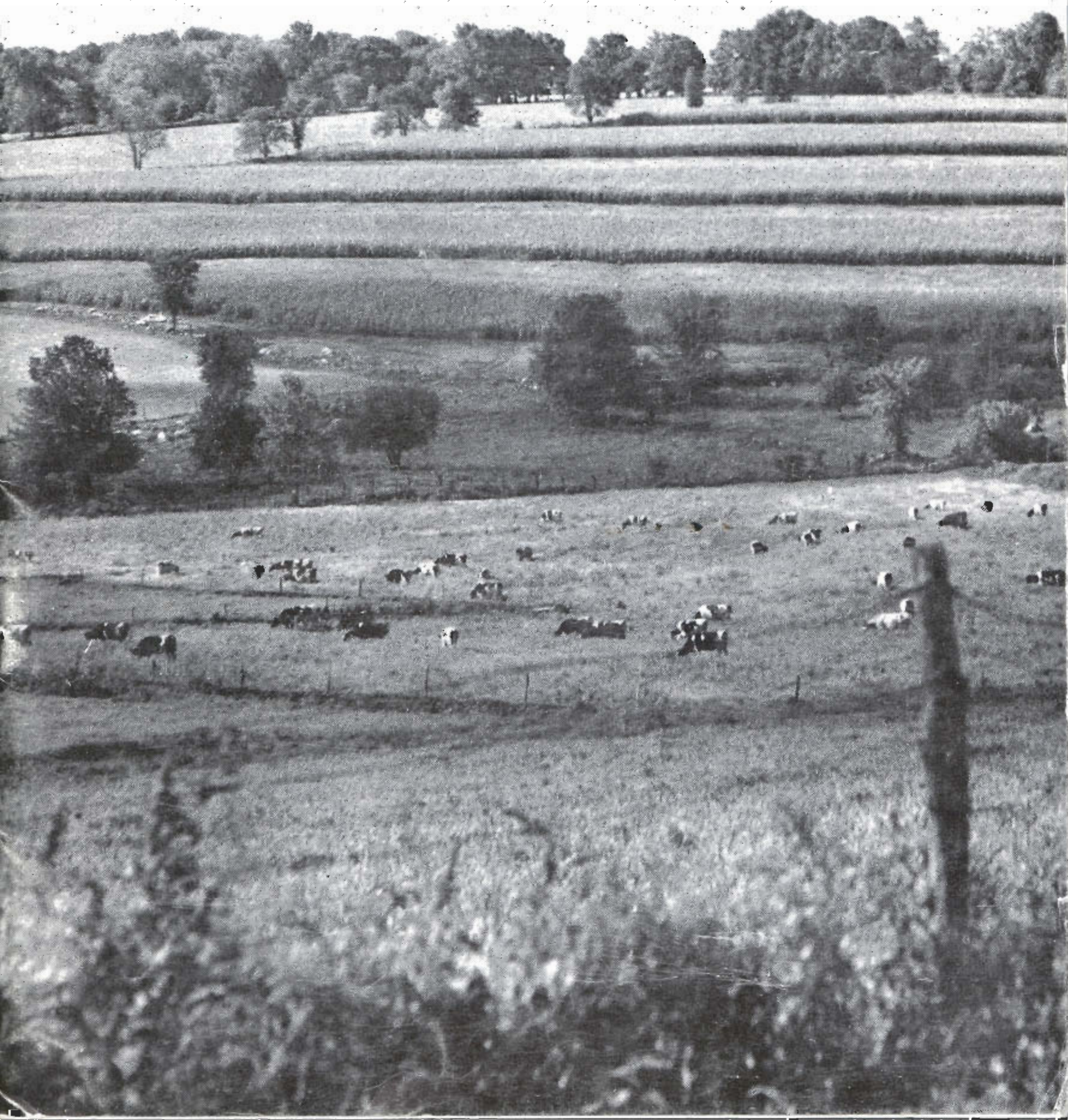
The Paxton Soils

David E. Hill and Walter N. Gonick



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THE MONOGRAPH—A BENCHMARK SOIL REPORT Many soils occur over a wide geographic area including several states. Soil scientists in each state have been examining their soils for many years, recording their properties, and interpreting them for agricultural and urban use. To gain a broader knowledge of the soil throughout its geographical range, available data are being assembled from each state on the important agricultural soils. These soils are known as benchmark soils and this monograph is the Paxton benchmark soil report. A monograph for the Paxton soils is especially significant for Connecticut since it is one of the major soils of the Eastern and Western Highlands covering more than 6 per cent of the 3,135,000 acres in the State. The assemblage of all knowledge about the Paxton soils will aid soil scientists and technicians in properly identifying similar soils, interpreting their properties for various uses, and determining the needs for future study.

ACKNOWLEDGMENTS Special credit is due the State Soil Scientists of the Soil Conservation Service in Maine, Massachusetts, New Hampshire, New York, and Vermont for assembling data in their states. The authors wish also to express sincere appreciation to Dr. Arnold Baur, Mr. Lloyd Garland, and Mr. Robert Shields of the Northeast Soil Correlation Staff, Soil Conservation Service, to Mr. Arthur Shearin, Connecticut State Soil Scientist, Soil Conservation Service, and Dr. Paul E. Waggoner, Chief, Department of Soils and Climatology, for their many helpful suggestions and contributions to this publication.

THE COVER PHOTO The Paxton soils are among the most productive of those used for dairying in New England. In the background, corn in contour strips yielded 17 tons to the acre in spite of drouth in 1957 when this photo was taken in Sherman, Connecticut, by Soil Conservation Service photographer Newby. The photo was made available for use in this publication by the Cartographic Unit, Soil Conservation Service, U. S. Department of Agriculture, Beltsville, Maryland.

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INTRODUCTION

The Paxton soils are well-drained Brown Podzolic soils. Their notable characteristic is the compact layer found 22 to 24 inches below the surface, and this profoundly affects drainage; hence use of the soils.

These soils, found in all New England states and New York, are exemplified by picturesque hillside pastures and are among the most productive soils used for dairying in New England.

Although Paxton soils may be found in many situations, they are most common on drumlins, smooth hills that were elongated north to south by glacial movement. Here, the Paxton soils developed on compact till originally deposited beneath the glacier during the Late Wisconsin Age.

The upper portion of the compact till is a fragipan, a layer 18 to 28 inches thick whose platy structural units or peds are glazed with material such as clay which has washed or illuviated into this layer. The fragipan horizons, known locally as hardpan, are hard when dry, and even when moist are very firm.

The till from which Paxton developed is principally mica schist, gneiss, and granite, but small amounts of other rocks may be present, especially near other petrographic provinces. Within this same petrographic province are the well-drained Charlton soils which developed on loose to firm glacial till, and the shallow Hollis soils that developed in thin mantles of till that lie over bedrock.

Within the same drainage sequence or catena where Paxton is found, are the moderately well-drained Woodbridge, the somewhat poorly to poorly-drained Ridgebury and the very poorly drained Whitman soils. Along lower slopes the associates of Paxton are extensive, and higher up the slope they are confined to seeps.

Distribution and Land Use

Paxton soils are found in all New England states and in New York, but in Rhode Island the area is slight and in New York it is confined to the counties bordering Connecticut, Figure 1. The acreages in each New England state have been estimated from 2 per cent random samples of the recent Soil Conservation Needs Inventories, Table 1. The slight acreage in Rhode Island was omitted. The acreage in Dutchess County was obtained from the Soil Survey Report for that county (23), and the acreage in Westchester and Putnam County is unknown.

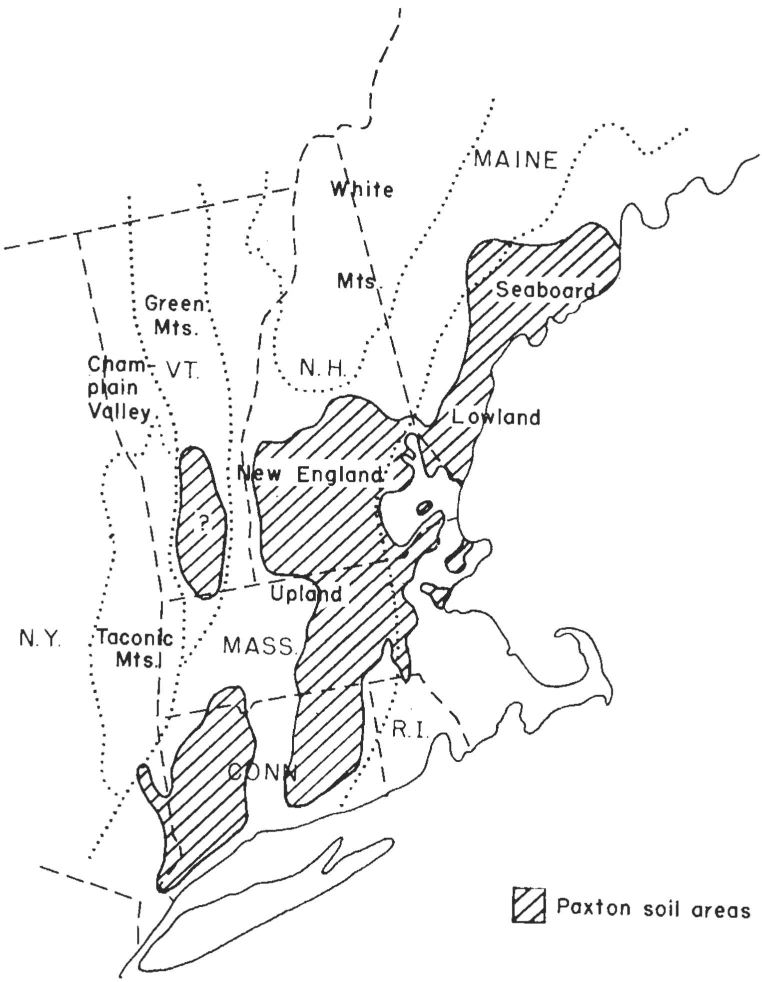

Figure 1. Physiographic provinces of New England and distribution of Paxton soils (physiography after Fenneman (12) and Lobeck (17)).

Table 1. Distribution and use of Paxton soils

Land use (acres)	Vermont	N. H.	Maine	Mass.	Conn.	N. Y.	Total	Per cent total
Cropland	1,777	29,867	14,039	28,502	51,519	2,790	128,494	21
Pasture	693	3,693	131	12,393	17,319	1,661	35,890	6
Woodland	7,730	171,747	20,850	86,806	105,192	811	393,136	65
Idle and Urban	186	8,230	95	15,653	22,703	2,123	48,990	8
Total	10,386	213,537	35,115	143,354	196,733	7,385	606,510	100

The use to which Paxton is put is also shown in Table 1. Nearly two-thirds of the soil is wooded, only one-quarter is cropland or pasture, and less than one-tenth is urban or idle. Among the states, however, the proportions vary.

In Vermont and New Hampshire, where few acres have been cleared of stones, 80 per cent are wooded and only 16 per cent are in crops and pasture. In Connecticut, Massachusetts, and southern Maine, where many acres have been cleared of stones, 55 to 60 per cent are wooded and 25 to 40 per cent are cropped or pastured. In New York fully 60 per cent are cropped or pastured and only 10 per cent are wooded. The proportion of the soil that is urban or idle is, of course, greater in the thickly settled southern states than in the northern ones.

Ninety-five per cent of the acres in crops are nearly free of surface stones and 55 per cent are on slopes that rise less than 8 feet in 100 feet (Table 2). The growing of forage and corn silage for the dairy herd is the predominant use of these cropped acres. Orchards and potatoes are also grown on Paxton soils.

The acres of Paxton soils devoted to permanent pasture have variable stoniness and slope. About half is on slopes less than 8 per cent and half on slopes greater than 8 per cent.

The acreage in woodland is predominantly the steep, stony phases. Only 17 per cent is non-stony and only 30 per cent has slopes less than 8 per cent.

Of the small amount of Paxton acreage devoted to urban uses or lying idle (Table 1), 65 per cent is on slopes less than 8 per cent, and 70 per cent is non-stony (Table 2).

Table 2. Use of Paxton mapping units in New England

Mapping Unit	Cropland (acres)	Pasture (acres)	Woodland (acres)	Idle and urban (acres)	Total
Non-stony phases					
A-1[1]	3,429	150	1,475	1,528	6,582
B-1, B-2	65,693	9,341	26,595	18,072	119,701
C-1, C-2	37,654	4,448	18,195	9,156	69,453
D-1, D-2	12,530	3,389	19,058	2,967	37,944
Stony phases[2]					
A-1	46	....	2,037	....	2,083
B-1, B-2[3]	2,608	7,870	84,742	6,866	102,086
C-1, C-2	2,087	3,717	95,830	3,125	104,759
D-1, D-2[4]	1,235	4,906	119,653	3,634	129,428
E-1, E-2	237	25	22,443	143	22,848

[1] The letters indicate per cent slope; A, <3; B, 3-8; C, 8-15; D, 15-25; E, 25-35. The numerals indicate erosion; 1—slightly; 2—moderately.
[2] Includes stony, very stony, and extremely stony phases.
[3] Includes very stony and extremely stony phases designated BC slopes.
[4] Includes very stony and extremely stony phases designated DEF slopes.

The pattern of land use is clear and reflects the physical features of the land as well as past use. Most land that is neither steep nor stony is tilled. Pasture occupies a wide range of slopes and stoniness. Most of the woodland is on the steep and stony slopes. In Southern New England, and in coastal Maine the Paxton soils have been more intensively used and more acres have been cleared of surface stones because the climate is more favorable and there are fewer steep slopes. In the interior of Northern New England, where the climate is more severe and much of the land is steep, the land has been less intensively farmed.

Physiography

The Paxton soils are found in three sections of the New England province; the New England Upland, Seaboard Lowland, and Green Mountain section (Figure 1).

The most extensive section, the New England Upland, rises from the Southern Coast and reaches 2,000 feet in the north. This section was an area of low relief at the close of the Mesozoic era, some 70 million years ago. Regional uplift and erosion dissected this old-land surface.

The Seaboard Lowland lies east of the New England Upland and extends to the sea. This lowland belt is a continuation of the New England Upland. Its landscape is nearly level to gently rolling. Elevations seldom exceed 200 feet.

The Green Mountain section extends from northern Massachusetts to Canada. It rises above the New England Upland to elevations exceeding 4,000 feet. The acres of Paxton in the Green Mountains are few; their distribution is questionable (Figure 1).

