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A REPORT CONCERNING THE SOILS OF A PORTION OF THE OKEFENOKEE SWAMP.

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concerning the Soils

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Introduction.

The Okefenokee Swamp lies in Charlton, Clinch, and Ware counties in the southeastern part of the state of Georgia. It has an area of about 500,000 acres, being about 40 miles in length from north to south and 20 miles in width from east to west. At the southern end is the Georgia-Florida state line. It is only about 40 miles inland from the South Atlantic Coast at its eastern border. Completely surrounding the swamp, the upland consists of characteristic "palmetto flatwoods". These flatwoods are nearly level and offer no hint or indication that there is a swamp until one is right at its edge. The swamp, then, is an upland swamp, though the upland is low and almost level. The swamp is in reality an immense, shallow basin in the flatwoods of irregular outline and depth. Dr. Loughridge describes it in the X Census, Vol. VI. as follows:

"The eastern part, 12 miles in width, is an open "prairie" or marsh, largely covered with waterin which are long rushes and water-lilies. Under its surface is a dense body of mosss from four to six feet thick, the great mass of which is decayed, forming muck and peat. It is so dense that it will readily bear a man's weight, merely sinking a little and rising for many feet around; hence the name Okefenokee - "trembling earth". Small islands, covered with clumps of cypress, bay, and cassino, frequently occur. The western part of the swamp is mostly covered by cypress trees and a dense growth similar to that of the small swamps outside, so tied together by bamboo briers and vines as to be impenetrable except by slow and tedious cutting away with brush knives. Small open marshes, and also a number of large islands are found throughout this region. These islands are quite level, but are slightly elevated above the

swamp lands, and have a sandy soil, with an open timber growth of long-leaf pine and a low undergrowth of saw palmetto, and are similar in every respect to the mainland. Their dimensions are three or four miles by from one to two, and they are bordered by a low * * hammock land, on which there is a growth of magnolia, oak, etc. * The soil or bottom of the swamp proper seems to be little else than white sand".

The writer has described the northern end as follows:

"Along the edge of this swamp there is a thick growth of cypress and some pines, all veiled heavily with the gray hanging Spanish moss. This timber becomes thinner away from the edge, until the trees are scattering and are hardly more than stunted shrubs. The water is generally shallow. There are narrow channels called "runs" which are more open and deeper than the rest of the swamp. These runs vary in width from a few yards to a few rods. Sometimes there are more open spaces of water called "lakes". The surface of these lakes and runs is usually covered with a growth of lilies and other aquatic plants, forming a thick mat. Along the margins are many smal cypress trees and hushes. The country on each side of them looks like a low flooded marsh with trees here and there. Around these cypress trees there is a clump of huckleberry bushes, while the intervening space is covered with a luxuriant growth of aquatic vegetation. In other places there are extensive beds of aquatic vegetation. In still other places there are extensive beds of ferns. These open and almost treeless areas are called "prairies". Along and in the runs there is a tangled mass of roots and plant stems, overlying a deposit of organic matter which seems to be in a condition approaching peat. A pole can be easily thrust through it to a solid sandy bottom. Outside these runs on the prairies it is likely that oxidation has proceeded more rapidly, as the water level fluctuates, leaving them dry at times, and a stratum of muck has been formed." (Soil Survey of the Waycross,Area, Georgia. Page 32.)

In another part of the above report it is stated in reference to the draining of the swamp, that; "This would reclaim thousands of acres of rich valuable soil # # #."

This report covers the investigations made on a tract of the swamplyingon both sides of the Suwanee Canalon the eastern edge southwest of Folkston. This area consists of a rectangular tract of approximately I2,000 acres, it being about 3 miles wide from the edge of the swamp and about 6 miles long. The soil was examined over this whole tract, its depth determined at the corners of each 40-acre square, and other items of interest noted. Samples were secured at various points to represent variations in the character

of the soil material and its state of decay.

Description.

All along the eastern edge for a distance of from one-half mile to about two miles there is a jungle of brushy undergrowth and timber. North of the canal this "bay" has anaverage width of approximately three-fourths of a mile, while south of the canalits average width is fully twice as great. Included in this are some small prairies and a number of islands, the largest of which, Chesser's, contains about 400 to 500 acres. Other islands are LLoyds, Scrub, Little, Board Pile Point, and an extension of the upland east of Chesser's Island, which is not quite separated by the swamp. In addition to the above there is John's Nigger Island lying northwest of scrub Island but not shown on map made last spring. Taken altogether these islands cover an area of about 650 acres or 5 per cent of the tract. Lying west of this wooded portion is a prairie extending entirely across the tract from north to south. This extends to about the western boundary of the tract south of the canal, the last line on the west being partly in the prairie and partly in a bay. North of the canal, however , this prairie still keeping its width swings to the east as the bay along the upland becomes narrow. This leaves the northwest corner of the tract in a bay for the most part.

