SOIL SURVEY OF THE KEARNEY AREA, NEBRASKA.

By J O. MARTIN and A. T. SWEET.

LOCATION AND BOUNDARIES OF THE AREA.

The area included in the present survey is that part of the Platte Valley in south central Nebraska lying between the ninety-ninth and one hundredth meridians of west longitude. It includes also about a mile of the hills or upland which bound the valley on the north and south. The area contained within the above boundaries is about 792 square miles. At the eastern end the area is about 7 miles in width, growing gradually wider as the western boundary is approached,

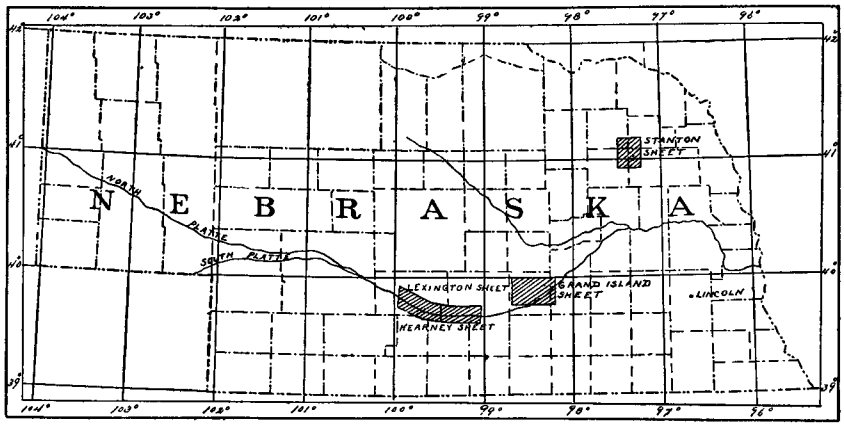


FIG. 36.—Sketch map showing location of the Kearney area, Nebraska.

where it has a width of about 15 miles. It is situated on the great southern bend of the Platte River, which at Kearney reaches its southern limit.

Kearney lies near the eastern boundary of the area, and Cozad at the western border, with the towns of Odessa, Elmcreek, Overton, and Lexington between. Kearney is the largest town of the area, with a population of about 5,600. It is the county seat of Buffalo County. Lexington is the next town in size, with about 1,400 inhabitants, and is the county seat of Dawson County. Cozad is the third town in size,

its population being 750. The other towns have less than 500 inhabitants each.

The area includes parts of Buffalo, Dawson, Phelps, Kearney, and Gosper counties. The first two lie mainly to the north of the Platte River and form the greater part of the area, while the others lie to the south of that stream.

The area is crossed from east to west by the main line of the Union Pacific Railroad, which follows in general the course of the Platte River, and it is along this railroad that all the towns of the area are situated.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

It is believed by some that the early Spanish settlers penetrated into Nebraska, but it seems more probable that the first white visitors to the region in which the present survey lies were the hardy and adventurous trappers and hunters who used the valley as a natural roadway to the western mountains. Later, the discovery of gold in California started great numbers westward and the valley of the Platte became the popular route, not only to the California gold fields, but also to those discovered later in the Black Hills.

The Mormons, passing up the Platte Valley on their way to Utah, made the first settlement in the region on Wood River, north of Kearney, in 1858. This was simply a stopping and resting station for these people on their westward migration.

Agricultural development began with the advent of the cattlemen, who grazed their herds on the natural prairie grass of what was then public land, unhampered by fences or cultivated fields.

In 1866 the Union Pacific Railroad pushed westward through the valley, and its advent marked the beginning of the real settlement of the region. The land was homesteaded by hardy pioneers, who built themselves sod houses (prairie sod being the only building material available on those nearly treeless plains), fenced their holdings, and commenced to break the virgin prairie.

The cattlemen viewed with displeasure the advent of these fence builders, and as they continued to come trouble arose between the opposing interests. The cattlemen, however, were gradually forced westward, and the region settled down to the pursuit of agriculture, for which it is so well suited.

In 1874 and 1875 great clouds of grasshoppers appeared and devoured crops and every green thing, but since that time their attacks have not been serious.

The Union Pacific Railroad originally owned large tracts of land in the valley, but this has mostly been sold to individual holders. The Government land is all taken up and the valley is now a fairly thickly settled farming region, with practically no other industries.

CLIMATE.

The climate of this portion of the Platte Valley is that of the great semiarid plain east of the Rocky Mountains. The average yearly rainfall for the last fourteen years is about 22.5 inches, as deduced from the table of precipitation given below, which was compiled from the records of the Weather Bureau station at Lexington, the most central point in the area where observations have been made. Up to 1901, however, the average was only about 20.6 inches, having been increased by the relatively heavy rainfall of the last three years.

