REPORT

of

COMMITTEE ON THESIS

THE undersigned, acting as a committee of the Graduate School, have read the accompanying thesis submitted by Paul M. Harmer for the degree of Master of Science. They approve it as a thesis meeting the requirements of the Graduate School of the University of Minnesota, and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science.

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May 27 1915

A STUDY OF THE CHEMICAL CONSTITUENTS OF THIRTY SEVEN PEAT BOGS OF SOUTHERN MINNESOTA.

By Paul M. Harmer.

A THESIS

Submitted to the Graduate School of the University of Minnesota in partial fulfillment of the requirements

For the Degree of Master of Science.

St. Paul, Minnesota,

May 19, 1915.

For the Registrar

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II Sem. 191	Courses of Study	Approval of Courses	Credits
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	Minor Veg Pathology 102 Stadman	Adviser	OK. E.S.
		By Guy Standford	
	Miscellaneous	Dean	

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INTRODUCTION

The history of peat cultivation dates from the 16th century, when it was begun in the lowlands of Holland and Germany. The method used then was known as "Fehn-culture." [1] It was practiced on low moor peats and depended for its success on the use of the peat for fuel and upon the covering of the bog with sand or mineral soil.

In the 17th century a process known as "fire culture" came into use. Because of its simplicity it has not yet entirely disappeared in some parts of the north countries of Europe, in spite of the fact that it causes a loss of valuable plant food. By this method the bog is burned over, causing a loss of all the nitrogen in the burned portion and a concentration of the mineral matter on the surface. The objections to this method are, first, the loss of valuable nitrogen; second, the fact that it is

not of lasting benefit, the essential mineral salts deposited in burning soon being leached away; and third, the smoke from the burning moor injures the neighboring districts.

The discovery of the value of the Stassfurt potash salts for agricultural purposes and the drainage of the large Prussian bogs by the Prussian prisoners of war marked a great advance in the use of peat for agricultural purposes. The Rimpau method,[2] discovered by Theodore Herman Rimpau, with the addition of artificial potash and phosphoric acid fertilizers proved highly successful on low bogs. Inasmuch as most of the bogs of the German Empire were high bogs, a need of further investigation existed. This resulted in the establishment in 1877 of the Bremen Moor Experiment Station, which, more than any other institution, has advanced peat cultivation. By the establishment of sub-stations and demonstration farms, by the analysis of many samples of peat soils, and by the circulation of publications on peat culture, the

Station was able to give expert advice on peat cultivation with the result that flourishing communities were established on what was previously waste land.

Bavaria early called the attention of its citizens to the possibilities of moor cultivation when, in 1725, a mandate was issued fining land owners who failed to cultivate their moors. In recent years the establishment of the Royal Moor Culture Anstalt at Munich, with its Experiment Station at Bernau and experimental fields on several moors, has met with marked success in furthering the cultivation of peat lands. The establishment of the Experimental Moor Farm at Admont, Austria with other sub-stations which give free courses in moor cultivation, shows the interest taken by the Austrian Government in peat culture. The formation of Unions for moor cultivation, the establishment of demonstration farms and in many cases moor experiment stations in these countries and in Denmark, Finland, Norway and Sweden indicates the extensiveness of the peat lands and the great importance placed upon their better cultivation by the

different countries of northern Europe.

Almost no work has been done in America on peat analysis, the available data being limited to northern Europe. Sweden has two moor experiment stations, one on high bog moors at Flahult and one on low bogs at Jönkoping. The Bremen Experiment Station distinguishes between high and low bogs according to the lime content, those bogs containing one half per cent or less lime content being classed as high bogs while those containing 2½ per cent or more of lime are classed as low bogs. Bogs with a lime content between one half per cent and 2½ per cent are known as transition bogs. The Jönkoping Experiment Station likewise classifies the bogs according to lime content, those containing less than one per cent being high bogs and those containing more than one per cent, low bogs.

Low bogs are those subject to overflow from uplands, bringing mineral soil and salts in solution, thus aiding in the growth of grasses. High bogs, on the other hand, depend on the direct rainfall

for their supply of moisture. There is no addition of salts sufficient for the growth of grasses, with the result that mosses predominate. Transition bogs are those which have existed as low bogs but have either reached such a height or else climatic or drainage conditions have so changed that the grasses have been superceded by mosses.

The bogs of North Germany have been built up upon a sea deposit of coarse sand. Those of Sweden however, have been formed under climatic and surrounding conditions which more nearly resemble the prevailing conditions of Minnesota. For that reason these data have been used later (see Digest of Data) in a comparison with the chemical analyses of the Blue Earth Bogs. Table No. 1 shows the chemical analyses of 37 Swedish Low Bogs and 29 Swedish High Bogs.

These analyses are perhaps not exactly comparable with the analyses of the Blue Earth bogs, inasmuch as the lime contents were determined by different methods. In the Swedish determinations

Table No. 1. Composition of Swedish Bogs, showing composition of both surface 8 inches (20 cm.) and second 8 inches (20 to 40 cm.).

Reference Set No.	Locality of Bog	Depth of Section	Volatile Matter	CaO	N	Weight per cubic meter air dry
		cm.	Per cent			kgm.
Westerbotten						
1	Hornas, Nyaker, Rengardsmyran (9)	0-20	73.18	0.76	2.10	205
	" "	20-40	82.45	0.60	2.22	160
Jemtland						
2	Nordanberg, Lockne, Hanpkällsmyran 4)	0-20	87.49	3.74	2.44	211
	" "	20-40	90.29	4.61	2.46	204
3	Hallen, Hallviken, Sjoflon 8)	0-20	93.53	3.03	2.50	147
	" "	20-40	89.62	3.47	2.52	162
4	Hammerdal, Hallviken 9)	0-20	92.73	2.19	2.87	167
	"	20-40	95.24	2.06	2.56	145
5	Rörön, Månsåsen Oviken 9)	0-20	81.84	3.98	2.30	220
	" "	20-40	90.32	4.08	2.55	197
Average for Province		0-20	88.90	3.23	2.53	186
" " "		20-40	91.37	3.55	2.52	177
Gefleborg						
6	Sandviken 8)	0-20	83.09	1.39	2.09	226
	"	20-40	90.53	1.24	2.10	187
7	Främlingshem Arsunda 9)	0-20	90.34	1.57	2.29	192
	"	20-40	91.47	2.30	2.40	200
Average for Province		0-20	86.71	1.48	2.19	209
" " "		20-40	91.00	1.77	2.25	193

Table No. 1, cont.

Reference Set No.	Locality of Bog	Depth of Section	Volatile Matter	CaO	N	Weight per cubic meter air dry kgm.
			Per cent			
Kopparberg						
8	Nusnas, Fu, Budasmyran 10)	0-20	84.64	0.99	2.34	272
	" "	20-40	80.66	1.03	1.99	240
Orebro						
9	Sörby, Hidingsta, Experimental Field 6)	0-20	70.65	0.56	2.74	330
	" "	20-40	64.94	1.64	2.52	362
10	Nynäs, Kvismaren 7)	0-20	77.29	2.90	2.82	315
	" "	20-40	85.88	4.43	2.88	228
Average for Province		0-20	73.97	1.73	2.78	322
" " "		20-40	75.41	3.03	2.70	295
Westmanland						
11	Aspnäs, Tierp, Idaholm I 8)	0-20	64.43	7.55	1.83	240
	" "	20-40	92.93	00.52	2.08	135
Upsala						
12	Tobo 6)	0-20	92.93	2.72	1.52	177
13	" 6)	20-40	95.31	1.34	1.31	170
	Bemersberg Skuttunge south bog, moist portion	0-20	91.11	1.89	2.28	137
	" "	20-40	93.89	1.70	1.96	115
14	Tolfta, Bromaden 6)	0-20	74.44	0.81	2.59	195
	"	20-40	76.89	1.82	3.00	210
Average for Province		0-20	86.16	1.81	2.13	170
" " "		20-40	88.70	1.62	2.09	165
Stockholm						
15	Snara, Edsbro 7)	0-20	95.87	1.51	1.56	169
	" "	20 -40	96.05	1.85	1.32	175

Table No. 1, cont.

Reference Set No.	Locality of Bog	Depth of Section	Volatile Matter	CaO	N	Weight per cubic meter air dry
			Per cent			kgm.
Stockholm, cont.						
16	Lovisedal, Rö, Kamphafvet 9)	0-20	55.33	3.17	2.07	385
	" "	20-40	72.50	3.83	2.57	302
Average for Province		0-20	74.60	2.34	1.81	277
" " "		20-40	84.27	2.84	194	338
Södermanland						
17	Nygård, Katrineholm 4)	0-20	71.51	2.33	1.83	393
	" "	20-40	85.74	3.00	2.13	200
Oster Gotland						
18	Väsby, Horn Högbjörksmossen 7)	0-20	91.06	1.13	1.72	257
	" "	20-40	90.12	1.13	1.06	209
19	Rhenstad, Rök, Mellanjärnshagen	0- 20	73.93	2.53	2.41	279
"	" "	20-40	72.02	2.02	1.99	190
Average for Province		0-20	82.49	1.83	2.06	268
" "	"	20-40	84.07	1.57	1.52	199
Skaraborg						
20	Skattegärden, Asle Hallemossen 9)	0-20	87.07	3.57	3.09	275
	" "	20-40	93.05	2.83	2.54	147
21	Mönarp, Slutarp, Langholmens pasture 8)	0-20	87.89	4.72	3.27	195
	" "	20-40	89.69	4.64	3.15	142
22	" Lanjaberg-skiftet 8)	0-20	87.72	3.18	2.95	195
	" "	20-40	92.52	2.96	2.73	167
23	" Najlarpsskiftet 8)	0-20	91.10	2.95	2.87	180
	" "	20-40	93.46	2.76	2.54	137
24	"Gamlegard-skiftet 8)	0- 20	89.47	3.41	3.07	197
	" "	20 -40	90.83	3.71	3.02	160

Table No. 1, cont.

Reference Set No.	Locality of Bog	Depth of Section	Volatile Matter	CaO	N	Weight per cubic meter air dry
			Per cent			kgm.
Skaraborg, cont.						
Average for province		0-20	88.65	3.57	3.05	208
" " "		20-40	91.91	3.38	2.80	150
Elfsborg						
35	Vinsarpsmad, Dalum,[3] cultivated portion	0-20	90.21	1.68	3.18	165
	" "	20-40	93.18	1.90	3.09	166
	" another part of bog[3] cultivated portion	0-20	74.23	1.17	2.48	161
	" "	20-40	87.25	2.09	2.82	166
27	Skoghem, Skene[7]	0-20	85.75	0.76	1.72	277
	" "	20-40	94.29	0.71	1.88	212
28	Tranemo, Munthebo[10]	0-20	61.15	0.25	2.25	295
	" "	20-40	74.38	0.56	2.60	223
Average for Province		0-20	77.84	0.96	2.41	224
" " "		20-40	87.27	1.31	2.60	191
Jonkoping						
29	Hagalund, Kärda, Hagalundsmossen[5]	0-20	96.70	0.33	1.35	132
	" "	20-40	97.19	0.37	2.01	131
30	Kvinnelsbo, V. As,[5] Kvinnelsbomaden	0-20	92.09	0.56	2.01	--
	" "	20-40	93.24	0.29	2.24	--
31	Eckersholm, Torestorpmossen					
	Exp'tl. plots 298, 302, 303[5]	0-20	68.60	0.81	1.58	439
	" "	20-40	88.63	1.04	2.27	231
	" " 300	0-20	70.54	0.51	1.05	482

Table No. 1, cont.

Reference Set No.	Locality of Bog	Depth of Section	Volatile Matter	CaO	N	Weight per cubic meter air dry
			Per cent			kgm.
	Jönköping, cont.					
	Exp'tl. plots, cont.					
32	" " 300 [5]	20-40	90.38	1.09	2.46	216
33	" " 304-305 [5]	0-20	52.47	0.54	1.62	502
	" " " "	20-40	82.61	0.99	2.18	240
34	" " 306 [5]	0-20	80.16	0.91	2.09	296
	" " "	20-40	93.68	0.97	1.63	208
35	Vireda, Lekeryd, [6]	0-20	89.05	1.55	2.23	280
	" "	20-40	94.14	2.51	1.32	162
36	" " 6)	0-20	83.82	1.37	3.04	362
	" "	20-40	92.94	1.65	2.37	133
37	Brunstorp, Lekeryd, Långholmen [6]	0-20	78.14	2.66	2.53	275
	" "	20-40	85.46	4.03	2.14	212
38	Etrarp, Hook, Gardemossen [6]	0-20	95.65	0.22	1.41	145
	" "	20-40	95.38	0.20	1.09	115
39	Krämered, Bottnaryd, Lönas [7]	0-20	59.75	0.44	1.99	397
	" " "	20 -40	77.87	2.27	2.63	216
40	Frinnaryd, Maderna [8]	0-20	89.70	2.24	2.41	140
	" "	20-40	90.67	3.58	2.95	190
41	Gripenberg, Tranerydsmosse [9]	0-20	85.34	3.86	3.09	282
	" "	20-40	89.63	4.47	2.71	230
42	Eckersholm, Bratteborg [9]	0-20	74.35	1.62	2.04	191
	" "	20-40	83.45	2.56	2.00	192
43	Krakshult, Vintorpamossen [10]	0-20	90.29	1.81	1.98	260

Table No. 1, cont.

Reference Set No.	Locality of Bog	Depth of Section	Volatile Matter	CaO	N	Weight per cubic meter air dry kgm.
			Per cent			
Jonkoping, cont.						
43 cont.	Krakshult, Vinterpamossen	20-40	92.07	1.15	2.02	207
Average for Province		0-20	80.44	1.30	2.03	291
" " "		20-40	89.82	1.81	2.13	192
Kalmar						
44	Ogestad, Odensviholm 3)	0-20	84.29	1.59	2.53	254
	" "	20-40	85.82	2.55	2.81	187
45	Falsterbo Bruk, Hjorted, Kodön 3)	0-20	66.29	0.49	1.21	453
	" "	20-40	89.39	0.62	1.44	218
46	O·Grindrum, Hallerum, Vadängama 3)	0-20	81.06	0.48	1.37	416
	" "	20-40	96.68	0.85	1.88	147
47	Hvena, Hvenamader 9)	0-20	88.61	0.89	1.73	322
	" "	20-40	74.61	0.81	2.26	294
48	Skoarp, Emarp, Sjomossen 10)	0-20	69.55	0.99	1.15	252
	" "	20-40	96.45	0.42	1.06	210
49	Ramshult, Verlebo, Fliseryd, Gatvallen 10)	0-20	81.64	0.88	1.98	390
	" "	20-40	68.84	0.79	1.50	287
50	Länghult, Mönsteras, Smedkärret 10)	0-20	77.36	1.68	2.02	337
	" "	20-40	75.58	1.58	1.30	272
Average for Province		0- 20	78.40	100	1.71	346
" " "		20-40	83.91	1.09	1.75	231
Kronoberg						
51	Skifarps, experimental field 7)	0-20	89.96	0.08	2.50	217
	" "	20-40	92.98	0.24	2.07	185

Table No. 1, cont.

Reference Set No.	Locality of Bog	Depth of Section	Volatile Matter	CaO	N	Weight per cubic meter air dry
		cm.	Per cent			kgm.
Kronoberg, cont.						
52	Linnerydsby, Linneryd, Norre Bog 7)	0-20	85.95	0.47	2.53	236
	" "	20-40	92.75	0.53	2.21	151
53	Aneboda, Lamhult, Trollekärr 7)	0-20	90.45	1.05	1.96	100
	" "	20-40	93.97	0.57	2.74	175
54	" Vinterdammen 7)	0-20	67.53	0.91	2.09	142
	" "	20-40	80.61	057	2.35	220
55	" Ofrehalls-dammen 7)	0-20	90.47	0.50	1.74	80
	" "	20-40	87.51	0.29	2.16	140
56	" OfreSaj-dammen 7)	0-20	91.63	0.50	1.82	90
	" "	20-40	94.83	0.57	2.64	155
57	Blödings, Alfoestad 6)	0-20	87.71	1.04	2.06	247
	" "	20-40	95.02	0.58	1.22	135
Average for Province		0- 20	86.24	0.65	2.10	159
" " "		20-40	91.10	0.48	2.20	166
Halland						
58	Häralt, Skallinge, Mastskomaden 9)	0-20	93.44	2.64	2.51	152
	" "	20-40	97.03	0.23	2.58	167
59	Timmershult, Knäred 10)	0-20	65.48	0.80	1.79	340
	" "	20-40	91.44	2.24	1.77	170
Average for Province		0- 20	79.46	1.72	2.15	246
" " "		20-40	94.23	1.24	2.17	168
Christianstad						
60	Sosdala I 3)	0-20	97.49	0.19	1.43	170
	II	20-40	97.30	0.15	1.48	166

Table No. 1, cont.

Reference Set No.	Locality of Bog	Depth of Section	Volatile Matter	CaO	N	Weight per cubic meter air dry
		cm.	Per cent			kgm.
Christianstad, cont.						
61	Sösdala III [3]	0-20	97.21	0.15	1.56	133
	" IV	20-40	97.18	0.18	1.36	114
62	Tyringe, Blankebygget [10]	0-20	64.73	1.34	2.39	335
	" "	20-40	71.12	1.47	2.18	242
Average for Province		0-20	86.48	0.56	1.79	213
		20-40	88.53	0.60	1.67	174
Blekinge						
63	Eringsboda [9]	0-20	92.58	1.01	2.30	267
	"	20-40	92.91	0.59	2.23	255
Malmohus						
64	Bjersjö-Lagard [9]	0-20	93.04	0.72	1.88	230
	" "	20-40	94.10	0.80	1.80	225
Gotland						
65	Mästermyr [3]	0-20	89.64	3.36	2.27	117
	"	20-40	83.02	6.00	3.63	160
66	Skäggs, Martebomyr [3]	0-20	80.28	2.83	2.75	232
	" "	20-40	89.94	3.09	2.32	140
Average for Province		0-20	84.96	3.10	2.51	174
" " "		20-40	86.47	4.55	2.98	150
Average for Bogs		0-20	82.30	1.67	2.17	244
" " "		20-40	88.45	1.77	2.20	191

the lime was determined according to a modification of Eggertz and Nilson's[11] method in the acid extract obtained by shaking the unburned peat with concentrated 12 per cent hydrochloric acid for 48 hours. In the analyses of the Blue Earth bogs, as reported later, the lime was determined in that portion of the ash soluble in aqua regia. However, as Eggertz and Nilson have shown, the percentage of lime obtained by one method is roughly comparable with that obtained by the other method.

Minnesota has a larger acerage of peat soil than any other state in the Union but, up to the present time, very little work has been done in the investigation of the chemical and physical properties of these peculiar soils of the state. Also practically no reliable information has as yet been published as to the real agricultural value of Minnesota peat lands. The only chemical study reported is that of Hungerford,[12] "Minnesota Peat Soils," 1914.

A detailed study of the chemical composition of 37 peat bogs, 33 in Blue Earth County and 4

in Ramsey County, was undertaken, in the hope that it would permit of some advance in our knowledge of the character of the typical grass covered peat lands of the southern part of the state. The data secured are presented and analyzed in the following paper.

I desire at this point to express my thanks to Dr. L. J. Alway at whose suggestion the investigation was undertaken and under whose direction it has been carried on, and to Dr. R. A. Gortner for much assistance. I also wish to acknowledge the work of Mr. F. C. Clapp who did the sampling and collected the field data, and also that of Messrs C. O. Rost and P. R. McMiller who gave me some assistance in the laboratory analysis.

METHODS OF SAMPLING

In the sampling of a bog for analysis, as in the sampling of other soils, the important thing is to get samples which are representative of the composition of the area under investigation. The following method was finally adopted in securing the peat samples whose analyses are reported later. Ten surface samples were taken to a depth of eight inches, using a long-bladed, square-cornered spade six inches in width. The sections, 6 x 3 x 8 (depth)inches, were taken at a distance of 10 to 20 paces apart usually crosswise of the bog, the distance between the individual samples varying with the width of the bog. These samples were gathered in a pile on an oilcloth and by the use of a board, thru which alternate rows of nails had been driven, the peat was shredded until a representative sample for analysis could be secured. This varied in weight from 5 to 10 pounds, depending on the percentage of moisture present.

A second composite of the second eight inches of peat was taken in a similar manner, the sections being a continuation downward of the first sections. A third composite was taken with a two inch soil auger, this being a composite of ten borings and representing the section from 17 to 32 inches inclusive. These borings were made adjacent to the individual samples above mentioned.

Previous to deciding upon the line along which the samples were to be taken, a line of borings was run to determine the depth and contour of the bottom of the bog. The borings were made either 25 or 50 paces apart depending on the size of the bog and the unevenness of the bottom. Except in one case a photograph of each bog was taken.

PREPARATION OF THE SAMPLE FOR ANALYSIS

In the early attempts to prepare the peat for analysis, it was finely shredded in a hand made shredding machine made of two boards bearing alternate rows of nails, somewhat similar to the field instrument mentioned above. The peat was dried in a steam bath at approximately 65 degrees C. until nearly water free and then ground in a mortar. This process, however, proved too tedious. The method finally adopted was to pass the peat in the moist condition as received at the laboratory, thru an ordinary food chopper. The coarsely ground peat was then thoroughly mixed and one half of it stored in the moist condition and the other half dried in a steam oven at approximately 65 degrees C. until nearly water free. Drying the peat required 24 to 48 hours and was more rapid when the peat was dried in the sacks in which it had been received from the field than when it was placed in pans, presumably

because of the greater air circulation. The dry peat was again ground in a food chopper until it would pass thru a 2mm. sieve. By this proceedure, approximately 75 per cent would pass thru a 1 mm. sieve and 50 per cent thru a ½mm. sieve. The sample containing more or less hygroscopic water was then stored in jars. In some of the first analyses made the air dry sample was used, the percentage of moisture present was determined and the correction was made to a dry basis. This was done because of the hygroscopicity of the peat. Later it was decided that the amount of moisture absorbed by the water free peat in weighing out the sample was not sufficient to cause any greater error than might be incurred in the determination of the moisture content and the calculation to the dry basis. The samples were therefore dried for at least 12 hours at the temperature of boiling water. When the drying was conducted at 110 degrees C. there was an appreciable loss from the peat as dried in the water oven but inasmuch as this loss persisted and the weight did not

become constant it was thot very probable that decomposition of the organic matter was taking place. Therefore no samples were analyzed which had been dried at 110 degrees C.

METHODS OF DETERMINATION OF THE CHEMICAL CONSTITUENTS

The chemical analysis of the peat samples was made by methods which had been found satisfactory in previous peat investigations. Determinations of organic matter, total ash and insoluble matter were made according to the methods devised by the Bremen Experiment Station.[13] All methods used will be discussed in detail. All determinations of lime, phosphoric acid, nitrogen and acidity were made in duplicate. All, except nitrogen and acidity determinations, were made from a single peat sample of 5 grams. Check samples of peat or soil of known chemical composition were analyzed at intervals or along with the peat determinations.

Since the results of European analyses had shown that the percentage of potash in true peat soils is extremely low and that all true peats need a potash fertilizer no determinations of potash were made. For

the determination of the percentages of the organic matter and of ash, 5 grams of the water free sample wereignited in a platinum dish over the low flame of a Me ker burner until combustion in the sample had ceased. After heating at the full strength of the burner for some time it was transferred to a muffle furnace and ignited to constant weight. The Meker drove off all carbon in the lower part of the ash while the muffle furnace completed the ignition of the surface layer. Attempts were made to hasten the ignition by stirring the ash with a platinum spatula before putting it in the furnace and again after it had been ignited in the furnace for 15 minutes. Indications were that it did not appreciably hasten the ignition. The ash was of very fine texture, varying in color with the different bogs from nearly white, or light yellow, to a brown, the color variations being due to the iron content. The dish was cooled, weighed and, if there was any trace of carbon in the ash, reignited to constant weight. The loss in weight of the original

sample gave the volatile or organic matter.

For the determination of the insoluble ash in the peat samples, the total ash was transferred from the platinum crucible to a quartz evaporating dish. This was a delicate operation for the peat ash dusted very easily. This may be obviated to a considerable extent if the dry ash be exposed to the air of the laboratory for some minutes before transference. It was then moistened slightly and 20 c. c. of concentrated hydrochloric acid and 3 c.c. of concentrated nitric acid were added, and the mixture allowed to stand for half an hour to allow any violent action to cease. It was then evaporated to dryness. Evaporation should be complete in order to dehydrate the silica. Fifteen cubic centimeters of concentrated hydrochloric acid were then added and the mixture again evaporated to dryness. Sufficient dilute hydrochloric acid (one part hydrochloric to 2 parts water) was added to cover the ash and the evaporation repeated. The soluble ash constituents were then taken up with dilute hydrochloric

acid and filtered into a 500 c.c. graduated flask. The ash was washed on the filter with hot water and the washing continued until there was no trace of chlorides in the filtrate. The graduated flask usually contained about 250 c.c. of filtrate when that point was reached.

The filter paper and contents were then placed in a weighed platinum crucible and ignited wet. As soon as the filter paper had burned off, the crucible was transferred to a muffle furnace and ignited to constant weight and the percentage of insoluble ash in the original sample calculated.

For the determination of the lime content of the peat samples, the filtrate from the acid digestion was used. The filtrate in the graduated flask was diluted to 500 c.c. and duplicates of 100 c.c. each removed with a certified pipette.

The iron and aluminum were removed by a double precipitation, essentially as directed by Washington [14] P.P.97-103. The filtrates from the iron

and aluminum were united and the calcium precipitated as calcium oxalate under the usual conditions (see Washington[14] p.p. 126-129). Here again the double precipitation was employed. Instead of weighing the lime as CaO as Washington directs, the volumetric titration with standard potassium permanganate was employed (see Hillebrand[15] p.122).

In the determination of the percentage of phosphoric acid in the peat samples both volumetric and gravimetric methods were used. The gravimetric determinations were made as a check upon the volumetric methods and constituted about one-fourth of the total phosphoric acid determinations. All determinations were made in duplicate.

The volumetric method adopted was that of Prescott[16] and was followed in every detail. The solution was prepared for the gravimetric determination as follows: A 100 c.c. portion of the filtrate from the insoluble ash determination was placed in a 5 inch Royal Berlin porcelain evaporating dish and

evaporated to dryness on a steam bath. The residue was then carefully ignited over a Chaddock burner, to dull redness, to drive off chlorides, inasmuch as hydrochloric acid and chlorides interfere with the complete precipitation of ammonium phosphomolybdate. To the residue was added 10 c.c. of concentrated nitric acid and the mixture digested for a short time on the steam bath. The solution was then filtered thru a 7 cm. Blue Ribbon filter, refiltering thru the same filter, in case the filtrate was cloudy due to presence of iron oxide. The residue on the filter was washed with dilute nitric acid and warm water. From the solution as prepared above the phosphoric acid was precipitated by the addition of ammonium nitrate and ammonium molybdate as ordinarily prescribed, (see Washington[14] p.p. 162-167), the phosphorus being weighed after ignition as magnesium pyrophosphate.

In the determination of nitrogen in peat a modification of the Kjeldahl was employed, in which the mercuric oxide was replaced with a crystal of copper sulphate. All of the other details were carried

out as in the official methods of A. O. A. C.[17)]

For the determination of acidity in the Blue Earth peat samples, Truogs[18)] zinc sulphide method was followed. The chemical reactions involved in this test are the decomposition of a metallic sulphide by the soil acidity with the liberation of free hydrogen sulphide and the detection of the liberated hydrogen sulphide by the blackening of moistened lead acetate paper. From the intensity of the blackening the degree of soil acidity may be roughly determined. Since at the time the determinations were made the method had not been worked out for peat soils, experiment was made with known acid peats to determine the amount of soil required. From these results it was decided to use a 1 gram sample of peat. Since then the Wisconsin Experiment Station has issued a bulletin[19)] stating that 2½ grams of peat should be used in the determination of acidity by the Truog method. This being true, it is probable that some of the faintly acid peats would show a

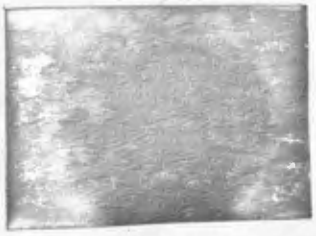
greater degree of acidity and that some of the "not acid" peats may be faintly acid.

The Truog method is as follows: To one gram of peat, placed in a 300 c.c. Erlenmeyer flask, there was added 1 gram of calcium chloride, one tenth gram of zinc sulphide and 100 c.c. of distilled water. The mixture was shaken and then boiled for one minute. A piece of lead acetate paper was then placed over the mouth of the flask and the boiling continued for two minutes more. The paper was then removed and the degree of acidity determined from the intensity of the color produced by formation of lead sulphide. The acidity determinations were classified as strong, medium, slight, faint, and not acid.

