Issued December 21, 1908.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL SURVEY OF THE MINIDOKA AREA, IDAHO.

BY

A. T. STRAHORN AND C. W. MANN.

[Advance Sheets—Field Operations of the Bureau of Soils, 1907.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1908.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., July 17, 1908.

SIR: In compliance with urgent requests from citizens of southern Idaho, which requests were indorsed by the Hon. W. B. Heyburn, a soil survey was made of the Minidoka area. This area comprised lands lying within one of the Federal reclamation projects and the work was done in cooperation with the U. S. Reclamation Service. As this part of the State is comparatively new to agriculture, the map and accompanying recommendations should have an added value to the settlers.

I submit herewith the report and map covering this survey for publication as advance sheets of Field Operations, 1907, as authorized by law.

Very respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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SOIL SURVEY OF THE MINIDOKA AREA, IDAHO.

By A. T. STRAHORN and C. W. MANN.

DESCRIPTION OF THE AREA.

The Minidoka area is situated in the south-central part of a great stretch of country known as the "Snake River Plains" or the "Snake River Desert." It comprises about 146 square miles lying along the Snake River in the southeastern part of Lincoln County and in the northern part of Cassia County. In shape it is roughly rectangular and is included within Rs. 22, 23, 24, and 25 E., and Tps. 8, 9, and 10 S.

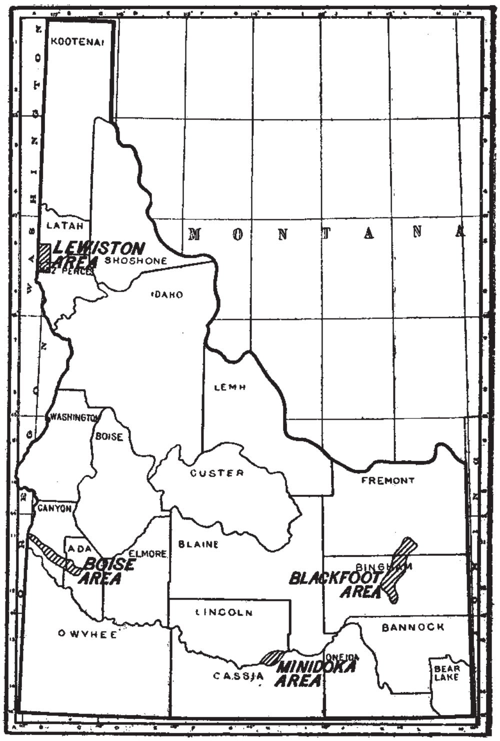

FIG. 1.—Sketch map showing location of the Minidoka area, Idaho.

The Snake River enters the area at the northeastern corner, and flows in a general southwesterly course, leaving the area at the southwestern corner. Nearly all of the area is located on the north side of the river. The small portion, about 12 square miles in extent, on the south side, occurs as a long, narrow body between the Southside Canal and the stream.

The northern and western boundaries are determined by an abrupt rise of lava rock above the surface. On the south and east the Southside Canal and the course of Snake River determine the limits of the area.

North of the river the surface is without any striking topographic features, except a few high sand dunes in the northeast and the high bench along the northern and western sides. Aside from a shallow,

poorly defined drainage course running through the central portion of the area, there is absolutely no system of surface drainage north of the river. The appearance of this portion is that of a rolling plain, with rounded knolls of wind-blown sand along the river, and occasional outcrops of black lava rock. At first sight the land south of the river presents the same appearance as the northern portion, but it differs in that there is a fair slope from the line of the canal toward the river, and at intervals there are more or less well-defined courses, which usually afford ample drainage.

The early immigrant trail across this section of the West ran from the town of Albion, near the southern State line, to Boise. Albion is about 25 miles southeast of Rupert, and is said to have been the first settlement in Idaho east of Boise. After the construction of the Central Pacific from Ogden westward cattlemen began driving their herds northward, and ranged them over this part of the State. After the construction of the Utah and Northern (now the Oregon Short Line) from Ogden to Butte more cattlemen came in, and a few ranch houses were built along the banks of Snake River. These, however, were few and far between, and until four years ago there were but three buildings within the area embraced by the Minidoka Project.

Shortly after the construction of the irrigation system started settlers began to move into the area in greater numbers, and three villages soon sprang up. From north to south these villages were Acequia (formerly Sherrer), Rupert, and Heyburn. Across from Heyburn, south of the river, is the town of Burley, on patented land, and promoted by a private corporation. Rupert, which is at present the largest town in the area, and located near the center of the project, is the headquarters of the Reclamation Service. Acequia and Heyburn are smaller villages, the former being near the northern boundary and the latter near the southern boundary of the project.