Precipitation for fourteen years at Lexington, Nebr.

[In inches.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1890	0.74	0.10	0.16	2.13	1.55	2.46	1.22	1.59	0.07	1.01	1.14	.....	12.17
1891	1.10	.65	2.35	2.71	3.44	7.27	4.75	1.43	.81	.80	.05	1.84	27.20
1892	1.40	2.10	.90	3.08	6.55	1.11	3.61	3.56	.79	1.69	.05	.80	25.64
1893	.....	1.40	1.58	2.30	3.46	2.74	2.24	1.78	1.00	.50	.15	1.32	18.47
1894	1.80	1.10	1.63	.81	.70	3.15	.94	.76	1.86	1.57	.20	.34	14.74
1895	1.20	1.40	.30	1.53	2.71	3.37	1.86	5.43	2.31	.50	2.20	.50	26.41
1896	.38	.20	1.96	4.66	3.90	1.97	2.27	1.69	3.02	1.65	.28	.20	22.12
1897	.20	.81	1.59	4.24	.30	4.61	.72	1.57	1.60	4.13	.72	1.30	21.70
1898	.30	.30	.10	2.23	2.62	4.36	1.29	2.51	2.92	.73	.80	.35	18.51
1899	.05	1.25	1.40	.47	2.66	4.12	4.06	2.39	.65	.11	1.23	.95	19.34
1900	.....	1.55	.60	4.03	2.70	.94	3.56	2.51	2.71	.65	.20	.47	19.93
1901	.20	1.00	3.53	3.14	1.18	7.27	.87	2.99	5.64	1.55	.41	.65	28.43
1902	1.00	.80	.86	.72	5.72	2.98	6.28	3.39	2.64	3.66	.15	1.04	29.24
1903	.35	1.55	.83	1.15	5.80	3.18	9.24	5.42	.81	.88	.72	.....	29.93

An examination of this record shows that as a rule the fall and winter months have the least rain. It shows also that there is a tendency to increased precipitation during late spring and summer, this being especially the case during the last three years, and from present indications during the present year (1904).

The average normal temperature of the area is about 49.5° F. This rather low average is due to low winter temperatures and the fact that the summers are not, as a rule, excessively hot. Frosts, both early and late, are a source of danger to growing crops, especially corn, which is sometimes ruined by September frosts. The record of killing frosts is shown in an appended table.

One of the most pronounced features of the climate of this part of Nebraska is the high winds which prevail during the winter and spring, and which are likely to occur at intervals throughout the year. These windstorms sometimes cause great damage to crops and farm buildings. In connection with prairie fires they are also a great source of danger.

Another climatic feature unfavorable to agricultural interests is

found in the destructive hailstorms which occur during the growing season and often completely ruin the crops on narrow local strips.

The following table, compiled from records of the Weather Bureau, gives the normal monthly and annual temperature and precipitation at Minden and Lexington. Minden is situated in Phelps County, a short distance south of the area, but conditions at that point may be regarded as fairly representative of those in the area surveyed.

Normal monthly and annual temperature and precipitation.

Month.	Minden.		Lexington.		Month.	Minden.		Lexington.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	Inches.	° F.	Inches.		° F.	Inches.	° F.	Inches.
January	22.0	0.88	25.6	0.62	August	73.3	3.68	72.1	2.64
February	23.7	1.12	25.1	1.02	September	64.4	2.78	63.1	1.92
March	35.4	1.50	35.9	1.28	October	52.4	2.00	52.7	1.28
April	50.9	3.63	50.6	2.37	November	36.4	.93	36.4	.58
May	60.4	5.31	59.4	3.09	December	28.0	.71	28.6	.69
June	70.2	5.13	68.0	3.54	Year	49.4	32.45	49.2	22.09
July	75.6	4.78	72.7	3.06					

The table below gives the dates of first and last killing frosts of fall and spring during nine years past and also the average date of occurrence:

Dates of first and last killing frosts.

Year.	Lexington.		Gothenburg.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1895	May 25	Sept. 21	Apr. 22	.....
1896	May 16	Sept. 18	Apr. 17	Sept. 18
1897	May 13	Oct. 8	May 13	Oct. 8
1898	May 6	Sept. 6	May 6	Sept. 6
1899	Apr. 28	Sept. 16	Apr. 21	Sept. 16
1900	May 1	Oct. 6	Apr. 17	Sept. 17
1901	.....	.....	.....	.....
1902	Apr. 25	Sept. 11	Apr. 26	Sept. 12
1903	May 3	Sept. 15	May 4	Sept. 16
Average	May 7	Sept. 20	Apr. 27	Sept. 19

PHYSIOGRAPHY AND GEOLOGY.

