slopes of the basin below the rim-rocks. The soils in the uplands around Waltham are dark-colored clay loams, with carbonate zones below 7 to 12 inches.

Topography and tillable area.—The Marias clay loams in the preglacial basins have a level to undulating relief, and in the uplands are gently rolling. The clay loams cover 92 square miles, most of which is clasisfied as grazing forage land except for the tract around Waltham, which is included among the farming lands.

Utilization.—Much of the Marias clay loam was under cultivation before the time of the drought, but during the dry years a large acreage was abandoned in the northwestern part of the county. In 1925, 16 per cent of the area was under cultivation, most of the improved land being found near Aznoe, Waltham, and on the slopes of Sample Flat. Spring wheat is the most important crop, grown on the heavy loams. The soils are rather plastic when moist, and disk and slat mold-board plows are employed in turning over the stubble. The land is usually summer fallowed for a season to mellow the clods and to accumulate a reserve of soil moisture. The soils drift during the early spring months before the spring rains crust the surface.

The Marias clay loams are among the more productive soils in north-central Montana in wet seasons. The soils have a high water-

holding capacity and in dry seasons the seasonal moisture is held largely in the surface layers. The soils having a high lime content in the surface 6 inches crumble readily and are less retractive than those having carbonate zones below the depth of plowing. The surface acre-foot contains from 4000 to over 5000 pounds of nitrogen, and fair amounts of phosphorus and lime. The yields of spring wheat in wet seasons have averaged a few bushels higher on well-prepared summer-fallowed land than on the darker-colored phase of the Scobey silt loams.

Vegetation.—Western wheat grass forms the principal cover on the Marias clay loams. Grama grass is associated with it below the Knees, around Aznoe, and on the slopes of the basins, where the soils are modified with colluvial wash. The density of the grass cover is fair and in normal seasons 25 to 30 acres would support a steer through a grazing period of ten to twelve months.

MARIAS SILTY CLAY LOAMS

Description.—The surface 1 to 2 inches of the Marias silty clay loams is a granular light grayish-brown loose silty clay mulch. The humus-bearing layer is a columnar-structured cloddy dull-brown silty clay loam, averaging 6 to 8 inches thick. The subsurface layer has a faint columnar structure and is somewhat more compact and lighter colored. The carbonate zone below 18 to 23 inches is a structureless olive-brown compact silty clay, blotched with lime and flecked with alkali. The lower soil depths are calcareous structureless silty clays. The surface soils effervesce weakly with acid along drainage courses.

Topography and vegetation.—The Marias silty clay loams cover approximately one square mile in the bottom of the preglacial valley of Belt Creek around Waltham. The land is classified as farming land and in 1925, 77 per cent of the total area was in crops. The surface acre-foot contains over 5000 pounds of nitrogen and fair amounts of lime and phosphorus. The yields of spring wheat on summer-fallowed land are high. Western wheat grass forms the principal cover on the silty clay loams. The carrying capacity of the heavy loams is about the same as that of the Marias clay loams.

LLOYD GRAVELLY LOAMS

Description.—The surface 1 inch of the Lloyd gravelly loams is a loose sandy mulch. The humus-bearing layer is a friable columnar-structured dark-brown gravelly loam, averaging 6 to 8 inches thick.

The columnar-structured gravelly subsurface layer has a reddish cast and is rather compact. The carbonate zone below 24 inches is a grayish-brown structureless gravelly silt loam, grading into semicemented sands and gravels at 40 inches. Loose red quartzite sand and gravel underlie the cemented hardpan for 10 to 15 feet.

Topography and utilization.—Lloyd gravelly loams cover 3 square miles on the high gravel-capped benches along Arrow Creek. The benches are cut into irregular tracts by deep coulees and their borders are badly indented. The land is classified as non-tillable grazing land on the land classification map. The tillable land on the benches was well under cultivation in 1925, and devoted chiefly to the production of spring wheat. The surface acre-foot contains 4000 to 5000 pounds of nitrogen. The phosphorous and lime content average lower than in the soils developed over drift. The yields of spring wheat on the Lloyd gravelly loams are good.

Vegetation.—Grama grass and its associated species form the principal cover on the Lloyd gravelly loams. The live stock carrying capacity is between 20 and 25 acres per head.

LEROY STONY LOAMS

Description.—The surface 7 inches of the LeRoy stony loams is friable and dark brown. The reddish-brown columnar-structured subsurface layer is rather compact on the bench south of Highwood. The carbonate zone below 18 to 20 inches is a compact grayish-brown silt loam, grading into more friable reddish-brown silty material with depth. Rock and rock fragments are distributed through all layers and become more abundant with depth. The soils on the bench south of Shonkin grade into sandy loams and gravelly loams, and their gravelly subsoils are locally stratified. The benches on the northern slopes of the Highwood Mountains have been lightly glaciated and a few boulders occur on the surface.

