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TABLE 1: SELECTED PROPERTIES OF SOIL ASSEMBLAGES IN MONTGOMERY COUNTY, MARYLAND

(Based in part on Table 5 - Brief description of soils and their estimated physical properties and Table 6 - Soil characteristics that affect engineering in Soil Survey of Montgomery County, Maryland, 1961: U. S. Dept. of Agriculture Soil Conservation Service in cooperation with Maryland Agricultural Experiment Station)

Soil Map Unit	Agricultural Soils (USDA)	Dominant Parent Material	Soil Thickness Range and Average (feet)	Engineering Classification 2/ AASHO	Unified 3/	Maximum Dry Density (lbs/ft³) 4/ (AASHO T180)	Optimum Moisture Content Percent By Weight 4/ (AASHO T180)	Permeability Range (in/hr) and Average (Underlined)	Drainage Class	Clay or Clay and Silt Content	Atterberg Limits and Indices 5/ Liquid Limit%	Plastic Limit%	Shrinkage Limit%	Shrinkage Ratio	Range of CBR (Calif. Bearing Ratio) 6/	Remarks
U-1	Wehadkee, Worsham, Congaree, Chewsele, Calvert, Lindside, Watchung, Ashton, Bermudian, Bowmansville, Croton, Huntington, Rowland, Malvin silt loams.	Alluvium composed of gravel, sand, silt & clay transported & derived from crystalline or sedimentary rocks. Surface Materials Unit 2. 1/	1-8, Ave. 3 Thin to moderate	AA to A7	ML, CL	117-130	9-13 (Normally very wet; 11-32% moisture content).	.06-.63, 0.2 Moderate to low	Very poor to poor; flood-plain water table generally high (0.4').	13-36% clay; 25-95% silt & clay.	26-40	6-16	17-27	1.55-1.77	4-8	Very strongly acid to neutral (pH 4.5-7.0) soil subject to recurrent flooding; streams cause marshy places; some iron concentration; bedrock shallow. Use as construction material, subgrade or fill poor; local source of sand and gravel. Many serious limitations for single family residences, septic systems and highways; some limitations for excavation or agriculture due to flooding. Erodibility and susceptibility to frost action moderate to high; shrink-swell potential low to high.
U-2	Roanoke, Holston, Waynesboro, Elk, Captina, Wickham, sand, silt, silty clay and gravelly silt loams.	Terrace gravel-quartz, quartzite limestone; Surface Materials Unit 3. 1/	3-4, Ave. 3 Moderately thick	A2 to A6	ML, CL, SM, GC	120-127	9-12 (Sometimes wet, locally with fragipan).	0.2 to 2.0, 2.0 Moderate to high	Well to poor; water table generally 3-4' deep; sometimes at surface.	Clay 20-34%; 20-85% silt & clay.	26-38	8-16	14-23	1.66-1.73	4-8	Strongly acid (pH 4.5-7.0) to neutral soil. Minor water problems except where fragipan present; negligible rock problems. Slight to very strong erodibility and susceptibility to frost action; use as road subgrade or fill good to poor; some limitations for single family residences, septic systems and agriculture; shrink-swell potential is low to moderate. Locally suitable as source of sand and gravel.
U-3	Beltsville, Chillum, Croom, Lakeland, Leonardtown, Rumford, Sassafras silt loam, sandy silty clay loam & gravelly silt loams.	Coastal Plain stratified gravel, sand and clay; Surface Materials Unit 4. 1/	3-6, Ave. 4 Moderately thick	A1 to A7	ML, GM, MH, SM, CL, GP, CH	118-129	9-14 (Normally wet above fragipan and hardpan; dry below. 10-35% moisture content).	0.2 to 6.3, 2.0 High to very low, but Beltsville would be very low.	Well to excessive, fragipan some hardpan 2-7'	2-75% silt & clay; clay 0-37%.	17-40	1-17	13-24	1.61-1.82	4-10	Strongly acid (pH 4.5-7.0) to neutral soil. Minor water problems except where fragipan present; drainage depends on particular soil. Negligible rock problems. Slight to very strong erodibility and susceptibility to frost action; use as road subgrade or fill very good to poor; many limitations for single family residences, septic systems, excavations and agriculture mainly due to fragipan and high water table. Locally suitable as source of sand and gravel.