A branch of the Oregon Short Line, known as the Minidoka and Southwestern Railroad, was built across the area in 1904, in a southwesterly direction, passing through the three towns mentioned. This branch connects with the main line of the Oregon Short Line at Minidoka, and furnishes a ready outlet for the produce shipped. With the present railroad connections it is likely that the principal markets will be in the northeastern part of the State and in Montana and Wyoming. Should fruit prove well adapted to this section the markets farther east doubtless will be reached.

Wagon roads are either open or projected along each section line. So far no care has been given them except the removal of sagebrush. Where the soil is heavy and packs well the roads are in good condition, but on the lighter soils the material is loose and traveling is slow.

Although there are many substantial dwellings and barns on the farm units, there are many which are very crude and poorly built. These, however, are for temporary use, and in a few years will be replaced by better structures. Nearly all of the farms are well fenced.

CLIMATE.

The climate of this section of the State is arid and is characterized by a low annual precipitation, cold winters, hot summers, and a high percentage of cloudless days. The records of temperature and precipitation are very meager. The winters as a rule are open; in some years no snow falls before the latter part of December. In very exceptional years the thermometer may go as low as 25° below zero, but usually the minimum winter temperature is but little below zero. "Chinook" winds are frequent during the winter season.

The average annual temperature of several points along Snake River is as follows: Boise 50.4°, Pocatello, 46.9°, Blackfoot, 45.5°, Twin Falls, 48°, and American Falls, 46° F. Owing to the short time in which records have been kept, the average dates of frosts can not be exactly stated, but it seems probable that the date of the last frost in the spring is about May 1 and the first in the fall about the last of September. In the present year (1907) the first frost to affect crops occurred September 20.

Maximum temperatures of 105° in summer have been reported, but the usual summer heat is much less. The low humidity of the air tempers the extremes of temperature, and renders the climate endurable at all times.

The season of precipitation along Snake River covers the period of late winter and spring, rain usually falling until the 1st of June or a little later. With the exception of a short rainy period about the middle of November, very little rain falls except in the winter and spring months; such rains as do occur are light showers hardly sufficient to lay the dust. The annual precipitation at the different points along Snake River varies from 8 to 17 inches, and from the data at hand it seems likely that the average annual precipitation is about 12 inches.

The prevailing direction of the wind is from the southwest. Winds of sufficient violence to damage crops are rare. During the hot summer days dust storms sometimes occur, and electrical storms are frequent along the mountain ranges a few miles to the south, but rarely sweep across the area.

The data given below are taken from the records of the Weather Bureau stations at the towns named:

Normal monthly and annual temperature and precipitation.

Month.	American Falls.		Milner.		Minidoka Dam.[a]	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	°*F.*	*Inches.*	°*F.*	*Inches.*	°*F.*	*Inches.*
January	25.4	1.15	28.5	0.91	24.7	1.26
February	26.4	1.22	31.6	1.22	29.4	1.23
March	35.1	1.66	38.7	1.62	31.2	2.13
April	45.4	1.35	47.5	0.77	48.2	1.07
May	53.4	1.56	55.9	0.74	54.4	1.50
June	61.8	0.66	61.9	0.97	59.8	1.62
July	69.7	0.52	73.0	0.07	74.0	0.22
August	69.3	0.43	71.9	0.32	71.0	0.94
September	58.2	0.64	63.5	0.16	62.5	0.06
October	47.1	0.89	47.4	0.22	50.0	0.17
November	35.3	1.26	37.2	0.71		
December	25.3	0.61	28.2	1.12		
Year	46.0	11.95	48.8	8.83		

[a] The figures given for Minidoka Dam represent the temperature and precipitation for the year 1906 without departures from the normal.

AGRICULTURE.

The area surveyed occupies, as has been stated, a vast, rolling, treeless plain covered with a dense growth of sagebrush and rabbit brush, being part of what is known as the Snake River Desert. This stretch of rolling country is broken at intervals by benches and outcrops of black lava rock, which sometimes form a series of huge steps from one level of the plain to another. This apparently barren country held no attractions for the early adventurers or prospectors, and they passed it by for the more promising country to the west. Consequently, with the exception of the few ranches previously mentioned, no settlement was made in the area until the withdrawal of land by the United States Reclamation Service for the construction of the irrigation system.

Soon after the beginning of this work settlers moved in and took up the land under the project. As the land was densely covered with bushes and rain was often insufficient for crop production, it was a disheartening struggle for the settler to hold on until he could get water, and many abandoned the undertaking and moved to other sections. Many of the settlers, however, were better equipped and were able to clear their land and prepare it for irrigation.

It was the intention to have the irrigation system completed in April, 1907, but, owing to delays of one kind and another, water was not delivered until the early summer, when a sufficient quantity for

nearly 1,000 of the 1,208 farm units in the project was rendered available. Although a large number of the farm units had been filed on and occupied for at least two years, few more than 500 were prepared to receive the water, and owing to the location of some of these it was possible to deliver water to only 475. These, however, received an abundant supply.