Topography and tillable area.—LeRoy stony loams occur on the breccia-capped benches often covered with colluvial wash on the slopes of the Highwood Mountains. The stony loams cover 16 square miles, of which 11 square miles are classified as farming land and the remainder as non-tillable grazing land.

Utilization.—The LeRoy stony loams were taken up by the early stockmen largely as winter grazing lands. During the dry-land movement the less stony phases were placed under cultivation. In 1925, 13 per cent of the total area was being cropped. The improved land

was found chiefly on the benches north of the Highwood Mountains. Fall wheat was the most important crop up to about 1915, after which winterkilling discouraged its use and spring wheat has taken its place. Other small grains are grown largely for forage. The surface acre-foot contains over 5000 pounds of nitrogen and is well supplied with lime and phosphorus. The yields of spring wheat on summer-fallowed land often average between 20 and 30 bushels per acre.

Vegetation.—The vegetation on the LeRoy stony loams consists of the short grasses at the lower, and the tall grasses at the higher elevations. The live stock carrying capacity of the stony loams averages 15 to 20 acres per head.

BLAINE STONY LOAMS

Description.—The Blaine stony loams, such as are found in the Highwood Mountains around Square and Round buttes, have a shallow dark-colored organic mulch on the surface. The humus-bearing layer is a dark-brown, almost black, friable stony loam averaging 5 inches thick. The faintly columnar-structured stony subsurface layer ranges from a reddish-brown silt loam in the upper part to a compact heavier-textured brown silt loam at greater depths. The carbonate zone below 19 inches is a structureless grayish-brown silt to silty clay stony loam grading into dull-brown more friable stony silty material or into yellowish brown residual material, derived from the sedimentary sandstones underlying the stony colluvial wash on the slopes of the mountains. The soils mapped as Blaine stony loams in the basin along Highwood Creek include both stony loams and stony silt loams, subsoils of which are often flecked with white ashy non-effervescing material. The soils above Shonkin Creek are modified with residual material, derived from the yellowish sandstones outcropping in the more broken sections

The Blaine stony loams on the southern slopes of the Bear Paw Mountains have developed largely over hard sandstone and shales. These soils have a shallow dark-colored mulch on the surface, and the humus-bearing layer, averaging 4 to 5 inches thick, is dark reddish brown. The subsurface layer is a yellowish-brown compact sandy loam. The carbonate zone below 16 inches is grayish-brown structureless compact stony sandy loam, grading into lighter-textured stony material or into residual material derived from the sedimentary sandstones. Dark-colored shales outcrop below the sandstones at the lower

elevations and the soils in the lower basins are often dark-colored alkaline silts and silty clay loams.

Topography and utilization.—Blaine stony loams cover the broken slopes of the Bear Paw and Highwood mountains above the glaciated area. The stony loams include 242 square miles, of which 184 square miles are too broken for cultivation. On the land classification map, 12 square miles are classified as farming land and the remainder as non-tillable grazing land.

The Blaine stony loams are among the better grazing types in north-central Montana. In 1925, 11 per cent of the area suitable for farming was under cultivation. The cropped acreage was found largely on the Belt-Highwood divide and in the basins along Shonkin and Highwood creeks. Fall wheat was the principal crop grown. Small grains, such as oats, are grown chiefly for forage. The irrigated tracts along the perennial streams are devoted chiefly to forage crops, such as alfalfa, clover, and timothy. The surface acre-foot contains over 6000 pounds of nitrogen and a fair amount of phosphorus, while the lime content is often low. The growing season is rather short in the high mountain basins but the yields of forage crops are good.

Vegetation.—A mountainous type of vegetation covers the Blaine stony loams. The tall grass and shrubs are not considered as nutritious as the short grasses, but make a palatable feed for sheep and goats during the summer months. The stony loams are covered with snow for several months in the year.

BELKNAP LOAMS

Description.—The surface 4 to 6 inches of the Belknap loams is a dark reddish-brown friable loam to sandy loam, overlain with a shallow dark-colored organic mulch. The structureless reddish-brown subsurface layer is a rather compact heavier-textured loam. The carbonate zone below 30 inches is a grayish-brown gritty silty clay loam, grading into residual material, having the color, structure, and texture of the parent hard red sandstones and shales. Rock and rock fragments occur on the surface and in the surface soils but are not abundant in the lower soil depths.