There are two sharply defined topographic regions in the area; one a broad, flat valley floor, the other a dissected plateau upland which borders the valley on each side. The line of demarcation between these regions is an escarpment which rises with a fairly steep grade to the level of the plateau and forms the valley wall.

The valley floor is very gently rolling and slopes to the east with a uniform fall of about 7 feet to the mile. It is undoubtedly a very old valley, cut at some former period of greater continental elevation and now partly filled with later deposits.

The bordering upland was once a nearly level, rolling plain, and even now one may look across it and receive the impression of an uninterrupted prairie with no hint of the canyonlike valleys which traverse it. This upland also has a general slope eastward.

The stream now occupying the valley is doing no cutting within this area, expending all its energy in transporting the sediments with which it is overburdened. The Platte has an average width of about three-fourths of a mile, and, owing to the fall of its valley, has an unusually straight course for an overburdened stream. During its highest periods it has an average depth of but 4 to 6 feet, while during normal flow it consists of a great number of intercommunicating shallow streams, 6 inches or less in depth, flowing between shifting sand bars and more permanent low islands. These streams are constantly changing their course as they move the sand along, and also with the shifting of the wind, which has a tendency to divert the water to the side toward which it is blowing. During the late summer and fall the Platte apparently dries up and becomes a bed of dry, wind-driven sand. There is, however, in the lower portion of this sand bed a continuous body of water known as the underflow, which never entirely fails.

The tributary streams of the Platte in this area are all small, carrying very little water except after heavy rains. They all have their source in hill valleys, out of which they flow across the valley floor in meandering trenchlike courses. Most of them are dry during the greater part of the year.

The surface deposits of this section of Nebraska are of comparatively recent geological age, and they are undoubtedly related to the Glacial period, though the relation at present is not understood.

The principal of these deposits is an extensive bed of silty and very fine sandy material which forms the plateau and probably underlies all other surface deposits. This silt loam bears a strong resemblance to the Mississippi loess in its physical properties, but differs in others. It contains the shells of fresh-water mollusks of still existing species and in places shows distinct evidences of stratification. It also contains concretions of carbonate of lime. This silt loam at lower depths grades into fine, loamy sand, and deeper still into coarse sand.

The other deposits of the region are of later date than the above and are probably underlain by it. They consist of fine sands and sand in terraces and dunes and represent late stream deposits.

SOILS.

Seven types of soil were mapped, including Meadow. The following table gives the actual and proportionate extent of each type:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall silt loam	322,688	63.7	Dunesand	21,312	4.2
Meadow	46,272	9.1	Marshall fine sandy loam	15,424	3.0
Marshall loam	45,568	9.0	Total	506,688	
Riverwash	33,984	6.7			
Marshall fine sand	21,440	4.2			

MARSHALL SILT LOAM.

The Marshall silt loam occupies the greater part of the area and is the most valuable of the soil types. The soil consists of from 10 to 14 inches of dark-brown to black silty loam, grading occasionally to fine sandy loam. It is very mellow and friable when worked under proper conditions of moisture, but cakes into large, hard clods when plowed too dry or when allowed to dry out before harrowing. The subsoil consists of a yellowish drab to gray silty clay loam, heavier than the soil, and extending from 3 to 6 feet in depth, beyond which it again grows lighter. In the lower part of the subsoil concretions of lime frequently occur. Some of this type in the valley is underlain by sand and gravel at 3 feet.

This type is derived from the basal geologic formation of this portion of the Platte Valley and probably underlies the valley in part. It forms the upland region except where it is covered by deposits of later age. It is also the predominant type of the valley itself. In the hills the Marshall silt loam once extended as a rolling plain, but is now badly cut by large, canyonlike valleys, though on the remnants of this plain there are many fine farms. The valley sides are generally too steep for cultivation and are used chiefly for pasturage.

Areas of this type in the valley proper are derived from the erosion of the valleys in the upland plateau, the materials having been carried down by the intermittent streams. These areas are almost uniformly level and frequently poorly drained. Most of the land would be greatly improved by drainage. It is almost entirely in areas of this type that alkaline conditions prevail.

The Marshall silt loam is derived from deposits of the loesslike silt which forms the valley walls, and was probably deposited in a fresh-water lake during or immediately after the Glacial period. It may be divided into two classes, viz, that derived by weathering

of the original deposits, and that which has been carried into the valley by streams from the valleys eroded in the upland.

This is the most productive type of soil in the area, growing in seasons of sufficient rainfall good crops of corn, wheat, oats, rye, alfalfa, and sugar beets. Alfalfa grows especially well upon this type, and large acreages have been planted to this crop since the last census was taken, at which time the culture of alfalfa was in an experimental stage. It gives yields of from 3 to 6 tons per acre in three to four cuttings. Corn yields from 20 to 50 bushels per acre, depending largely on the season. Wheat gives an average of about 20 bushels, and oats about 30 bushels per acre. All the above crops do well when under good irrigation, and this type has a larger irrigated acreage than any of the others.