S-1	Penn, Bucks, Readington, (Croton) silt loams, silty clay loams.	Residuum or regolith on siltstone, shale, sandstone, limestone conglomerate, Rock Units S-1 and S-3. 1/	0-4, Ave. 2 Thin	A2 to A7	ML, CL, GM, GC	119-131	7-16 (Very wet in Spring; 20% moisture content. Dense fragipan in subsoil locally).	0.06-2.00, .2 Low to moderate	Moderately well to excessive; locally poor where fragipan present.	15-85% silt & clay.	23-52	4-14	17-25	1.61-1.81	2-6	Residual, strongly acid (pH 4.5 to 6.0) soil formed mainly on Triassic siltstone and shale. Major water and minor rock problems. Slight to strong erodibility and susceptibility to frost action; some limitations for single family residences, septic systems, and highways. Shrink-swell potential is low to moderate.
S-2	Lewisberry sandy loam.	Residuum or regolith on sandstone, conglomerate, siltstone and shale. Rock Unit S-2. 1/	1-3, Ave. 2 Thin	A2 to A4	SM, GM	115-125	11-15	2.0-6.3, 2.2 High	Excessive	Silt and clay 10-30%.	23-30	1-22	20-30 (est.) 7/	1.5-1.7 7/ (est.) 7/	6-18 (est.) 7/	Residual, strongly acid (pH 5.1 to 5.5) soil with very shallow Triassic sandstone and conglomerate bedrock and shallow soil profile. Use as road subgrade or road fill good, with good stability and bearing values. Soil is erodible but susceptibility to frost action is slight. Few limitations for single family residences but soils drain excessively and have serious limitations for sewage disposal because of shallow permeable bedrock, especially in areas of steep slopes. Locally severe rock and water problems.
A	Mt. Airy, Linganore, Urbana, Glenelg channery, Manor channery, silty clay and channery silt loams.	Thin to thick saprolite on phyllite; Rock Unit A. 1/	1-6, Ave. 2 Thin to moderate	A2 to A7	ML, CL, GM, GC	110-130	(Urbana locally with fragipan) est. 11-13 (Sometimes wet).	.06 to 2.0, 1.0 Low to high	Moderately well to excessive; locally poor where shallow fragipan present.	20-75% silt and clay.	37-42	24-34	16-26 (est.)	1.6-1.8 (est.)	3-6 (est.) (4-18 est.)	Residual, strongly acid (pH 4.5-5.5) soil with abundant relatively fresh chips of foliated schist, phyllite and quartz. Slight to strong erodibility and susceptibility to frost action; severe rock and water hazards in areas of shallow bedrock and steep slopes; shrink-swell potential is low to moderate.
B	Glenelg, Manor, Elioak, Chester and Glenville silt loams.	Thick saprolite on schist, Rock Unit B; moderately thick saprolite on gneiss, Rock Unit D. 1/	1-10+, Ave. 6 Thick	A2 to A6	ML, CL, MH, GH, SC	114-127	9-16 (Normally wet; 14-40% moisture content; some very wet, 50-70%).	.06-2.0, 1.0 Low to high.	Well to excessive; water table generally low.	8-30% clay; 15-80% silt & clay.	31-48	3-15	20-34	1.39-1.66	3-8	Residual, strongly acid (pH 4.5-6.0) soil. High mica content increases with depth; compaction is difficult. Moisture critical; fluffy when dry, greasy when wet. Bedrock is foliated mica schist and massive to banded mica gneiss overlain by saprolite as much as 140 ft. thick; soil profile thick. Use as construction material, subgrade or fill poor to fair with many limitations. Few limitations for single family residences, septic systems, highways, excavations or agriculture except on steep slopes in areas of SI or in areas of shallow bedrock. Erodibility & susceptibility to frost action high; shrink-swell potential low to moderate.
