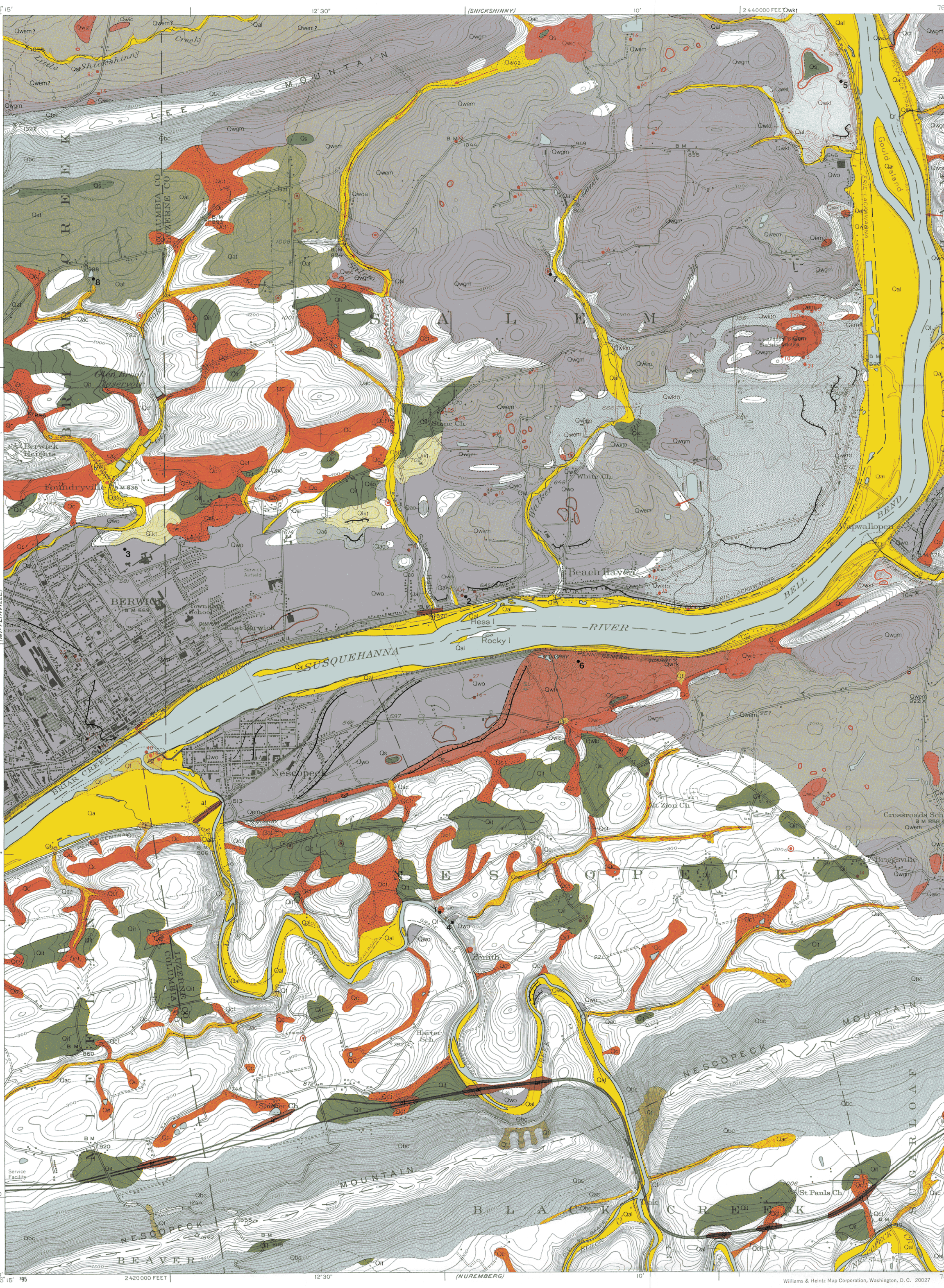
TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, *State Geologist*

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES



Williams & Heintz Map Corporation, Washington, D.C. 20027

Base map from U.S. Geological Survey Berwick 7½-minute quadrangle.

