DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY
DIVISION OF SCIENCE AND RESEARCH
NEW JERSEY GEOLOGICAL SURVEY

SURFICIAL GEOLOGY OF THE PRINCETON QUADRANGLE
MERCER AND MIDDLESEX COUNTIES, NEW JERSEY
OPEN FILE MAP NO. 11

INTRODUCTION

Surficial materials in the Princeton quadrangle include wetland, hillslope, and windblown deposits, several generations of alluvial deposits, and weathered bedrock materials. These materials occur within a landscape sculpted by two major episodes of valley incision and dissection, accompanied by several major drainage shifts. The deposits are delineated on the map and sections and are described below. The large-scale erosional landforms are shown on figure 1, and small-scale erosional landforms such as fluvial scarps and rock-cut terraces are delineated on the map. The temporal relationships of the deposits and landforms are shown on the correlation chart.

DESCRIPTION OF MAP UNITS

af — **ARTIFICIAL FILL**--Excavated bedrock and surficial material, and discarded man-made material (construction debris, cinders, ash, and trash). As much as 30 feet thick. Many small areas of fill, particularly in urban areas, are not mapped.

Deposits in Modern Valleys (Holocene and Pleistocene)-This suite of deposits occurs in floodplains, terraces, wetlands, and on gentle valley-side slopes within modern valleys. It includes sediments of postglacial origin (units Qal, Qs, part of Qald and Qcal), of glacial origin (Qtt), and of periglacial origin (Qts, Qtc, Qaf, Qe, part of Qald and Qcal). The postglacial deposits are of Holocene and latest Pleistocene age. The glacial and periglacial deposits are primarily of Late Pleistocene age (the late Wisconsinan and, possibly, Illinoian glaciations).

Qal — **ALLUVIUM**--Silt, sand, clay, and pebble-to-cobble gravel. Moderately- to well-sorted, stratified. Contains variable but generally minor amounts of organic matter and peat. Color of fine sediment is brown and reddish brown in deposits derived from mudstone and sandstone, brown and yellowish brown in deposits derived from unit TQb and Coastal Plain formations. In deposits derived from mudstone and sandstone, the gravel consists of subangular to subrounded chips, flagstones, pebbles, and cobbles of mudstone and sandstone, with minor subrounded pebbles and cobbles of diabase and quartz, quartzite, and chert from units TQb and TQp in basins containing those units. In deposits derived from unit TQb and Coastal Plain formations, the gravel consists of subrounded to rounded quartz, quartzite, chert, and ironstone. Generally, overbank deposits of fine sediment overlie gravelly channel deposits. The overbank deposits are dominant in wide, gently-sloping floodplains; the channel deposits are dominant in narrow, steep floodplains. Total thickness of alluvium is as much as 20 feet in main valleys, 10 feet in tributary valleys (estimated). Unit may include some small deposits of colluvium (unit Qcsl) in narrow upland valleys in the area north and west of Routes 206 and 27.

Qs — **SWAMP AND MARSH DEPOSITS**--Black to brown peat overlying gray to dark gray silt and clay containing organic matter. Maximum thickness 10 feet (Neumann, 1976). Deposited in abandoned valleys after deposition of units Qtt and Qtc ceased and glacio-isostatic rebound began to reverse local drainages. These events likely occurred sometime between 14,000 and 10,000 years ago.

Qald — **ALLUVIUM AND DIABASE BOULDER LAG**--Silt, sand, minor clay and organic matter, dark brown to brown, moderately-sorted and weakly stratified; overlying and alternating with surface concentrations (lags) of rounded to subrounded diabase boulders and cobbles formed by winnowing of weathered diabase. Maximum thickness 10 feet (estimated). In places where valley gradients are steep, unit consists of boulder fields with little fine sediment.

Qcal — **COLLUVIUM AND ALLUVIUM, UNDIVIDED**--Gravelly, mudstone- or diabase-rich alluvium as in unit Qal, and colluvium as in units Qcsl and Qcd, filling the bottoms of narrow, steep tributary valleys in the upper Stony Brook basin and north of Mount Rose. Maximum thickness 10 feet (estimated).

Qe — **EOLIAN DEPOSITS**--Reddish yellow to yellow silt and fine sand in the Millstone River, Stony Brook, and Shipetaukin Creek valleys, as much as 5 feet thick but generally less than 3 feet thick; and yellow fine sand, slightly micaceous, in Central Mercer County Park, as much as 10 feet thick. Well-sorted, nonstratified to weakly stratified. These windblown deposits were probably blown from the unvegetated surfaces of units Qtt and Qtc under periglacial conditions during the late Wisconsinan and, possibly, Illinoian, glaciations.

Qaf — **ALLUVIAL FAN DEPOSITS**--Gravel, silt, and sand. Moderately-sorted, stratified. Color of fine sediment reddish brown to brown. Gravel consists of subangular to subrounded chips, flagstones, pebbles, and cobbles of mudstone and sandstone. As much as 10 feet thick (estimated).