Geology

The great continental ice sheets of the Pleistocene epoch, covering New England about 10,000 years ago, scoured the pre-glacial landscape and deposited glacial drift. Some of the rocks, sand, silt, and clay were sorted by water and wind; some were left virtually unchanged. Post-glacial erosion slightly modified the surface features.

The glacier made two significant contributions to the present landscape: the valleys were filled with stratified, water-laid materials, and smooth elongate drumlins of compact unsorted fragments were deposited.

The origin of drumlins has received much attention by Pleistocene geologists. Its compactness was probably caused by the sheer weight of glacial ice overriding masses of drift entrapped at its base. On the other hand, uncompact drift was found where the topography hindered free flowing movement of the ice mass and deposition occurred as the ice melted in place.

The thickness of glacial drift in drumlins is variable. It may represent the total height of the drumlin or may be less if there is a rock core over which drift has been molded.

In Connecticut 192 drumlins have been mapped (13), 80 in Litchfield County alone. Several occur in the Connecticut Lowland, whose materials are from local red sandstone and shale. These soils are members of the Wethersfield catena (24).

Gates (14), studying the geology of the Litchfield and the New Preston quadrangles of Connecticut, recognized 158 drumlins or drumloidal hills. The Paxton soils are closely related to drumlins; they may also be found on broad, gentle slopes lacking drumlin features. The topographical relationship between Paxton and its drainage associates is seen in Figure 2.

The coarse fragments in the olive, compact drift are primarily schist, gneiss, and granite with small mixtures of other local rocks. Most of the coarse fragments in the unsorted drift originated within a few tens of miles of their present location. In contrast, terminal moraines contain rock fragments transported hundreds of miles.

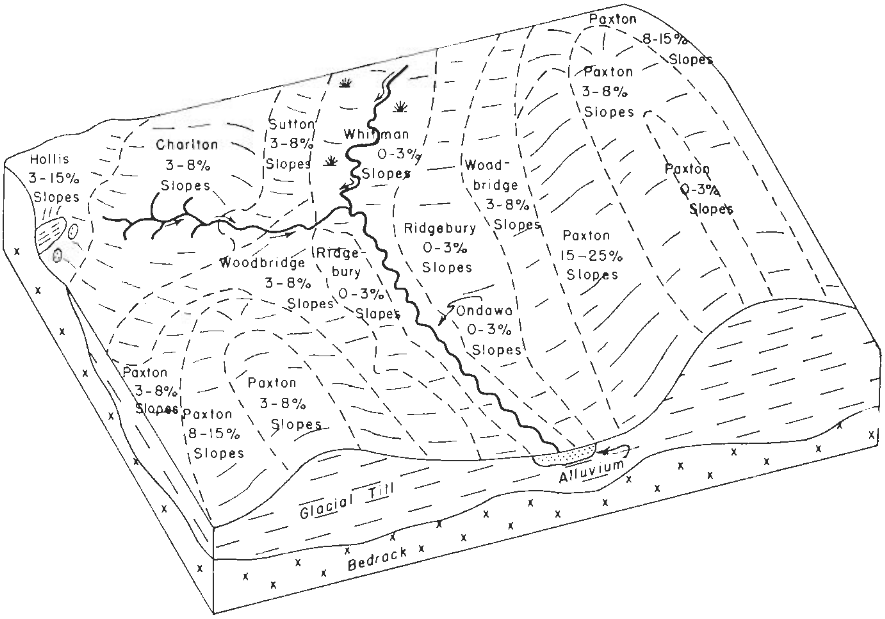

Figure 2. Physiographic relationship between members of the Paxton catena and associated soils in southern New England. The Hollis, Charlton, and Sutton soils do not have well developed fragipan horizons.

Climate

Where Paxton soils are found, the climate is humid and temperate, with long, cool winters and short, mild summers.

Average January temperatures range from 19°F in southern Maine to 27°F in southern Connecticut; average July temperatures from 69°F to 71°F. Thus, during January the region of Paxton soils is colder in the north than the south, but in July temperatures are relatively uniform (29).

The frost-free season in southern New Hampshire and Vermont is about 130 days, while in southern Connecticut it is about 155. In southern Maine, the frost-free season ranges from 159 days at Lewiston to 173 at Portland, showing the influence of the coastal climate (29).

The average annual precipitation within the region of Paxton soil ranges from 37 inches at Bennington, Vermont, to 49 inches at Colchester, Connecticut (29). Precipitation is distributed fairly evenly throughout the year: 3.2 inches per month in southern New Hampshire and Vermont, 3.6 inches in coastal Maine and central Massachusetts, and 4.0 inches in Connecticut (29).

Prolonged droughts are uncommon throughout the area, although short rainless periods may occur during summer and early fall. During late summer and early fall severe coastal storms occur; the 1938 and 1955 hurricanes are well remembered. Coastal northeasters contribute much snow as do storms which originate in the interior, pass over the Great Lakes, and sweep through Vermont and New Hampshire.

DESCRIPTION OF THE SERIES

History

The Paxton series was first mapped in 1922 in Paxton Township, Massachusetts, and was first described in the Soil Survey of Worcester County, published in 1927 (16). The mapping units recognized were the Paxton loam and the Paxton loam, stony phase.

The outstanding characteristic of the series was the presence of compact glacial till known locally as "hardpan." The report stated: "In many places a 'hardpan' occurs at depths of from 20 to 30 inches, composed of gravel cemented together with clay material. Below this hardpan the subsoil is decidedly lighter in texture. Beds of gravel are found here and there in the substratum" (16).

The typical profile was described as "a dark yellowish-brown to greenish-yellow fairly heavy loam 7 to 8 inches deep. The subsoil is a greenish-yellow, fairly heavy, compact, loamy material . . . below which is the substratum, which in many places is lighter in texture and less compact than the subsoil and carries a noticeable quantity of coarse sand" (16). The report stated that the glacial till included a mixture of schist, slate or phyllite, and granite. The surface texture was a loam, the subsoil a loam to clay loam; the substratum, below 24 inches, a clay loam extending to bedrock.

In 1930 M. F. Morgan (19), of the Connecticut Agricultural Experiment Station, recognized the Paxton and Litchfield soils on drumlin topography in the Highlands. The two soils were distinguished by small differences in color. The Paxton soils had an olive-brown surface and a yellowish-olive to olive-drab subsoil. The Litchfield soils had a dark grayish-brown surface and a yellowish-olive subsoil. Both had olive-drab to grayish-olive compact substrata at depths of 16 to 24 inches. Two textures were recognized; fine sandy loam and loam.

In 1939 these two soils were again separated on small color variations (20) in the profile which reflected local color variations in the bedrock types. Only one surface texture was recognized: a loam. The Litchfield soil representing a local variation in till never became an established series.

The original concept of the Paxton series in the Worcester County Soil Survey Report has changed little since 1922. Yellowish-brown subsoils underlain by olive substrata remains the dominant color. Laboratory data now reveal that surface textures are fine sandy loams rather than loams. Mechanical analyses indicate that many fine particles, formerly estimated in the field as clay, are fine silt.

Soil Genesis

The soils of the Paxton series are classified as Brown Podzolic soils. In the new classification system, the 7th Approximation, they belong to Spodosol order, the Entic Typorthod subgroup, and their tentative family is light loamy-mixed-fragipan.

Brown Podzolic soils are dominated by acid weathering. However, the intensity is not great enough to cause gross translocation of iron, aluminum, organic matter, or silicate clays. This is demonstrated by the lack of textural B horizons or well developed illuvial (spodic) horizons. The structure is predominantly weak, fine granular in the solum and moderately thin platy in the fragipan. The underlying compact drift has a massive structure.

Paxton soils are somewhat unique; they have been described as having bisequums. The upper sequum (A and B horizons) is inferred by the presence of a weak illuvial (spodic) horizon even though the eluvial (albic) horizon is usually lacking. Only isolated areas are found where incipient albic horizons have formed. We may only speculate that a thin continuous albic horizon was present, prior to man's disturbance, to complete the eluvial-illuvial sequence, or that the A1 horizon substitutes for an A2 horizon as a source for translocated sesquioxides and organic matter.

The development of a fragipan horizon, occurring at depths varying between 16 and 30 inches, constitutes the lower sequum.

Data from characterization profiles in Massachusetts and New Hampshire (Table 4), and from soil genesis studies in Connecticut (Tables 5, 6, 7), reveal that free iron is greatest in the upper horizons and decreases with depth to the fragipan horizons. Here it increases slightly. Clay follows a similar pattern, with one exception: a maximum is reached in the B22 horizon of profile S55Mass-14-2. Clay at the surface ranges between 5 and 14 per cent. Free iron exceeds 1 per cent in the B2 (spodic) horizons but is generally not greater than 2 per cent. Organic carbon is greatest at the surface and decreases sharply below the A horizon. The plowed horizons of cultivated soils (Ap) have 2.5 to 3.0 per cent organic carbon, one unplowed horizon (A1) has nearly 7 per cent. The C/N ratios are generally less than 15 and are quite low for spodic horizons. This is not uncommon in well drained cultivated soils found on acid parent materials in the Northeast. In the Paxton profile of Connecticut, SiO_2/R_2O_3 ratios were lowest at the surface and increased slightly with depth.

Although the nature of fragipan formation is not clearly understood, Carlisle (10) hypothesized that the eluvial-illuvial sequence (A′2 and B′2 horizon designations) stems from the lateral movement of water over compact, impermeable till. Fine silt and clay are washed from the A′2 horizon and fill vertical cracks and large pores in the B′2 horizon or fragipan. Non-capillary pore space and the permeability of the fragipan are reduced as the bulk density increases (Table 9).

The physical translocation of fine material from the A′2 to the B′2 horizon of the fragipan are seen as increases in clay (Table 3). These are most pronounced in the characterization profiles from Massachusetts. In Paxton soils with low clay, the translocation involves fine silt. Field examination shows the glossy deposition of fines on vertical ped (units of soil structure) surfaces, in some large pores, and on the upper surfaces of rock fragments in the fragipan or B′2 horizon. The pores within the peds branch repeatedly, yet they terminate inside the ped, and seldom are continuous between adjacent peds (18). Microscopic examination of peds from fragipans in New Hampshire reveals the compactness of the fragipan with little pore space. Some mica shows parallel orientation. The poorly sorted soil particles are closely packed and the thin, discontinuous films of clay act as cementing agents contributing to the brittleness of the pan.

The lower sequum, consisting of A′2 and B′2 horizons, is not continuous throughout the range of the Paxton soils. Although the official series description describes this as a dominant feature, the formation of the lower sequum weakens to the north. Those lacking the complete lower sequum do have B′2 horizons or C horizons with fragipan characteristics. Fragipan development is not limited to compact tills. It is well expressed in some soils with medium to moderately coarse textures in imperfectly drained positions (11).

Table 3. Physical properties of Paxton soils in Worcester County, Massachusetts, and Merrimack County, New Hampshire[1]

Horizon	Depth inches	Very coarse sand 2-1	Coarse sand 1-0.5	Medium sand 0.5-0.25	Fine sand 0.25-0.10	Very fine sand 0.10-0.05	Silt 0.05-0.002	Clay <0.002	International 0.2-0.02	International 0.02-0.002	>2.0	Textural class
		S55Mass-14-1 (1-11)							Paxton very stony loam			
A1	0-4	5.8	9.2	9.0	18.5	16.3	31.2	10.0	40.9	16.5	4	fsl
B21	4-9	4.5	9.6	9.7	19.8	15.2	31.7	9.5	40.7	16.9	12	fsl
B22	9-16	5.1	9.9	10.2	22.2	16.1	31.2	5.3	43.2	16.7	11	fsl
B23	16-26	4.8	10.6	10.7	23.4	17.9	29.3	5.3	45.5	14.9	24	fsl
B'21	26-34	6.5	10.7	10.1	22.9	16.6	27.2	6.0	53.8	13.2	20	fsl
B'22g	34-48	5.4	8.4	7.2	13.8	14.3	33.0	17.9	32.6	22.3	22	loam
B'23g	48-64	5.0	9.1	7.9	16.0	14.0	31.3	16.7	33.2	20.9	42	fsl/l
C11	126-138	6.1	9.8	7.6	15.4	13.8	28.3	19.0	34.4	16.6	26	fsl/l
C12	144-156	6.7	9.4	7.7	15.4	13.3	27.6	19.9	33.6	16.2	18	fsl/l
C2	174-180	6.1	9.2	7.8	15.9	13.4	27.4	20.2	34.3	15.8	17	scl/sl/l
C3	198-210	6.9	10.0	7.7	14.9	13.0	27.1	20.4	33.0	15.9	20	scl/sl/l
		S55Mass-14-2 (1-7)							Paxton loam			
Ap	0-8	5.4	9.2	8.7	19.1	14.2	29.6	13.8	38.5	16.4	6	fsl
B21	8-14	5.7	9.7	9.0	19.6	14.8	28.8	12.4	38.4	16.6	8	fsl
B22	14-22	5.8	9.0	8.5	19.0	14.8	27.3	15.6	36.4	16.8	7	fsl
B'21	22-32	5.2	9.4	9.4	21.0	16.9	27.6	9.9	42.2	15.2	11	fsl
B'22	32-41	5.6	9.8	9.0	20.1	15.7	27.0	12.8	39.0	15.6	13	fsl
C1g	41-48	4.9	9.8	8.6	19.5	15.1	27.3	14.8	38.2	15.9	7	fsl
C2	48-55	5.9	9.0	8.4	19.1	15.0	27.5	15.1	37.9	15.8	15	fsl

S56NH-7-1 (1-7)							Paxton loam					
Ap	0-9	5.6	10.6	9.9	20.0	14.4	32.1	7.4	40.3	17.2	19	fsl
B21	9-15	5.4	10.8	9.8	21.7	15.5	31.5	5.3	44.1	15.4	12	fsl
B22	15-21	6.6	12.0	9.2	19.6	14.9	30.8	6.9	40.8	16.3	16	fsl
B3	21-25	6.2	12.0	8.8	17.9	13.7	33.9	7.5	38.5	19.4	12	fsl
B'21m	25-34	5.2	11.0	9.1	19.8	15.9	30.5	8.5	41.2	16.9	10	fsl
B'22m	34-43	4.6	10.4	8.6	18.2	14.4	33.3	10.5	39.9	18.6	14	fsl
B'23m	43-52	5.4	11.9	9.3	18.4	15.4	31.9	7.7	40.2	17.9	10	fsl
S56NH-7-2 (1-7)							Paxton loam					
Ap	0-7	2.5	9.2	9.1	19.0	18.9	35.9	5.4	50.0	15.7	6	fsl
B21	7-12	3.0	8.9	8.9	19.2	20.9	35.6	3.5	53.6	13.6	10	fsl
B22	12-17	3.7	9.6	9.1	19.3	19.7	36.2	2.4	53.8	13.2	19	fsl
A'2m	17-21	4.3	11.1	9.7	19.5	18.7	34.4	2.3	51.0	13.0	7	fsl
B'21m	21-33	4.3	16.8	11.9	20.2	16.2	27.0	3.6	41.8	12.7	23	sl
B'22m	33-45	4.9	14.5	10.1	18.4	17.2	30.6	4.3	44.3	14.4	8	fsl
B'23m	45-60	4.8	13.1	9.2	18.3	17.5	33.0	4.1	46.9	14.5	5	fsl

[1] Data by Soil Survey Laboratory, Soil Conservation Service, Beltsville, Maryland. For methods used, see Characterization Reports for Worcester County, Mass., November 1960, and for Merrimack County, N. H., May 1960.

