U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS

SOIL SURVEY OF THE MOAPA VALLEY AREA, NEVADA

BY

F. O. YOUNGS, IN CHARGE, AND E. J. CARPENTER

[Advance Sheets—Field Operations of the Bureau of Soils, 1923]

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON
1928

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[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, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]

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SOIL SURVEY OF THE MOAPA VALLEY AREA, NEVADA

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AREA SURVEYED

The Moapa Valley area is in the eastern part of Clark County, Nev., about 50 miles northeast of Las Vegas, the county seat. Clark County is of irregular shape and is in the extreme southern end of Nevada. The area surveyed comprises two long narrow strips, one extending in a northwesterly direction from the confluence of Muddy Creek with Virgin River to the head of the valley above the source of Muddy Creek, and an arm extending from the mouth of Meadow Valley Wash northwest about 12 miles. It is a Y-shaped area about 33 miles long, varying in width from 1 to 6 miles, with an average width of about 3 miles. The total area is 125 square miles, or 80,000 acres.

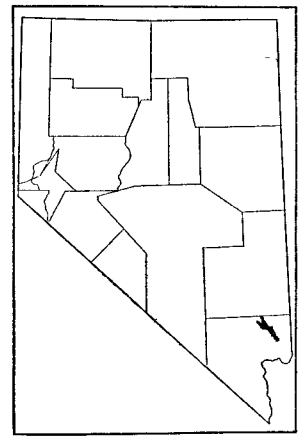


FIG. 26.—Sketch map showing location of the Moapa Valley area, Nevada

The valleys of these two creeks are deeply cut into deposits of old valley-filling and lake-laid materials, which form bench lands on both sides. A low limestone mountain ridge crosses the area at The Narrows between Logandale and Moapa, separating the upper valley from the lower valley. A similar ridge extends across the the head of the valley above the source of Muddy Creek. The valley lands consist of comparatively level bottom lands and gently sloping alluvial fans at the mouths of the lateral washes which flow down from the higher bench lands. The edges of the bench lands form very distinct escarpments, which in places reach a height of several hundred feet. These benches are usually thoroughly dissected by erosion, although there are some fairly large areas of level lands. The elevation at the mouth of Muddy Creek is approximately 1,100 feet above sea level; at St. Thomas, 1,150 feet; at Overton, 1,300 feet; at Moapa, 1,664 feet; and at the sources of Muddy Creek, probably about 1,800 feet. The bench lands bordering the valley and the low mountain ridges reach an elevation of more than 2,000 feet above sea level.

On account of deep cutting by streams, the higher lands are well drained; but the low, flat bottom lands and the lower alluvial-fan slopes adjacent to them are poorly drained and in some places

swampy. Fresh cuts by streams, aided in places by artificial straightening of their channels, are remedying this condition and making the adjacent lands better drained.

The construction of a large dam across Colorado River in Boulder Canyon has been proposed as a means of impounding the water of that stream. If this were constructed to the proposed height of 600 feet above sea level, the resulting backwater would submerge nearly one-half of the lower Moapa Valley, including the town of St. Thomas. In the event that the dam were constructed to a greater height, a large part of the lower valley would be flooded. If the proposed low dam of approximately 400 feet height should be built, the backwater would little more than touch the extreme lower part of the lower valley below St. Thomas.

The inhabitants of Moapa Valley are principally Mormons. They are mostly native born and many of them of old American stock, although there are many Scandinavians, Dutch, and Germans. The lower valley is more thickly populated. There are only a few ranches in the upper valley and but two in Meadow Valley Wash. The Moapa Indian Reservation is west of the town of Moapa. According to the census the population is all classed as rural. There are a number of small towns and settlements with populations of less than 200, Overton, St. Thomas, and Moapa being most important. Las Vegas, about 50 miles southwest, is the nearest town of any importance.

Moapa Valley is served by the Salt Lake-Los Angeles line of the Union Pacific Railroad, the main line passing through Moapa. From Moapa a branch line runs southeast through Logandale and Overton to St. Thomas at the lower end of the valley. The Arrowhead Trail, or Zion Park Highway, a highway from Salt Lake City to Los Angeles, crosses the valley just south of Moapa. A fairly good highway runs the length of the lower valley, and the road from Moapa through the upper valley is in fair condition. Most of the other roads are rough, sandy, and at times almost impassable. Telephone service is maintained between Moapa and the towns of the lower valley. The lower valley has a good centralized school system, and there are two small schools in the upper valley.

A large part of the produce of the area is marketed locally, and some grain and hay is fed to livestock on the ranches. Hay, vegetables, and dairy and poultry products are shipped to Las Vegas and to the small railroad and mining towns of southern Nevada. Vegetables, fruits, and melons are shipped largely to Salt Lake City, Ogden, and other places in Utah. From these points fresh fruits and vegetables are diverted to other Rocky Mountain and Middle West States. Hogs, cattle, sheep, and poultry products are shipped principally to Los Angeles, Calif.

CLIMATE

The rainfall in the Moapa Valley area is very low and is of little benefit to crops. During a period of 17 years the annual precipitation at Logandale has ranged from 2.15 inches (1913) to 9.72 inches (1915), with an average of 6.13 inches for that period. The precipitation comes largely during the winter, but is supplemented by heavy rains in July and August.

The warm, temperate climate is characterized by long, hot summers and short, mild winters. During a 13-year period the maximum temperature at Logandale was 117° F., the minimum 6°, and the mean annual temperature 64.8°.

The frost-free season is long, November 11 being the average date of the first killing frost in the fall and March 21 of the last in the spring. Killing frost has been recorded at Logandale as late as May 17 and as early as October 20. These dates vary, of course, with elevation and local conditions of topography and air drainage. Almonds and apricots are often killed by late frosts on the low ground around St. Thomas but are not even injured on higher lands farther up the valley. On a ranch just below the mouth of The Narrows, oranges and dates are successfully grown, whereas around Overton all orange trees planted in the past have been winter-killed. The higher fan slopes and bench lands are more nearly frost free than the flatter valley lands.

Strong winds are common, and cloud-bursts occur occasionally during the summer. South winds prevail from February through September and north winds during the remainder of the year.

Rapid radiation, due to high altitude, combined with great dryness and clearness of the air, tends to make the nights cool, even after the hottest days, thus effecting wide diurnal temperature ranges.

The following table gives the rainfall and temperature data as recorded at Logandale Weather Bureau station. This station is in a level valley with high mountains to the north.

Normal monthly, seasonal, and annual temperature and precipitation at Logandale

[Elevation, 1,355 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1913)	Total amount for the wettest year (1915)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	44.3	76	10	0.56	0.19	0.16	0.4
January	43.7	87	6	1.09	.01	2.31	.0
February	49.6	86	10	.73	.23	1.97	Trace.
Winter	45.9	87	6	2.38	.43	4.44	.4
March	55.8	93	19	.62	.00	.20	.0
April	63.5	103	25	.24	.22	.68	.0
May	71.1	114	29	.18	.00	.27	.0
Spring	63.5	114	19	1.04	.22	1.15	.0
June	80.9	117	34	.17	.08	.30	.0
July	87.0	116	49	.53	.05	.88	.0
August	85.5	117	48	.65	.74	.18	.0
Summer	84.5	117	34	1.35	.87	1.36	.0
September	77.1	114	34	.40	.21	.77	.0
October	65.7	101	29	.54	.00	.00	.0
November	53.2	89	19	.42	.42	2.00	.1
Fall	65.3	114	19	1.36	.63	2.77	.1
Year	64.8	117	6	6.13	2.15	9.72	.5

AGRICULTURE

The lower Moapa Valley was first settled by Mormons from Utah in 1866; but when the Nevada-Utah State line was established in 1871, Nevada included Moapa Valley. The settlers abandoned their farms and returned to Utah, so that a period of several years elapsed before the valley was again inhabited and brought under cultivation. In 1903 the area of cultivated land was estimated at 3,000 acres, and at present the total area cultivated is approximately 5,000 acres.

In the past much of the land was farmed year after year to the same crop and sometimes "double cropped." At one time considerable cotton was raised, but alfalfa, wheat, corn, and barley have been the most common crops of late. Comparatively little attention has been given to the use of fertilizers or to the maintenance of soil fertility.

The land now farmed represents only about 40 per cent of that which could be brought under cultivation if complete storage and economic use of all spring, flood, and waste waters were effected.

The most important crops are alfalfa, wheat, barley, and corn. The growing of asparagus and early vegetables is increasing and promises good returns. Dairying is carried on in a small way and range cattle are fed during the winter on a number of ranches.

Most of the ranches in the area are small and most farmers do not hire much help. Some of the larger ranchers, however, and those growing crops which require much work, hire Indian and Mexican laborers. Improved land in 1923 ranged in value from $100 to $200 an acre, and where planted with orchards, vineyards, or asparagus it is valued at about $500 an acre.