Geology based on field mapping during 1976-77. Woodfordian morainal deposits mapped by G. W. Crowl (slightly modified by Inners).

Albert E. VanOlden, Cartographer

SURFICIAL GEOLOGIC MAP OF THE BERWICK QUADRANGLE, LUZERNE AND COLUMBIA COUNTIES, PENNSYLVANIA

BY JON D. INNERS

1978

APPROXIMATE MEAN DECLINATION, 1969

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

Figure 1. Convoluted sharpstone colluvium derived from greenish-gray sandstone and silty clay shale of Irish Valley Member (Catskill Formation), cut on Nescopeck Township Route 376, 0.4 mile (0.6 km) north of Zenith, Luzerne County (41°02'09"N/76°11'34"W). Convolutions suggest formation under permafrost conditions in a periglacial environment. Hammer is 11 inches (27.9 cm) long.

Figure 2. Typical bedding and sorting variations in Woodfordian outwash, abandoned gravel pit on north side of U. S. Route 11, about 0.75 mile (1.2 km) west of Beach Haven, Luzerne County (41°04'03"N/76°11'21"W). Note current rippling in lenticular sand bed. Hammer is 11 inches (27.9 cm) long.

Figure 3. Cobbly Woodfordian outwash of 575-foot (175-m) terrace, excavation for foundation of Immaculate Conception B.V.M. Church, about 600 feet (183 m) north of Berwick Borough line, Briar Creek Township, Columbia County (41°04'19"N/76°14'02"W).

Figure 4. Cut in Woodfordian outwash terrace (Qwo) on east side of Nescopeck Creek, 0.35 mile (0.56 km) north of Zenith, Nescopeck Township, Luzerne County (41°02'05"N/76°11'27"W). Note imbrication of large tabular sandstone blocks (upstream to right). Up to 4 feet (1.2 m) of grayish-red shale-chip colluvium (Qc) overlies gravel. Shovel (marked by arrow) is 27 inches (0.7 m) long; exposed face is about 20 feet (6.1 m) high.

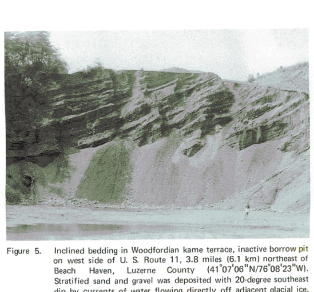


Figure 5. Inclined bedding in Woodfordian kame terrace, inactive borrow pit on west side of U. S. Route 11, 3.8 miles (6.1 km) northeast of Beach Haven, Luzerne County (41°07'06"N/76°08'23"W). Stratified sand and gravel was deposited with 20-degree southeast dip by currents of water flowing directly off adjacent glacial ice.

Figure 6. Torrential bedding in Woodfordian frontal-kame deposits, Honey Hole Sand and Gravel Company pit, south side of Susquehanna River, 2 miles (3.2 km) east of Nescopeck, Luzerne County (41°03'39"N/76°10'29"W). Note poor sorting in cobbly gravel beds and coal streaks in sand. Shovel is 27 inches (0.7 m) long.

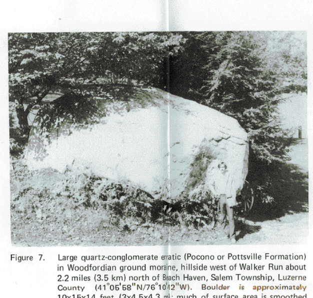


Figure 7. Large quartz-conglomerate erratic (Pocono or Pottsville Formation) in Woodfordian ground moraine, hillside west of Walker Run about 2.2 miles (3.5 km) north of Beach Haven, Salem Township, Luzerne County (41°05'58"N/76°10'12"W). Boulder is approximately 10x15x14 feet (3x4.5x4.3 m); much of surface area is smoothed and polished. Underlying bedrock is gray sandstone, siltstone, and shale of Trimmers Rock Formation.