The following table gives mechanical analyses of typical samples of this soil:

Mechanical analyses of Marshall silt loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
11265	7 miles SW. of Elmcreek.	Silty loam, 0 to 16 inches.....	0.0	0.3	0.4	2.8	19.3	69.9	6.8
11182	SE. ¼ sec. 10, T. 8 N., R. 21 W.	Silty loam, 0 to 13 inches.....	.0	.5	.5	2.2	38.5	46.7	11.2
11267	NW. cor. sec. 15 T. 10 N., R. 21 W.	Black silty loam, 0 to 12 inches.	.0	.0	.3	2.0	10.6	70.6	16.3
11266	Subsoil of 11265..	Silty loam, 16 to 36 inches....	.0	.0	.7	3.1	18.2	70.3	7.0
11183	Subsoil of 11182..	Very fine sand and silt, 13 to 36 inches.	.0	.2	.1	.6	37.2	50.6	11.3
11268	Subsoil of 11267..	Gray, heavy, silty loam, 12 to 36 inches.	.0	.0	.0	1.2	4.6	66.5	26.9

MARSHALL LOAM.

The soil of the Marshall loam consists of 10 to 12 inches of brown to black very fine sandy to silty loam, easily worked, but not as strong and durable as the type just described. In this area there are no stones present in this type, either in soil or subsoil.

The subsoil consists of very fine sand and silt to a depth of 3 feet or more, beyond which it changes suddenly to the black soil of the Marshall silt loam, over which it has been deposited. Occasionally this underlying soil comes nearer to the surface than 3 feet, but only in small areas of less than 10 acres.

This type is found both on the valley floor and on the upland border. On the valley floor it occurs in narrow strips along sloughs and stream courses, and bordering sandy areas.

It generally is slightly more rolling than the Marshall silt loam, but most of it is quite level. It is usually marked at the boundary by slight rises above the general level. Some isolated mounds of it also occur. This is a well-drained type, but it does not resist drought as well as the Marshall silt loam.

The Marshall loam is derived from two sources, one an outcrop of very fine sandy and silty material underlying the Marshall silt loam, the other consisting of stream deposits. The first of these is of unknown depth; the other is from 2 to 3 feet deep, and is underlain by the silt loam. Some of this type contains alkali when not well drained, but on most of it the drainage is good enough to prevent alkaline conditions.

On this type are grown the same crops that are found on the Marshall silt loam, with the same average yields in ordinary seasons. In dry seasons, however, it does not resist drought so well, and gives lower yields. During the last three wet seasons alfalfa has done better on this type, as it is less likely to be "drowned out."

The following table gives mechanical analyses of typical samples of this soil:

Mechanical analyses of Marshall loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
11259	5 miles SW. of Elmcreek.	Very fine sandy loam, 0 to 12 inches.	0.0	0.3	0.7	9.2	35.0	48.7	5.8
11261	¼ mile N. of Lexington.	Silty loam, 0 to 10 inches.....	.0	.2	.3	4.2	30.0	56.6	8.3
11262	Subsoil of 11261..	Silty and fine sandy loam. 10 to 36 inches.	.0	.2	.2	7.9	35.4	49.3	6.4
11260	Subsoil of 11259..	Fine sandy loam, 12 to 36 inches.	.0	.2	1.1	13.2	33.7	42.8	8.5

MARSHALL FINE SANDY LOAM.

The Marshall fine sandy loam consists of 10 to 14 inches of coarse to medium sandy loam, with a few scattered pebbles of small size on the surface. The subsoil is a sandy loam, with some clay and silt, and is heavier than the mellow soil. The subsoil contains some gravel and is generally underlain by gravel.

This type is found entirely within the valley, where it occurs as low terraces, and also as ridges and mounds. It is a well-drained type and is therefore generally free from alkali.

This soil was formed by stream action at some period when the rainfall was much greater than it is at present. It represents deposition at a level far beyond the reach of the present stream.

The type produces good yields of corn, wheat, oats, rye, alfalfa, and sugar beets.

The following table gives mechanical analyses of typical samples of the Marshall fine sandy loam:

Mechanical analyses of Marshall fine sandy loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
11253	½ mile E. of Kearney.	Black sandy loam, 0 to 14 inches.	1.7	8.3	13.6	29.8	16.1	22.5	7.6
11255	2½ miles SE. of Lexington.	Black sandy loam, 0 to 12 inches.	1.9	9.3	12.3	26.5	15.0	26.2	8.1
11254	Subsoil of 11253..	Gray sandy loam, 14 to 36 inches.	1.4	10.0	15.3	32.8	13.4	14.4	12.2
11256	Subsoil of 11255..	Gray sandy loam, 12 to 36 inches.	2.0	8.9	15.5	31.0	12.6	15.3	14.4

MARSHALL FINE SAND.