From experiments, tried with peat from Bog No. 1, which will be described later, it was found that the final result was influenced by other factors than the length of time that the lead acetate paper was left in contact with the mouth of the flask. After the removal of one paper, at the end of two

minutes, it was replaced by another, which was intensely black at the end of ten minutes more. This was replaced by a third, which was still blacker at the end of 15 minutes more. The blackening also appeared to be dependent on the rate of boiling. Still more important, it was dependent on the condition of the soil. Two portions of the same peat, bog No. 1, were tried. One was dried in the wateroven, and the other was in the condition in which it had been received from the field. Acidity determinations were made on both as described above. A weight of the moist peat equivalent to one gram of water free peat was used. The results of the two determinations are shown below.

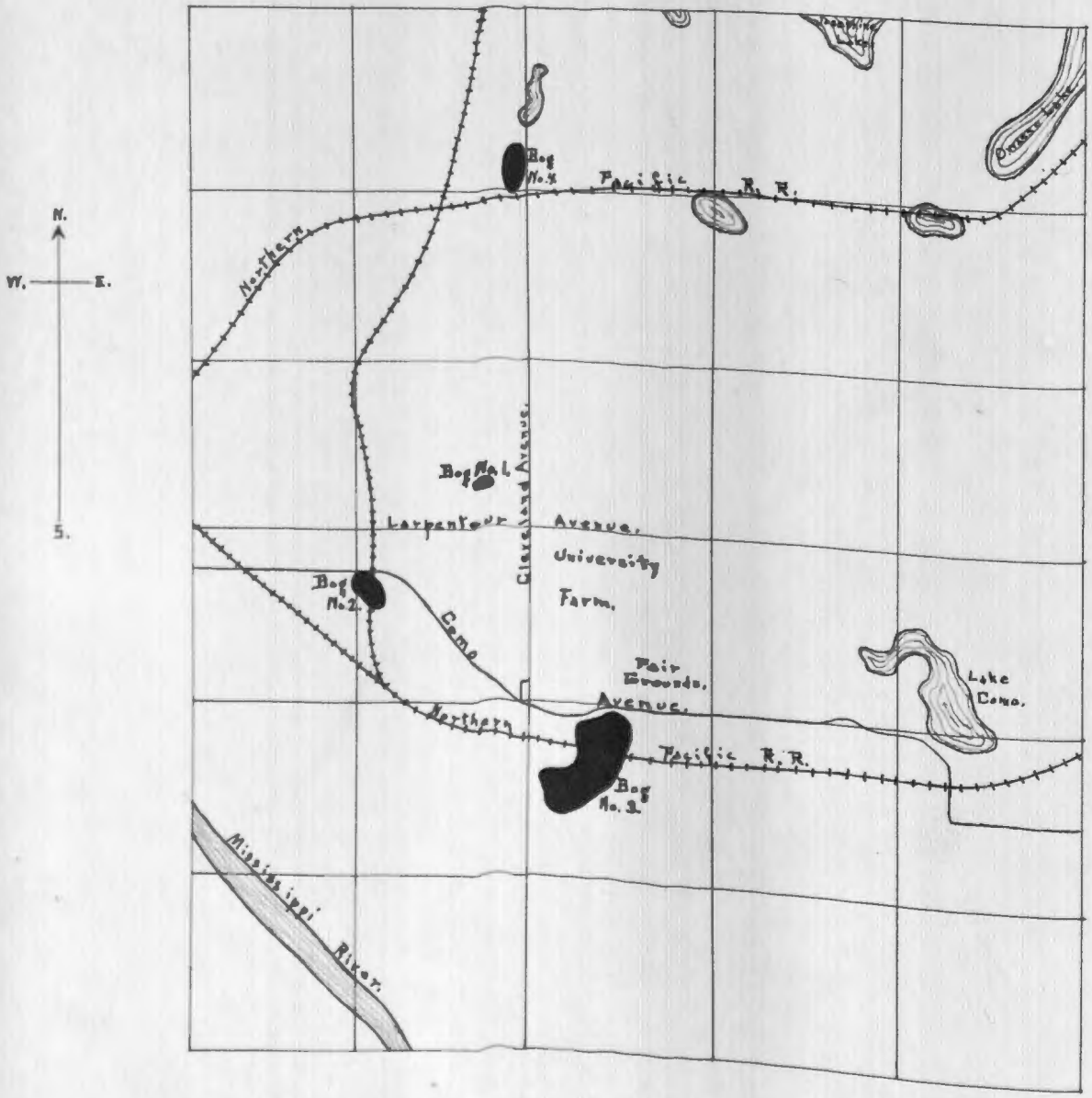
water free sample. moist sample.



The interpretation of the result from the moist peat would be "strongly acid," and from the water free peat "faintly acid." Apparently this result is not due to

loss of volatile acids in drying for by continuing the boiling of the water free peat for 10 to 30 minutes the more intense black given by the moist peat will be given also by the water free sample. Apparently, therefore, the substances producing acidity in the peat are altered in drying. For this reason the moisture contents of all peats were determined, in the condition as received from the field and weights of moist peat equivalent to one gram of water free material were used in determining the acidity. The determination of the moisture content was necessary, since different samples may contain from 70 to 500 per cent moisture calculated on a water free basis.

Plate No. 1.



Portion of Ramsey County around University Farm

Showing the Four Peat Bogs Sampled.

Scale 1 inch = 1 mile.

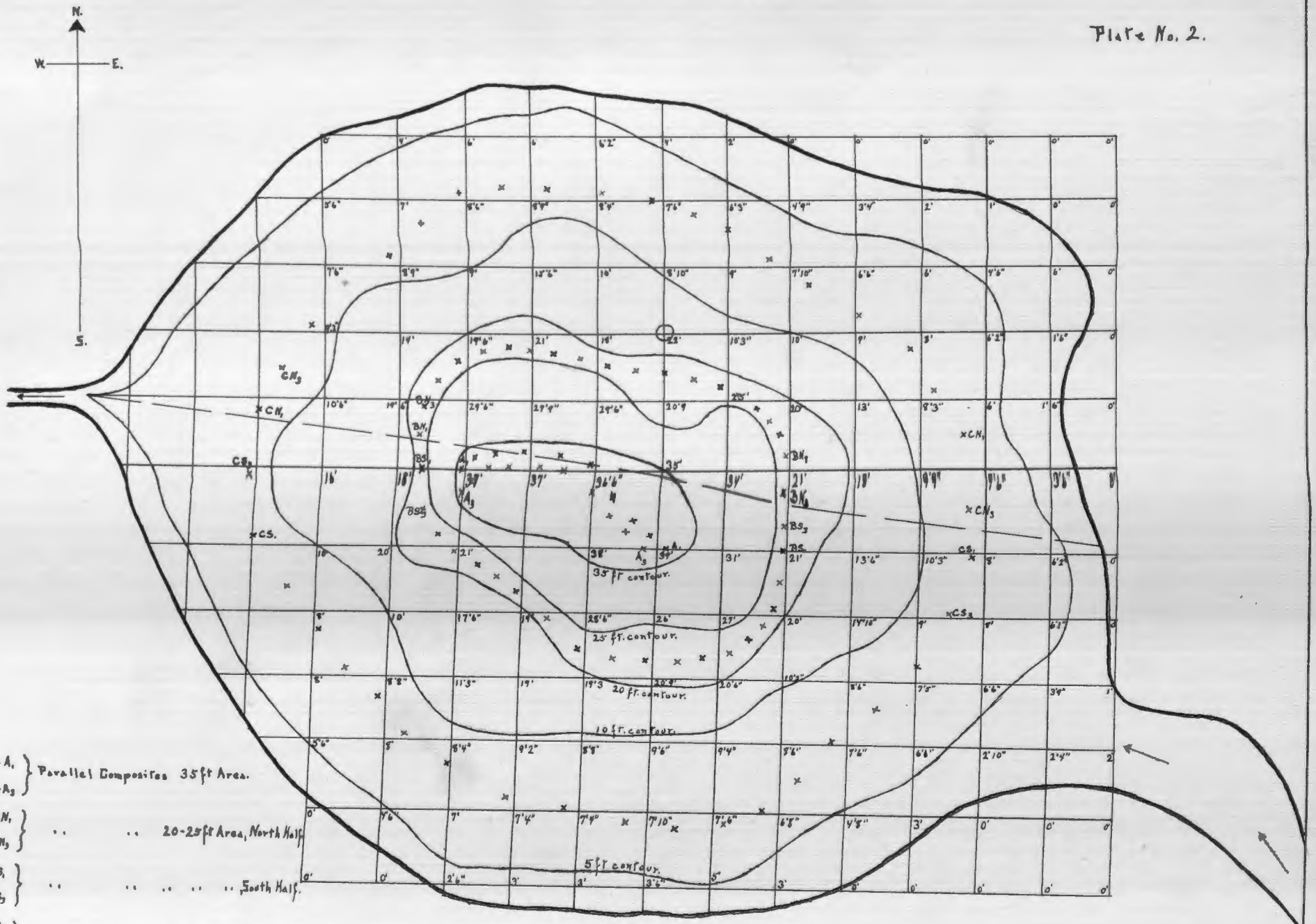
VARIATION IN COMPOSITION OF PEAT FROM DIFFERENT PARTS OF THE SAME BOG.

One of the most important considerations in interpreting the value of a chemical analysis is the manner in which the sampling has been conducted. We should know whether the peat bog in the area under investigation is sufficiently uniform in chemical composition so that a composite sample taken in the manner previously described, from what might be considered a representative area, is representative of the entire bog or whether different portions of the bog will show distinctly different chemical composition, thereby necessitating several sets of composite samples in order to gain reliable information as to its composition. These are questions which can be answered only by actual investigation.

In such an investigation a peat bog was selected within easy access of the laboratory and so

To face page 32.

Plate No. 2.



A1--A1 } Parallel Composites 35 ft Area.
A3--A3 }

BN1--BN1 } .. .. 20-25 ft Area, North Half.
BN3--BN3 }

BS1--BS1 } .. .. South Half.
BS3--BS3 }

CN1--CN2 } .. .. 5-10 ft Area, North Half.
CN3--CN3 }

CS1--CS1 } .. .. South Half.
CS3--CS3 }

Scale 1 inch = 60 yds.

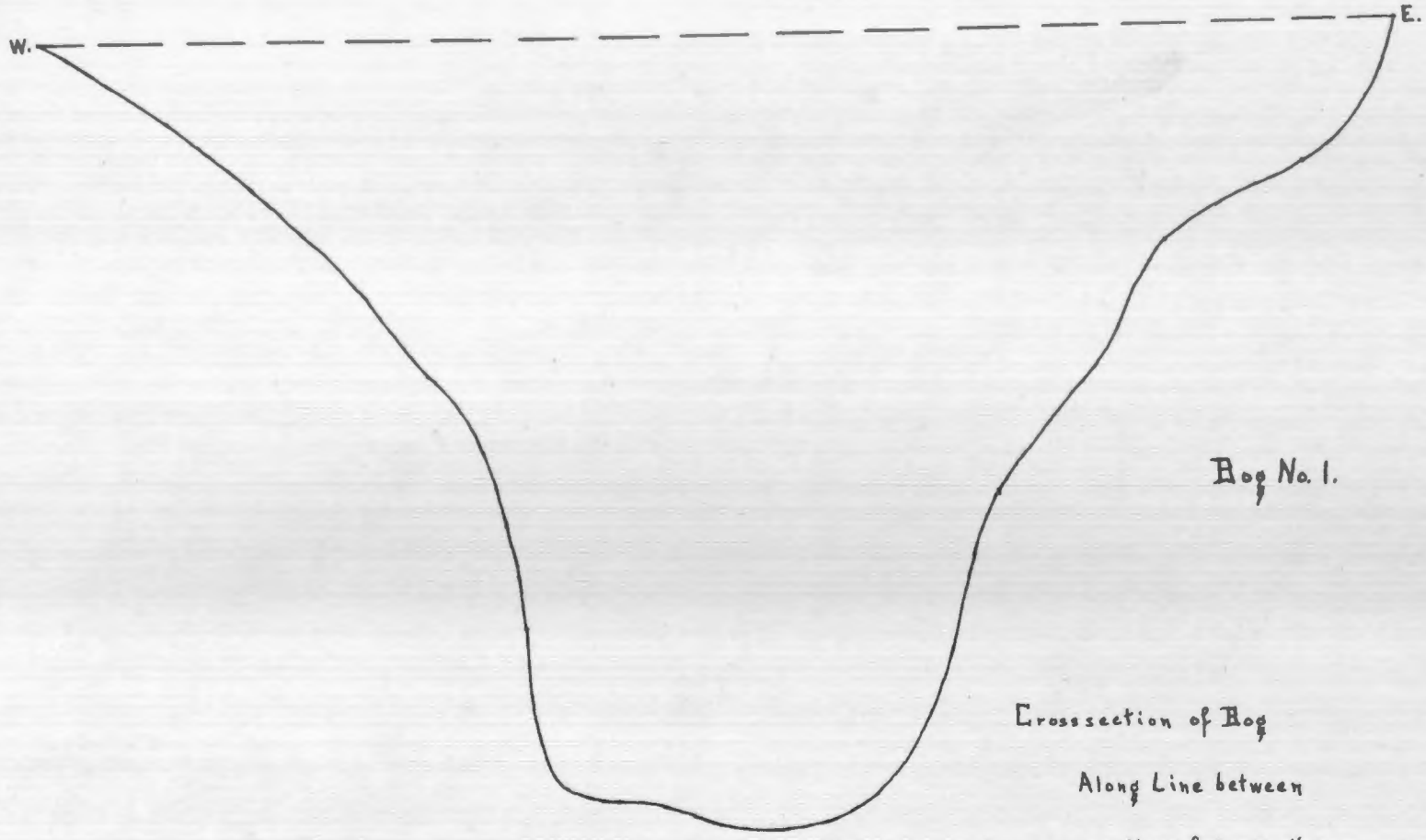
Bog # 1.

deep that it was especially suited to the purpose. It has an area of about four acres and lies northwest of University Farm approximately one half mile north of Larpenteur Avenue and one fourth mile west of Cleveland Avenue. Its location in Ramsey County is shown in Plate No. 1. For convenience it is referred to as Bog No. 1.

Some attempt has been made at draining this bog, employing open ditches but the water table lies so close to the surface that the center area was in 1914 covered with water thruout the entire year. The vegetation consists chiefly of grasses with rushes in the partly submerged portion. No attempt has ever been made to cultivate it.

The first step in the problem was the running of sets of borings for the purpose of obtaining a definite idea of the topography of the bottom of the bog. A topographic map, based on the results of these borings, is shown in Plate No. 2. A construction of a cross section of the bog, based on these borings

To face page 33.



Bog No. 1.

Crosssection of Bog

Along Line between

North & South Halves.

Scale { Vertical ½ inch = 1 ft.
Horizontal ½ inch = 22.5 ft.

is shown in Plate No. 3. The maximum depth of peat was found to be 39.5 feet.

Using this survey as a basis the bog was divided into a northern and a southern portion, as indicated on the map. Duplicate sets of composite samples, each made up from 10 individual samples, were taken within the area in which the peat was 35 feet or more in depth, this being almost entirely water covered. The locations of the individual samples of the 10 sets of borings are indicated by the black and red crosses within the 35 foot contour line. Duplicate sets of composites, of ten samples each, were taken in the north half on the area having peat with a depth of 20 to 25 feet. Likewise two similar sets were taken in the same area in the south half. These also are indicated by black and red crosses within the area between the 20 and 25 foot contour lines on the map. Duplicate sets were also taken in the 5 to 10 foot area in both the north and the south half of the bog. Since the determinations of the organic matter and total ash in the duplicate sets were found

to check closely, complete analyses was made of only one of each set of duplicates with the exception of the central area, both of which were analyzed. The results from the analyses of the different sets of samples taken on bog No. 1 are given in table No. 2.

A study of the data leads to the following conclusions. First, the percentages of organic matter and ash vary within fairly narrow limits in different areas of the same bog. Second, the outer areas of the bog contain higher percentages of mineral matter. This is due to the inwash of mineral soil from the adjacent upland. The variation becomes more evident by referring to table No. 3 which shows the average composition of the different areas.

The insoluble ash varies directly with the total ash. The lime content is uniform thruout the bog, within narrow limits. The phosphoric acid content is slightly more variable but no one area can be said to be uniformly higher than another. The central water covered portion was lower in phosphoric acid and

Table No. 2. To show the composition of the various samples taken from the different areas in Ramsey County Bog No. 1.

No. of Sample	Depth of Section	Organic Matter percent	Total Ash pct.	Insol. Ash pct.	CaO pct.	P_2O_5 pct.	N pct.	Acidity
Central Area 35 feet in depth								
A1	1-8 in.	86.59	13.41	9.81	0.80	0.26	2.53	medium acid
A2	9-16 in.	87.38	12.62	9.28	0.84	0.23	2.78	
A3	1-8 in.	86.28	13.72	10.18	0.95	0.28	----	medium acid
A4	9-16 in.	87.78	12.22	8.85	0.78	0.24	----	
Area of 20 to 25 foot depth								
BN_1	1-8 in.	85.13	14.87	10.90	0.87	0.31	2.85	medium acid
BN_2	9-16 in.	85.78	14.22	11.16	0.76	0.27	2.80	
BN_3	1-8 in.	85.11	14.89	-----	----	----	----	
BN_4	9-16 in.	85.75	14.25	-----	----	-----	----	
BS_1	1-8 in.	84.29	15.71	11.66	0.94	0.48	2.81	MEDIUM acid
BS_2	9-16 in.	83.79	16.21	12.38	0.71	0.39	2.78	
BS_3	1-8 in.	83.57	16.43	-----	----	-----	----	
BS_4	9-16 in.	84.72	15.28	-----	----	----	----	
Area of 5 to 10 foot depth								
CN_1	1-8 in.	81.46	18.52	14.29	0.88	0.35	2.83	Medium acid
CN_2	9-16 in.	86.39	13.61	10.31	0.79	0.28	2.80	
CN_3	1-8 in.	81.49	18.51	-----	----	----	----	
CN_4	9-16 in.	87.73	12.27	-----	----	----	----	
CS_1	1-8 in.	77.97	22.03	17.71	0.78	0.34	2.78	Medium acid
CS_2	9-16 in.	84.10	15.90	11.82	0.72	0.24	2.74	
CS_3	1-8 in.	77.99	22.01	-----	----	----	----	
CS_4	9-16 in.	82.97	17.03	-----	----	----	----	
Average for bog 1 to 8 in.		82.99	17.01	12.71	0.87	0.35	2.76	
Average for bog, 9-16 in.		85.64	14.36	10.95	0.76	0.28	2.78	

The data in Table No. 2A arranged according to location on the Bog.

		Average Per cent				
		North side Samples over 5-10ft depth area	Samples over 20-25ft depth area	Central Samples over 35 ft. depth area	South Side Samples over 20-25 ft. depth area	Samples over 5-10ft depth area
Organic Matter	1-8 in.	81.47	85.12	86.43	83.93	77.98
" "	9-16 in.	87.06	85.76	87.58	84.25	83.53
Total Ash	1-8 in.	18.53	14.88	13.57	16.07	22.02
" "	9-16 in.	12.94	14.24	12.42	15.75	16.47
Insoluble Ash	1-8 in.	14.29	10.90	10.00	11.66	17.71
" "	9-16 in.	10.31	11.16	9.06	12.38	11.82
Lime (CaO)	1-8 in.	0.88	0.87	0.87	0.94	0.78
" "	9-16 in.	0.79	0.76	0.81	0.71	0.72
Phosphoric Acid(P_2O_5)	1-8 in.	0.35	0.31	0.27	0.48	0.34
" " "	9-16 in.	0.28	0.27	0.23	0.39	0.24
Nitrogen	1-8 in.	2.83	2.85	2.53	2.81	2.78
"	9-16 in.	2.80	2.80	2.78	2.78	2.74

Table No.3. Average composition of the peat from the different areas in Bog No. 1, arranged to show the relation of composition to depth.

		Average Outside Area 5-10ft. depth Percent	Average Intermed. Area 20-25ft. depth Percent	Average Central Area 35 plus ft. depth Percent
Organic Matter	1-8in.	79.72	84.52	86.43
" "	9-16 in.	85.30	85.00	87.58
Total Ash	1-8 in.	20.28	15.48	13.57
" "	9-16 in.	14.70	15.00	12.42
Insoluble Ash	1-8 in.	16.00	11.38	10.00
" "	9-16 in.	11.06	11.77	9.06
Lime (CaO)	1-8 in.	0.83	0.90	0.87
" "	9-16 in.	0.75	0.73	0.81
Phosphoric Acid (P_2O_5)	1-8 in.	0.34	0.39	0.37
" " "	9-16 in.	0.26	0.33	0.23
Nitrogen	1-8 in.	2.80	2.83	2.53
"	9-16 in.	2.76	2.79	2.78

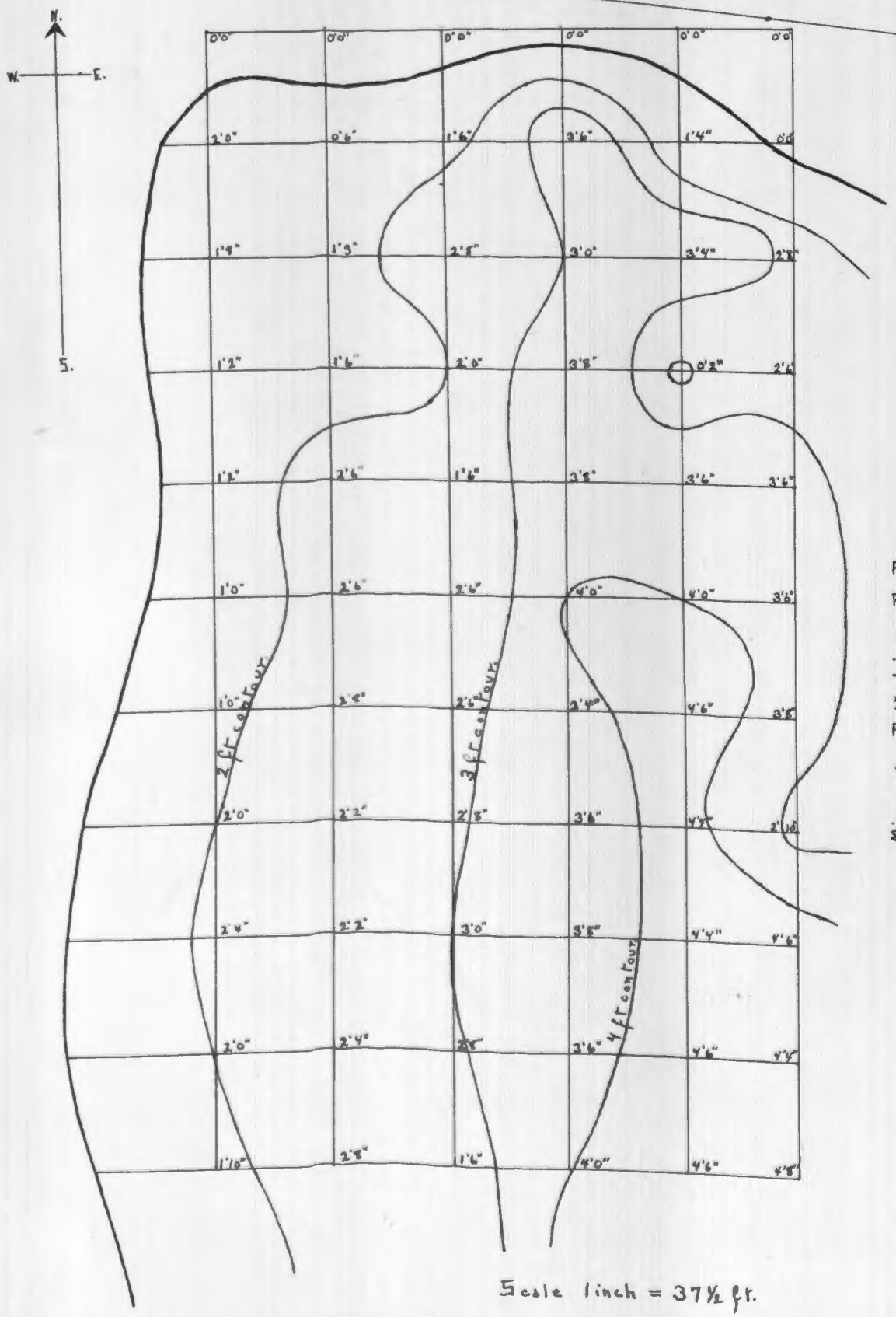
nitrogen content than the rest of the bog. All the areas were strongly acid according to the Truog test. However, no one of these analyses is so different from the average that it can not be taken as representative of the composition of the whole bog.

If instead of taking a composite in a given area it were taken crosswise of the bog so as to contain sections from all areas the result of the analysis would be somewhat more nearly the average of all the analyses. If one composite were taken crosswise of the bog from the north edge to the center and another from the south edge to the center the analyses should be very similar and should be approximately those given in table No. 4 and either would be representative of the chemical composition of the entire bog. Therefore, it was decided that in the sampling of the Blue Earth County Bogs one composite of 10 samples taken in a straight line so located that it would extend over the different depths of the bog would give data which should be representative of that bog's composition.

Table No.4. Approximate composition of two composite samples, one taken from north side to middle and one from south side to middle of the bog.

		Average per cent North side to Middle	South side to Middle
Organic Matter	1-8 in.	84.34	82.78
" "	9-16 in.	86.80	85.12
Total Ash	1-8 in.	15.66	17.22
" "	9-16 in.	13.20	14.88
Insoluble Ash	1-8 in.	11.73	13.12
" "	9-16 in.	10.18	11.09
Lime (CaO)	1-8 in.	0.87	0.86
" "	9-16 in.	0.79	0.75
Phosphoric Acid (P_2O_5)	1-8 in.	0.31	0.36
" " "	9-16 in.	0.26	0.29
Nitrogen	1-8 in.	2.74	2.71
"	9-16 in.	2.79	2.77

Plate No. 4.

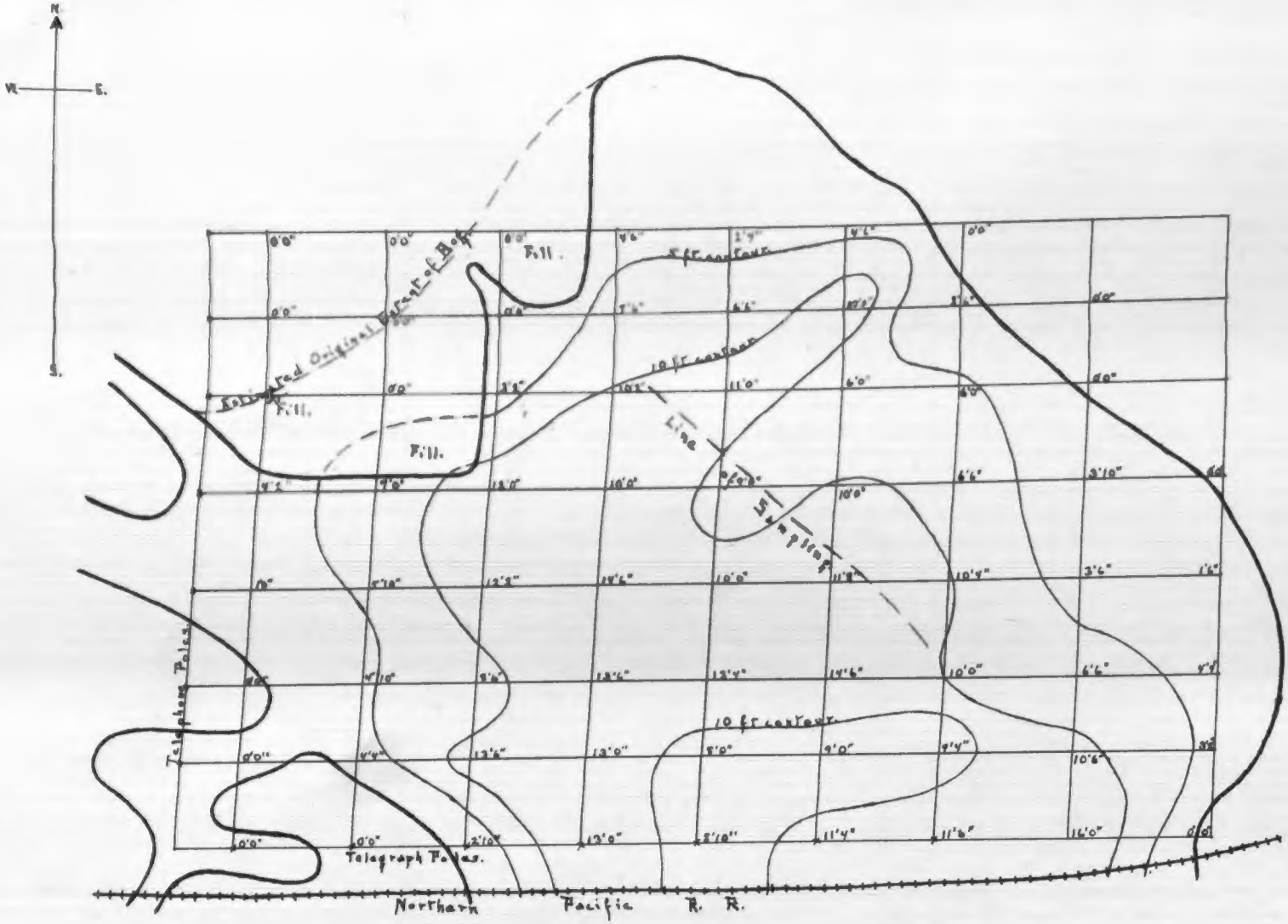


Bog No. 2.
Topographic Map
of
Portion of Bog
Sampled.