C	Edgemont, gravelly, sandy loam.	Residuum of thin rubified sand on quartzite; Rock Unit C. 1/	1-3, Ave. 2 Thin to moderate	A2 to A4	SM, SC, GC	120-135 est.	8	.63-6.3, 1.0 High	Well.	Silt & clay 20-30%	20	0-15 (est)	20-30 (est)	1.5-1.7 (est)	25, 7-30 (est)	Residual, strongly acid (pH 4.0-5.0) gravelly or channery soil with very shallow quartzite bedrock and shallow soil profile. Use as road subgrade or road fill good with few limitations. Soil is erodible but susceptibility to frost action is slight. Few limitations for single family residences or septic systems except on very steep slopes.
D	Brandywine gravelly loam.	Moderately thick saprolite on gneiss; Rock Unit D. 1/	1-2, Ave. 1 Thin	A1 to A4	SM, GM, GC	120-135 est.	Sometimes 12	2.0-6.3, 2.2 High	Excessive	Silt & clay 10-35%	21	0-15 (est)	25-36 (est)	1.4-1.7 (est)	18, 7-30 (est)	Residual, strongly acid (pH 5.1-6.0). Shallow friable soil on gneiss or saprolite with core stones; few limitations except for shallow bedrock hazards. Erodibility and frost action susceptibility low to moderate; shrink-swell potential low.
E	Aldino silt loam, Chrome & Conowingo gravelly silty clay loams.	Thin to no saprolite on ultramafic; Rock Unit E. 1/	2-4, Ave. 2 Thin	A2 to A7	ML, CL, CH, GC, SC	101-120	10-13 (Normally very wet; 20-30% moisture content).	0.00-2.00, .02 Very low.	Poor; fragipan common; water table generally low (0-15').	17-45% clay; 20-85% silt & clay.	34-54	7-23	17-32	1.43-1.75	3-6	Residual, strongly acid to neutral (pH 5.1-7.0) soil which is hard when dry, plastic when wet. Ultramafic (serpentinite) bedrock is shallow with steep stony cuts usually stable; soil profile is shallow. Use as construction material, fill or subgrade good to poor with few limitations. Many serious limitations for single family residences, septic systems, highways, excavations and agriculture. Erodibility and susceptibility to frost action moderate; shrink-swell potential low to moderate.
F	Legore silt loam, Iredell & Meehanicy silty clay loams.	Thin to moderately thick saprolite on mafic; Rock Unit F. 1/	1-8, Ave. 3 Thin to moderate	A4 to A7	SC, ML, CL, CH	130-120	9-13 (Normally wet; 13-45% moisture content, est.)	.06-2.0, 0.8 Low	Poor; heavy clay locally; water table generally low.	15-40% clay; 45-90% silt & clay.	31-50 (est)	5-20 (est)	18-34 (est)	1.4-1.8 (est)	3-7 (est)	Residual, strongly acid to mildly alkaline (pH 5.1-7.8) soil which is hard when dry, plastic when wet. Foliated mafic bedrock if moderate to shallow; soil profile moderate to shallow; heavy clays locally impede drainage severely. Use as construction material, subgrade or fill poor to fair with many limitations. Few limitations for single family residences or highways except on steep slopes or in areas of shallow bedrock; some limitations to agriculture and excavation, and many limitations to septic systems. Erodibility and susceptibility to frost action moderate to high; shrink-swell potential low to high.
G	Montalto, Meehanicy, Iredell silt, silty clay, and stony silt loams.	Residuum on diabase; Rock Unit G. 1/	0-8, Ave. 3 Thin (to moderate)	A2 to A7	ML, CL, CH, SC, GC	118-120	10-13 (Normally very wet; 20-30% moisture content).	0.00-2.00, .02 Very low	Well to poor; water table generally low (0-15').	17-45% clay, 45-90% silt & clay.	34-54	7-23	17-32	1.43-1.75	3-6	Residual, strongly acid to mildly alkaline (5.1-7.8) soil which is hard when dry, plastic when wet. Triassic igneous diabase bedrock is moderate to very shallow, soil profile moderate to shallow; heavy clays locally impede drainage. Moderate to strong erodibility and susceptibility to frost action; severe limitations for residences, septic systems, highways and excavations; shrink-swell potential low to high.