The soil of the Marshall fine sand is a yellow to black fine sand or loamy sand, underlain by fine sand of the same general texture, but as a rule lighter in color.

This soil occurs as gently rolling terraces at the edge of the valley and as elevated regions on the valley floor. It is so well drained that in dry seasons crops do not resist drought well, and consequently do not give as large yields as on the other types.

The Marshall fine sand results in most cases from a stream deposition laid down on the basal loess. It occurs, however, as an outcrop underlying the loess and fine sand along the western end of the south valley wall.

This type is planted to the same crops as the other types, but as a rule the yields are not so good. Alfalfa especially does not seem to do so well on this type, though some very good fields were observed on it during the progress of the present survey. Probably two-thirds of it is in pasture, and wild grasses seem to do well.

The following table gives mechanical analyses of typical samples of this soil:

Mechanical analyses of Marshall fine sand.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
11247	NE. cor. sec. 2, T. 9 N., R. 21 W.	Brown loamy sand, 0 to 14 inches.	1.0	9.2	12.7	37.7	20.5	12.1	6.7
11249	Cen. N. side sec. 12, T. 9 N., R. 23 W.	Black loamy fine sand, 0 to 12 inches.	.0	1.6	4.8	41.0	33.8	11,5	7.0
11250	Subsoil of 11249	Brown fine sand, 12 to 36 inches.	Tr.	1.4	5.9	50.5	29.1	7.4	5.6
11248	Subsoil of 11247	Yellow fine sand, 14 to 36 inches.	.6	5.1	11.0	35.9	27.7	10.9	8.9

DUNESAND.

The Dunesand type of this area shows no appreciable difference between soil and subsoil. Until a very recent period it consisted of shifting sand blown about by the wind, but it is now held down in most places by wild grasses and various sand-growing plants. It is loose incoherent sand of little agricultural value.

As above noted, the type is an æolian deposit, but its source is not easy to determine, especially when it occurs as isolated patches in the center of the valley. It has a very low crop value, though it is sometimes planted to corn, wheat, rye, and oats. The yields are small and are likely to fail without plenty of rain. Its greatest present value is as pasture, and most of it is now utilized for that purpose.

The following table gives mechanical analyses of typical samples of Dunesand:

Mechanical analyses of Dunesand.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand. 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay. 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
11271	4 miles S. of Elm-creek.	Loose fine sand, 0 to 10 inches.	Tr.	0.8	8.2	74.2	13.6	0.2	2.8
11273	Cen. sec. 7, T. 9 N., R. 22 W.	Loose fine sand, 0 to 12 inches.	.0	.6	5.6	56.5	30.2	1.0	6.2
11272	Subsoil of 11271	Loose fine sand, 10 to 36 inches.	.0	1.3	9.9	71.5	14.4	.1	2.8
11274	Subsoil of 11273	Loose fine sand, 12 to 36 inches.	.0	.7	6.0	62.5	25.4	.2	4.8

MEADOW.

Meadow in this area represents the lowest level lands bordering the Platte River, as well as the islands in that stream. The soil is variable, being sandy, gravelly muck, and even clay, with various subsoils. A great deal of it is sandy loam, with many different subsoils.

The type is nearly level, and is broken only by low ridges and sloughs lying parallel to the river. Much of it is true swamp.

The water table everywhere lies from a few inches to 3 feet from the surface, and alkali often shows white on the surface, though its amount seldom reaches 0.20 per cent.

Much of the Meadow is cultivated, and in dry seasons grows very good crops, but in wet seasons most of it becomes so wet that crops can not be harvested. At Kearney large, mucky tracts are planted to celery, which does very well. The usual crops of the area are all grown in the Meadow soil, though 75 per cent of it is in pasture or growing wild grass, which is cut for hay. It is probably better adapted to pasturage than to the growing of cultivated crops.

RIVERWASH.

The Riverwash of the Platte River bed consists mainly of coarse, quite sharp sand, with streaks of gravelly sand, the gravel stones rarely reaching an inch in size. These gravel streaks are found more commonly in the numerous side channels, though they often occur in mid-stream. The sand is sharp for a river sand, and makes a good building sand, which is the only value possessed by this type. Part of the year it is covered by water, and shifts and moves with the currents, while during the rest of the year it is dry, blowing about with the winds.

WATER SUPPLY FOR IRRIGATION.