Scale 1 inch = 37½ ft.

SIMILARITY IN CHEMICAL COMPOSITION OF PEAT FROM BOGS LOCATED NEAR ONE ANOTHER.

In undertaking an investigation of the bogs of Blue Earth County it was of utmost importance to know whether those of a given locality would be so similar in composition that the analysis of one bog from a single locality would represent the group of bogs of that locality or whether each bog was distinctive in chemical composition, thereby necessitating separate analyses. To answer this question three bogs in Ramsey County within easy access of the laboratory were selected and samples secured from each in the manner decided upon previously. These three as well as Bog No. 1 all lie within a radius of one and one half miles. None of the bogs has ever been cultivated. No. 1 has been already described. No. 2 is crossed by the belt line railway tracks midway between St. Paul and Minneapolis on the south side of Como



Bog No. 3.

Scale 1 inch = 15 rods.

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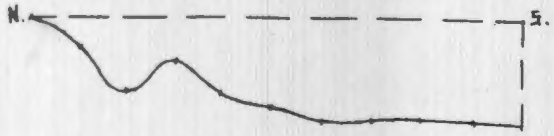
Avenue. It has an area of approximately 7 acres. The portion west of the tracks was sampled and a series of borings made. A topographic map of the bottom of the bog shows the shape and slope presented on Plate 4. No. 3 lies ¼ mile directly south of the Minnesota State Fair Grounds. It has a total area of approximately 100 acres but is crossed along the center by railroad tracks so that only the north half was mapped and sampled. The maximum depth of peat recorded from borings was 16 feet. Plate No. 5 shows a topographic map and cross section of the part sampled. Bog No. 4 lies two miles north of University Farm and just west of Cleveland Avenue. This was a marshy lake but has been drained by a large open ditch so that there is only a small area in the center now water covered. Soundings for depth were made lengthwise thru the center. The maximum depth of peat recorded was 14 feet. Plate No. 6 shows a topographic map of the bog and cross section along the line of borings.

The average for all analyses made of Bog No. 1 samples, together with the results from Bogs

Bog No. 2.

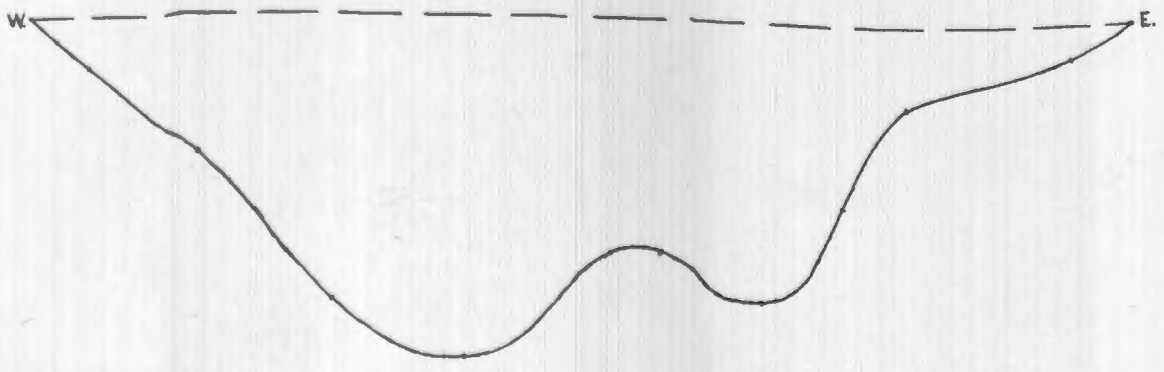


Crosssection Along Line of Sampling,

of Part of Bog Investigated.

Scale { Vertical ⅛ inch = 1 ft.
Horizontal ⅛ inch = 15 ft.

Bog No. 3.



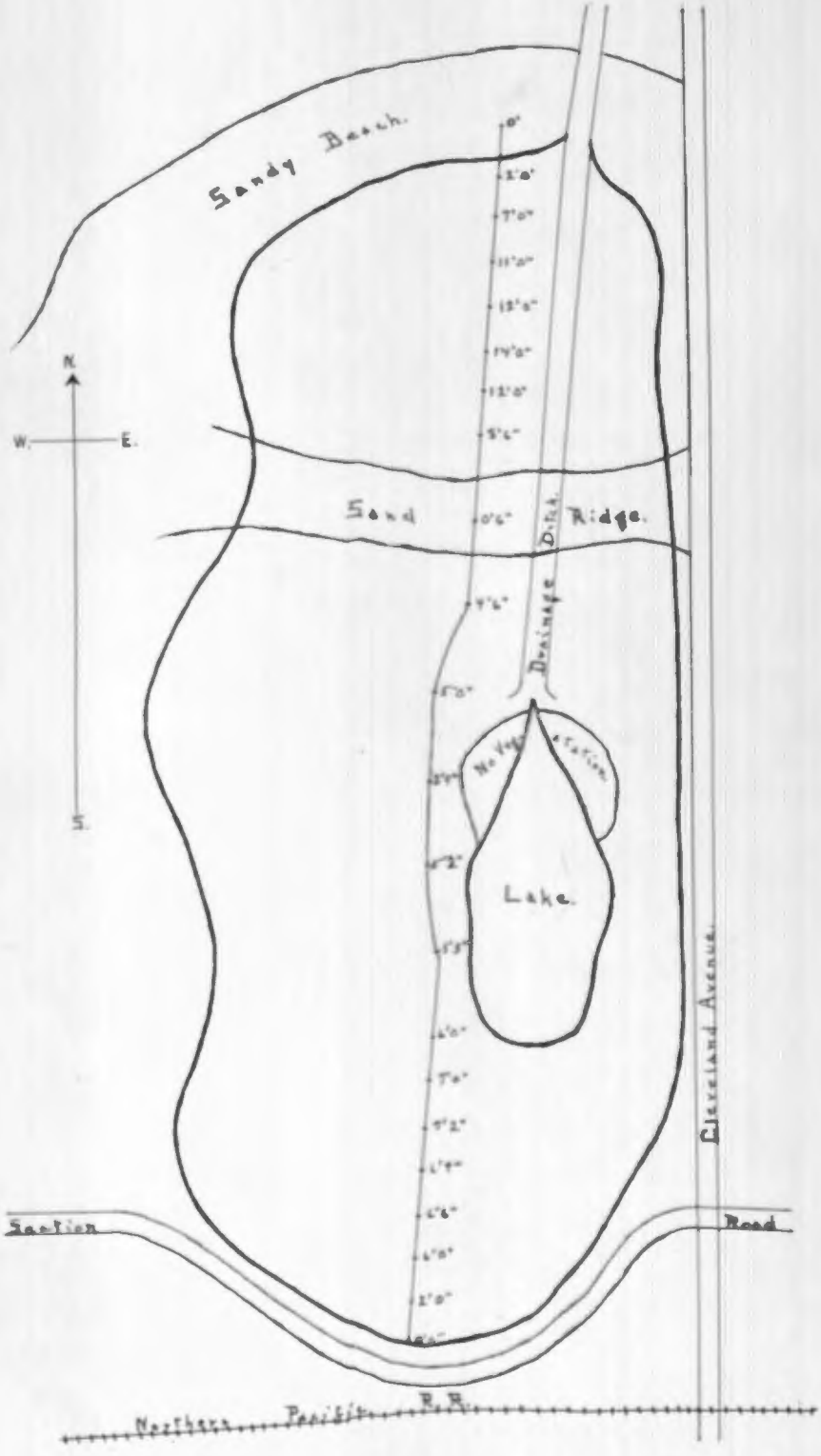
Crosssection of Bog Across North Portion.

Scale { Vertical ⅛ inch = 1 ft.
Horizontal ⅛ inch = 30 ft.

No's. 2, 3 and 4, are given in table No. 5. The results of the analyses show first that material in Bogs 1, 2 and 3 is true peat while that in bog No. 4 is a muck. Bogs No's. 1 and 3 are quite similar in all chemical constituents except lime. Bog No. 3 has nearly four times as much lime as bog No. 1. Bog No. 2 is the lowest of the three true peats in organic matter but is high in lime content and high in phosphoric acid content. In acidity Bog No. 1 is strongly acid while bogs 2 and 3 are not acid. In lime, phosphoric acid, and nitrogen, bog No. 4 is lower than No's. 1, 2 and 3.

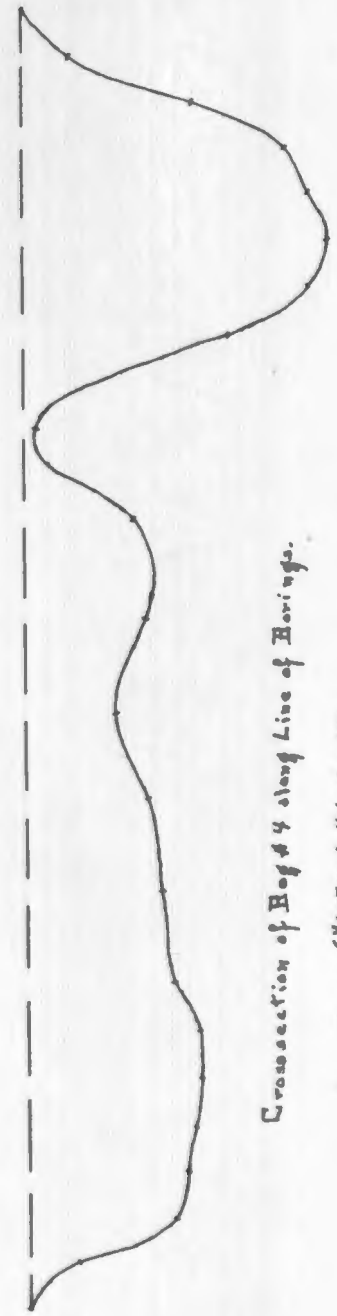
No other conclusion can be arrived at from a comparison of these analyses than that different bogs in the same locality may be distinctly individual in their chemical compesition. Many factors enter into the determination of the character of a bog, such as depth, vegetation, drainage, rainfall, composition of surrounding upland, etc., and influence its chemical composition. Because of this it was decided necessary to sample each individual bog in Blue Earth County study.

Plate No. 6.



Bog # 4.

Scale 1 inch = 100 yds.



Cross section of Bog # 4 along Line of Borings.

Scale { Vertical 1 inch = 15ft.
Horizontal 1 inch = 317½ ft.

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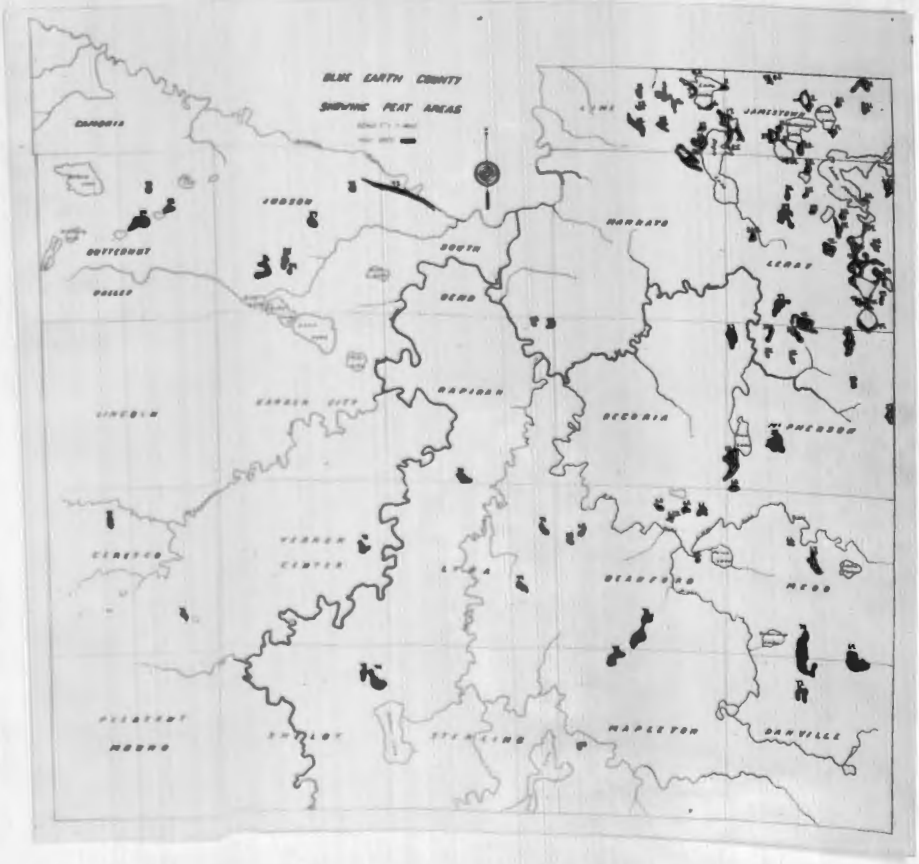
Table No. 5, To show the variation in the chemical composition of Ramsey County Peat areas.

True Peats	Depth of Section	Organic Matter pct.	Total Ash pct.	Insol. Ash pct.	CaO pct.	P_2O_5 pct.	N pct.	Acidity
Bog No. 1								
Average	1-8in.	82.99	17.01	12.71	0.87	0.35	2.76	strongly
"	9-16in.	85.64	14.36	10.95	0.76	0.28	2.78	acid
Bog No. 2	1-8in.	71.97	28.03	12.13	6.15	0.48	2.76	not acid
	9-16in.	81.41	18.59	8.60	3.70	0.56	3.10	
Bog No. 3	1-8in.	86.31	13.69	6.04	3.11	0.29	3.12	not acid
	9-16in.	89.53	10.47	4.73	2.25	0.20	2.59	
Average composition of the true peats	1-8in.	81.42	19.58	10.29	3.38	0.37	2.88	
	9-16in.	85.53	14.47	7.43	2.24	0.35	2.82	
Muck Bog No.4	1-8in.	26.74	73.25	67.97	0.28	0.11	1.39	slightly acid
	9-16in.	29.14	70.85	64.50	0.17	0.15	1.24	

Plate No. 7.



Map of Blue Earth County

Showing Peat Areas, in Black.

Scale 1 inch = 6 3/4 miles

To Case page 44.

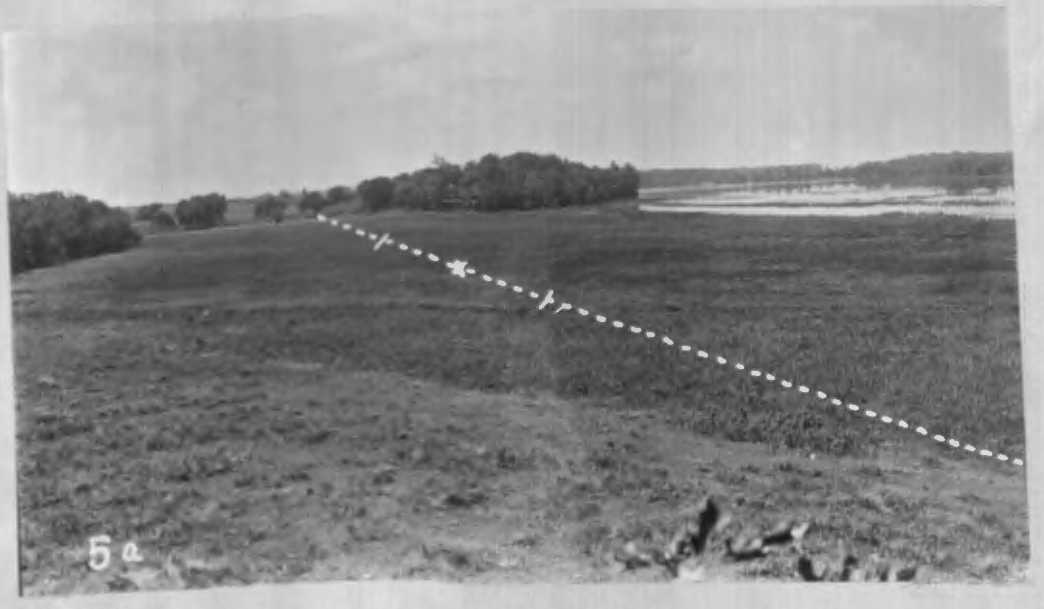
THE BOGS OF BLUE EARTH COUNTY.

The county of Blue Earth lies in the southern part of Minnesota about 90 miles south of the cities of Minneapolis and St. Paul and in the second tier of counties north of the boundary between Minnesota and Iowa. It embraces the territory just south of the southernmost point reached by the Minnesota River. This county was chosen as the best location for this project for two reasons. It is one of the few counties in Minnesota in which a soil survey has been made, and such a survey is of great advantage in assisting in the location of peat areas to be sampled. The county lies in the area covered by the Late Gray Drift, the most recent drift in the state and that which has the poorest drainage. Not being a sandy soil, it has large areas which were at one time lakes but have become filled with accumulating vegetation until they are now peat bogs. According to the survey by the United States Bureau of Soils, there are in the county

more than 100 such bogs with an area of over 10 acres each, varying in size to about 400 acres. In upland surface features the county varies from flat to rolling. The northeastern portion is quite broken and hilly. In this section are several lakes and the greatest number of peat bogs of any area in the county. The northwest portion is gently rolling while the central and southern parts, including about three-fourths of the county, are flat or slightly rolling, becoming more level as the southern boundary is approached. The total area is 479,104 acres while the amount of peat land is estimated at 7680 acres by the United States Bureau of Soils.

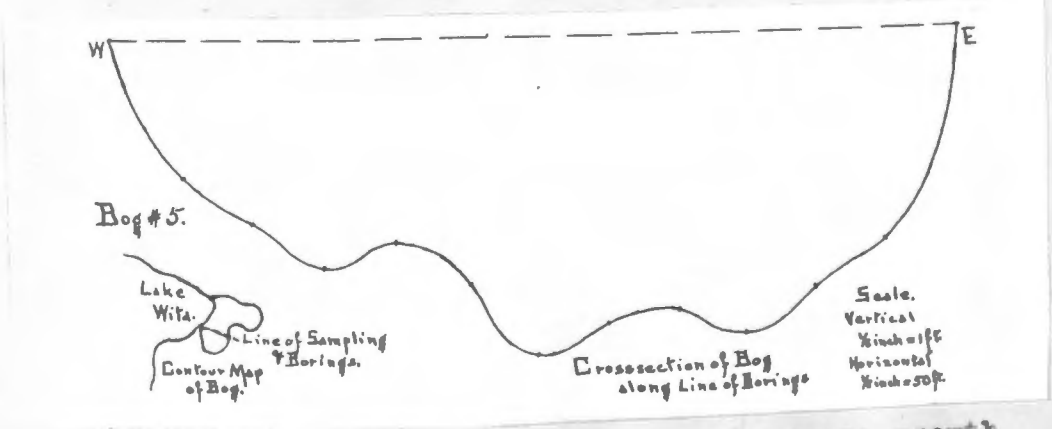
In order to facilitate the sampling and the description of the bogs, they were numbered in order beginning with those in the northeast section of the county. In so far as possible the more important ones were selected for sampling, special attention being paid to those which had been cultivated. The different peat areas sampled will be considered in detail.

BOG No. 5



BOG No. 5.

This bog, located in sections 19 of Jamestown township and 24 of Lime township, has an area of about 15 acres. It has an average depth of 11 feet along the line of borings, the maximum depth recorded being 13.5 feet although there were probably deeper portions north of the line of borings. It borders on the east side of Lake Wita and has little opportunity for drainage. The water table was about 3 inches below the surface along the line of sampling.



The vegetation consists of a dense growth of marsh grass, ferns and rushes, with considerable

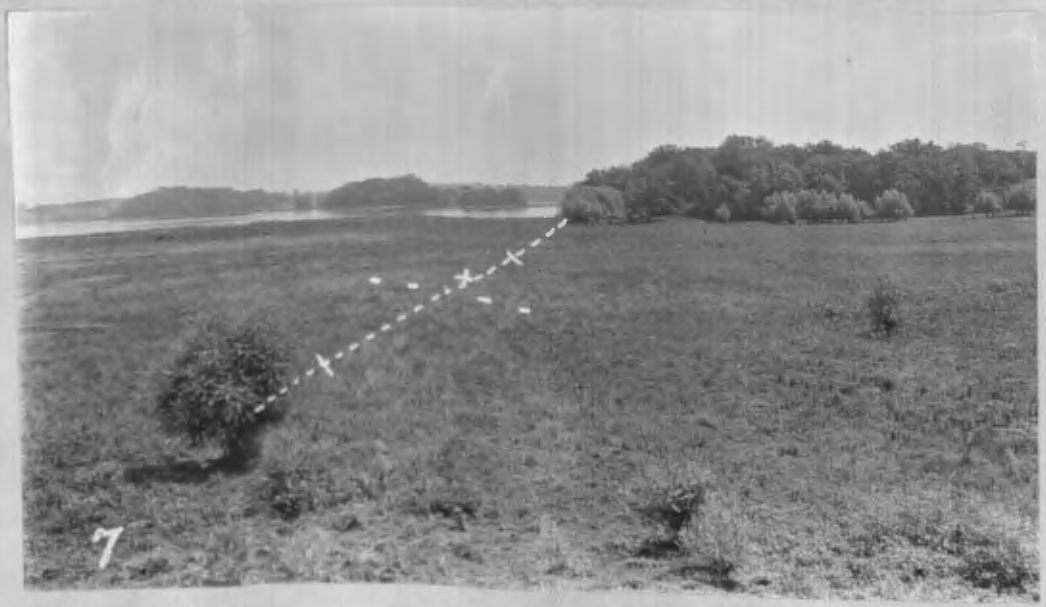
willow about the north point. The grass crop has never been cut for hay.

Analysis of the peat showed it to be a true peat with the lowest lime content of any analyzed from this county.

ANALYSIS OF SAMPLES

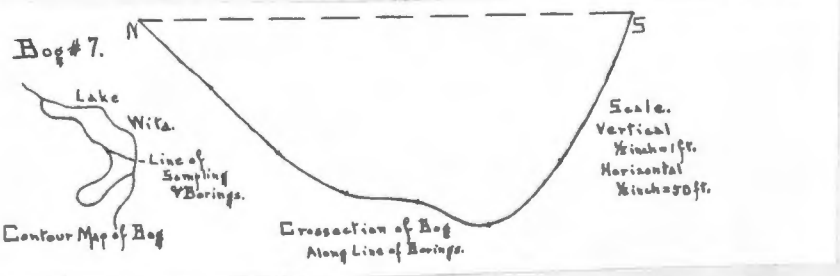
	Depth of Section. 1-8 in. Per cent	9-16 in. Per cent	17-32 in. Per cent
Organic Matter	78.92	85.58	84.95
Total Ash	21.08	14.42	15.05
Insoluble Ash	16.30	10.08	11.23
Lime (CaO)	1.31	1.29	1.10
Phosphoric Acid	0.37	0.29	0.25
Nitrogen	2.39	2.57	2.29
Acidity	not acid	----	----

BOG No. 7



BOG No. 7

This bog lies along the west bank of Lake Wita just across the lake from Bog No. 5 just described. The outlet of the lake has been lowered, causing a drop in the lake of about 3 feet, which leaves one portion of the bog higher and drier than the other. The portion to the right of the line of borings as viewed in the photograph is the dry part. The water table of the lower part is about at the surface while that of the higher part is about two feet deep. The bog has an average depth of about 7 feet with a maximum of 9 feet along the line of borings.



Vegetation is chiefly marsh grass with some catnip and smartweed. Canada thistles thrive on the drier portion. The northwest point is filled with

willows. The area of the bog is about 30 to 40 acres, all of which is pastured.

Chemical analysis shows this bog to resemble Bog No. 5 except in lime content. It is interesting to note that of these two bogs, situated on opposite sides of the same lake the lime content of No. 5 is less than half that of No. 7.

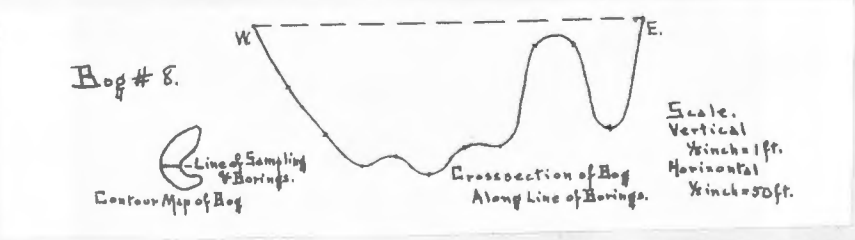
ANALYSIS OF SAMPLES

	Depth of Section		
	1-8 in. Per cent	9-16 in. Per cent	17-32 in. Per cent
Organic Matter	84.39	78.43	86.11
Total Ash	15.61	21.57	13.89
Insoluble Ash	10.03	15.99	9.61
Lime (CaO)	3.10	2.11	1.73
Phosphoric Acid (P_2O_5)	0.32	0.24	0.26
Nitrogen	2.45	2.31	2.56
Acidity	not acid	----	-----

BOG No. 8

BOG No. 8

This bog lies directly north of Lake Wita in Lime township with one end extending into Le Sueur County. It has an area of 10 or 12 acres with an average depth along the line of borings of about 5 feet. The maximum depth recorded is 6.4 feet. Drainage is inadequate with a hand made ditch. The water table was about 1 foot below the surface at the time of sampling (July 24, 1914).



The vegetation, chiefly of marsh grass, is very dense and is used for hay and pasture. No cultivation has been attempted on the bog.

Chemical analysis of the bog shows it to be higher in mineral matter than No's. 5 and 7 and about midway between the two in lime content.

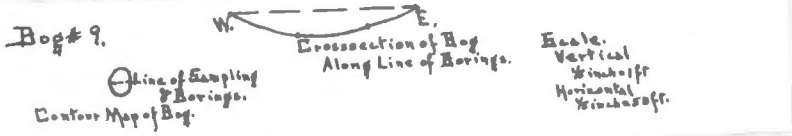
ANALYSIS OF SAMPLES

	Depth of Section 1-8 in. Per cent	9-16 in. per cent
Organic Matter	73.47	73.66
Total Ash	26.53	26.34
Insoluble Ash	19.70	20.35
Lime (CaO)	2.52	2.29
Phosphoric Acid (P_2O_5)	0.32	0.22
Nitrogen	2.47	2.38
Acidity	faintly acid	----

BOG No. 9

BOG No. 9

Bog No. 9 lies one mile west of bog No. 7. It has an area of about 4 acres with an average depth of peat of about 1 foot. This bog really should not be classed as a peat bog as it is practically a muck in the first foot. Drainage is accomplished with a hand made ditch and is inadequate, the water table being at a depth of one foot at the time of sampling (July 8, 1914).



The vegetation is chiefly swamp grass, foxtail, milkweed and timothy. The timothy was sown into the meadow with desirable results. The photograph shows the upland crops coming down to the edge of the bog with the drainage ditch at the right hand side. No cultivation had ever been attempted on the bog.

Chemical composition places the bog among the mucks.

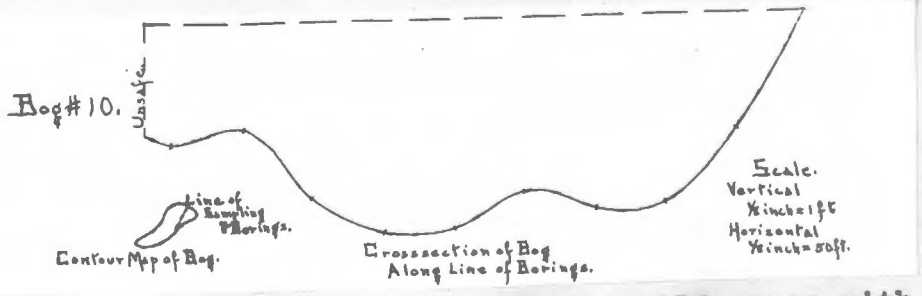
ANALYSIS OF SAMPLES

	Depth of Section	
	1-8 in. Per cent	9-16 in. Per cent
Organic Matter	51.08	16.34
Total Ash	48.92	83.66
Insoluble Ash	40.93	79.58
Lime (CaO)	2.22	0.75
Phosphoric acid (P_2O_5)	0.24	0.16
Nitrogen	1.93	0.58
Acidity	not acid	----

BOG No. 10

BOG No. 10

This bog, lying one half mile south of bog No. 9, has an area of about 15 acres. It averaged in depth along the line of borings about 7 to 8 feet with a maximum depth of 9 feet. Part of the bog was too wet to be sounded for depth. Drainage was secured by one main hand made-ditch two feet deep thru the center with a lateral from the north. It was inadequate and the water table when sampled (July 8,'14) was about 14 inches below the surface at the part sampled.