Topography and vegetation.—Belknap loams occur as isolated tracts in the Bear Paw Mountains. They cover 7 square miles, of which 5 are too broken for cultivation. On the land classification map the loams are classified as non-tillable grazing lands. Along Little Birch Creek a small acreage is devoted to clover and timothy. The

loams have a tall grass and shrub cover and are used for grazing during the summer months.

BOX ELDER LOAMS

Description.—Box Elder loams include a group of undifferentiated alkaline soils in the preglacial valley of Missouri River. The more barren phases have a bad-land basin character. The shrub-covered phases have a loose granular light-gray silty mulch on the surface, averaging 1 to 2 inches deep. Below the mulch the soils are light olive-brown compact plastic clays and silty clays, grading into stratified dark olive-brown clays at 15 to 20 inches. The soils effervesce weakly with acid at the surface and also in the lower depths.

Topography and vegetation.—Box Elder loams cover several alkaline flats below the Hill County line in the preglacial valley of Missouri River. The flats cover approximately one square mile and are classified as non-tillable grazing land. The vegetation on the Box Elder loams consists chiefly of shrubs such as greasewood, adapted to alkaline conditions. The carrying capacity for live stock is low.

CHEYENNE GRAVELLY LOAMS

Description.—Cheyenne gravelly loams have a loose shallow light grayish-brown sandy gravelly mulch on the surface. The humus-bearing layer is a friable brown sandy loam to sandy gravelly loam averaging 7 to 9 inches thick. The subsurface layer has a faintly columnar structure and is usually compact. The carbonate zone below 15 to 24 inches is a structureless gravelly sandy loam, grading into loose stratified yellowish sands and gravels. The amount of gravel in the different layers and on the different tracts is quite variable.

Topography and vegetation.—Cheyenne gravelly loams occur on the isolated terraces in the upper part of the preglacial valley of Missouri River. The gravelly loams cover 5 square miles, all of which is classified as grazing forage land. The Cheyenne gravelly loams were placed under cultivation during the dry-land movement, but the soils proved poorly adapted to farming and have been largely abandoned. The surface acre-foot averages rather low in the plant food elements. Grama grass and nigger wool form the principal cover. The live stock carrying capacity of the gravelly loams is between 30 and 35 acres per head.

ORMAN CLAY LOAMS

Description.—Orman clay loams in Chouteau County include a group of soils ranging in texture from silt to silty clay loams. The

surface 1 to 2 inches of the clay loams on the low terraces around Verona is a shallow silty fine sandy mulch. The humus-bearing layer is a brown friable silty to silty clay loam averaging 4 inches thick. The subsurface layer has a columnar structure and is fairly compact. The carbonate zone below 12 inches is a grayish-brown silty clay loam grading into stratified sands and silty clays with depth. Alkali usually flecks the lower soil depths. The surface soils of the Orman clay loams on the low bench east of Big Sandy are rather gravelly silt loams, and the humus-bearing layers average 5 to 6 inches thick. The carbonate zone lies within 8 to 12 inches of the surface.

The heavier and more alkaline phases of the Orman clay loams are found in the bottom of Shonkin Sag. The surface 3 inches is a granular dark-brown cloddy silty clay loam, grading into stratified olive-brown clays. Below 30 inches the stratified clays are blotched with lime and flecked with alkali. The barren colluvial wash below the shaly breaks has the character of a bad-land basin.

Topography and vegetation.—The Orman clay loams occur on low terraces and in shallow depressions in the preglacial valley of Missouri River above the flood plains of Big Sandy Creek and in the bottom of Shonkin Sag. The clay loams cover 21 square miles, all of which is classified as grazing forage land, except for 5 square miles located in Shonkin Sag and classified as non-tillable grazing land. In 1925, 10 per cent of the area was under cultivation. The cropped land was found largely on the low gravelly terraces east of Big Sandy. The surface acre-foot contains a fair amount of plant food, but the soils are rather retractive for dry-land farming, hence are used chiefly for grazing. Grama grass and western wheat grass form the principal cover. Between 30 and 35 acres would carry a steer through a grazing period of ten to twelve months.

LAUREL LOAMS

Description.—The surface 6 to 8 inches of the Laurel loams in the preglacial valley of Missouri River is a light-gray calcareous cloddy silt to silty clay loam, grading into stratified calcareous olive-brown clays and yellowish sands. Sandy loams and silt loams predominate along Big Sandy Creek in the area annually flooded, but usually grade into silt and silty clay loams within one-fourth mile of the stream. The heavier loams are quite alkaline and scabby. The surface soil of the irrigated tract south of Big Sandy is a silt to silty clay loam, underlain with yellowish stratified sands below 2 feet.