On account of the lateness in the season when water was received, the generally poor condition of the ground, and the lack of knowledge of methods of irrigation by the farmers, the crop yields this season have been very low and are not regarded as a measure of the productiveness of the soil. According to acreage, the crops planted this season rank about as follows: Oats, wheat, barley, potatoes, alfalfa, and corn. At the time of writing this report (November, 1907) very little harvesting had been done, so that figures which will accurately represent the average yields obtained this year can not be stated. It would seem from the oats which have been thrashed that about 30 bushels per acre would be the average for this crop. Much of the crop, however, was not thrashed, but cut for winter feed. The yield of alfalfa was very small, as the crop was only seeded last spring and a light cutting obtained this fall. No estimates can be formed as yet for the yields of wheat, but a very large proportion of this grain, like oats, will be used for winter feed. Little of the corn reached maturity on account of the early frost. Of all crops grown this year, potatoes have made the best showing, and it would seem that a large proportion of this area is well adapted to their production. Not very much of the crop has been harvested yet, but yields of 150 to 200 bushels per acre are reported.

Judging from the growth and yields made even under the adverse conditions, it would seem that the soils of this area will prove well adapted to the growing of the crops mentioned. It will probably be found, however, that the profitable production of corn in this area will be somewhat difficult, not on account of soil conditions, but because cool nights and frosts will injure the plant before it matures. In view of this fact corn should be planted as early as possible and the varieties confined to those that mature early. It is believed, with good reason, that this area will prove well adapted to a wide variety of fruits. Many of the settlers have set out small orchards and some small fruits, all of which have made a healthy growth during the last season.

On the lighter soils of the area it will probably not be necessary to irrigate much before the 1st of June, while on the heavier soils crops will probably not require water until a somewhat later date.

The limited size of the farms (40 and 80 acres) will eliminate, as far as it is possible to do so, the necessity of hiring farm labor. It is thought that, except for hiring thrashing crews in the fall, the need

of additional labor will be met by the exchange of work by neighboring farmers.

The entire acreage within the Minidoka Project, except the usual sections of school lands and about 300 acres of patented land, is held by individuals under the homestead and reclamation laws. All of the land within a radius of 1½ miles of the various town sites has been divided into 40-acre farm units. Outside of these boundaries the size of the farms has been made 80 acres, although along correction lines the farms may contain a little more or less than that figure.

At present the agricultural methods differ with the individual farmer, but as soon as a better knowledge of soil, crop, and climatic requirements becomes general more uniform methods of cultivation will prevail.

SOILS.

The underlying geological formation of the Minidoka area is lava rock composed of three or four strata, sometimes outcropping at the surface in the form of ledges, but more frequently found at depths ranging from 15 to 100 feet.

Above this lava bed is found a thick mantle of coarse black sand which extends upward to within 5 or 6 feet of the surface. This sand has been deposited by water action over the lava beds, being an alluvial deposit from the river at a former time. The material overlying this stratum is much finer in texture, and is of varying depth. It doubtless was also deposited by the agency of water at a later date.

To the wearing away of the immense lava beds a large proportion of the subsoils of the area owe their formation. To some extent this process has also contributed to the formation of the soils, in which, however, material derived from a wide range of rocks along the upper courses of the Snake River is present.

In the soil mass above the lava bed rock, the distinct stratification of material, varying from gravel to fine sand and silt, leaves no doubt as to the method by which the soil material has been deposited.

Along a portion of Snake River and the lava ledges there is a considerable area of soil formed by aeolian agencies, which has been indicated on the map as Yakima sand.

In this area the most irregular topography is represented by the extent of Yakima sand, in which the surface varies from high rolling dunes, outcrops of ledges of lava rock, and marked depressions with no drainage outlets, to areas which are only slightly rolling.

The Yakima fine sandy loam, next to Yakima sand, presents the greatest irregularity of surface, but in the area occupied by this soil the differences in the elevations between the knolls and depressions is not so pronounced, and stretches of fairly level land occur within this type. The Yakima sandy loam and the Yakima loam represent the most level portions of the area surveyed, although the surface here

and there is somewhat uneven. Where protected by the native vegetation there is little or no movement of the surface soil, but where the sagebrush has been removed, and to some extent on the unprotected sand dunes, the soils are affected by wind movement. The effects may be seen in the sagebrush adjoining cleared lands, where the winds of a single season have formed miniature sand dunes around the clumps of bushes.

The types of soil within this area belong to a series which has been previously recognized in other western areas.

Below are given the names and the actual and relative extent of the several types of soil mapped in the area surveyed:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Yakima fine sandy loam	31,872	34.2	Yakima loam	12,736	13.6
Yakima sandy loam	29,760	31.9	Meadow	1,600	1.7
Yakima sand	17,344	18.6	Total	93,312	

YAKIMA SAND.