SOILS

The Moapa Valley area is in that general soil region termed the arid Southwest, and its soils have developed under conditions of low rainfall and high temperature. They have been only slightly modified by the removal of lime and other soluble constituents. Lime in varying quantities is abundant in both topsoils and subsoils throughout the area; on low and poorly drained lands the soils are high in alkali; and in most places they are very low in organic matter.

Very little of the soil material of this area has been in place long enough to have undergone much change by weathering. The soils which have advanced most in their development are best represented by those of the Las Vegas series which occur on bench lands and are principally nonarable. The Mohave and San Pedro soils are also somewhat maturely developed. Soils of these three series are discussed under the heading, "Soils from old valley-filling materials." The soils which have developed from the more recently deposited materials, those classified as the Tonopah, Land, Gila, and Redfield series, are discussed under the heading, "Soils from recent-alluvial materials."

The rocks cut through by valleys are principally limestone and sandstone or old valley-filling materials derived from them. The soils in the valley and on alluvial-fan deposits have developed from these sedimentary formations. Igneous-rock materials are abundant

in the valley fill at the head of the valley and have undoubtedly contributed to the formation of land along the stream bottoms. Much of the stream-bottom material has been carried from far outside the area through Meadow Valley Wash, Arrow Canyon, and other large washes.

Practically all the soils of the area may be classed as alluvial, and divided into two groups: (1) Soils derived from old valley-filling materials, and (2) those derived from recent-alluvial materials. Only the miscellaneous groups, rough broken and stony land and the dune phase of Redfield fine sand, are not included in this classification.

SOILS FROM OLD VALLEY-FILLING MATERIALS

Old valley-filling materials have been in place for a long period and show distinct modifications as the result of weathering. The soils developed from them may be classed into two groups, (1) soils which have developed under good drainage conditions and (2) those which have developed under poor drainage conditions.

The soils which have developed from old valley-filling materials under conditions of good drainage are characterized by a high concentration of carbonate of lime in the subsoil. This concentration is the result of the weathering and leaching of the surface material and the transfer of topsoil material to the subsoil. They commonly occur on high bench lands and are composed principally of coarse-textured materials. These are classified as Las Vegas and Mohave soils.

Old valley-filling soils developed under poor drainage conditions have dark topsoils high in organic matter and heavy greenish-gray subsoils with mottles of reddish brown and black. These soils occur along the valley floors of streams and are fine textured. These are classed as the San Pedro and Riggs soils.

Las Vegas soils.—Las Vegas soils include high bench lands along both sides of Moapa Valley and the valley of Muddy Creek, which have fairly level or slightly rolling surfaces. These soils have a surface covering of light-textured material, or mulch, less than an inch thick; a layer of compact material a few inches thick, and heavier in texture than the material above or below it; a layer of mellower, redder, and comparatively loose material, several inches thick; a slightly cemented layer of pinkish-brown material containing lime nodules, underlain by solid, firmly cemented lime hardpan. This hardpan in most places is within a foot of the surface and continues to a depth of many feet.

The Las Vegas soils have advanced further in their development than other soils of the area, and the parent material appears to be derived mostly from sedimentary rocks, although there are some basalt and other igneous materials. Surface drainage is good and the soil is free from the more soluble salts. Las Vegas gravelly fine sandy loam is the only member of this series mapped in this survey. (Pl. 33, fig. 1.)

Mohave soils.—Mohave soils also occur as high bench lands, where the surface is fairly smooth or slightly rolling. They are less developed than the Las Vegas soils. Here the topsoils consist of loose sandy material to a depth of a foot or slightly more, and the subsoils are compact and high in lime. Firmly cemented hardpan has not

yet formed. The topsoils are redder and the subsoils are slightly heavier in texture and grayer or pinker in color than the La Vegas soils. A slightly cemented layer occurs at depths ranging from 15 to 30 inches and continues in most places to a depth of 6 feet or more, although in some places it is somewhat less compact below a depth of 3 or 4 feet. In many places the deep substratum consists of loose gravel.

These soils appear to have developed from materials derived from sedimentary rocks, although materials derived from basic igneous formations are also present. Drainage is well developed, and there are no harmful concentrations of alkali. Mohave fine sand is the only member of this series indicated on the soil map.

San Pedro soils.—San Pedro soils occur as low bottom lands along Muddy Creek and at the mouth of Meadow Valley Wash. They have the following characteristices: A thin covering of recently deposited alluvium consisting of a light grayish brown material high in organic matter; a layer of dark material, formerly the surface layer; and a heavy subsoil of a peculiar greenish-gray color with iron mottlings and streaks of reddish brown and black in some places. The color of the subsoil is probably caused by the exclusion of air during the process of development and the consequent deoxidation of the soil material.

Drainage is poor, and both topsoil and subsoil are highly calcareous and moderately high in alkali. Fine sand with a deep phase, and very fine sand are the members of this series indicated on the soil map.

Riggs soils.—In occurrence, surface features, and drainage conditions, the Riggs soils resemble those of the San Pedro series. The topsoils are dark gray or dark grayish brown, the dark color being the result of the accumulation of organic matter under poor drainage conditions. The subsoils consist of stratified dark and light colored materials, similar to those of the San Pedro soils. (Pl. 33, fig. 2.) These soils are high in lime, which is fairly evenly distributed throughout the topsoil and subsoil. Riggs silty clay loam and Riggs clay, with a red phase, are indicated on the soil map.

SOILS FROM RECENT-ALLUVIAL MATERIALS

The soils derived from recent-alluvial materials have undergone little or no modification by weathering. Many of them are still receiving fresh alluvium, so that their characteristics indicate the nature of the parent material from which they have developed. These soils occur along stream bottoms and on slopes of recent-alluvial fans. They are often poorly drained and in many places contain alkali accumulations which vary in depth and concentration, depending largely on the drainage conditions. These soils have been differentiated as Tonopah, Land, Gila, and Redfield soils.

Tonopah soils.—Tonopah soils occur on slopes of alluvial fans in the upper Moapa Valley and along Meadow Valley Wash. They are characterized by the loose structure and coarse texture of the soil material. The topsoils are light brown, yellowish brown, pinkish brown, or grayish brown, with a slight development of mulch and compact layers, and in some places slight lime accumulations within

2 feet of the surface. The subsoils are loose, unmodified gravelly sand, and in some places hardpan has developed. These hardpan formations are probably remnants of older materials which have been covered by a recent deposition of alluvium.

Unimportant variations, including some incipient deposition of lime in the gravelly subsoil, were noted. Three members of the Tonopah series have been mapped in this area, gravelly sand, fine sand, and gravelly sandy loam.

Land soils.—Soils of the Land series occur as stream-bottom lands along the lower end of Meadow Valley Wash. The topsoils are light brown or light grayish brown with a slight pinkish tinge, and in virgin condition consist of a thin surface crust and mulch underlain by a comparatively compact subsurface layer. The subsoils are practically unmodified and consist of irregularly stratified materials, varying in texture from clay to fine sand, the heavier-textured materials being reddish brown and the sandier materials grayish brown.

Drainage is poor, although it has been somewhat improved by the recent erosion of the stream channel. Lime accumulation has hardly begun in these soils, since the materials are practically unmodified by weathering. They are high in alkali, crystals of alkali salts and gypsum being abundant. They have developed from a great variety of rock materials, both igneous and sedimentary. Inkweed (Suaeda), an alkali-resistant plant, is the characteristic vegetation. Members of the Land series mapped in this area are loamy fine sand and silty clay loam.

Gila soils.—Gila soils occur as bottom lands and on slopes of recent-alluvial fans along Meadow Valley Wash and as bottom lands in the extreme upper end of Moapa Valley above the source of Muddy Creek. The topsoils are light brown or light grayish brown, in some places having a slight pinkish or yellowish tinge. The subsoils are irregularly stratified, the materials varying in texture from silt loam to fine sand, and in color from light brown to grayish brown, the coarser material being grayer than the finer. A substratum of loose gravel occurs in some places.

Drainage is usually fair or good and the quantity of alkali is moderate or low. In a few small areas the subsoil is heavy, the drainage is poor, and soil tests indicate high alkalinity. To a depth of 6 feet or more the materials comprising the Gila soils are practically unmodified by weathering, and they have originated from both igneous and sedimentary rocks, mostly igneous. The materials are micaceous, and there is very little evidence of lime accumulations. Gila fine sand and Gila loam are the only soils of this series mapped in this survey.

Redfield soils.—Soils of the Redfield series occur as the bottoms of the lateral washes which lead into the valleys, and on the slope of alluvial fans which occur at the mouths of these washes. The topsoils and subsoils are pale red, brownish red, or pale reddish brown in color when dry, and deeper red when wet. The heavier-textured topsoils usually have crust and mulch layers. The subsoils are mostly sandy, but on the lower parts of alluvial-fan slopes, the heavier-textured subsoils are irregularly stratified with heavier materials.

