SOIL SURVEY OF THE JACKSONVILLE AREA, FLORIDA.

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DESCRIPTION OF THE AREA.

Duval County, situated in the northeastern part of the State of Florida, is bounded on the north by Nassau County, on the west by Baker County, on the south by Clay and St. John Counties, and on the east by the Atlantic Ocean. It has an area of 822 square miles. The present survey, with an extent of about 210 square miles, or a little less than one-third the area of the county, occupies the center of the county west of the St. Johns River. It includes a section typical of the whole county.

The base map of the area was constructed by plane-table traverse as the soil mapping progressed. It is on the scale of 1 inch to the

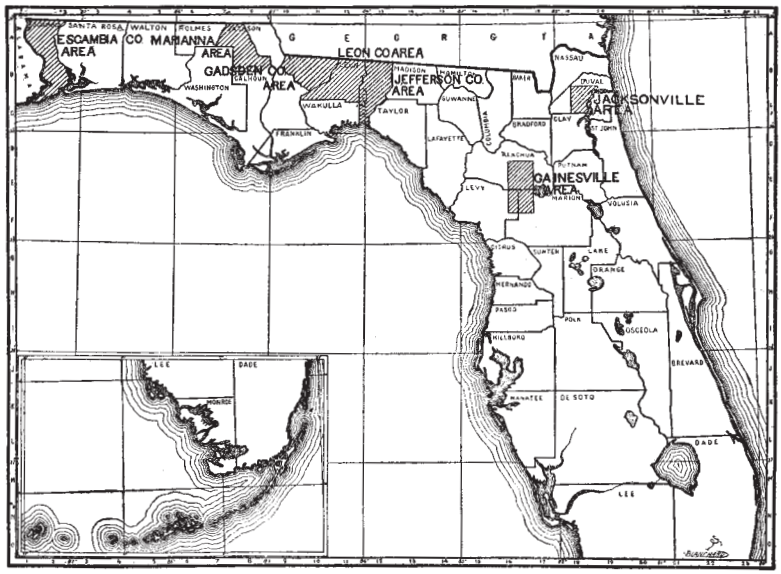

FIG. 15.—Sketch map showing location of the Jacksonville area, Florida.

mile and shows the location of roads, railroads, streams, towns, stations, schoolhouses, churches, dwellings, etc.

Although this area lies in the flatwoods region, there are some rather conspicuous surface variations. The general topography ranges from flat or gently undulating to gently rolling, with here and there occasional low hills, depressions, and narrow valleys. In the northeastern corner of the area the highest elevations are attained,

the country along Cedar Creek, St. Johns River, and on the south side of Trout Creek having a gently rolling or billowy surface, with occasional irregular dunelike sand ridges, and terminating in a bluff bordering the streams.

A striking feature of the area is the number of navigable tidewater streams, branches of the St. Johns River. These streams usually originate in a swamp and in their upper reaches are mere drainage ways or wet-weather streams. As they approach the river the channels become deeper and wider. They are navigable for small craft where shown in the map by water lines.

Small "cypress ponds" varying in size from 1 acre or less to 10 acres or more are numerous, especially throughout the western half of the survey. Only the larger of these are shown on the map, those containing less than 10 acres being too small to represent without great exaggeration.

The channels of all the small streams are conspicuously fringed with a growth of cypress and hardwood, while the tidewater creeks are generally bordered by smaller water-loving vegetation. Formerly there were extensive areas of longleaf pine in the area, but the turpentine and lumber interests have exhausted much of the merchantable timber.

Drainage systems are not well defined in all parts of the area, and emponded conditions exist in many level areas, especially in the southwestern part. During seasons of copious rainfall much of the low-lying country becomes inundated and cypress ponds and swamps remain filled with water for lengthy periods. During the progress of this survey, in the spring of 1910, the rainfall was scant, only the larger streams carried water, and the swamps were practically dry. Cedar, Trout, and Six Mile Creeks, together with their tributaries, drain the northern half of the area, while the southern half is drained by McGirts and Cedar Creeks with their tributaries.

Duval County, which was formed in 1822, was one of the first counties created, and bears the name of Florida's second governor, William P. Duval. The early settlers came principally from Georgia and the Carolinas, from the Bahama Islands, and even from the North Atlantic States.

Jacksonville, the only city in the area, is situated on the St. Johns River, and according to the Thirteenth Census, has a population of 57,699, an increase of 29,270, or 103 per cent, over 1900. It has many important and flourishing industries, and for several years has been the chief Florida port of entry for coastwise traffic. One steamboat line runs to New York and Boston, and many transatlantic freighters make this port, which is a large exporter of naval stores and lumber. Besides adequate water transportation, eight railroads enter

the city, affording exceptionally good shipping facilities to outside markets.

The wagon roads radiating from Jacksonville are hard surfaced with either shells, clay, or vitrified brick for an average distance of about 6 miles. Duval County has recently voted $1,000,000 for good roads, and it is the intention to surface all the county roads within its boundaries.

CLIMATE.

The climate of Duval County is practically subtropical. The winters are short and mild; the summers long and warm, although the sensible temperatures are moderated by breezes from the St. Johns River, and to a less extent from the ocean, which render the nights in particular quite pleasant.

During the coldest months—December, January, and February—the temperature records show an average absolute minimum of 12° F. The absolute minimum occurs in February, and, as shown in the table, is 10° F. Traces of snow have occasionally fallen, but the only measurable amount was 2 inches on the night of February 12–13, 1899. Usually during winter there are three or four days of cool, bracing weather, followed by an equal number of warm days, frequently ending with rain. The high humidity makes the cold more penetrating than would the same or lower temperature in a drier region.