Table 4. Chemical properties of Paxton soils in Worcester County, Massachusetts, and Merrimack County, New Hampshire[1]

Horizon	Depth inches	pH 1:1	Organic matter: Organic carbon %	Organic matter: Nitrogen %	C/N	Free iron oxides % Fe_2O_3	Cation exchange capacity (sum)	Extractable Cations (meq./100g. soil): Ca	Mg	H	Na	K	Base Sat. %
	S55Mass-14-1 (1-11)							Paxton very stony loam					
A1	0-4	4.5	7.19	0.486	15	2.1	41.2	1.9	0.3	38.4	0.1	0.5	7
B21	4-9	4.5	0.96	0.085	11	2.0	13.1	0.4	0.1	12.3	< 0.1	0.3	6
B22	9-16	4.9	0.56	0.055	10	1.5	10.5	0.4	0.1	9.8	0.1	0.1	7
B23	16-26	5.3	0.27	0.029	—	1.0	7.4	0.4	0.1	6.6	0.1	0.2	11
B'21	26-34	5.5	0.09	0.018	—	1.1	7.2	2.5	0.3	4.1	0.1	0.2	43
B'22g	34-48	5.7	0.11	0.021	—	1.9	9.1	4.0	0.9	3.9	0.1	0.2	57
B'23g	48-64	5.7	0.09	0.012	—	2.0	11.2	5.8	1.1	4.0	0.1	0.2	64
C11	126-138	6.1	0.13	0.012	—	1.8	7.8	3.8	1.2	2.5	0.1	0.2	68
C12	144-156	6.3	0.09	0.012	—	1.7	7.7	3.9	1.4	2.1	0.1	0.2	73
C2	174-180	5.8	0.17	0.013	—	1.2	6.3	2.7	1.0	2.1	0.1	0.4	67
C3	198-210	6.3	0.13	0.012	—	1.2	6.0	2.7	1.1	1.7	0.1	0.4	72
	S55Mass-14-2 (1-7)							Paxton loam					
Ap	0-8	6.2	2.65	0.250	11	1.3	22.5	10.3	1.5	9.6	0.2	0.9	57
B21	8-14	5.7	0.32	0.037	—	1.2	8.0	2.0	0.1	5.4	0.1	0.4	32
B22	14-22	5.3	0.09	0.020	—	1.3	7.6	2.3	0.3	4.6	0.1	0.3	39
B'21	22-32	5.4	0.05	0.012	—	1.0	5.8	2.2	0.1	3.1	0.1	0.3	46
B'22	32-41	5.8	0.05	0.009	—	1.1	7.4	4.0	0.3	2.9	0.1	0.1	61
C1g	41-48	5.8	0.07	0.010	—	1.2	9.6	5.6	0.7	3.1	0.1	0.1	68
C2	48-55	5.8	0.07	0.009	—	1.2	10.0	5.8	0.9	3.1	0.1	0.1	69

		S56NH-7-1 (1-7)							Paxton loam				
Ap	0-9	5.2	2.50	0.190	13	1.6	18.0	2.8	0.1	14.7	0.1	0.2	18
B21	9-15	5.4	0.60	0.052	12	1.4	9.0	0.5	0.1	8.2	0.1	0.1	9
B22	15-21	5.6	0.41	0.037	11	1.2	8.0	0.8	0.1	6.8	0.1	0.2	15
B3	21-25	5.7	0.28	0.024	—	1.2	6.7	0.7	0.1	5.6	0.1	0.2	16
B'21m	25-34	5.4	0.10	0.015	—	1.3	5.9	0.8	< 0.1	4.8	0.1	0.2	19
B'22m	34-43	5.1	0.05	0.015	—	1.3	5.6	0.7	< 0.1	4.6	0.1	0.2	18
B'23m	43-52	5.0	0.05	0.012	—	1.3	5.6	0.7	0.2	4.4	0.1	0.2	21
		S56NH-7-2 (1-7)							Paxton loam				
Ap	0-7	5.0	3.13	0.257	12	1.7	20.4	1.6	0.3	18.1	0.1	0.3	11
B21	7-12	5.2	1.24	0.113	11	1.3	12.0	0.6	< 0.1	11.1	0.1	0.2	8
B22	12-17	5.4	0.63	0.061	10	1.3	8.1	0.4	0.1	7.4	0.1	0.1	9
A'2m	17-21	5.5	0.21	0.018	—	0.5	5.8	0.5	< 0.1	5.0	0.1	0.2	14
B'21m	21-33	5.6	0.10	0.012	—	0.6	5.2	0.5	0.2	4.2	0.1	0.2	19
B'22m	33-45	5.8	0.05	0.008	—	0.6	4.4	0.4	< 0.1	3.6	0.1	0.3	18
B'23m	45-60	6.0	0.05	0.006	—	0.6	4.8	0.7	0.1	3.6	0.1	0.3	25

[1] Data by Soil Survey Laboratory, Soil Conservation Service, Beltsville, Maryland. For methods used, see Characterization Reports for Worcester County, Mass., November 1960, and for Merrimack County, N. H., May 1960.

The mineralogical composition of the clay shows illite and vermiculite to be the chief components (Table 8) (25). Vermiculite dominates the horizons above the fragipan and interstratified illite-vermiculite dominates the fragipan and underlying parent material. Small quantities of gibbsite are present above the fragipan. The vermiculite, forming in upper horizons, is related to the weathering of illite which loses interlayer potassium and then hydrates. Aluminum and hydrogen saturation of clays dominate (22). The aluminum is most stable in well-drained areas. The formation of aluminum interlayers, known as the "chloritization process," in a mild acid environment may account for a reduction of the cation exchange capacity by 30 to 40 per cent.

Base saturation is low in the surface horizons of the Paxton soils (Table 4). Below the fragipan, saturation increases slightly in the profiles from New Hampshire and is pronounced in S55Mass-14-1. S55Mass-14-2 has a high base saturation in the solum; the result of local liming and fertilization practices.

Official Series Description Established Series

PAXTON SERIES

The Paxton series comprises well-drained, moderately coarse-textured Brown Podzolic soils with distinct fragipans, developed in deep, compact, platy glacial till. The till is derived principally from gray mica schist, gneiss, and granite, but may contain appreciable amounts of weathered brown schist in some areas. Solum textures are centered on fine sandy loam relatively low in coarse and very coarse sands. Paxton soils are members of a drainage sequence (catena) that includes the moderately well-drained Woodbridge series, the somewhat poorly and poorly-drained Ridgebury series, and the very poorly drained Whitman series. Other associated and similar Brown Podzolic soils are the Charlton, Essex, Gloucester, and Brookfield series. Woodbridge and Charlton soils are similar to the Paxton series in texture and mineralogical composition but Woodbridge soils are distinctly mottled within 2 feet of the surface and Charlton soils lack distinct or prominent fragipans. Essex soils have solum textures centered on stony sandy loam or stony loamy sand relatively high in very coarse, coarse, and medium sands. Gloucester soils have solum textures like those of the Essex series and lack fragipans. Brookfield soils also lack fragipans and have reddish colors in upper B horizons related to weathering products from pyritiferous schist in soil materials. Marlow soils are Podzol analogues of Paxton soils and have distinct bleicherde A2 and orterde B2 horizons. The Paxton soils are extensive and the less stony areas are locally important agriculturally.

Soil Profile:		Paxton fine sandy loam.
Ap	0-7″	Dark brown (10YR 3/3) fine sandy loam; weak fine granular structure; very friable; many fine roots; 5 or 10 per cent gravel; strongly acid; clear wavy boundary. 6 to 8 inches thick.
B21	7-12″	Dark yellowish-brown (10YR 4/4) fine sandy loam; breaks, when disturbed, into soft irregular clods that crush readily to weak fine granules; friable; many fine roots; 5 or 10 per cent gravel; strongly acid; clear wavy boundary. 5 to 7 inches thick.
B22	12-17″	Olive-brown (2.5Y 4/4) gravelly fine sandy loam; breaks, when disturbed, to soft irregular clods that crush readily to weak fine granules; friable; many fine and medium roots; 20 per cent gravel; strongly acid; abrupt wavy boundary. 4 to 6 inches thick.

A′2	17-21″	Olive (5Y 5/3) gravelly fine sandy loam; weak medium platy structure; friable; common roots; some clean sandy particles on the surface of platy peds; 20 per cent gravel and a few stones; strongly acid; clear wavy boundary. 0 to 4 inches thick.
B′21m	21-33″	Olive-gray (5Y 4/2) gravelly sandy loam; moderate thin platy structure; firm; few roots; common fine glazed pores on platy ped surfaces; 20 per cent gravel and a few stones; medium acid; diffuse boundary. 11 to 13 inches thick.
B′22m	33-45″	Olive (5Y 4/3) gravelly fine sandy loam; moderate thin platy structure; firm; common fine glazed pores on platy ped surfaces; 25 per cent gravel and a few stones; medium acid; diffuse boundary. 6 to 15 inches thick.
C	45-50″+	Olive (5Y 4/3) gravelly fine sandy loam; structureless, massive; firm; 20 to 30 per cent gravel and stones; medium acid.

Range in Characteristics: Fine sandy loam is the dominant type in cleared fields and very stony fine sandy loam is dominant in wooded areas. Solums are commonly gravelly and stony and range from about 5 to 25 per cent (by volume) of coarse fragments in all sizes. In the fine earth fraction, surface soils and upper B horizons range from loam through sandy loam and are relatively low in coarse and very coarse sands. In the fragipan, this fraction also ranges from loam through sandy loam. The C horizons contain between 10 and 30 per cent coarse fragments of all sizes. Depth to the fragipan ranges from about 16 to more than 30 inches and usually is about 22. Reaction ranges from medium through strongly acid, but surface soils of limed fields may have a pH above 6.0. Color of the Ap horizon is 10YR in hue and ranges from 3 through 4 in value and 1 through 4 in chroma. Colors of the B horizon above the fragipan range from 7.5YR through 2.5Y in hue, 3 through 5 in value, and 4 through 8 in chroma. Color of the fragipan ranges from 2.5Y through 5Y in hue, from 4 through 5 in value, and 2 through 4 in chroma. A few small, yellowish-brown mottles may be present in the fragipan or just above it. Color notations are for moist soil; dry colors are about one unit higher in value.

Topography: Drumlins, drumloidal hills, and hillsides. Gently sloping or steeply sloping. The majority of the areas occur on slopes of between 3 and 15 per cent.

Drainage and Permeability: Well drained, but approaching the moderately well drained class in places. Runoff is medium or rapid depending on the slope. Permeability is moderate above the fragipan and slow in the fragipan. In wet seasons water may seep out along the lower slopes.

Vegetation: Red, white, black and scarlet oak, red and sugar maple, beech, birch, white pine, and hemlock. Also spruce and fir in the higher elevations and latitudes.

Use: Non-stony areas are used largely for hay, pasture, silage corn, oats, rye, and apples. Stony areas are mostly in forest, but some have been cleared and are in pasture.

Distribution: New England and eastern New York.

Type Location: Merrimack County, New Hampshire; Franklin Town.

Series Established: Worcester County, Massachusetts, 1922.

National Cooperative Soil Survey, U.S.A.

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MEASUREMENT OF SOIL PROPERTIES

Soil characterization studies in Massachusetts and New Hampshire by the Soil Survey Laboratory, Soil Conservation Service, Beltsville, Maryland, and soil research by The Connecticut Agricultural Experiment Station are chief sources for the physical, chemical, and mineralogical properties of Paxton soil. Additional physical data from New Hampshire are given by the Bureau of Public Roads in the engineering section.

Characterization samples from Massachusetts and New Hampshire[1]

1. Interpretation of data (Tables 3 and 4).

Sample number S55Mass-14-1 and S55Mass-14-2

In general, the particle size distribution of these profiles is typical of glacial till. There is very little change with depth in particle size distribution of profile (14-2) which was sampled to a 55-inch depth. However, profile (14-1) has a break in particle size distribution at 34 inches. At this depth there is a decrease in the coarse, medium, fine, and very fine sand fraction, and a marked increase in the clay content. This break does not conform to the beginning of the firmer pan horizons at 26 inches depth. The calculated cation exchange capacity of the clay in horizons above and below the 34-inch depth are 120 and 51 meq./100 g. respectively. Since the organic carbon contents of these horizons are nearly alike, this drastic change indicates some change in mineralogy or fineness of clay, unless the clay in the overlying horizons is incompletely dispersed. The cation exchange capacity of the clay of the unoxidized material at 16½-17½ feet is 29.4 meq./100 g. and is much lower than that of the overlying material. This layer also has higher exchangeable potassium than the more oxidized till above. However, the exchangeable K of the upper four horizons of profile (14-2) is also quite high. Further study is needed to explain this feature.

The lack of sorting of the material in the upper horizons would tend to refute the speculation that the upper profile was developed in aeolian material (see Major Profile Features in profile description). Also, there is no evidence in the particle size distribution for a lithologic disconformity at the 13-foot depth between the oxidized and unoxidized till. In fact, the particle size distribution of the layer above and the two layers below this point are nearly identical. This indicates that the difference in the two layers is not due to depositional causes as postulated in the profile description.