Qtt — **TRENTON GRAVEL**--Sand, silt, pebble gravel, minor cobble gravel. Well- to moderately-sorted, stratified. Color of fine sediment is reddish brown to reddish yellow, pale brown, and light gray. Sand is chiefly quartz and rock fragments, with some feldspar and a little mica. Gravel includes, in approximate order of abundance, gray and brown mudstone and sandstone, quartz, quartzite, chert, reddish brown mudstone and sandstone, and gneiss. The gray and brown mudstone and sandstone and the gneiss are derived chiefly from bedrock in the Delaware valley; the other clasts are derived chiefly from units TQb and TQp and from local bedrock. Some sandstone and gneiss clasts may have a thin weathering rind, otherwise the clasts are unweathered. Forms terraces 5 to 10 feet above the modern floodplain. As much as 30 feet thick.

This deposit is a northeasterly extension of the late Wisconsinan glaciofluvial gravel of the Delaware valley. It was termed the "Trenton gravel" by Cook (1880), and was included in the Cape May Formation by Bascom and others (1909a). The Cape May has recently been subdivided and redefined in its type area (Newell and others, 1989) and no longer includes glacial deposits, so the name is not used here. Owens and Minard (1975, 1979) renamed the deposits the "Spring Lake beds". They considered it to be an interglacial deposit of Sangamon age by correlation to an estuarine clay near Camden (the "Fish House clay" of Woolman, 1897). Mapping and field descriptions by Salisbury and Knapp (in Bascom and others, 1909b) show that the Trenton gravel in the Camden area forms a terrace cut into and below the Fish House clay, demonstrating that it is younger than Sangamon. Thus, the correlation and nomenclature of Owens and Minard (1979) is not used here, and the original nomenclature of Cook (1880) is reinstated.

The Trenton gravel terrace extends northeasterly from the plain at Trenton, across the low Delaware-Millstone divide at Port Mercer, and down the lower Millstone valley to Manville, about 16 miles northeast of Princeton, where it merges with glaciofluvial deposits in the Raritan valley. From Trenton to Manville the surface of the terrace maintains a nearly constant elevation of about 60 feet. When adjusted for the effects of postglacial crustal rebound, which has raised the northern end of the terrace relative to the southern end, an even slope down the Delaware valley, across the divide at Port Mercer, and down the Millstone valley, results (Stanford, 1990). This reconstruction indicates that during the late Wisconsinan glaciation (which reached its maximum about 20,000 years ago), with the earth's crust depressed to the north by the weight of the glacier, glacial meltwater in the Delaware valley was partially diverted down the lower Millstone and deposited unit Qtt. A similar diversion may have occurred during the Illinoian glaciation (about 150,000 years ago), but Illinoian sediments within unit Qtt have not been observed in the Princeton quadrangle.

Upon deglaciation, crustal rebound gradually flattened the terrace gradient northeast of Trenton. Eventually, drainage across the divide at Port Mercer stopped, and valleys V2, V3, and V4 (fig. 1) were abandoned. A radiocarbon date of 10,430±1160 years (I-16,554, plotted on map) on basal peat directly overlying the Trenton gravel on the divide at Port Mercer is a minimum date for valley abandonment.

Qtc — **TERRACE DEPOSITS, COASTAL PLAIN PHASE**--Sand and pebble gravel, minor silt and clay. Well-sorted, stratified. Color of fine sediment is pale brown, yellow, light gray, gray, and brown. Sand is chiefly quartz but includes some mica and glauconite. Gravel is chiefly quartz and quartzite, with minor chert and ironstone and a little gray mudstone near contact with unit Qtt. The sand is derived from Coastal Plain formations and unit TQb; the gravel is derived chiefly from unit TQb. Forms terraces 5 to 10 feet above the modern flooplain. As much as 30 feet thick. Qtc terraces are on grade with Qtt terraces, and Qtc interfingers with Qtt along their contact. These relationships indicate that the units are largely contemporaneous, and that Qtc was deposited under periglacial conditions as deposition of Qtt in the Assunpink-Millstone lowland caused valley aggradation in tributary valleys.

Qts — **TERRACE DEPOSITS, MUDSTONE AND SANDSTONE PHASE**--Gravel, sand, and silt. Moderately-sorted, stratified. Color of fine sediment is reddish brown to brown. Sand is chiefly quartz and rock fragments, with some feldspar and a little mica. Gravel consists of subangular to subrounded chips, flagstones, pebbles, and cobbles of chiefly mudstone and sandstone, with some quartz, quartzite, and chert in the deposit along Shipetaukin Creek and minor diabase in the Stony Brook deposits. Forms terraces 5 to 10 feet above the modern floodplain. As much as 15 feet thick (estimated). Age relationships and origin same as unit Qtc.

Deposits that Predate the Formation of Modern Valleys (Late Miocene?-Early Pleistocene?)--These sediments were deposited by former streams not directly related to the modern drainage network. They are extensively dissected and deeply weathered. They are generally preserved as erosional remnants on hilltops and divides, although they are still continuous in the southeastern corner of the map, where they are thick.