The soils predominating on the low terraces along Teton River are loams and sandy gravelly loams. The colluvial wash below the breaks of the stream ranges from loams to barren alkali silty clays, depending upon the character of the wash from the breaks. The bottoms of the Missouri and Marias rivers are covered largely with wash from the rugged breaks and bad lands. The soils developed over the colluvial wash derived from the Colorado and Clagget shales consist chiefly of barren alkali silty clays and clays, while those developed over wash from the Eagle sandstones are gray calcareous loams and sandy loams. The sandy loams have a faint humus-bearing layer averaging 3 inches thick. Around Kabo the heavy loams have a fair grass cover. The sage-covered terraces along the streams are chiefly gravelly sandy loams. Barren alkali silty clays predominate in the valley of Arrow Creek and deep dark-colored clay loams in the depressions along Flat Creek. The flood plains of the larger perennial streams on the slopes of the mountains are dark-colored stony loams and gravelly loams which are usually low in alkali. The poorly drained alkaline bottoms of the larger upland coulees in the glaciated sections are gravelly loams and sandy loams, unless the streams have eroded their beds into sedimentary sandstones and shales. The soils covering the bottom of glacial lake beds are gray calcareous silty clays, often underlain with yellowish stratified sands in the central part of the county and by olive-brown stratified clays in other parts.

Topography and tillable area.—The Laurel loams have a low terraced relief in most of the stream valleys. In the valleys of the Missouri and Marias rivers the gullied colluvial wash is cut into irregular tracts by the meandering of the streams. In the Teton River valley low terraces lie below the less broken breaks, and west of Big Sandy Creek a few glacial hummocks rise above the flood plains. Laurel loams cover 122 square miles, of which 67 square miles are classified as grazing forage land and the remainder as non-tillable grazing land.

Utilization.—Laurel loams are not cultivated except where the land is subirrigated or where water is available for irrigation. Some of the heavy bottoms are valuable hay land, where they are annually flooded. In 1925, 10 per cent of the Laurel loams was under cultivation. The improved land was confined largely to irrigated tracts in the valleys of the Teton and Missouri rivers and Big Sandy and other perennial creeks heading in the mountains.

The silt and silty clay phases of the Laurel loams are rather retractive and several years are usually required to bring them to a fair state of productiveness. The soils are often alkaline and in need of drainage. The surface acre-foot contains a fair amount of nitrogen, phosphorus, and lime. The more important crops grown under irrigation are spring wheat, oats, barley, alfalfa, and such intensive crops as beans, potatoes, and sugar beets. The irrigated land on the slopes of the mountains is devoted largely to forage crops, such as alfalfa and the tame grasses. In 1925 the tract south of Big Sandy was a native blue-joint meadow.

Vegetation.—Grama grass and nigger wool form the chief cover on Laurel loams above the high-water mark in the valleys of the Teton, Missouri and Marias rivers. Western wheat grass predominates on the heavier loams, which are annually flooded. Black sage and greasewood occur on the heavier-textured colluvial slopes and salt grass in the more poorly drained alkaline sections. The valley of Arrow Creek is poorly covered with grass, while the depression along Flat Creek is well covered with western wheat grass. The flood plains of Big Sandy Creek below the Hill County line are strongly alkaline and approach a greasewood flat. Trees and large shrubs are confined largely to the less alkaline subirrigated land along the larger perennial streams. The live stock carrying capacity of the Laurel clay loams is low.

LAUREL CLAY LOAMS

Description.—The Laurel clay loams usually have a compact grayish crust on the surface, which checks into irregular squares. Below the crust the surface soil for 6 to 8 inches is a compact cloddy dark olive-brown silty clay to clay, grading into olive-brown stratified silts and silty clays with depth. Pockets of gray ashy alkaline material usually occur in the soils below 15 to 18 inches. The soils effervesce weakly with acid and often crack to a depth of 10 to 15 inches. The Laurel clay loams in the bottom of Shonkin Sag have a silty granular mulch on the surface and are non-calcareous dark-colored clays to a depth of 15 to 18 inches. The lower soil depths are blotched with lime and flecked with alkali.

Topography and utilization.—Laurel clay loams cover dark-colored heavy depressions in the valleys of streams and also cover glacial lake beds in the uplands. The clay loams cover 15 square miles which are classified chiefly as grazing forage land. The heavy loams are not under cultivation unless water is available for irriga-

tion. In 1925 only 7 per cent of the area was devoted to irrigated hay land. Although the soils contain a fair amount of plant food, they are too retractive for farming.