The date of the latest killing frost in spring is April 6, and of the earliest in fall November 12. Killing frosts, though erratic, are likely to occur at any time between November 1 and March 1. The average date of the last killing frost in spring is February 19 and of the first in the fall December 6.

June, July, and August, the hottest months, have a mean temperature of 81° F. Temperatures of 100° F. are frequently recorded, while the absolute maximum shows 104° F.

The rainfall, which is ordinarily sufficient for most of the crops grown, is quite favorably distributed throughout the growing season. However, during periods of scant rainfall, especially in May, June, and July, crops planted upon the more sandy soils are apt to suffer from lack of moisture. To guard against such conditions the truck growers, especially, are rapidly installing plants for irrigating their fields.

With the exception of short intervals, the growing season covers practically the whole year, and plowing and similar work can be readily carried on the year round, especially upon the better drained soils.

The table following, compiled from the Weather Bureau records, gives the essential details of the meteorology of this section of Florida.

Normal monthly, seasonal, and annual temperature and precipitation at Jacksonville.

Month.	Temperature.			Precipitation.				
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.	Greatest depth of snow in 24 hours.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.	
December	56	81	14	3.0	2.4	7.8	0	T.
January	55	81	15	3.0	4.0	7.2	0	T.
February	58	86	10	3.4	3.4	5.2	0	1.9
Winter	56			9.4	9.8	20.2	0	
March	63	88	26	3.5	1.4	5.7	0	0
April	68	92	34	2.9	3.2	1.2	0	0
May	75	98	46	4.0	1.9	7.7	0	0
Spring	69			10.4	6.5	14.6	0	
June	80	101	54	5.5	4.5	9.0	0	0
July	82	104	66	6.2	6.1	7.2	0	0
August	82	101	64	6.2	3.9	7.6	0	0
Summer	81			17.9	14.5	23.8	0	
September	78	98	49	8.1	5.1	19.6	0	0
October	71	92	40	5.1	2.7	3.4	0	0
November	62	86	26	2.5	0.1	0.5	0	0
Fall	70			15.7	7.9	23.5	0	
Year	69	104	10	53.4	38.7	82.1	0	1.9

AGRICULTURE.

The early settlers of Duval County paid little attention to agriculture. They grew small patches of corn, vegetables, and tobacco, but game and fish were abundant and furnished their main subsistence. Owing to the mild climate, cattle and hogs could live on the open range without feeding or attention the year round. Under these circumstances a living was easily secured, and there was little incentive to labor beyond the supplying of the immediate needs or to extend the clearings and keep the older fields in productive condition.

Cattle raising formed the first important industry, and this was followed by lumbering. About 1903 the turpentine business began to be developed and at the present time it and lumbering are the principal interests. With the rapid disappearance of the valuable timber the energy of the people will of necessity turn to the cultivation of the land. Most of the marketable timber has been removed already and what remains is boxed for turpentine. Some "fat" pine logs are being cut for railroad ties and some charcoal is produced.

In several sections of the South where the timber has been removed turpentine and other products are derived from stumps of pine trees by a new process of extraction and distillation. This appears to be the last step in the utilization of the timber resources. At present there is plenty of stump land in this section to support an industry of this kind. Utilization of the stumps in this way reduces the cost of clearing the land for agricultural use. Contracts for clearing land are often made, the average price for extracting stumps being about 20 cents each. The expense could be lessened considerably by the use of the stump puller.

There are a few farms in the surveyed area that have been under cultivation for a number of years, but the farmed area has never been large. That the agricultural development of Duval County has been slow is shown by the following data taken from the United States census of 1900: Total acres in farms, 66,795; total acres improved, 9,609. The average size of farms is given as about 87 acres and the per cent of farms operated by the owners, 76.1. These statistics, however, do not give a correct idea of the county at the present time. During the last few years a considerable area of the lands included within this survey has been bought by land and development companies and subdivided into lots and tracts of varying size. Many of these small farms have been purchased, principally by northern men, and are being improved. Jacksonville Heights, Dinsmore, and Ortega are recently developed farming communities, and there are a number of other divisions and additions closer to Jacksonville. Marietta and Whitehouse are small villages surrounded by tracts of land suitable for farming.

Land values have advanced sharply within the last few years, in some instances several hundred per cent. The price at present depends to a large extent upon location rather than upon the type or kind of soil. Swamps and sandhill frequently are included in a single tract of land less than 10 acres in extent. Small farms may be had at $10 to $30 an acre. The cost of clearing ranges from $40 to $75 an acre, depending upon the kind of soil and character of timber growth. The Portsmouth soils require greater labor and expense to prepare them for cultivation than does the Norfolk fine sand. Besides the large pine stumps on the Portsmouth soils there are small pine trees, saplings, bays, and vines. Where the saw palmetto grows in profusion a great deal of labor is necessary to remove the roots, which are tough and spread for considerable distances in all directions, making a network near the surface.

In addition to clearing, drainage is usually necessary upon the Portsmouth and Plummer soils, and this materially increases the original cost per acre. It is well, therefore, to know the nature of

the soil before purchasing, and the only sure method is by personal inspection.

Of the crops grown corn has the largest acreage, but none of it is produced for market. It is grown upon the Norfolk fine sand and the Portsmouth fine sandy loam, the latter being the better soil and if properly handled returning good yields. Oats, sweet potatoes, and miscellaneous vegetables are the other more important products. Some sugar cane is grown and its production for the manufacture of table sirup could be made a profitable industry.

Cotton has been successfully grown in Duval County, though none was observed in the section covered by the present survey. There seems to be no reason why the Sea Island variety could not be grown here as well as in other parts of the county.

