DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
APPALACHIAN REGIONAL COMMISSION

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–1035

This map identifies areas with potential slope-stability problems significant to development. Essentially, it is a guide to areas of past landsliding and present landslide susceptibilty. The map is not designed to replace detailed studies of specific sites within these areas by competent technical personnel. Rather, it delineates areas where detailed studies are most vital to the safety and welfare of the general public. In these areas, site examinations provide evidence of the difficulties that slope instability may pose to a contemplated land use; it can then be decided whether costs of hazard prevention are commensurate with the value of the contemplated use. Preparation of the map was sponsored by the Appalachian Regional Commission (ARC contract no. 74–131).

The map is based on interpretation of large-scale (1:12,000) aerial photographs (series GS–VDGY) taken on April 14, 1973. About a week and a half of field work during early 1974 supplemented the aerial photographic interpretations.

Information from soil surveys by the Soil Conservation Service (U.S. Dept. of Agriculture, 1973) was integrated with data from early geologic maps (Shaw and Munn, 1911 and Johnson, 1928) and other reports listed in the references.

Large recent landslides are readily seen on aerial photographs. The aerial photographs are also an excellent means of locating ancient slump benches and hummocky areas at the bases of slopes which indicate landslide-prone areas. In addition, arcuate scars at the heads of slide areas are well displayed on aerial photographs. In contrast, the contour interval and the configuration of the contours on topographic maps are not sufficiently detailed to allow for the delineation of many landslide-prone areas.

The rocks exposed in the Pittsburgh West quadrangle are horizontal to very gently dipping shales, mudstones, sandstones, siltstones, and minor coal beds and limestones of the Conemaugh, Monongahela, and Dunkard Groups of Pennsylvanian and Permian age (figs. 1 and 2). Colluvial and residual soils derived from nonbedded red mudstone of the Conemaugh Group (fig. 3) are particularly susceptible to landsliding. In Allegheny County approximately 83 percent of the landslides occur within the Conemaugh Group (fig. 2). Most areas with moderate to severe slope-stability problems are underlain by either (1) the principal red mudstone horizon ("Pittsburgh redbeds"), which ranges from 20 ft (6.1 m) to 65 ft (19.8 m) in thickness north of the Ohio River (Winters, 1969), or (2) a lesser known red mudstone sequence ("Clarksburg redbeds") higher in the section. In the overlying Monongahela and Dunkard Groups, thin complex zones of earth material derived from non-red interbedded shale, siltstone, and limestone are also susceptible to landsliding. These zones, however, are not readily delineated by geologic marker horizons and occur in various stratigraphic positions. Most slopes in the quadrangle are relatively stable under natural conditions. However, many slopes are sensitive, and their natural equilibrium can be readily upset. By far the greatest number of landslides in the region occurred because a slope was oversteepened, overloaded, or otherwise modified by man during development of housing, roads, pipelines, and other features. The prehistoric landslides probably occurred under extremes of climate no longer characteristic of the area. Most recent landslides on natural, undisturbed slopes are caused by unusual climatic conditions, such as extremely heavy and prolonged rainfall.

The highest concentration of recent landslides in the Pittsburgh West quadrangle occurs in the Riverview Park area north of the Ohio River. In this area, an unusual sparsity of sandstone units and a thicker-than-average sequence of highly weathered reddish and grayish-green claystone and shale are conducive to the development of highly unstable slopes. Other high-density landslide areas lie west and southwest of the mouth of Sawmill Creek south of the Ohio River.

Large areas in the quadrangle average less than one landslide per square mile (Pomeroy, 1974a, b). However, it is not to be construed that these latter areas are reasonably safe areas where slopes can tolerate poor engineering practices. Conversely, areas showing a high density of landslides per square mile are not necessarily areas where new construction should be curtailed. In many cases such a high landslide density results from the lack of sound engineering planning at a particular development. An overwhelming majority of recent landslides in Allegheny County has resulted from manmade changes on unstable slopes as discussed by Briggs (1974).

Further information about landsliding in the Pittsburgh region is available in Pomeroy and Davies (1975) and Briggs and others (1975).