The vegetation was chiefly wild grass with some weeds. Part of the bog had been broken and sowed to timothy which was of good quality. This shows in the second photograph, at the left of the fence. The rest of the bog was part in pasture and part in hay. The corn in both photographs is on upland.

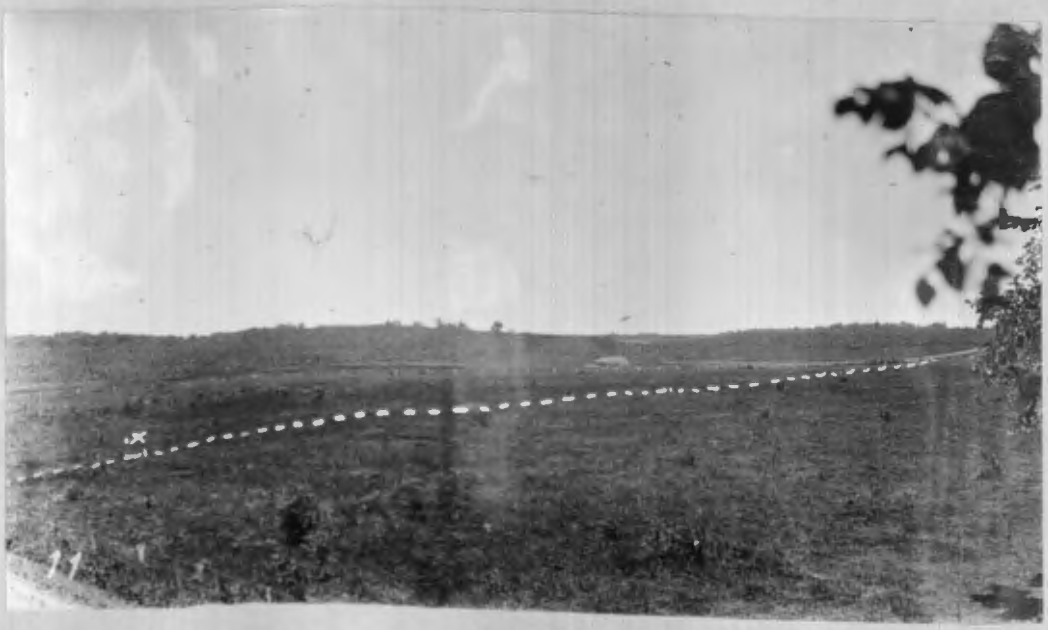
In chemical composition the bog resembled

bog No. 8.

ANALYSIS OF SAMPLES

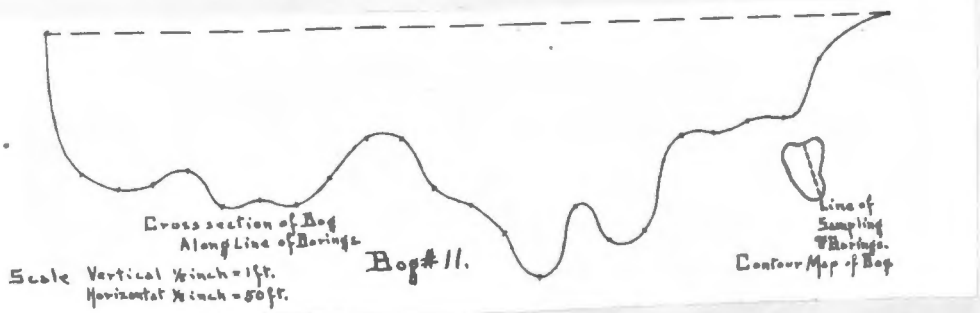
	Depth of Section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	74.30	73.57
Total Ash	25.70	26.43
Insoluble Ash	17.76	20.59
Lime (CaO)	2.85	2.15
Phosphoric acid (P_2O_5)	0.27	0.25
Nitrogen	2.64	2.50
Acidity	not acid	----

BOG No. 11



BOG No. 11

Bog No. 11 located one mile west of No. 10 has an area of about 20 acres. It has an average depth of 7 feet with a maximum depth of 11 feet along the line of borings. It is drained by a hand made ditch thru the center which does not give it adequate drainage. The water table was at a depth of 1 foot 4 inches at the time of sampling (July 7, 1914). Another larger bog to the southeast, not mapped in the United States Soil Survey, drained into it.



The vegetation was chiefly marsh hay with some weeds and scattering willows. The field west of the section road was hay meadow, that east of the road, pasture. No attempt had been made at cultivation.

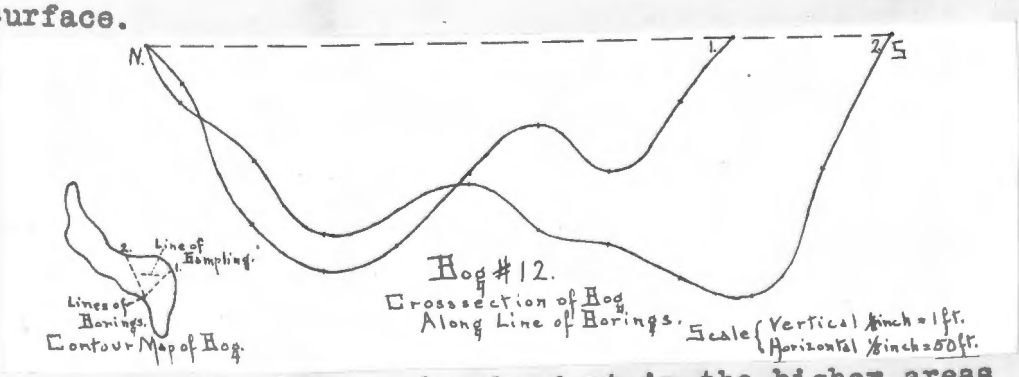
ANALYSIS OF SAMPLES

	Depth of Section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	76.07	77.03
Total Ash	23.93	22.97
Insoluble Ash	16.80	17.00
Lime (CaO)	2.49	2.51
Phosphoric Acid(P_2O_5)	0.31	0.25
Nitrogen	2.78	2.68
Acidity	not acid	----

BOG No. 12

BOG No. 12

Bog No. 12 has an area of approximately 75 acres. In depth it averages about 7 feet, with a maximum of 11 feet along the lines of borings. It is drained by a hand made ditch which is not sufficient and the lower areas have ground water close to the surface.



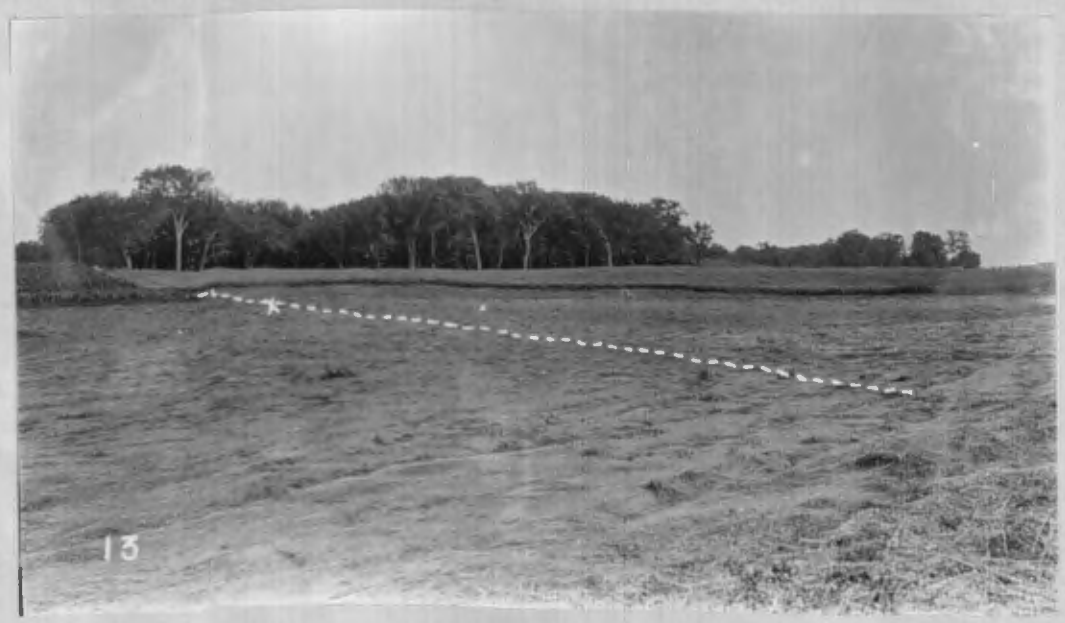
June grass is abundant in the higher areas and marsh grass in the lower, with milkweed and willow clusters scattered around the bog. The part on the east side of the section road is used for pasture, that on the west side, for hay meadow. The photograph shows the hay meadow with hay cut and in swath. A good yield was secured.

Two lines of borings were made, the constructed cross section showing their relationship. Samples were taken in the area between the lines of borings. From analyses the bog proves to have a high organic content, and the analyses of the first 8 inches compares more closely with the second 8 inches than in most of the analyses run.

ANALYSIS OF SAMPLES

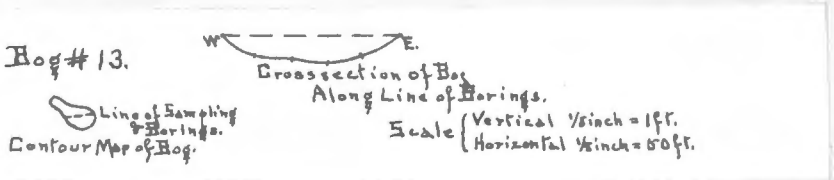
	Depth of Section 1-8 in. Per cent	9-16 in. Per cent
Organic Matter	84.00	83.72
Total Ash	16.00	16.28
Insoluble Ash	9.91	10.96
Lime (CaO)	2.47	2.35
Phosphoric Acid (P_2O_5)	0.33	0.23
Nitrogen	2.73	2.30
Acidity	not acid	-----

BOG No. 13



BOG No. 13

This bog has an area of about 6 acres. The peat has an average depth of hardly 1 foot. The second foot is a heavy mucky soil so only a surface 8 inch sample was taken. The section line road crosses the bog and the road ditches drain it.



Meadow and marsh grass constitute the vegetation on the bog which gives a good yield of hay. The corner of the corn field at the left of the photograph, extends into the bog and the corn on one foot of peat was of very good quality.

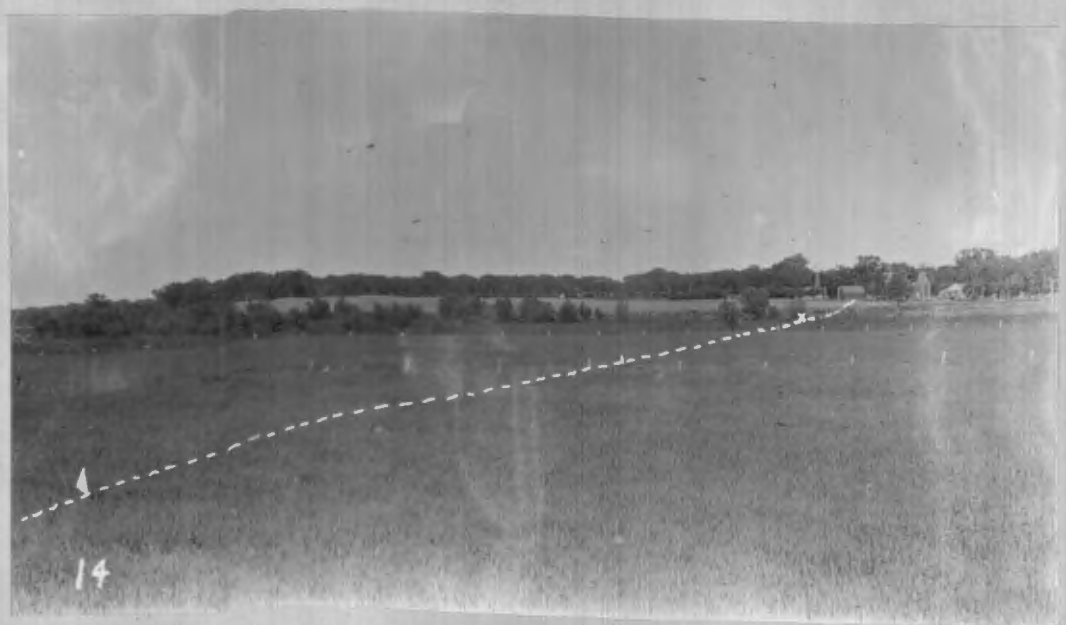
Chemical analysis of the bog places it with No. 9 in the class of mucks.

Bog No. 13 cont.

ANALYSIS OF SAMPLES

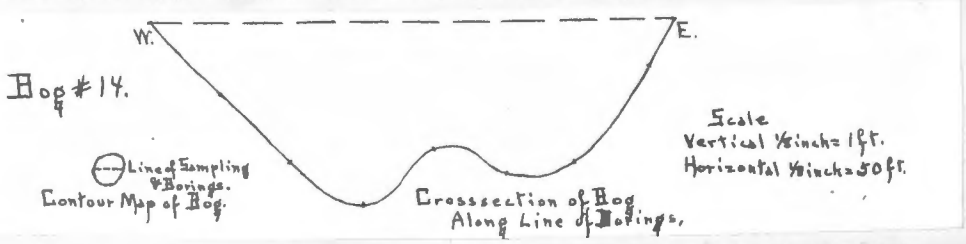
	1-8 inch section
	Per cent
Organic Matter	43.61
Total Ash	56.39
Insoluble Ash	48.06
Lime (CaO)	1.94
Phosphoric Acid (P_2O_5)	0.23
Nitrogen	1.61
Acidity	faintly acid

BOG No. 14



BOG No. 14

Bog No. 14, lying about 40 rods southeast of Bog No. 10, has an area of 15 acres. The depth of the peat averages 6 feet with a maximum of 8 feet along the line of boring. The drainage is hardly sufficient for best results from crops.



Part of the bog is pastured and contains June grass, weeds and willows which may be seen, in the lower portion of the bog, in the photograph. Five acres of the bog has been broken and seeded to timothy which can be seen extending to the second fence in the photograph. It was of very rank growth and very good quality, altho slightly rusted due to too much moisture. The estimated yield for the timothy in 1914 was 3 to 4 tons per acre.

Chemical analysis of the bog shows it to be rather high in mineral matter.

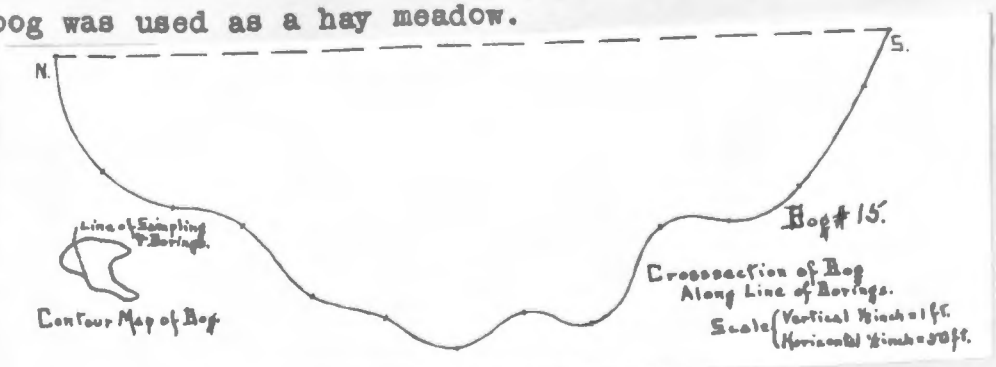
ANALYSIS OF SAMPLES

	Depth of Section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	68.40	71.91
Total Ash	31.60	28.09
Insoluble Ash	25.65	20.80
Lime (CaO)	2.03	2.89
Phosphoric Acid (P_2O_5)	0.24	0.31
Nitrogen	2.52	2.60
Acidity	faintly acid	---

BOG No. 15

BOG No. 15

Bog No. 15, located one mile east of Bog No. 12, has an area of 50 acres. The peat is firm and compact, with an average depth of 9 feet and a maximum of 13 feet along the line of borings. The bog is drained by a hand made ditch which is inadequate. The water table was about 15 inches below the surface at the time of sampling (July 13, 1914). The vegetation was chiefly meadow grass, red top and milkweed. The bog was used as a hay meadow.



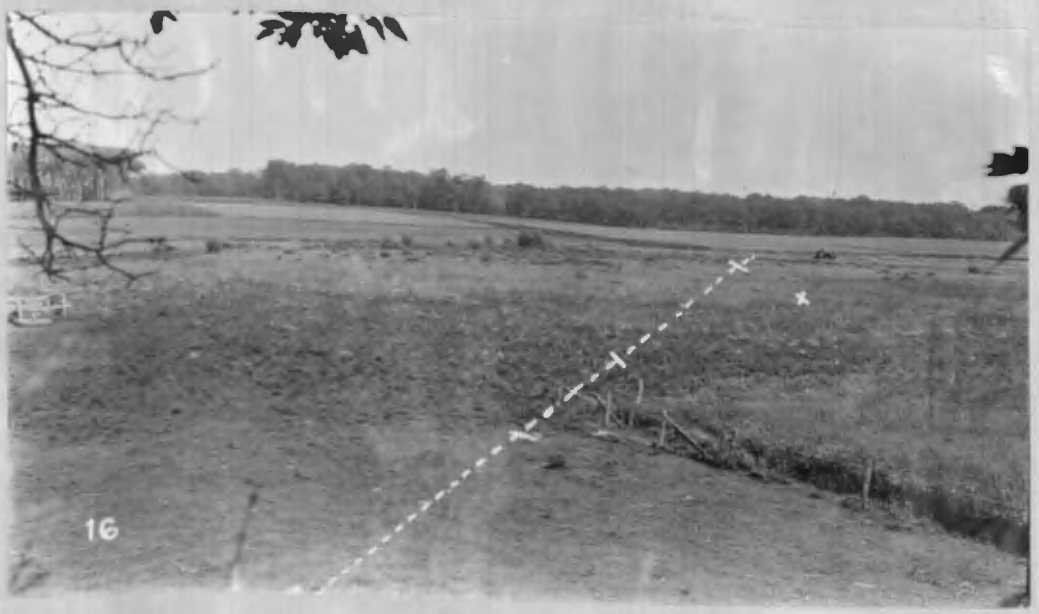
Analysis showed the bog to have considerable more mineral matter in the surface area than in the lower sections.

Bog No. 15 cont.

ANALYSIS OF SAMPLES

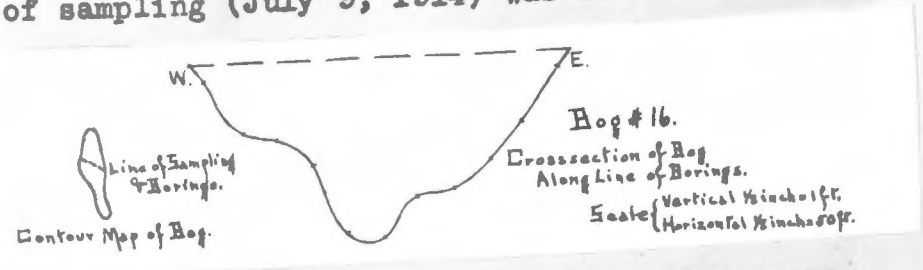
	Depth of Section		
	1-8 in. Per cent	9-16 in. Per cent	17-32in. Percent
Organic Matter	66.67	79.10	80.82
Total Ash	33.33	20.90	19.18
Insoluble Ash	24.54	14.12	12.44
Lime (CaO)	2.74	2.82	2.80
Phosphoric Acid (P_2O_5)	0.37	0.31	0.26
Nitrogen	2.53	2.83	2.76
Acidity	not acid	----	----

BOG No. 16



BOG No. 16

This bog has an area of approximately 15 acres. It had an average depth of about 6 feet and a maximum of 7.7 feet along the line of borings. The drainage was accomplished with a small hand made ditch which proved inadequate and the water at the time of sampling (July 9, 1914) was at the surface.



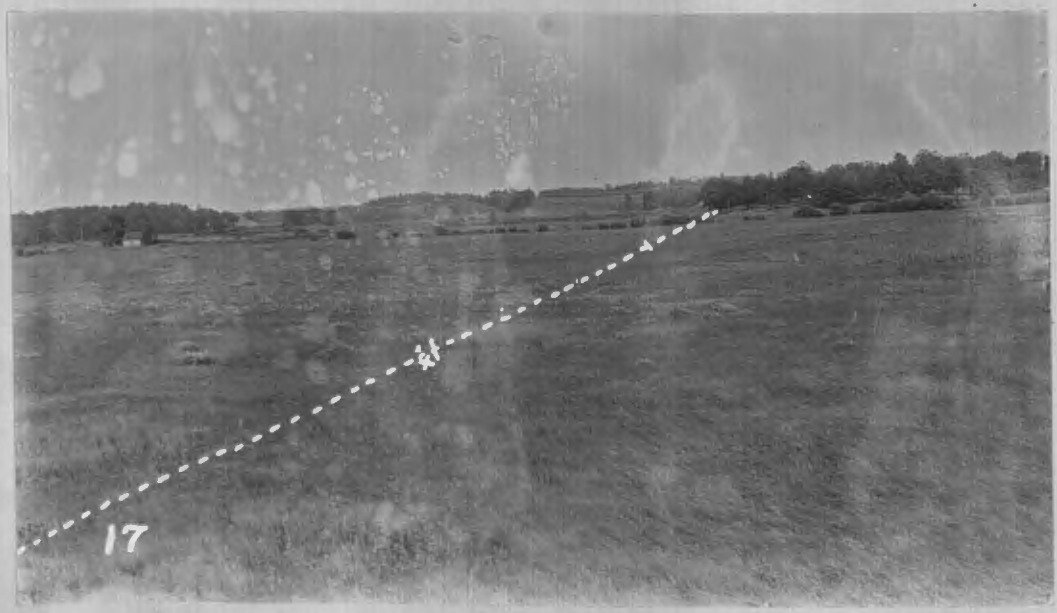
The vegetation was chiefly marsh grass and June grass with weed and willow clusters scattered about. Part of the bog was cut for hay and part was pastured. Good yields of hay were secured. Cultivation of the higher parts had been carried on and the neighboring farmers reported fine crops of corn and potatoes in dry years.

Bog No. 16 cont.

ANALYSIS OF SAMPLES

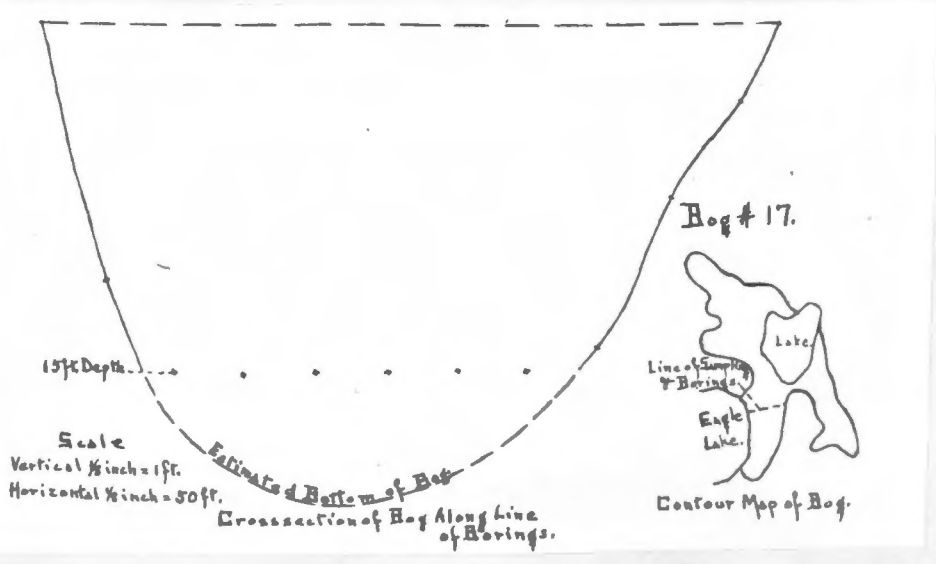
	1-8 inch section
	Per cent
Organic Matter	78.07
Total Ash	21.93
Insoluble Ash	14.64
Lime (CaO)	3.03
Phosphoric Acid (P_2O_5)	0.29
Nitrogen	2.67
Acidity	not acid

BOG No. 17



BOG No. 17

This bog borders on Eagle Lake and surrounds another small lake. It is an irregularly shaped bog having an area of approximately 280 acres. It has little opportunity for drainage, the water table at the time of sampling (July 23, 1914) being only from 3 to 8 inches below the surface.



The vegetation consists for the most part of marsh grass with rushes around the lakes and willows in the northwest part of the bog. It has never

been cultivated. In depth it exceeds most of the bogs previously described, a considerable area being deeper than 15 feet which was the limit of the auger.

In composition the peat is typical with a fairly high percentage of organic matter.

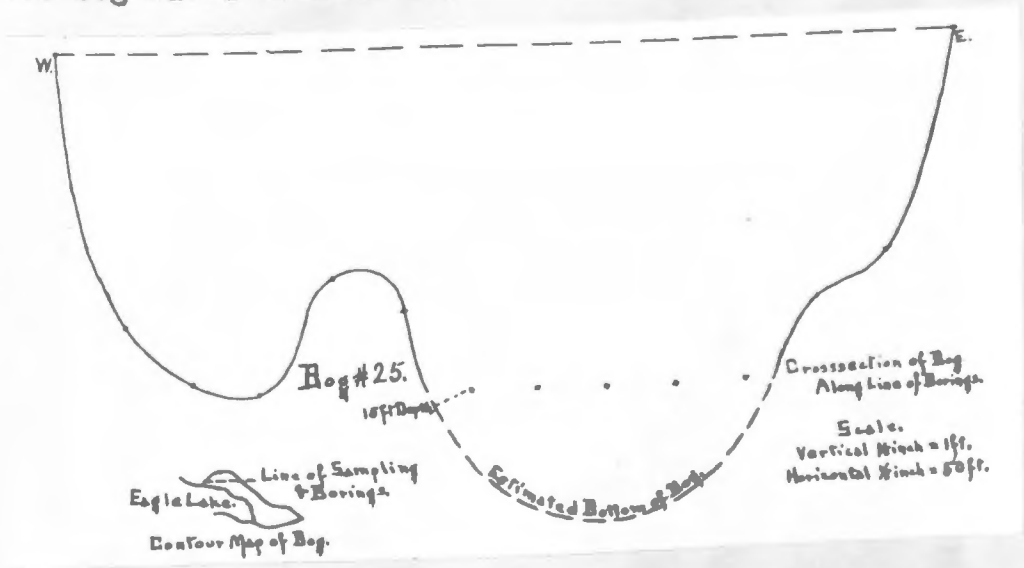
ANALYSIS OF SAMPLES

	Depth of Section		
	1-8 in. Per cent	9-16 in. Per cent	17-32 in. Per cent
Organic Matter	83.22	86.73	86.14
Total Ash	16.78	13.27	13.86
Insoluble Ash	11.28	9.39	8.50
Lime (CaO)	1.81	1.89	1.92
Phosphoric Acid (P_2O_5)	0.37	0.27	0.28
Nitrogen	2.89	2.63	2.65
Acidity	not acid	----	----

BOG No. 25

BOG No. 25

This Bog, which borders on Eagle Lake, lies 80 rods south of Bog No. 17. It is really a continuation of No. 17, the portion lying between the two, mapped as "Meadow" in the United States Soil Survey of Blue Earth County, being in reality "Peat." It has an area of about 30 acres, including some of the area mapped as "meadow" which contains deep peat. The bog has a maximum depth of more than 15 feet.