Very little of the hay and grain consumed is grown in the area, and such feed is consequently expensive. Farmers buy grain and baled hay in Jacksonville that they could better produce at home. Cowpeas furnish an excellent growth of vine on the Norfolk fine sand and make good hay as well as furnishing pasturage for hogs and cattle. The Iron, Brabham, and Whippoorwill varieties are most resistant to "wilt." The velvet bean is one of the best of forage plants for newly cleared lands, as its growth is so dense and rapid that it smothers all weeds, sprouts, and grass. The vines require some support and the beans are usually planted with corn. Like cowpeas, velvet beans improve the soil wonderfully. Beggar weed and Japan clover are other leguminous plants which make a fine quality of hay and afford good pasturage. The latter will do best on the well-drained Portsmouth fine sandy loam, and when once started spreads quite rapidly.

There are thus a variety of forage crops that can be cheaply produced on the soils of this area, with the assistance of which dairying and stock raising can be made a more important feature of the agriculture than at present.

Peanuts should be grown for fattening hogs. They may be grazed on a number of wild plants. "Mexican clover" is a valuable plant for this purpose from May until after heavy frosts. It reseeds the ground abundantly without aid, especially on sandy soils. Where it is desired to furnish pasture of cultivated plants rye and oats may be sown in the spring and followed with cowpeas, velvet beans, peanuts, and vetch. Not only hogs but cattle as well can in this way have excellent green feed throughout the year.

For the successful development of agriculture in the area a great deal depends upon proper drainage. The Norfolk fine sand is the only soil that can be said to have satisfactory natural drainage conditions. The Portsmouth soils can be utilized to some extent in their present condition, but to grow successfully the crops to which they are best suited they need to be drained artificially.

In 1900 the expenditure for fertilizers in Duval County amounted to about $9,000; at present the annual consumption must be considerably greater, as it is now recognized that fertilizers are necessary for successful crop production upon the light soils of this region, especially in the intensive cultivation of truck crops and small fruits. The soils need organic matter and every means should be used to increase this valuable soil constituent. Stable manure is the best form in which to supply vegetable matter, and some may be secured at Jacksonville. The supply, however, is entirely inadequate and other means will need to be found. All vegetable refuse, such as cornstalks, weeds, grass, etc., should be plowed into the soil instead of being burned, as is often done at present. Cowpeas or other leguminous crops should be planted for the express purpose of turning under as green manure. The latter practice is strongly recommended for all types of soil, and especially for the Norfolk fine sand and Leon fine sand.

The rotation of crops is very important and should be practiced in order to keep the soils in a high state of productivity. No cultivated crop should occupy the same field for two successive years. A desirable rotation in general farming is one including some crop as cotton or potatoes, to be followed by corn with cowpeas, the latter to be turned under after the corn is harvested, then by oats followed by cowpeas sown broadcast for hay. Where truck growing is practiced two or more different crops can often be produced on the same field in one year. When a particularly early crop is desired cowpeas or a grain crop can follow it and be matured in time to plow in the late fall in preparation for next season's truck crops. A number of winter vegetables can be grown usually with little protection, making possible almost continuous utilization of the land throughout the year.

Pecans do well upon the Norfolk fine sand, and a few small orchards of improved varieties planted on this soil are doing nicely. The pecan industry when once established is a very profitable one, and there appear to be excellent opportunities for its development in this area.

Plums, pears, and peaches do fairly well on the Norfolk fine sand without care or attention. The Scuppernong grape and a number of other varieties grown for home use and for wine do particularly well on this soil.

Within the last few years some attention has been given to market gardening, and lately the interest in this line has increased rapidly. Some of the soils of the area are quite similar to the celebrated celery soils of Sanford and to the Irish potato soils of Hastings (Fla.), and there is reason to believe that if handled properly[1] the same crops could be grown successfully around Jacksonville and in Duval County. A successful trucking industry in any region requires favorable climatic conditions, suitable soils, rapid transportation facilities, and

[1] See Circular 21, Bureau of Soils, pp. 4–8.

efficient labor. This area not only possesses these factors, but in addition has a better local market than many of the successful trucking sections. There is also a bountiful supply of artesian water which may be developed for irrigation. The greater part of the surveyed area lies within the "artesian flow" and wells are numerous.

Up to the present time trucking has been conducted principally upon the Norfolk fine sand and the Portsmouth fine sandy loam. On the latter type close to the city limits of Jacksonville is a splendid truck garden which fully demonstrates the possibilities of this soil for this purpose. The garden is supplied with a well-arranged subirrigation system, the water being secured from a nearby artesian well. The main is a 6-inch pipe with a 1-inch opening every 20 feet. The laterals are 3-inch tiles placed 16 to 18 inches below the surface. At the outlet of each lateral there is a cement trap for regulating the height of the water in the ground as desired. This method of irrigation has proved very satisfactory and excellent results have been obtained. All the vegetables common to this section are grown. Tomatoes, lettuce, radishes, cabbage, onions, peppers, cucumbers, celery, etc., all do well.

Celery requires heavy applications of high-grade fertilizer, and land intended for this crop should be so situated that it can be readily irrigated, for no other plant suffers so severely from drought. Stable manure applied directly to the crop is apt to make the stalks rusty. It is better to plant celery after a crop of early cabbage that has been heavily manured. August and September are the best months to set the plants for an early crop.

The Norfolk fine sand is better adapted to the earlier truck crops, and a number of promising gardens were seen on this type. All the vegetables and small fruits can be produced on this soil with heavy applications of high-grade fertilizer and composted stable manure. Irrigation and competent labor are also essentials.

Surface irrigation by the furrow method is the simplest and cheapest, where a low but perceptible grade can be given to the rows. The "Skinner method" is a sprinkler device consisting of reversible perforated pipes. It is very satisfactory where surface irrigation is required. This and other sprinkler systems have been used with success upon the Norfolk fine sand.