Bascom and others (1909a) included these deposits with the Pensauken Formation, which is the lower yellow gravel of the Delaware valley south of Trenton (Salisbury and Knapp, 1917). Owens and Minard (1975, 1979) divided these deposits into an upper and a lower unit. They correlated the lower unit with the Pensauken Formation, and the upper unit with the Bridgeton Formation, which is the upper yellow gravel of the Delaware valley south of Trenton (Salisbury and Knapp, 1917), based on projection of the base elevation of the units from their type areas in southern New Jersey. Because the yellow gravel at East Trenton Heights forms a distinctly lower surface than the yellow gravel elsewhere in the quadrangle, the nomenclature and correlations of Owens and Minard (1975, 1979) are adopted here.

The ages of the Bridgeton and Pensauken are uncertain. Berry and Hawkins (1935) describe plant fossils from the Bridgeton near New Brunswick (about 15 miles northeast of Princeton) that they consider to be of Pleistocene age. Owens and Minard (1979) assign both units a Late Miocene age based on correlation to units in the Delmarva Peninsula, although this correlation cannot be physically demonstrated because the deposits are not continuous across Delaware Bay. Pollen from a black clay bed within the Bridgeton, exposed in a gravel pit near Plainsboro (about 4 miles east of Princeton), includes cool-temperate to cold-temperate species and a few exotic pre-Pleistocene species (G. Brenner, written communication), an assemblage suggesting a Pliocene age. These data indicate that it is possible that the deposits span the period from the Late Miocene to the Early Pleistocene.

TQp — **PENSAUKEN FORMATION**--Sand and pebble gravel, minor cobble gravel and silt. Well-sorted, stratified. Color of fine sediment is yellow, reddish yellow, and light gray. Sand is chiefly quartz with some weathered feldspar. Gravel is chiefly quartz and quartzite with some chert, ironstone, and decomposed sandstone and mudstone. As much as 65 feet thick. Forms a terrace with a surface altitude of 55-60 feet that is incised about 40 feet below the Bridgeton surface. May have been deposited by Assunpink Creek and other local tributaries that dissected and reworked the Bridgeton deposit after diversion of the Bridgeton river.

TQb — **BRIDGETON FORMATION**--Sand and pebble gravel, minor cobble gravel, silt, and clay. Well-sorted, stratified. Color of fine sediment is yellow, reddish yellow, and light gray. Sand is chiefly quartz with some weathered feldspar. Gravel is chiefly quartz and quartzite with some chert, ironstone, and decomposed sandstone and mudstone. As much as 90 feet thick. Deposited by a large river flowing southwesterly along the inner edge of the Coastal Plain from the New York City area to the Delmarva Peninsula (Salisbury and Knapp, 1917; Owens and Minard, 1979). Deposition ceased and the Bridgeton valley was abandoned when the Bridgeton river was diverted seaward in the New York City area, possibly during Late Pliocene or Early Pleistocene glaciation (Stanford, 1990).

Hillslope Deposits (Pliocene?-Late Pleistocene)--These sediments form aprons at the base of hillslopes. They are deposited by downslope movement of weathered bedrock material, chiefly under periglacial conditions when permafrost may be present, vegetation is scant, and slopes are unstable. The deposits are predominantly of Late Pleistocene age, but may be older in the subsurface parts of unit Qcd in a few places protected from Pleistocene erosion.

Qcsl — **MUDSTONE AND SANDSTONE COLLUVIUM, LOWER PHASE**--Poorly-sorted, nonstratified sediment composed of angular to subangular chips and flagstones of mudstone and sandstone in a matrix of reddish brown sandy clayey silt. Tabular clasts generally have a strong slope-parallel orientation. Forms aprons with surfaces that grade distally to heights of 5 to 10 feet above the modern floodplain, or that grade distally to the surface of unit Qts. As much as 15 feet thick (estimated). This deposit grades to and interfingers with unit Qts and so is, in part, contemporaneous with units Qts, Qtt, and Qtc.

Qcsu — **MUDSTONE AND SANDSTONE COLLUVIUM, UPPER PHASE**--Sediment as in unit Qcsl. Forms aprons on rock-cut benches in the upper Stony Brook valley with bases 10 to 30 feet above the modern floodplain. As much as 15 feet thick (estimated). These deposits predate final incision of Stony Brook and deposition of units Qcsl and Qts.

Qcd — **DIABASE COLLUVIUM**--Poorly-sorted, nonstratified sediment composed of subrounded to rounded boulders and cobbles of diabase in a matrix of reddish yellow clayey silt to slightly sandy silt. Maximum thickness 20 feet (estimated).

Qcdl — **DIABASE COLLUVIAL LAG**--Surface concentrations of rounded diabase boulders and thin, discontinuous, reddish yellow to brownish yellow clayey silt to slightly sandy silt, with small amounts of organic matter. Maximum thickness 10 feet (estimated). Occurs on gently-sloping aprons formed by winnowing of fine material from weathered diabase by spring seepage and surface runoff on hillslopes.

