DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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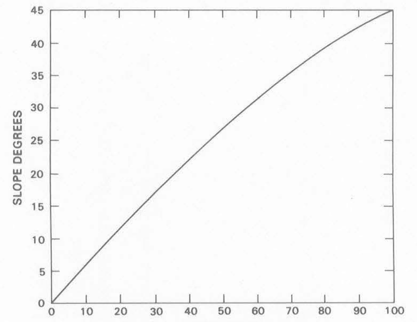
TABLE 4

Surface materials map unit (pl. 1)	Description of parent bedrock	Weathered profile	Unified Soil Classification[1] of saprolite and B horizon	Total unit weight (kgf/m³)	Drainage and natural-moisture characteristics		Suitability as compacted material	Excavation properties	Susceptibility to erosion	Shear strength and compressibility characteristics	Allowable bearing pressure (kgf/cm²)	Slope stability	Road-performance characteristics
					Surface drainage	Internal drainage and natural moisture							
Ultramafic u	Serpentinite, including altered peridotite, pyroxenite, dunite, gabbro; may locally include small bodies of gabbro and other rocks. Massive to locally foliated and tightly folded. Commonly sheared near contact with other rock bodies and along fold limbs; shear zones at least 1 cm thick containing talc schist of soft to medium consistency. Shear zones possibly much thicker. Joints common, forming 3-m-thick blocks where massive and 1-cm-thick plates where foliated.	Commonly forms very thin, highly plastic clay within upper 0.7 m of ground surface, underlain by weathered or unweathered rock. Transition from clay to unweathered rock typically very abrupt. Depth to unweathered rock varies from 0 to 2.7 m, averaging 1 m.	Commonly CH within uppermost 0.7 m.	1,700 and higher; generally increases with depth to unweathered rock.	Water commonly found at surface after rainy period because of very low permeability of highly plastic clay and shallow or outcropping bedrock.	Perched water common above unweathered rock after rainy period. Permeability very low in B horizon, and generally low in weathered material beneath.	Saprolite commonly unsuitable because of plastic clay.	Highly plastic soils and platy weathered rock can generally be excavated using light to moderate power equipment.	Low.	Medium to stronger consistency, generally increasing with depth. Shear zones containing talc schist may be soft to medium consistency near ground surface and highly compressible. Effective friction angle of shear zones probably about 15°–20°.	Commonly 1–2 for spread footings at shallow depth in saprolite. May have weak shear zones and swelling soils. Unweathered bedrock can support very large loads close to ground surface.	Temporary vertical slopes in saprolite commonly stable to depths of at least 2 m, but in small ultramafic bodies and along margins of large bodies, weak shear zones and foliated plates make slopes unstable at unpredictable locations and depths. Permanent long slopes rarely unstable at angles less than 27°–30° in saprolite, weathered rock, or unweathered rock; stability depends almost entirely on defects such as joints and shear zones. Unweathered rock commonly stable at much higher angles.	Highly plastic clay retains water, commonly weakening subgrade.
Mafic m	Metamorphosed igneous rocks, commonly called "greenstone," include epidote-chlorite schist, amphibolite, chlorite-actinolite-talc schist, metagabbro, metadiorite, and others. Mapped unit generally massive in interior and foliated at margins, but interior also banded to foliated, locally having many fractures and joints at different orientations; locally fissile, splitting along 0.1-5-cm-thick planes. Locally tightly folded.	Very plastic B horizon commonly 0.7–1.3 m deep on hilltops formed on massive rocks in interior of mapped unit; depth to unweathered rock typically very close to base of B horizon, averaging 1–1.3 m. Weathering much deeper in foliated rock, and soils much less plastic, typically slightly micaceous clayey silt; depth to unweathered rock 0–25 m, averaging about 5 m. Saprolite-weathered rock contact may be very irregular in foliated rocks.	B horizon: CH, MH-CH, MH. Saprolite: MH, ML, SM.	1,300 and higher; lowest in saprolite immediately beneath B horizon, increases with depth from saprolite to unweathered rock.	Variable, depending on parent bedrock. Generally well drained above foliated rocks, and moderately to poorly drained above massive rocks.	Weathered material above foliated rocks generally well drained and has low to medium permeability; natural-moisture content of saprolite normally less than plastic limit. Above massive rocks, B horizon commonly very wet after rainy period, drains slowly and has very low permeability; saprolite permeability generally low but higher than B horizon, and water commonly at shallow depth because of proximity of unweathered rock.	Saprolite on foliated rocks generally moderately easy to compact, but compaction can be very sensitive to moisture content. Moderately strong and not highly compressible where properly compacted. Saprolite on massive rocks commonly unsuitable or poor source of fill because of highly plastic clays or thinness of saprolite.	Saprolite can be excavated using light power equipment to depths of at least 2–3 m. Weathered rock must be blasted where massive; some weathered rock may be excavated using heavy power equipment; excavation becomes increasingly difficult with depth.	Highly plastic materials and saprolite on massive rocks generally low erodibility; on foliated rocks, erodibility much greater, especially where clay content is low and where remolded.	