Early Irish potatoes, asparagus, snap beans, English peas, cantaloupes, watermelons, strawberries, and blackberries, do well and are remunerative trucking crops.

Laborers for market gardening can be secured for $1.25 a day.

SOILS.

The geological deposits which compose the State of Florida are of comparatively recent date. No rocks have been found older than

those of the Vicksburg group, and it is believed that members of this group underlie the entire State. During the time of submergence the materials which give rise to the several soil types were laid down as marine deposits and more or less assorted by tidal and wave action. The soils of Duval County are predominantly sandy and consist of the finer grades of sand, silt, and clay. Since the elevation of the land surface above sea level, erosion, weathering, and plant life have further changed the uplifted material, altering particularly the topography, and in places the organic matter content, thus giving rise to the various soil types.

The Miocene beds lie stratigraphically between the underlying Oligocene and the overlying Pliocene and Pleistocene. To the Miocene belongs the Jacksonville formation, which is composed largely of arenaceous and siliceous beds. The limestone of this formation is rarely over 4 to 6 feet in thickness, while the formation proper has been determined by well borings at Jacksonville to be between 400 and 500 feet thick.[1]

At Jacksonville the formation of that name appears to rest unconformably upon the eroded surface of limestones of the Vicksburg group. The limestone of the Jacksonville formation varies in color when freshly broken from light gray to nearly white, and upon weathering changes to a pale yellow or yellowish gray. Fossils are abundant in some localities. Nowhere in the area surveyed was the Jacksonville formation observed near the surface, and it is believed that it has exerted little if any direct influence upon the formation of the soils, though the sink-hole topography of some localities would tend to indicate its presence at no great depth.

The area is fairly typical of the flatwoods country of the Atlantic and Gulf Coastal Plains. There are, however, some conspicuous surface irregularities. There are no high hills or ridges, but in a country so predominantly flat as this region, even the slight elevations are conspicuous. The soils of the area are unusually similar in texture. Their separation into series was based mainly upon differences in color as determined by differences in the organic matter content, the result of the varying drainage conditions under which the soils have existed. Where inadequately drained, the materials have given rise to the Portsmouth and Plummer soils. The Portsmouth series is characterized by poor drainage conditions, high content of dark-colored organic matter, and drab and gray subsoils. The Plummer fine sandy loam represents a poorly drained soil, slightly elevated above Swamp and having a drab or mottled subsoil.

A conspicuous feature in a phase of the Portsmouth fine sand and in the Leon fine sand is the reddish brown, somewhat compact layer of material commonly styled "hardpan." This layer is usually

[1] Second Annual Report, Florida State Geological Survey.

developed at some 18 to 24 inches below the surface. Its origin is not very clear, but from the fact that the material contains a large amount of organic matter it would seem that the characteristic brown color is due to translocation of this matter downward to this filter bed, as it were, and not to iron oxide, as has been believed by many. The material burns to a white fine sand, the small lumps quickly falling to pieces as the organic matter is burned out.

The Leon fine sand is a white or light-gray excessively drained fine sand with a brown hardpan subsurface layer. It is a very definite soil throughout the flatwoods of the Atlantic and Gulf Coastal Plains.

The Norfolk fine sand is the result of better drainage and represents one of the earliest trucking soils of the Atlantic seaboard. It is widely distributed. The "rolling phase" of this type has probably been changed in topography since originally laid down by wind action and erosion. Between Trout and Cedar Creeks it resembles "sand dunes" in topography.

Both the Portsmouth and Norfolk series of soils have long been established by the soil survey, and occur throughout the greater part of the Atlantic and Gulf Coastal Plains east of the Mississippi River.

Swamp represents very poorly drained, unclassified material, occupying cypress ponds, bogs, and even stream bottoms.

Tidal marsh is a recent sediment which is still in process of deposition.

The following table gives the name and extent of each type of soil shown in the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Portsmouth fine sand	24,704	46.5	Leon fine sand	4,032	3.0
Hardpan phase	37,696		Plummer fine sandy loam	3,264	2.4
Norfolk fine sand	2,304	29.5	Tidal marsh	1,600	1.2
Rolling phase	37,376		Total	134,400	.....
Swamp	16,000	11.9			
Portsmouth fine sandy loam	7,424	5.5			

NORFOLK FINE SAND.

The Norfolk fine sand consists of a rather loose, gray or pale yellowish-gray to dark-gray fine sand, ranging in depth from 8 to 15 inches. The soil is yellower than that of the Leon fine sand of the area, which has a white, bleached appearance. The subsoil is a yellow, pale-yellow, or light-gray sand of texture similar to the soil, extending to a depth of more than 3 feet. The finer grades of sand predominate, although in some portions of the type white, fairly

well-rounded quartz pebbles the size of a pea and occasionally larger are not uncommon. This condition exists chiefly in the uplands, where the type occurs as low hills and ridges. In the western part of the area the surface soil is frequently whiter than the typical soil.

The Norfolk fine sand occurs scattered throughout the area in bodies of varying size. The most extensive occurs in the eastern part along the St. Johns River and the larger tidewater tributaries.

As typically developed the Norfolk fine sand occupies the nearly level to gently undulating country and is more loamy and darker in color than the rolling phase, to be described later, on account of the higher percentage of organic matter accumulated under the wetter conditions prevailing over this more nearly level soil. This level portion of the type is regarded as a very desirable early truck soil. It is extensively utilized along the Atlantic seaboard for growing such crops as must be forced to an early maturity in order to command the high prices of the winter or early spring markets.