1/ Surface Materials & Rock Units refer to maps in Montgomery County Environmental Folio (Froelich, 1974).

2/ AASHO Soil Classification

A-1 - well graded sand and gravel
A-2 - silty or clayey sand and gravel
A-3 - fine sand
A-4 - silt
A-5 - clayey and micaceous silt
A-6 - sandy and silty clay
A-7 - clay, colloidal clay, muck & peat, granular

In general, granular soils A-1, A-2 or A-3 are rated excellent to good as subgrade; silt-clay soils A-4, A-5, A-6 and A-7 are rated fair to poor as subgrade. Classification based on sieve analysis to determine percent by weight of size categories.

A4 to A7 means A4, A5, A6, or A7.

Unified Soil Classification 3/

First Letters	Second Letters
G - gravel	W - well graded
S - sand	P - poorly graded
M - silt	C - clayey
C - clay	L - low plasticity
	H - high plasticity
	M - silty

4/ AASHO T-180 - A standardized test used by the American Association of State Highway Officials for moisture-density relations of soils when compacted in a mold using a 10 lb. rammer and an 18 inch drop (55,900 ft. lbs. per ft.³). (Soils Manual for Design, 1963, p. 227).

5/ Atterberg Limits - Consistency tests which include liquid limit (moisture content at which soil changes from liquid to the plastic state); plastic limit (the border between plastic and semi-solid state); shrinkage limit (delineates semi-solid from solid state). Plasticity index is the arithmetic difference between the liquid and plastic limits, i.e., the range of moisture content over which a material is in the plastic state (Soils Manual for Design, 1963, p. 52).

6/ CBR - California Bearing Ratio (CBR Method) - a comparative measure of the shearing resistance of a soil; used in design of asphalt pavement structures (Soils Manual for Design, 1963, p. 99).

7/ (Est.) - Estimated values for CBR & Atterberg limits based on tests of similar soils in adjacent Counties.

EXPLANATION

ASSEMBLAGE 1: Soils on Unconsolidated Sediments

	Dominant Parent Material	Remarks
U-1	Alluvium - sand, silt, clay, gravel	Poorly drained, deep; in lowlands; formed on transported floodplain materials with bedrock shallow; major water and negligible rock problems.
U-2	Upland Deposits - gravel, sand, clay	Well to poorly drained, moderately deep; on nearly level upland terraces formed on transported fluvial materials with bedrock deep; no rock and negligible water problems except where shallow fragipan soils cause local water problems.
U-3	Coastal Plain Deposits - gravel, sand, clay	Well or excessive to poorly drained, moderately deep; on rolling uplands with hard bedrock deep, no rock and negligible water problems except where shallow fragipan soils cause severe water problems.

ASSEMBLAGE 2: Soils on Sedimentary Rocks

	Dominant Parent Material	
S-1	Triassic - shale, siltstone	Moderately well, excessive to poorly drained, residual, shallow; sloping uplands with bedrock moderately deep; minor rock and major water problems in local areas of fragipan soils.
S-2	Triassic - sandstone, conglomerate	Excessively drained, residual, shallow; on sloping uplands and steep valley walls with bedrock shallow; major rock and negligible water problems.

ASSEMBLAGE 3: Soils on Crystalline Rocks

	Dominant Parent Material	
A	Phyllite - quartzite	Moderately well, excessive to poorly drained, residual, shallow, channery; on hilly uplands with bedrock shallow to deep; minor rock but locally severe water problems in local areas of fragipan soils.
B	Schist - mica gneiss	Well to excessively drained, deep residual, micaceous; on rolling uplands; bedrock deep to moderate; negligible water or rock problems
C	Quartzite	Well drained, residual, shallow; on hilly uplands with shallow bedrock; negligible water but severe rock problems locally.
D	Gneiss	Excessively drained, residual, shallow; on uplands and steep valley sides with shallow to moderately deep bedrock; negligible water and minor rock problems.
E	Ultramafic	Poorly drained, very shallow, residual; on uplands with shallow bedrock; major water and serious rock problems.
F	Mafic	Poorly drained, shallow, residual; on rolling uplands with moderate to shallow bedrock; major water and negligible rock problems.
G	Triassic Diabase	Moderately well to poorly drained; shallow to moderately deep, residual; on uplands with bedrock shallow to moderately deep; major rock and water problems.

The soils map of Montgomery County arbitrarily groups the great variety of soils present into 3 major assemblages with twelve map units. The subdivision is considered 'natural', as it is formulated chiefly on the basis of the underlying parent material. Those soil assemblages formed on unconsolidated sediments are labeled U-1, U-2, U-3; those formed on consolidated sedimentary rocks are labeled S-1, and S-2; and those formed on crystalline metamorphic or igneous rocks are labeled A through G. Each unit consists of soils with grossly similar agricultural characteristics, engineering properties, erodibility, drainage, and water storage capabilities. As the map units are labeled to reflect the close relationship to parent material, this map should be compared with the Bedrock Map and Surface Materials Map. 1/

The soil assemblages are usually moderately to severely eroded. Susceptibility to further erosion is most severe on steeper slopes, and all groups are highly erodible where disturbed by construction; in some areas the soils are difficult to compact. The shrink-swell potential of most soils is generally low to moderate, although it is high in some F and U-1 soils containing heavy clay. Permeability and acidity range across wide limits (see Table 1). A list of the major assemblages, the agricultural soils, their parent materials, and selected engineering characteristics which bear on optimum land use are also indicated on the tabular summary. More detailed agricultural and engineering aspects are treated specifically in the relevant published references.