During the last four years, owing to the abundant rainfall, there has been little need of irrigating water, but prior to that time there were constructed extensive systems of irrigation canals, which cover a large part of the valley. The Platte River is the sole source of water supply for these canals, and thus far has proved far from reliable. During the spring months it generally contains sufficient water to fill the canals, but at this time there is usually enough rainfall. Later on, when the crops are maturing and water is most needed, the Platte sinks to the underflow stage, which has heretofore proved insufficient to supply the water rights now sold, to say nothing of the lands under ditches which are not provided with such water rights. Plans for a more complete utilization of this underflow water are contemplated, but the abundant rains of the last four years have brought irrigation projects to a standstill.

Storage reservoirs are not practicable within the area, on account of the lack of suitable sites. The most feasible sites for reservoirs are near the western boundary of the State or in Wyoming. Up to the present all of the canals have been dependent upon the uncertain flow of the Platte River. During the present summer the Platte reached its highest recorded stage, but this supply was not used, as the abundant rains precluded the need of irrigation. In fact, during the last four years there has developed a greater need for drainage than for irrigation ditches.

UNDERGROUND AND SEEPAGE WATERS.

There is a never-failing and abundant supply of underground water in the area for stock-watering and household purposes, but it is doubtful if any very extensive irrigation could be accomplished from this source, even if the water were suitable for such purposes. Most of it appears to contain a relatively high percentage of soluble salts. The water table lies at distances from the surface ranging from a few feet to about 40 feet. There are generally two veins of water, the upper of which contains the higher percentage of soluble salts. The lower is generally the one tapped for domestic use.

The large percentage of silt in the soils through which most of the irrigation ditches are dug prevents any great loss from seepage, and the rains have kept the soils so saturated of late that there is little chance for observation on the amount of seepage. It is said, however, that a few lands have been damaged in this manner.

ALKALI IN SOILS.

Beginning at Odessa and stretching westward, there is an area in which much of the soil contains enough alkali to be injurious to crops. For the most part the alkali spots lie north of the Platte River, but there are a few south of that stream. These alkali areas grow larger and more numerous toward Lexington, beyond which they gradually diminish in size and number, so that the worst affected areas are to be found between Lexington and Overton. They follow approximately the line of the Union Pacific Railroad, the main body being on the north side of its tracks. Patches of alkali land extend as far west as Gothenburg, a distance of 14 miles beyond the western boundary of the present area. They diminish, however, toward that point. The areas south of the Platte River occur south of Lexington and Cozad.

The origin of this alkali is not obvious, but it appears to be an accumulation through many years of wash from the upland valleys, traces of alkali in small amounts frequently showing on the sides of these valleys. Washed into the valley and remaining in its most

poorly drained portions, these small amounts become concentrated by evaporation during the dry seasons. The ground water also becomes in like manner impregnated to a greater or less degree with alkali, and, where it is near the surface, as is frequently the case, becomes a continuous source of supply. The ground water is not of a uniform concentration, but varies with the conditions of its flow. The fact that in most instances the alkali areas are poorly drained seems to indicate that the above is the origin of these troublesome deposits.

The chemical composition of the alkali in these areas is quite variable. It consists mainly of salts of sodium, potassium, and calcium, with some magnesium in different combinations. The appended table shows an analysis of a fair average sample of surface drainage water taken after a heavy shower, and consequently containing a complex sample of the surface alkali; also the analysis of a sample of ground water taken at a depth of 3 feet. Both samples were taken at Lexington, in a badly alkaline area.

Analysis of drainage and ground water from alkali tract.

Constituent.	Drainage ditch near Lexington.	Ground water near Lexington.	Constituent.	Drainage ditch near Lexington.	Ground water near Lexington.
Ions:	*Per cent.*	*Per cent.*	Conventional combinations—Continued.	*Per cent.*	*Per cent.*
Calcium (Ca)	2.68	1.34	Potassium chloride (KCl)	3.39	3.67
Magnesium (Mg)	.80	1.06	Potassium bicarbonate ($KHCO_3$)	20.46	43.67
Sodium (Na)	19.26	13.35	Sodium sulphate (Na_2SO_4)	13.63	----------
Potassium (K)	9.83	19.03	Sodium bicarbonate ($NaHCO_3$)	34.05	32.80
Sulphuric acid (SO_4)	21.50	7.44	Sodium carbonate (Na_2CO_3)	12.69	10.00
Chlorine (Cl)	1.56	1.69	Total solids	223.80	207.00
Bicarbonic acid (HCO_3)	37.18	50.44			
Carbonic acid (CO_3)	7.19	5.65			
Conventional combinations:					
Calcium sulphate ($CaSO_4$)	11.80	4.59			
Magnesium sulphate ($MgSO_4$)	3.98	5.27			

From the above it will be seen that the ions of soda and potash form the main alkaline salts. The surface water showed by the phenolphthalein test a strong reaction for carbonates, while the soil water showed but a trace, which has proved to be the case in all of the alkali areas examined. Wherever there was carbonate or black alkali it was in the crust or surface inch or two, and not enough black alkali was encountered to warrant making a separate map. The carbonate, where observed, was invariably in the most poorly drained localities, and seemed to be due to the effect of decaying vegetation upon the bicarbonates, which form the bulk of the alkali.