The southern end of this prairie is almost an open marsh. The remainder of its area is dotted thickly with many small and large "houses". These houses are circular areas which support a heavy undergrowth of brush, bamboo briers, vines, etc. with often a good growth of both cypress and pine timber. In many places in the prairie there are open spaces of water?"gator holes". These are

usually small. Some of the larger ones have the distinction of being called lakes and cover from a few acres up to about 8 or IO acres of surface. These are Cooter, Sego, Trout, and Big Hole lakes.

In both the prairies and bays the water usually covers the surface to a depth of from a few inches to a few feet. This wet, swampy condition provides for not only the growth of the swamp-loving trees and brush but also for a varied, numerous, and luxuriant growth of lilies, mosses, grasses, and other aquatic vegetation. Almost nowhere is the surface bare, the vegetation usually covering it completely. This growth of water-loving plants has formed a perfect mat over which one can usually walk without fear of bogging down deeply. In many places the surface sinks perceptibly when one steps upon it, the surrounding surface rising and trembling. In not a few places this surface mat may break through with ones weight and then one bogs to considerable depth in the soft organic mud below.

The timber growth on the islands is similar to that of the surrounding upland. The tree growth consists of long leaf pine chiefly. There are a few oaks and along the edge bays and gums. There is a sod of wire grass with an undergrowth of gall berry bushes and short stemmed saw palmetto. Around the islands and along the outer edge of the swamp there is usually a heavy dense growth of bays and other brushy trees. In places there are many black gum, etc. All through these positions there is generally a pretty good growth of both pine and cypress. In some places on the prairie there is a perfect jungle of bamboo vines, making it impossible to get through without cutting the way. I n other places the vegetation is almost entirely of

maiden cane, and in other places plants of the lily family, and in still other places spagnum moss predominates. A characteristic growth in many places,which is in reality neither bay or prairie, is a dense, thick brushy growth called "hoorah" brush. These brush seldom grow larger than about three-fourths of an inch in diameter and from 4 to 8 feet in height. However, in many places they stand on the surface as thiek as a good stand of grain in a grain field.

Soils.

Soils are composed of two classes of material, Mineral and Organic. Most soils are largely of the former class. In many places locally there are small and large areas in which the soil forming material is made up almost entirely of the latter class of material. Such is the case with the soils of the Okefenokee Swamp. The drainage conditions of this large area hace been poor from the time when the region in which it is found was first raised above the oceanic waters. From that time to the present there has been a luxuriant annual growth of water-loving or swamp vegetation. The growth, death, and decay of the many generations of this plant life has left a thick deposit of organic soil material. This material is in all stages of decomposition from that of the present years growth to that which has rotted and lost all semblance of its original form. It varies from black to brown in color. Some of it is still fibrous, only the softer and less stable portions of the plant form having rotted. Such material is usually brown to yellowish-brown in color and spongy in appearance. Other portions aresoft and unctious, having decayed to such an extent that the material has completely lost its fibrous structure and semblance to vegetable life. This material is generally of a dark-brown or black color.

The conditions under which these materials have decayed have been such that there has been only a partial decay in both cases, more in one than in the other. The ordinary decomposition of organic matter, where access is had to both air and sunshine, results largely in gaseous products with only a minimum of solid residue. Here, however, the wet, swampy conditions have excluded the air and sunshine, and aeration and oxidation of the materials has been slight. This has resulted in the formation of a maximum of solid matter as a product of decomposition. Thus the soils of this tract of land vary from an upland sand composed almost entirely of mineral matter on the islands to organic soil materials in various stages of partial decay in the swamp portion.

Marginal Soils.

Along the margin of the swamp and around the edges of the islands included there is a more or less narrow strip of land which is more or less a mixture of both classes of soil material.

The surface soil of this strip of land is a black sand to sandy loam from 6 to 24 inches or more in depth. In many places this surface soil is Muck, well decomposed organic matter, to about the same depth, also black in color. The subsoil here is a grayish sand to sandy loam.

This soil has been formed under semi-swamp conditions. It has been wet enough for the growth of most of the swamp vegetation, but when the water is low, it is dry and the materials have been subjected to the influence of oxidation, aeration, and other weathering processes, which has resulted in the formation of a mantle of well rotted organic soil intermingled with sand overlying the sandy upland materials.