The Norfolk fine sand supports a growth of pine, thickets of scrub oak with pine, and occasional clumps of live oak. It is naturally a warm soil, while the texture is such as to maintain, especially in the more nearly level areas, a uniform water supply sufficient for maturing most crops. It is well adapted to the production of early Irish potatoes, cucumbers, peppers, snap beans, watermelons, cantaloupes, lettuce, radishes, green peas, strawberries, blackberries, dewberries, etc. Corn, oats, and some hay are at present grown, and as areas of this type are placed under cultivation cowpeas, velvet beans, sorghum, and cotton should be included in some system of crop rotation. Peanuts for fattening hogs should be grown. Pecans and figs do well. In other localities cigar wrapper tobacco has been successfully grown on this type under shade and with irrigation. It is not known what effect the climate of this section, lying so near the ocean, would have on the crop. Certainly no attempt should be made to grow the crop on an extensive scale without previous experiment.

The type occurring in the surveyed area is for the most part advantageously located for market gardening, both in nearness to market and transportation lines and in the presence of artesian water for irrigation. Remote areas of Norfolk fine sand would best be devoted to general farm crops.

Prices for much of this land are influenced by favorable situation for dwellings, factory sites, and town sites along the St. Johns River and other water fronts. The timber growth largely governs the price of the outlying areas.

Rolling phase.—The rolling phase—locally called "scrub oak" land—of the Norfolk fine sand, which supports a good growth of long-leaf pine and much scrub oak, occupies the highest elevations in

the area. The body between Trout and Cedar Creeks is known locally as "sand hills." This phase is loose in texture and droughty in seasons of scant rainfall. In places along streams and in cuts and excavations a yellow or reddish-yellow sandy clay was exposed at depths below 6 feet. This substratum is used for making bricks and surfacing roads.

This phase of the Norfolk fine sand is considered rather an undesirable agricultural soil, both on account of its topography and the necessity of making frequent and heavy applications of fertilizer in order to secure profitable returns. It is capable of great improvement, which can best be accomplished by turning under at frequent intervals crops like velvet beans and cowpeas. This practice, in conjunction with liberal applications of barnyard manure, will establish a loamy structure, make the soil more resistant to drought, and much more productive.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Norfolk fine sand:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
23584, 23586.....	Soil.....	0.0	0.3	2.2	84.6	6.7	2.8	3.3
23585, 23587.....	Subsoil.....	.0	.3	2.1	86.9	6.0	2.6	1.8

PORTSMOUTH FINE SAND.

The Portsmouth fine sand, in its typical development, consists of a black or dark-gray fine sand, which has a slightly loamy feel owing to the presence of considerable organic matter. Beginning at about 8 inches the soil grades into a gray to grayish-brown fine sand, which continues with uniformity of texture and color to 3 feet or more. Occasionally the subsoil is slightly mottled with grayish and brownish colors. It is usually moist, the degree of saturation increasing with depth.

The Portsmouth fine sand occupies level, flat areas and gentle slopes toward small stream courses. The soil is extensively developed along the western edge of the area and in the southwest corner along McGirts Creek. It is poorly drained. Low knolls do not occur in areas of the typical soil, as in the case with the hardpan phase and the Portsmouth fine sandy loam. The type is closely associated with the other members of the Portsmouth series, and it is not uncommon to find small areas of the two phases of this type so intimately associated as to make it necessary to map them together, giving the color of the predominating soil. The important difference between

this phase of the Portsmouth fine sand and the Portsmouth fine sandy loam is the absence of the sandy clay subsoil in the former.

The typical Portsmouth fine sand was separated from the compact hardpan phase, not alone because of the presence of this stratum, but because of differences in the surface features, in drainage conditions, and, as a consequence, in agricultural value. The absence of the hardpan permits ready movement of the soil moisture, which makes the typical soil a more favorable environment for plants. While very little of the type is under cultivation, it is believed that when cleared and drained it will make an excellent soil for potatoes, cabbage, onions, lettuce, celery, oats, and forage crops.

While the soil is not so retentive of moisture as the Portsmouth fine sandy loam and is more inclined to leach, the structure of the subsoil is such that usually a sufficient amount of moisture is retained to meet the requirements of most crops adapted to soil of this kind.

Care must be exercised in handling the land when brought under cultivation, as the organic matter content is rapidly depleted unless vegetable manures are occasionally added. The humus content should be maintained by turning under green crops and by the application of barnyard refuse.

The agricultural value of the land at present is not considered and the price depends upon the timber and turpentine resources. It supports a better growth of longleaf pine and grass than the hardpan phase and upon the typical soil no palmetto is found. Pitcher plants are very common.

Representative samples were found to be slightly acid, a fact that indicates the need of lime. Probably something like 1,500 pounds of burnt lime or twice this quantity of ground limestone or shells would be sufficient to correct this condition.

Hardpan phase.—The hardpan phase of the Portsmouth fine sand consists of a dark-gray to black fine sand having a loamy feel, owing to the relatively high content of organic matter. The surface soil is underlain at about 8 inches by a light-gray, incoherent fine sand, which rests upon a dense, compact stratum locally known as "hardpan."

This stratum generally occurs at a depth of about 18 to 24 inches. In the upper part it is usually black, but it quickly grades into a rusty brown color and becomes less hard with depth. This stratum is usually from 4 to 8 or 10 inches in thickness, the black, hardest portion averaging about 3 inches. The remainder of the 3-foot soil section is a brownish to almost white, loose, fine sand, usually saturated. Poor drainage has been the chief factor in the development of the dark color of the surface portion of the soil.

The dense brown layer in the subsoil is apparently quite impervious to water, and obstructs the movement of soil moisture from the subsoil to the soil, although the texture of the soil materials above and

below the layer favor such movement. On the other hand, during seasons of heavy rainfall the percolation of water is hindered. Crops are thus likely to suffer both from insufficient moisture and from excess of water, as the seasons vary from dry to wet. The agricultural value of this phase is greatly affected by the hardpan stratum.