Weathered materials above massive bedrock have properties similar to diabase unit, except saprolite above massive bedrock does not extend to such great depths, and materials are generally stronger and less compressible. Weathered materials above foliated bedrock have properties closely resembling phyllite, gneiss, schist, and metagraywacke units (table 3).	Commonly 1–2 for spread footings at shallow depths in saprolite. Load generally increases with depth but desiccated clay-rich soils above weaker saprolite may decrease load. Possible shrink-swell problems at depths less than 1.7 m.	Temporary vertical slopes in saprolite commonly stable to depths of at least 2 m, but parting planes and shear zones make slopes unstable at unpredictable locations and depths. Permanent long slopes rarely unstable at angles less than 27°–30° in saprolite, weathered rock, or unweathered rock; stability depends almost entirely on defects such as joints and shear zones. Unweathered rock commonly stable at much higher angles.	Highly plastic clay in B horizon can retain water, weakening subgrade. Micaceous and silty soils common and susceptible to frost heaving and softening; clayey, micaceous, silty soils may be difficult to stabilize with cement, but micaceous silts of low plasticity should be easily stabilized. Road performance generally poor unless design consideration given to frost susceptibility of micaceous silty soils.
Granitoid rock g	Granite, adamellite, aplite, pegmatite, tonalite, and granodiorite. Massive to foliated along margin of igneous bodies, where highly foliated schist may be vertically oriented in layers as wide as 1 m. Joints typically 1 m or more apart away from margins and many are steeply inclined; has prominent subhorizontal sets. Has numerous quartz pods and lenses.	B horizon varies from clay-rich sandy soil, as thick as 1.3 m on hilltops, to silty sand containing some clay. Saprolite typically silty sand containing some clay, highly micaceous in places, and predominantly clay in places. Saprolite may be 20 m deep on hilltops away from major streams. Saprolite at some places crossed by 1-2.5-cm-thick, high-angle dikes weathered to highly plastic clay, much weaker than surrounding saprolite or weathered rock. Thickness of weathered rock relatively uniform except near foliated rocks and dikes.	B horizon: MH-CH, CL, SM, SC, SM. Saprolite: SC, SM, (ML, MH).	1,600 and higher, lowest in saprolite beneath B horizon, typically increases gradually with depth from saprolite to unweathered rock.	Water commonly at ground surface above clay-rich B horizon after rainy period.	Permeability of very clay rich B horizon very low. Permeability of saprolite much higher, but commonly low because of small amount of clay present throughout saprolite. Natural-moisture content of saprolite commonly near or exceeds plastic limit; most saprolite readily dried and wetted.	Saprolite generally compacts well, but ease of compaction of highly micaceous or silty saprolite may depend on moisture content. Generally strong and not highly compressible except where mica content unusually high.	On hilltops, saprolite can be excavated using light power equipment to depths of at least 2–3 m. Generally increasingly difficult to excavate with depth, but transition commonly gradual. Quartz veins and pods in places throughout weathered profile may require blasting.	B horizon typically low erodibility, except where clay content very low. Saprolite, typically low to moderate erodibility, but higher where silty and micaceous and where remolded.	B horizon stiff or stronger; saprolite medium to stiff, typically increasing with depth. Aplite dikes weathered to fine-grained saprolite may be much weaker than surrounding saprolite or weathered rock. Effective peak friction angle of saprolite commonly 25°–35°, residual effective friction angle probably 20° or higher, except for fine-grained aplite dikes. Clay-coated, continuous joints at some places beneath clay-bearing Coastal Plain sediments; these joints may have peak effective friction angles as low as 10° and very small or no cohesion intercept on strength envelope. Apparent preconsolidation stress commonly slightly exceeds overburden load near ground surface. Saprolite in virgin part of consolidation curve generally much less compressible than diabase unit and gneiss, schist, and metagraywacke unit, because granite saprolite typically more coarse grained.	Commonly 1-2 for spread footings at shallow depths. Allowable load generally gradually increases with depth. Possible weak, highly plastic dikes.	Temporary vertical slopes in saprolite commonly stable to depths of at least 2 m, but parting planes, shear zones, and aplite dikes make slopes unstable at unpredictable locations or depths. Permanent long slopes normally stable at angles less than 27°–30° in saprolite, weathered rock, or unweathered rock; stability depends almost entirely on defects such as joints and shear zones. Unweathered rock commonly stable at much higher angles. Saprolite and weathered rock beneath Coastal Plain sediments may have clay-coated, continuous planar joints. Here long slopes may be unstable on low-angle slopes, depending on joint orientation.	Clay in B horizon may retain water, weakening subgrade. Saprolite generally clayey and silty sand, somewhat susceptible to frost heaving and softening; micaceous silty soils very susceptible to adverse frost actions, and should be easily stabilized with cement.