Figure 8. Grayish-red, compact Altonian till in eroded gully, east side of small earth dam on tributary of Glen Brook, 1.35 miles (2.2 km) north of Foundryville, Columbia County (41°05'56"N/76°14'17"W). Note unsorted nature of till and abundance of subrounded pebbles. Hammer is 11 inches (27.9 cm) long.

EXPLANATION

	GEOLOGIC DESCRIPTION	UNIT	ENVIRONMENTAL CHARACTERISTICS
HOLOCENE	Compacted embankments of mixed surficial and rock materials, usually locally derived. Thickness variable, ranges up to 100 feet (30 m).	ARTIFICIAL FILL af	No water resource potential. Inclination of stable slopes dependent on materials: rock-fragment slopes generally have moderate to high stability at angles greater than 25 degrees; fill slopes formed by surficial materials must be vegetated to maintain slope of about 25 degrees. Easy to moderately difficult excavation with light machinery. No mineral resource potential.
HOLOCENE	Mostly sand, silt, and gravel, with some cobbles and boulders; coarsest material occurs along tributary streams having steep gradients; unconsolidated and stratified; poorly to moderately well sorted, with pebbles, cobbles, and boulders mostly subangular to well rounded, often angular in alluvial fans; poorly bedded, silty fine sand, up to 10 feet (3 m) thick, commonly forms surface layer along Susquehanna River; pockets of stiff, silty clay locally present; abundant particulate anthracite coal in sizes ranging from silt to small pebbles in deposits along Susquehanna River, Nescopeck Creek, and Black Creek. Surface of deposits flat to gently rolling and gently sloping; forms broad floodplains along Susquehanna River and Nescopeck Creek (where alluvium commonly overlies Woodfordian outwash), narrow floodplains on some tributary streams (alluvium, and alluvium and Woodfordian outwash, undivided), and fan-shaped deposits at mouths of many streams (alluvial fan). Mostly less than 6 feet (1.8 m) thick in tributary valleys, but 10 to 40 feet (3 to 12 m) thick in valley of Susquehanna River.	ALLUVIUM Qal ALLUVIAL FAN Qf ALLUVIUM AND WOODFORDIAN OUTWASH, UNDIVIDED Qwoa	Moderate to high infiltration capacity. Low aquifer potential, because of limited thickness and susceptibility to surface pollution; wells drilled through alluvial materials will require special completion techniques to prevent pollution of bedrock aquifer. Low stability in cut slopes greater than 25 degrees; silty sands are easily eroded, but pebbly and cobbly beds form armor on many stream bottoms. Readily excavated with light machinery. Low to moderate foundation support strength, suitable for light structures only; foundations can usually be excavated to bedrock. Rapid drilling rates, except where large boulders are encountered. Unsuitable for septic systems and sanitary landfills because of high infiltration rate and high water table. Susceptible to flooding. Possible source of sand and gravel; limited potential for small supplies of particulate anthracite coal.
HOLOCENE	Organic silty clay with some peat; brownish black to medium gray; water-saturated in natural state. Surface of deposits flat to slightly hummocky; occurs mostly in undrained and poorly drained depressions in glaciated terrain. Thickness unknown.	SWAMP DEPOSIT Qs	Swamp conditions. No aquifer potential. Very low cut-slope stability. Easily excavated with light machinery. Highly compressible. Unsuitable for any structure because of lack of bearing strength. Unsuitable for septic systems or sanitary landfills because of high water table. Possible source of peat for agricultural purposes.