Weathered Bedrock Material (pre-Cretaceous?-Holocene)--Sediment formed by mechanical and chemical weathering of bedrock. These materials are predominantly of Quaternary age but may be of Tertiary age in places where they have been protected from Pleistocene erosion--for example, on parts of upland erosion surfaces S1 and S2 (fig. 1) and subjacent to unit TQb. Subjacent to Cretaceous deposits (unit K), the weathered rock material may be partly of Cretaceous or older age (sections AA', BB', CC'). At the surface the weathered bedrock units include discontinuous colluvium generally less than 3 feet thick.

Qsw — **WEATHERED MUDSTONE AND SANDSTONE**--Poorly-sorted, nonstratified to weakly stratified material consisting of some to many angular to subangular chips of red to gray mudstone in reddish brown, red, reddish yellow, and yellow silty clay to clayey silt (on mudstone bedrock); few to many angular to subangular chips, flagstones, pebbles, and cobbles of sandstone (some decomposed) in yellow, pale brown, white, light gray, reddish brown, red, and reddish yellow clayey sand to silty sand (on sandstone bedrock). Sand is mostly quartz but includes some mica, weathered feldspar, and rock fragments. Generally less than 10 feet thick on mudstone bedrock, which crops out primarily north and west of routes 206 and 27; as much as 80 feet thick on sandstone bedrock, which crops out primarily south and east of routes 206 and 27. On sandstone bedrock weathering occurs preferentially in certain beds (chiefly in coarse-grained arkosic sandstones), and zones of unweathered rock may overlie or interbed with zones of weathered rock. Small outcrops are common in streambanks, stream beds, and man-made excavations on mudstone bedrock but are less common on sandstone bedrock.

Qdw
Qdwt — **WEATHERED DIABASE, BOULDERY PHASE**--Poorly-sorted, nonstratified material consisting of some to many subangular to subrounded diabase cobbles and boulders in a matrix of yellow, reddish yellow, brown, and light gray clayey silt to slightly sandy silt. Generally less than 10 feet thick. Occurs on sloping surfaces on Rocky Hill. Unit Qdwt is thin, bouldery broken-rock rubble with little matrix material, on steep slopes.

Qdwc — **WEATHERED DIABASE, SILTY PHASE**--Moderately-sorted, nonstratified material consisting of few subangular to subrounded, partially decomposed pebbles and cobbles of diabase in a matrix of reddish yellow, red, and brown clayey silt. Maximum thickness 15 feet (estimated). Occurs on flat to very gently sloping surfaces on the summit of Rocky Hill.

Qscw — **WEATHERED SCHIST AND GNEISS**--Poorly-sorted, nonstratifed to weakly stratified material consisting of some subangular to subrounded pebbles and cobbles of partially decomposed gneiss or schist in a matrix of yellow, brown, yellowish brown, white, olive yellow, olive brown, and light gray micaceous sand to clayey sand (on gneiss bedrock) and micaceous clayey silt to silty clay (on schist bedrock). As much as 70 feet thick.

K — **CRETACEOUS DEPOSITS, UNDIFFERENTIATED**--Sand, silt, and clay of the Raritan and Magothy Formations of Cretaceous age. Variably oxidized to white, yellow, pink, red, brown, pale brown, and gray. As much as 200 feet thick in the southeastern corner of the quadrangle (Zapecza, 1989).

MAP SYMBOLS

- **Contact**--Dashed where approximately located, short-dashed where gradational or feathering, dotted where concealed by fill or lakes.
- **Fluvial scarp of postglacial age**--Line at top of scarp, ticks on slope.
- **Fluvial scarp of Early to Middle Pleistocene age**--Line at top of scarp, ticks on slope.
- **Fluvial scarp of Bridgeton age (Late Miocene-Early Pleistocene)**--Line at top of scarp, ticks on slope. Marks northwest border of unit TQb.
- **Artificial excavation scarp**--Line at top of scarp, ticks on slope. Marks extent of sandstone quarries.
- **Crest of low bedrock ridge**--Line at crest of low (generally less than 6 feet high) bedrock-controlled ridge, parallel to strike of beds. Drawn from aerial photographs.
- ⚒ **Inactive sandstone quarry**
- ⊙ **Shallow topographic basin**--Line marks rim of basin, dot marks bottom of basin. Height of closure generally less than 10 feet. Of probable periglacial origin (Wolfe, 1953).
- ▨ **Rock-cut terrace**--Flat surfaces cut on shale bedrock by Stony Brook, about 10-15 feet above the modern floodplain. Cut in the Early to Middle Pleistocene, before final incision of Stony Brook to form the modern floodplain.
- (w) **Bodies of water**--Not shown on base map.
- Qe/TQb **Thick eolian sand overlying Bridgeton Formation**--Eolian sand continuous and generally greater than 6 feet thick.
- (Qe)/Qsw **Thin eolian loam overlying weathered mudstone and sandstone**--Eolian loam generally continuous but less than 3 feet thick.
- ● 47 **Well or boring with log in table 1**--Location judged to be accurate to within 100 feet.
- ⊙ 47 **Well or boring with log in table 1**--Location judged to be accurate to within 500 feet.
- 60 **Elevation of base of Bridgeton and Pensauken formations**--Contour interval 20 feet. Shown only in southeast part of map where the base of the units is not exposed. Mapped from well and boring data (table 1).
- I-16,554 ▲ 10,430± 160 **Site of radiocarbon-dated peat**--With laboratory number and age. Sample taken at a depth of 5 feet, directly on top of unit Qtt.