The organic matter which gives to the Portsmouth fine sand its characteristic dark color and loamy texture is rapidly depleted under cultivation if frequent additions are not made, the soil tending toward an ashy-gray color. Cowpeas and velvet beans grown for green manuring are the best means for maintaining the organic-matter content where stable manure can not be obtained.

The hardpan phase of the Portsmouth fine sand is the most extensively developed and widely distributed soil of the area. It occupies nearly level country varied with low sand mounds and small cypress ponds. In some places the hardpan is well developed under the slight mounds or hummocks, while none is found in the slightly lower lying surrounding land.

A very characteristic natural vegetation is found on this phase. Saw palmetto is the chief distinguishing growth and where found there is usually a hardpan layer somewhere within the 3-foot section. The relation of the palmetto and the hardpan layer is very interesting, but it is not clear what this relation depends upon. The hardpan stratum has frequently been ascribed to the precipitation of iron salts leached from the surface, but laboratory examinations show only a trace of iron, while the organic content is high.[1] The peculiar characteristics of this stratum then appear to be due to the presence of organic matter.[2] Whether this organic matter is in the form of a precipitate or simply represents an accumulation of fine particles through a translocation process has not as yet been determined. A water solution shows a brownish color somewhat like that of the streams of this region. To the south of Duval County it is said that the hardpan layer is deeper and more compact, in some instances being so hard as to require blasting in order to get proper holes for trees.

Besides the palmetto, gallberry bushes and a fair growth of longleaf pine are found. Most of the pine that remains is boxed for turpentine. Very little of this hardpan phase of the Portsmouth fine sand is improved. Only a few small fields of corn and light truck crops were seen. It is best adapted to these crops.

Many of the owners of this class of land deem it unwise to bring material of the brown hardpan layer to the surface in plowing, as it is claimed crops give poor results on this soil where exposed. Many advocate the use of lime to improve the condition of the hardpan

[1] Soil sample No. 23579 shows a content of 1.09 per cent of organic matter; the corresponding hardpan subsoil No. 23580 contains 3.51 per cent organic matter.

[2] See Third Annual Report, Florida State Geological Survey, pp. 96–97.

stratum for crop production. Samples of the phase show signs of acidity (the hardpan itself is decidedly acid) and, like the typical soil, it probably needs lime, irrespective of any effect it may have on the hardpan.

Considering the low agricultural value of the Portsmouth fine sand, it would seem advisable to reforest the greater part of it.

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

Mechanical analyses of Portsmouth fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
23592, 23595, 23597, 23599.	Soil.....	0.0	0.8	2.4	84.9	4.0	4.9	2.7
23593, 23596, 23598, 23600.	Subsoil.....	.0	.5	2.5	83.7	5.9	3.8	3.5
23594, 23601.....	Lower subsoil.	.0	.4	2.1	83.8	5.7	4.1	3.3

PORTSMOUTH FINE SANDY LOAM.

The surface soil of the Portsmouth fine sandy loam consists of a dark-gray or black loamy fine sand with a depth of about 6 to 10 inches. A high content of organic matter gives the soil a more loamy feel than would be expected in one containing so little silt and clay. Below this depth there is less organic matter and the material is a gray or grayish-brown fine sand or loamy fine sand frequently mottled with small lenses of gray and yellow clay.

This stratum varies in depth, but is found resting somewhere between 24 and 36 inches upon a mottled gray and yellow sticky fine sand to fine sandy clay. In swampy and poorly drained spots the clay is more sticky and plastic and has a drab color. Sometimes in areas bordering slight depressions the clayey material comes nearer the surface, in places within 8 or 10 inches. Blue, drab, and yellow mottling is seen in this phase.

The largest bodies of this type lie directly west of Jacksonville, the greater part between the Atlantic Coast Line and Seaboard Air Line Railways. Small bodies also occur in the vicinity of Dinsmore, but the type is not found in the southern quarter of the area.

The native timber growth consists of pine. It has nearly all been removed from the larger areas, which are inclosed with improved wire fencing and used chiefly for pasture. Cypress, pine, and pitcher plants are found on the wetter areas.

The type occupies nearly level to flat country and the natural drainage over most of the areas is poor. Throughout the better drained areas are scattered low hummocks of the hardpan phase of

the Portsmouth fine sand, supporting the characteristic growth of palmetto. The two types do not differ greatly in texture of the soil, but the former does not have the hardpan layer and is always underlain by clayey material within 3 feet of the surface.

The Portsmouth fine sandy loam is derived from the same deposit as the Norfolk soils and other members of the Portsmouth series. The swampy condition under which it has existed for a long time has made it rich in organic matter, an important factor influencing its productiveness when other conditions, such as drainage and aeration, are improved.

Poorly drained black soils of this kind when reclaimed are often benefited by applications of lime, and tests of representative samples show this soil to be no exception, for it is slightly acid. Burnt lime applied at the rate of 1 ton per acre would likely correct any such unfavorable condition.

The Portsmouth fine sandy loam is the strongest soil of the area and the type best suited to the general and special crops of this section. Its loamy texture and relative high content of organic matter, together with its clayey subsoil, render it capable of retaining a larger supply of moisture than the other soils. It is an excellent soil for the grasses, such as Augustine, crab, and crow's-foot, and for oats and corn. The native grasses afford splendid pasturage, making the type well suited to dairying.

The Portsmouth fine sandy loam is well adapted to the production of truck crops, especially cabbage, lettuce, onions, Irish potatoes, tomatoes, eggplant, peppers, cauliflower, carrots, celery, and strawberries. Near Jacksonville all these crops and many others common to the vicinity are being successfully grown, the best results being obtained where irrigation is practiced. Great quantities of edible mushrooms are gathered from this type of soil after warm rains in the early spring, many of which find their way to the local market.