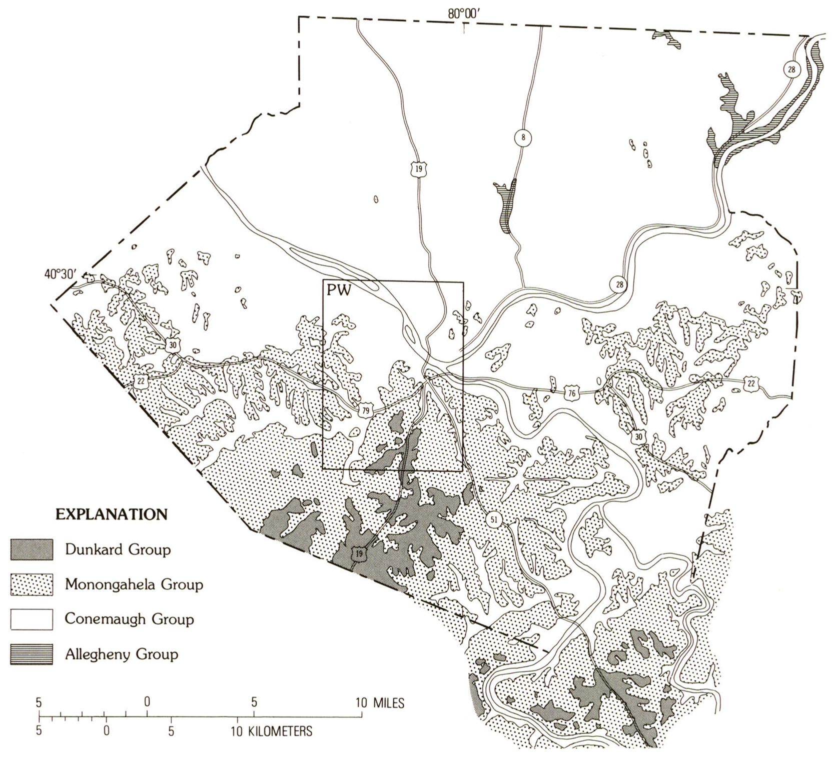
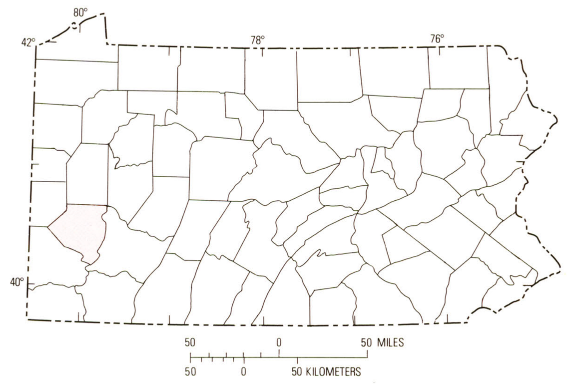



FIGURE 1.—Geologic map of Allegheny County (modified from Wagner and others, 1970) showing location of Pittsburgh West (PW) quadrangle, Pa.

| APPROXIMATE INTERVAL EXPOSED IN QUADRANGLE | GROUP | THICKNESS, IN FEET (METERS) | FORMATION | KEY HORIZONS | PERCENTAGE OF RECENT LANDSLIDES |
|---|---|---|---|---|---|
| | DUNKARD | 100+ (30+) | WAYNESBURG | | <0.5 |
| | | | | WAYNESBURG COAL | |
| | MONONGAHELA | 300+ (91+) | UNIONTOWN / PITTSBURGH | | 16 |
| | | | | PITTSBURGH COAL | |
| | CONEMAUGH | 280 (85) | CASSELMAN | ("Clarksburg redbeds") | 47 |
| | | | | AMES LIMESTONE MEMBER | |
| | | 300+ (91+) | GLENSHAW | ("Pittsburgh redbeds") | 36 |
| | | | | UPPER FREEPORT COAL | |
| | ALLEGHENY | 100 (30) | FREEPORT | | <1 |

FIGURE 2.—Generalized geologic column correlating geologic units with incidence of recent landsliding, Allegheny County, Pa.