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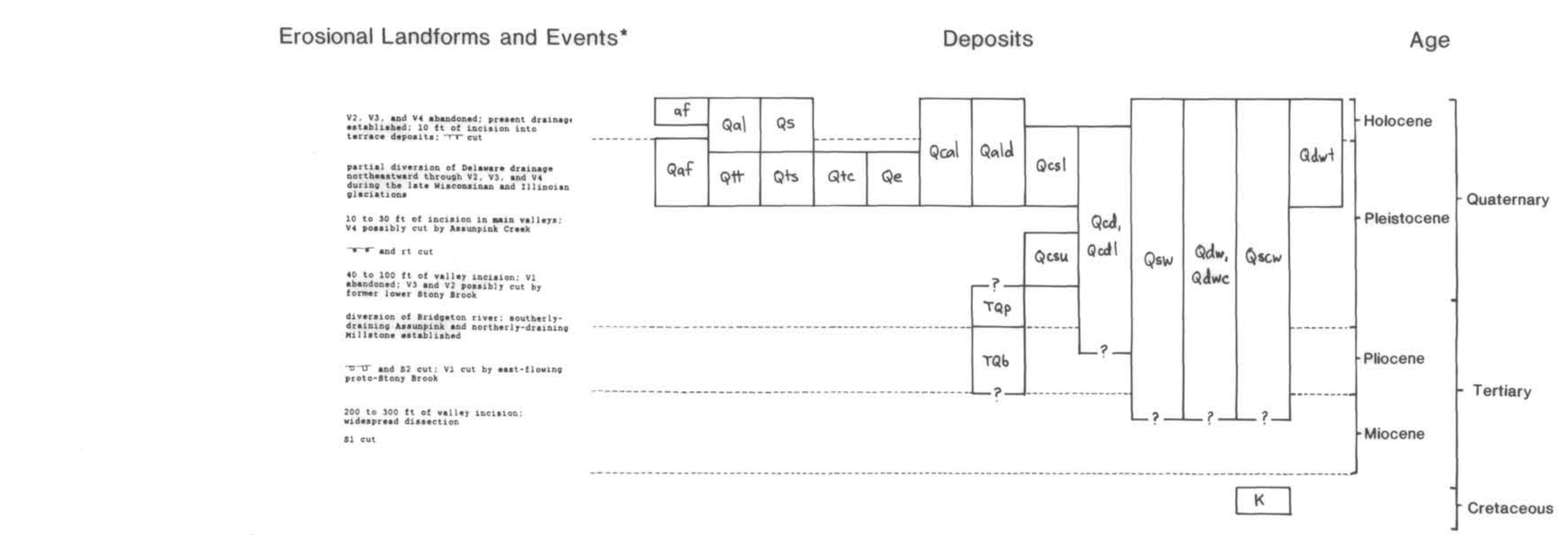
Correlation Chart



*S1, S2, rt, V1, V2, V3, V4 are shown on fig. 1; fluvial scarp symbols are identified under "Map Symbols" and are shown on the map.