The data from these profiles were compared with that of the Paxton profiles collected in New Hampshire in 1956, and it was found that the Massachusetts profiles have a higher clay content and a higher degree of base saturation, especially in the pan horizon. In general, however, the profiles from both locations are similar.

Sample number S56NH-7-1 and S56NH-7-2

There is little significant difference in the particle size distribution of these two Paxton soils. The cation exchange capacity is low in all of the mineral

[1] Interpretations, tabular data, and profile descriptions have been taken from Characterization Report, Worcester County, Massachusetts, November 1960; and Characterization Report, Merrimack, Rockingham, and Stratford Counties, New Hampshire, May 1960. Soil Survey Laboratory, Soil Conservation Service, U.S.D.A., Beltsville, Maryland.

horizons of these soils. The present base saturation is low in the Brown Podzolic portion of the profile and increases in the pan horizons. The base saturation is expected in view of their good drainage. pH values are high considering the low per cent base saturation. The free iron oxide content of these soils is low. In general, the free iron oxide content is higher in the surface and becomes constant or decreases with depth in the profile. Examination of the particle size distribution data indicates no significant difference between the friable material above the fragipans and that in the fragipan. However, the bulk density increases in the pan horizons and microscopic examination shows the main matrix of the pan is very compact, and open pore space is almost absent. Also, there are spots in which mica has parallel alignment probably due to pressure. The brittleness of the pan may be due to slight cementation caused by thinly distributed or discontinuous clay films between larger particles, with a particle size distribution conducive to close packing, permitting a high cementing capacity for the small amount of clay present.

2. Profile descriptions of characterization samples.
Paxton very stony fine sandy loam (S55Mass-14-1)

Horizon	*Depth*	
A1	0-4″	Very dark brown (10YR 2/2) very stony loam or silt loam (feels like a silt loam in comparison with texture of horizon below); weak, fine, granular structure with no tendency toward cloddiness; very friable. There is no coarse skeleton except for the 1 to 3 feet in diameter granite and schist boulders on and in the horizon. Surface has a 1 to 1½ feet micro-relief principally related to the stones rather than to previous windthrow by trees.
B21	4-9″	Dark yellowish-brown (10YR 4/4) to yellowish-brown (10YR 5/8) very friable fine sandy loam with 10 to 15 per cent coarse skeleton mostly in the ¼-2-inch diameter range. Large stones occur at distances of about 6 feet. Weak, fine granular structure with very little tendency for cloddiness or for subangular blocky structure; non-sticky, non-plastic, not distinctly micaceous. This horizon has distinctly stronger chroma than the horizon below and is a typical Brown Podzolic upper B horizon.
B22	9-16″	Dark yellowish-brown (10YR 4/4) fine sandy loam, very friable. When removed, the soil mass consists of about 20-30 per cent 1-inch subangular blocky peds, which crush very readily to a weak, very fine granular structure; 10-15 per cent coarse skeleton; not mottled, non-sticky, non-plastic, not distinctly micaceous. A lithology count of a random sample of 1-3-inch diameter fragments from the B21 and B22 horizons showed the following:

Coarse grained granites and gneisses	14
Fine grained, thin bedded, nearly black micaceous gneiss or schist (mostly flattened)	17
Quartzite or quartz	3
	34 fragments

Horizon	*Depth*	
B23	16-26″	Olive-brown (2.5Y 4/4) (slightly browner than the horizon below) gravelly fine sandy loam with a 20 to 30 per cent coarse skeleton, friable. Breaks out into 1-2-inch subangular clods or very weak subangular blocky peds which crush easily to weak fine granular structure; no pores, non-sticky, non-plastic, not distinctly micaceous.
B′21	26-34″	Olive-brown (2.5Y 4/4) fine sandy loam; firm both in place and when removed; 20 to 30 per cent coarse skeleton; moderate, medium, platy structure with peds about 1 to 1½ inches in length. A few fine glazed pores occur both on the surface and interior of the peds. Very faint dark brown (MnO_2) stains occur on a few peds. Not distinctly micaceous, non-sticky, non-porous.
B′22g	34-48″	Grayish-brown (2.5Y 3/2) gravelly loam with interior of peds olive brown (2.5Y 4/4); 20 to 30 per cent coarse skeleton; weak, medium, platy structure; firm; fine glazed pores common on exterior of plates, with fewer on the interior. Very finely micaceous, non-sticky, non-porous. Grayish-brown (2.5Y 5/2) surfaced, vertical cracks (polygon faces?) occur at distances of about 2-3 feet. These have a ¼-inch wide, dark brown (7.5YR 4/4) border. The cracks are not very distinct in this horizon, but become more distinct in the horizon below.
B′23g	48-64″	Essentially like the horizon above, but perhaps more distinctly mottled and with vertical cracks slightly more prominent. These cracks are not evident below 5 feet. Pores are less evident below 5 or 6 feet, but the consistence and structure seem to continue unchanged to the unoxidized till at 13½ feet. The grayish-brown (2.5Y 5/2) and olive-gray (5Y 5/2) mottling is not evident below 6 feet.
C11	10½-11½′	Oxidized 10½-11½ feet (24 to 36 inches above contact). Gray (5Y 5/1) and olive gray (5Y 4/2) dominant colors on the exterior of the weak very coarse, platy peds with yellowish-red (5YR 4/6) prominent discontinuous coatings on the surfaces; very firm in place and difficult to remove with a shovel, even from the side of the pit; gravelly heavy loam or slightly sandy clay loam, with 20 to 30 per cent coarse skeleton mostly in the ½-13 inches diameter range, but with stones or boulders at distances of 5 or 6 feet. Non-porous; slightly sticky and plastic; not noticeably micaceous. Brown, soft, weathered finely micaceous "ghosts" 1 to 4 inches in diameter occur at distances of 1 to 4 feet.
C12	12-13′	Oxidized 12 to 13 feet (6 to 18 inches above contact). Like the horizon above, but just above the junction.
C2	16½-17½′	Unoxidized 16½ to 17½ feet (36 to 48 inches below contact). Like the above except perhaps with coarse trapezoidal structure; non-calcareous.

Sampled: October 12, 1955, by Alexander, Coates, Reiske, and Lyford. Gallon-sized horizon samples were collected. Description by Lyford. Colors described are for moist soils.

Location: 20 to 30 feet. Deep borrow pit, west side of Route 31, one-half mile north of Charlton Depot, Worcester County, Massachusetts.

Landscape: On the lower edge of a drumlin in a pasture on about a 30 per cent slope. The area had never been plowed but has been pastured. It is cleared of brush. Subrounded stones ranging from 1 to 3 feet in diameter are very numerous on the surface occurring about 2 to 3 feet apart. This borrow pit is probably about 2 years old.

Major Profile Features:

A prominent "blue" unoxidized till is exposed at a depth of about 13½ feet. This contrasts markedly in color from the olive brown oxidized till above. The junction between the two is sharp and smooth paralleling the surface. Closer inspection showed three major features:

1) 0 to 26 inches Brown Podzolic, friable, brown and olive-brown loam upper solum.
2) 26 inches to 13½ feet olive-brown, firm to very firm, platy stony loam middle sequence.
3) 13½ to 20 feet "blue" very firm, nearly massive stony till, which seems to have more clay than the material above.

There was some speculation *for* and *against* three different deposits corresponding to the above three profile features. Those *for* suggested that the upper solum might have some aeolian component, and the lower blue till might be of an earlier age. Those *against* suggested that all three features are common to Paxton soils and are seen if a deep pit is available, and the differences can be explained by development from one single deposit.

Paxton fine sandy loam (S55Mass-14-2)

Horizon	*Depth*	
Ap	0-8″	Very dark brown (10YR 2/2) very friable loam (about central for loam textures in New England) with 5 to 10 per cent coarse skeleton; weak, moderate, medium and fine granular structure. Earthworms common and nightcrawlers numerous; the nightcrawlers penetrate vertically down to 24 to 30 inches but cause essentially no mixing in the B21 horizons.
B21	8-14″	Olive-brown (2.5Y 4/4) and dark yellowish-brown (10YR 4/4) friable, gravelly loam with 10 to 20 per cent coarse skeleton. As broken out, 30 per cent of the material has a very weak, coarse subangular blocky structure, and 70 per cent weak fine granular structure. A few fine non-glazed pores occur in the blocky peds.

Horizon	*Depth*	
B22	14-22″	Olive-brown (2.5Y 4/4) friable gravelly loam, with 20 to 30 per cent coarse skeleton; very weak, moderate, platy structure with a very few glazed pores. A few brown soft weathered finely micaceous ghosts occur. These may not be limestone ghosts. The soil to 22 inches was dug fairly easily with a shovel, but a pick was also used.
B′21	22-32″	Olive-brown (2.5Y 4/4) firm sandy loam with 15 to 20 per cent coarse skeleton; weak, moderate, coarse platy structure with fine glazed pores common and prominent. This material felt sandy when first rubbed between the fingers but after some rubbing, felt like a loam. A pick was used to loosen the material in this horizon and in those below.
B′22	32-41″	Like the horizon above, but deeper water runs in from the side of the hole at about 22 inches; seems to come in more rapidly above 41 inches.
C1g	41-48″	Olive-brown (2.5Y 4/4), dominantly, with about 20 per cent olive-gray (5Y 5/2) and olive (5Y 5/3) faint mottling on and in the peds; heavy loam to light sandy clay loam till with 15 to 20 per cent coarse skeleton. Firm at this moisture, but Reiske had dug a hole 100 feet away when the soil was dry and found this horizon to be very firm and very difficult to remove. Weak to moderate medium platy structure with a few faint glazed pores visible on the peds.
C2	48-55″	Olive-brown (2.5Y 4/4) faintly mottled with olive-gray (5Y 5/2) and olive (5Y 5/3) very firm, heavy loam to sandy clay loam with 15 to 20 per cent coarse skeleton in the ½ to 3-inch range; massive or perhaps very weak, coarse, platy structure; no pores and no glazes. Brown micaceous ghosts 1 to 2 inches in diameter are fairly common. Finely micaceous. *Lithology* determination on 1 to 3 inch coarse fragments taken at random from pile of soil by the pit:

Black fine grained thin bedded gneiss or schist	12
Granitoid	10
Quartz or quartzite	1
	23 fragments

Sampled: October 12, 1955, by Alexander, Coates, Reiske, and Lyford. Gallon-sized horizon samples were collected. Soil wet when sampled and water seeped into hole. Hole was dug in the field at the time of sampling. Description by Lyford.

Location: Field opposite intersection of Dresser Hill Road and Route 31, Charlton, Worcester County, Massachusetts. Dress Hill Farm.

Landscape: Eight per cent slope on easterly side of drumlin in a long field 200 to 300 feet north of a stone wall.

Major Profile Features:

1) 0 to 22 inches—Brown Podzolic upper solum.
2) 22 to 41 inches—firm platy B2 horizons.
3) 41 to 55 inches—firm mottled C2 horizons.
4) Olive-brown color and loam or fine sandy loam throughout.
5) Coarse skeleton mostly subrounded. Material a till.

Paxton fine sandy loam (S56NH-7-1)

Horizon	*Depth*	
Ap	0-9″	Dark brown (10YR 3/3, moist) fine sandy loam with 5 to 10 per cent coarse skeleton; weak, medium, subangular blocky clods breaking to weak, fine, granular structure; very friable; very many fine roots; strongly acid; clear and wavy boundary. 8 to 10 inches thick.
B21	9-15″	Light olive-brown (2.5Y 5/4, moist) fine sandy loam with 10 to 20 per cent coarse skeleton; weak, medium, subangular blocky clods averaging 1 to 2 inches in size; friable; many fine to medium roots; medium acid; clear and wavy boundary. 5 to 6 inches thick.
B22	15-21″	Olive-brown (2.5Y 4/4, moist) fine sandy loam with 20 to 25 per cent coarse skeleton; weak, medium, subangular blocky clods averaging 1 inch in size; friable; many fine to medium roots; medium acid; clear and wavy boundary. 5 to 7 inches thick.
B3	21-25″	Olive-brown (2.5Y 4/4, moist) fine sandy loam with 5 to 10 per cent coarse skeleton; weak, medium, subangular blocky clods averaging 1 inch in size breaking to weak, fine, granular structure; friable; few roots; medium acid; abrupt and wavy boundary. 3 to 5 inches thick.
B′21m*	25-34″	Olive-brown (2.5Y 4/4, moist) loam with 25 to 35 per cent coarse skeleton; moderate, coarse, platy structure; peds have gray-brown coating (2.5Y 5/2, moist) on outside with interior being olive-brown (2.5Y 4/4, moist); fine glazed pores common on outside of plates; very firm; no roots; pocket of fine sand occurred at 25 inches depth (approximately 8 inches deep by 14 inches wide) not sampled as part of horizon; medium acid; diffuse boundary. 8 to 10 inches thick.
B′22m*	34-43″	Dark gray-brown (2.5Y 4/2, moist) loam with 25 to 35 per cent coarse skeleton; moderate, coarse, platy structure; gray-brown coatings (2.5Y 5/2, moist) on outside of peds with strong dark brown (MnO_2) stains on many peds; fine glazed pores common on outside of plates; very firm; no roots; medium acid; arbitrary boundary.
B′23m*	43-52″	Similar description to B′22m horizon.

* Arbitrary subdivision made for sampling purposes.

Sampled: July 19, 1956, by A. Dickason, E. Hutchinson, A. D. Hamilton, D. van der Voet, E. J. Pedersen, and L. E. Garland. Approximately 15-pound samples were collected from each mineral horizon for mechanical and chemical analysis by the Soil Conservation Service and New Hampshire Agricultural Experiment Station. Description by van der Voet and Garland.

Location: Northfield, Merrimack County, New Hampshire, approximately three-fourths of a mile east of Hart Hill on the Usilka Farm. The pit was dug in a hayfield approximately 200 feet east of town road (dirt) and about 300 yards north of farmhouse.

Landscape: On the top of a broad drumlin with slope averaging 3 per cent. The area has been plowed in the past but the present hay stand indicates infrequent cultivation.

Major Profile Features:

1) 0 to 25 inches—Brown Podzolic upper solum.
2) 25 to 52 inches—firm platy B′ horizons (question as to whether they are B′ or C horizons).
3) Dominantly olive-brown color and fine sandy loam or loam texture throughout.
4) Glacial till material.