The distribution of the alkali in the soil is very irregular, scarcely

any two borings giving the same result. Where the water table lies close to the surface the alkali is in the few feet of unsaturated soil.

A few instances were noted where the alkali was present in considerable quantity throughout the 6-foot section, but in the majority of cases the bulk of it was in the second and third feet. Many times good fields of alfalfa were noted on 0.40 to 0.60 per cent alkali areas, with no trace showing on the surface; in other instances the surface was coated with alkali crust and readings of but 0.20 to 0.40 per cent obtained. Where the alkali was found in the third foot it could be easily distinguished as white spots throughout the subsoil, but cases were observed where these spots were not visible, though alkali existed. There seems to be no general rule for the vertical or horizontal distribution, and its irregularity is probably due to the unequal passage of water through these poorly drained soils. It seems probable that the unusually wet season of the present year has had something to do with the unequal distribution in carrying the alkali from the soil to the subsoil, or in washing it completely out of the surface foot, and it is probable that during a dry season the percentages for these areas would be much higher.

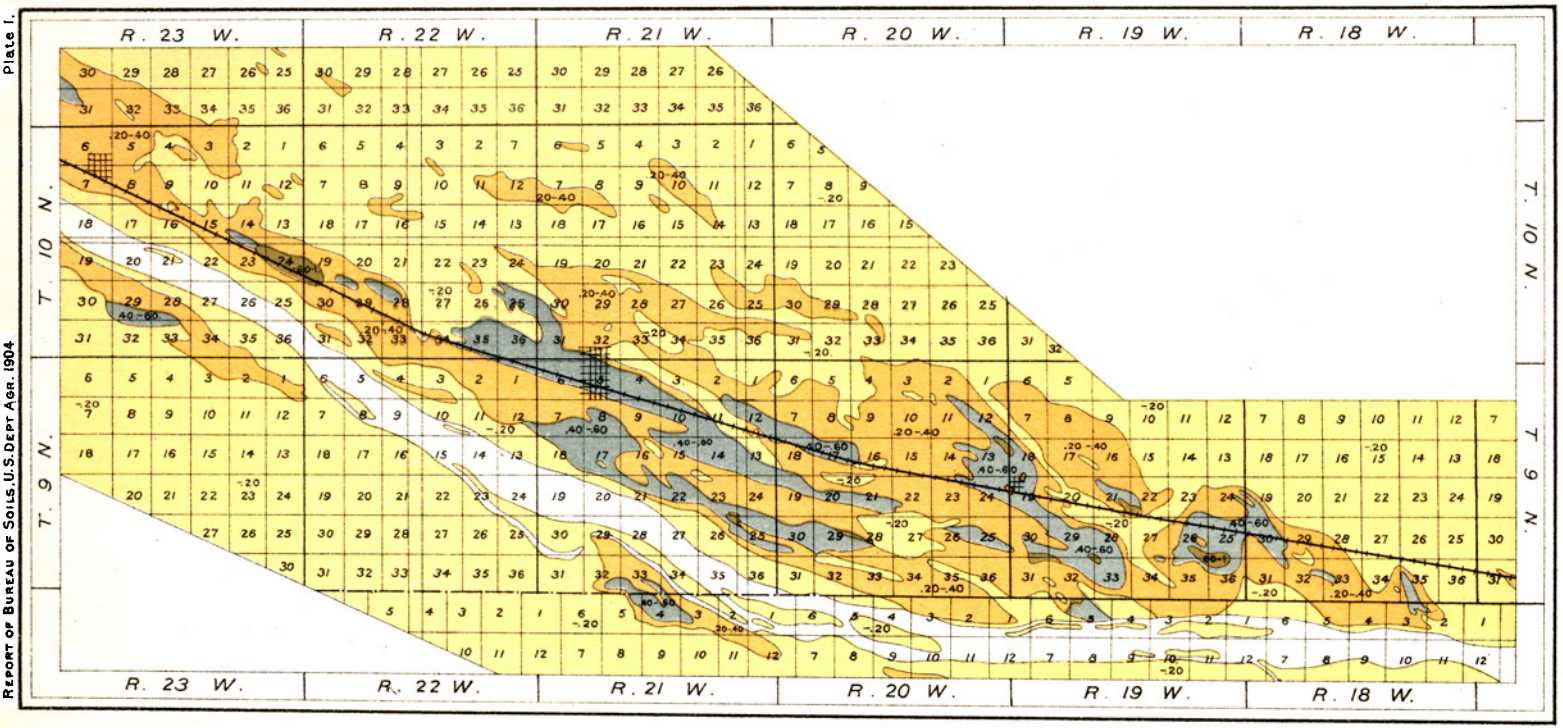
From the results of experiments in other areas it seems feasible to reclaim a great deal of this alkali soil, but, judging from the general conditions, it would probably require cooperative effort. All of these soils would be greatly benefited by drainage, but the falls are so slight that the drainage of individual tracts would be very difficult, and the result could best be accomplished by the construction of large public or corporate ditches, into which individuals could discharge their drains.