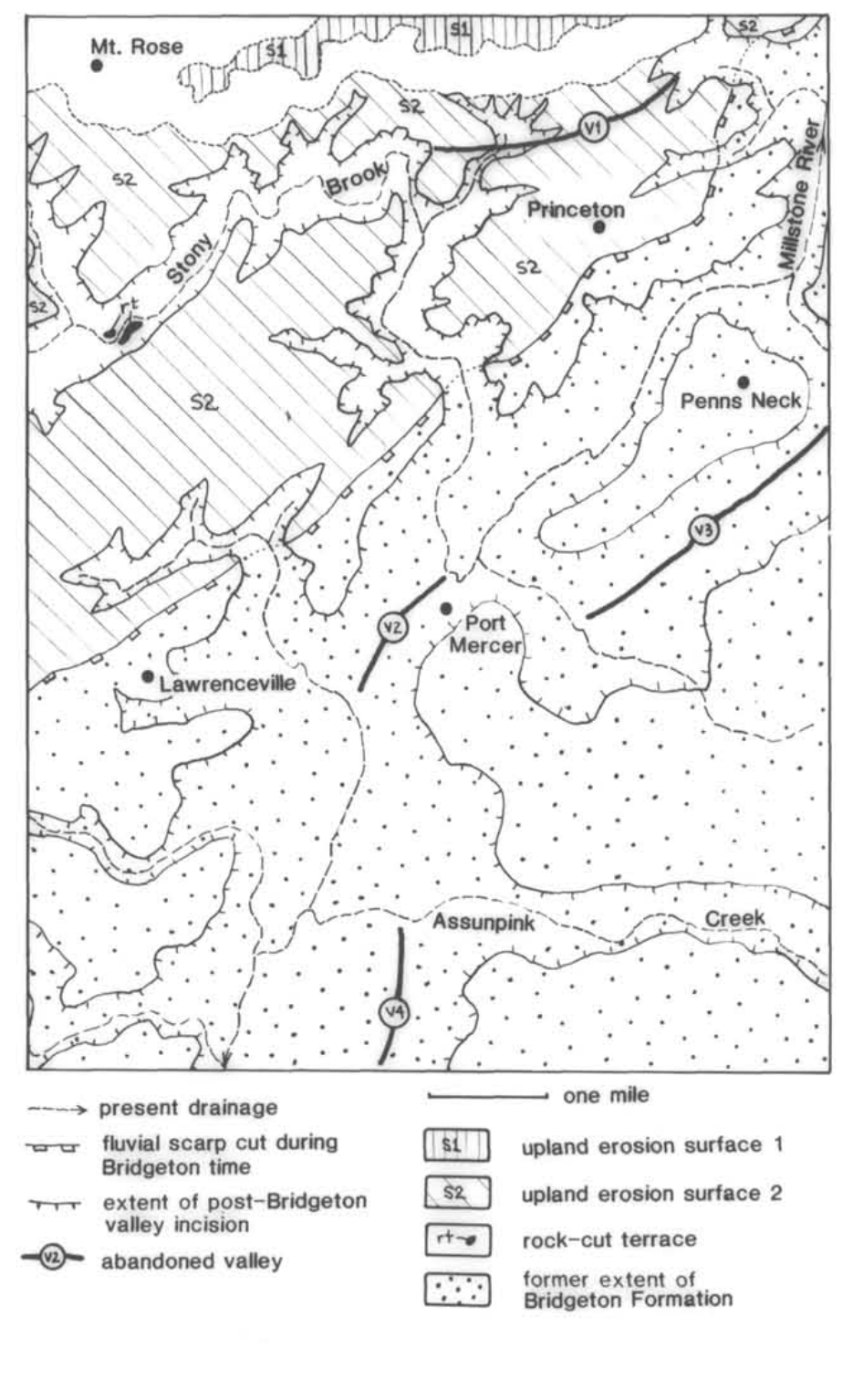
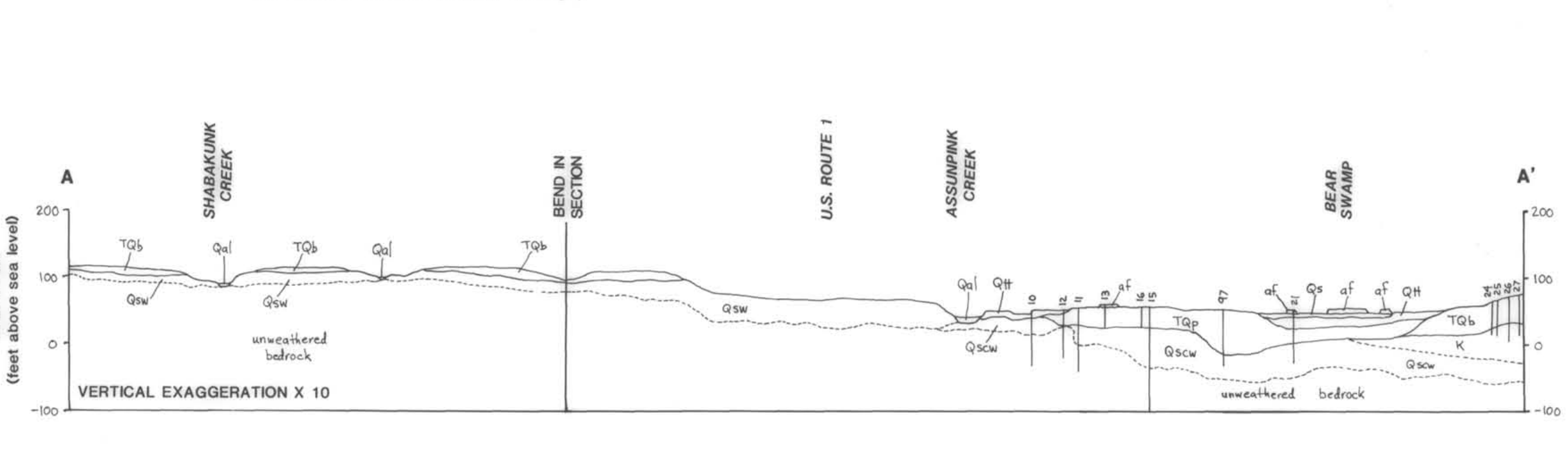