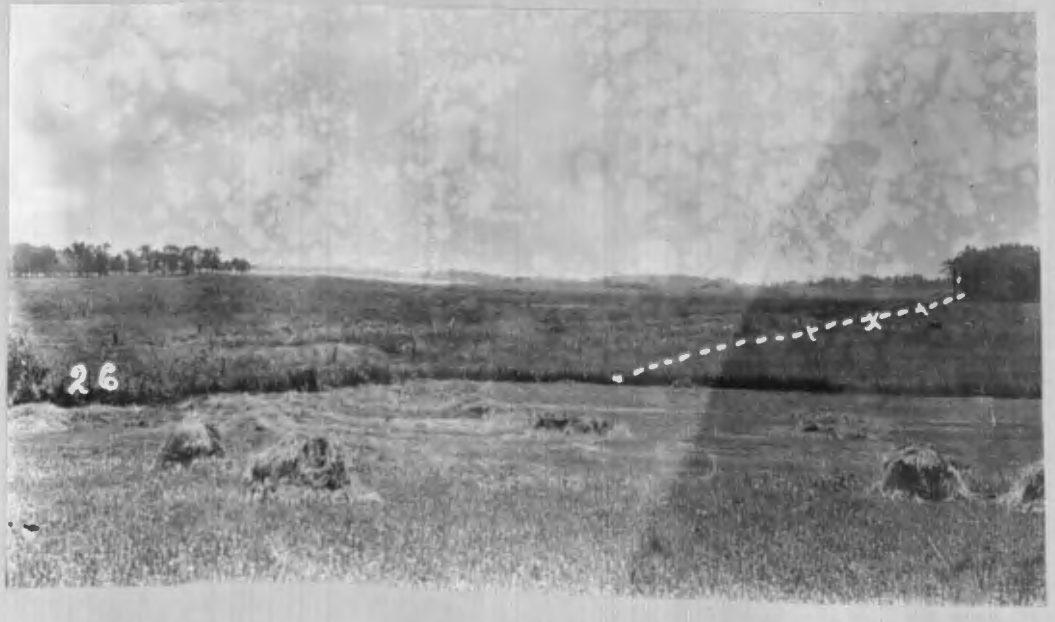
Drainage is poor, the water table at the point of sampling (July 23, 1914) being within six inches of the surface. The point of the lake is shown at the extreme right of the picture. For several rods back from the edge of the lake the peat is a floating bog. Vegetation in the bog includes marsh grass, willow clusters and an abundance of ferns. Rushes and cattails are found along the lake. The marsh grass in the north part of the bog is cut for hay while the rest is pastured.

In composition the bog resembles bog No. 25 very closely.

ANALYSIS OF SAMPLES

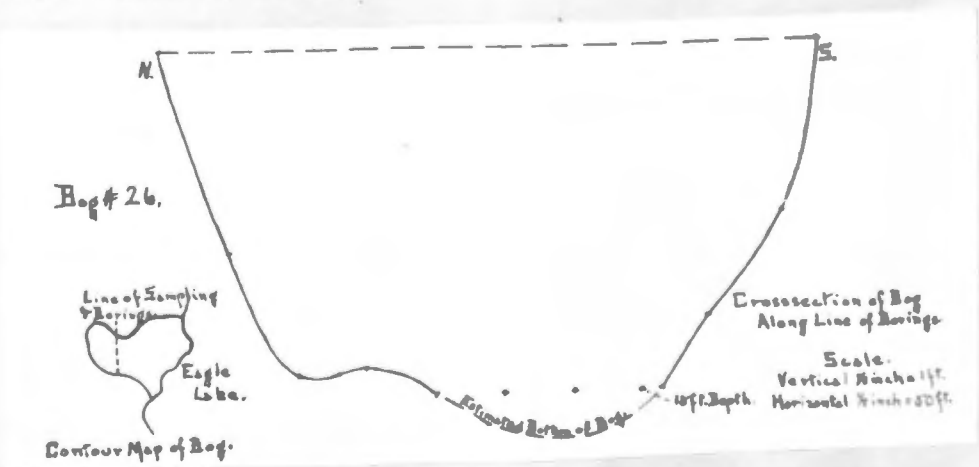
	Depth of Section 1-8 in. Per cent	9-16 in. Per cent	17-32 in. Per cent
Organic Matter	81.24	85.00	85.53
Total Ash	18.76	15.00	14.47
Insoluble Ash	12.52	10.21	10.13
Lime (CaO)	2.25	1.78	1.70
Phosphoric Acid (P_2O_5)	0.40	0.25	0.23
Nitrogen	2.91	2.58	2.54
Acidity	not acid	----	----

BOG No. 26



BOG No. 26

Bog No. 26, lying just west of bogs 17 and 25, borders on the west bank of Eagle Lake. It has an area of approximately 100 acres. Drainage is accomplished by hand made ditches and ditches along the road which crosses it. It is inadequate as there is not enough fall to the lake. The water table was within 3 or 4 inches of the surface at the time of sampling (July 21, 1914). In depth it has a considerable area deeper than 15 feet.



The vegetation comprises marsh grass, June grass, sedge, ferns and willow, with rushes and cat-tails next to the lake. Part of the bog is cut for hay, part is pastured, while part is too wet for use. No part has ever been cultivated. The shocks in the foreground in the photograph are on upland bordering on the bog. Eagle Lake can be seen in the distance.

Chemical analysis of this bog shows it to be similar in organic and mineral matter to No's. 17 and 25 bordering on the same lake. It is, however, higher in lime content and lower in phosphoric acid and nitrogen content than the two last named.

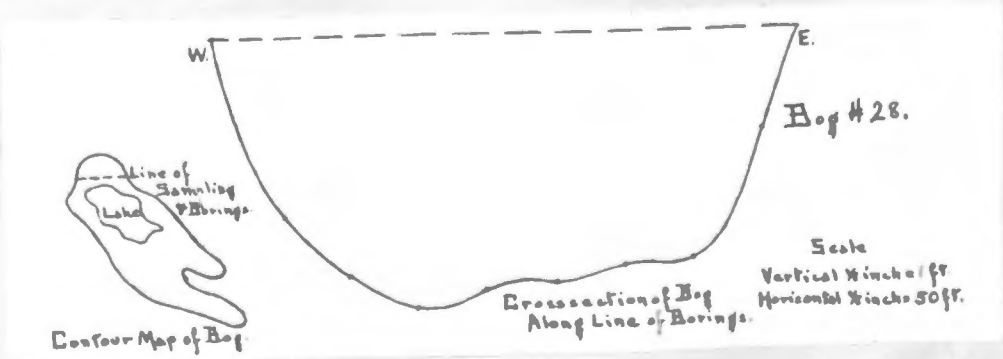
ANALYSIS OF SAMPLES

	Depth of Section 1-8 in. Per cent	9-16 in. Per cent	17-32 in. Per cent
Organic Matter	81.15	82.47	84.92
Total Ash	18.85	17.53	15.08
Insoluble Ash	13.29	12.71	10.59
Lime (CaO)	1.96	1.94	1.50
Phosphoric Acid (P_2O_5)	0.29	0.23	0.20
Nitrogen	2.56	2.35	2.28
Acidity	not acid	---	---

BOG No. 28

BOG No. 28

This bog is located in sections 35 of Lime township, and 1 and 2 of Mankato township, and has an area of approximately 200 acres. No attempt has been made to drain it and the water table is for a considerable part at the surface. It contains a lake 12 to 15 acres in area. In depth it averages about 10½ feet with a maximum of 12 feet along the line of borings.



The vegetation is composed chiefly of marsh grass, canebrake, rushes and cattails. Parts of the bog are cut for hay but most of it is in pasture. It has never been cultivated.

Chemical analysis shows the bog similar in

composition, except in lime content, to bog No. 26 which lies one half mile northeast of it.

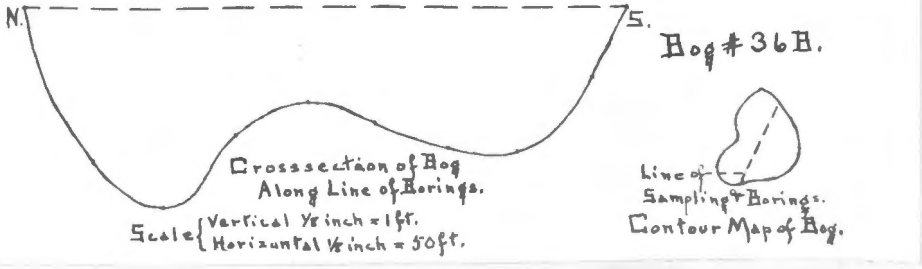
ANALYSIS OF SAMPLES

	Depth of Section		
	1-8 in.	9-16 in.	17-32 in.
	Percent	Per cent	Per cent
Organic Matter	84.92	86.52	82.30
Total Ash	15.08	13.48	17.70
Insoluble Ash	12.43	8.22	9.19
Lime (CaO)	2.53	2.48	2.32
Phosphoric Acid (P_2O_5)	0.20	0.22	0.24
Nitrogen	2.40	2.48	2.51
Acidity	not acid	----	----

BOG No. 36B

BOG No. 36 B

This bog has an area of about 10 acres of peat which reaches a maximum depth of 8.5 feet. The line of borings for depth and of sampling is shown in the photograph, and a construction of a cross section along the line of borings follows: The soil underlying the peat is a blue clay. The drainage which is accomplished with hand made ditches is entirely inadequate and the water table is not lower than 2½ to 3 feet.



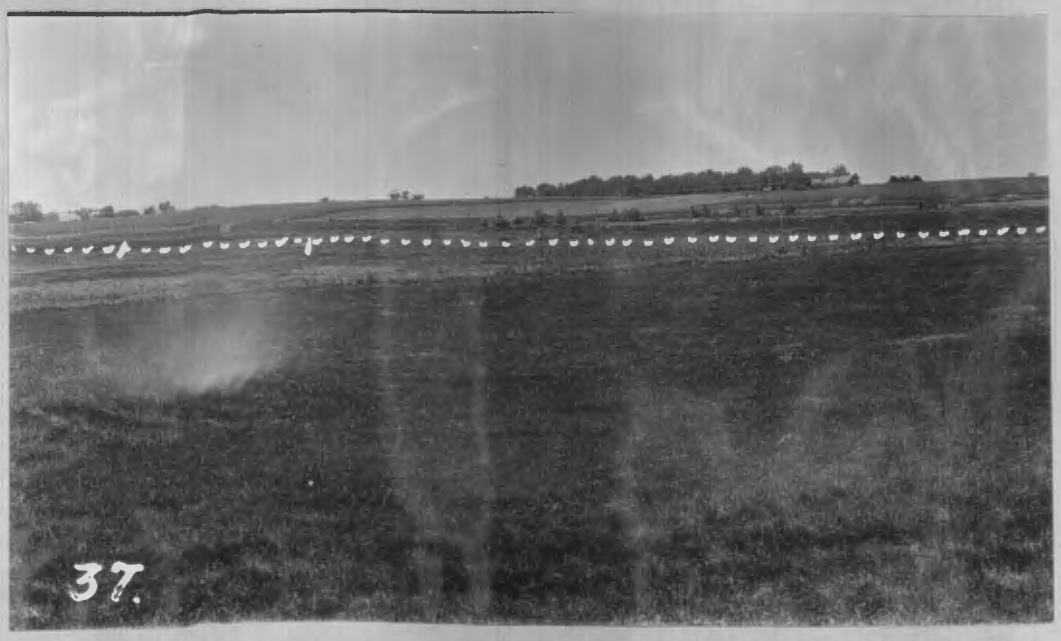
The vegetation in the bog is chiefly wild hay and pasture of hay and weeds of various kinds. There are a few rushes in the lower spots. No part of the bog was under cultivation at the time of

of sampling (1914), altho the southern half had been broken up and cropped to flax by Henry Westfall about 1900. No cultivation had been continued since then.

ANALYSIS OF SAMPLES

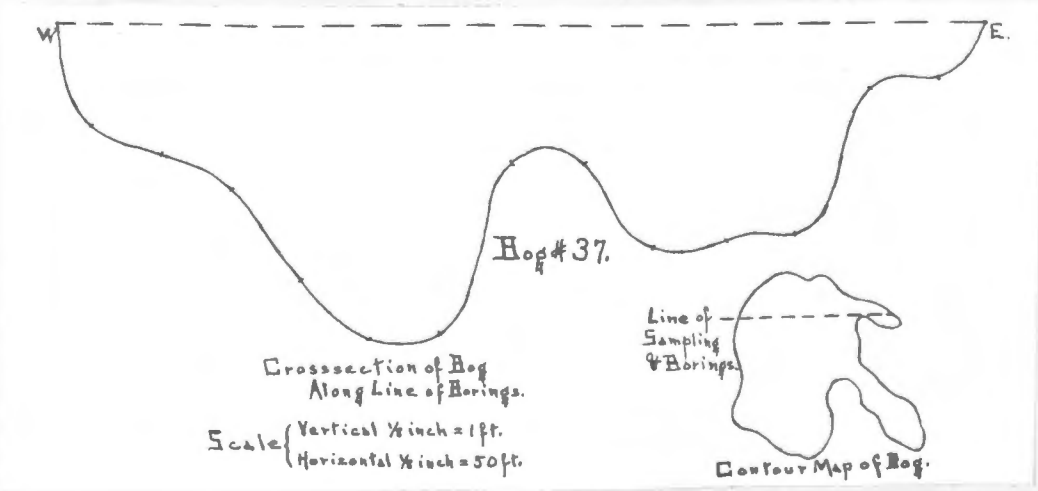
	Depth of Section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic matter	76.01	72.98
Total Ash	23.99	27.02
Insoluble Ash	17.65	21.50
Lime (CaO)	2.64	1.99
Phosphoric Acid (P_2O_5)	0.31	0.21
Nitrogen	2.79	2.59
Acidity	not acid	----

BOG No. 37



BOG No. 37

Bog No. 37, which lies about one half mile southeast of No. 36B, comprises an area of from 125 to 150 acres with a depth of 12 to 15 feet, along the line of borings, of firm peat underlaid by blue clay. Borings showed the bottom to be somewhat uneven as indicated by the construction. The surrounding land is somewhat rolling.



Drainage is accomplished with open ditches but is insufficient, the water table at the time of

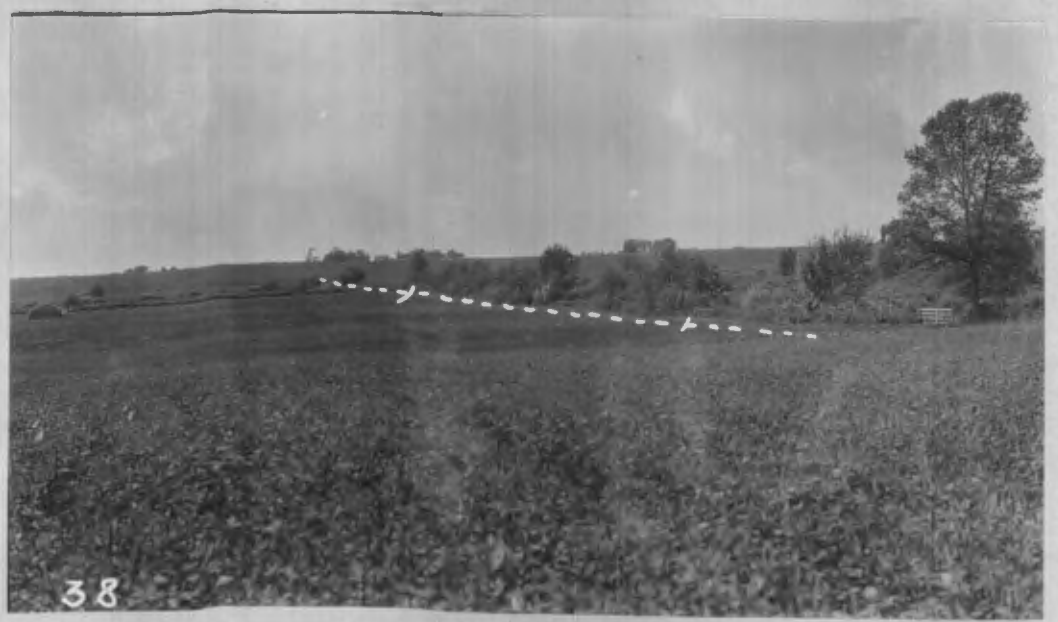
sampling (August, 1914) being at a depth of only 2 feet. Drainage by tile would be a comparatively easy matter, there being plenty of fall to a tributary of the Le Sueur River a short distance away.

There were no cultivated parts of the bog at the time of sampling, the vegetation being wild hay and pasture. The pasture area on the west side of the bog was broken up about 10 years ago and cropped to flax and corn but the drainage proved insufficient for successful results. In composition the bog resembles bog No. 36B.

ANALYSIS OF SAMPLES

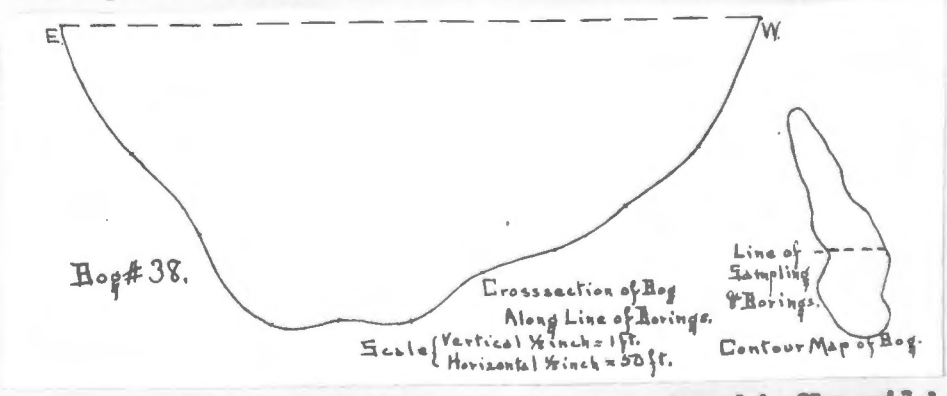
	Depth of Section 1-8 in. Per cent	9-16 in. Per cent
Organic Matter	77.39	79.59
Total Ash	22.61	20.41
Insoluble Ash	15.80	14.05
Lime (CaO)	2.84	2.97
Phosphoric Acid (P_2O_5)	0.37	0.24
Nitrogen	3.00	2.91
Acidity	not acid	----

BOG No. 38



BOG No. 38

This bog lies 1½ miles east of No. 37 and has an area of 60 to 70 acres. It is firm peat reaching a depth of 12 to 15 feet and is surrounded by gently rolling land. A cross section constructed from borings made across the center shows a gentle even sloping bog bottom, the underlying layer being blue clay which in some places contained snail shells.



The vegetation of the bog is chiefly wild grasses and pasture of weeds and wild hay. The drainage afforded by open ditches is wholly inadequate, the water table at the time of sampling (August 1914) being at a depth of 16 to 18 inches. No part of the bog had ever been cultivated before the year of sampling when

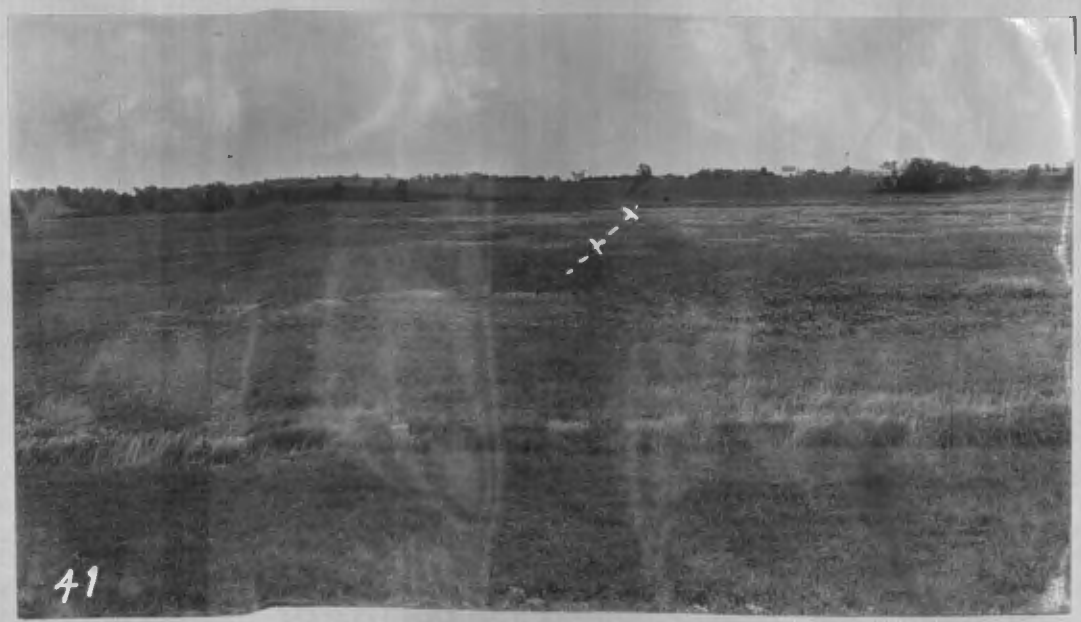
about 5 acres on the southeast corner was broken and cropped to flax. It was sown late and was still green and hindered by weeds at the time of sampling. The crop also apparently suffered from an oversupply of water.

In chemical composition this bog resembled No. 38 closely.

ANALYSIS OF SAMPLES

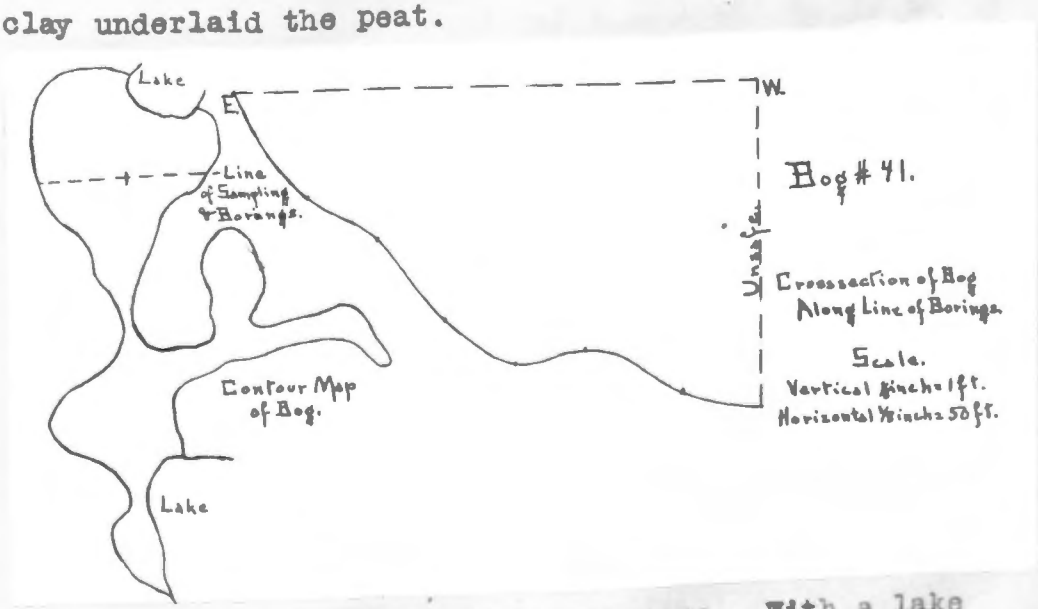
	Depth of Section 1-8 in. Per cent	9-16 in. Per cent
Organic Matter	77.55	78.93
Total Ash	22.45	21.07
Insoluble Ash	15.53	14.79
Lime (CaO)	3.13	2.94
Phosphoric Acid (P_2O_5)	0.34	0.26
Nitrogen	3.03	3.02
Acidity	not acid	----

BOG No. 41



BOG No. 41

Bog No. 41 is an irregular bog of unknown area, approximating 320 acres. As far as borings were taken across the larger portion of the bog the depth reached fourteen feet but owing to the central area being soft that portion was not sounded. It probably would not reach a depth greater than 20 feet. Blue clay underlaid the peat.



Of drainage there was none. With a lake at each end of the bog the water table was only a few inches below the surface, the central area being too

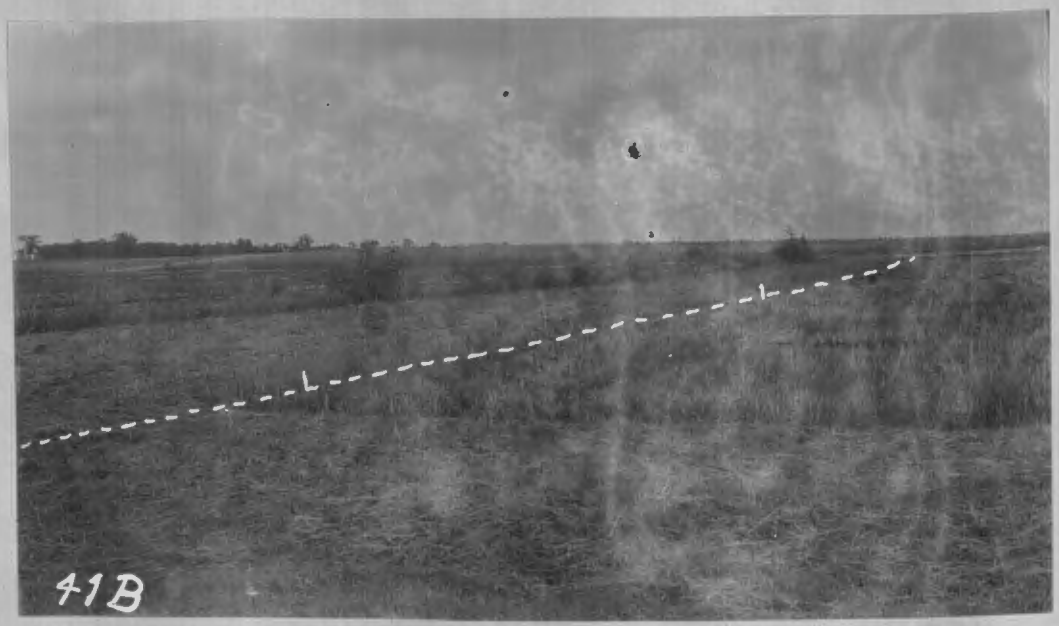
soft for crossing. The bog was pastured, the vegetation being wild grasses and canebrake. The lake area was grown up to rushes. No attempt has ever been made to cultivate any portion of the bog.

Its chemical composition shows it to be somewhat lower in lime and nitrogen content than Bog No. 38.

ANALYSIS OF SAMPLES

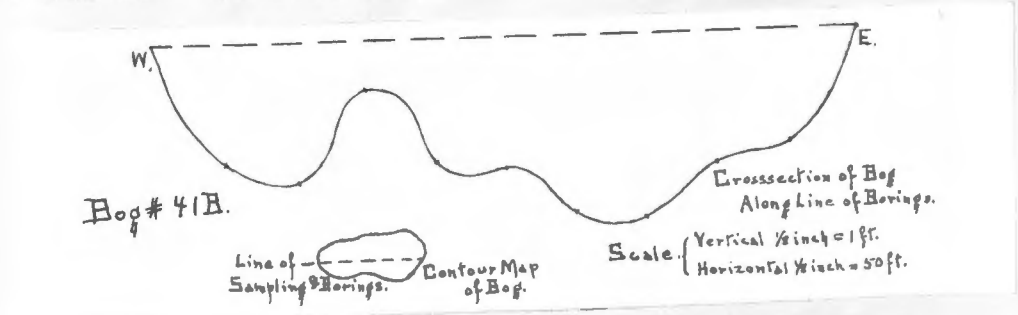
	Depth of Section	
	1-8 in. Per cent	9-16 in. Per cent
Organic Matter	79.09	77.21
Total Ash	20.91	22.79
Insoluble Ash	14.74	16.71
Lime (CaO)	2.18	2.36
Phosphoric Acid (P_2O_5)	0.25	0.29
Nitrogen	2.61	2.96
Acidity	faintly acid	----

BOG No. 41B



BOG NO. 41B

This bog, which lies one half mile west of bog No. 41, has an area of 20 to 25 acres. From borings taken lengthwise of the bog, the average depth is six feet with no point exceeding eight feet.



Drainage is efficiently accomplished by an open county ditch with lateral tile. The water table was at a depth of 3 to 4 feet at the time of sampling (August, 1914).