The Yakima sand consists of 40 inches to 6 feet of an incoherent yellowish or occasionally blackish sand, and in texture varies from a fine to a medium sand. When the type does not extend uniformly to a depth of 6 feet it is underlain by either a coarse black sand or by the lava bed rock. Along the northern edge of the area, and frequently just outside of it, the lava rock sometimes outcrops, and in places detached fragments of lava may be observed lying on the surface of the soil. Between the soil and the underlying black sand there is sometimes a thin layer of white compact material, usually a very fine sand. This, however, is not characteristic of the type.

On the north side of the river this soil extends in an almost unbroken body across the northern portion of the survey, and then along the north bank of the river southward for a distance of about 9 miles. Smaller detached areas occur along the course of the river, and at intervals throughout the survey. On the south side of the river the only considerable body of this soil lies above Montgomery's Ferry. Only a few detached areas are found on this side of the river.

The topography of the type is generally very irregular, consisting of numerous knolls or dunes of loose, shifting sand, frequently having an elevation of 20 feet above the more level portions of the type. The most level stretches lie south and east of Rupert. Along the river this soil terminates with an abrupt slope of 6 to 10 feet, which drops either to the water's edge or to low, small areas of overflowed land. The larger proportion of the type is above the water level of the present gravity irrigation canals, but will be irrigated at some future time by pumping.

The type has absolutely no surface drainage, but as the soil is loose and open in structure rain water passes readily through it, and even after unusually heavy storms finds its way to the depressions, where it soon passes below the surface.

This soil owes its origin to the sands of the bed of the Snake River, which are exposed during low water. The surface soil is made up of this material blown by the winds onto the adjacent lands, or carried for a considerable distance and deposited along the lava rim rock. The coarse black sand, lying below the wind-blown material, is an alluvial deposit from a former stream. The black color in this subsoil is due to the presence of considerable quantities of particles of black or dark-colored lava, and occasionally portions of the surface soil are slightly colored by fine particles of this same material.

No alkali occurs within the area covered by this type.

The areas of Yakima sand are entirely treeless, but are usually covered with a good growth of sagebrush and rabbit brush. The areas so covered are stationary, but probably receive slight additions of wind-blown material; where the surface is uncovered the soil is subject to the action of the wind and is being slowly shifted.

No average yields can be given for this soil, as but little of it was prepared for irrigation or received water during the past season. It will probably be found well adapted to the growing of alfalfa, root crops, and fruits. Small grain may prove profitable if abundant water is available.

On account of the loose, incoherent nature of the soil, it will, when cleared of the native vegetation, be subject to the drifting action of the wind. This drifting is to be avoided if possible, as it will necessitate releveling of the land for subsequent irrigation and the possible relocation of the laterals. For this reason alfalfa is strongly recommended for as much of the land as can now be irrigated, as it will effectively hold the soil in place, and in addition will furnish organic matter for the use of future crops. Small fruits will also tend to hold the soil and return a profit to the owner.

It is also recommended that those portions of this soil lying above the present canals remain covered with the native vegetation until it is possible to irrigate by pumping. Fall plowing is to be avoided, as it will leave the soil open to the action of the winter winds.

The following table gives the results of a mechanical analysis of this soil:

Mechanical analysis of Yakima sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18091	Soil	0.1	9.5	16.7	61.9	8.5	1.4	2.6

YAKIMA SANDY LOAM.

The Yakima sandy loam consists typically of 18 to 40 inches of coarse sandy loam, underlain to a depth of 6 feet or more by a coarse black sand or occasionally by a very light-textured coarse black sandy loam.

The surface soil, except along contact with the Yakima sand, is usually compact and becomes somewhat heavier in the third and fourth feet. Quantities of small waterworn gravel may occur in the surface soil. The color is usually of a light brownish yellow, but darker areas are seen where the soil contains considerable quantities of fine particles of black lava rock. The structure of the subsoil usually shows prominent stratification of its constituents. Fine gravel nearly always is scattered through it, and in a few places forms the larger part of the soil mass.

This soil grades almost imperceptibly into the Yakima sand or the Yakima fine sandy loam, and the line of demarcation between it and these types is often vague.

The Yakima sandy loam is the most extensive soil in the area, the principal body lying in the center and extending eastward nearly to the dam. Other bodies of greater or less size were found.

The topography of this type presents no features strikingly different from the other soils mapped, except that it has a decidedly more level surface than the Yakima sand. Its most irregular surface features are usually found along the boundary of the Yakima sand, where the surface consists of low knolls and depressions. The remainder of the type is more level, though there is very little of this soil but will require leveling before irrigation.

The shallow drainage course which traverses this type affords at best only poor surface drainage, but the soil is rather porous, and storm waters soon find their way into the sandy subsoil, and are removed by subdrainage.