HOLOCENE / PLEISTOCENE	Fragmental material derived principally from local bedrock and transported downslope mainly by force of gravity (colluvium); but mixed with alluvial materials on floors of many small valleys (alluvium and colluvium, undivided) or with till on some slopes and in numerous ravines (colluvium and till, undivided); unconsolidated; unstratified to crudely stratified; unsorted to moderately sorted, with size range of fragments dependent on fragmentation characteristics of source; mostly angular to subangular clasts, with silty clay matrix (Figure 1). Fills small valley and headwater areas and also occurs as moderately sloping aprons and gently sloping lobate masses at base of prominent scarps and on valley sides. Thickness variable, generally less than 10 feet (3 m), but locally may be much thicker.	ALLUVIUM AND COLLUVIUM, UNDIVIDED Qac COLLUVIUM Qc COLLUVIUM AND TILL, UNDIVIDED Qct	Moderate to high infiltration capacity. Low aquifer potential, because of limited areal extent and thickness of deposits. Locally a source of small springs. Low stability in cut slopes greater than 25 degrees; subject to slumping and severe erosion. Easily excavated with light machinery. Low to moderate foundation support strength; generally suitable for light structures only. Fast drilling rates. Usually unsuitable for septic systems or sanitary landfills because of moderately high infiltration rate, excessively steep slopes, and/or high water table. Locally may be source of shale- or rock-fill material.
PLEISTOCENE	Fine sand and silt; unconsolidated, poorly stratified; generally dark yellowish orange to moderate yellowish brown; occurs as discontinuous blanket over much of quadrangle; locally interbedded with colluvium. Generally less than 2 feet (0.6 m) thick, but locally may be considerably thicker; mapped only at scattered locations where 6 feet (1.8 m) or more were observed banked against steep slopes, and at site of Susquehanna Steam Electric Station, where thicknesses of 5 to 30 feet (1.5 to 9 m) were recorded in test borings.	EOLIAN MANTLE Qem	No water resource potential. Low stability in cut slopes greater than 25 degrees; thick deposits form blocky landslides where undercut. Very easily excavated with light machinery. Very low foundation support strength, but deposits are usually too thin to influence foundation conditions. Generally not a significant factor in siting of septic systems and sanitary landfills; should be stripped from surface before construction begins. Locally may be a source of sand for construction purposes.
PLEISTOCENE	Mostly sandstone and conglomerate cobbles and boulders; no interstitial matrix in talus; mixed sand, silt, and clay matrix in boulder colluvium; unsorted to poorly sorted; clasts angular to subrounded, mostly 0.5 to 3 feet (15 cm to 0.9 m) in diameter, with largest clasts commonly concentrated on surface of ground. Surface moderately to steeply sloping; broad blanket on mountain slopes (boulder colluvium) or sheets and narrow tongues, mostly on steep slopes below outcrops of bedrock ledges (talus). Thickness variable, usually less than 5 feet (1.5 m), but may exceed 10 feet (3 m) locally.	TALUS Qt BOULDER COLLUVIUM Qbc	High infiltration capacity. No groundwater potential. Locally a source of small springs. Generally low to moderate stability in cut slopes greater than 25 degrees; because of natural high slope angle, talus subject to massive rock slides if undercut or otherwise disturbed. Difficult excavation with light machinery. Low to moderate foundation support strength, generally suitable for light structures only. Fast to moderate drilling rates; some problems caused by boulders. Unsuitable for septic systems and sanitary landfills because of high infiltration rate and steep slopes. Economic potential limited to use as riprap.
PLEISTOCENE	Predominantly sand, gravel, and cobbles, with some boulders; unconsolidated and stratified; mostly moderately to well sorted, with considerable variation in grain size and sorting between adjacent beds (Figures 2 and 3); profusely rippled and crossbedded, with frequent channel cut-outs; cobbles and boulders mostly rounded, but large clasts may be angular where nearby tributary streams supplied coarse debris (Figure 4); sand beds rich in particulate anthracite coal are common; pebbles of igneous and metamorphic rocks are locally abundant; beds are often inclined 15 to 30 degrees in kame terrace deposits (Figure 5), subhorizontal in outwash; may contain beds of varved sand, silt, and clay