Vegetation.—The Laurel clay loams are poorly grassed unless the land is annually flooded. Western wheat grass grows well on flooded land, and squirreltail grass (*Hordeum jubatum*) thrives where the land is covered with water for several weeks in the spring. Black sage is the chief cover above the high-water mark. The clay loams have a low carrying capacity for live stock.

CHOUTEAU LOAMS

Description.—Chouteau loams include a group of dark-colored stony gravelly soils in the higher mountain basins along the larger perennial streams. At the higher elevations the soils are dark-colored stony loams without definite lime horizon, but at the lower elevations a carbonate zone is usually found at depths of 15 to 18 inches. The quantity of rock and gravel usually increases with depth.

The surface 6 inches of the Chouteau loams on the outwash plain of Cottonwood Creek is a dark-brown, almost black, friable stony silt loam, grading into a heavier-textured more compact brown subsurface layer. The grayish-brown silty clay carbonate zone below 18 inches is fairly well developed. Rock and rock fragments are abundant in all layers and increase in quantity with depth.

Topography and vegetation.—Chouteau loams are located in the bottoms of streams in the higher parts of the mountains and cover 10 square miles, of which 8 square miles are classified as non-tillable grazing land and the remainder as farming lands. In 1925, 15 per cent of the tillable area was under cultivation. The cropped land was devoted chiefly to forage crops, and was fairly well distributed along the larger streams. The small grains grown on the loams are harvested chiefly for hay. A mountainous type of vegetation covers the Chouteau loams, which have about the same carrying capacity for live stock as the Blaine stony loams.

BAD-LAND BASINS

Bad-land basins have a gray glazed silty crust on the surface below which the silty material is honeycombed or vascular-structured for an inch or more. The lower soil depths are stratified compact non-calcareous olive-brown silt and silty clays. Gray ashy alkaline material flecks the lower soil depths. Wide cracks penetrate the soils for 12 to 15 inches below the crust.

Bad-land basins cover small tracts in the bottom of Shonkin Sag and in the valley of Arrow Creek below the shaly breaks. The basins cover approximately one square mile, which is classified as non-tillable grazing land. The vegetation consists chiefly of black sage, greasewood, and salt sage. The last-named makes a fair range forage where it occurs in sufficient quantity and is located near water-holes. Bad-land basins are among the poorest grazing lands in the county.

BAD LANDS

Bad lands cover 92 square miles along Missouri and Marias rivers and along Arrow and Birch creeks. On the land classification map the land is classified as non-tillable grazing land. Bad lands have no agricultural value except for the grazing of stock. The gullied clay hills and ridges formed by the weathering of Colorado, Claggett, and Bear Paw shales are poorly grassed. Black sage, rabbit brush, greasewood, isolated plants of western wheat grass, and weeds make up most of the vegetable cover. Grama grass and nigger wool form the principal cover of the more gentle slopes of the sandstone breaks. The carrying capacity of bad lands for live stock is low.

ROUGH BROKEN LAND

Rough broken land covers 157 square miles in the Highwood and Bear Paw mountains. It consists chiefly of bald peaks, barren ridges, rocky ledges, and talus-covered slopes.

The soils developed above the aspen belt of 4500 feet in elevation have black, organic loamy surface soils averaging 6 inches deep in the Highwood Mountains. Between 6 and 14 inches deep the stony loamy material has a yellowish-brown color, grading into a more compact heavier-textured brown loam. Below 22 inches the material is a light-brown structureless silty stony loam grading into stony non-calcareous grayish silty material below 40 inches. In the Bear Paw Mountains the subsoils are often reddish-brown silty to silty clay loams with carbonate zones below 30 inches.

Fair stands of lodge-pole pine are found on the higher mountain slopes, and willows and aspen in the more moist gulches and basins. Sedges predominate over the grasses in the open parks. The undergrowth consists chiefly of shrubs. Rough broken land has a low carrying capacity for cattle, but is fair for sheep and goats during the time the area is open for grazing.

SAND DUNES

Sand dunes cover a few square miles above Missouri River west of Little Sandy Creek. The tall grasses, adapted to drought conditions, form a fair cover on the dunes. The live stock carrying capacity is low.

THE AGRICULTURE OF CHOUTEAU COUNTY

Stock raising was the chief industry in Chouteau County before the settlement of the public range land under the dry-land movement which began about 1910. The breaking of the prairies and the acquisition of land were the more noticeable features between 1910 and 1917. Crop yields were good and land values increased rapidly. This part of the State experienced a severe drought between 1917 and 1921, which greatly reduced the cropped acreage, and the marginal farm lands in the central, north-central, and western part of the county were largely abandoned. Land values were greatly deflated after the drought and a large acreage passed into the hands of mortgage holding companies. In 1925, 59 per cent of all the farm lands in the county carried a mortgage indebtedness of $7.14 per acre on land valued at $11.30 per acre. The conditions in the county have greatly improved during the past few years and land values are becoming more firmly established.