The surface layer is made up of material brought by the Snake River and its tributaries from distant sources and to a certain extent from weathered and disintegrated portions of lava rock. The coarse sandy subsoil is almost wholly derived from basaltic material. The surface material has been more or less modified by wind action.

The larger proportion of the type is free from harmful quantities of alkali, although traces of alkali may be observed in the smaller bodies. In a small portion of the type, east of Heyburn, some alkali is found, but the largest quantity in the soil in no case exceeded 0.40 per cent.

A heavy growth of sagebrush, rabbit brush, and in alkali areas greasewood, covers the entire extent of this soil. Some grass is found between the larger plants, but the growth is not extensive.

No satisfactory figures can be given for the crop yields made. On a very few fields, yields of oats were reported at 60 bushels per acre.

It is very probable that the yield of oats this year will be about 30 bushels per acre, but when cultural conditions are more favorable and the farmers are more experienced a much higher average yield may be expected. A considerable acreage of this soil was planted to potatoes. Little of the crop has yet been harvested, but judging from the few fields where the crop was dug, a yield of about 200 bushels per acre may be expected. From the thrifty growth of the plants, and the size, form, and quantity of the tubers, it appears that this soil will prove productive for this crop. Alfalfa has made a good growth for the first year, and will undoubtedly prove a paying crop eventually. The various small grains made a good growth, but for various reasons a large part did not fill out and the yield was light. A large amount of the grain was cut to provide winter feed for farm stock.

The soil has a loose texture, and aside from plowing and the subsequent leveling for irrigation, few cultural operations will be required. On this soil little advantage will be gained from fall plowing, and it is advised that this be omitted, as the uncovered surface will be damaged by the action of the winds.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil:

Mechanical analyses of Yakima sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18089	Soil	1.5	14.5	15.9	39.6	13.1	8.4	7.1
18090	Subsoil	3.2	20.4	18.9	40.9	5.4	6.3	5.1

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 18089, 1.84 per cent; No. 18090, 5.23 per cent.

YAKIMA FINE SANDY LOAM.

The Yakima fine sandy loam shows a considerable variation in the texture of the surface soil and in the depth of the coarse sand below the surface. Typically the soil consists of from 10 to 40 inches of a medium textured fine sandy loam, underlain by a heavier and finer textured sandy loam extending to a depth of from 50 to 72 inches, beneath which is found the usual bed of coarse black sand. Lava rock sometimes occurs within 6 feet of the surface, but this is not usually the case. The texture of the surface soil varies from a fine sandy loam to a very coarse sandy loam, and the subsoil from a fine light textured sandy loam to a heavy, compact, sticky phase in which the texture may be either fine or coarse. The surface soil is a light yellowish brown, while the subsoil varies from a light yellowish brown to almost white. The subsoil when exposed to the air turns

white or a light ashy gray. The sand underlying this subsoil is of the same texture as that underlying the other soils of the area.

The principal body of this type is found between Rupert and Heyburn and extends westward to the limits of the area. Smaller bodies occur east of Rupert and along the northern edge of the area and south of the river. Next to the Yakima sandy loam this type is the most extensive soil in the area.

From an irrigation standpoint only a very small portion of this type could be classed as level land, the surface being usually somewhat rolling, and in the southern portion of the area frequently very uneven, caused by numerous depressions, occasionally 8 to 10 feet deep.

Aside from a narrow strip adjoining the drainage course, there is no system of surface drainage. The texture of the soil usually favors a ready movement of water through the subsoil, and water never remains long on the surface. In the depressions along the southern portion of this type the soil is somewhat heavier and does not permit ready percolation. Consequently these depressions will probably contain seepage water throughout the larger part of the irrigating season.

The bed of coarse sand in the subsoil of this type is doubtless the same in origin as that underlying the other soils. The upper soil seems to have been formed by alluvial agencies, which have also caused the deposition of the finer heavy material of the sticky subsoil. Wind action probably has modified the surface soil, and to a certain extent probably aided in building it up. Knolls of wind-blown sand and of Yakima sandy loam occur at intervals throughout it. The subsoil above the black coarse sand contains traces of alkali through its entire body, but only in the southern portion was there found a sufficient amount of alkali to necessitate mapping. In the alkali areas the surface foot is usually free from alkali. Below 12 inches the amount of soluble material usually increases until the bottom of the fourth foot is reached, and below this there is a decreasing quantity of soluble salt. When the sand is within 6 feet of the surface there is no alkali in the lower section. The usual quantity of alkali in this soil averages 0.20 to 0.40 per cent, there being only three small areas where the concentration was greater.

The Yakima fine sandy loam, except for a scattering growth of low willows along the edge of the river, is treeless. The native vegetation consists of sagebrush, rabbit brush, and greasewood.