This soil type will be found to be somewhat different in its crop

adaptation than will be the true swamp soils. It will produce some of the upland crops like corn, sweet potatoes, etc. to excellent advantage. Besides these general farm crops it is well suited to about all of the special crops that can be grown on the swamp soils.

Island Soils.

On the islands the surface soil consists of from 6 to 12 inches or more of grayish-black to black sand. Just below this there usually occurs a stratum of sand of yellowish-brown to brown color. This is generally quite loose and does not interfere with soil moisture movements, though occassionally it forms a dense, compact crust or "hard pan". In such areas natural drainage is poor, the hard pan holding water above it in wet weather and preventing the rise of moisture from below in dry seasons.

These island soils support an excellent stand of pine timber and an undergrowth of wire grass, palmetto, gall berry, etc. They are adapted to corn, Sea Island cotton, sweet potatoes, peanuts, sugar cane, and forage crops among the general farm crops. They are also well adapted to strawberries, water melons, cantaloupes, English peas, cucumbers, lettuce, radishes, Bermuda onions, Carrots, turnips, table beets, okra, spinach, Cabbage, cauliflower, snap beans, asparagus, egg plant, tomatoes, early Irish potatoes, etc among the special truck crops. An item of more than passing interest is the fact that the sugar cane grown on these island soils makes a syrup of unexcelled quality.

Swamp Soils.

The swamp soils of the tract will be considered under three heads according to their character. These are as follows: Bays and Houses, Prairie South of Canal, Prairie North of Canal.

Soils of the Bays and Houses.

The soils of that portion of the tract included in the timbered area, the Bays and Houses, are very similar all over the whole tract. The surface few inches is composed of leaves, roots, and other material of recent accumulation. Just below this and extending for a number of feet in depth the soil is a dark-brown or black peaty Muck, or Muck. This soil is an accumulation of organic material that is well rotted. It is in a fine state of subdivision and contains but little spongy fibre other than that of the live roots of the trees, shrubs, and other vegetation growing over its area.

The surface of this soil usually lies slightly higher than the prairie areas. This difference in elevation has afforded an opportunity for alternate wetting and drying, especially at the surface, as the swamp waters rise and fall with the natural supply of water. Thus these soil materials have been subject to aeration, oxidation, etc. and are more perfectly decayed, forming Muck rather than Peat. The original materials have lost their plant form and structure and the resulting product is a soft mud.

This soil, when drained and tilled, will compact readily to form a stable surface and will be of excellent quality for special purposes. No chemical analyses of the material are available but it is safe to state that it is high in Nitrogen content and rather low in both Potash and Phosphoric Acid, especially the former. It is also very likely deficient in carbonates and to some extent sour or acid. In its cultivation judiceous fertilization will be of benefit, and the fertizer used should be high relatively in potash and phosphoric acid and low in nitrogen. The use of lime in the carbonate form will also be

found to be advantageous.

This material is an excellent soil and when drained, cleared, and put into cultivation will be adapted to a wide range of truck or special crops. Among these crops that may be mentioned are; lettuce, spinach, egg plant, celery, table beets, asparagus, okra, snap beans, English peas, turnips, carrots, cabbage, cauliflower, etc. Sugar cane and forage crops will also grow well but it is likely that the syrup from the cane would be dark and strong and of inferior quality, though it might be grown on a scale to manufacture sugar. If this is done the impurities responsible for the quality of the syrup would be removed in the processes of sugar manufacture. It is certain that a good tonnage of cane could be grown, and its growth for sugar making purposes is well worth considering.

Corn would probably grow well but would scarcely make the grain on account of the soil not being balanced in its chemical makeup.

In the utilization of this soil, the production of that class of plants of which the leaves or roots or fleshy, watery portion is edible and marketed, should be paramount. About all of this class of plants are quick in their growth and usually several crops may be grown each season on the same field. No serious effort should be attempted to grow and mature crops of which the seed is the part striven for. When not in use for the production of the special crops, use could be made of some of the fields for growing forage for the work stock necessary in cultivating the soil for the production of the special crops.

Soils of the Prairie South of the Canal.

The soil of the prairies lying south of the canal differ considerably from that north of the

canal. Here the top foot or so consists of a mass of plant remains only partially decomposed. This material is somewhat spongy and fibrous though filled with fine well rotted matter. It is brown to dark-brown in color. In places it is more thoroughly decayed and consequently less fibrous and spongy in structure. Such areas also have a darker color, being dark-brown to black. Underneath this surface material the organic matter is in a well rotted condition and is a soft mud black in color.