Paxton fine sandy loam (S56NH-7-2)

Horizon	*Depth*	
Ap	0-7″	Dark brown (10YR 3/3, moist) fine sandy loam with 5 to 10 per cent coarse skeleton; weak, fine, granular structure; very friable; many very fine roots; strongly acid; clear wavy boundary, 6 to 7 inches thick.
B21	7-12″	Dark yellowish-brown (10YR 4/4, moist) fine sandy loam with 5 to 10 per cent coarse skeleton; weak, medium, subangular blocky clods ½ to 1½ inches in size, breaking to weak, fine granular; friable; many fine roots; medium acid; clear wavy boundary. 5 to 7 inches thick.
B22	12-17″	Olive-brown (2.5Y 4/4, moist)fine sandy loam with 15 to 25 per cent coarse skeleton; weak medium subangular blocky clods ½ to 1½ inches in size breaking to weak fine granular structure; many fine to medium roots; medium acid; abrupt and wavy boundary. 4 to 6 inches thick.
A′2m	17-21″	Olive (5Y 5/3, moist) fine sandy loam with 15 to 25 per cent coarse skeleton; weak, medium, platy structure; clean sandy particles around plates indicating strong possibility of eluviation in down slope movement through this horizon.
B′21m*	21-33″	Olive-gray (5Y 4/2, moist) fine sandy loam with 15 to 25 per cent coarse skeleton; moderate fine, platy structure; peds have gray-brown coatings (2.5Y 5/2, moist) on exterior surfaces; fine glazed pores common on outside of plates; firm, few roots; medium acid; diffuse boundary. 12 inches thick.

Horizon	*Depth*	
B′22m*	33-45″	Olive (5Y 4/3, moist) fine sandy loam with 20 to 30 per cent coarse skeleton; moderate fine platy structure; peds have gray-brown coatings (2/5Y 5/2, moist) on exterior surfaces; fine glazed pores common on outside of plates; firm; no roots; medium acid.
B′23m*	45-60″	Olive (5Y 4/3, moist) fine sandy loam with 20 to 30 per cent coarse skeleton; moderate, fine, platy structure; peds have gray-brown coatings (2.5Y 5/2, moist) on exterior surfaces; fine glazed pores common on outside of plates; firm; no roots; medium acid.
Sampled:		July 20, 1956, by A. Dickason, E. Hutchinson, A. D. Hamilton, D. van der Voet, E. J. Pedersen and L. E. Garland. Approximately 15-pound samples were collected from each mineral horizon for mechanical and chemical analysis by the Soil Conservation Service and New Hampshire Agricultural Experiment Station. Description by van der Voet.
Location:		Franklin, Merrimack County, New Hampshire. Pit dug in hay pasture field on L. L. Leighton Farm on east side of East Pleasant Street one quarter of a mile south of farm house. Pit approximately 500 yards from crest of hill.
Landscape:		On the northeast slope of drumlin with average slope of 4 per cent at sample spot. The area has been disturbed by plowing and grazing cattle.

Major Profile Features:

1) 0 to 22 inches—Brown Podzolic upper solum.
2) 22 to 60 inches—firm platy B′ horizons (question as to whether these horizons are B′ or C horizons).
3) Dominantly fine sandy loam texture throughout.
4) Glacial till material.

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* Arbitrary subdivision of the B′ horizons for sampling purposes except for slight color change and absence of roots in two lower horizons.

Physical, chemical, and mineralogical properties of Paxton fine sandy loam, Connecticut (25)

Soil profile description

Ap	0-8″	Very dark grayish-brown (10YR 3/10)* fine sandy loam, firm in place and friable when removed; granular structure 0 to 3 inches changing into medium subangular blocky at 3 to 8 inches which breaks down into a granular mass when crushed. Worm channels present throughout horizon. Several yellowish-brown subsoil fragments incorporated in the lower part. No evidence of grit, but small stone fragments 1 cm. in diameter abundant. Grass roots numerous. pH 5.8.

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* Munsell color notation of moist soil.

Horizon	*Depth*	
B21	8-14″	Yellowish-brown (10YR 5/8) fine sandy loam, very weak medium subangular blocky structure 8 to 11½ inches; 11½ to 14 inches very weak coarse subangular blocky. From 8 to 10½ inches considerable incorporation of organic matter in worm channels; below 10½ inches worm channels seem to be absent, but root channels are abundant. Rock composition is variable; about 5 to 10 per cent of the fragments are chert and quartz from gneissic and granitic rocks, most of them very angular; the larger fragments originate from hornblende and garnet-chlorite varieties of schists and are in a moderate state of weathering. The larger fragments of schist are oriented at random. pH 5.9.
B22	14-19″	Light olive-brown (2.5Y 5/6) fine sandy loam, very weak coarse subangular blocky structure; firm in place and friable when removed. Rock fragments of schist, diabase, and granite make up about 5 to 10 per cent of the coarse materials. Many roots extend to this horizon but few penetrate deeper. pH 6.0.
B3	19-25″	Olive (5Y 5/4) gritty fine sandy loam, more compact in place than the overlying horizon, but friable when removed. Rock fragments of same composition as in B22 make up about 5 to 10 per cent of the materials. Virtually no roots penetrate deeper than 25 inches. pH 6.0.
Cm	25-45″	Olive-gray (5Y 5/2) compact fine sandy loam. Percentage of gravel up to 2 cm. in diameter (25 per cent by volume) considerably higher than in overlying horizon. This material is firm till, which at the time of sampling was thought to be less compact than the Paxton till but later was found to be just as compact. Most of the flat rocks and boulders lie horizontally, but the smaller rock fragments are randomly oriented. The systematic orientation of boulders indicates some compression of these materials while the till was still friable. The sharp difference between the B and C horizons suggests differential depositional environments rather than differential weathering. Both fresh and altered materials make up the material below 25 inches. Drainage conditions below 30 inches are poor and some mottling shows up in places. Boulders and stones are not uniformly distributed within the finer materials. pH 6.2.
D1	45-70″	Olive (5Y 5/4) fine sandy loam. This material is different in appearance from the overlying horizon. It is loose and crumbles readily into medium subangular blocky fragments. The general trend of structure is toward platiness but not regularly so; a discontinuity in the structural pattern suggests some kind of disturbance after the original platy structure was developed. Very peculiar forms of dark brown rusty spots occur as circular lenses 1 to 3 mm. in diameter and as shreds between irregular plates; these were found to be weathered garnets. This intricate pattern of weathered

Table 5. Mechanical analysis of Paxton fine sandy loam[1] (25)

				Soil class and diameter of particles in mm.							
Horizon	Depth	Acidity	Organic carbon	Very coarse sand 2-1	Coarse sand 1-0.5	Medium sand 0.5-0.25	Fine sand 0.25-0.1	Very fine sand 0.1-0.05	Coarse silt 0.05-0.02	Med. and fine silt 0.02-0.002	Clay <0.002
	inches	pH	%	%	%	%	%	%	%	%	%
Ap	0-8	5.8	3.03	5.2	7.0	6.6	20.4	15.1	10.5	16.1	10.1
B21	8-14	5.9	0.89	5.1	7.4	7.3	22.0	15.8	20.3	16.4	5.7
B22	14-19	6.0	0.42	6.1	8.5	7.7	24.0	16.6	17.8	15.0	4.3
B3	19-25	6.0	0.22	6.1	8.0	7.8	23.8	16.9	14.8	14.5	8.1
C	25-45	6.2	0.12	5.8	10.0	9.5	27.0	17.4	12.9	11.5	5.9
D1	45-70	6.4	0.03	5.4	9.4	8.6	25.7	16.7	12.4	13.6	8.2
D2	70-85	6.2	0.10	5.6	12.3	10.9	27.3	16.6	11.9	10.7	4.7
D3	85-91	6.4	0.02	5.8	11.0	10.2	27.4	16.3	11.9	10.9	6.5

[1] Mechanical analysis data by the Agricultural Research Service, Beltsville, Maryland.

Table 6. Chemical analysis and heating weight-loss data for the clay fractions of Paxton fine sandy loam (25)

Size	Horizon	Depth	Oxides											Total	"Free" Fe_2O_3
			SiO_2	Al_2O_3	Fe_2O_3	TiO_2	K_2O	MgO	200°C. H_2O	300°C. H_2O	400°C. H_2O	600°C. H_2O	900°C. H_2O		
μ		inches	%	%	%	%	%	%	%	%	%	%	%	%	%
2-0.2	Ap	0-8	34.6	32.1	11.1	0.90	1.96	2.58	5.20	4.77	2.82	3.75	1.12	100.9	....
	B21	8-14	34.6	31.5	11.6	0.98	2.29	2.94	4.12	4.70	3.54	1.55	1.50	99.3	7.5
	B22	14-19	38.9	28.8	9.6	0.73	2.73	3.59	4.58	3.43	3.10	2.47	1.05	99.0	2.8
	B3	19-25	45.1	27.8	9.6	0.60	3.58	4.30	2.24	1.95	1.56	2.88	1.26	97.2	1.8
	C	25-45	42.1	27.9	10.3	0.42	3.92	4.24	1.56	0.89	2.32	3.54	1.39	98.5	3.2
	D1	45-70	42.8	27.3	9.3	0.43	4.45	4.08	0.72	0.43	2.80	3.72	1.78	97.8	2.8
	D2	70-85	41.4	27.6	11.5	0.46	4.41	4.58	2.58	1.64	1.78	3.19	0.94	100.1	....
	D3	85-91	48.9	25.8	10.4	0.38	4.90	4.16	0.51	0.50	1.26	3.73	1.16	100.7	4.7
<0.2	Ap	0-8	26.8	31.5	13.5	1.52	1.21	1.66	3.54	10.40	3.88	3.37	1.18	98.7	11.2
	B21	8-14	29.7	33.6	13.6	1.63	1.48	1.95	3.17	8.46	3.39	3.26	0.94	100.1	11.7
	B22	14-19	28.6	30.1	11.1	1.38	1.97	2.11	5.79	10.20	4.08	2.87	0.79	99.0	9.0
	B3	19-25	39.6	28.3	16.2	1.45	1.78	3.76	1.23	3.78	1.96	3.19	0.88	100.7	14.5
	C	25-45	40.0	30.7	13.9	0.90	2.07	2.14	1.18	2.41	2.36	4.83	0.82	101.3	11.9
	D1	45-70	40.9	27.7	13.7	0.73	2.41	2.22	0.91	1.95	2.06	5.26	0.85	98.7	11.1
	D2	70-85	37.8	28.1	15.0	1.04	2.53	2.79	2.28	3.49	2.52	3.30	0.83	99.7	11.7
	D3	85-91	38.7	22.5	21.0	0.86	3.13	2.89	1.85	2.05	1.45	3.62	0.76	98.8	17.6

Horizon	*Depth*	
		garnets is imprinted on stones. Many micaceous mineral fragments (muscovite and chlorite) were noticed in the gravels of this material. The water table was found at 70 inches. pH 6.4.
D2	70-85″	Sample taken with an auger. pH 6.2.
D3	85-91″	Sample taken with an auger. pH 6.4.
Location:		Agronomy plots, University of Connecticut, Storrs; Plot G3, southwest corner in roadway (pit).
Topography:		Drumloidal hill; slope 2 per cent.
Vegetation:		Hay.

Table 7. Total free oxide content of Paxton fine sandy loam[1] (25)

Horizon	Depth	Oxides SiO_2	Fe_2O_3	Al_2O_3	MnO	Total
	Inches	%	%	%	%	%
Ap	0-8	0.65	1.75	2.67	0.04	5.11
B21	8-14	0.75	1.61	2.26	0.02	4.64
B22	14-19	0.85	1.16	1.85	0.01	3.87
B3	19-25	0.75	1.38	2.40	0.01	4.54
C	25-45	0.49	1.52	1.44	0.02	3.47
D1	45-70	0.53	1.79	0.74	0.02	3.08
D2	70-85	0.65	1.17	1.88	0.02	3.72
D3	85-91	0.43	1.45	1.44	0.02	3.34

[1] Average of duplicate 2.0 g. samples of <2 mm. soil. Determination methods by Jeffries, C. D., 1946. "A Rapid method for the removal of free iron oxides in soils prior to petrographic analysis." Soil Sci. Soc. Amer. Proc. (1945) 11:211-212.

SOIL FERTILITY

The natural fertility of Paxton soils is low. Soil nutrients, slowly released from weathering minerals, are leached from the upper soil horizons and are removed by subsurface drainage. Acid soils are produced as the cations are replaced by hydrogen on the exchange sites. The cation exchange capacities of the B and C horizons range from 5 to 13 milliequivalents per 100 grams of soil (Table 4). The exchange capacities of the A horizons range from 18 to 41 milliequivalents per 100 grams of soil; the result of increased organic matter. The pH values range from 4.5 to 5.5 in the sola and are greater than 5.5 in the substrata.

Crops grown on Paxton soils respond well to lime and fertilizer. At the Agronomy Research Farm, Storrs, Connecticut, highest yields of alfalfa were obtained when the plow layer was limed to raise the pH to 7.0; however, satisfactory yields were obtained when one-third the amount was applied. Lime penetrates the subsoil following prolonged application. After 17 years, applica-

Table 8. Mineralogical content of the clay fractions of Paxton fine sandy loam[1] (25)

Size	Horizon	Depth	Qr.	Fl.	Chl.	Ill.	Interst. Ill. Verm.	Verm.	Mont.	Kl.	Gb.	Hm.	Total
μ		Inches	%	%	%	%	%	%	%	%	%	%	%
2-0.2	Ap	0-8	< 5	< 5	< 5	30	....	30	0	10	5	5	< 95
	B21	8-14	< 5	< 5	< 5	25	15	20	0	10	5	5	< 100
	B22	14-19	< 5	< 5	< 5	30	20	15	0	10	0	3	< 93
	B3	19-25	< 5	....	< 5	30	35	10	0	10	0	2	< 97
	C	25-45	< 5	....	< 5	30	45	5	0	10	0	3	< 103
	D1	45-70	< 5	....	....	40	45	0	0	10	0	3	< 103
	D2	70-85	< 5	....	....	40	45	0	0	< 10	0	....	< 100
	D3	85-91	< 5	< 5	....	45	45	0	0	5	0	5	< 100
>0.2	Ap	0-8	0	0	0	20	....	45	0	....	10	10	85
	B21	8-14	0	0	0	25	....	45	0	....	< 10	10	< 90
	B22	14-19	0	0	0	20	15	40	0	....	5	10	< 90
	B3	19-25	0	0	0	20	45	10	0	....	0	15	< 90
	C	25-45	0	0	0	15	50	5	0	....	0	10	< 80
	D1	45-70	0	0	0	15	60	0	0	....	0	10	85
	D2	70-85	0	0	0	20	60	0	0	....	0	10	90
	D3	85-91	0	0	0	25	50	0	0	....	0	15	90

[1] Norelco geiger counter was used for oriented samples and a 114.59 mm. diameter camera for unoriented specimens. Qr.=quartz; Fl.=feldspars; Chl.=chlorite; Ill.=illite; Interst.=interstratified; Verm.=vermiculite; Mont.=montmorins; Kl.=kaolin; Gb.=gibbsite; Hm.=hematite; Zero=absence of mineral; Dash=presence of mineral is doubtful.

tions of lime totaling 7 to 10 tons increased the pH of the layer 8 to 12 inches deep to the same level as the 0 to 8-inch layer. The pH of the layer 24 to 30 inches deep was also appreciably affected (6). Light applications over prolonged periods or heavy single applications are necessary to raise the pH levels of lower horizons. A single application of 2 tons of lime per acre only temporarily raises the pH of surface horizons (7).