These soils are derived from materials resulting from the erosion of red sandstone and from old, red valley-filling materials. Drainage varies according to location; the fine sandy soils which occur on washes and higher fan slopes are well or excessively drained, and the heavier soils on the lower slopes are generally poorly drained and contain considerable concentration of alkali salts. Three members of the Redfield series, fine sand with a dune phase, loam, and clay are mapped in this area.

MISCELLANEOUS MATERIALS

The miscellaneous materials in this area are classed as rough broken and stony land and riverwash. Although these are extensive they are of practically no importance agriculturally.

The distribution of the various types of soil in the surveyed area is shown in the following table, with the acreage and proportionate extent.

TYPES OF SOIL

The acreage and proportionate extent of the soils of Moapa Valley

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Riggs clay	3,904	7.0	Gila loam	1,344	1.7
Red phase	1,664		Land loamy fine sand	448	.6
Riggs silty clay loam	2,432	3.1	Land silty clay loam	1,024	1.3
Redfield loam	3,072	3.8	Las Vegas gravelly fine sandy loam	4,224	5.3
Redfield clay	512	.6	Tonopah gravelly sand	1,856	2.3
Redfield fine sand	5,760	7.5	Tonopah fine sand	832	1.0
Dune phase	256		Tonopah gravelly sandy loam	1,024	1.3
San Pedro fine sand	512	1.1	Rough broken and stony land	44,864	56.1
Deep phase	384		Riverwash	1,024	1.3
San Pedro very fine sand	1,920	2.4			
Mohave fine sand	2,112	2.6	Total	80,000	
Gila fine sand	832	1.0			

RIGGS CLAY

Riggs clay is one of the most extensive and widely distributed soils in Moapa Valley. In the upper valley of Muddy Creek an almost unbroken area extends from near Home Ranch to a point south of Moapa; and from The Narrows to a point below St. Thomas, this soil occurs in rather narrow strips on both sides of Muddy Creek.

The surface soil of Riggs clay consists of dark-gray or dark grayish-brown clay varying from 6 to 12 inches in depth, in some places having a thin crust, and usually having a thin subsurface granular mulch. This is underlain by a layer of compact, dark material. The subsoil is compact, light greenish-gray clay with reddish-brown or black mottlings, and in many places is irregularly stratified with materials ranging in texture from fine sand to clay loam, and in color from light brown to light grayish brown. (Pl. 33, fig. 2.) Thin layers of reddish material occur in some places especially where this soil is adjacent to areas of Redfield soils. The surface soil is heavy but friable, owing to the rather abundant supply of organic matter; and it has a tendency to granulate when properly plowed and cultivated. Several distinct, old-surface, stratified layers are present in some places in the subsoil and substratum.

The surface of areas of this soil is level, and the drainage is poor. In the upper valley much of the land is marshy, but in the lower valley, some areas are drained by the deeply cut channel of Muddy Creek. Where the water table is high, there is usually a high concentration of alkali in the topsoil; but in other places the soluble salts are either uniformly distributed throughout the soil to a depth of 6 feet or are slightly concentrated in the deeper part of the subsoil.

Riggs clay is the most important agricultural soil in the valley. Probably about 3½ square miles of it are under cultivation, and two-thirds of the remainder furnishes good natural pasturage. Alfalfa, wheat, barley, corn, asparagus, lettuce, and other truck crops are grown, ranking in importance in the order named. Cantaloupes and cotton have been grown rather extensively in the past, although their acreage is now small; but truck crops are being grown on an increasing scale. Grapes, almonds, figs, apricots, peaches, apples, and other fruits, mainly for home consumption, are grown on small areas. Pecans, dates, and oranges are also raised in small quantities. Alfalfa yields range from 3 to 8 tons an acre on this soil; wheat averages between 30 and 35 bushels, with some yields as high as 60 bushels to the acre; barley yields from 40 to 50 bushels; and corn, from 30 to 50 bushels. Asparagus is reported to yield 3,000 pounds or 120 crates an acre. Lettuce, radishes, spinach, and onions produce good yields.

In the past, on some ranches, this soil has been cropped year after year to the same crop and often double cropped, resulting in apparent soil exhaustion and dwindling of crop yields. The soil, though naturally rich in organic matter as well as in mineral plant-food elements, needs legumes, green manure, and stable manure to maintain its fertility. Plowing should be done when the soil has the proper moisture content to avoid puddling and clodding. The swampy and alkaline areas could doubtless be made productive by proper drainage, as much of this soil has been reclaimed.

The current value of improved land of this kind varies from $150 to $200 an acre, or may be as high as $500 for land in asparagus, vineyards, and orchards.

Riggs clay, red phase.—The red phase of Riggs clay consists of comparatively recent alluvium of brownish-red or reddish-brown clay, low in organic matter, and which is underlain by older material which shows the development of dark-gray and light greenish-gray layers which are characteristic of the Riggs soils. The red material averages about 3 feet deep, although in places it may be as shallow as 6 inches and in other places as deep as 5 or 6 feet. It is practically unmodified except by alkali concentration. This soil consists of a very thin well-developed surface crust underlain to a depth of a few inches by loose granular material forming a mulch, and this, in turn, is underlain by comparatively compact material. The surface "puffs up" when wet, and the soil is known locally as "self-rising ground." Crystals of alkali salts are visible, especially in the mulch.

In places the clay is irregularly stratified with lighter-textured materials, and in a few small areas the color of the surface soil is dark brown or yellowish brown, as that which occurs northwest of Overton. The difference in color is probably due to the yellower parent material which comes from adjacent old deposits along the

rim of the valley. Along upper Muddy Creek between The Narrows and the Indian reservation, small areas of this soil have clay loam rather than clay surface soils. The surface material, like that of the Redfield soils, has probably originated largely from sedimentary rocks which were derived from red sandstone and reddish old valley-filling deposits. The subsoil probably contains a greater variety of material, much of which originated from igneous rocks, as is characteristic of the Riggs soils.

This soil occurs on bottom lands of both the upper and lower valleys. It occurs as narrow strips on flats at the foot of alluvial-fan slopes where the Redfield soils border the Riggs soils. One of the largest bodies occurs just north and northwest of Overton, with a narrow strip extending to the southeast. Another somewhat larger area lies along upper Muddy Creek about a mile east of Home ranch.

The surface is fairly flat and drainage is poor. Most of this soil contains harmful quantities of alkali. The native vegetation consists largely of a sparse growth of salt grass and inkweed, with screw bean and sacaton grass in places. Some small areas are bare of vegetation.

Only a very small area, probably not more than 40 acres altogether, is under cultivation, most of this being just northwest of Overton. The land produces fairly good alfalfa and wheat, although there are small bare alkali spots in cultivated fields. This land has been irrigated for a number of years and the alkali seems to be gradually decreasing. The uncultivated areas of this soil produce rather scanty natural pasturage.

Most of this soil needs drainage and copious use of irrigation water to wash out the excessive quantities of salts before it can be used for cultivated crops. It also needs organic matter to improve its physical and chemical condition.

RIGGS SILTY CLAY LOAM

An area of Riggs silty clay loam of considerable extent is adjacent to the junction of Muddy Creek and Meadow Valley Wash. Other areas have developed above the Moapa Indian Reservation along Muddy Creek, and also in the valley south of The Narrows.

The surface soil has been extensively modified by recent deposits of alluvium, with the result that the texture, color, and structure vary markedly in areas not widely separated. The surface soil usually consists of grayish-brown silty clay loam to depths varying from a few inches to a foot or more, and the underlying layer, about 6 inches thick, consists of dark-gray or dark grayish-brown silt loam or clay loam material containing many roots and other organic matter. This layer is succeeded by one of variable thickness, made up of fairly compact silty clay or clay, dark gray in color and occasionally slightly mottled with greenish or brown tints. The underlying material is irregularly stratified. These strata represent successive periods of deposition, and range in texture from clay to fine sand, with the heavier-textured materials predominating. This underlying material (pl. 33, fig. 2) ranges in color from greenish gray to light grayish brown, the darker colors occurring in the

heavier-textured materials. In a few small areas in the valley of upper Muddy Creek, the surface soil is almost black, and the upper part of the subsoil is light-gray, highly calcareous clay loam material. An underlying lime-cemented hardpan occurs within 3 feet of the surface.

Typical Riggs silty clay loam consists of dark-colored topsoil and subsoil. As occurring in this area, however, it differs from typical in having a topsoil which has been extensively modified by overwash of more recent alluvium of lighter color.

This soil is rather widely distributed, occurring as narrow strips parallel to the creek channel in both the upper and lower valleys and in the lower end of Meadow Valley Wash. The surface is usually fairly level, and drainage is poor. The water table and surface concentration of alkali are high except along the newly cut stream channel, where drainage is good and the alkali content of the soil is moderate. The native vegetation consists principally of sacaton, salt grass, mesquite, arrow weed, saltbush, and inkweed.