County index map of Pennsylvania showing location of Allegheny County

| SOIL NAME | TYPE | STRATIGRAPHIC INTERVAL | LITHOLOGY OF PARENT MATERIAL |
|---|---|---|---|
| Guernsey | Residual | Monongahela and Dunkard | Non-red shale and limestone |
| Gilpin-Upshur | Residual | Conemaugh | Largely red mudstone and shale |
| Wharton | Residual | Conemaugh | Non-red shale |
| Guernsey-Vandergrift | Residual | Monongahela and Conemaugh | Non-red and red mudstone and shale; limestone |
| Ernest | Colluvial | Mostly Conemaugh | Non-red shale and siltstone |
| Library | Residual | Monongahela and Dunkard | Non-red shale and limestone |
| Ernest-Vandergrift | Colluvial | Mostly Conemaugh | Non-red and red mudstone and shale |
| Gilpin-Vandergrift | Residual-colluvial | Conemaugh | Largely red mudstone and shale |

NOTE: Soils shown above are highly plastic and have a moderate or high shrink-swell potential.

FIGURE 3.—Major landslide-prone soils in Pittsburgh West quadrangle

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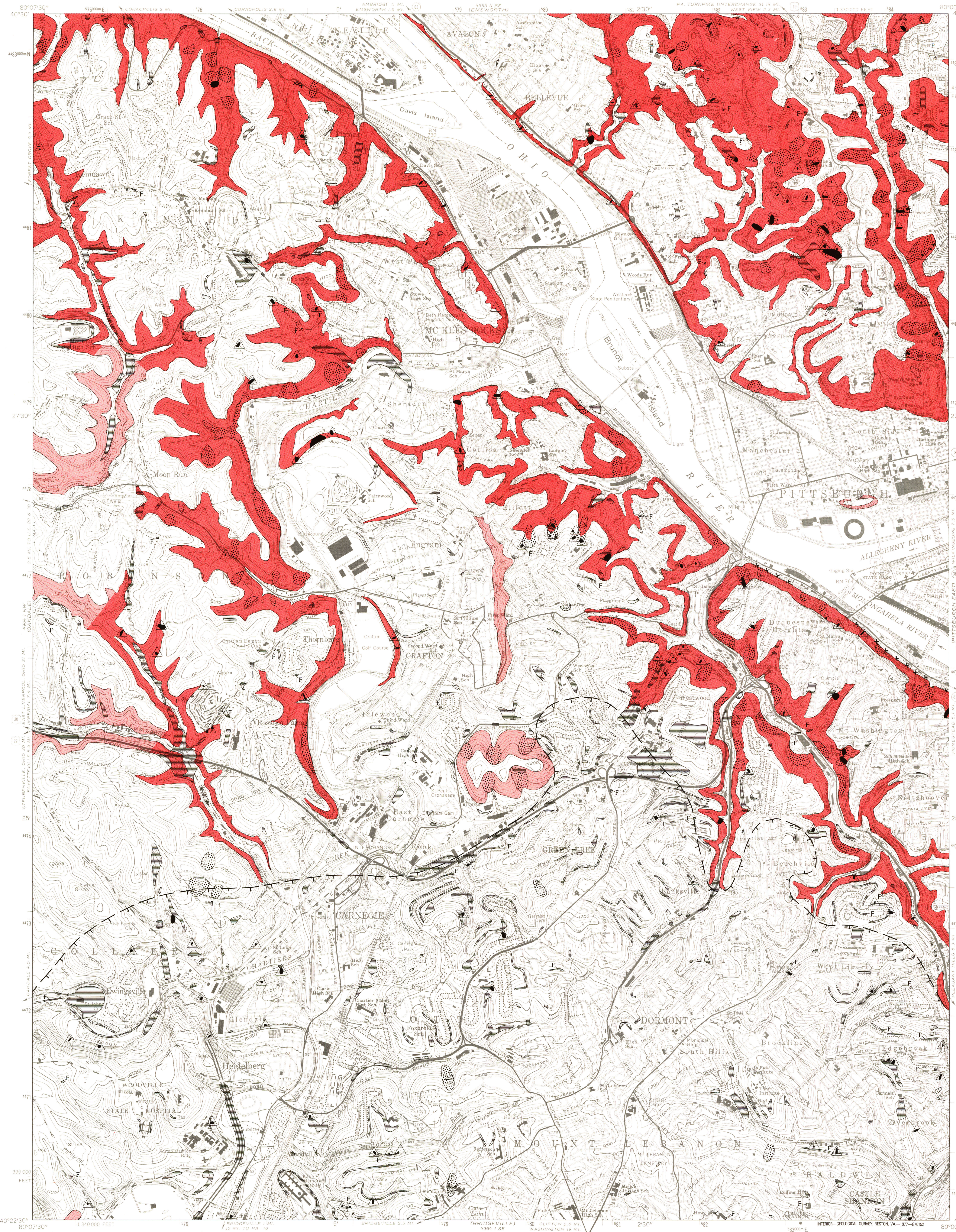