Plant nutrient deficiencies can be corrected by fertilization and manuring. Most of the potash in Paxton soils is found in the crystal structure of biotite and the potash feldspars. Little is available to the plant in exchangeable form.

Annual application of 180 pounds of potash (K_2O) per acre was found to be desirable for long-lived, high-yielding stands of alfalfa. Exchangeable phosphorus, also low in Paxton soils, may be added as superphosphate or other phosphorus carrying compounds. Nitrogen is also a limiting factor in the growth of most forage and pasture crops. The amount and grade of fertilizer added depend upon the crop grown and past fertilization. Nutrient deficiencies may be assessed by laboratory tests.

Boron deficiencies in Paxton soils have been demonstrated at the Agronomy Research Farm, Storrs, Connecticut. Borax added at 20 pounds an acre corrected deficiencies in alfalfa for 5 years (8). Boron deficiency symptoms in alfalfa should not occur as long as 0.7 parts per million available boron is present in the soil.

Poor plant growth on Paxton soils may occur if fragipan horizons are near the surface. Root penetration is restricted by the fragipan. Subsoiling effectively breaks up plow soles formed by intensive cultivation; however, no ways have been found to break up the deep, compact fragipan (26).

AIR AND MOISTURE REGIMES

Non-capillary porosity decreases below the B3 horizon, coinciding with an increase in bulk density in the fragipan (Table 9). There is also evidence of a weak plow pan at a depth of 8 to 10 inches. Capillary porosity also decreases

Table 9. Physical properties of a Paxton fine sandy loam (3)

Horizon	Depth of sample	Specific gravity	Bulk density	Porosity: Capillary	Porosity: Non-capillary	Porosity: Total
	Inches		g/cc.	%	%	%
Ap	0-2	2.56	0.99	43.3	18.6	61.9
Ap	2-4	2.53	1.04	46.2	22.5	58.7
Ap	5-7	2.56	1.13	39.5	16.3	55.8
B21	8-10	2.60	1.20	37.2	16.6	53.8
B21	11-13	2.60	1.16	35.4	18.7	55.3
B22	14-16	2.57	1.30	37.0	12.3	49.4
B22	17-19	2.61	1.36	35.0	13.4	47.8
B3	20-22	2.62	1.43	31.5	12.2	45.5
B3	23-25	2.63	1.59	32.4	7.0	39.4
C	32-34	2.63	1.67	31.2	5.5	36.7
C	38-40	2.62	1.80	30.3	4.5	31.6
C	43-45	2.59	1.82	30.9	1.7	29.7
D1	49-51	2.58	1.81	30.6	2.7	30.3

at the top of the B3 horizon, but it is more gradual than the decrease in non-capillary porosity. The compaction of the fragipan horizons and clogging of many non-capillary pores with fine silt and clay accounts for the change in pore size distribution. Field observations show normal root penetration being limited by the fragipan. Penetration of the fragipan by roots occurs only through vertical cracks in the fragipan (18).

The release of moisture from Paxton fine sandy loam (S56NH-7-1) from Merrimack County, New Hampshire, was determined by the Agronomy Department, University of New Hampshire (Table 10) (21). By assigning average bulk densities for the major horizons, the inches of available moisture can be estimated. Fifty-two inches of soils would contain nearly 7.9 inches of available moisture. About half the total, or 3.9 inches, was stored above the fragipan; about 4.0 inches below the fragipan. This is 2 inches per foot of solum or fragipan. These estimates compare with average available moisture storage capacities in Connecticut soils with fine sandy loam textures (15).

Table 10. Moisture release in a Paxton fine sandy loam in Merrimack County, New Hampshire (21)

		Water by weight at suction of						
Horizon	Depth inches	% at .1 atm.	% at .33 atm.	% at .66 atm.	% at 5 atm.	% at 15 atm.	% by wt. available moisture	Approx. in. of avail. water[1]
Ap	0-9	26.9	19.5	16.5	10.4	8.6	10.9	1.3
B21	9-15	26.0	14.9	12.2	7.4	5.0	9.9	0.9
B22	15-21	24.8	15.8	12.8	7.3	4.5	11.3	1.0
B3	21-25	21.6	16.1	13.1	7.0	4.2	11.9	0.7
B'21m	25-34	17.2	12.7	11.2	7.4	4.7	8.0	1.3
B'22m	34-43	20.5	14.1	11.4	8.0	5.8	8.3	1.3
B'23m	43-52	18.4	13.6	11.5	7.2	5.0	8.6	1.4

[1] Bulk densities not given. Assumed average bulk density of 1.30 for the Ap horizon; 1.45 for the B horizons; 1.80 for the fragipan horizons (B').

Permeability rates for Paxton soils are not available. Estimates may be made, however, from Wethersfield soils formed on compact glacial till derived from red Triassic sandstone and shale. Permeabilities of modal Paxton sola are between 0.63 and 2.0 inches per hour; substrata permeabilities are between 0.02 and 0.63 inches per hour. Profiles intergrading to Charlton soils may have sola permeabilities up to 6.3 inches per hour and substrata permeabilites up to 2.0 inches per hour. Water percolating through Paxton soils is largely restricted by the impervious fragipan. Water accumulates over the fragipan and forms temporary or perched water tables in late fall and early spring. Water moves downslope over the fragipan and may seep out on slopes if the pan is shallow. Seeps may be difficult to manage.

Faint mottles in the upper fragipan horizon indicate poor aeration during saturation with water. A steady flow of water does not, however, appear to affect adversely root development above the fragipan. The vertical cracks forming a rough polygonal pattern in the fragipan permit some seepage of water into the till and eventually to the deeper, permanent water table.

In the early spring, the accumulation of water over the fragipan causes the soils to warm and dry later than well drained soils that do not have fragipans. Tillage may be delayed as much as 2 weeks.

In the woods, water tables remain high in the early spring. When the trees come into leaf, however, the transpiration of water from the leaves lowers the water tables rapidly.

CROP YIELDS—EXPERIMENTAL PLOTS

Many crop research plots at the Agronomy Research Farm of the Storrs Agricultural Experiment Station are located on Paxton soil.[1] The yields of various crops grown on these plots are summarized and/or tabulated in this section.

1. *Potassium fertilization of Ladino clover. (4)*

A 6-year study of potassium fertilization was conducted on a potassium-deficient soil. Yields were related to the time of application, the amount applied, and the influence of dolomitic limestone. Small, frequent potassium applications

[1] Early publications named this soil Charlton loam or fine sandy loam. After 1955 the soil was tentatively called Paxton loam. In 1960 final correlation with Paxton loam was established.

Table 11. The influence of rate and time of potassium fertilization on yields of Ladino clover (4)

Potassium applied lb./A.			Year Total yields of dry matter (cwt. per acre)						
Plowed under May 1949	Disked in Aug. 1949	Yearly 1950-1955	1950	1951	1952	1953	1954	1955	Average 6 years
300	300	0	60	64	53	44	37	28	48
150	150	100[1] all after 2nd cutting	72	64	41	36	43	51	51
0	50	50 all after 2nd cutting	57	56	44	40	40	38	46
0	100	100 all after 2nd cutting	55	62	52	50	53	56	55
0	100	100 ¼ after each 4 cut.	61	71	57	61	59	59	61
0	150	150 all after 1st cutting	70	67	62	60	59	53	62
0	150	150 all after 2nd cutting	66	71	62	68	57	61	64
0	150	150 all after 3rd cutting	64	59	56	58	60	52	58
0	150	150 all after 4th cutting	67	66	57	59	48	53	58
0	200	200 all after 2nd cutting	68	74	65	64	56	53	61
0	200	200 ¼ after each 4 cut.	61	70	61	60	60	56	61

[1] None applied in 1950, 1951, 1952.

Table 12. Interactions of limestone and potassium fertilization on yields of Ladino clover-orchard grass (4)

Limestone in 1949[1] tons per acre	Total yields of dry matter (cwt. per acre)						Average 6 years
	1950	1951	1952	1953	1954	1955	
	Potassium at 600 pounds before seeding						
1	66	71	56	53	44	31	54
2	60	64	53	44	37	28	48
4	72	71	62	52	36	27	53
8	73	64	61	50	48	43	57
Average	68	68	58	50	41	32	53
	Potassium at 300 pounds before seeding in 1949 100 pounds each July in 1953, 1954, 1955						
2	72	64	41	36	43	51	51
4	64	60	43	31	46	48	49
8	75	66	41	33	43	52	52
Average	70	63	42	33	44	50	50
	Potassium at 100 pounds each July						
1	64	61	53	50	53	51	55
2	55	62	52	50	53	56	55
4	59	66	58	51	55	56	60
8	69	66	59	51	60	56	60
Average	62	64	56	51	55	55	57

[1] The limestone was disked in before seeding in August 1949. At the 4 and 8 ton rates, half was plowed under in May 1949.

produced greater yields than large, infrequent applications. Increments applied after four annual cuttings produced highest yields. This was related to luxury consumption of potassium in the presence of heavy applications of dolomitic limestone (Tables 11, 12).

2. *Corn silage experiments on Paxton loam. (1)*

Continuously grown corn (Variety U.S. 13) was compared with silage corn in a 5-year rotation with oats, clover-timothy, and timothy. In ten years, continuous cropping with corn reduced organic matter in the plow layer from 4.7 to 3.5 per cent. Continuous corn plots receiving 20 tons of manure annually maintained the original organic matter levels, as did rotation corn without the benefit of manure.

Continuous corn responded more to nitrogen fertilization as organic matter decreased. The average yields of dry matter were 9,800, 10,700, 12,400, and 12,600 pounds per acre for 25, 50, 100, and 200 pounds per acre of nitrogen, respectively. On the rotation plots, the response to nitrogen was less than that of continuous corn. The variation in yields was less with phosphorus than nitrogen. The yields of dry matter were 11,000, 11,200, 11,900, 12,600 for 25, 50, 100, and 200 pounds per acre of P_2O_5 on the continuous corn plots.

Response to potash for these same years was 10,600, 11,600, 12,200, and 12,600 pounds of dry matter per acre for 25, 50, 100, and 200 pounds per acre of K_2O. Higher potash levels than phosphorus are required for increased yields of corn silage.

3. *Potassium and boron fertilization of alfalfa. (8)*

A study of five rates of potash application on alfalfa indicated yield variations were not significant between large, infrequent, single treatments applied before seeding and the same amount applied as small increments (Table 13). Small amounts of potash topdressed two or three times each season gave yields similar to one early application. Boron deficiencies were corrected for 6 years

Table 13. The effect of large infrequent, and small frequent potash applications on the yields of alfalfa[1] (8)

Treatment number[2]	Consecutive cuttings (1942, 1943, 1944) 1st	2nd	3rd	4th	5th	6th	Total
	Dry matter (cwt. per acre)[3]						
1	30	24	38	21	28	19	160
2	28	23	37	20	29	21	158
3	29	21	36	18	24	19	147
4	25	19	35	20	26	19	144
5	26	23	36	20	28	19	152

[1] Average results of four replicates.
[2] Treatments were:
1. K_2O at 360 pounds before seeding in August 1941.
2. K_2O at 240 pounds before seeding, plus 120 pounds in August 1943.
3. K_2O at 120 pounds in August 1941, 1942, 1943.
4. K_2O at 60 pounds in August 1941, June and August 1942, 1943, June of 1944.
5. K_2O at 40 pounds in August 1941, April, June and August 1942 and 1943, and April and June 1944.

[3] Includes volunteer grasses.

following one borax application of 20 pounds per acre. Borax did not prolong stands or increase alfalfa yields except for heavily limed soils (Tables 14, 15).

4. *Band versus broadcast fertilization of alfalfa. (5)*

Seedling growth of alfalfa was greater with banded superphosphate than equivalent amounts broadcast. Subsequent yields did not differ significantly (Table 16). Muriate of potash did not benefit establishment of alfalfa but was effective in maintaining stands and yields (Table 17).

5. *Permanent pastures. (9)*

The effects of various treatments on the production of permanent pastures were studied for 30 years on Paxton loam at the Storrs Agronomy Farm. Improvements were obtained with superphosphate alone and were substantially greater with superphosphate and lime (Table 18). Potassium was less effective when added alone or with other minerals. Nitrogen fertilizers, in addition to superphosphate, limestone, and potash, increased forage production equivalent to one ton of grain at one-fourth the cost (1).

Table 14. Boron fertilization of alfalfa[1] (8)

Fertilization[2]	Seeding of August 1938		Seeding of August 1941		
	1939	1940	1942	1943	1944
	Dry matter, cwt. per acre				
M	41	45	51	61	60
KP	44	40	50	56	48
KP and B	44	40	53	57	53
KPL and B	45	45	56	62	61
KP and BB	....	....	50	55	49

[1] Limestone at 7.5 or 9.0 tons had been applied between 1914 and 1929, but none since 1929 unless stated under fertilization.
[2] M—Manure at 10 tons annually, except 1940.
K—60% KCl at 200 lbs. annually, except 1940.
P—40% superphosphate at 200 lbs. in 1938 and 47% superphosphate at 300 lbs. in 1941.
L—Limestone at 1 ton in 1938 and 1941.
B—Borax at 20 lbs. in 1938.
BB—Borax at 20 lbs. both 1938 and 1941.