On account of irrigation for only part of a season, and late cultivation, it is hardly possible to give average yields. All of the crops observed seemed to be doing well, but from lack of a supply of water throughout the whole season the yields will be light. This soil will probably be found well adapted to the various small grains, root crops,

alfalfa, and fruits suited to the climate. In the alkali area, alfalfa, timothy, root crops, oats, and sorghum will doubtless succeed better than some of the other crops.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Yakima fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18098, 18101	Soil	0.5	6.2	8.1	45.8	22.0	10.1	7.3
18099, 18102	Subsoil	.2	3.6	4.2	21.7	19.6	40.0	10.9
18100, 18103	Lower subsoil	4.1	19.4	17.1	48.1	5.5	3.4	2.5

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 18099, 22.30 per cent; No. 18100, 3.86 per cent; No. 18103, 5.77 per cent.

YAKIMA LOAM.

The Yakima loam to a depth of 4 inches is a medium-textured sandy loam, underlain by a heavy silty loam extending to a depth of 4 to 6 feet. Where the latter does not extend to 6 feet it is underlain by a coarse black sand. When the surface soil is a sandy loam it has a light porous structure and is light yellowish brown in color. When the sandy loam is absent from the surface the color is a light brown with a slight reddish cast. Below the surface the color varies from a dark brown, through a light reddish brown, to dark gray. The texture of this soil is a fine silty loam at the surface, which may continue to a depth of 6 feet or until the sand is encountered, though more usually the soil becomes heavier below and grades into a light clay loam. In a few places, particularly in the northern portion of the area, the subsoil was nearly a clay. The lower subsoil of black sand is identical with the sand underlying the other soils of the area.

The principal body of this type begins at a point about 1 mile west and a little north of Rupert and, widening out, extends to the western edge of the survey. Several smaller bodies occupy depressions along the northern portion of the area, and a few detached bodies are found southwest of Rupert.

The larger part of the Yakima loam is level or only slightly rolling, while a smaller portion is rough and precipitous and not very valuable for agricultural purposes. This latter phase occurs along the northern and western edges of the area, where the lava rock approaches the surface and where one or two steep knolls rise out of the more level portion of the type. One of the depressions in the northern portion of the area, in sec. 10, T. 95, R. 23 E., is below the level of Snake River.

There is no system of surface drainage in this type, and on account of the heavy nature of the subsoil movement of water downward is

slow. Especially in the northern part, where in depressions the soil is more compact, is this true, and water usually stands in these depressions several months in the year.

It seems probable that the lighter surface soil is of aeolian origin, while the heavier portion is due to alluvial and possibly lacustrine agencies.

The larger proportion of the Yakima loam was once covered by a body of water having little movement and carrying only fine material in suspension. The smaller bodies in the depressions were probably formed in much the same way, although since the removal of the water more or less soil material has been added by the wash from adjacent higher lying soils.

This type is free from any harmful quantities of alkali. Traces of it are found throughout the greater part of the subsoil, but the alkali content of the soil is small. The banks of the canals are frequently thinly coated with alkali washed out of the soil by the irrigation water.

With the exception of the depressions which support a thick stand of grass, the native vegetation on this type consists of a heavy growth of sagebrush and rabbit brush. The type is treeless.

This soil, like the others, was not prepared for crops, although enough water was delivered to most of it. Where the land was tilled the crops made as good a growth as could be expected under the adverse conditions. It will doubtless be found that this soil will require fewer applications of water than the other soils and that water will not be required on the land so early in the spring. This type is probably adapted to alfalfa, small grains, and root crops. Fruits ought to do well on it, but the lighter soils will doubtless prove to be better suited to their production. Root crops will do well here in all probability, but potatoes will yield better on the lighter soils.

The larger part of this type may be plowed in the fall, if desired, as it is not so liable to be affected by the winter and spring winds. However, the areas with light surface soil should remain covered with stubble.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Yakima loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18092, 18095...	Soil.............	0.4	4.5	5.1	17.9	21.0	38.1	13.1
18093, 18096...	Subsoil.........	.0	1.1	2.3	15.9	11.4	44.2	24.7
18094, 18097...	Lower subsoil..	.4	20.7	20.9	41.4	7.7	4.9	4.1

MEADOW.

Meadow varies in texture from a heavy clay loam, 6 feet or more in depth, to a few inches of heavy soil underlain by a bed of coarse river sand and gravel. Between these extremes it is possible to find all gradations in structure and texture, with no regularity in the arrangement of the different classes of material.

Meadow occupies the smallest extent and is the least important of the soils recognized. Its long, narrow stretches along the river in some places are overflowed when the stream is high. The water table is usually within 6 feet of the surface, and the entire type is poorly drained.

This soil owes its formation to the action of the river at high-water stages, the varying carrying power of the stream resulting in the erratic distribution of soil material.

A considerable proportion of this type contains alkali, with an average concentration of 0.40 to 0.60 per cent for the surface 6 feet of the soil section. On the south side of the river all of this type contains traces of alkali.