Base by U.S. Geological Survey, 1969
Photorevision as of 1969
10,000-foot grid based on Pennsylvania coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 17

UTM GRID AND 1969 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1977—G76152

## EXPLANATION

RECENT LANDSLIDES—Predominantly slumps and earthflows (fig. 4 *B, C*) historically recorded or characterized by fresh scars observed in 1974. Small landslides enclosed by triangles

PREHISTORIC LANDSLIDES—Predominantly slumps and earthflows (fig. 4 *B, C*) characterized by uneven, hummocky ground surfaces and slump benches; relatively stable in natural undisturbed state, but can be reactivated by excavation, loading, or changes in ground-water and surface-water conditions. Areas shown probably include some recent undocumented landslides and landslides not recognized during field reconnaissance

SLOPES WITH MODERATE TO SEVERE SUSCEPTIBILITY TO LANDSLIDING—Chiefly areas underlain by thick redbeds and associated rocks of the Glenshaw and Casselman Formations. Red mudstone weathers rapidly on exposure; landsliding and creep (fig. 4*A, E*) often occur in thick reddish clayey soil. Prominent redbeds ("Pittsburgh redbeds") are below the Ames Limestone Member of the Glenshaw, and a lesser known sequence ("Clarksburg redbeds") is above the Ames Limestone Member. Generally cuts and fills in redbeds are not stable

SLOPES WITH SLIGHT TO MODERATE, LOCALLY SEVERE, SUSCEPTIBILITY TO LANDSLIDING—Chiefly areas underlain by weathered claystone and shale of the Casselman and Pittsburgh Formations on which landsliding is infrequent; soil creep, however, is conspicuous. Overloading caused by improper placement of fills or structures can greatly accelerate slope movement

GROUND WITH HIGHLY VARIABLE SLOPE CONDITIONS—Ground on side with ticks has been disturbed by earth-moving operations related to residential and commercial development and to surface mining of coal. Redbeds are relatively rare. Complex zones of thin to locally thick, stable to unstable soil and weathered rock mantle this area. These conditions combine to prevent consistent classification of slopes on the basis of soil creep. Largely underlain by rocks of the Monongahela and lower part of the Dunkard Groups

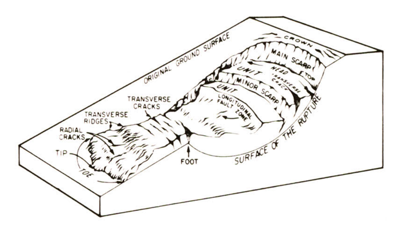
× × × STEEP SLOPES MOST SUSCEPTIBLE TO ROCKFALL—Steep, locally vertical, natural and manmade slopes and cliffs 15 ft (4.5 m) to more than 150 ft (45 m) high exposing layers of sandstone, subordinate limestone and flaggy, sandy shale, and interbedded claystone and shale. Sandstone and limestone are often highly fractured and are undercut by relatively rapid weathering of claystone and shale (fig. 4 *D*)