The average results of mechanical analyses of samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Portsmouth 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.*
23588, 23590.....	Soil.....	0.1	0.3	0.5	69.8	16.2	9.1	3.8
23589, 23591.....	Subsoil.....	.0	.2	.5	58.6	15.8	10.9	13.8

PLUMMER FINE SANDY LOAM.

The Plummer fine sandy loam occurs as low-lying level areas in two phases, one of which, usually found in the vicinity of swamps, is

less mucky and slightly better drained than the other, which is found adjacent to or surrounded by the soil mapped as Swamp.

The first phase, to a depth of 6 or 8 inches, is a gray to light gray loamy fine sand, with faint brownish mottlings. At a depth of from 4 to about 18 inches this material grades into a compact loamy fine sand, which is either gray or gray mottled with brownish or yellowish streaks. The soil is underlain at from 18 to 36 inches by a mottled yellow and gray fine sandy clay, or sticky sand with pockets or layers of yellowish plastic fine sandy clay. The type is next to the heaviest found in the area.

The lower lying or swampy phase of this type does not differ much from the Swamp and its position is only slightly higher. It consists of a gray soil varying in texture from a loamy fine sand to light fine sandy loam and containing nodules or streaks of yellow iron-stained sandy clay. The subsoil is a stiff drab fine sandy clay, which may be found as close to the surface as 8 inches, though usually lying at an average depth of 14 inches.

The wet phase of the Plummer fine sandy loam supports a scattered growth of cypress and pine and considerable coarse grass. The boundary between it and Swamp is not definite, and the timber growth served as the chief factor in the establishing of boundaries. Like Swamp, it is covered with standing water many times during the year, but this water soon disappears, whereas in case of the Swamp it frequently remains for considerable periods.

The Plummer fine sandy loam is found only in the northwestern corner of the survey. The larger areas occur in the vicinity of Kingsgrove and Plummers in oval-shaped bodies about stream heads or as bottom land along the lower courses of streams.

The soil of the Plummer fine sandy loam probably includes some material that has been washed in from surrounding higher lying areas by rain water, but the position of the type is not suggestive of an alluvial origin. It forms flat or slightly-depressed low-lying areas over which poor drainage conditions or intermittent wet and dry conditions have obtained. The peculiarities of the soil are due, at least in part, to long subjection to these conditions of poor drainage. Its characteristic light color is suggestive of the Elkton soils of the northern Coastal Plain, but there are sharp differences, especially in the relative low silt content of the Plummer and in the origin of the material. The low, flat surface may be due to the method of formation; that is, the type may represent areas that have been formed as the floors of lagoons or sounds when the ocean bordered these lands.

None of this type is at present under cultivation, owing to poor drainage, though simply by constructing open ditches much of it could be rendered fit for agriculture. The Plummer fine sandy loam

should prove well adapted to the production of lettuce, onions, cabbage, celery, carrots, etc. It is suggested that rice with proper cultivation, including irrigation, might be produced profitably. Oats, corn, and sugar cane should prove paying crops on the well-drained soil with liberal fertilization.

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

Mechanical analyses of Plummer 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.*
23582	Soil	0.0	0.2	0.7	63.2	18.7	11.0	6.1
23583	Subsoil	.0	.4	.5	48.7	20.9	10.8	18.4

LEON FINE SAND.

The Leon fine sand, to a depth of 8 to 12 inches, is a loose, incoherent, light-gray to white fine sand. Only the first 2 or 3 inches of the surface soil has a light-gray color, which is caused by a small amount of organic matter. Beneath this shallow layer the sand is white, being practically free of vegetable remains.

At depths ranging from 12 to 20 inches there is a compact layer of fine sand like that found under a part of the Portsmouth fine sand. This stratum has the same color as that underlying the Portsmouth soil, ranging from black in the immediate upper part to rusty brown below. In places the black color is wanting, and here the layer becomes less compact and grades toward a lighter brown with increased depth. This "hardpan" layer rests upon an incoherent medium to fine yellowish-brown or grayish fine sand extending to a depth of 3 feet or more. Occasionally the hardpan is near enough the surface to be reached in plowing.

The surface soil of the Leon fine sand is much lighter in color than that of the Norfolk fine sand. The topography, although nearly flat in places, is frequently slightly interrupted by hummocks, knolls, or low ridges similar in appearance, though not so high and conspicuous, to those found in areas of the Norfolk fine sand. The surface configuration of the former is really intermediate between the Norfolk and the Portsmouth fine sand types.

The Leon fine sand is confined to the western half of the survey. Its most extensive development is near the western boundary line where the characteristics of the type may best be seen.

The loose, open character of the soil and the small amount of organic matter present render the Leon fine sand susceptible to drought, and under ordinary seasonal conditions crops suffer for lack of moisture.

Practically none of the type is under cultivation, and it is generally considered an uncertain and unproductive soil.

Deficiency of organic matter greatly lessens the water-holding capacity of this soil, and this should be remedied by turning under green crops, such as cowpeas and velvet beans, and by adding heavy applications of barnyard manure. In this way the surface soil may be rendered sufficiently loamy to retain moisture for the early maturing crops. With irrigation and liberal fertilization there is no apparent reason why a great variety of vegetables common to the area should not be grown, but only with intensive methods can success be attained in the cultivation of this type.

The characteristic growth is saw palmetto, with a scattering of scrub oak and pine. "Oak-runners" are very plentiful and extend for many feet a short distance below the surface, hindering plowing. The saw palmetto frequently attains a rank growth, although in some places it is very scrubby and scattered. The pine trees also are rather scrubby in places.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of this type:

Mechanical analyses of Leon fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
23579.....	Soil.....	0.0	2.1	6.5	82.7	5.5	1.8	1.6
23580.....	Subsoil.....	.1	1.9	7.0	78.0	3.8	3.2	5.9
23581.....	Lower subsoil...	.0	1.8	7.1	80.8	3.1	3.0	4.0

SWAMP.