The bog is divided into two parts by the section road crossing near its center. The western half of the bog is meadow of wild grass, and pasture with June grass and ragweed. The eastern half of the bog was first broken up in 1913 and cropped to flax. A yield of 20 bushels per acre was secured. In 1914

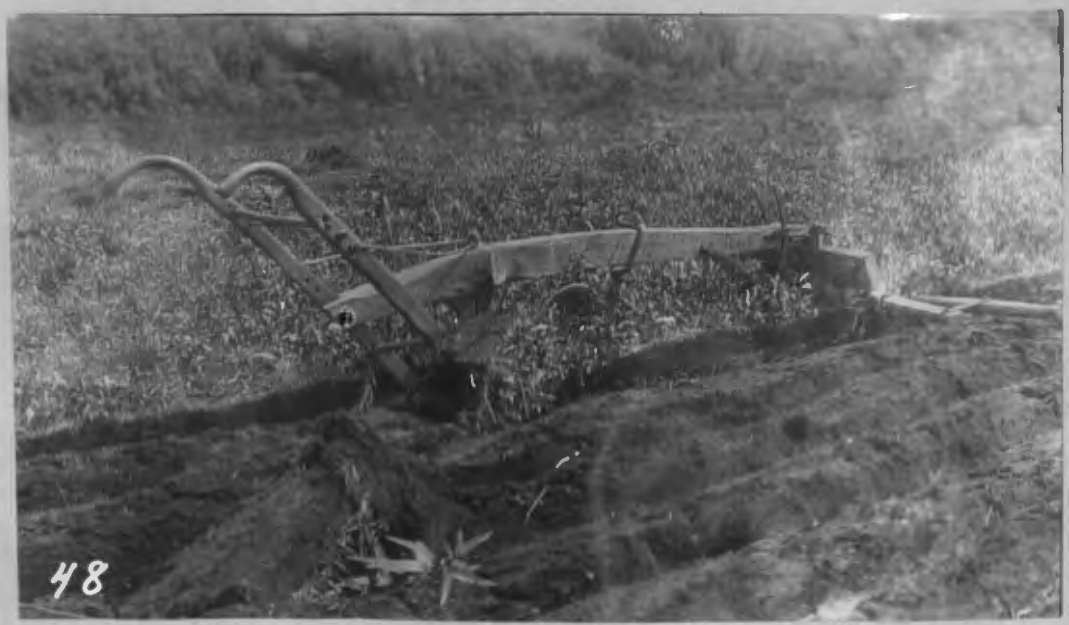
the same area was cropped to rye, the yield of rye being 20 bushels per acre.

In composition the bog is a typical peat with slightly higher content of mineral matter and lime than its neighbor bog No. 41.

ANALYSIS OF SAMPLES

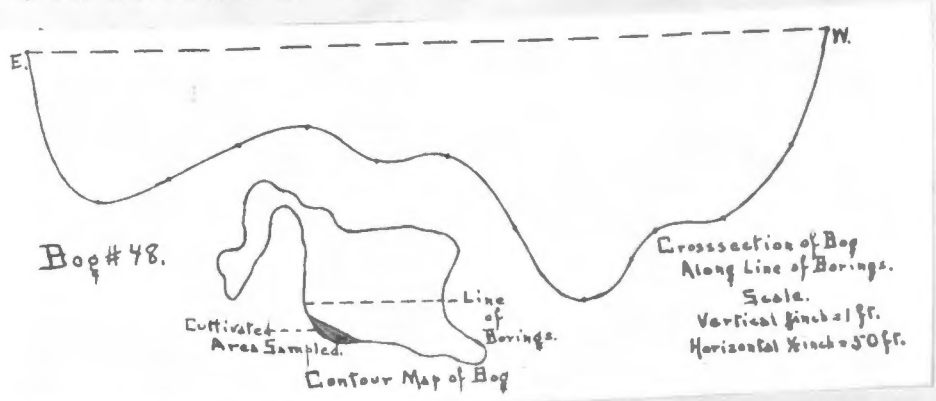
	Depth of Section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	72.15	74.79
Total Ash	27.85	25.21
Insoluble Ash	20.42	18.33
Lime (CaO)	3.14	3.06
Phosphoric Acid (P_2O_5)	0.31	0.24
Nitrogen	2.69	2.66
Acidity	faintly acid	---

BOG No. 48



BOG No. 48

This bog has an area of from 175 to 200 acres. In depth it is very uneven, some areas being very shallow while others are 13 to 15 feet deep. It is drained by a large open ditch 10 to 13 feet deep with tile laterals 285 feet apart.



Large areas were not in use at the time of sampling but were grown up to weeds of all kinds, chiefly canebrake and ragweed. Cultivation has been carried on to some extent. Corn was very successfully raised on one portion of the bog in 1913 and again in 1914. Flax has been raised with success on several parts of the bog. More of the bog is to be broken

this year. Samples for analyses were taken from the corn field shown in the photograph and indicated in black in the outline map. In composition the bog is on the border line between peat and muck. It is lower in organic matter and nitrogen than true peats, with a high percentage of ash.

ANALYSIS OF SAMPLES

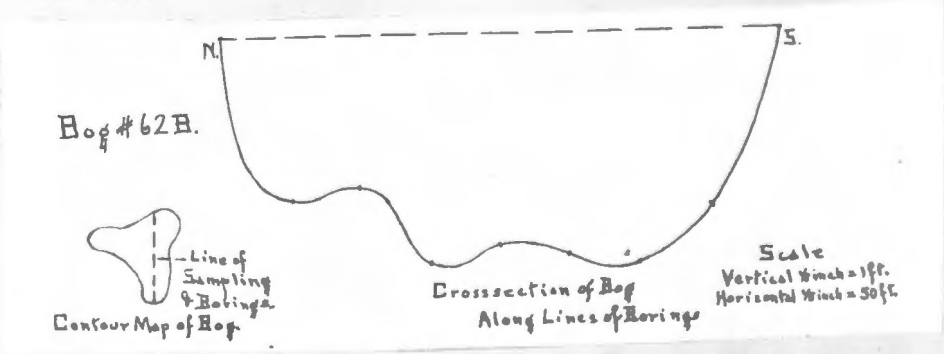
	Depth of Section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	44.45	30.79
Total Ash	55.55	69.21
Insoluble Ash	47.03	62.02
Lime (CaO)	2.14	1.53
Phosphoric Acid (P_2O_5)	0.31	0.21
Nitrogen	1.70	1.23
Acidity	not acid	----

BOG No. 62b

N.W. Corner Sec 11 Stafford Blue Ft. Jn. Conn.

BOG No. 62B

This bog, which is located in sections 10 and 11 of Beauford township, has an underlying soil of brownish clay. In depth it averages 6 to 8 feet with the deepest portions not more than 10 feet. It covers an area of about 15 acres. The bog was drained about 6 years ago by tileing around the edges and thru the center.



The photograph shows a view of the bog looking south, with wild hay to the east of the line of borings and fodder corn to the west. The fodder corn was not very good (August, 1914) probably due to the fact that it was on new breaking. West of the section road which crosses the bog, is a field which

has been cropped since the bog was drained. Fodder corn on this was very good.

In chemical composition the bog is rather high in mineral matter, and especially so in lime and phosphoric acid.

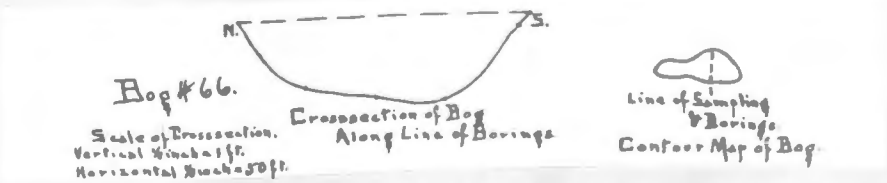
ANALYSIS OF SAMPLES

	Depth of Section	
	1-8 in. Per cent	9-16 in. Per cent
Organic Matter	67.29	75.97
Total Ash	32.71	24.03
Insoluble Ash	22.02	14.13
Lime (CaO)	4.75	5.77
Phosphoric Acid (P_2O_5)	0.48	0.38
Nitrogen	2.75	3.02
Acidity	not acid	----

BOG No. 66

BOG No. 66

This bog has an area of about 10 acres of well decayed peat. It is a shallow bog, averaging 3 to 4 feet in depth, underlaid by black loam. The bog was tiled six years ago with one main and two laterals on each side. Up to that time it was so wet that it was unfitted even for grazing. It is now well drained.



The bog is entirely under cultivation with barley on the east border and a good field of corn, which shows in the photograph. Since draining the owner states that the bog has been very successfully cropped to corn, cattle beets, potatoes and barley.

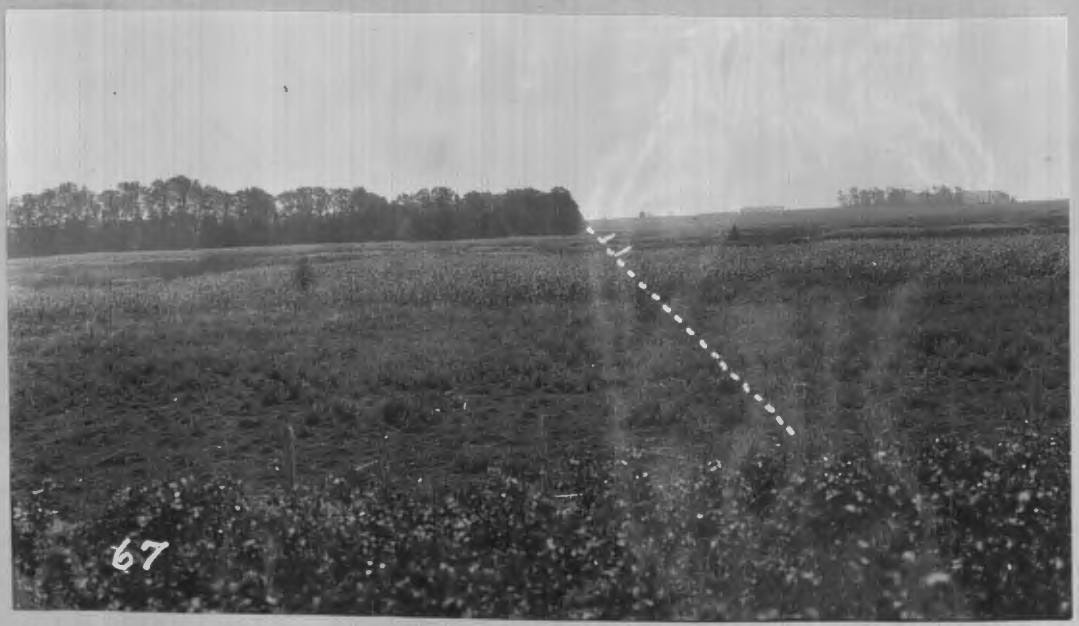
In composition the bog resembles No. 62B just described, altho somewhat lower in Nitrogen.

Bog No. 66 cont.

ANALYSIS OF SAMPLES

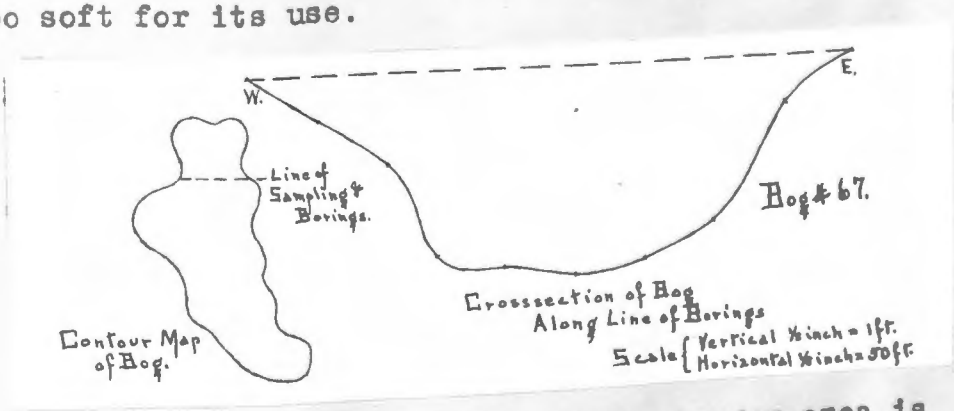
	Depth of Section 1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	66.08	68.56
Total Ash	33.92	31.44
Insoluble Ash	21.87	21.42
Lime (CaO)	6.63	4.59
Nitrogen	2.44	2.55
Acidity	not acid	----

BOG No. 67



BOG No. 67

This bog lies one mile southeast of bog No. 66 and has an area of 120 acres. A line of borings taken across one end of the bog showed a maximum depth of 9 feet altho it is probably deeper in the center. The bog was formerly a lake and water still is at the surface in the central area. One attempt was made to drain it with a capstan ditcher but the bog proved too soft for its use.



The vegetation around the border area is chiefly June grass, ragweed and marsh grass. Farther in is an area of canebrake and in the lake area is found sedge, rushes and cattail. Little attempt has been made at cultivation. Some corn and potatoes have

been grown on the north border of the bog.

In chemical composition the bog resembles its neighbor No. 66. It is especially high in lime content, the lower sections of the bog having an abundance of small snail shells.

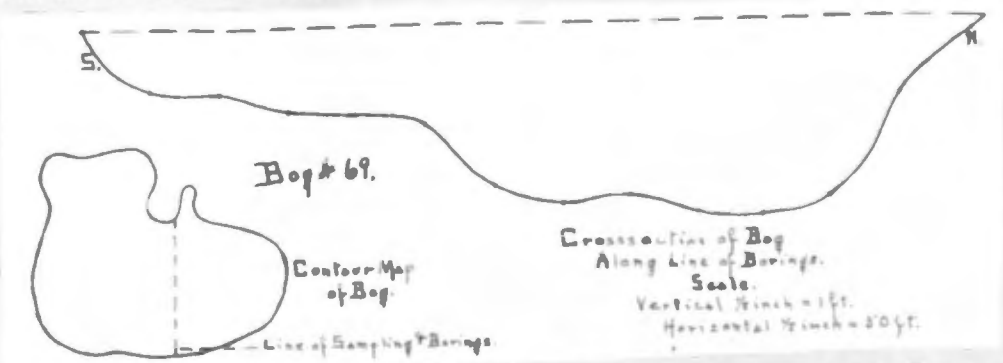
ANALYSIS OF SAMPLES

	Depth of Section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	63.98	53.54
Total Ash	36.02	46.46
Insoluble Ash	26.29	31.99
Lime(CaO)	4.35	8.13
Phosphoric Acid (P_2O_5)	0.34	0.20
Nitrogen	2.96	2.38
Acidity	not acid	----

BOG No. 69

BOG No. 69

This bog has an area of more than 200 acres. The peat averages 3 feet in depth in the border area and 8 feet in the lake area. It is underlaid with blue clay and sand mixed or either alone. Drainage is insufficient in wet years for best results with cultivated crops. It is drained by a county ditch constructed in 1902.



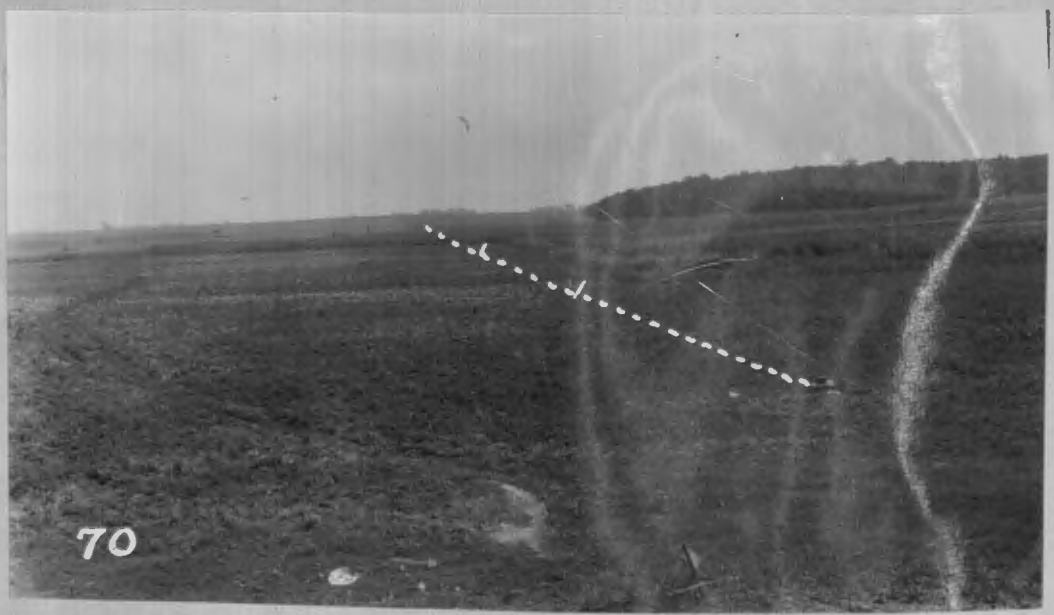
The vegetation in the pasture area is June grass, wild barley, white clover and weeds. The lake area contains rushes and cattails. The cultivated area was cropped to rye, barley and "Billion Dollar Grass" in 1914. The photograph shows the "Billion Dollar Grass"

in the foreground with rye in the shock. Parts of the bog have been cultivated by Mr. Charles Voigtlander for about 12 years. He has grown various crops but states that rye followed by potatoes or corn gives the best results. Corn does not always mature. Tame hay does well.

ANALYSIS OF SAMPLES

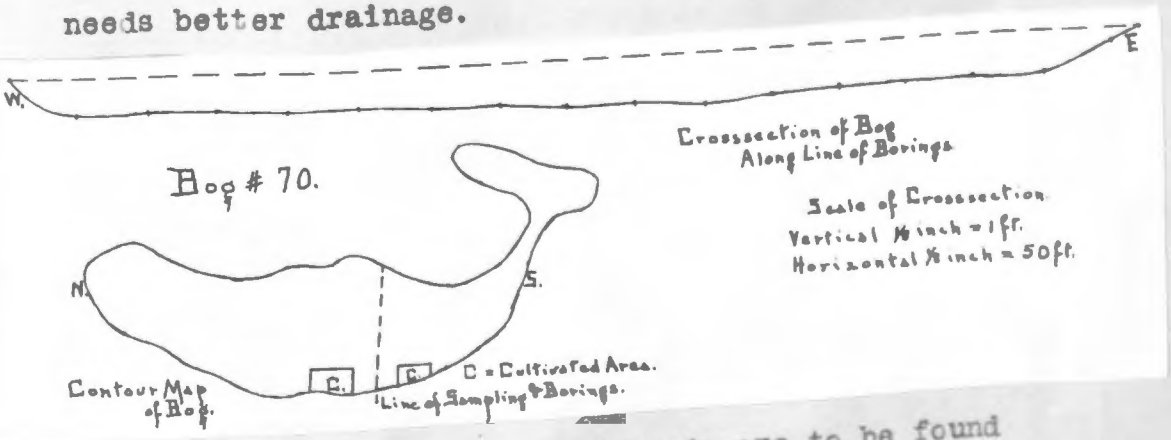
	Depth of Section	
	1-8 in. Per cent	9-16 in. Per cent
Organic Matter	69.82	65.36
Total Ash	30.18	34.64
Insoluble Ash	21.94	28.03
Lime (CaO)	3.20	2.42
Phosphoric Acid (P_2O_5)	0.31	0.21
Nitrogen	2.73	2.55
Acidity	not acid	----

BOG No. 70



BOG No. 70

This bog is located 1½ miles west of Bog No. 69. It has an area of over 300 acres of shallow peat averaging about 2 feet in depth. In texture it is compact and not very peaty and is underlaid with muck which has a depth of 12 feet in the deeper areas. The bog was formerly a lake area which was drained by a county ditch put thru in 1901 and 1902. This runs north and south thru the bog. The water table now has a depth of 5 to 6 feet on the west side but the bog needs better drainage.



Many varieties of weeds are to be found on the bog, with ragweed, mock sunflowers and wild

barley predominating. There is very little marsh grass. The areas indicated on the contour map are now under cultivation. Here the peat is 1½ to 2 feet deep. One field was cropped to fodder corn in 1914. The growth was good or better than upland corn and looked (Aug. 1) as if it would mature corn. Winter rye on the other field was a heavy crop with heads well filled and lodged in many places. Attempts were made to cultivate the bog previous to ditching. During a dry year a crop of barley was raised on the north end of the bog which neighbors state yielded 75 bushels per acre. The drowning out of crops during later years discouraged cultivation.

Chemical analysis shows the bog to be high in mineral matter with an abundance of lime and a fair amount of nitrogen.

Bog No. 70 cont.

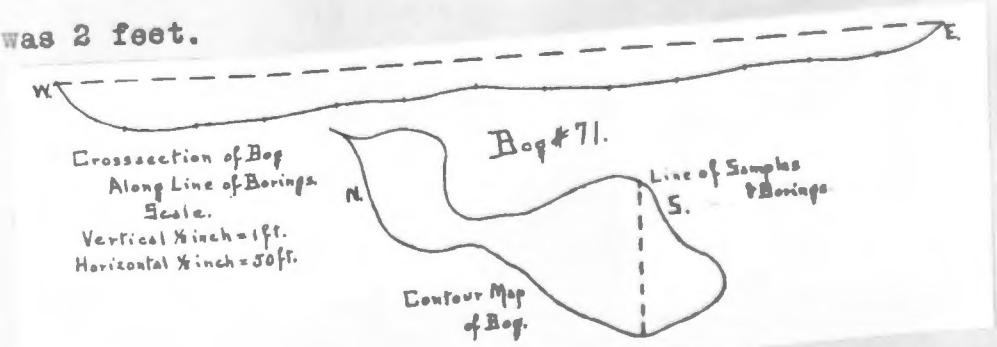
ANALYSIS OF SAMPLES

	Depth of section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	62.87	51.25
Total Ash	37.13	48.75
Insoluble Ash	28.27	36.12
Lime (CaO)	3.51	6.50
Phosphoric Acid (P_2O_5)	----	0.19
Nitrogen	3.10	2.47
Acidity	not acid	----

BOG No. 71

BOG No. 71

Bog No. 71, one mile north of the village of Mapleton, has an area of approximately 220 acres. It was naturally drained by a tributary of the Cobb River, which in 1902 was converted into a county ditch. This drains the bog thru the center of its entire length. It is a shallow bog with an average depth of peat of 1½ feet. The maximum depth located in the line of borings was 2 feet.



Vegetation on the bog comprises June grass, wild barley, ragweed and Kentucky blue grass. The bog was burned over several years ago and a white ash is deposited over the entire surface. It was not cultivated nor cut over at the time of sampling (Aug.1 '14).

Part was being manured at that time, the owner intending to break it up and crop it in 1915. Most of the bog was in pasture.

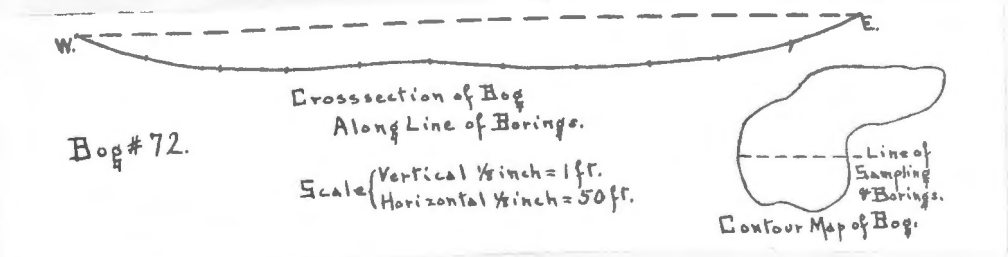
Chemical analysis shows considerable more lime in the first eight inches than in the second eight, probably due to the deposition in the burning over of the bog. It is of entirely different composition from bog No. 72 lying three-fourths mile southwest, which drains into it. It is not a true peat and should be classified with the mucks.

ANALYSIS OF SAMPLES

	Depth of Section 1-8 in. Per cent	9-16 in. Per cent
Organic Matter	39.20	41.83
Total Ash	60.80	58.17
Insoluble Ash	52.97	52.50
Lime (CaO)	1.83	1.24
Phosphoric Acid (P_2O_5)	---	0.16
Nitrogen	1.82	2.00
Acidity	not acid	---

BOG No. 72

This bog lies one half mile west of the village of Mapleton and has an area of more than 30 acres. The peat is compact and well rotted and has a depth of 1½ to 2 feet. It is underlaid by a shallow layer of muck which is in turn underlaid with sand or yellow clay. The bog is drained by a county ditch, dug in 1902. Drainage is inadequate for wet years, and is made worse by several tiles from upland areas which lead into the bog. The water table at the time of sampling (August, 1914) was 3 feet below the surface.



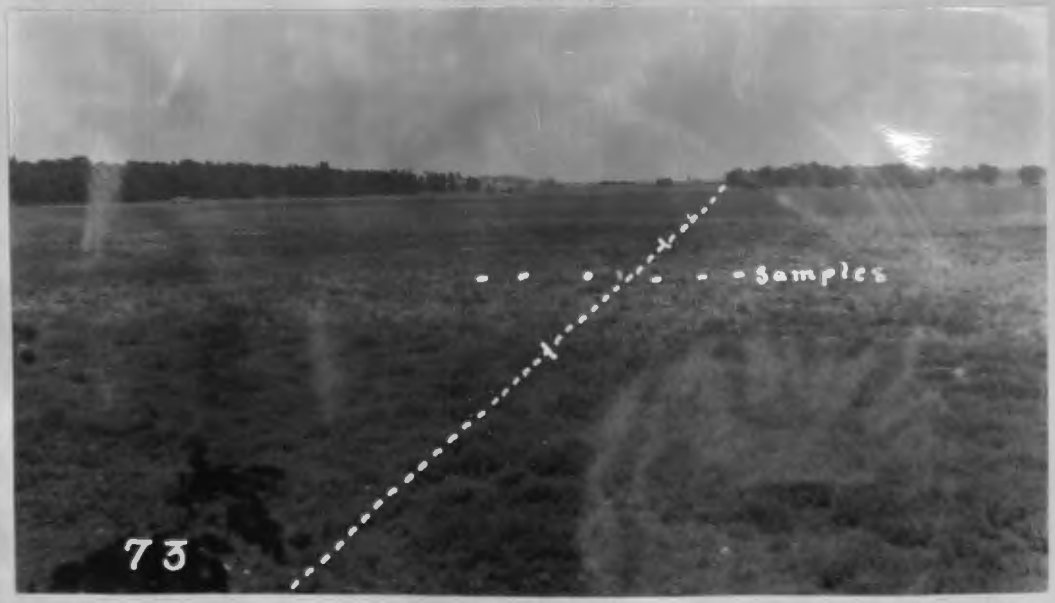
Vegetation in the bog is chiefly wild barley, June grass and white clover, with ragweed and quack grass abounding in patches. The bog is pastured.

It has never been cultivated except for a small patch of turnips in the central area, which did well.

ANALYSIS OF SAMPLES

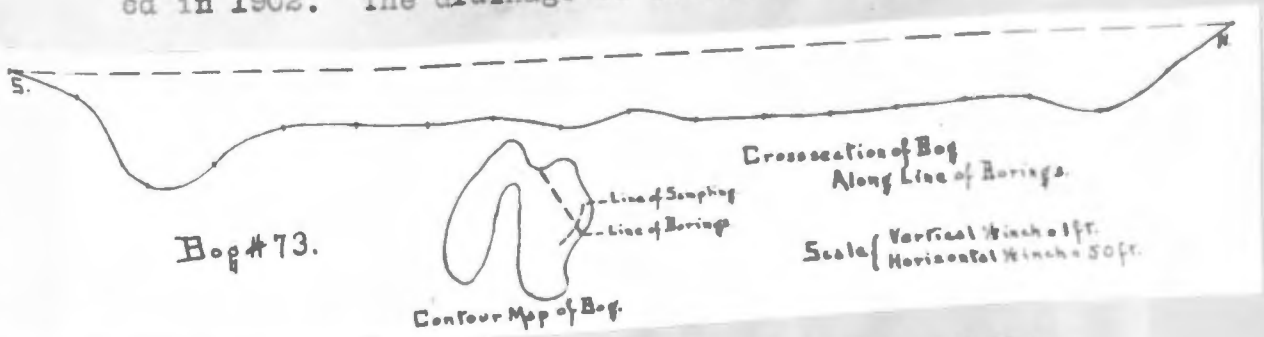
	Depth of Section 1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	71.22	76.51
Total Ash	28.78	23.49
Insoluble Ash	20.90	16.51
Lime (CaO)	3.15	3.19
Phosphoric Acid (P_2O_5)	0.29	0.18
Nitrogen	2.45	2.51
Acidity	faintly acid	----

BOG No. 73



BOG No. 73

Bog No. 73, lying one mile south of Bog No. 70, has an area of about 90 acres. It is a shallow bog with about 2½ feet of peat underlaid by muck, with clay at 5½ feet. The bog is drained by the county ditch which passes thru its center. This was constructed in 1902. The drainage is insufficient in wet years.



The vegetation in the outer area of the bog is chiefly ragweed and wild barley with some June grass, marsh grass and weeds. The inner or lake area contains Kentucky blue grass, marsh grass and June grass. Little cultivation was carried on on the bog in 1914. About 1½ acres on the northeast corner was cropped with potatoes which were a fine crop. A

photograph of the potato patch can be seen opposite. A small acreage of timothy hay was raised on the northwest part of the main area. This crop was also very good. The bog has been cropped for several years. Neighboring farmers reported that corn, potatoes, flax, barley, and rye have been grown on the outside area with great success.

In chemical composition this bog has less mineral matter than its neighbors just described, corresponding more nearly to bog No. 38 in the northern part of the county.