deposited in ice-marginal lakes (Woodfordian kame terrace) or massive silty clay deposited in undrained or poorly drained depressions. Forms high, discontinuous pitted terraces at elevations between 640 and 660 feet (195 and 200 m) on Susquehanna River upstream of Woodfordian glacial limit (Woodfordian kame terrace), and nearly flat to gently sloping, locally pitted terraces at elevations between 510 and 640 feet (155 and 195 m) on Susquehanna River and Nescopeck Creek (Woodfordian outwash). Kame terrace and outwash deposits are not differentiated on northwest side of Susquehanna River at Bell Bend (Woodfordian kame terrace and outwash, undivided). Thickness ranges from less than 10 feet (3 m) beneath low outwash terraces to over 100 feet (30 m) beneath high outwash and kame terraces.	WOODFORDIAN OUTWASH Qwo WOODFORDIAN KAME TERRACE Qwkt WOODFORDIAN KAME TERRACE AND OUTWASH, UNDIVIDED Qwkto	High infiltration capacity. Low to high aquifer potential, but water is subject to pollution from surface sources; wells drilled through these unconsolidated materials to reach bedrock aquifer will require special well completion techniques to prevent pollution. Source of water recharge for underlying bedrock formations. Low stability in cut slopes greater than 25 degrees. Generally easy excavation with light machinery, but thick boulder and cobble beds may cause difficulties. Moderate foundation support strength, generally suitable for heavy structures with properly designed foundations; possibility of encountering buried compressible clays. Rapid drilling rate, some problems with boulders and large cobbles. Unsuitable for septic systems or sanitary landfills because of high permeability. Excellent source of sand and gravel for construction purposes.
PLEISTOCENE	Sand, gravel, cobbles, and boulders; unconsolidated and stratified; poorly to moderately well sorted, with many boulders 5 feet (1.5 m) or more in diameter; larger clasts subangular to well rounded; extreme bed-to-bed variations in grain size and sorting (Figure 6); gravel beds lenticular, poorly bedded, mostly planar(?) with frequent channel cut-outs; sand beds lenticular, rippled, and crossbedded. Forms high, terrace-like mound on south side of Susquehanna River about 2 miles (3.2 km) east of Nescopeck; surface of deposit gently rolling, has relief up to 20 feet (6 m); many poorly drained depressions. Up to 180 feet (55 m) thick.	WOODFORDIAN FRONTAL KAME Qwfk	High infiltration capacity. Low to moderate aquifer potential for domestic supply, but water is subject to surface pollution; wells drilled to tap bedrock aquifer beneath kame will require special completion techniques to prevent pollution from surface sources. Low to moderate stability in cut slopes greater than 25 degrees. Moderately easy excavation with light machinery, although large boulders can pose problems. Moderate foundation support strength, generally suitable for heavy structures with properly designed foundations. Erratic drilling rates because of boulders. Unsuitable for septic systems or sanitary landfills because of high infiltration rate. Excellent source of sand and gravel for construction purposes.
PLEISTOCENE	Mostly sand, gravel, and cobbles, with some boulders; unconsolidated and stratified; individual beds generally moderately to well sorted, but with considerable variation in grain size and sorting in adjacent beds; profuse ripple bedding and crossbedding, with numerous small faults caused by slumping at sites of melted ice blocks; large clasts subangular to well rounded; locally contains varved sand, silt, and clay deposited in ice-marginal lakes. Surface of deposits smoothly rounded to intensely pitted; occurs mostly as knobby to elongate hills (kames) with local relief up to 20 feet (6.1 m). Thickness ranges up to about 25 feet (8 m) on uplands and possibly up to 100 feet (30 m) in Susquehanna Valley.	WOODFORDIAN ICE-CONTACT STRATIFIED DRIFT Qwic	High infiltration capacity. Low aquifer potential because of limited areal extent. Low stability in cut slopes greater than 25 degrees. Easily excavated with light machinery. Low to moderate foundation support strength, generally suitable for light structures only; possibility of encountering compressible lacustrine clays. Fast drilling rates, except where boulders are encountered. Generally poor material for siting of septic systems and sanitary landfills because of high infiltration rate. Local source of sand and gravel.