These prairie areas are only a shade less decomposed than the timbered Bays and Houses. It has been formed in the same manner by the partial decay of aquatic vegetation. Such areas, it seems, lie a very little lower than those covered with trees and brush and consequently are more saturated with water at all seasons of the year. Thus the influences of weathering and decomposition have been slightly less active. Aeration and oxidation have been held in check by this higher and more constant moisture content.

Such areas are, however, rotted to such an extent that the material is more of the nature of Muck rather than Peat. They will be found to be only slightly less valuable, at first, for cropping. This difference in value will soon disappear upon affording drainage and cultivation. Whatever difference now existing, being so small, will be more than counterbalanced by the fact that for these areas there will be no expense for clearing.

These soils are adapted to the same group or class of special crops as are those of the timbered portion of the tract. In their cultivation the use of lime will hasten the decomposition and tend to equalize the slight difference in character now existing.

Soils of the Prairie North of the Canal.

The soils of the prairie areas north of the canal consist of the same class of material as those south of the canal, but are considerably less rotted. These soils are made up of a spongy mass of plant remains. This material is very fibrous and yellowish-brown to brown in color. It is Peat rather than Muck. Evidently the conditions have been such that oxidation and aeration and accompanying decomposition have acted but little except upon the softer portions of the structure of the dead plant tissue. There is some fine decomposed organic matter intermingled with the spongy fibre. Usually in the lower portion of the deposit the material is more completely decayed and darker in color, often being black.

The soils of these areas are a grade below those of similar areas south of the canal in crop value. A little longer after draining and tilling will be required to induce further rotting and to equalize their natural value for cropping purposes. This can be done as already suggested by the use of lime and tillage to allow free circulation of air within the soil mass. In the way of crop adaptation these soils are similar to both the prairies south of the canal and the timbered areas. They are special purpose soils and their best utilization will be found in the production of the special truck crops.

Substratum Materials.

Underneath these organic soil materials there is found a substratum of the basal material of the region. This, in so far as could be determined consists of a grayish to drab sticky sandy loam or sandy clay. This mineral subsoil material is everywhere, except as the swamp margin and islands are approached, so far

beneath the surface that it has little or no effect on the organic soil covering or upon crop adaptations. The average depth at which it is found at 21% corners of 40-acre lots on the tract is a little over 5 feet. This substratum will, however, have the effect of preventing the surface materials from becoming too dry and therefore protect crops from drought conditions.

Soil Formation.

The process of the formation of soils from these organic materials is of recent geological time. It is still in progress and just as active as it ever has been. The draining and clearing of the tract will hasten the process greatly. The removal of the water and the stirring of the surface will allow the air to circulate freely among the organic materials which together with the sunshine will promote oxidation and thus accelerate the decomposition into soil. Also the mechanical effect of cultivation will break up the more fibrous material and thus have its effect on the decay of the materials to form soil. Likewise, as has been stated, fertilization especially the use of lime will tend to hasten the process. Thus, the very acts necessary in the utilization of these soils for growing crops will have a beneficial effect upon the material for its use. It is certain that the effect of these factors together with the subduing of the wild vegetation and virgin sod will put the soil into better condition for cropping in a few years time than it is to start with. It is believed that there will be a continued and accumulative improvement in the condition of the soil with each years cultivation.

Draining and Clearing.

Upon affording drainage the surface of the tract will settle as the soil compacts, thus lowering the elevation

slightly.

In the drainage of this tract it must be remembered that these swamp soil materials will burn readily when dry. Consequently the water-table should not be lowered too much. Another reason why it should not be lowered greatly is the fact that the crops adapted to these soils require large quantities of moisture for their growth and if the water-table is near enough the surface it can be supplied to them by capillary action from below, thus augmenting the natural supply at the surface from rainfall. Water could also be supplied from the drainage ditches for surface or overhead irrigation by pumping.

In the clearing of the tract care should be taken that in burning the brush not much of the surface of the soil is burned. All of the ashes from the burning of the brush, stumps, etc. should be returned to the soil. This will aid in furnishing some potash and other mineral matter to the soil which it needs.

Utilization.