The following data taken from the United States census reports indicate the trend of agriculture in the county since the time of the drought. In 1920, 56 per cent of the total area of the county was in farms, as against 46.2 per cent in 1925. During this period the number of farms decreased from 2573 to 1649, and the average size of the farms increased from 586.4 acres to 712.3 acres. The percentage of tenancy increased from 7.5 to 25.5. The total area of cultivated land in 1925 was 411,661 acres, of which 137,388 acres were either idle or summer fallowed. The agricultural income of Chouteau County was derived from the sale of products grown on the dry-land farms and from live stock. During the past few years the income from small grains, such as spring wheat, has been somewhat greater than that from live stock.

LIVE STOCK PRODUCTION

Stock raising was taken up in Chouteau County during the early eighties. Harris and Blankenbaker were among the first stockmen to run their herds in the Highwood Mountains, and Ed Richel in the

Teton section. The firm of McNamara and Marlow did not engage in stock raising until after the Blackfoot Indian Reservation was opened for settlement and the Bear Paw Mountains became available for grazing. In the early days stock were run at large on the open range without winter protection, but since the settlement of the range most stockmen provide a month or more of winter feed, consisting chiefly of alfalfa, native grass, and small-grain hay. On the dry-land farms the winter grazing lands are usually supplemented with straw and the native grass hays. The winters in this part of the State are usually open, with light snowfall, and often stock are carried through the season without supplementary feeds. The beef breeds, such as the Hereford and Shorthorn or their crosses, make up most of the stock found on the ranges. In 1920 the number of cattle in the county was 26,466, and in 1925 there were 37,606 head. The census report for 1925 shows 3745 head of dairy stock, of which probably more than one-third were the beef breeds used for milking purposes.

Sheep were brought into the county at an early date but did not compete with cattle until along in the nineties. Sheep are grazed chiefly in the poorer agricultural sections, such as are found in the central and northwestern parts of the county. Water-holes are not numerous in some sections and the bands are trailed from one grazing area to another as the holes dry up during the summer months. The fine wool breeds, such as the Rambouillet, or their crosses are usually found on the range. During the five-year period between 1920 and 1925 the number of sheep in Chouteau County decreased from 48,450 to 39,735.

The character of the range was somewhat better adapted to the grazing of sheep and cattle than of horses, and horse raising was never very popular in Chouteau County. During recent years the small tractor has reduced the number of horses maintained on the large grain farms. Between 1920 and 1925 the number of horses declined from 23,243 to 16,027, of which 1312 were less than two years old in 1925. The swine industry has shown a steady growth since the time of the drought. In 1920 the total number of hogs in the county was 3246 and in 1925 there were 5234 head, of which 1138 were breeding sows over six months of age. The Duroc Jersey is the most popular breed.

DRY-LAND FARMING

The State Department of Agriculture places the total cropped area in Chouteau County for the four-year period, 1925 to 1928, at

approximately 270,560 acres, most of which is non-irrigated. The acreage and yields of the more important crops are presented in Table 4.

TABLE 4.—ACREAGE AND YIELD OF MORE IMPORTANT CROPS GROWN IN CHOUTEAU COUNTY

	1*1919		*1924		**1928		**Average 1922-1928	
	Acreage	Acre yields	Acreage	Acre yields	Acreage	Acre yields	Acreage	Acre yields
		Bu. or tons		Bu. or tons		Bu. or tons		Bu. or tons
Cropped land harvested	53,434	—	247,762	—	283,880	—	252,196	—
Fallowed land	—	—	137,388	—	—	—	—	—
Cropped land, total	—	—	411,661	—	—	—	—	—
Barley	—	—	366	11.9	2,400	26.0	1,585	19.3
Beans	—	—	7	—	280	8.0	—	—
Corn, total	76	9.3	13,387	—	12,000	18.0	11,614	19.0
Corn harvested for grain	—	—	2,029	18.0	—	—	—	—
Corn cut for fodder and ensilage	—	—	5,764	—	—	—	—	—
Corn hogged off	—	—	5,594	—	—	—	—	—
Flax	26	3.2	239	4.2	700	10.1	400	6.5
Hay, tame	2,461	1.4	19,848	1.8	20,000	2.2	19,000	1.9
Hay, wild total	4,034	0.3	7,283	0.7	1,900	1.1	2,500	0.9
Hay, alfalfa	2,157	1.5	9,678	—	—	—	—	—
Hay, other legumes and grasses	304		3,596	—	—	—	—	—
Hay, small grains cut for hay	6,446	0.2	6,574	—	—	—	—	—
Oats	419	1.9	6,746	20.3	10,000	39.0	12,285	28.0
Potatoes	471	62.4	194	62.6	500	120.0	485	84.6
Sugar beets	—	—	—	—	80	80.0	—	—
Rye	203	1.5	655	7.4	10,000	12.0	5,828	11.5
Wheat, total	47,714	2.4	197,144	—	—	—	—	—
Wheat, fall	—	—	86,000	15.0	68,000	16.0	71,285	14.9
Wheat, spring	—	—	113,000	14.0	160,000	23.0	129,714	14.6