Only about 1½ square miles of this soil are under cultivation, because much of it is occasionally flooded, some of it is high in alkali, and the water supply is insufficient. Much of it, especially in the upper valley, where it produces a good growth of sacaton and salt grasses, furnishes fairly good natural pasturage. Alfalfa, wheat, barley, and corn are the principal crops. Asparagus and other truck crops are also grown. Alfalfa yields range from 5 to 7 tons an acre; wheat, from 30 to 40 bushels; barley, 40 to 50 bushels; and asparagus averages 115 crates.

This soil needs drainage, and alkali salts should be removed. It is comparatively rich in organic matter, and needs less manure than many of the other soils of the area. Crop rotation and the incorporation of organic matter will probably be necessary, however, where the land is farmed for many years.

The value of improved land ranges from $150 to $200 an acre, and that of unimproved land without water is about $15.

REDFIELD LOAM

This soil is most extensively developed on the west side of Muddy Creek Valley, south of The Narrows. Several small areas occur throughout the upper valley.

The surface soil of Redfield loam consists of pale red loam, containing considerable fine sand, the immediate surface of which is slightly crusted and underlain by loose granular mulch about 1 inch thick. The loose material is underlain by a compact layer. The pale-red fine sandy subsoil is unmodified by weathering. It sometimes shows stratified layers, particularly on the lower slopes, the materials of which range from fine sandy loam to clay. Where cultivated, the texture of the surface soil of Redfield loam is becoming heavier from deposition of fine sediment by irrigation water.

The surface drainage is good but the subsurface drainage is poor, especially on the lower portions of the slopes where heavy layers occur in the subsoil and substratum. In such places a high water table has developed under irrigation, and there may be a high surface concentration of alkali, in addition to the high percentage of alkali usually present in the heavy subsoil layers. On the upper slopes,

where the subsoil is predominantly sandy and the drainage good, the alkali content may be low or only moderate.

The native vegetation on this soil varies greatly, creosote bush being characteristic of the higher and better-drained locations, and mesquite, screw bean, inkweed, and salt grass plentiful on poorly drained places.

This soil ranks next to Riggs clay in agricultural importance, the total area cultivated being about 2 square miles. The principal crops are alfalfa, barley, wheat, and corn, with an increasing acreage devoted to asparagus and early vegetables. Cantaloupes, once grown extensively, are now little cultivated. Alfalfa yields well for the first few years but soon "runs out," and yields vary from 2 to 8 tons an acre. Barley yields range from 30 to 40 bushels; wheat, from 20 to 30 bushels; and corn, from 30 to 50 bushels an acre. Vegetables and melons mature earlier on this soil than on Riggs clay, but do not yield so heavily. Asparagus produces an average of 100 crates an acre, and cantaloupes yield from 100 to 200 crates. There are a number of small vineyards on this land and a few small orchards producing figs, apricots, peaches, almonds, and apples. Small areas are devoted to tame grasses for pasturage, and a considerable area furnishes natural pasturage.

Crop rotation, including the growing of alfalfa and other legumes, together with the turning under of barnyard and green manure, is essential in maintaining the fertilitiy of this soil. On this soil inoculation with nodule bacteria for legumes is beneficial. Improved land of this kind is worth from $100 to $200 an acre, or considerably more if in orchard, vineyard, or planted with asparagus.

REDFIELD CLAY

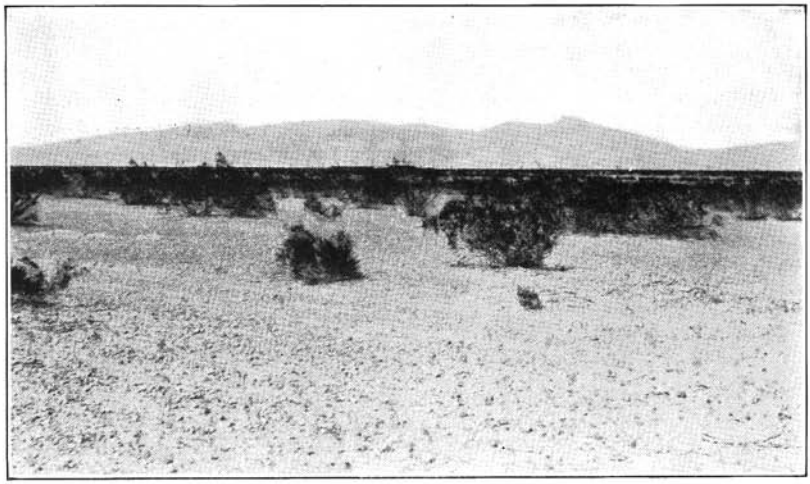
This soil occurs principally along the west side of the lower valley on alluvial-fan slopes in association with the fine sand and loam members of this series. Only a few small areas occur north of The Narrows.

The surface soil of Redfield clay is silty-textured clay ranging in color from brown to pale red. It is slightly crusted and has a mellow granular subsurface mulch from 1 to 3 inches thick. This is underlain by a compact layer several inches thick, and the subsoil is largely pale-red fine sand, showing thin strata of heavier materials. The deeper portion of the subsoil and substratum contain layers of red or reddish-brown clay.

Surface drainage is good but subsurface drainage poor, and the greater part of this soil is badly affected with alkali, in many places containing as much as 3 per cent of soluble salts.

Redfield clay is not an important soil agriculturally, the area under cultivation aggregating not more than 100 or 150 acres. Shortage of water, poor drainage, and the bad alkali condition have prevented cultivation. The more common crops are alfalfa and small grains, and a small area is devoted to pasture. Cantaloupes are grown on this soil northeast of Logandale (pl. 34), and a small acreage is devoted to garden truck and orchards. Alfalfa yields range from 2 to 5 tons an acre, and cantaloupes from 150 to 200 crates.

On poorly drained land, drainage and the washing out of the alkali salts are essential to successful agricultural development.



NO 11701

FIG. 1.—SURFACE FEATURES AND NATIVE VEGETATION ON LAS VEGAS GRAVELLY FINE SANDY LOAM. THE VEGETATION IS MAINLY CREOSOTE BUSH

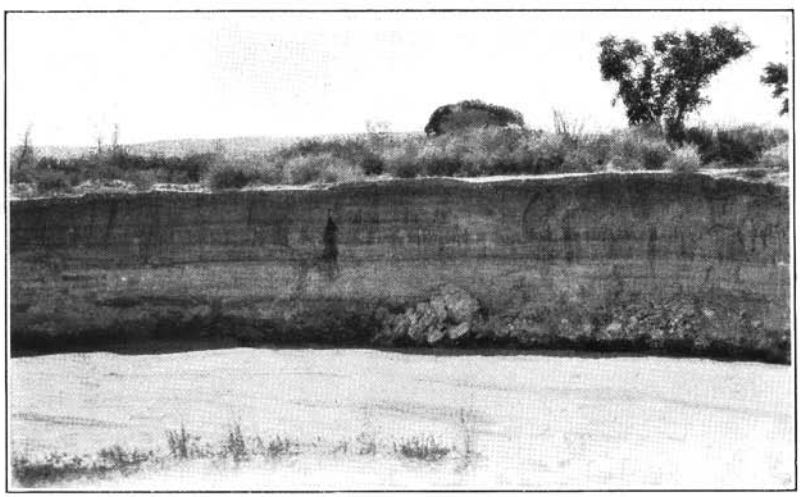


PHOTO BY E. J. CARPENTER

FIG. 2.—CROSS SECTION SHOWING STRATIFIED MATERIALS IN THE RIGGS SOILS, ALONG MUDDY CREEK

NO. 11775

TRACT OF REDFIELD CLAY RECENTLY CROPPED TO CANTALOUPES

This has been accomplished in small areas. Crop rotation and the incorporation of organic matter are also advised.

The results of mechanical analyses of samples taken at various depths in Redfield clay are given in the following table:

Mechanical analyses of Redfield clay

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*
530304	Surface crust, 0 to 1 inch	0.2	0.6	0.4	3.9	19.9	45.3	29.6
530305	Subsurface mulch, 1 to 3 inches	.0	.2	.3	8.4	9.9	46.4	35.0
530306	Subsurface, 3 to 7 inches	.0	.1	.4	3.2	15.0	45.8	35.4
530307	Subsoil, 7 to 26 inches	.0	6.5	14.2	57.4	6.0	7.6	8.1
530308	Subsoil, 26 to 72 inches	.0	1.8	13.0	67.8	6.0	5.4	5.8

REDFIELD FINE SAND

Redfield fine sand is one of the most widely distributed soils in Moapa Valley, occurring on the fan slopes and along lateral washes.

Redfield fine sand consists of uniform, pale-red, friable fine sand to a depth of 6 feet. In the vicinity of the washes waterworn gravel is scattered throughout the soil and some stratification with heavier-textured materials is present in places. Under irrigation the surface soil has been changed to fine sandy loam, loam, or even clay loam, through the deposition of fine-textured sediments by irrigation water. Such areas have been mapped as Redfield loam.

Areas of Redfield fine sand are usually gently sloping and are occasionally modified by hummocks and small dunes of wind-blown sand. The higher areas are excessively drained, but on the lower-lying situations subsurface drainage is poor. The heavy stratified materials in the subsoil usually contain considerable alkali. The native vegetation consists largely of cresote bush, though in the poorly drained areas arrow weed, inkweed, and salt grass are abundant.