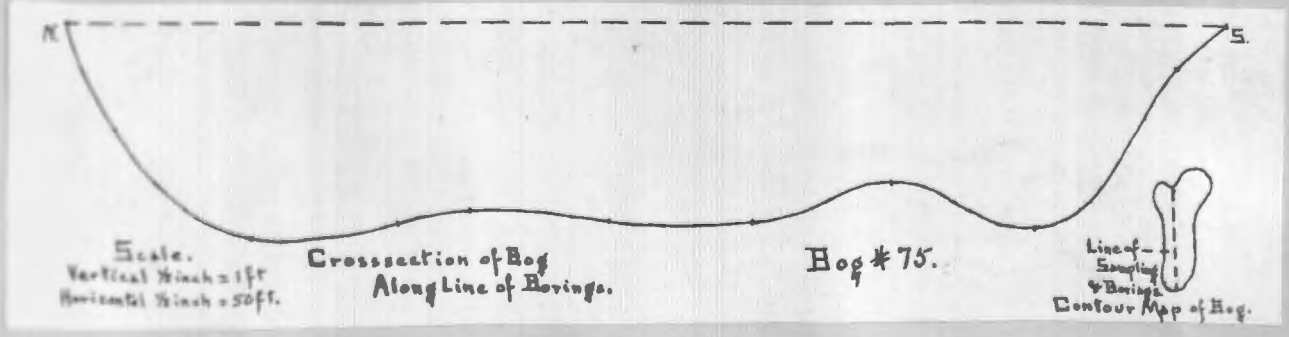
ANALYSIS OF SAMPLES

	Depth of Section 1-8 in. Per cent	9-16 in. Per cent
Organic Matter	78.30	81.71
Total Ash	21.70	18.29
Insoluble Ash	13.94	11.85
Lime (CaO)	3.48	2.99
Phosphoric Acid	0.34	0.20
Nitrogen	2.68	2.47
Acidity	very faintly acid	----

BOO No. 75

BOG No. 75

Bog No. 75, located two miles north of the village of Amboy, has an area of more than 30 acres. In depth it averages about 8 feet, the maximum depth recorded along the line of borings being 9 feet. The bog has no drainage except tile at the north end which makes it dry enough for crops. The water table is at the surface of the blue clay which underlies the peat.



Vegetation on the bog is chiefly wild marsh grass. Most of the bog is cultivated, including all the center area. Part was broken in 1913 and the rest in 1914. The crops during 1914 were corn, fodder corn, potatoes, and millet. The millet was on the newly

broken turf. The crops were excellent in every case at the time of sampling (August 6, 1914). A good crop of corn was secured in 1913.

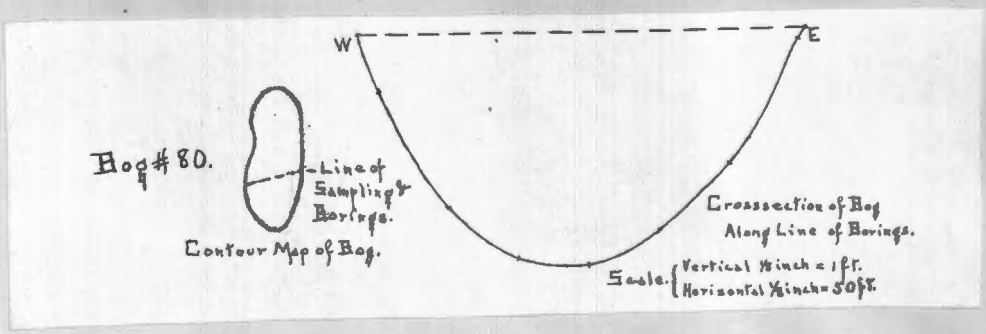
ANALYSIS OF SAMPLES

	Depth of Section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	71.54	79.99
Total Ash	28.46	20.01
Insoluble Ash	21.04	13.90
Lime (CaO)	3.20	2.91
Phosphoric Acid (P_2O_5)	0.33	0.22
Nitrogen	2.64	2.55
Acidity	faintly acid	----

BOG No. 80

BOG No. 80

This bog, located in Cresco township, has an area of about 60 acres. It has an average depth of about 8 feet, the maximum depth in the line of borings being 10½ feet. It has no artificial drainage, yet the water table was at a depth of 3 to 4 feet at the time of sampling.



The vegetation of the bog comprises ragweed, marsh grass, wild barley and other weeds. Willow trees are scattered thruout. It has never been broken up, the crop of corn seen in the photograph being on upland at the bog's edge.

Chemical analysis shows the bog to be high

in mineral matter and in lime.

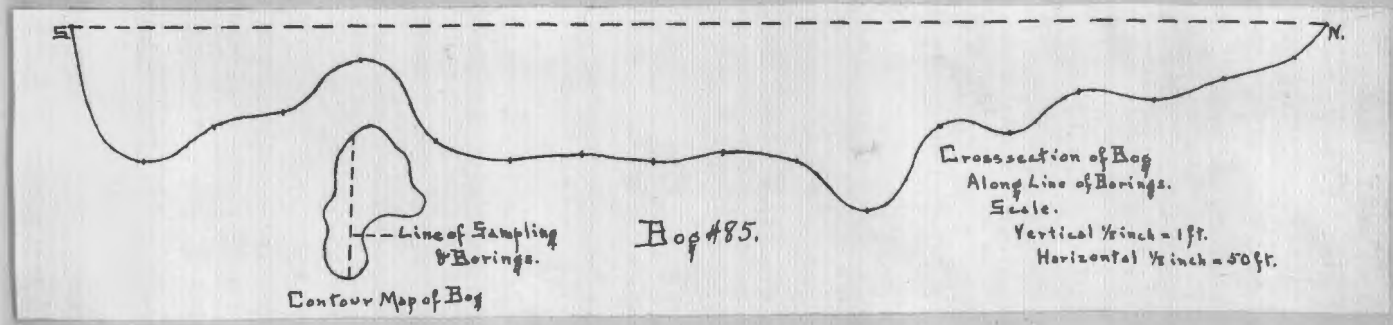
ANALYSIS OF SAMPLES

	Depth of Section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	54.66	56.47
Total Ash	45.34	43.53
Insoluble Ash	33.60	34.62
Lime (CaO)	5.67	3.04
Phosphoric Acid (P_2O_5)	0.34	0.27
Nitrogen	2.53	2.47
Acidity	not acid	----

BOG No. 85

BOG No. 85

Bog No. 85, located in Judson township, has an area of about 100 acres. The peat has an average depth of 5 to 6 feet, the maximum depth along the line of borings being 8 feet.



The underlying soil varied in different parts of the bog, sand, yellow clay and blue green clay being found in different borings. The drainage was accomplished by a few shallow ditches at the time of sampling (August 24, 1914), which were wholly inadequate, and the water table in the central area was at the surface. Tile were being laid by the county in 1914 at a cost of $40.00 per acre.

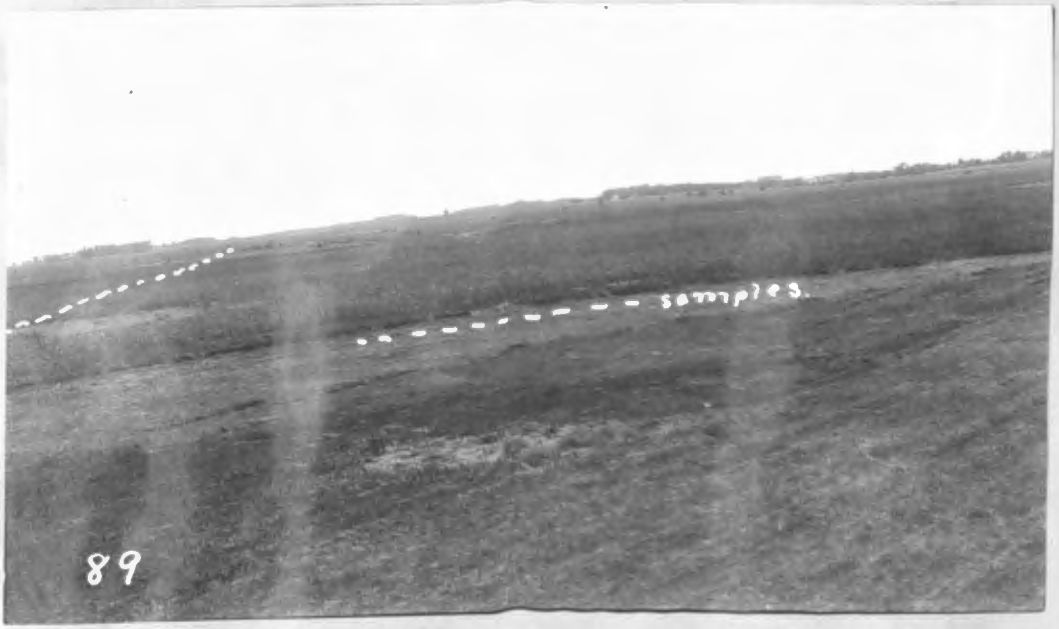
The bog was used for pasture and wild hay.

The central area was not in use. The vegetation was composed of ragweed, wild barley, June grass, marsh grass, rushes and cattails. The bog had never been cultivated. In the photograph, the area down to the fence is upland.

ANALYSIS OF SAMPLES

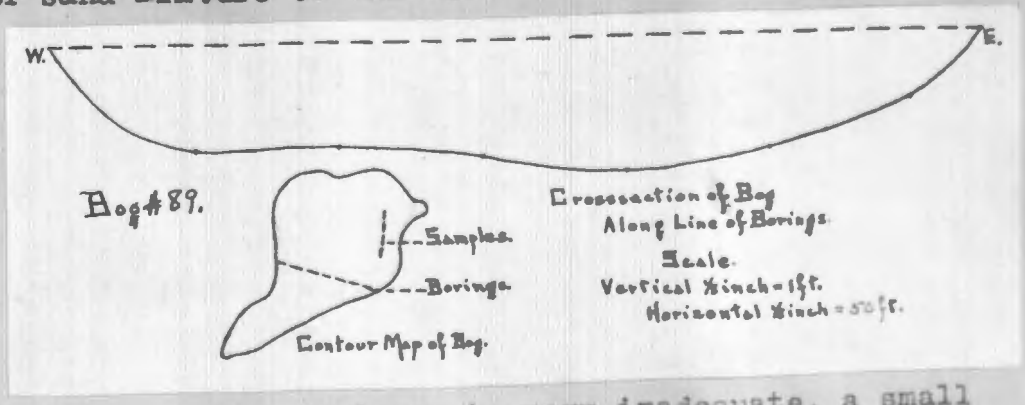
	Depth of Section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	75.48	68.88
Total Ash	24.52	31.12
Insoluble Ash	17.25	24.94
Lime (CaO)	3.27	2.45
Phosphoric Acid (P_2O_5)	0.36	0.24
Nitrogen	2.87	2.59
Acidity	not acid	----

BOG No. 89



BOG No. 89

This bog, located in Butternut Valley township, has an area of about 160 acres. In depth it averages about 5 feet, the maximum depth along the line of borings being 5.8 feet. The bottom of the bog is quite level as can be seen from the crosssection. The northwest and central parts of the bog are covered with water. The peat in this area probably reaches a depth of 7 to 9 feet. The underlying soil is a yellow clay or sand mixture of the two.



The drainage is very inadequate, a small open ditch on the west side being the only outlet. The vegetation of the bog is composed of marsh grass, cane brake and rushes. All of the south half and

borders of the north half of the bog are cut for wild hay. The photograph shows the central area looking west. The mowed area and haystacks mark the limit of solid peat.

In chemical composition this bog resembles bog No. 75.

ANALYSIS OF SAMPLES

	Depth of Section	
	1-8 in.	9-16 in.
	Per cent	Per cent
Organic Matter	73.50	75.70
Total Ash	26.50	24.30
Insoluble Ash	19.44	18.77
Lime (CaO)	2.82	2.27
Phosphoric Acid (P_2O_5)	0.52	----
Nitrogen	2.63	2.54
Acidity	not acid	----

DIGEST OF DATA

At the outset it was decided that a chemical analysis of each bog was necessary, inasmuch as bogs in one locality did not have a common chemical composition. However, it was thot possible that the bogs of widely separated areas might have certain differences peculiar to these areas. Accordingly the bogs were grouped according to location as in Table No. 6.

Lime township contains the largest number of bogs sampled. In this township 15 true peats were analyzed besides two bogs No's. 9 and 13 not included in this table which are classed as mucks.

With the exception of three bogs those in Lime township were small in area. The average area of all was 67 acres. For the five bogs in Leray township the average area was 95 acres giving an average area for the bogs of the northeast portion of the

Table No. 6A. Chemical constituents of the surface 8 inch samples of the bogs of Blue Earth County.

No. of Bogs	Maximum depth of bog	Organic Matter	Total Ash	Insol. Ash	CaO	P_2O_5	N	Acidity
	feet	Per cent						
True Peats								
Northeast Portion								
Lime Township								
5	13.5	78.92	21.08	16.30	1.31	0.37	2.39	not acid
7	9	84.39	15.61	10.03	3.10	0.32	2.45	" "
8	6.4	73.47	26.53	19.70	2.52	0.32	2.47	faintly acid
10	9	74.30	25.70	17.76	2.85	0.27	2.64	not acid
11	11	76.07	23.93	16.80	2.49	0.31	2.78	" "
12	11	84.00	16.00	9.91	2.47	0.33	2.73	" "
14	8	68.40	31.60	25.65	2.03	0.24	2.52	faintly acid
15	13	66.67	33.33	24.54	2.74	0.37	2.53	not acid
16	7.7	78.07	21.93	14.64	3.03	0.29	2.67	" "
17	15 plus	83.22	16.78	11.28	1.81	0.37	2.89	" "
25	15 plus	81.24	18.76	12.52	2.25	0.40	2.91	" "
26	15 "	81.15	18.85	13.29	1.96	0.29	2.56	" "
28	12	84.92	15.08	12.43	2.53	0.20	2.40	" "
Average for township	11.2	78.06	21.94	15.76	2.40	0.31	2.61	
Leray Township								
36B	8.5	76.01	23.99	17.65	2.64	0.31	2.79	not acid
37	13.5	77.39	22.61	15.80	2.84	0.37	3.00	" "
38	12.9	77.55	22.45	15.53	3.13	0.34	3.03	" "
41	14	79.09	20.91	14.74	2.18	0.25	2.61	faintly acid
41B	7.9	72.15	27.85	20.42	3.14	0.31	2.69	" "

Table No. 6A (cont)

No. of Bog	Maximum depth of bog	Organic Matter	Total Ash	Insol. Ash	CaO	P_2O_5	N	Acidity
	FEET	Per cent						
Leray Township cont.								
Average for Township	11.4	76.44	23.56	16.83	2.79	0.32	2.82	
Average for northeast portion	11.2	77.61	22.39	16.05	2.45	0.31	2.67	
SOUTHEAST PORTION Beauford Township								
62B	9.9	67.29	32.71	22.02	4.75	0.48	2.75	not acid
Medo Township								
66	3.7	66.08	33.92	21.87	6.63	-----	2.44	" "
67	9	63.98	36.02	26.29	4.35	0.34	2.96	" "
69	8.6	69.82	30.18	21.94	3.20	0.31	2.73	" "
70	2.1	62.87	37.13	28.27	3.51	----	3.10	" "
Average for township	5.8	65.69	34.31	24.59	4.42	0.32	2.81	
Mapleton Township								
72	2.1	71.22	28.78	20.90	3.15	0.29	2.45	faintly ac
Danville Township								
73	4.8	78.30	21.70	13.94	3.48	0.34	2.68	" "
Average for southeast portion	5.7	68.51	31.49	22.18	4.27	0.35	2.73	
Southwest portion of County								
Sterling Township								
75	9	71.54	28.46	21.04	3.20	0.33	2.64	faintly acid

Table No. 8A (concluded)

No. of Bog	Maximum depth of bog	Organic Matter	Total Ash	Insol. Ash	CaO	P_2O_5	N	Acidity
	feet	Per cent						
Southwest portion of County, cont.								
Ceresco Township								
80	10.2	54.66	45.34	33.60	5.67	0.34	2.53	not acid
Average for southwest portion of county	9.6	63.10	36.90	27.32	4.43	0.33	2.58	
Northwest portion of County								
Judson Township								
85	8	75.48	24.52	17.35	3.27	0.36	2.87	not acid
Butternut Valley Township								
89	5.8	73.50	26.50	19.44	2.82	0.32	2.63	" "
Average for northwest portion of county	6.9	74.49	25.51	18.34	3.04	0.34	2.75	
Average composition of surface 8 inches of true peats of county		74.20	25.80	18.46	3.07	0.34	2.71	
MUCKS								
Lime Township								
9	1.1	51.08	48.92	40.93	2.33	0.24	1.93	not acid
13	1.1	43.61	56.39	48.06	1.94	0.33	1.61	faintly "
Leray Township								
48	11.3	44.45	55.55	47.05	2.14	0.31	1.70	not acid
Beauford Township								
71	2.1	39.20	60.80	53.97	1.83	----	1.83	not acid
Average composition, surface 8 inches of mucks of county		44.58	55.42	47.35	2.03	0.26	1.76	
Average composition, surface 8 inches of all Blue Earth County bogs analyzed		70.61	29.39	21.95	2.94	0.33	2.60	

Table No. 6B. Chemical Composition of the second 8 inch samples of the bogs of Blue Earth County.

No. of Bog	Organic Matter	Total Ash	Insol. Ash	CaO	P_2O_5	Nitrogen
	Per cent					
TRUE PEATS						
Northeast portion of county						
Lime Township						
5	85.58	14.42	10.08	1.29	0.29	2.57
7	78.43	21.57	15.99	2.11	0.24	2.31
8	73.66	26.34	20.35	2.99	0.22	2.38
10	73.57	26.43	20.59	2.15	0.25	2.50
11	77.03	22.97	17.00	2.51	0.25	2.68
12	83.72	16.28	10.96	2.35	0.23	2.30
14	71.91	28.09	20.80	2.89	0.31	2.60
15	79.10	20.90	14.12	2.82	0.31	2.83
17	86.73	13.27	9.39	1.89	0.27	2.63
25	85.00	15.00	10.21	1.78	0.25	2.58
26	82.47	17.53	12.71	1.94	0.23	2.35
28	86.52	13.48	8.32	2.48	0.22	2.48
Average for Township	80.31	19.69	14.20	2.21	0.26	2.52
Leray Township						
36B	72.98	27.02	21.50	1.99	0.21	2.59
37	79.59	20.41	14.05	2.97	0.24	2.91
38	78.93	21.07	14.79	2.94	0.26	3.02
41	77.21	22.79	16.71	2.36	0.29	2.96
41B	74.79	25.21	18.33	3.06	0.24	2.66
Average for Township	76.70	23.30	17.08	2.66	0.25	2.83
Average for northeast portion	79.25	20.75	15.05	2.34	0.25	2.61

Table No. 58 (continued)

No. of Bog	Organic Matter	Total Ash	Insol. Ash	CaO	P_2O_5	Nitrogen
	Per cent					
Southeast Portion						
Beauford Township						
63B	75.97	24.03	14.13	5.77	0.38	3.02
Medo Township						
66	68.56	31.44	21.42	4.59	----	2.55
67	53.54	46.46	31.99	8.13	0.20	2.38
69	65.36	34.64	28.03	2.43	0.21	2.55
70	51.25	48.75	36.12	6.50	0.19	2.47
Average for Township	59.68	40.32	29.39	5.41	0.20	2.49
Mapleton Township						
72	76.51	23.49	16.51	3.19	0.18	2.51
Danville Township						
73	81.71	18.29	11.85	2.99	0.20	2.47
Average for southeast portion	69.56	30.44	22.86	4.80	0.23	2.56
Southwest Portion						
Sterling Township						
75	79.99	20.01	13.90	2.91	0.22	2.55
Ceresco Township						
80	56.47	43.53	34.62	3.04	0.27	2.47
Average for southwest portion	68.23	31.77	24.26	2.97	0.24	2.51
Northwest Portion of County						
Judson Township						
85	68.88	31.12	24.94	2.45	0.24	2.59

Table No. 8E (concluded)

No. of Bog	Organic Matter	Total Ash	Insol. Ash	CaO	P_2O_5	Nitrogen
			Per cent			
Northwest portion, cont.						
Butternut Township						
89	75.70	24.30	18.77	2.27	---	2.54
Average for northwest portion	72.29	27.71	21.85	2.36	0.24	2.56
Average composition of second 8 inches of true peats of county	74.98	25.02	18.01	3.01	0.25	2.68
MUCKS						
Lime Township						
9	16.34	83.66	79.58	0.75	0.16	0.58
Leray Township						
48	30.79	69.21	62.02	1.53	0.21	1.23
Beauford Township						
71	41.83	58.17	52.50	1.24	0.16	2.00
Average composition of second 8 inches of mucks of County	29.65	70.35	64.70	1.17	0.18	1.27
Average composition of second 8 inches of all Blue Earth County bogs analyzed	70.59	29.41	22.53	2.83	0.24	2.54

county of 75 acres each. The seven bogs in the southeast section of the county averaged 109 acres each, the two in the southwest quarter, 45 acres each, and the two in the northwest portion, 130 acres each. This makes an average area of 85 acres for each true peat bog sampled, with 430 acres of muck bogs, an estimated total of 2,887 acres represented by the analyses presented in this thesis.

As can be seen from the data there is a wide variance in the chemical composition of the bogs. Many border around the limit of 50% organic matter which has been taken as differentiating peats and mucks. For this reason in most of the following tables, all bogs will be included, whether true peat or mucks.

Returning to a discussion of the bogs as regards location we find that those in the southern half of the county are uniformly lower in organic content and higher in mineral content than those in the northern half. They likewise contain a greater per-

centage of lime than those in the northern part of the county. The Phosphoric Acid and Nitrogen content apparently bear no relation to the location of the bog and the few bogs giwing an acid reaction are fairly well distributed thruout the county.

The bogs of the northeast section are on the average the deepest bogs in the county and those in the southeast portion, the shallowest. There appears to be no relation between depth and area. No depth was reached in any bog in Blue Earth County as great as that reached in bog No. 1 in Ramsey County, previously referred to and which had a maximum depth of 39.5 feet and an area of only 4 acres.

In order to ascertain whether or not there was any relationship between the depth of a bog and its chemical composition Table No.7 was prepared. In this table the average chemical compositions are shown for those bogs having a maximum depth of less than five feet, for more than five feet and less than ten feet, and for more than ten feet. The averages show

Table No. 7-8. To show the average composition of 33 Blue Earth Bogs grouped according to maximum depth.

No. of Bogs	Range of Maximum depth in feet	Organic Matter av. pct.	Total Ash pct.	Insol. Ash pct.	CaO pct.	P_2O_5 pct.	Nitrogen av. percent.
1 to 8 inch depth							
7	0.1-5	58.91	41.09	31.56	3.25	0.28	2.29
13	5.1-10	72.96	27.04	19.53	3.09	0.33	2.68
13	10.1-15	74.57	25.43	18.75	2.57	0.33	2.62
Average all bogs 1-8 in.							
33	0.1-15	70.61	29.39	21.95	2.94	0.33	2.60
9 to 16 inch depth							
6	0.1-5	56.03	43.97	36.33	3.21	0.18	2.06
12	5.1-10	72.07	27.93	20.78	3.20	0.24	2.56
13	10.1-15	76.09	23.91	18.07	2.68	0.26	2.54
Average all bogs 9 to 16 inches							
31*	0.1-15	70.59	29.41	22.53	2.83	0.24	2.54

* Second 8 inch sections of Bogs 13 and 16 not analyzed.

a relationship between depth and some of the constituents. The deeper is the bog the greater is the amount of organic matter and the lower is the percentage of Total Ash, Insoluble Ash and Lime. These results are probably due to two factors. In the first place the mineral matter beneath the shallow bogs is nearer the surface and more readily becomes mixed with the surface layer. Second, the deeper bogs are generally in more rolling land with less drainage from the upland and consequently less mineral matter is carried on to the bog. The deeper bogs are more subject to leaching and therefore contain less lime. There are, however, a number of exceptions to these generalizations. For example Bog No. 73 lies in the shallow bog group yet has an organic content greater than the average for the deep bog group. On the other hand, Bog No. 48 has an organic content of 44.45% and would be classed as a muck, yet it falls in the deep bog group. Both of these bogs, however, agree well in lime content with the group in which they fall.

Exceptions in the lime content are to be found among the shallow bogs in Bog No. 71 which has a lime content of only 1.83% while among the deep bogs, bog No. 80 has a lime content of 5.67%.

The phosphoric acid and the nitrogen contents in the shallow bog group are less than in either the medium bog group or the deep bog group.

The peats in the deep bog group are, with one exception neutral while the proportion of acid bogs in the shallow and medium groups are about evenly divided. No bog having a lime content greater than 3.5% is acid. A quantative determination of the acidity of bog No. 1 of Ramsey County shows that this bog, which contains less lime, and is much more acid than any of the Blue Earth bogs, would have to be raised in lime content to 2.82% in order to be rendered neutral. In other words, some of the bogs of Blue Earth County would be rendered even more acid than bog No. 1 if the lime in those bogs were leached out to the extent it has in bog No. 1.

These observations are amply corroborated by an inspection of Table No. 8 which shows the corresponding analyses of the 9 to 16 inch sections.

In order to ascertain whether or not the maximum depth relationships, discussed above were not more or less accidental, since many of the bogs had only a small area at the maximum depth, the analyses were rearranged according to the mean depths of the bog. The bogs were averaged into shallow, medium and deep groups as before, the depths taken being 1 to 5 feet, 5 to 7½ feet and 7½ to 15 feet plus mean depths respectively. The averages are shown in Table No. 9. These results not only corroborated the relationship between depth and Organic Matter, Total Ash, Insoluble Ash, and lime but they show a relationship between depth and phosphoric acid and nitrogen contents. The deeper the bog the higher the phosphoric acid content and the higher the nitrogen content. As in the other relationships there are here marked exceptions to the rule.

Table No. 9. The Average Composition of 33 Bogs grouped according to the mean depth.

No. of Bogs	Range of mean depth feet	Organic Matter	Total Ash	Insol. Ash	CaO	P_2O_5	N
		Average Per cent					
11	1 to 5	64.81	35.19	27.09	3.13	0.30	2.42
11	5.1 to 7.8	71.37	28.63	21.32	2.87	0.31	2.60
11	7.6 to 15	75.65	24.35	17.46	2.83	0.34	2.69

In order to ascertain whether any relationship existed between organic matter and the other chemical constituents, the bogs were next rearranged according to organic content. Averages were taken by dividing the series into 3 groups of 11 bogs each, one of high, one of medium and one of low organic content. The four muck bogs are included in the last named group. The average analyses are given in Table No. 10. From this table it is apparent that the organic content varies directly with depth as noted above. It also varies inversely with the insoluble ash and with the lime. The phosphoric acid content is approximately constant thrucut, while the nitrogen content falls in the low organic content group but this is due to the low nitrogen content of the four muck bogs. Omitting the mucks the average nitrogen content for the third group is 2.69% making the nitrogen content of the 3 groups constant within the limits of error. In other words, the organic content shows no relationship to the total nitrogen content in the Blue Earth peat

Table No. 10. The Average composition of 33 Bogs grouped according to the percentage of Organic Matter.

No. of Bogs	Range of percentage Organic Matter	Av. depth of bogs	Organic Matter	Total Ash	Insol. Ash	CaO	P_2O_5	N
		feet	Average Per cent					
11	84.92-77.50	11.8	80.99	19.01	13.15	2.48	0.32	2.67
11	74.49-69.00	8.2	73.72	26.28	18.97	2.92	0.32	2.70
11	68.99-39.20	6.5	57.12	42.88	33.75	3.44*	0.32	2.35*
						*4.41		*2.69

*Average not including the 4 muck bogs

bogs. It is of interest to note that a similar conclusion has been reached by M. Shmook[20] in regard to the nitrogen and organic matter of the mineral soils of Russia.

In order to make certain that there was no relationship between nitrogen and organic matter the bogs were arranged according to nitrogen content. They were divided into four groups, one of high, one of medium, one of low nitrogen, and one containing only the mucks in which the nitrogen content is the lowest of all. The averages are given in Table No. 11. Here the nitrogen content shows no relationship to either the organic matter or the lime content of the true peats. It does appear to vary directly with the phosphoric acid content.

The nitrogen contents of the different peats were then computed as per cent nitrogen in the organic matter and the bogs rearranged accordingly. Averages were taken of three groups of 11 bogs each, one of high nitrogen in the organic matter including

Table No. 11. The average composition of 33 Bogs grouped according to the nitrogen content.