Diabase d	Intrusive dikes and sills, finely crystalline at margins and coarser in interior; local pegmatite, gabbro, and norite. Joints commonly near vertical, and some subhorizontal joints near surface. Vertical joints commonly 1–3 m apart, may be centimeters apart near contacts with other rock bodies. Thin dikes may be shattered throughout, and fractures only a few centimeters apart at random orientations.	B horizon highly plastic, rich in montmorillonite, sometimes as thick as 1.3 m, and may be soft where wet. Clayey sand saprolite generally about 1.3 m thick, in some places 3–8 m deep. Core-stones of many sizes found throughout profile, but generally increase in size with depth. Core-stones may be completely surrounded by much weaker saprolite, of medium consistency and stronger. Weathered rock zone is normally 1.3–5 m. Total depth of weathering rarely greater than 10 m and is deepest over shattered rock. Average depth of weathering about 3 m. Joints in saprolite commonly cemented but may be coated with montmorillonite washed down from above. Depth to unweathered rock typically highly variable. Many boulders at ground surface.	B horizon: CH, MH-CH, CL. Saprolite: MH, ML, SM-SC, SC.	1,200 and higher, lowest in saprolite beneath B horizon. Commonly increases somewhat erratically with depth, from saprolite to unweathered rock; high density values indicate remnants of core stones.	Water commonly at ground surface after rainy period because of highly plastic clay in B horizon.	Permeability of B horizon very low. Permeability of saprolite much higher than B horizon but commonly low because clay commonly present throughout saprolite. Natural-moisture content of saprolite highly variable but commonly exceeds plastic limit; most saprolite readily dried and wetted.	B horizon commonly unsuitable because of highly plastic clay. Compaction of silty saprolite is sensitive to moisture content. Sandy and gruslike saprolite generally compacts easily and is strong and not highly compressible.	B horizon and saprolite can be excavated with light power equipment, commonly to depths exceeding 3–5 m; however, rounded boulders as much as 0.7–1 m diameter common at random depths, completely surrounded by saprolite. Partly weathered rock requires blasting.	B horizon, typically low erodibility. Saprolite, silts of low plasticity highly erodible, especially where remolded; erodibility decreases with increasing clay content.	B horizon medium or stronger consistency where dry, but commonly soft to medium where wet. Fine-grained saprolite may be medium consistency as deep as 7 m. Strength may be erratic as function of depth because of core-stones. Effective peak friction angle of saprolite probably 25° or more; clay-coated joints probably have much smaller effective friction angles. Apparent preconsolidation stress of saprolite commonly as low as 1–2 kgf/cm²; low preconsolidation values present as deep as 7 m; silty saprolite may be extremely compressible in virgin part of consolidation curve.	Commonly 1–2 for spread footings at shallow depths. Allowable load generally gradually increases with depth. Highly plastic B horizon soils may shrink and swell. Possibility of shrink-and-swell problems as deep as 1.7 m.	Temporary vertical slopes in saprolite commonly stable to depths of at least 2 m, but clay-coated joints make slopes unstable at unpredictable locations and depths. Permanent long slopes commonly unstable at angles less than 27°–30° in saprolite and weathered rock; stability depends almost entirely on defects such as joints and shear zones. Unweathered rock commonly stable at much higher angles.	Same as "Mafic" rocks.
Quartz q	Veins, dikes, and pods filling fractures in weaker schist, gneiss, phyllite, and granitic rocks. Small quartz bodies as thick as 0.7 m commonly shattered into small fragments; larger bodies commonly have well-defined joint sets 0.7 m to much farther apart. Large bodies shown on Drake and Froelich (1977).	Quartz does not weather sufficiently to develop a weathered profile; commonly fresh at ground surface. Large boulders commonly at ground surface. Large bodies commonly occur as cores of linear hills.	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

[1]The following letters indicate certain soil characteristics. First letter: G, gravel; S, sand; M, silt; C, clay; O, organic; Pt, peat. Second letter: W, well graded; P, poorly graded; M, silty; C, clayey; L, low plasticity; H, high plasticity. The materials are described in terms of major and minor occurrences; minor occurrences are in parentheses.



RELATIONSHIP BETWEEN SLOPE DEGREES AND SLOPE PERCENT

PHYSICAL PROPERTIES AND ENGINEERING CHARACTERISTICS OF WEATHERED MATERIALS DERIVED FROM IGNEOUS OR SLIGHTLY METAMORPHOSED IGNEOUS ROCKS, FAIRFAX COUNTY, VIRGINIA

TYPICALLY HAS MASSIVE, JOINTED SAPROLITE, AND BLOCKY TO ROUNDED CORE-STONES AT SAPROLITE-WEATHERED ROCK CONTACT