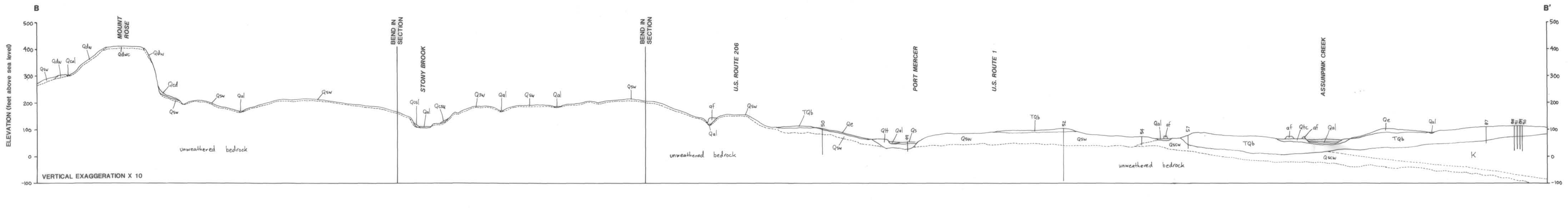
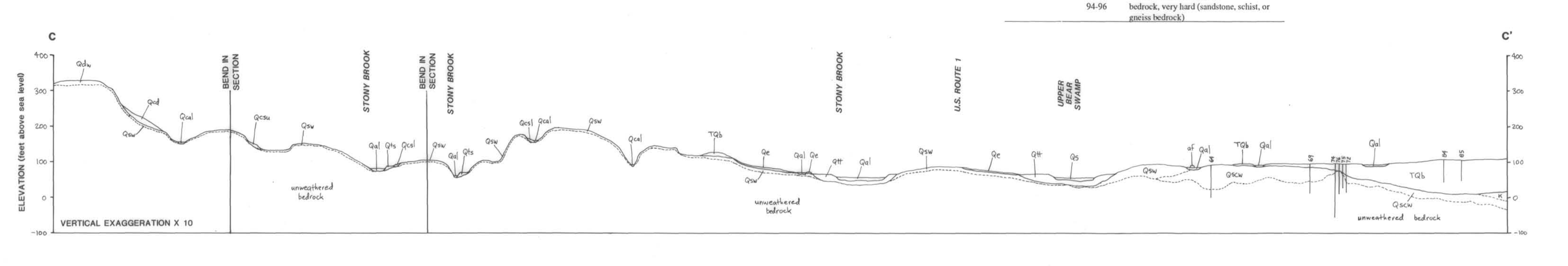