This soil, although comparatively extensive, is not important agriculturally, the total area under cultivation being less than half a square mile. This is due to a number of causes. Much of this soil is above the present irrigation ditches; it is subject to occasional floods which deposit thick layers of sand in some places and cause deep erosion in others; it is mostly loose and leachy, requiring an excessive supply of water, and where the water supply is insufficient, as it is in this area, the water may be used more economically on other soils; and the surface dries out rapidly and wind drifting is apt to occur, thus rendering it difficult to obtain a stand of most crops. The low land along Virgin River is too badly water-logged and affected with alkali to be of much agricultural value. Alfalfa, corn, small grains, melons, and vegetables are grown on this soil. Alfalfa yields well for a few years but soon "runs out," the yields ranging from 2 to 7 tons an acre. Small grains do not yield very heavily, wheat producing from 15 to 30 bushels an acre, and barley and corn a little more. Vegetables and melons ripen early on this soil, but do not yield so heavily as on the heavier types of soil.

Tree fruits and grapes would doubtless thrive better on well-drained parts of this soil than on most of the other soils of the area as its position on higher ground renders it freer from frost than most of the lower lands. Incorporation of organic matter and crop rotation are the principal needs, and drainage is advisable in a few places. Inoculation of legumes has proved beneficial on this soil.

Redfield fine sand, dune phase.—Dune-phase Redfield fine sand consists of loose fine or medium sand to a depth of 6 feet or more, ranging in color from pale red to light grayish brown. It occurs in wind-piled ridges or dunes. These dunes are formed where sand drifts into mesquite thickets, forming "mesquite knobs" which have a core of mesquite branches and roots, the live twigs extending only a few inches above the sand.

Areas of this soil are small and scattered and most extensively developed along Virgin River and in the lower part of the Moapa Valley near the mouth of Muddy Creek. A few small scattered areas occur along Meadow Valley Wash. The total area is less than one-half square mile. The material is variable, being similar to that of the surrounding sandy soils, but it is most closely associated with and related to Redfield fine sand.

In places this phase may be successfully developed for agricultural purposes. Its crop adaptations and needs are much the same as those of the sandy soils with which it is associated, but considerable work and expense are required to level the "mesquite knobs" and other areas and prepare them for irrigation.

SAN PEDRO FINE SAND

San Pedro fine sand occurs as narrow strips chiefly along Muddy Creek south of The Narrows.

Its surface soil is light grayish-brown fine sand, varying in depth from 6 inches to 3 feet or more, and may be underlain by light-textured materials; but when these are not present the surface sand rests upon dark grayish-brown silt loam or clay from 4 or 5 inches to a foot or more thick. The subsoil is lighter-greenish clay, with reddish-brown and black mottlings, and is, in some locations, stratified with lighter-textured materials, varying from fine sand to clay loam.

The surface of this soil is fairly level though somewhat hummocky in places, because of drifting of the surface soil by the wind. Drainage varies from fair to poor, and the alkali content from moderate in the light-textured surface soil to high in the heavier-textured subsoil.

Only a small proportion of this soil, not more than 100 acres, is under cultivation. The fact that it has been subject to frequent overflow and heavy deposits of fresh sandy material has hindered its agricultural development, but this condition is being remedied as creek waters cut down into the newly straightened channel. Alfalfa grown on this soil yields well, probably from 4 to 7 tons an acre; but the rapid drying out of the surface and its shifting by the wind make it difficult to obtain a stand of most crops. Grains do fairly well where the heavy subsoil is close to the surface, and the soil is well suited to the production of early vegetables. The surface soil lacks organic matter, and the plowing under of green and barnyard

manures is recommended, as well as a system of crop rotation which includes alfalfa and other legumes.

Because of flooding, this kind of land has been considered practically worthless. Unimproved land has been estimated as worth $15 an acre, and improved land, free from floods, is probably worth from $100 to $200 an acre.

San Pedro fine sand, deep phase.—Deep San Pedro fine sand occurs in The Narrows and north of this along Muddy Creek. The surface soil of deep San Pedro fine sand consists of a deep recent wash of light grayish-brown fine sand stratified in places with slightly heavier materials. This surface layer varies from 3 to 6 feet or more in depth and is underlain by the heavy gray subsoil characteristic of the San Pedro soils. In a few small areas the surface material has been in place long enough to acquire a slightly dark gray tinge from the accumulation of organic matter.

The surface of this land is fairly smooth but is modified by low wind-blown hummocks, and the areas are divided by the deeply cut channel of the creek, which has effected good and even excessive drainage. The surface soil, excepting for a small strongly alkaline area near the mouth of Meadow Valley Wash, is practically free from alkali, but the heavy subsoil contains alkali salts.

None of this soil is as yet under cultivation. Its agricultural value under irrigation would probably be somewhat less than that of typical San Pedro fine sand, because the water-holding capacity is undoubtedly lower. That area of this soil which lies in The Narrows could be farmed only on a small scale because of its limited width and the fact that it is bordered by rough broken and stony land. The same crops are adapted to, and the same treatment advised for this soil as for typical San Pedro fine sand.

SAN PEDRO VERY FINE SAND

This soil occurs principally in the lower valley in narrow strips along or near and roughly parallel to Muddy Creek channel.

The surface soil of San Pedro very fine sand consists of friable, micaceous, light grayish-brown very fine sand, somewhat loamy in texture, ranging from 6 inches to 3 feet deep. In some places it is underlain by, or stratified with heavier-textured materials. The heavier subsoil is dark grayish brown, stratified with light greenish-gray clay, and profusely mottled with a variety of colors, black, red, and reddish brown predominating.

The surface is usually fairly level, and drainage is poor, except along the deep stream channel. The soil contains from moderate to high quantities of alkali, and where the water table is high the alkali concentration of the surface soil is high. Native vegetation consists largely of saltbush (*Atriplex* sp.) and salt grass.

Much of this soil type has been subject to frequent overflow, and comparatively little of it, probably not more than 1 square mile, is under cultivation. Alfalfa, wheat, barley, and corn are the crops of largest acreage, though asparagus, lettuce, spinach, radishes, and other vegetables do well on this soil, and are increasingly grown. A very small area is devoted to vineyards and orchards. Alfalfa yields range from 4 to 8 tons an acre; barley, from 30 to 70 bushels;

wheat, from 25 to 60 bushels; and the asparagus yield has been estimated at 3,000 pounds, or 120 crates an acre.

The value of improved land ranges from $150 to $200 an acre, or as high as $500 if planted with asparagus, vineyards, or orchards.

Crop rotations including the growing of alfalfa or other legumes, and the incorporation of organic matter are advised. It is probable that with better drainage, harmful alkali could be removed from those areas which are now strongly affected.

MOHAVE FINE SAND

This soil occurs as a strip of land on the bench along the east side of the lower valley, northeast and north of Overton.

Its surface soil is loose pale-red fine sand from 3 inches to 1 foot or more deep, usually containing a small percentage of gravel. This is underlain by rather compact, light pinkish-brown loamy fine sand or fine sandy loam material which continues to a depth of about 24 inches, and in turn, by light pinkish-brown or light pinkish-gray fine sand or fine sandy loam material which extends to a depth of about 6 feet. The substratum usually consists of beds of loose gravel.

The upper part of the topsoil contains a high percentage of lime and shows some soft lime carbonate nodules, whereas the deeper part of the subsoil, above the gravel substratum, is compact, slightly cemented, and contains many hard nodular lime concretions.

This land rises with a gentle slope from the escarpment along the edge of the valley toward the bordering areas of rough broken and stony land. Both surface and subsurface drainage are good, and the soil is free from alkali. The native vegetation consists largely of creosote bush and wormwood.

This soil is high above the present irrigation ditches in the valley, though there is some possibility that water may be diverted farther up the valley and brought onto the bench, in which case the soil may be developed agriculturally. It is probable that alfalfa, grapes, and tree fruits with some early vegetables would be best adapted to this soil. Its position on a high, sloping bench renders it comparatively frost free and thus suited to crops which could not be grown on the lower lands of the valley.

If brought under cultivation, this soil would need nitrogen and humus, both of which could be supplied in the form of barnyard manure and green manures.

GILA FINE SAND

The soil occurs principally as long narrow strips constituting bottom lands of Meadow Valley Wash, and extending, with a few breaks, for a distance of about 6 miles.

Gila fine sand has a surface soil of light grayish-brown, loose fine sand, varying from a few inches to 2 or 3 feet deep, and underlain by a subsoil of irregularly stratified materials varying in texture from silt loam to fine sand. The heavier materials are light brown with a slight yellowish or pinkish tinge, and the lighter ones grayish brown. The soil material is distinctly micaceous, and a gravel substratum is usually present, in places within 6 feet of the surface.