[1]Extremely dry year.
*United States census report.
**Montana Department of Agriculture reports.

The crops grown under the climatic conditions which prevail in north-central Montana are the early and medium early maturing varieties. The more important varieties of small grains grown on the dry-land farms are Marquis wheat, N. D. R. No. 114 flax, Markton and Sixty Day oats, Horn barley, and Rosen rye. Winter grains, except fall rye, winterkill too frequently in the plains to be depended upon; but Karmont and Newturk winter wheats are grown successfully on the benches around the Highwood and Bear Paw mountains. In normal seasons corn, such as Northwestern Dent and the flints. matures for grain and fodder at the lower elevations. Spring wheat

is the most important crop, and in 1927 the area seeded to it amounted to 150,000 acres. Flax is a profitable crop on new breaking but on old land the yields are rather low. More than one-half of the total area devoted to oats and barley is harvested for hay. The acreage of corn harvested for grain is small, as most of it is cut for fodder or is pastured off in the field by swine and sheep. The average yields of small grains shown in Table 4 are comparatively low, but with the low cost of production secured on the large grain farms the yields are sufficient for fair returns.

Land utilization is one of the more important problems in Chouteau County at the present time. A large acreage of the original homestead tracts is held by non-resident owners, and is under short-time leases for grazing and farming. However, since the time of the drought, the farming and grazing lands have been slowly consolidated into farms of one section or more and ranches of from five to ten sections. On the large grain farms the efficient use of tractors and big-team outfits has characterized the growing of wheat, and small combines are replacing the headers and binders. On many farms from 200 to 600 acres are cropped annually. Spring wheat and other small grains are usually grown until the land becomes foul with weeds when a clean summer fallow is introduced every second or third year. Exclusive grain growing is not considered a permanent system of farming, but where clean fallow is introduced every second or third year grain can probably be grown for several generations without a noticeable decline in yields due to decreased soil fertility.

The plains of Chouteau County are subject to strong winds, especially in the early spring, hence soil drifting may become a serious problem as the root fiber is destroyed by cultivation. Various tillage implements have been employed with varying success to check soil drifting. Duck-foot cultivators and similar implements, which reduce the cost of production and are fairly efficient in controlling soil drifting, are commonly used on the large grain farms in preparing the land for spring seeding and in cultivating the summer-fallowed fields.

On the more diversified farms, corn replaces summer fallow to some extent and a greater acreage is devoted to forage crops, such as sweet clover and brome grass. The income from these farms is derived largely from the sale of grain, live stock, poultry, and dairy products. Small herds of cattle and occasionally a band of sheep are often found on the smaller farms, especially in localities where grazing land is available.

The forage and hay crops consist chiefly of alfalfa, sweet clover, brome grass, and the native grasses. The tame grasses and legumes produce a low average yield and do not cover a large acreage in the plains of Chouteau County. Satisfactory stands of these grasses and legumes are also difficult to obtain in average seasons. Most of the tame hay is grown in the valley around the mountains.

The yields of potatoes and other root crops are rather low under dry-land conditions and only a sufficient quantity is produced for home consumption. During the past few years a small acreage of potatoes has been grown for seed with fair success. Gardens and small fruiting shrubs are usually located in protected nooks where the snow accumulates during the winter months or in depressions which are flooded during the spring run-off.

Slick spots are rather common on the soils composing the Joplin, Scobey, and Phillips series, especially at the heads of drainage basins. These spots usually show in grain fields after several years of cultivation. Where more than 30 per cent of the Phillips loams consists of slick spots, the land is devoted chiefly to the grazing of stock. The reclamation of the scab lands by the use of green and barnyard manures is prohibitive at present land values.

Variations in yields of small grains in different parts of the county are usually attributed to low rainfall and poor farming. The yields of small grains are greatly influenced by the amount and distribution of the rainfall and by the cropping and tillage methods but a closer study of crop yields and cultural methods on the different soil types may show that differences in fertility produce results which are now attributed to other causes.