Table 15. Boron on heavily limed soils[1] (8)

Borax added in 1941 lbs. per acre	Available Boron in soil 1942 ppm.	Dry matter—Ave. 1942-1944 (cwt. per acre)[2]	
		Hydrated lime	Carbonated lime
0	0.52	56	60
20	1.04	60	62
40	1.26	60	62
80	1.67	58	63

[1] The pH of the soil in 1942: with hydrated lime, 6.75; with limestone, 6.39.
[2] Dry matter yields include any volunteer grasses which were more prevalent on the plots without borax.

Table 16. Effects of rates and placement of superphosphate (46%) on yields of alfalfa[1] (5)

Superphosphate (46%) applied when seeded		Total dry matter (cwt./A.)				
lbs./A.	Placement	1955	1956	1957	1958	Average
0	....	62	59	52	65	60
90	Disked 4″ deep	55	65	53	73	62
90	Disked 2″ deep	57	64	54	69	61
90	Banded[2]	59	71	58	68	64
180	Disked 4″ deep	61	68	54	69	63
180	Disked 2″ deep	62	66	55	67	63
180	Banded[2]	60	61	51	69	60
360	Disked 4″ deep	65	65	56	74	65
360	Disked 2″ deep	61	68	55	68	63
360	Banded[2]	65	60	48	66	60
720	Disked 4″ deep	68	64	61	70	66
720	Disked 2″ deep	70	67	56	69	66
720	Banded[2]	64	59	58	73	64
360	Banded[3]	60	63	53	66	61

1 Seeded July 21, 1954, with 10 lbs. Buffalo alfalfa per acre. Paxton loam tested "medium" available phosphorus before present fertilization. Seed was drilled ½ inch deep. In the last treatment, it was broadcast and covered by cultipacking. All data are averages of quadruplicate plots.

2 Banded 1.5 inches below seed with grain drill.

3 Seed broadcast.

Table 17. Effects of rates and placements of muriate of potash (60 per cent) on yields of alfalfa[1] (5)

Muriate of potash (60%) applied before or at seeding		Total dry matter (cwt./A.)			
lbs./A.	Placement	1955	1956	1957	Average
0	....	58	51	41	50
50	Disked 4″ deep	66	53	42	54
50	Disked 2″ deep	70	54	48	57
50	Banded[2]	66	56	44	56
100	Disked 4″ deep	70	58	52	60
100	Disked 2″ deep	62	55	51	56
100	Banded[2]	70	60	48	59
200	Disked 4″ deep	69	57	48	58
200	Disked 2″ deep	75	61	50	62
200	Banded[2]	70	64	60	65
400	Disked 4″ deep	70	65	57	64
400	Disked 2″ deep	72	66	52	63
400	Banded[2]	71	68	59	66
200	Banded[3]	72	60	52	61

1 All data are averages of quadruplicate plots.

2 Placed 0.5 inches below seed with grain drill.

3 Seed broadcast.

Table 18. Effects of fertilization treatments on the production of permanent pasture grasses 1924-1954 (9)

Treatments[1]					Total digestable nutrients (lbs. per acre)			
1924	1927-28	1929-31	1932-41	1943-54	1924-28	1929-31	1932-41	1943-54
PL	0	PL	PL	PL	1237	1449	1194	1004
PL	0	P	P	P	....	....	1262	1064
P	0	P	P	P	1126	1040	948	815
P	0	P	P	PL	....	....	971	1022
LK	0	LK	LK	PLK(LA)	793	705	725	1066
LK	0	LK	PLK	PLK(OM)	....	....	1278	1315
K	N	BS	PLKN123	PLK(DL)	513[2]	772	1845	1135
K	N	BS	PLKN23	PLK(HL)	969[3]	....	1654	1051
0	0	0	0	0	675	544	568	546
L	PKN	PKLNN1	PLKNN1	PLK(PM)	620[2]	1799	1684	1278
L	PKN	PKLNN1	PLKN12	PLKN1	1733[3]	....	1796	1414
PK	0	PK	PK	PLK(L)	1083	1040	1196	1227
PK	0	PK	PKN3	PLK(DL)	....	....	1369	1435
PLK	0	PLK	PLK	PLK	1451	1431	1256	1141
PLK	0	LK	LK	LK	....	....	1007	806
PKN	N	PKN	PKN1	PKN1	1066[4]	1687	1554	1414
PKN	N	PKN	PKN2	PLK(T)	1576[5]	....	1355	1106

[1] Treatments:
P—superphosphate to supply 80 lbs. P_2O_5 per acre once in 3 to 5 years.
L—limestone at one ton an acre in 1924, 1929, 1943, and 1948.
K—muriate of potash to supply 50 lbs. K_2O per acre once in 3 to 5 years.
N—nitrogen at 28 lbs./acre; NN—56 lbs./acre annually.
N1 or NN1—applied in spring; N2 or NN2 in June; N3 or NN3 in August.
BS—basic slag at 500 lbs. in 1929 (14.5% P_2O_5 and 40% CaO).
LA—Ladino seeded.
OM—optimum minerals annually.
DL—disked and Ladino seeded.
HL—herbicides to kill vegetation and Ladino seeded.
PM—poultry manure at 2 tons/acre in 1947 and 1948.
T—Birdsfoot trefoil seeded.

[2] Yields 1924-26.

[3] Yields 1927-28.

[4] Yields in 1925 and 1926 with no nitrogen.

[5] Yields in 1924, 1927, and 1928 with nitrogen.

WOODLANDS—SITE INDEX

Site index studies for white pine, red pine, and mixed oak have been made in New Hampshire and Massachusetts on Paxton soils. The site index is an estimation of tree height at 50 years of age. It is estimated from growth rate tables developed for each species. The average site index for red pine on four plots is 69; for white pine on eleven plots, 66; for mixed oak (red, scarlet, and black) on two plots, 60 (Table 19). Paxton soils are in Site Class II for these species.

Table 19. Site indices for red pine, white pine, and mixed oak on Paxton soils in Massachusetts and New Hampshire

Soil description	Location and plot number	No. of trees	Age	Height	Site index
		Red Pine[1]			
Paxton loam, 15% slope, S.E. aspect.	Franklin Co. Mass.-5	10	32	43	69
Paxton loam, 5% slope, S. aspect.	Berkshire Co. Mass.-38 ..	10	32	37	61
Paxton fine sandy loam, 18% slope, S.W. aspect.	Hampden Co. Mass.-16 ..	10	30	44	75
Paxton very stony loam, 6% slope, N.E. aspect.	Hampden Co. Mass.-49 ..	10	32	47	73
				Average	69
		White Pine[1]			
Paxton very stony loam, 11% slope, N.W. aspect, upper position.	Belknap Co. N.H.-15	5	53	72	70
Paxton loam, 13% slope, N.W. aspect, middle position.	Belknap Co. N.H.-11	5	49	62	62
Paxton very stony loam, 24% slope, N.W. aspect, middle position.	Rockingham Co. N.H.-7	5	99	87	55
Paxton very stony loam, 7% slope, N. aspect, middle position.	Merrimack Co. N.H.-15a	5	52	65	63
Paxton loam, 8% slope, N.W. aspect, low position.	Merrimack Co. N.H.-10	5	53	77	74
Paxton loam, 4% slope, N.E. aspect, middle position.	Grafton Co. N.H.-12-59	5	40	58	72
Paxton fine sandy loam, 2% slope, N. aspect, upper position.	Worcester Co. Mass.-5-4	10	40	46	58
Paxton fine sandy loam, 3% slope, S. aspect, low position.	Merrimack Co. N.H.-14	6	37	54	73
Paxton very stony loam, 30% slope, W. aspect, middle position.	Rockingham Co. N.H.-8	6	60	67	57
Paxton fine sandy loam, 6% slope, N.W. aspect, low position.	Belknap Co. N.H.-12	5	49	67	69
Paxton fine sandy loam, 3% slope, N. aspect, middle position.	Belknap Co. N.H.-7a	6	54	63	67
				Average	66
		Mixed Oak[2]			
Paxton very stony fine sandy loam, 34% slope, W. aspect, middle position.	Worcester Co. Mass.-5-1	5	57	65	60
Paxton very stony loam, 24% slope, W. aspect.	Worcester Co. Mass.-5-2	5	44	54	59

[1] Based on "White pine under forest management" by E. H. Frothingham, U.S.D.A. Bulletin No. 13, 1914.

[2] Based on "Site index curves for red oak group in Massachusetts" prepared by J. C. Mawson, University of Massachusetts, Department of Forestry and Wildlife Management.

SOIL INTERPRETATIONS

The following sections have been included in this monograph to demonstrate various interpretations of soil data for practical use. The classification and grouping of Paxton mapping units for different uses are based on their physical, chemical, and morphological properties. Estimates of properties are sometimes made if the data is incomplete.

The "Estimated Crop Yields" and "Soil Capability Classification" are two interpretations used for agriculture. Estimated crop yields predict how much corn, potatoes, or hay may be expected under average and intensive forms of management. In the capability classification, soil mapping units with similar properties are grouped, suggesting similar use and management.

Finally, the engineering interpretations are based on physical properties determined in soils laboratories and special engineering tests by the Bureau of Public Roads. Soils are evaluated as potential construction materials and as construction sites.

Soils properties may also be interpreted for urban use, tax assessment, and real estate appraisal.

Estimated Crop Yields

The estimated yields of principal crops and pastures grown on Paxton soils in Connecticut and New Hampshire, under two levels of management, are given in Table 20. Dashes indicate that the crop is not commonly grown in the area.

Yields in columns A result from average management with insufficient applications of lime, fertilizer, and manure. Soil and water conservation is also inadequate. Yields in columns B may be expected under long-term intensive management with sufficient lime, fertilizer, and manure. Erosion control, crop rotation, drainage, and irrigation are used as needed. The selection of proper seed varieties, control of plant diseases, insects, and weeds are also important for maximum yields.

Capability Classification

The Paxton mapping units have been grouped into six of eight land classes described in the Land Capability Classification of the Soil Conservation Service (30). The classes are based on soil limitations in producing crops, their risk when used, and their response to treatment. Soils in Classes I, II, and III are suitable for annual or periodic cultivation with narrowing use and greater risk toward Class III. Soils in Class IV can be cultivated occasionally under very careful management. Soils in Classes VI and VII are not suitable for cultivation but only for pasture, wildlife, or woodland.

The subclasses are identified by the type of limitation: "e" indicates slopes that erode if not protected; "s" indicates shallow, stony,[1] or droughty conditions.

[1] In New England, Connecticut alone delineates the stony phase of Paxton soils, as well as the very stony phase. The other states delineate very stony and extremely stony phases, omitting the stony phase. Stony phases on 0 to 15 per cent slopes are in Class IV; very stony phases on 3 to 25 per cent slopes are in Class VI; extremely stony phases on all slopes are in Class VII.

Table 20. Estimated average acre yields of principal crops grown on Paxton soils under two levels of management (24) (27)

Soil mapping unit	Grain corn A	Grain corn B	Silage corn A	Silage corn B	Alfalfa hay A	Alfalfa hay B	Mixed hay A	Mixed hay B	Potatoes A	Potatoes B	Oats A	Oats B	Permanent pasture A	Permanent pasture B	Rotation pasture[1] A	Rotation pasture[1] B
	Bushels		*Tons*		*Tons*		*Tons*		*Bushels*		*Bushels*		*Cow acre days*[2]			
Connecticut																
Paxton fine sandy loam, 0-3% slopes	....	....	12	17	2.0	3.5	1.5	2.5	......	......	....	....	50	110	100	170
Paxton fine sandy loam, 3-8% slopes	....	....	12	17	2.0	3.5	1.5	2.5	......	......	....	....	50	110	100	170
Paxton fine sandy loam, 8-15% slopes	....	....	12	17	1.5	3.0	1.1	2.1	......	......	....	....	50	110	75	145
Paxton fine sandy loam, 15-25% slopes	....	....	....	....	....	....	0.9	1.8	......	......	....	....	35	90	60	120
Paxton stony fine sandy loam, 3-8% slopes	....	....	....	....	....	....	....	....	......	......	....	....	40	75	......	......
Paxton stony fine sandy loam, 8-15% slopes	....	....	....	....	....	....	....	....	......	......	....	....	35	70	......	......
Paxton stony fine sandy loam, 15-25% slopes	....	....	....	....	....	....	....	....	......	......	....	....	30	65	......	......
New Hampshire													*Acres/animal unit*[3]			
Paxton loam, 0-3% slopes	60	80	10	15	2.5	4.0	2.5	4.5	350	500	40	55	3	1	......	......
Paxton loam, 3-8% slopes	60	80	10	15	2.5	4.0	2.5	4.5	350	500	40	55	3	1	......	......
Paxton loam, 3-15% slopes	60	80	10	15	2.5	4.0	2.5	4.5	350	500	40	55	3	1	......	......
Paxton loam, 8-15% slopes	60	80	10	15	2.5	4.0	2.5	4.5	350	500	40	55	3	1	......	......
Paxton loam, 15-25% slopes	....	....	....	....	2.5	4.0	2.5	4.5	......	......	....	....	3	1	......	......
Paxton stony loam, 3-8% slopes	....	....	....	....	....	....	....	....	......	......	....	....	3	1	......	......
Paxton stony loam, 8-15% slopes	....	....	....	....	....	....	....	....	......	......	....	....	3	1	......	......
Paxton stony loam, 0-15% slopes	....	....	....	....	....	....	....	....	......	......	....	....	3	1	......	......
Paxton stony loam, 15-25% slopes	....	....	....	....	....	....	....	....	......	......	....	....	3	1	......	......

1 Revised estimates for Soil Survey Report of Tolland County, Connecticut. (Manuscript).
2 "Cow acre days" is the number of days per year one acre will graze a cow giving 25 pounds of milk (3.5% butterfat) per day, without injury to the pasture.
3 An animal unit is equivalent to one cow, steer, or horse; 5 hogs; 7 sheep or goats.

Capability Unit I

Paxton fine sandy loam, 0-3 per cent slopes

This unit consists of nearly level, well-drained Paxton soils that have a slowly to very slowly permeable, compact fragipan at depths averaging 2 feet. The surface soil and subsoil are medium to moderately coarse textured. They are moderately permeable above the fragipan and have a moisture holding capacity of 2 inches per foot of soil. Crops seldom lack moisture during the growing season. The fragipan interferes with internal drainage causing them to warm slowly in the spring. The soils are easy to work and are responsive to fertilization and good management. They are nearly free of surface stones but rock fragments are common in the subsoil.