The surface is fairly level though modified here and there by low, wind-formed hummocks, which may be 2 or 3 feet high. Drainage is good in most places and the soil is practically free from alkali; but there are small areas back from the stream channels where drainage is only fair and the subsoil contains considerable alkali.

Not more than 10 to 15 acres of this soil is under cultivation. This is above the source of Muddy Creek, and is irrigated by water which is pumped from wells. This soil is all above gravity water so that pumping seems to be the only feasible means of irrigation. The small area now farmed is producing excellent alfalfa and fairly good grain, alfalfa yielding from 4 to 8 tons an acre. Vegetables, grapes, and tree fruits might do well on this soil.

Crop rotation and the application of manures are advised. Some trouble is experienced in obtaining crop stands on account of the blowing of loose surface material. A rather large head of water is essential in irrigating, on account of the loose soil, though the fine texture of the subsoil makes the water-holding capacity good.

GILA LOAM

Gila loam occurs as small irregular strips along Meadow Valley Wash, in a few small areas along upper Muddy Creek, and at the head of Moapa Valley.

The surface soil of Gila loam is mellow or very slightly compacted loam of silty texture, which varies from a few inches to several feet deep. The color is light brown with a yellowish or pinkish tinge. The subsoil consists of stratified materials which vary in texture from silt loam to fine sand rarely as heavy as silty clay loam. The finer materials are light brown and the coarser ones grayish brown. In places the material, to a depth of 6 feet is almost uniform silt loam or very fine sandy loam in texture. A gravel substratum underlies much of this soil and may be within 6 feet of the surface. No perceptible modification of this soil material by weathering is evident.

The surface is fairly level, so that surface drainage is not particularly well developed; but subsurface drainage is usually good, especially near the deeply cut stream channels. These better-drained areas are practically free from alkali. In some places, on low ground or at some distance from the stream channels, the drainage is not good and alkali has accumulated, especially in the subsoil; but only rarely does a strong surface accumulation exist. The native vegetation consists largely of wormwood, with some creosote bush, and on the more alkaline areas inkweed is common.

Not more than 30 acres of this soil are under cultivation. This cultivated land is at the head of Muddy Creek Valley and is irrigated by pumping from wells with a water lift of about 20 feet. The rest of this soil probably should be similarly irrigated. The area under cultivation is producing only alfalfa, which yields from 4 to 8 tons an acre.

Gila loam if sufficiently irrigated would doubtless be well adapted for alfalfa, corn, small grains, asparagus, melons, and early vegetables; and where drainage is good tree fruits and grapes should thrive. For satisfactory results this soil should be supplied with nitrogen and humus, both of which may be supplied by the growing of leguminous crops and the incorporation of organic manures.

The results of mechanical analyses of samples of Gila loam topsoil and subsoil are shown in the following table:

Mechanical analyses of Gila 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*
530350	Topsoil, 0 to 30 inches	0.2	6.8	4.2	23.8	6.2	45.8	13.0
530351	Subsoil, 30 to 36 inches	.6	24.8	6.0	34.0	6.0	22.2	6.6

LAND LOAMY FINE SAND

Land loamy fine sand occurs as narrow strips constituting bottom lands extending from a point 1 mile above the junction of Meadow Valley Wash and Muddy Creek to a point about 4½ miles north.

The surface material of Land loamy fine sand is loose or slightly compact, light grayish-brown loamy fine sand, varying from a few inches to several feet deep. This is underlain by irregularly stratified material of darker brown color and varying in texture from clay with a reddish tinge to grayish-brown fine sand. The only noticeable modification in the profile is the concentration of alkali in the heavier layers, alkali salts and gypsum crystals being common in these layers.

In places the surface is covered with low wind-formed mounds of loose fine sand, between which are hollows of heavier and more compact material. Except for these mounds the surface is generally fairly flat, and the drainage poor except along the newly cut stream channel. The alkali content varies from low to high in the light-textured surface material, and is invariably high in the heavier subsoil. The vegetation consists largely of inkweed, with some wormwood.

This soil is all in the virgin state. Apparently the only feasible means of irrigation would be by means of wells. It has not been demonstrated that a sufficient water supply could be obtained from this source. With an ample supply of water this should make good agricultural land. Artificial drainage might prove necessary, and in places the excess salts would have to be washed out before crops could be grown successfully. Wind drifting of the surface would probably make it difficult to obtain a stand of some crops. The growing of legumes and the incorporation of organic matter would doubtless be beneficial. Alfalfa, corn, small grains, and vegetables should be adapted to this soil.

LAND SILTY CLAY LOAM

Land silty clay loam occurs as bottom lands in the lower portion of Meadow Valley Wash. The topsoil consists of light-brown silty clay loam with a slight pinkish tinge, with a thin surface crust, a mulch layer of granulated material an inch or two thick, and a compact subsurface layer a few inches thick. The subsoil consists of variously stratified materials ranging in texture from fine sand to silty clay or clay. The lighter-textured materials are grayish brown

and the heavier ones darker brown with a distinct reddish tinge. The heavy subsoil layers contain salt concentrations, with some crystals, and in many places a slight mottling or flecking with light gray may be seen. Areas of Land clay loam, Land fine sandy loam, and Land fine sand, too small to be indicated on the map, are included with mapped areas of this soil.

Land of this kind is fairly level and the drainage is poor, except near the stream channel. Both topsoil and subsoil are highly impregnated with alkali. In many places the surface material, 1 foot deep, contains more than 3 per cent of salts, and the subsoil nearly as much. The native vegetation consists almost entirely of inkweed, and some small areas are bare of vegetation.

None of this land is under cultivation, nor is there at present any adequate supply of irrigation water available. It is possible that at some future time water may be diverted from Muddy Creek to irrigate the lower part of Meadow Valley Wash. Under cultivation it might need artificial drainage in some places, and most of it would need to be irrigated heavily to reduce the salt concentration sufficiently to enable crops to be grown successfully. Alfalfa, small grains, corn, sorghum, and vegetables could probably be grown. Crop rotation, including the growing of legumes and the incorporation of organic matter, would benefit this soil under cultivation.

The following table gives the results of mechanical analyses of samples of subsurface and subsoil of Land silty clay loam:

Mechanical analyses of Land silty clay 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*
530346	Subsurface, 1½ to 5 inches	0.1	0.2	0.2	5.9	4.9	65.6	23.0
530347	Subsoil, 5 to 13 inches	.0	.1	.1	5.7	6.9	51.6	35.7

LAS VEGAS GRAVELLY FINE SANDY LOAM

Las Vegas gravelly fine sandy loam occurs principally as high bench lands north of Moapa. A few small bodies lie along the edge of the bench lands. The surface is fairly level or gently rolling, the surface drainage is good, and no accumulations of alkali are present. The characteristic vegetation consists of creosote bush. (Pl. 33, fig. 1.)

Las Vegas gravelly fine sandy loam has a surface concentration or "desert pavement" of angular or slightly rounded dark-colored gravel stones. Between the stones on the surface of this pavement is a loose covering of light-brown fine sand or fine sandy loam material, only a fraction of an inch thick. This loose surface covering gives to the land its characteristic light-brown or light grayish-brown color, with a very slight pink tinge. This surface material is underlain by a 2-inch layer of light-brown, compact, heavy, fine sandy loam material, with a distinct pink tinge, and containing considerable gravel and caliche. This compact layer is underlain by loose, pale reddish-brown fine sandy loam material, containing from 10 to 20 per cent of gravel, which extends to a depth of a few inches, or to

18 inches where the hardpan is unusually deep. It grades into compact, slightly cemented, pinkish-brown fine sandy loam material, containing gravel, lime nodules, and caliche fragments. All this is underlain by a massive lime-cemented gravel hardpan, which occurs at depths varying from a few inches to 2 feet, and usually extends downward for many feet. In some places the surface compact layer is not well developed, small areas of Las Vegas sandy loam and Las Vegas sand are included with this soil as mapped, and in a few places the gravel substratum is not cemented into solid hardpan.

As elevation of this soil above the streams has prevented its irrigation and development, it is all in the virgin state; and even if irrigation water were obtainable, it is doubtful whether this soil would have much agricultural value. The occurrence of the firmly cemented lime-carbonate hardpan near the surface and the high percentage of gravel render the water-holding capacity low, so that the soil would undoubtedly dry out very rapidly. Very little grass grows, so that the value of the land for grazing purposes is slight.

The following table shows the results of mechanical analyses of samples of the subsurface and subsoil materials of Las Vegas gravelly fine sandy loam:

Mechanical analyses of Las Vegas gravelly 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*
530335	Compact subsurface ½ to 2½ inches	0.9	3.7	4.6	43.0	9.6	24.1	14.0
530336	Loose subsurface, 2½ to 6 inches	1.8	5.4	5.5	57.0	9.2	13.2	7.8
530337	Subsoil, 6 to 13 inches	1.5	6.0	4.5	50.9	7.1	16.0	14.0

TONOPAH GRAVELLY SAND

Tonopah gravelly sand occurs on slopes of alluvial fans along the west side of Meadow Valley Wash and below an escarpment on the western bench, and small detached bodies occur on fans bordering the valley along the upper course of Muddy Creek.