IRRIGATION FARMING

Irrigation has been practiced in the valleys of the larger streams in Chouteau County for a number of years. Many of the projects depend upon the direct flow of the streams, and in dry seasons water for irrigation may be short. During the dry years storage reservoirs and diversion dams were constructed in the larger coulees for the irrigation of small tracts but most of them have been abandoned. Many of the smaller irrigation projects are not assessed as irrigated land because of the limited and uncertain water supply.

There are approximately 4000 acres of land under irrigation in Chouteau County. The older projects in the valleys of Shonkin and Highwood creeks cover between 1500 and 2000 acres. In the Missouri

River valley several electrical pumping plants supply water for approximately 1000 acres at the present time. It is estimated that between 10,000 and 15,000 acres may be irrigated in the valley of Missouri River with a lift of less than 30 feet. The waters of Teton River are appropriated in Teton County and only a small portion of the normal flow is available for irrigation in Chouteau County. Several small gravity and pumping projects covering a few hundred acres are located on the low benches along the stream. South of Big Sandy 1000 acres or more of hay land are irrigated with flood waters of Big Sandy Creek. Small irrigated tracts are also found along Eagle, Birch, and other creeks. The valley of Marias River is cut into such small, irregular tracts by the meandering of the stream that it is impossible to irrigate a large acreage. Storage reservoirs and diversion weirs are found in the bottoms of the upland streams in different parts of the county.

Several projects have been proposed to irrigate a large upland acreage in Chouteau County. The Marias River Irrigation Project contemplates the reclamation of 75,000 acres in the north-central part of the county. The proposed reservoir and dam site are located on Marias River near Brinkman in Hill County with Lonesome Lake providing additional storage. The feasibility of the project depends largely upon the available water supply. In Chouteau County most of the land lies in the Lonesome Prairie area, covered with the undulating Scobey loams and sandy loams. The soils are well adapted to the cereal and forage crops grown under irrigation in north-central Montana. The location of the proposed project is shown on the land classification map. Another project proposes that water be diverted from Sun River for storage in Benton Lake in Cascade County, to irrigate 100,000 acres on the Teton divide west of Carter.

The land in Chouteau County which is now irrigated is located chiefly in the bottoms of the larger streams, covered with the Laurel loams and clay loams and Chouteau loams. The Laurel loams and clay loams are rather retractive, contain more or less alkali, and are often in need of drainage. The alkali occurs largely in the form known as while alkali. The irrigated lands are devoted chiefly to pasture and hay crops, such as alfalfa and native blue-joint, although in the valleys of the Teton and Missouri rivers a small acreage is devoted to small grains and root crops. The small grains grown below the ditch are largely the medium late maturing varieties. Sugar beets have been

grown with fair success on the lighter soils during the past few years. Beans and other intensive crops are also grown. Dairying is practiced on a few of the irrigated farms to supply local demands.

WATER AND FUEL RESOURCES

The agricultural development of the farm lands of Montana depends upon an adequate supply of water and fuel for domestic use. The quality of water found in the drift and in the geological formations underlying the drift varies greatly in Chouteau County. The Kootenai formation, characterized by its reddish sandstones and shales outcropping in the breaks of Belt Creek and Missouri River in the southwestern part of the county, is the source of a fair quality of water for domestic use. In Cascade County it is one of the more important coal-bearing formations. The Judith River sandstones, which outcrop on the western slopes of the Bear Paw Mountains and underlie the drift in the Lonesome Prairie section, extend southeast to Missouri River east of the preglacial valley of Judith River. These sandstones contain a good quality of water for domestic use. The coal fields east of Big Sandy are in this formation. The sandstones of the Eagle formation underlie the drift in a narrow belt east of the Colorado shales and extend southeast along Missouri River. These sandstones supply a fair quality of water and a few workable beds of coal in the central part of the county. An excellent quality of water is found in the mountains and on the gravel-capped benches along Arrow Creek.

The massive rusty-colored shales of the Colorado formation underlying the drift and stream deposits west of a line drawn diagonally a few miles east of Marias River to Square Butte are often destitute of water. Such water as is obtained from the shaly sandstones of this formation is generally alkaline and unfit for domestic use. The dark-colored shales of the Claggett formation occur below the drift in a broad belt extending southeast from the north-central part of the county to Arrow Creek as far east as Kabo. The water from these alkaline shales is often unfit for domestic use. The Bear Paw shales outcrop chiefly south of the Bear Paw Mountains above the Judith River sandstones. The water from this formation is also unfit for domestic purposes. The chief sources of water in the area underlain with the Colorado, Clagget, and Bear Paw formations are from the deeper deposits of drift and from surface run-off impounded in small reservoirs.

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