These soils are widely used in dairy farming. They are well suited for silage corn, grain corn, small grains, truck crops, hay, and pasture. Alfalfa grows well on soils limed to a pH of 6.0 but is subject to some heaving in winter and early spring.

Capability Unit IIe

Paxton fine sandy loam, 3-8 per cent slopes

This unit is found on gently sloping or undulating land. In addition to the crops in Unit I, fruit trees are also well suited. The risk of erosion is greater for this unit than for Unit I.

Capability Unit IIIe

Paxton fine sandy loam, 8-15 per cent slopes, slightly and moderately eroded

This unit is found on sloping or rolling land. The soils are used mainly for hay, pasture, and orchards. Small acreages are used for silage and grain corn, small grains, and truck crops. The risk of erosion limits intensive cultivation for row crops.

Capability Unit IVe

Paxton fine sandy loam, 15-25 per cent slopes, slightly and moderately eroded

This unit is found on strongly sloping or hilly land. These soils are used mainly for hay, pasture, and fruit trees, or are idle. Steep slopes, and the risk of erosion, severely limit cultivated crops.

Capability Unit IVs

Paxton stony fine sandy loam, 0-3 per cent slopes

This unit is similar to Unit I except for the presence of surface stones interfering with cultivation. These soils are suited for small grains, hay, and pasture. The soils are less suited for row crops than non-stony areas.

Capability Unit IVes

Paxton stony fine sandy loam, 3-8 per cent slopes, slightly and moderately eroded

Paxton stony fine sandy loam, 8-15 per cent slopes, slightly and moderately eroded

This unit is found on gently sloping to rolling stony land. Most of the land is wooded. Cleared areas are used for hay and pasture. Scattered areas are used for fruit trees and small grains. Stones limit row crop production.

Capability Unit VIe

Paxton fine sandy loam, 25-35 per cent slopes, slightly and moderately eroded

This unit is found on steeply sloping or very hilly land. These soils are rarely cultivated because of the steep slopes. They are mostly wooded. Small, scattered areas are pastured or are idle.

Capability Unit VIs

Paxton very stony fine sandy loam, 0-3 per cent slopes
Paxton very stony fine sandy loam, 3-8 per cent slopes
Paxton very stony fine sandy loam, 8-15 per cent slopes
Paxton very stony fine sandy loam, 15-25 per cent slopes

These soils are mostly wooded because of the very stony surfaces. Scattered areas have been cleared for pasture, or remain idle.

Capability Unit VIes

Paxton stony fine sandy loam, 15-25 per cent slopes, slightly and moderately eroded

This unit is found on strongly sloping or hilly, stony land. These soils are mostly wooded. Small scattered areas are used for orchards, pasture or are idle.

Capability Unit VIIs

Paxton very stony fine sandy loam, 25-35 per cent slopes
Paxton extremely stony fine sandy loam, 0-3 per cent slopes
Paxton extremely stony fine sandy loam, 3-8 per cent slopes
Paxton extremely stony fine sandy loam, 8-15 per cent slopes
Paxton extremely stony fine sandy loam, 15-25 per cent slopes
Paxton extremely stony fine sandy loam, 25-35 per cent slopes

Steep slopes or extremely stony surfaces limit the use of these soils to woods or wildlife habitats. Small areas may have been cleared for pastures, and some areas lie idle.

Engineering interpretations for construction

Engineering data for three Paxton soils from New Hampshire are presented in Table 21. The A.A.S.H.O. and Unified Engineering classifications of these materials estimate their use as construction materials or potential construction sites.

The A.A.S.H.O. classifications for the C horizons are A-4 and A-2-4 with group indices (in parentheses) varying between 0 and 2. Soil materials with A-4 and A-2-4 classifications provide firm riding surfaces when dry, with little rebound after loading. The compaction characteristics of these materials are good; however, they are subject to frost heave and lose stability when saturated with water. Adequate drainage must be provided when these materials are used as subgrade. Materials designated A-2-4 are somewhat better subgrade materials than those classified A-4.

Paxton soils, intergrading to Charlton, often have A-2 classifications. These granular materials have higher proportions of fines than A-1 materials. They must be properly drained and compacted when used as road subgrade. They are stable when dry and dusty when not surfaced.

The plasticity indices (PI) of the substrata are either low or non-plastic. Small changes in moisture content change the soil from solid to semi-solid to liquid states. Excess moisture produces rapid unstable conditions in Paxton soils. Since the permeability of the fragipan is slow, the solum quickly saturates, resulting in poor roadability of field or farm roads.

The soil above the C horizon is less suitable for subgrade because of textural variability. The A horizons are good sources of topsoil.

The grade of road embankments should be given careful consideration. Frost loosens the exposed fragipan and seep water causes solifluction. Soil creep and slides are common. Paxton soils are fairly well adapted to winter grading.

Paxton subsoil and substrata may be used for making earthen dams. It compacts well, forming an impermeable barrier. The soil is compacted at optimum moisture with sheepsfoot rollers or bulldozers.

Drainage fields for septic tanks

Paxton soils are limited for the disposal of septic tank effluents. The slowly permeable fragipan restricts downward percolation of water, forcing it to move laterally over the pan. If the fragipan is at shallow depths, effluents may be forced to the surface. The rate at which effluent can move from a drainage field depends upon pore sizes and slope gradients. Level land drains slowly; moderate slopes drain faster along preferred channels over the fragipan. Slopes greater than 8 per cent are poor sites for drainage fields. The friable soil above the fragipan has a permeability that generally exceeds 0.63 inch per hour. Drainage fields may function properly if the fragipan lies 30 inches or more below the ground surface. Drainage lines placed entirely within the fragipan generally fail. The enlargement of the drainage fields to compensate for slow drainage is often restricted by minimum distance requirements to water wells and property boundaries.

Profile descriptions of Bureau of Public Roads samples—New Hampshire[1]

1. *Modal profile*—Rockingham County

This is a modal profile representative of Paxton loam mapped in the Rockingham County Soil Survey according to the Soil Survey legend for New Hampshire dated June 10, 1954. The slope is 10 to 16 per cent with a sod cover.

Horizon	*Depth*	
Ap S30978	0-9"	Dark brown (10YR 4/3, moist) loam with weak, fine, subangular, blocky structure breaking to weak, coarse crumb. Friable when moist. pH 5.4. Many roots. Underlying boundary clear and wavy. Range in thickness 8 to 10 inches.

[1] Taken from Bureau of Public Roads Report on the correlation of physical properties, Rockingham County, New Hampshire. Harold Allen, Acting Chief, Physical Research Branch, Sept. 1956. Sample number corresponds to those in Table 21.

Table 21. Soil engineering data for three Paxton profiles, Rockingham County, New Hampshire[1] (27)

Soil and location	Bureau of Public Roads report No.	Depth	Horizon	Moisture-density: Maximum dry density[4]	Moisture-density: Optimum moisture[4]	Discarded in field sampling: Larger than 3 inches	Discarded in field sampling: From 1 to 3 inches	3 in.	1 in.	¾ in.
		Inches		Lbs. per cu. ft.	Per cent	Per cent	Per cent			
Paxton loam[7]										
0.65 mile S. of S.E.	S30978	0 to 9	Ap	110	15	10	5	90	71	69
corner of Epsom	S30979	9 to 15	B2	118	12	10	5	90	84	83
(modal profile)	S30980	22+	C2	125	10	10	5	90	80	80
Paxton loam[7]										
0.4 mile N. of	S30981	0 to 3	A1	98	19	5	10	95	85	85
Suncook Pond	S30982	3 to 8	B21	109	16	5	10	95	74	70
	S30983	27+	C	121	9	5	10	95	85	85
Paxton loam[7]										
1.05 miles N. of	S30984	0 to 7	Ap	95	21	5	10	95	85	82
Northwood Ridge	S30985	14 to 22	B22	113	15	5	10	95	84	82
	S30986	22+	C	122	12	5	10	95	84	84

[1] Test by the Physical Research Branch, Bureau of Public Roads, using standard procedures of the American Association of State Highway Officials (A.A.S.H.O.).

[2] The mechanical analyses are not designed for determining textural classes of soils because of differences in procedures and calculations.

[3] NP—non-plastic.

Mechanical Analysis[2]													
Percentage passing sieve						Percentage smaller than						Classification	
⅜ in.	No. 4 4.7 mm.	No. 10 4.7 mm.	No. 40 0.42 mm.	No. 60 0.25 mm.	No. 200 0.074 mm.	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.	Liquid limit	Plasticity index	A.A.S.H.O.[5]	Unified[6]
67	66	63	53	47	30	25	17	11	8	NP[3]	NP	A-2-4(0)	SM
81	78	75	63	55	36	30	21	13	10	22	3	A-4(1)	SM
78	76	74	61	53	32	25	18	11	8	NP	NP	A-2-4(0)	SM
84	82	80	65	56	34	29	20	12	8	NP	NP	A-4(0)	SM
63	59	55	44	37	23	19	12	7	5	NP	NP	A-1-b(0)	GM-SM
83	82	81	74	67	37	27	16	8	5	NP	NP	A-4(1)	SM
81	78	75	64	58	41	34	23	14	10	41	8	A-5(2)	SM
80	78	75	66	60	43	38	28	19	13	27	6	A-4(2)	SM-SC
82	81	77	66	60	44	36	26	17	13	22	5	A-4(2)	SM-SC

4 Test on material passing No. 4 sieve (A.A.S.H.O. Designation T99) (2).
5 Based on Standard Specification for Highway Materials and Methods of Sampling and Testing (2).
6 Based on Unified Soil Classification System (28).
7 For detailed descriptions of these soils by D. van der Voet, State Soil Scientist, New Hampshire, see text.

Horizon	*Depth*	
B2 S30979	9-15″	Light olive-brown (2.5Y 5/4, moist) loam with weak, medium subangular blocky structure. Friable when moist. pH 5.4. Roots common. Underlying boundary clear and wavy. Range in thickness 4 to 8 inches.
C1[2]	15-21″	Olive (5Y 5/3, moist) fine sandy loam (10 per cent coarse skeleton) with weak, medium subangular blocky structure. Friable when moist. pH less than 5. Few roots. Underlying boundary clear and wavy. Range in thickness 4 to 8 inches.
C2[2] S30980	21″	Olive (5Y 5/3, moist) fine sandy loam (5 per cent coarse skeleton) with moderate medium platy structure. pH less than 5. Few roots. Friable when moist.

[2] Probably should be B or B′ horizons.

2. *Non-modal profile,* Rockingham County

This is a non-modal Paxton loam intergrading to Charlton loam, with weak platy structure in the fragipan. Based on Soil Survey legend for New Hampshire dated June 10, 1954. The slope is 10 to 16 per cent with a forest cover.

A0	1½-0″	Dark brown layer of partially decomposed leaves, needles, and twigs. Range in thickness 0 to 1.5 inch.
A1 S30981	0-3″	Very dark brown (10YR 2/2, moist) loam with weak, medium, subangular blocky structure. Friable when moist. pH 5.1. Many roots. Underlying boundary clear and wavy. Range in thickness 3 to 4 inches.
B21 S0982	3-8″	Dark brown (7.5YR 4/4, moist) fine sandy loam with weak, medium, subangular blocky structure. Friable when moist. pH 5.4. Roots common. Underlying boundary clear and wavy. Range in thickness 4 to 6 inches.
B22	8-11″	Yellowish-brown (10YR 5/8, moist) fine sandy loam with weak, medium subangular blocky structure. Friable when moist. pH 5.5. Roots common. Underlying boundary clear and wavy. Range in thickness 3 to 5 inches.
B23	11-18″	Yellowish-brown (10YR 5/6, moist) fine sandy loam with weak, medium subangular blocky structure. Friable when moist. pH 5.4. Roots common. Underlying boundary clear and wavy. Range in thickness 6 to 9 inches.
B3	18-27″	Light olive-brown (2.5Y 5/4, moist) sandy loam with weak, medium, subangular blocky structure. Firm when moist. pH 5.4. Few roots. Underlying boundary clear and wavy. Range in thickness 3 to 10 inches.
C[1] S30983	27″+	Dark grayish brown (2.5Y 4/2, moist) fine sandy loam with moderate, coarse, platy structure. Very firm when moist. pH 5.3. Few roots.

[1] Probably should be a B′ horizon.

3. *Non-modal profile,* Rockingham County

This profile is a non-modal Paxton loam with a grittier C horizon. Based on Soil Survey legend for New Hampshire dated June 10, 1954. The slope is 10 to 16 per cent, with a sod cover.

Horizon	*Depth*	
Ap S30984	0-7″	Dark yellowish-brown (10YR 3/4, moist) loam with weak, coarse, subangular blocky structure. Friable when moist. pH 5.5. Many roots. Underlying boundary clear and wavy. Range in thickness 6 to 9 inches.
B21	7-14″	Yellowish-brown (10YR 5/6, moist) loam with weak, medium subangular blocky structure. Friable when moist. pH 5.5. Roots common. Underlying boundary clear and wavy. Range in thickness 5 to 9 inches.
B22 S30985	14-22″	Dark yellowish-brown (10YR 4/4, moist) loam with moderate, medium subangular blocky structure. Friable when moist. pH 5.8. Roots common. Underlying boundary clear and wavy. Range in thickness 7 to 9 inches.
C^1 S30986	22″+	Light olive-brown (2.5Y 5/4, moist) loam with weak medium platy structure. Friable when moist. pH 5.5. Few roots. Underlying boundary clear and wavy.

ADDITIONAL DATA NEEDED

Of the many soils in the Northeast, the Paxton soils have been studied extensively. Despite the wealth of data already accumulated, additional information would be helpful in evaluating its past by its genetic and morphological properties, its present use in growing crops and trees, and its possible future urban use. Such studies might include:

1. Micromorphological studies to determine the origin of the fragipan and its relationship to plant roots.

2. Clay mineralogical studies to define the genetic characteristics throughout its geographical range and to define its intergrading relationships with neighboring soils.

3. Engineering data that can be related to its use as sites for construction and as construction materials.

4. Permeability studies for septic tanks, foundation drainage, and lot subdivision appraisal.

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