The topsoil of Tonopah gravelly sand is light grayish-brown or light pinkish-brown sand with a slight yellowish tinge, containing large quantities of fine sand and from 25 to 50 per cent of gravel. It usually has a thin loose mulch on the surface, underlain by somewhat more loamy and more compact material a few inches deep. The subsoil is unmodified, loose, porous, gravelly, or coarse sand. In many places the surface soil is loose, showing no zone of compaction. The soil is low in organic matter and both surface and subsoil materials are highly calcareous.

The surface is gently or rather steeply sloping, the drainage is excessive, and the soil is low in alkali. Native vegetation consists largely of creosote bush, with some wormwood.

This land, practically all in the virgin state, occurs at too great an elevation for effective irrigation, and is too coarse and porous to be of much value.

TONOPAH FINE SAND

Tonopah fine sand occurs on fan slopes only along the east side of Meadow Valley Wash, beginning about 8 miles above the mouth and extending northward for nearly 4 miles.

Tonopah fine sand consists of loose fine sand 6 or more feet deep, with gravel scattered through it. Occasionally gravel strata occur in the deeper material, and the proportion of gravel is greater at the mouths of the washes and in the upper portions of alluvial fan slopes. The profile is much like that of Redfield fine sand, but the material is a different color, being grayish brown with a yellowish tinge, resembling Tonopah gravelly sand. The surface is modified in many places by the wind.

Tonopah fine sand occurs on gentle or even fairly steep slopes, the surfaces of which may be hummocky owing to the drifting of loose sand by the wind. Drainage is excessive, the soil is free from alkali, and the native vegetation is largely creosote bush.

Because of insufficient available water, this soil has little agricultural value.

TONOPAH GRAVELLY SANDY LOAM

Tonopah gravelly sandy loam occurs principally on lower alluvial-fan slopes along the west side of Meadow Valley Wash, beginning at a point about 5 miles above the mouth of the wash and extending with few breaks to near the north end of the area. Three very small bodies occur 1½ miles southeast of Logandale along the foot of the bench.

Tonopah gravelly sandy loam has a gravel concentration or "desert pavement" on the surface, between the gravels of which is a loose covering of mulch, only a fraction of an inch thick, of light grayish-brown fine or very fine sand with a slight yellowish tinge. This is underlain by a compact layer of sandy loam material several inches thick, light brown in color with a slight pinkish tinge, and having a slight concentration of lime and containing about 10 per cent of gravel. Underlying this, to depths ranging from about 10 inches to 2 feet, is a layer of fairly compact sandy loam or fine sandy loam, of light-brown color tinged with gray, the lighter color being the result of the slight accumulations of lime. This layer probably contains about 25 per cent of gravel. It is underlain by loose, open subsoil of light grayish-brown gravelly sand, the gravel averaging about 75 per cent of the material and in some places showing a slight coating of lime. Some small areas are underlain by hardpan within 3 feet of the surface, but it is probable that these are remnants of an older formation over which the more recent materials have been deposited.

The surface is fairly smooth and has a gentle slope from the higher lands toward the stream channel. Drainage is excessive and there are no alkali accumulations. The typical vegetation consists of creosote bush and wormwood.

This soil is all in the virgin state and its agricultural possibilities seem very limited. Its situation above any present supply of water, and the fact that it is so coarse textured and porous and has low

water-holding capacity, will probably prevent any successful agricultural development.

The results of mechanical analyses of samples of the subsurface and the subsoil materials of Tonopah gravelly sandy loam are given in the following table:

Mechanical analyses of Tonopah gravelly 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*
530364	Subsurface, ¼ to 6 inches	6.8	12.8	6.6	35.6	10.2	14.0	13.9
530365	Subsoil, 6 to 20 inches	8.9	29.4	9.9	24.6	4.6	14.0	8.4

ROUGH BROKEN AND STONY LAND

Rough broken and stony land is more extensive than any type of soil in this area, comprising more than one-half the total area surveyed. It forms a distinct escarpment bounding the valleys of Muddy Creek, Meadow Valley Wash, and Virgin River, and in most places extends to the boundaries of the area. It borders the bench lands and their escarpments around Moapa, and includes small isolated bodies occurring in the valley along the edge of the inclosing escarpments.

Under this head are included lands which have too steep slopes or which are too badly cut by erosion to be of much agricultural value, and areas having outcroppings of bedrock. Small patches of fairly level bench land are included which are too isolated and inaccessible to have any agricultural value, but if differentiated they would be classed mostly as gravelly types of the Las Vegas soils. A solid lime-cemented hardpan within a foot of the surface is typical of the flatter areas of this kind of land. The lands on a low limestone mountain ridge which crosses the valley at The Narrows, and another above the head of Muddy Creek, are also included under this class.

The materials vary greatly in origin, color, and texture, ranging from stone and gravel to silt and clay. Many of them are old deposits firmly cemented with lime, and along the lower valley sedimentary rock materials predominate, though along the upper valley and Meadow Valley Wash much basalt and other igneous materials are present.

This land has a scant growth of bunch grass, which gives it a slight value as grazing land.

RIVERWASH

Virgin River is subject to great variation in stream flow, and Meadow Valley Wash, usually dry along much of its course, is subject to frequent floods. These streams spread out in periods of high water over wide stream beds, and upon receding, leave barren flats of stream-deposited materials which have been mapped as riverwash. This material ranges widely in origin, color, and texture, varying from loose rounded bowlders and cobbles to gravel and medium and

fine sand. The soil mass is usually loose and leachy, is practically barren of vegetation, and is without value as an agricultural soil.

IRRIGATION

The cultivated lands of the lower valley and a number of ranches along the upper valley are irrigated from Muddy Creek or from its tributaries. Above the source of the creek two small ranches are irrigated by water pumped from shallow wells. The flow of the creek is perennial but it diminishes in the summer when the demand for water is greatest, and for this reason only a small part of the available land is under irrigation. Except for a small reservoir located south of Kaolin, no provision is made for storing water for irrigation, though there has been some thought of building a dam at The Narrows for storing the winter run-off and the flood waters from Meadow Valley Wash. There is also some possibility of building a dam many miles above in Meadow Valley Wash, for flood control and storage of irrigation water. Considerable land now lying idle could be used for growing vegetables or other crops in the winter when the water supply is greatest.

A cooperative irrigation system exists in the lower valley under which one share of water stock is issued for each acre watered, preferred stock entitling the holder to water the year round, and common stock entitling him to water only from about October 1 to May 1 of each year. A rotation system of water distribution is used.

The more level lands are commonly irrigated by flooding and the more sloping ones by the furrow or corrugation method. The heavier-textured soils, as a rule, have a higher water-holding capacity and do not require such frequent irrigation as the lighter ones. Subsoil conditions, rather than the texture of the surface soil, probably determine this. Only one soil now under cultivation, Redfield fine sand, has excessive water requirements, although a number of soils still in the virgin condition such as gravelly sand, fine sand, and gravelly sandy loam members of the Tonopah series, Las Vegas gravelly fine sandy loam, and parts of Gila fine sand, might require a great deal of irrigation water.

DRAINAGE AND ALKALI

In general the bench lands, lateral washes, and upper parts of the alluvial-fan slopes bordering the valleys are well or excessively drained and free from alkali. Poor drainage characterizes many of the low-lying bottom lands and lower alluvial-fan slopes. This condition has been ameliorated by the recent cutting of deep channels by Muddy Creek and Meadow Valley Wash. There are several areas, however, at some distance from these channels or where the streams have not cut down, in which a high water table or even a marshy condition exists. Many of the lower-lying fan slopes in the lower valley have developed a high water table since the higher land has been irrigated.

In most places where the water table is within 3 or 4 feet of the surface and the land is not irrigated, a high surface concentration of alkali salt exists, though the average salt content in the 6-foot section

may be rather low. Where the land has been irrigated the surface concentration is usually moderate. In lands which have been drained by the fresh cutting of the stream channel, and the surface occasionally overflowed, a low or moderate alkali content usually exists in the surface soils, and the heavy subsoils contain moderate or high percentages. The subsoils of most soils in the area contain sandy strata, and it seems probable that by digging deep ditches or laying tile at sufficient depth, the water table, now dangerously high, could be lowered. Alkali concentrations are being reduced in places by flooding the surface with copious supplies of water. Seepage from ditches and reservoirs is doubtless responsible in part for the water-logging of much land.

The alkali in this area is practically all composed of white alkali salts, sulphates and chlorides of sodium predominating. Little evidence of black alkali (sodium carbonate) exists. This is probably largely due to the quantity of gypsum in the soil materials of this region, which neutralizes or converts the black alkali into less injurious forms of white alkali.

The conditions of alkali accumulation in the soils of the area have been graphically represented on the alkali map accompanying this report.