PLEISTOCENE	Till; unsorted mixture of clay, silt, sand, and gravel, with many cobbles and boulders; boulders are commonly 3 feet (1 m) or more in diameter and range up to 15 feet (4.5 m) (Figure 7); yellowish brown to reddish brown; large clasts angular to well rounded; compact, moderately cohesive. Very vague depositional topography; surface of deposits relatively smooth, generally conforming to topography of underlying bedrock. Thickness less than 25 feet (8 m), probably averaging 10 to 15 feet (3 to 4.5 m).	WOODFORDIAN GROUND MORAINE Qwgm	Low to moderate infiltration capacity. Low aquifer potential. Low slope stability in cut slopes greater than 25 degrees; landslides may occur on steep natural slopes, e.g., along unnamed tributary on east side of Susquehanna River opposite north end of Gould Island (41°06'56"N/76°07'31"W). Usually easily excavated with light machinery, although some large boulders may be encountered. Moderate foundation support strength, suitable for heavy structures with properly designed foundation. Erratic drilling rates because of boulders. Probably satisfactory in some areas for septic systems, but should be thoroughly investigated because of low permeability. Suitable for sanitary landfill sites if deposit is thick enough to provide adequate blanket over permeable bedrock or surficial materials. Local source of artificial fill.
PLEISTOCENE	Till; unsorted mixture of clay, silt, sand, gravel, cobbles, and boulders; boulders often 3 feet (1 m) or more in diameter; moderate brown, yellowish brown, and reddish brown; large clasts angular to well rounded; compact and cohesive to moderately friable; contains considerable undifferentiated stratified sand and gravel (Qwem?) in Shickshinny Valley (northwestern corner of quadrangle). Well-developed depositional topography; surface is hummocky, with many closed depressions (kettles); local relief commonly 10 to 15 feet (3 to 4.5 m). Up to 100 feet (30 m) thick.	WOODFORDIAN END MORAINE Qwem	Low to high infiltration capacity. Generally low aquifer potential, although adequate domestic supply may be locally obtainable where deposits are thick and sandy. Low stability in cuts steeper than 25 degrees. Easily excavated with light machinery, except where large boulders are encountered. Moderate foundation support strength, suitable for heavy structures with properly designed foundations. Generally unsuitable for septic systems or sanitary landfills because of great variability in materials and permeability. Potential source of artificial fill.
PLEISTOCENE	Mostly sand and gravel, with a few cobbles and boulders; unconsolidated and stratified; moderate brown to orangish brown; pebble-sized and larger clasts are well rounded, unweathered to slightly weathered. Forms narrow, flat terraces at elevation of 650 feet (198 m) on north side of Susquehanna Valley, west of Salem Creek, and also caps low, rounded bedrock knobs in same area. Thickness probably ranges from 5 to 20 feet (1.5 to 6 m).	ALTONIAN OUTWASH Qao	No groundwater potential because of limited areal extent. Low stability in cut slopes greater than 25 degrees. Easily excavated with light machinery. Low to moderate foundation support strength, generally suitable for light structures only. Fast drilling rates. Unsuitable for septic systems or sanitary landfills because of high infiltration rate, generally shallow depth to bedrock, and narrow width of terraces. Very limited source of sand and gravel.