Soils on Unconsolidated Sediments

Assemblage 1 - Three soil units are developed mainly on unconsolidated parent material, chiefly transported debris. Unit U-1 comprises a variety of soils, chiefly silty clay loams or silty sandy loams, formed principally on alluvium composed of sand, gravel, boulders, silt and clay in floodplains and adjacent low terraces. The soils are thick to thin, generally poorly drained, and are subject to frequent floods. Bedrock is commonly less than 3 meters (10 feet) deep except along major streams or under terraces; therefore, rock problems are negligible but water problems are severe. Unit U-2 comprises soils formed on unconsolidated upland gravels and sands in a matrix of silt and clay. The soils are chiefly sandy or gravelly silt loams, moderately thick, generally well drained, but locally poorly drained where shallow fragipan causes local water problems; with negligible rock problems. Unit U-3 comprises soils formed on partly consolidated Coastal Plain sand, gravel, silt or clays. The soils are of two main types: those with a shallow fragipan or clay pan are commonly shallow, poorly drained with no rock problems but locally serious water problems; those sandy without a fragipan are thick, well to excessively drained, with no rock or water problems.

Soils on Sedimentary Rocks

Assemblage 2 - Two residual soil units are developed on consolidated sedimentary (Triassic) rocks in the southwestern part of the county. Unit S-1 include soils formed on interbedded siltstone, shale and minor sandstone. The soils are silty and silty clay loams, generally thin over a weathered regolith or residuum on shallow bedrock, with poor to excessive drainage, major water and rock problems. Unit S-2 comprises soils formed on sandstone and conglomerate with minor interbeds of siltstone and shale. The soils are thin, sandy loams, bedrock is shallow, drainage is excessive, with minor water and locally severe rock problems.

Soils on Crystalline Rocks

Assemblage 3 - Two residual soil units are formed on intensely foliated metamorphic rocks of Montgomery County. Unit A is formed mainly on interbedded phyllite, phyllitic schist, slate, and minor quartzitic sandstone. The soils are usually thin, channery silt loams, moderately well to excessively drained, with moderately thick saprolite, bedrock moderately deep to shallow. Water and bedrock problems are negligible on the upland surfaces, but serious in sloping areas and on steep valley sides. Unit B comprises soils formed mainly on mica schist, chlorite schist and minor interbeds of impure chloritic or micaceous quartzite; locally this unit includes soils formed on massive felsic (rich in quartz and feldspar) metamorphic and igneous rocks such as gneiss, granite and granodiorite. The soils are thick loams or silt loams, micaceous, well to excessively drained, with bedrock usually deep and saprolite thick, especially beneath upland surfaces. Severe seasonal high water tables are encountered where three to eight percent (3% to 8%) slopes abut the alluvial soils.

Two residual soil units are formed on thick bedded to massive felsic metamorphic and igneous rocks. Unit C mainly overlies quartzite, micaceous impure quartzite with minor interbeds of phyllite and slate. The soils are shallow, gravelly to sandy loams, well drained with minor water and locally severe rock problems. Unit D includes soils formed on massive gneiss, granite, granodiorite and similar felsic rocks. Soils are deep, coarse textured, excessively drained, with bedrock deep to moderately shallow.

Unit E is formed on massive to sheared serpentinite or other ultramafic (very rich in iron and magnesium) parent rock. The soil is thin, residual, silty or gravelly clay loam, poorly drained with thin to no saprolite, a shallow fragipan, with major water and rock problems.