Four general classes of land are indicated by colors on the alkali map, as follows: Alkali-free lands, moderately affected lands, strongly affected lands, and nonagricultural lands. The quantity of alkali in the different soils was determined in the field by the use of the electrolytic bridge; the percentage of alkali in the air-dry soil within a foot of the surface and to a depth of 6 feet being estimated. The results are indicated on the alkali map by figures; the upper figure is the percentage of alkali salts within a foot of the surface, and the lower figure is the percentage of salts to a depth of 6 feet. These proportions vary greatly within short distances, but the results recorded give a general idea of the alkali content in the vicinity of the borings.

Alkali-free soils include those containing less than 0.2 per cent of alkali salts, and many of them contain less than 0.04 per cent. There is probably little danger that harmful alkali concentrations will form in these soils unless a high water table should develop. The soils included in this group are, Las Vegas gravelly fine sandy loam, Mohave fine sand, Tonopah gravelly sand, Tonopah fine sand, Tonopah gravelly sandy loam, some of the Gila fine sand and Gila loam, most of the Redfield fine sand, some of the Redfield loam, and a small portion of the deep San Pedro fine sand.

Moderately affected soils include those which contain from 0.2 to 0.5 per cent of alkali salts within 1 foot of the surface, and from 0.2 to 1 per cent to a depth of 6 feet. Where there is nearly 1 per cent, the alkali is practically all in the subsoil, the topsoil being comparatively free of salt. The alkali in these soils apparently produces very little harmful effect on the crops commonly grown, but harmful concentrations may take place under conditions favorable to further accumulations. Included in this group are most of the San Pedro fine sand with its deep phase, most of the San Pedro very fine sand, some of the Riggs silty clay loam, much of the Riggs clay, some of the Land loamy fine sand, much of the Gila fine sand and

Gila loam, some of the Redfield fine sand and Redfield clay, and much of the Redfield loam.

Strongly affected soils include those containing more than 0.5 per cent alkali within 1 foot of the surface (though the percentage to a depth of 6 feet may be less), and all soils having more than 1 per cent to a depth of 6 feet. These soils require reclamation by drainage and washing out the salts before crops can be grown successfully. Very little of this land is now under cultivation. The soils included in this group are, some of the deep San Pedro fine sand, San Pedro very fine sand, much of the Riggs silty clay loam, much of the Land loamy fine sand, probably all of the Land silty clay loam, some of the Gila loam, some of the Redfield fine sand, Redfield loam, and most of the Redfield clay.

SUMMARY

The Moapa Valley area, Nevada, comprises 125 square miles or 80,000 acres. It is in the eastern part of Clark County about 50 miles northeast of Las Vegas, and constitutes a Y-shaped valley which has been cut deeply into eroded beds of old unconsolidated valley-filling deposits. A low mountain ridge crosses the valley at The Narrows, and another at the head of the valley. The area is drained by Muddy Creek which flows into Virgin River, and by Meadow Valley Wash, a tributary of Muddy Creek. Muddy Creek is a perennial stream though the flow diminishes somewhat during the summer. Meadow Valley Wash is an intermittent stream which has several times in the past carried destructive floods to the lower valley. This danger is being warded off and poor drainage conditions improved by the deep cutting of the channel of Muddy Creek aided by artificial straightening of the channel.

The population is all classed by the United States census as rural, although there are a number of small towns and settlements. Roads are fair and they are connected with an excellent Federal highway at Glendale. There is a good consolidated school system in the lower valley. The Mormon church is the only one established. The main Los Angeles-Salt Lake City line of the Union Pacific Railroad, and a branch line supply the transportation.

The climate is arid, and the annual rainfall averages about 6 inches, occurring largely in the winter and as occasional heavy rainstorms during July and August. The summers are long and hot, and the winters short and mild, very low temperatures being unknown. The growing season is long, so that a wide range of crops may be grown. Occasional cloud-bursts occur and there is considerable wind.

The principal crops, ranked according to their importance, are alfalfa, wheat, barley, corn, asparagus, and early vegetables of various kinds. Cantaloupes, grapes, apricots, peaches, apples, almonds, figs, pomegranates, pecans, dates, and cotton are grown on a small scale. Some dairying and poultry farming are carried on and some beef cattle are fed.

The soil materials of the area are derived from sandstone, limestone, basalt, and other igneous rocks. The soil materials are practically all water-laid, are highly calcareous, and have been classed as old valley-filling soils and recent-alluvial soils.

Sixteen soil types and 3 phases grouped in 8 soil series were mapped, besides 2 classes of miscellaneous materials. Many of the soils mapped are closely related to one another, but physical and chemical differences of sufficient importance exist to warrant their differentiation. A considerable area of soil is still undeveloped agriculturally because of inadequate water supply, poor drainage, and the occurrence of destructive floods.

Irrigation is necessary for the successful growth of crops, water being carried in small unlined ditches from Muddy Creek. Under present conditions some water is wasted in winter, and there is need of economy in summer. Though there is no provision for water storage, excepting a small reservoir near Kaolin, good progress is being made toward storage for irrigation, flood control, and power development. With improved management in the distribution and use of the present normal flow of water and that which may be stored through the enlargement of flows from springs and the impounding of flood waters, more land could be brought under cultivation and irrigation.

The higher-lying lands are well drained and free of alkali, but the lower lands are poorly drained and are affected by alkali in many places. It is probable that most of these poorly drained lands can be reclaimed by drainage and by leaching out the salt.

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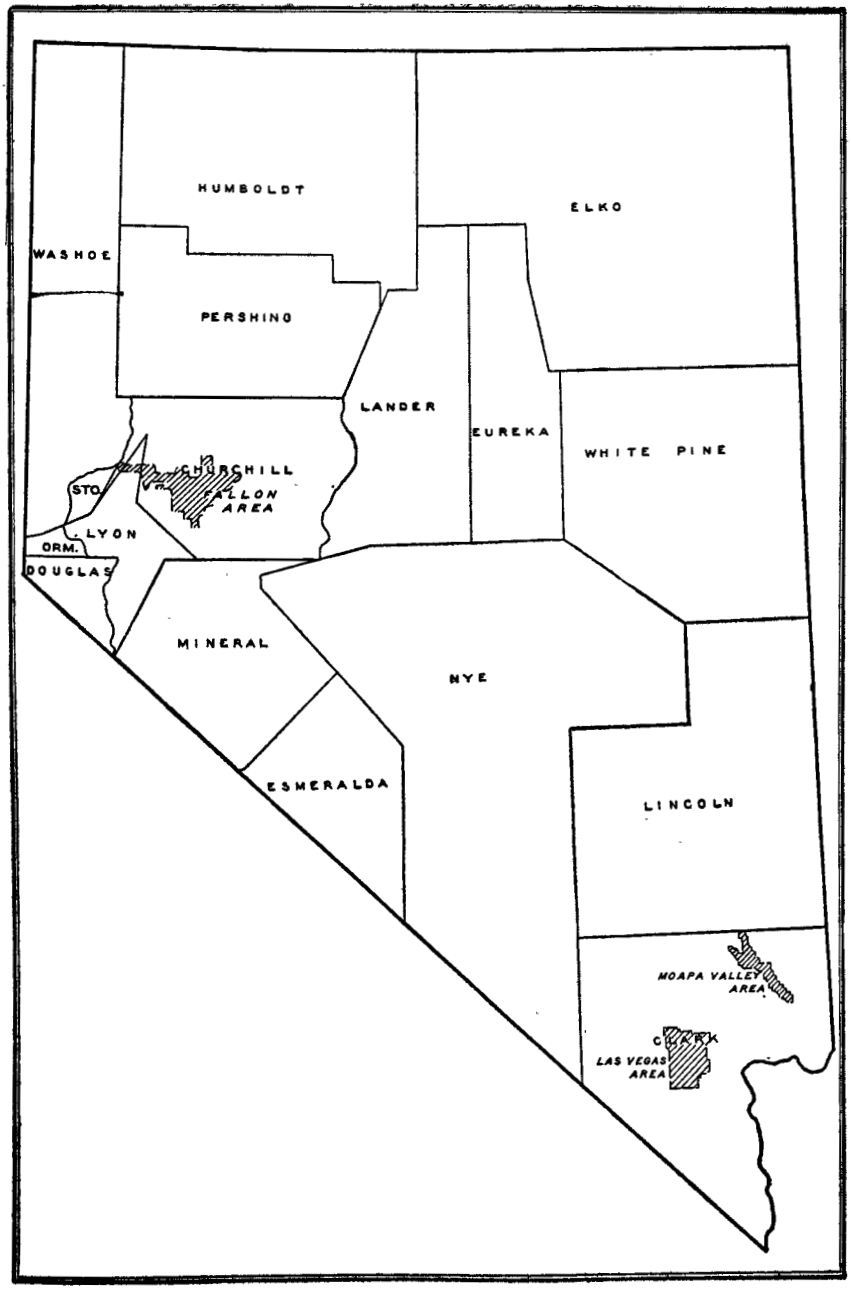

Areas surveyed in Nevada, shown by shading

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