The native vegetation consists of a low growth of willows along the bank of the river, sagebrush, greasewood, and at times a heavy growth of grass. At present none of this type is cultivated, and a considerable portion of it contains too much alkali for the growing of any but the more alkali-resistant plants. As it is overflowed yearly, it will be difficult to irrigate, as the ditches will require rebuilding each spring. It is suggested that its most profitable use will be for grass.

IRRIGATION.

Water for irrigation in the Minidoka area is obtained from the Snake River. This stream has its source in the high mountains of northeastern Idaho and northwestern Wyoming, and the melting snow in these elevations supplies water throughout the year. The river is lowest throughout the late summer months, but increases in volume until the maximum flow is reached late in May or early in June. Gauging stations have been kept by the Geological Survey for a number of years, and the average minimum flow has been found to be about 4,000 second-feet and the average maximum about 30,000 second-feet. Minimum flows as low as 1,800 second-feet and maximum flows as high as 39,000 second-feet have been reported.

The water of Snake River is of very good quality for irrigation. Tests made in the field showed that the amount of soluble material was between 30 and 40 parts in 100,000 parts of water. Analysis shows the exact amount of soluble material to be 111.3 parts for 100,000 of water. The sample analyzed was taken in October, when the river was near its lowest stage, at which time the soluble content was probably highest.

The irrigation enterprises along the Snake River prior to the construction of the present system were confined to a few small areas in the vicinity of the ranch houses, water being lifted to the land by large water wheels. After the construction of the irrigation system by the United States Geological Survey and other systems to the westward, these wheels could not operate on account of a lack of current in the river and they are not now used.

About 12 miles east and a little north of Rupert the Snake River has cut through a stratum of lava rock and made a narrow gorge about 50 feet deep. At this point in the river the Reclamation Service constructed a concrete sluiceway, spillway, and a dam made of concrete, rock, and earth, which checks the flow of the river and raises the water level 40 feet. The water is led onto the land from the dam by a canal on each side of the river.

The total flow of the river can not be used for the irrigation of the project and adjacent lands, as there are prior water rights on the lower Snake River. To insure a plentiful supply for these prior rights and for the present Minidoka Project, taking into consideration also its possible extension, a dam is being constructed across the outlet of Jackson Lake, one of the tributaries of the Snake River, in Wyoming, where a large volume of water will be stored. This will be used during the summer months to increase the flow of the river. Provision has been made at the dam, at the head of the project, for the future installation of water-power plants, which will furnish electricity for lighting purposes and for power pumps to be used in extending the irrigation system to the higher and more remote areas.

The main canal on the north side of the river is about 35 miles in length, and has a capacity at the headgates of 1,060 second-feet. The south side canal is about 8 miles long, and has a capacity of about 170 second-feet. This latter canal is so constructed that it may be enlarged in the future, as it is intended to irrigate a considerable area south of the end of the present canal by pumping.

The irrigation system of the Minidoka Project was constructed under the terms of the Reclamation Act, by which the settlers agree to return the cost of the system to the Government in ten annual payments. In addition to these payments, there is an annual fee for maintenance. The cost to the settlers in this project is $22 per acre, and a maintenance fee of 40 cents per acre each year. When all payments have been made, the system is to be turned over to the people by the Government, and is to be managed by them. The total area which can be irrigated by this gravity system of canals is placed at 71,348 acres. It is estimated that this area may be nearly doubled by means of pumping.

There are as yet no generally accepted methods of irrigating in this area. The water was turned into the canals for only a few months of the past season, and the settlers followed their own ideas in applying

it. The quantity necessary for the successful growing and maturing of crops will probably be found to vary considerably with the soil. On the lighter soils a relatively large quantity will be required, as some of it will pass down through the soil beyond the reach of the crops. The irrigated portions of the Yakima sand will probably require the largest quantity and the Yakima loam the least. No measurements have been made of the rate of seepage from the canals, but it must reach a very high figure, as the bottom of many of them is within a short distance of the underlying coarse black sand, and probably is a contributing cause to the rise of ground water in the adjacent soils.

It has been suggested that the seepage into the larger sinks might be used for irrigating the higher lands by pumping. It is possible to irrigate in this manner, but the use of the seepage water must be carefully watched. It would be better to use water directly from the canals for this purpose.

The soil throughout the northern portion of the area is free from alkali, and water seeping into sinks located there will be of good quality; but it is doubtful if the water will be found suitable for irrigation in the southern portion after the first year or two. The subsoil in this portion contains alkali, sometimes in considerable quantities, some of which will be carried into the sinks by the seepage. If care is not used, therefore, much damage may be done by applying this seepage water to the land.