These swamp soils are primarily special purpose soils, as has been pointed out, and their highest value will be in their use for the production of the special crops to which they are adapted. These crops are enumerated in another part of this report. Most if not all of them can be grown in the latitude of this tract of land during the winter season when the northern markets demand them at high prices. In addition to these special truck crops these soils can be used for many other purposes. During that part of the year when it is not advisable to grow truck they could be utilized in growing forage for the work stock or for market. Corn for ensilage would likely do well and thus provide for dairy farming as an adjunct to truck growing.

Fuel.

Peat has long been used for fuel. Its value for this purpose depends upon the amount of combustible matter present, the cost of preparing it for market and the marketing of it. Up to the present "no quantity of peat fuelof any type sufficient to prove its value has yet been produced in the United States;" "It appears to reach its highest value, however, as a source of producer gas in properly constructed gas producers". Peat has been so used in some of the European countries for many years and seemingly successfully. In the United States but little data is available to show the value of Peat for making producer gas. A test was made several years ago at the fuel-testing plant of the United States Geological Survey at St. Louis, Mo., using ~~[illegible]~~ air-dried machine Peat from near Orlando, Florida. This test was of fifty hours duration and 29,250 pounds of Peat were consumed or 585 pounds per hour. This gave a gas having a calorific value of 175 British thermal units per cubic foot, which was higher than that obtained during the same year from bituminous coals from Indiana, Kentucky, Illinois, Ohio, Pennsylvania, and Virginia gassified in the same producer. During the entire run the average electrical horse power developed at the switch board was 205. The amount of Peat consumed per horsepower hour per electric horsepower commercially available was 2.98 pounds. The Peat bricks used had been dried and contained an average of only 21 per cent of moisture. The gas produced was rich in hydrogen and comparatively low in nitrogen. In large plants for the manufacture of producer gas arrangements may be made for the recovery of the ammonia contained in the gas as ammonium sulphate, a by-product which finds a ready market at a high price.

It would seem that with the cities of Savannah, Jacksonville, Brunswick and Waycross within a reasonable distance, a plant for the utilization of these materials in the manufacture of producer gas , and using this in turn for generation of electricity would be worthy of serious consideration, and especially so with the recovery of the by-product, ammonium sulphate.

(Note.)
Samples of this material have been sent to Dr. Caro of the Deutche Bank, Berlin, Germany for analysis and examination as to the possible use of the deposit for producer gas and ammonium sulphate. Dr. Caro is an expert on the subject and one of the patentees of the Frank-Caro process of ammonium sulphate recovery from the manufacture of producer gas from Peat. Upon the receipt of his report his findings will be submitted.

Fertilizer Uses.

These organic soil materials are often dried, pulverized, sacked and sold as humus for fertilizing purposes. It is especially desirable for use in top dressing lawns in the city on account of its freedom from all odors. There is no better material that can be used as an absorbent in stables for saving the liquid manures. It can also be used as a filler in the mixing of commercial fertilizers, augmenting the nitrogen content by that contained in it.

(Note.)
The questions of Experimentation and Organization are covered in the preliminary report submitted June 24, 1913 and will not be considered. Reference is to made to that report on these questions.

Summary.

The soils of this tract of land in the Okefenokee Swamp are of a quality far superior to that indicated by what was seen and considered in the preliminary report submitted in June 1913. All along the edge of the swamp the organic materials appear to be very well decayed, forming Muck soil rather than Peat. It is believed that the

quality is such that from the soil point of view the drainage of the tract can be advised. The depth of the material is sufficient that there will be found no difficulty from its drying out excessively. Its state of decomposition is such as to insure profitable crop yields with judiceous fertilization and proper care and management. The soil is adapted to a class of crop that almost always command a high market price. Such prices can be maintained to a greater or less extent by organization of the selling end of the proposition on a business basis. The soil will grow better and better with cultivation instead of deteriorating.

The material will make excellent fuel. It can be used in the manufacture of producer gas with ammonium sulphate as a by product. Besides this it makes an excellent odorless top dressing for lawns, city gardens, etc. It is a fine absorbent for use in stables, and also can be used as a filler in commercial fertilizers.

All these factors seem to indicate that its drainage is advisable and feasable from the soil point of view.

Addenda.

During the investigations made on this tract of land a trip was made into the interior of the swamp. Through Billy's Bay the soil was found to be black in color and well decayed. It is of good quality and depth. North from Billy's Island the soil was found to be of excellent quality and depth. It is, in this region, very well decayed and a deep black in color. Here the soil is of the best quality seen in the whole swamp. Examination was made of the material on the southern end of Chase Prairie. The soil in this section is not so well decomposed, being brown in color and more of the nature of Peat as is that of the prairies north of the canal.