Two residual soil groups overlie foliated to massive mafic (rich in iron and magnesium) metamorphic or igneous rock. Unit F overlies metabasalt, metavolcanic greenstones (rich in epidote and chlorite) amphibolite and foliated mafic metamorphosed igneous rocks. The soils are thin, silty clay loams, poorly drained, with saprolite usually thin and bedrock shallow to moderately deep, resulting in major water and minor rock problems. Unit G which overlies usually massive diabase, is thin stony silt loam to silty clay loam which is well to poorly drained. Rock and water problems are locally severe; spheroidal "boulders" commonly are surrounded by poorly drained residuum and soil.

Possible Uses of the Map - The map portrays the areal distribution and lateral variation of soil assemblages which differ significantly in physical properties, as indicated on the Engineering summary. When used in conjunction with the Surface Materials Map and Thickness of Overburden Map and Bedrock Map, the map can be used to define the areal extent, nature and characteristics of similar subsoil parent materials. As the soils define the properties of only the uppermost two to ten feet, this factor is particularly significant in siting dry well septic tank fields which are commonly emplaced to depths exceeding 20 feet. As the engineering data are based on shallow tests, prediction of water infiltration, percolation, absorption and shrink-swell potential of clays below the true soil zone is tenuous at best. These data, however, are useful when coupled with thickness of overburden, surface materials and bedrock parent and contour data in analysis and prediction of surface infiltration and subsurface fluid migration routes and rates relevant to water quality studies.

Such studies may also have applicability in predicting subsurface migration of effluents from septic tank fields, leachate from sanitary landfills, or outfall from waste water treatment plants.

In conjunction with the topographic map or a slope map derivative and the Thickness of Overburden Map, a generalized erodeability map can be compiled. Using the same combination of maps, areas of similar saprolite or shallow bedrock can be delineated, thus showing areas with comparable physical properties in regions of similar topography.

The distribution of alluvial soils provides a generalized overview of county-wide flood hazards, especially when used with published flood-prone area maps.

Soil: The natural medium for the growth of land plants on the surface of the earth; composed of mineral and organic material (U.S.D.A., 1961, p. 103).

The term 'soil' as used by the agricultural soil scientist varies from the sense of the term commonly used by engineers, as shown in the schematic diagram, Figure 1. Soil, as used in this study, includes all of agricultural horizons A, B, and C. Underlying units are considered as Surface Materials or Bedrock.

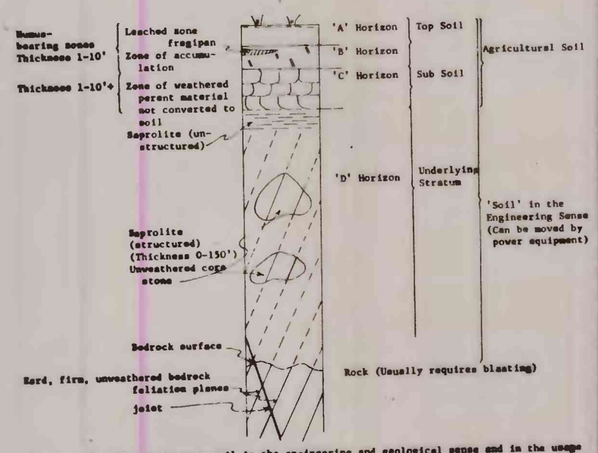

Fig. 1 - The relation between soil in the engineering and geological sense and in the usage of the agricultural soils scientists.

References

Natural Features of the Washington Metropolitan Area, 1968, The Metropolitan Washington Council of Governments, p. 20-25.

Pipar, H. W., 1965, Maryland Engineering Soil Study, Final Report for Maryland State Roads Commission and U. S. Dept. of Commerce, Civil Eng. Dept. Univ. of Maryland at College Park, Md., 35 p.

Soils Manual for Design of Asphalt Pavement Structures, 1963, The Asphalt Institute, 2nd ed., MS-10, 269 p.

U. S. Dept. of Agriculture, 1961, Soil Survey, Montgomery County, Maryland, Soil Conservation Service in cooperation with Maryland Agricultural Experiment Station, 107 p.

U. S. Dept. of Agriculture, 1971, Guide for interpreting engineering uses of soils, Soil Conservation Service, 87 p.

1/ Froelich, A. J., Montgomery County Folio, unpublished data.

U. S. Geological Survey
OPEN FILE MAP 74-78
This map is preliminary and has not been edited for conformity with Geological Survey standards or nomenclature.

NATURAL SOIL ASSEMBLAGES MAP OF MONTGOMERY COUNTY, MARYLAND

BY ALBERT J. FROELICH