A great part of the worst alkali land is underlain at from 3 to 6 feet by a sandy and gravelly layer, which at all times contains water carrying relatively large quantities of salts. Ditches would have to be of sufficient depth to drain thoroughly this sand layer, after which the addition of tile drains would make the problem of reclamation a simple one. The expense of this work would undoubtedly be more than compensated by the increased value of the land. The position of these alkali soils, located as they are in close proximity to a trunk railroad, makes them of considerable value, and they are well worth the expense of reclamation.

AGRICULTURAL METHODS.

The methods of farming in the area are extensive rather than intensive. Large acreages of the crops grown are planted, and both planting and harvesting are done with the latest and most improved machinery. Cornfields with rows half a mile in length and quarter-

Plate I.



ALKALI MAP KEARNEY AREA NEBRASKA

Report of Bureau of Soils, U.S. Dept Agr. 1904

JULIUS BIEN & CO NY

-.20	.20-.40	.40-.60	.60-1
LESS THAN 20 PER CENT.	FROM 20 TO 40 PER CENT.	FROM .40 TO 60 PER CENT	FROM .60 TO 1 PER CENT.

sections of wheat and oats are not uncommon, and occasionally whole sections of a single crop may be observed. This is made possible by the exclusion of hand work and the use of machine cultivators that enable one man to keep in cultivation a hundred acres or more of corn. Four to six horses are generally employed, and cultivation is usually deep and thorough. There is a tendency, however, in plowing large areas to allow such fields to dry out on the surface before harrowing, and the Marshall silt loam is inclined to clod under such conditions. This tendency could be obviated by following up the plows closely with the harrows and breaking up the soil while it is still mellow.

AGRICULTURAL CONDITIONS.

The general prosperity of the farming classes is much greater than that of the same classes in eastern areas. During the last four years of abundant rains good crops have been the rule, and this, with the small expense of operation and the good prices obtained, has placed most of the farmers on a sound financial basis and enabled them to free themselves from debt. Few of the farms are now mortgaged, and when so mortgaged are regarded as the best of security. Many farmers have money to loan. Over 50 per cent of the farms are rented, the owners being in business in town or retired from active work, and their farms give good returns to both owner and operator.

The average size of farms in the area is about 250 acres, the largest containing several sections and the smallest about 40 acres. Quarter-section farms are the most frequent, but there are many containing half or even a whole section.

Farm labor is scarce and inefficient, but commands high prices. This is especially true during harvest time, when hands receive as much as $1.50 or $2 a day.

The principal farm products of the area are corn, wheat, oats, rye, alfalfa, sugar beets, and cattle and dairy products, the latter just now coming into prominence. A great deal of the grain is shipped out of the area, every railroad having one or more elevators. A large part is ground in the area by the various roller mills, and the remainder is fed for fattening cattle and hogs—an important industry of the area. Corn is at present the principal crop, with wheat second and oats third. Alfalfa is fast increasing its acreage and seems especially adapted to the area. It is the best forage crop available and gives good yields, being especially valuable in fattening cattle and hogs. Some millet is grown as forage, and also some Hungarian grass, but these are not extensively produced. There is a market for sugar beets at both Grand Island and North Platte, but at present the acreage of this crop for the whole area is small. Vegetables are grown

chiefly for home consumption, but potatoes are shipped in small quantities. Wild prairie or meadow grass is also an important product.

The broad, level, easily cultivated prairies are well adapted to the crops above mentioned, the Marshall silt loam being especially productive and adapted to corn, grain, and alfalfa.

The sole avenue of transportation for most of the area is the Union Pacific Railroad, though at Kearney there is a branch of the Burlington and Missouri River Railroad. Freight rates are high, and the movement of crops is impeded at times by lack of cars or congestion of traffic.

Omaha is the grain and cattle market nearest the area, and to this point most of the products are shipped.

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