Since irrigation began the ground water has risen to a higher level and is a matter of concern. Before water was turned into the canals the level of the ground water was from 15 to 40 feet below the surface, but after applications had been made the water table rose to within 9 feet of the surface in some places, and at the time the gates were closed the average level of the ground water was about 20 feet below the surface and has since been steadily falling. The amount of water applied to the land must be carefully regulated or considerable loss will result through the submergence of the roots of growing crops and a consequent diminution of yields.

Drainage in this area to remove the excess of ground water would be very expensive and should be avoided if possible. The success of irrigation will depend upon whether the porous subsoil will be able to lower the level of the underground water, during the winter season, to a sufficient depth so that the succeeding season's irrigation will not raise the water to a dangerous height.

ALKALI.

The alkali is confined to a narrow irregular strip of land in the southern part of the area and to a small outlying body about 1 mile east of Heyburn. Traces of alkali exist in the soil joining the main body of

alkali in places along the river and in portions of the soil west of Rupert, but the quantities are not sufficient to warrant mapping.

The origin of this alkali is somewhat uncertain, but it seems that its accumulation is due to a rather compact subsoil which has retarded underdrainage. The precipitation is not sufficient to permit the rain water to reach and percolate the heavier subsoil, and the soluble material has been slowly leached out of the surface soil and deposited at a point representing the lowest depth of percolation.

Qualitative tests of the alkali in the field show that it is made up largely of sulphates and bicarbonates. No black alkali was encountered by the party making the survey.

The amount of soluble salts in the larger part of the alkali district averages 0.20 to 0.40 per cent for the surface 6 feet of soil. Two or three small areas of alkali with a concentration of 0.60 to 1 per cent were found, as well as two others in the lowlands along the river containing 0.40 to 0.60 per cent.

The larger part of the alkali in the soil occurs below 20 inches and above 48 inches. Outside of these limits the soil is nearly always free from soluble material, and in only a few cases was the soil below 4 feet found to contain alkali.

Considering the quantity of alkali in the soil, there is only a very small portion of the area where growing plants might be injured. It is not unlikely, however, that in future years some trouble may be experienced with lands now shown to contain alkali through a rise and concentration of the salts at or near the surface. On account of the lack of natural drainage facilities considerable trouble will be experienced in removing the alkali when it becomes dangerous. A few of the farms near the river may be drained without much expense, and where the coarse sand is near the surface the alkali may be removed by the downward percolation of water, but in a large number of cases there is no ready outlet for drains and the reclamation of these lands will be a heavy expense.

SUMMARY.

The Minidoka area comprises about 146 square miles of the rolling lands bordering Snake River in southern Idaho.

Aside from a shallow, poorly defined drainage course through the central portion of the area there is no system of surface drainage. The gradient of the drainage course is very low. The surface features consist of numerous knolls, ridges, and depressions. The greatest elevations occur along the northern boundary of the area near the river.

The settlement of the area dates approximately from the beginning of the construction of the present irrigation system, about three years ago. The area now supports a population of about 4,500, has

three towns and railroad connections with the Oregon Short Line at Minidoka, Idaho.

Markets for the produce grown in the area are assured in Idaho, Montana, and Wyoming, and for fruits in the outlying States.

The climate is arid, and is characterized by low annual precipitation, rather high winds, hot summers, cold winters, and few cloudy days. In average years frosts may be expected in the spring until early May and in the fall about the 1st of October.

The agricultural development of the area began with the present year, and little knowledge, therefore, is to be had concerning the capabilities of the soils. All of the crops in the area made excellent growths considering the adverse conditions.

The relative acreage of crops planted the past season is about as follows: Oats first, then wheat, barley, potatoes, alfalfa, and corn. It seems probable that the cultivation of all these crops will prove profitable, with the exception of corn, which will be in danger from fall frosts in average years. Fruit, particularly apples, prunes, plums, and small fruits, will yield fairly well, and will probably be one of the important products of the area.

The farms are of 40 and 80 acres in size, and are held by the settlers under the homestead law.

The texture of the soils of the area varies from wind-blown sand to a silt loam, the larger proportion being made up of two sandy loams. The upper mantle of soil extends to an average depth of about 5 feet, underlain by several feet of coarse black river sand. Outcrops of lava occur along the northern boundary and on the south side of the river, but do not affect to any great extent the area of irrigable land. The soils are largely free from alkali, except those occupying the long, narrow strip bordering the river in the southern part of the survey. No black alkali was encountered.

Water for irrigation is taken from Snake River and is diverted by means of a dam at the eastern extremity of the area. There is an abundant supply of water not only for the present project, but for an extension of irrigation to the higher lands and more remote areas by pumping. The quality of the water is excellent for irrigation.

The irrigation of the area during the past season has caused a considerable rise in the level of the ground water. Unless care is taken in the quantity applied, a considerable acreage is in danger of becoming damaged by the high water table.

The cost to the settlers of land located in the area, under the terms of the reclamation act, is $22 an acre, which is to be paid in ten annual installments, together with a maintenance fee of 40 cents per acre each year.

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