GROUND WITH LITTLE SUSCEPTIBILITY TO LANDSLIDING—Slopes commonly exhibit slight soil creep but are susceptible to significant landsliding only where extensively modified by man (see map area 1.2 mi (2 km) southwest of Brunot Island

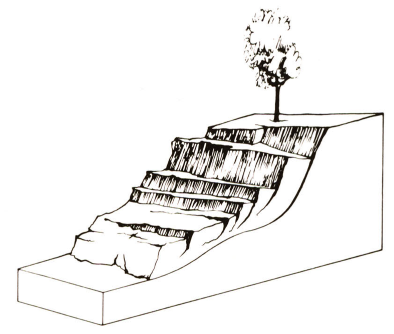
F MANMADE FILL—Heterogeneous soil and rock material with variable susceptibility to slope failure depending on nature of material, foundation conditions, design, and construction. Fills in redbed areas commonly contain red bedrock and soil which rest on redbeds and, therefore, are less stable than similarly constructed fills in other areas. Fills in older urbanized areas and fills resulting from mining are shown only where associated with significant recent landslides. Many fills are too small to show by pattern and are identified by letter "F"

Area boundary

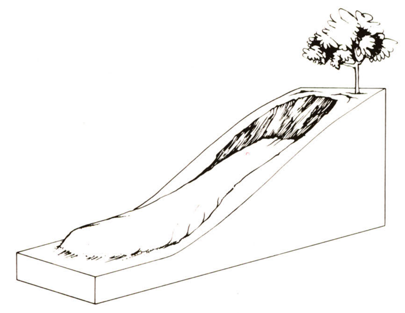
Variations in slope sensitivity may occur at any point within a unit. The boundaries shown on this map are largely inferred; at this scale they are gradational over tens and locally hundreds of feet, so their locations are approximate. Information given is intended as a general guide to potential problem sites and should not be construed as applicable to all localities within the area shown. This map cannot be used as a substitute for detailed engineering investigations of specific sites.



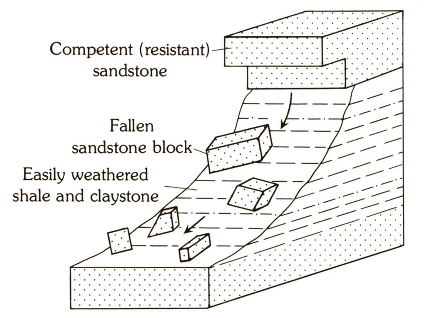

*A*, Nomenclature of parts of a landslide (from Eckel, 1958).



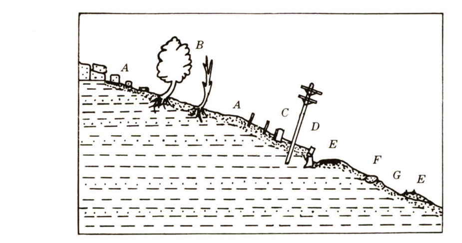
*B*, Slump: coherent or intact masses that move downslope by rotational slip on surfaces that underlie as well as penetrate the landslide deposit (from Nilsen, 1972).



*C*, Earthflow: colluvial materials that move downslope in a manner similar to a viscous fluid (from Nilsen, 1972).




*D*, Rockfall: rock masses that move primarily by falling through the air (from Pomeroy, 1974a).



*E*, Creep: common evidences include: (*A*) moved joint blocks of layered rock; (*B*) trees with curved trunks concave upslope; (*C*) displaced posts, poles, and monuments; (*D*) broken or displaced retaining walls and foundations; (*E*) roads and railroads moved out of alignment; (*F*) turf rolls downslope from creeping boulders; (*G*) stone-line at approximate base of creeping soil (modified from Sharpe, 1938).

FIGURE 4.—Diagrammatic representation of mass movement phenomena.


# LANDSLIDE SUSCEPTIBILITY MAP OF THE PITTSBURGH WEST QUADRANGLE, ALLEGHENY COUNTY, PENNSYLVANIA

By
John S. Pomeroy
1977







For sale by Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202