The Swamp of the Jacksonville area embraces those bodies of poorly drained soils found along small streams and creeks and as drains and depressions in the several soil types. Areas border most of the watercourses in the survey, lying as narrow strips of soggy land subject to overflow or in such a wet condition that they are of no agricultural value until reclaimed. The extent of Swamp along the drainage ways is usually in proportion to the size of the stream. The soil in these areas has a wide range in texture and consists of a dark-colored material, containing a large amount of decaying vegetation. The distinctive native vegetation is cypress, black gum, bay, and Cuban pine, which form a dense growth.

Associated with the various soil types as isolated bodies occurs the other phase of Swamp, numerous swales, drains and depressions, varying in size from the small cypress pond to large swamps and bays holding water part of the year. Such wet places generally support the same forest growth as is found along the water courses

with oak and some ash in addition. Many bodies of this phase of Swamp too small to be represented on the map are scattered through the survey.

Several extensive areas of Swamp are mapped, the largest coinciding with Cross Swamp, located in the northwest corner of the area. No Catch Bay, another important area, the source of Six Mile Creek, is intersected by the western boundary line, and the map will show the situation of other swamps and bays of considerable size.

The soils of these isolated swamp areas vary according to the adjacent material. In the sandy types the surface soil generally consists of a fine, black, mucky sand or fine sandy loam, and this is underlain by a grayish or white sand, similar in texture to that of the surface. Frequently a drab and yellow mottled sandy clay is reached within 3 feet or less. Areas of Swamp occurring within the Portsmouth fine sandy loam, or adjacent to it, have a much heavier soil. For the most part it consists of a heavy loam or clay loam grading into a heavy plastic drab clay. Such areas represent the heaviest and strongest soil of the area.

Some of these swamps could be ditched and when properly drained would be ordinarily adapted to the production of corn, rice, sugar cane, cabbage, celery, lettuce, etc.

TIDAL MARSH.

Along all the tidewater creeks, with the exception of McGirts, and in one or two places along the St. Johns River, are found strips of low land of a marshy character. The material in these areas consists usually of a fine sand mixed with a large amount of organic matter, forming a dark-colored, mucky, fine sandy loam. In many places the material resembles Peat or Muck.

The areas are frequently overflowed with salt water, and at present are of no agricultural value. They support a growth of coarse marsh grass and reeds which afford some pasturage for cattle.

The widest areas of Tidal marsh occur along Trout Creek and Cedar Creek in the northern part of the area.

SUMMARY.

The Jacksonville area comprises 210 square miles in the central part of Duval County, Fla. The topography varies from flat to hilly. Much of the area is poorly drained.

The climate is mild, the mean temperature for the coldest months—December, January, and February—being 56° F. The mean summer temperature is 81° F. Traces of snow have been recorded and heavy frosts may occur at any time between November 1 and March 1. The mean annual rainfall is about 53 inches.

Transportation facilities for the larger part of the area are good. Besides eight railroads entering Jacksonville, the St. Johns River furnishes facilities for water transportation to outside markets.

A very small percentage of the land embraced within the survey is in cultivation, and agriculture, while making progress, is only in the first stages of development.

Lumber, turpentine, crossties, and charcoal are the chief products of the area at the present time. Some truck is grown in the vicinity of Jacksonville. The farm crops consist of corn, oats, cowpeas, and sweet potatoes, but these are not grown extensively. Cotton is not at present grown in the area, but both the long and short staple varieties would find soils well suited to their culture. Sugar cane for the production of sirup for home use and the local market could be grown profitably.

Of the fruits, grapes, figs, pears, plums, peaches, and pecans do well on the better drained soil areas.

The soils consist of fine sands and sandy loams, and owe their origin almost exclusively to the Columbia formation. The types are comparatively few and belong for the most part to the Norfolk and Portsmouth series, with one type of the Leon series, the Plummer fine sandy loam, a miscellaneous type, and the nonagricultural types Tidal marsh and Swamp.

The Norfolk fine sand occurs extensively as gently undulating country and as hills and ridges. The hilly phase is less loamy, more droughty, and requires heavier manurial applications than the undulating phase. The Norfolk fine sand is one of the earliest reliable truck soils.

The soils of the Portsmouth series all need drainage to fit them for profitable cultivation. The fine sandy loam has better natural drainage than the fine sand, and is the strongest general farming soil in the area. It is cool and moist and an excellent soil for late truck crops, especially celery, lettuce, and late strawberries. With irrigation, rice should do well on this type.

The Portsmouth fine sand occurs in two phases. In one a hard though weakly cemented stratum is encountered at a depth of 18 to 24 inches. This phase does not rank high as an agricultural soil and most of it should be reforested. The other phase, which lacks the hardpan, is better drained and is considered a much better soil. Where drainage is adequate either phase is better suited to truck crops than general farm crops. Of the latter, corn does best.

The Plummer fine sandy loam is an unimportant type owing to its unfavorable topographic position. In its present condition it is best suited for pasture land. If properly ditched it would probably prove adapted to rice culture.

The Leon fine sand is a light-textured, warm-natured soil, well suited to early truck. It is naturally droughty and deficient in organic matter, and irrigation as well as heavy applications of fertilizer are necessary to insure successful cultivation.

The agricultural development of the area depends chiefly upon the construction of adequate drainage and irrigation systems. There are unlimited opportunities for the development of the truck industry, and much land well adapted to it can be had at reasonable prices. The natural conditions of climate, soil, and an abundant supply of artesian water for irrigation make possible the development of an extensive trucking industry in this section of Florida.

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