PLEISTOCENE	Till; unsorted mixture of clay, silt, sand, gravel, cobbles, and some boulders (Figure 8); usually reddish brown to orangish brown, locally light gray; pebble-sized and larger clasts are angular to well rounded, may be moderately weathered depending on lithology, often exhibiting weathering rinds to about 0.25 inch (0.6 cm) thick; sparsely developed weathering prisms. Vague depositional topography locally preserved; surfaces often gently rolling and have some ill-defined closed depressions; forms continuous belt 1 to 1.5 miles (1.6 to 2.4 km) wide south of Lee Mountain. Thickness normally 5 to 10 feet (1.5 to 3 m), but ranges up to 75 feet (23 m).	ALTONIAN TILL Qat	Low to moderate infiltration capacity. Low aquifer potential. Low stability in cut slopes greater than 25 degrees. Easy to difficult excavation with light machinery; may be extremely dense hardpan locally. Moderate foundation support strength, suitable for heavy structures with properly designed foundations. Fast drilling rates, although boulders may cause problems. Generally unsuitable for septic systems because of low infiltration capacity. Probably suitable for sanitary landfills if deposit is thick enough to adequately blanket underlying permeable bedrock. Potential source of impervious fill material.
PLEISTOCENE	Poorly sorted mixture of clay, silt, sand, and pebbles with some cobbles and boulders; unconsolidated and crudely stratified; reddish brown to orangish red; matrix generally slightly plastic. Larger clasts well rounded; most have weathering rinds to about 0.5 inch (1.3 cm) thick; some are soft and decomposed. Forms flat terraces on north side of Susquehanna Valley at elevation of about 700 feet (215 m). Thickness uncertain, probably 10 to 25 feet (3 to 8 m).	ILLINOIAN KAME TERRACE Qikt	Moderate infiltration capacity. Poor aquifer potential because of limited areal extent and small recharge area. Low stability in cut slopes greater than 25 degrees. Easily excavated with light machinery. Low to moderate foundation support strength, generally suitable for light structures only. Rapid drilling rates. Suitable for septic systems. Although material has satisfactory properties, geographic position and limited areal extent of terraces preclude use as sites for sanitary landfills. Possible source of moderately permeable and readily compactible fill material.
PLEISTOCENE	Till; unsorted mixture of clay, silt, sand, and pebbles, with some cobbles and boulders; compact and clayey; reddish brown to light gray and yellowish gray; pebble-sized and larger clasts are angular to well rounded, and most have weathering rinds 0.25 to 0.5 inch (0.6 to 1.3 cm) thick; siltstone pebbles commonly rubified (altered to reddish coloration); characteristically contains frequent light- to dark-gray chert pebbles; weathering prisms are prominently developed. No depositional landforms; forms discontinuous patches on uplands north and south of Susquehanna River in west-central and southern portions of quadrangle. Locally may attain thickness of 35 feet (11 m), but generally is less than 10 feet (3 m) thick.	ILLINOIAN TILL Qit	Low infiltration capacity. Low aquifer potential. Low stability in cut slopes greater than 25 degrees. Easy to difficult excavation with light machinery; may be extremely dense hardpan locally. Moderate foundation support strength, suitable for heavy structures with properly designed foundations; foundations can usually be excavated to bedrock. Rapid drilling rates, but some boulders may be encountered. Generally unsuitable for septic systems because of low infiltration capacity. Probably suitable for sanitary landfill sites if deposit is thick enough to form adequate blanket over underlying permeable bedrock. Limited source of impervious fill material.

SYMBOLS

Contact
Dashed where approximately located; dotted where inferred.

Major — Minor — Bedrock channel with potholes
Meltwater channel

Spring

Thickness, in feet, of surficial deposits in water wells and bore holes

Top — Base
Terrace scarp

Glacial striation
Showing inferred direction of glacial flow.

Landslide scarp

Kettle hole

Erratic boulder

Location of photograph shown on this plate
Number corresponds to figure number.

LOCATION OF AREA