No. of Bogs	Range of Nitrogen content percent	av. depth feet	Organic Matter av. pct.	Total Ash av. pct.	Insol. Ash av. pct.	CaO pct.	P_2O_5 pct.	Nitrogen av. pct.
10	3.1-2.75	10.5	74.11	25.89	18.34	3.10	0.36	2.91
9	2.74-2.60	8.6	75.64	24.36	17.09	2.93	0.31	2.67
11	2.59-2.30	10.3	72.99	27.01	19.83	3.16	0.30	2.47
4	1.93-1.61	3.9	44.58	55.42	47.25	2.03	0.26	1.76

percentages from 4.93 to 3.8 nitrogen, one of these bogs ranging from 3.8% to 3.5% nitrogen, and one from 3.5% to 2.8% nitrogen in organic matter. The averages are given in Table No. 12. Here the nitrogen percentage in the organic matter varies inversely with the percentage of organic matter. That is, the more organic matter present in a peat, the less will be the amount of nitrogen in every unit of that organic matter. Apparently, then, in the decomposition of a peat, there is a tendency either toward a greater decomposition of the non-nitrogenous parts such as cellulose or if nitrogenous compounds are decomposed, the nitrogen remains fixed in the peat.

In the discussion of the table arranged according to content of organic matter it was shown that the phosphoric acid varied directly with the organic matter. In table No.12 however, the relation appears to be an inverse ratio altho not very apparent. This might be explained on the grounds that plant ash is higher in phosphoric acid than is mineral soil.

Table No. 12. The Average composition of 33 bogs grouped according to the percentage of nitrogen in the organic matter.

No. of Bogs	Range of percentage nitrogen in organic matter	Nitrogen in organic matter	Organic Matter	Total Ash	Insol. Ash	CaO	P_2O_5	N
		av. pct.	av. pct.	pct.	pct.	pct.	pct.	pct.
11	3.8 to 4.93	4.18	63.58	36.42	27.75	3.39	0.35	2.64
11	3.5 to 3.8	3.66	68.54	31.46	23.83	2.93	0.27	2.50
11	2.83 to 3.5	3.23	79.71	20.29	14.29	2.50	0.30	2.57

A decomposition which increases the nitrogen content in the organic matter would have a tendency toward concentrating the phosphoric acid as well as the nitrogen so that the phosphoric acid content would vary with the percentage of nitrogen in the organic matter. The percentage of total nitrogen appears to have no connection with the other chemical constituents as grouped in this table. The percentage of nitrogen in the organic matter is directly proportional to the percentage of lime in the peat. Thus the greater the percentage of lime in the peat the greater is the decomposition of the organic matter with concentration of nitrogen. This can be accounted for by the fact that many bacteria such as cellulose dissolving bacteria work best in an alkaline medium. In fact in culture sclutions of cellulose dissolving bacteria it is necessary to have an excess of calcium carbonate present to neutralize the acid products of the bacteria. In peat, apparently, the lime acts in a similar capacity.

In order to ascertain whether these conclusions would be substantiated by European data, the 37 Swedish low bogs for which data are available, were arranged according to the nitrogen content of the organic matter. The results are shown in table No. 13. The averages were taken for those having more than 3% nitrogen in the organic matter, for those having from 3 to 2.5% nitrogen in the organic matter, and for those having less than 2.5% nitrogen in the organic matter. In every case the conclusions drawn from Blue Earth County data are corroborated by these Swedish data. Moreover, in the Swedish sampling, weights of the air dry peat were determined. The averages show the peat to be heaviest where the percentage of nitrogen in the organic matter is greatest, that is, where the decomposition has been greatest. Incidentally the percentage of nitrogen in the organic matter of Blue Earth peats is higher than that of the Swedish peats, the upper and lower limits for Blue Earth peats being 4.93% and 2.83% nitrogen in the

Table No. 13. Surface 8 inches of Swedish Low Bogs arranged According to Nitrogen content based on Organic Matter.

Reference Set No.	Percentage Nitrogen in Organic Matter	Organic Matter	Lime	Nitrogen	Weight per cubic meter, air dry
		Per cent			kgm.
16	3.88	53.33	3.17	2.07	385
21	3.72	87.89	4.72	3.27	195
62	3.69	64.73	1.34	2.39	335
10	3.65	77.29	2.90	2.82	315
36	3.63	83.82	1.37	3.04	262
41	3.62	85.34	3.86	3.09	282
20	3.55	87.07	3.57	3.09	275
25	3.52	90.21	1.68	3.18	165
24	3.43	89.47	3.41	3.07	197
66	3.42	80.28	2.83	2.75	232
22	3.36	87.72	3.18	2.95	195
26	3.34	74.23	1.17	2.48	161
19	3.26	73.93	2.53	2.41	279
37	3.24	78.14	2.66	2.53	275
23	3.15	91.10	2.95	2.87	180
4	3.10	92.73	2.19	2.87	167
44	2.99	84.29	1.59	2.53	254
5	2.81	81.84	3.98	2.30	220
2	2.79	87.49	3.74	2.44	211
42	2.74	74.35	1.62	2.04	191
58	2.69	93.44	2.64	2.51	152
40	2.69	89.70	2.24	2.41	140
3	2.67	93.53	3.03	2.50	147
50	2.61	77.36	1.68	2.02	337
17	2.56	71.51	2.33	1.83	393

Table No. 13. (concluded)

Reference Set No.	Percentage Nitrogen in Organic Matter	Organic Matter	Lime (CaO)	Nitrogen	Weight per cubic meter air dry
		Per cent			kgm.
65	2.53	89.64	3.36	2.27	117
7	2.53	90.34	1.57	2.29	198
6	2.51	83.09	1.39	2.09	226
13	2.50	91.11	1.89	2.28	137
35	2.50	89.05	1.55	2.23	280
63	2.48	92.58	1.01	2.30	267
57	2.35	87.71	1.04	2.06	247
43	2.19	90.29	1.81	1.98	260
53	2.17	90.45	1.05	1.96	100
18	1.89	91.06	1.13	1.72	257
12	1.64	92.93	2.72	1.52	177
15	1.63	95.87	1.51	1.56	169
Averages					
Bogs above 3 per cent nitrogen in Organic Matter	3.47	80.74	2.66	2.81	244
Bogs with from 2.5 per cent to 3 per cent nitrogen in Organic Matter	2.68	84.72	2.43	2.27	215
Less than 2.5 per cent Nitrogen in Organic Matter	2.15	91.23	1.52	1.96	210
Av. all bogs	2.85	84.73	2.34	2.42	226

organic matter respectively while those for the Swedish low bogs are 3.88% and 1.63% respectively. The averages of the chemical constituents of the 37 Swedish low bogs and of the 33 Blue Earth low Bogs are as follows:

	Bogs	
	Swedish Percent	Blue Earth Percent
Organic Matter	84.73	70.61
Total Ash	15.27	29.39
Insoluble Ash	-----	21.95
Lime (CaO)	2.34	2.94
Phosphoric Acid(P_2O_5)	----	0.33
Nitrogen	2.42	2.60
Weight per cubic meter air dry kgm.	226	----

From these averages it is apparent that in general the organic matter in the Swedish bogs is higher than that in the Blue Earth bogs. On the other hand the nitrogen content is lower than that of the Blue Earth bogs. The average percentage of nitrogen in the organic matter of the Swedish bogs being 2.86 while that

of the Blue Earth bogs is 3.68%. The average percentage of lime is also greater in the Blue Earth peats. With these greater elements of soil fertility, more mineral matter, more lime and more nitrogen in his peat soils, it would appear that the Blue Earth farmer has a distinct advantage over the Swedish farmer.

In order to ascertain whether any relationship existed between the lime content of the peats and the other chemical constituents, the Blue Earth bogs were rearranged according to lime content. They were divided into five groups and averages of each group taken. The first group contains bogs having from 6.63 to 4.35% of lime, the second, from 3.51 to 3.03% , the third, from 2.85 to 2.62%, the fourth, from 2.49 to 2.03% and the fifth, from 1.91 to 1.31% lime. The averages are given in Table No. 14. From these results it is apparent that the lime content has no relationship with the other averages shown except those of nitrogen and possibly the phosphoric acid. These vary directly with the lime. There are, however,

Table No.14. The average composition of 33 bogs grouped according to lime content.

No. of Bogs	Range of Lime content percent	Av. depth of bogs feet	Organic Matter percent	Total Ash pct.	Insol. Ash pct.	CaO pct.	P_2O_5 pct.	Nitrogen Percent
4	6.63-4	8.2	63.00	37.00	25.94	5.35	0.39	2.67
10	3.9 -3	7.2	74.14	25.86	18.40	3.22	0.33	2.73
7	2.9 -2.5	6.8	75.18	24.82	15.91	2.37	0.31	2.64
7	2.49-2	10.2	69.19	30.81	23.94	2.25	0.30	2.45
5	1.99-1.31	9.3	65.22	34.78	28.38	1.77	0.31	2.35

exceptions even in these relationships. While the mucks have a low lime content yet three of the five peats in the fifth group have over 78% organic matter. In other words, there is no relationship between lime content and organic content.

The bogs were again rearranged this time according to the percentage of the ash which was soluble in aqua regia. Averages were taken of those analyses having more than 8 per cent, from 7 to 8 per cent and less than 7 per cent soluble ash respectively. The averages appear in Table No. 15. As is to be expected there is more soluble ash in those peats having low organic and high mineral content. The lime content varies directly with the soluble ash, while nitrogen follows the organic matter in increasing as the soluble ash content decreases. Phosphoric acid is apparently independent of the soluble ash.

The analyses were further rearranged according to the percent of soluble ash in the total ash. These were averaged into 3 groups, the first group

Table No. 15. The average composition of 33 bogs grouped according to the percentage of soluble ash in the anhydrous sample.

No. of Bogs	Range of percentage soluble ash	Sol. Ash	Organic Matter	Total Ash	Inscl. Ash	CaO	P_2O_5	N
		Average Per cent						
9	12.05- 8	9.66	59.94	40.06	30.40	3.88	0.33	2.48
11	7.99- 7	7.55	69.17	30.83	23.28	2.86	0.31	2.53
13	6.99-2.65	5.80	79.21	20.79	14.99	2.37	0.32	2.69

containing 11 bogs having more than 30 per cent soluble ash in the total ash, the second 11 having from 25 to 30 per cent and the third 11 having less than 25 per cent. The averages are given in Table No. 16. The results show that the greater the amount of total ash the less is the percentage of soluble ash in that total ash. This is due to the fact that in the low ash peats a very considerable part of the ash is derived from plant residues and is, therefore, almost wholly soluble in acids. In those peats containing a larger proportion of total ash, a very considerable portion of the ash consists of mineral soil, which is relatively insoluble. As is to be expected the soluble ash in the total ash varies directly with the lime and phosphoric acid contents. It also varies directly with the nitrogen content. These results, as noted above, are probably due to the low ash peats consisting almost entirely of plant residues.

In order to ascertain whether the analysis of the surface section gave an accurate indication of

Table No. 16. The Average Composition of 33 bogs grouped according to the percentage of soluble ash in the total ash.

No. of Bogs	Range of percentage soluble ash in total ash	Sol. ash in Total ash	Organic Matter	Total Ash	Insol. Ash	CaO	P_2O_5	N
		av.pct.	av.pct.	pct.	pct.	pct.	pct.	pct.
11	38.06-30	33.54	77.44	22.56	15.03	3.30	0.35	2.74
14	29.9 -25	27.37	71.77	28.23	20.54	3.09	0.32	2.66
8	24.9 -12.88	17.78	59.18	40.82	33.95	2.19	0.27	2.18

the chemical composition of the bog, both first 8 inch and second 8 inch sections, and in a few cases, a third section of sixteen inches were analyzed. A table showing the excess of organic matter, total ash, phosphoric acid and nitrogen in the first eight inches over the same in the second eight inches, is presented as Table No. 17. A minus sign indicates difference in favor of the lower section. The bogs are arranged in the order of organic content as in Table No. 10. The bogs were then divided into three groups as in Table No. 10 and the averages taken. The second eight inches of bogs 13 and 16 were not analyzed, and the second eight inch section of bog No. 9 proved to be essentially a mineral soil. Therefore, these three bogs are not included in the table.

As a rule the organic content of the second eight inches was greater than that in the surface eight inches. The averages show that, in the bogs of high organic content, the second eight inches is higher in organic matter than is the surface eight, and the same

Table No.17 to show the excess of Organic Matter, Total Ash, Insoluble Ash, Lime, Phosphoric Acid and Nitrogen in first 8 inches over same in second 8 inches of Blue Earth County Peat Bogs. Bogs arranged according to organic content.

Bog No.	Organic Matter Percent	Total Ash Percent	Insoluble Ash Percent	CaO Percent	P_2O_5 Percent	N Percent
28	-1.60	1.60	4.21	0.05	-0.02	-0.08
7	5.96	-5.96	-5.96	0.99	0.08	0.14
12	0.28	-0.28	-1.05	0.12	0.10	0.43
17	-3.51	3.51	1.89	-0.08	0.10	0.26
26	-1.32	1.32	0.58	0.02	0.06	0.21
25	-3.76	3.76	2.31	0.47	0.15	0.33
41	1.88	-1.88	-1.97	-0.18	-0.04	-0.35
5	-6.66	6.66	6.22	0.02	0.08	0.18
73	-3.41	3.41	2.09	0.49	0.14	0.21
29	-1.38	1.38	0.74	0.19	0.08	0.01
37	-2.20	2.20	1.75	-0.13	0.13	0.09
11	-0.96	0.96	-0.20	-0.02	0.06	0.10
36B	3.03	-3.03	-3.85	0.35	0.10	0.20
85	6.60	-6.60	-7.69	0.82	0.12	0.28
10	0.73	-0.73	-2.83	0.70	0.02	0.14
89	-2.20	2.20	0.67	0.55	----	0.09
8	-0.19	0.19	-0.65	0.23	0.10	0.09
41B	-2.64	2.64	2.09	0.08	0.07	0.03
75	-8.45	8.45	7.14	0.29	0.11	0.09
72	-5.29	5.29	4.39	-0.04	0.11	-0.06
69	4.46	-4.46	-6.09	0.78	0.10	0.18

Bog No.	Organic Matter Percent	Total Ash Percent	Insoluble Ash Percent	CaO Percent	P_2O_5 Percent	N Percent
14	-3.51	3.51	4.85	-0.86	-0.07	-0.08
62B	-8.68	8.68	7.89	-1.02	0.10	-0.27
15	-12.43	12.43	10.42	-0.08	0.06	-0.30
66	-2.48	2.48	0.45	2.04	----	-0.11
67	10.44	-10.44	-5.70	-3.78	0.14	0.58
70	11.62	-11.62	-7.85	-2.99	-----	0.63
80	-1.81	1.81	-1.02	2.63	0.07	0.06
48	13.66	-13.66	-14.99	0.61	0.10	0.47
71	-2.63	2.63	0.47	0.59	----	-0.18
Av. for bogs of high organic content	-1.35	1.35	0.90	0.21	0.07	0.10
Av. for bogs of medium organic content	-0.65	0.65	-0.48	0.35	0.09	0.12
Av. for bogs of low organic content	0.46	-0.46	-0.62	-0.32	0.07	0.08
Total Average	-0.35	0.35	-0.06	0.11	0.08	0.09

holds true to a less degree in the medium organic content bogs. In the group possessing a low organic content there were extreme differences, with the average organic content slightly greater in the surface eight inches.

Insoluble ash, as is to be expected from the discussion above, predominates in the surface eight inches in the bogs of high organic content. The lime content is generally greater in the surface eight inches altho a few bogs of low organic content show a decided increase in lime in the second eight inches.

The phosphoric acid content is, with only three exceptions, greater in the surface eight inches than in the second eight inches. It is interesting to note that in each of those three exceptions the nitrogen content was also greater in the second eight inches. The nitrogen content is,as a rule, greater in the surface section than in the second eight inches.

While the organic matter, total ash, and insoluble ash vary to a considerable extent in the analysis of the surface and second eight inches, yet they are

not so essential as to make that variation important, the essential plant foods, phosphorus, nitrogen and lime are quite uniformly higher in percentage in the surface area than in the second eight inches. Therefore, it would seem that in an analysis for the determination of plant food, the analysis of the surface eight inches would be preferable and, in most instances, sufficient. Occasional peats show a large increase in lime content in the second eight inches due to deposition of small shells but this can be readily distinguished in sampling.

A similar table was prepared of the four Ramsey County bogs. The results are presented in table No. 18. Without exception these bogs show a greater organic content in the second eight inches than in the first. The excess of organic matter in the second 8 inches appears to accompany a deficiency in lime, again suggesting what has appeared in several tables, that the rate of organic decomposition varies with the lime content. In the three elements essential

Table No. 18. To show the excess of Organic Matter, total Ash, Insoluble Ash, Lime, Phosphoric Acid, and Nitrogen in surface 8 inches over same in second 8 inches in Ramsey County Bogs.

Bog No.	Organic Matter Percent	Total Ash Percent	Insoluble Ash Percent	CaO Percent	P_2O_5 Percent	N Percent
1	-2.65	2.65	1.76	0.11	0.07	-0.02
2	-9.44	9.44	3.53	2.45	-0.08	-.034
3	-3.22	3.22	1.31	0.86	0.09	0.53
4	-2.40	2.40	3.47	0.11	-0.04	0.15
Average excess for Ramsey County bogs	-4.43	4.43	2.52	0.88	0.01	0.08

to plant growth the average of the four bogs shows the surface eight inches to be the better indication of the peat fertility.

The excess of the different chemical constituents in the first eight inches over those of the second eight inches was also computed for the analyses of the different areas of Bog No. 1. This data is presented in table No. 19. A survey of this data shows that the outer area of the bog has received considerable washing from the mineral soil adjacent, causing a higher total ash content. This excess of mineral matter in the surface 8 inches decreases in the intermediate set of samples and then slightly increases in the center, probably due to the inwash from the slough above. The excess of insoluble ash follows closely the variation of total ash in the different areas, altho the excess is not as high as in the total ash. The lime content is greater in every case in the first eight inches than in the second, with the greatest excess in the intermediate area, which area receives

Table No.19.

Excess of Organic Matter, Total Ash, Insoluble Ash, Lime, Phosphoric Acid, and Nitrogen in first 8 inches of bog No. 1 over that in second 8 inches.

	North side of Bog		Central area of Bog		South side of Bog
	5-10ft. depth area	20-25ft. depth area	20-25ft. depth area	20-25ft. depth area	5-10ft. depth area
Bog No. 1	pct.	pct.	pct.	pct.	pct.
Organic Matter	-5.59	-.0.64	-1.15	-0.32	-5.55
Total Ash	5.59	0.64	1.15	0.32	5.55
Insoluble Ash	3.98	-0.26	0.94	-0.72	5.89
Lime (CaO)	0.09	0.11	0.06	0.23	0.06
Phosphoric Acid	0.07	0.04	0.04	0.09	0.10
Nitrogen	0.03	0.05	-0.25	0.03	0.04

the least washing and therefore the least leaching. The phosphoric acid content is greater in the first eight inches in all areas, with the excess slightly greater in the outer areas. The nitrogen content is slightly greater in the surface layer in all areas except the central area which is slightly lower in the surface area, probably due to less decomposition in the water logged portion.

In order to make a still wider comparison the Swedish bogs were arranged in a similar table. Averages are taken of the bogs of each province with a final average for all provinces. The results appear in table No. 20. With only one exception the averages for the provinces show a decided increase in organic content in the second eight inches. The exception contains only one bog. In the majority of the provinces a greater lime content is found in the second eight inches than in the first. The average lime content for all bogs is slightly in favor of the second eight inches. The excess of nitrogen among the provinces

SWEDISH BOGS

ARRANGED ACCORDING TO PROVINCES

Table No. 20. To show the excess of Organic Matter, Lime, Nitrogen, and weight per cubic meter in surface 8 inches over that of second 8 inches.

Reference Set No.	Organic Matter Percent	CaO Percent	N	Weight per cubic meter kgm.
Westerbotten				
1.	-9.27	0.16	-0.12	45
Jemtland				
2.	-2.80	-0.87	-0.02	7
3.	3.91	-0.44	-0.02	-15
4.	-2.51	0.13	0.31	22
5.	-8.48	-0.10	-0.25	23
Average for province	-2.47	-0.32	0.01	9
Geflegorg				
6.	-7.44	0.15	-0.01	39
7.	-1.13	-0.73	-0.11	-8
Average for province	-4.28	-0.29	-0.06	16
Kopparborg				
8.	3.98	-0.04	0.35	32
Orebro				
9.	5.71	-1.08	0.22	-33
10.	-8.59	-1.53	-0.06	87
Average for province	-1.44	-1.30	0.08	55

Table No. 20 (continued)

Reference Set No.	Organic Matter Percent	CaO Percent	Nitrogen Percent	Weight per cubic meter kgm.
Westmanland				
11.	-28.50	7.03	-0.25	105
Upsala				
12.	- 2.38	1.38	0.21	7
13.	- 2.78	0.19	0.32	22
14.	- 2.45	-1.01	-0.41	-15
Average for province	- 2.54	0.19	0.04	5
Stockholm				
15.	-0.18	-0.34	0.24	-6
16.	-19.17	-0.66	-0.50	83
Average for province	- 9.67	-0.50	-013	39
Sodermanland				
17	-14.23	-0.67	-0.30	193
Oster Gotland				
18	- 5.06	0.00	0.66	48
19	1.91	0.51	0.42	89
Average for province	- 1.58	0.26	0.54	69
Skaraborg				
20	- 5.98	0.74	0.55	128
21	- 1.80	0.08	0.12	53
22	- 4.80	0.22	0.22	28
23	- 2.36	0.19	0.33	43
24	- 1.36	-0.30	0.05	37
Average for province	- 3.26	0.19	0.25	58
Elfsborg				
25	- 2.97	-0.22	0.09	-1
26	-13.02	-0.92	-0.34	-5

Table No. 20 (cont)

Reference Set No.	Organic Matter Percent	CaO percent	Nitrogen percent	Weight per cubic meter, kgm.
Elfsborg, cont.				
27	- 8.54	0.05	- 0.16	65
28	-13.23	-0.31	- 0.35	72
Average for province	- 9.43	-0.35	- 0.19	33
Jonkoping				
29	- 0.49	-0.04	- 0.66	1
30	- 1.15	0.27	- 0.23	--
31	-20.03	-0.23	- 0.69	198
32	-19.84	-0.58	- 1.41	266
33	-30.14	-0.45	- 0.56	262
34	-13.52	-0.06	0.46	88
35	- 5.09	-0.96	0.91	118
36	- 9.12	-0.28	0.67	129
37	- 7.32	-1.37	0.39	63
38	0.27	0.02	0.32	30
39	-18.12	-1.83	-0.64	181
40	- 0.97	-1.34	-0.54	-50
41	- 4.29	-0.61	0.38	52
42	- 9.10	-0.94	0.04	-1
43	- 1.78	0.66	-0.04	53
Average for province	- 9.38	-0.51	-0.10	99
Kalmar				
44	- 1.53	-0.96	-0.28	67
45	-23.10	-0.13	-0.23	235
46	-15.62	-0.37	-0.51	269
47	14.00	0.08	-0.53	28

Table No. 20 (cont)

Reference Set No.	Organic Matter Percent	CaO Percent	Nitrogen Percent	Weight per cubic meter kgm.
Kalmar, cont.				
48	-26.90	0.57	0.09	42
49	12.80	0.09	0.48	103
50	1.78	0.10	0.72	65
Average for Province	- 5.51	-0.09	-0.04	116
Kronoberg				
51	- 3.02	-0.16	0.43	32
52	- 6.80	-0.06	0.32	85
53	- 3.52	0.48	-0.78	-75
54	-13.08	0.34	-0.26	-78
55	2.96	0.21	-0.42	-60
56	- 3.20	-0.07	-0.82	-65
57	- 7.31	0.46	0.84	112
Average for Province	- 4.89	0.20	-0.18	-16
Halland				
58	- 3.59	3.41	-0.07	-15
59	-25.96	-1.44	0.02	170
Average for province	-14.77	0.48	-0.02	78
Christianstad				
60	0.19	0.04	-0.05	4
61	0.03	-0.03	0.20	19
62	- 6.39	-0.13	0.21	93
Average for Province	- 2.05	-0.04	0.12	39
Blekinge				
63	- 0.33	0.42	0.07	12

Table No. 20 (cont)

Reference Set No.	Organic Matter Percent	CaO Percent	Nitrogen Percent	Weight per cubic meter kgm.
Malmohus				
64	- 1.06	-0.08	0.08	5
Gotland				
65	6.62	-2.64	-1.36	-43
66	- 9.66	-0.26	0.43	92
Average for Province	- 1.51	-1.45	-0.47	24

Table No. 20 (concluded)

Province	No. of bogs	Organic Matter	CaO	Nitrogen	Weight per cubic meter air dry
		Percent	percent	Percent	kgm.
Averages for Provinces					
Westerbotten	1	- 9.27	0.16	-0.12	45
Jemtland	4	- 2.47	-0.32	0.01	9
Gefleborg	2	- 4.29	-0.29	-0.06	16
Kopparborg	1	3.98	-0.04	0.35	32
Orebro	2	- 1.44	-1.30	0.08	55
Westmanland	1	-28.50	7.03	-0.35	105
Upsala	3	- 2.54	0.19	0.04	5
Stockholm	2	- 9.67	-0.50	-0.13	39
Sodermanland	1	-14.23	-0.67	-0.30	193
Oster Gotland	2	- 1.58	0.26	0.54	69
Skaraborg	5	- 3.26	0.19	0.25	58
Elfsborg	4	- 9.43	-0.35	-0.19	33
Jonkoping	15	- 9.38	-0.51	-0.10	99
Kalmar	7	- 5.51	-0.09	-0.04	116
Kronoberg	7	- 4.89	0.20	-0.18	-16
Halland	2	-14.77	0.48	-0.02	78
Christianstad	3	- 2.05	-0.04	0.13	39
Blekinge	1	-0.33	0.42	0.07	12
Malmohus	1	- 1.06	-0.08	0.08	5
Gotland	2	- 1.51	-1.45	-0.47	24
Average for all Swedish Bogs	66	- 6.15	-0.10	-0.03	55

is about equally divided between the first and second eight inches. With one exception the averages for the provinces show a decidedly greater weight per cubic meter for the surface eight inches. The average for all bogs shows that the surface eight inches is 55 kilograms heavier per cubic meter than is the second eight inches. This isprobably due to inwash from the surrounding upland, and to the greater decomposition of the surface section. From these analyses it seems safe to draw the same conclusion as for the Blue Earth Bogs, that an analysis of the surface section would be sufficient for the determination of the bog's chemical composition.

S U M M A R Y

A study of the chemical composition of 37 peat bogs of southern Minnesota, together with the comparison of these analyses with those of certain Swedish bogs leads to the following conclusions:

1. The chemical analysis of a single composite sample consisting of ten individual samples taken crosswise of the bog will be representative of the chemical composition.

2. In the securing of a sample for chemical analysis, a composite of peat sections 8 inches in depth will give an analysis representative of the bog's chemical composition.

3. Bogs located near one another may vary widely in composition, thereby necessitating the sampling of each.

4. Certain comparisons between chemical analyses of Blue Earth County bogs and of Swedish low bogs indicate that the same generali-

zations hold true in both instances.

5. The chemical analyses of the Bogs of Blue Earth County indicate that they are all true low bogs. Three of the four bogs of Ramsey County are likewise true low bogs.

6. The true peats of Blue Earth County average lower in organic matter than do those of Ramsey County and the low bogs of Sweden.

7. The bogs in Blue Earth County vary in depth according to location, the deepest bogs being in the more rolling uplands, in the northeastern part of the country.

8. The Organic content varies directly while Total Ash, Insoluble Ash, and Lime vary inversely with the depth.

9. The phosphoric acid and nitrogen are nearly independent of the depth, altho the more mucky and, therefore, generally shallower peats are lower in phosphoric acid and nitrogen. Twelve more of the shallower bogs are acid.

10. The organic matter of the Blue Earth Peats varies inversely with the insoluble ash and with the lime content.

11. The organic content is independent of the nitrogen content computed as nitrogen in the dry sample.

12. The nitrogen content of Blue Earth peats varies directly with that of phosphoric acid.

13. The greater the proportion of organic matter in the peat the lower is the nitrogen content in the organic matter.

14. The greater the percentage of lime in the peat the greater is the nitrogen content in the organic matter, probably due to more far-reaching decomposition.

15. The lime content has a direct but not marked variation with the phosphoric acid and nitrogen. 16. The soluble ash in peat varies directly with the total ash and lime.

17. The amount of soluble ash in the

total ash of a peat varies inversely with the amount of total ash, and directly with that of lime, phosphoric acid and nitrogen.

18. A comparison of the analyses of the first and of the second 8 inch sections of Blue Earth County peat shows that the organic content of the surface 8 inches is slightly greater in the bogs of low organic content but is less in those of high organic content.

19. The lime, phosphoric acid and nitrogen average slightly higher in the surface eight inch section.

20. In all the generalizations concerning the chemical constituents noted above, there are marked exceptions to the rule. These are, however, few in number.

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