Figure 1. -- Erosional landforms of the Princeton quadrangle. Upland erosion surfaces are flat to very gently sloping surfaces on summit and interfluve areas that truncate bedding and layering in the underlying bedrock. Abandoned valleys are stream-cut valleys that do not carry through-flowing streams today. The extent of post-Bridgeton valley incision is drawn approximately, at the location of slope inflections from undissected upland areas on erosion surface 2 and remnants of unit TQb to steeper slopes on the sides of incised valleys.







Base from U. S. Geological Survey, 1954
Photorevised 1981

Geology mapped in 1990-91
The interpretations presented here are provisional pending peer review. There may be revisions prior to publication.

SURFICIAL GEOLOGY OF THE PRINCETON QUADRANGLE
MERCER AND MIDDLESEX COUNTIES, NEW JERSEY

by
Scott D. Stanford
1993

Table 1.--Selected Well Logs

Well No.	Permit No. (1)	Driller's Log Depth (feet)	Description (2)
1	28-311	0-34	sand and gravel (Qsw)
		34-61	sandstone, some shale
2	28-584	0-43	sand and gravel (Qsw)
		43-76	medium to hard sandstone
3	28-525	0-42	sand, gravel, clay (Qsw)
		42-71	hard sandstone
4	28-19323	abbreviated log	
		0-30	sand (Qtt)
		30-56	soft red sandstone (Qsw)
		56-200	gray and brown rock
5	28-3967	log by D. G. Parillo (N. J. Geological Survey), abbreviated here	
		0-20	brownish yellow fine to coarse quartz sand with some shale fragments and white clay lumps (Qtt, Qsw near base?)
		20-40	light greyish yellow medium to very coarse slightly clayey quartz sand (Qsw)
		40-55	reddish brown slightly variegated clay with some coarse sand (Qsw)
		55-65	reddish brown medium to coarse clayey feldspathic sand and sandstone (Qsw, bedrock)
		65-105	brown clayey gravel and conglomerate (Qsw, bedrock)
6	28-4499	0-16	sand and gravel (Qtt)
		16-33	coarse gravel (Qtt or Qsw)
		33-90	red shale
		90-135	white rock
		135-180	red rock
7	28-13290	0-3	black and brown silty fine sand (Qtc)
		3-15	gray brown fine sand (Qtc)
		15-23	brown white coarse sand and gravel (Qtc)
		23-27	reddish clay (Qsw)
		27-35	white and yellow silty clay (Qsw)
		35-49	reddish silty clay (Qsw)
		49-68	bedrock
		68-80	bedrock with lots of fractures
8	28-4183	0-5	brown sand (Qtc)
		5-8	yellow sand (Qtc)
		8-16	brown sand (Qtc)
		16-25	red clay (Qsw)
		25-46	white green clay rock (Qsw)
		46-60	white sandstone
		60-70	red shale
9	28-6988	0-10	dark brown fine-medium sand (Qtt)
		10-27	dark brown medium-coarse sand (Qtt)
		27-30	brown silty clay, trace of red shale, in green silty clay (Qsw)
		30-52	red shale in siltstone
10	27-2262	0-12	sand and gravel (Qtt)
		12-28	green clay (Qscw)
		28-36	gray sandstone (gneiss or schist bedrock)
		36-40	hard sandstone (gneiss or schist bedrock)
		40-81	very hard gray sandstone (gneiss or schist bedrock)
11	27-3131	0-38	yellow sand and gravel (TQp)
		38-51	green clay and gravel (Qscw)
		51-93	gneiss rock formation
12	28-2813	0-23	clay and gravel (thin Qtt over TQp or Qscw)
		23-65	gray rock (gneiss or schist bedrock)
13	28-14993 well 8		abbreviated log
		0-30	brown sand and gravel (TQp)
		at 30	blue clay (TQp or Qscw)
14	28-14993 well 9	abbreviated log	
		0-5	brown silt and sand with large gravel (TQp)
		5-10	silt and clay with large gravel (TQp)
		10-15	silt, clay, fine sand on light blue clay (TQp)
		15-16	light blue clay (TQp or Qscw)
15	28-1730	log by E. S. Lenker, N. J. Geological Survey, abbreviated here	
		0-10	pale yellowish orange clay with scattered quartz grains, few quartz pebbles (TQp)
		10-20	moderate yellowish brown fine to coarse sand, quartz pebbles, scattered decomposed feldspars (TQp)
		20-30	dark yellowish orange decomposed bedrock; fragments of mica and decomposed feldspar (Qscw)
		30-90	greenish yellow to olive decomposed gneiss (Qscw)
		90-200	gabbro
16	28-14993 well 7	abbreviated log	
		0-30	brown sand and gravel (TQp)
		at 30	rocks, refusal
17	28-2623	0-28	gravel and clay (TQp)
		28-46	blue rock
		46-55	boulders and sand (Qscw)
18	28-14993 well 6	abbreviated log	
		0-25	brown sand and gravel (TQp)
		25-30	brown sand grading into weathered shale (TQp over Qsw or Qscw)
19	28-4241	0-21	boulders (thin TQp over Qscw)
		21-165	gray rock (gneiss or schist bedrock)
20	28-4055	0-17	sand (Qtt)
		17-25	yellow clay (Qscw)
	at 25		green clay (Qscw)
21	28-4896	log by F. J. Markewicz, N. J. Geological Survey, abbreviated here	
		0-40	yellowish orange to yellowish gray sand and pebble gravel (Qtt over TQp)
		40-70	yellowish gray to greenish gray finely micaceous silt and clay saprolite (Qscw)
22	28-5951	0-42	yellow sand and gravel (TQb)
		42-53	white and yellow sand (K)
23	28-2613	0-41	yellow clay (TQb)
		41-45	yellow sand (TQb)
		45-50	white clay (K)
		50-51	gray clay (K)
		51-64	white clay (K)
		64-72	sand (K)
24	28-6085	0-38	yellow sand and gravel (TQb)
		38-45	white clay (K)
		45-50	white sand (K)
25	ND	0-23	brown medium sand (TQb)
		23-27	brown coarse sand and gravel (TQb)
		27-40	brown medium sand (TQb)
		40-50	white brown medium sand (K)
26	28-7324	0-13	brown medium-fine sand and gravel (TQb)
		13-32	brown coarse to medium sand (TQb)
		32-47	light brown medium to fine sand (K)
		47-62	light brown coarse sand (K)
		62-65	light brown decomposed silt stone (iron-cemented K)
27	27-5270	0-11	brown sand and gravel (TQb)
		11-18	yellow sand (TQb)
		18-20	brown sand (TQb)
		20-50	yellow sand (TQb)
		50-54	white clay (K)
		54-58	white sand (K)
		at 58	white clay (K)
28	28-5652	0-70	yellow sand and gravel (TQb)
		70-85	yellow white clay (K)
29	ND	0-45	brown sand, clay, and gravel (TQb)
		45-55	white clay (K)
		55-68	white sand (K)
30	28-3930	0-39	yellow clay and sand (TQb)
		39-60	white clay (K)
		60-65	sand (K)
		at 65	clay (K)
31	28-6979	0-10	brown silty sandy clay, trace of gravel (TQb)
		10-45	brown fine to medium sand (TQb)
		45-51	brown silty clay in layers of fine sand (K)
		51-53	light brown fine sand (K)
		53-63	light brown coarse sand, layers of white clay (K)
		63-70	light brown coarse sand (K)
		70-80	light brown coarse sand to fine silty sand, layers of white clay (K)
32	28-4986	log by F. J. Markewicz, N. J. Geological Survey, abbreviated here	
		0-25	yellow sand (TQb)
		25-58	yellow sand and gravel (TQb)
		58-62	light gray sand and gravel (TQb)
33	28-856	0-32	brown clay and gravel, some fine sand (thin Qtc over TQb)
		32-52	brown and yellow clay and gravel (TQb)
		52-54	gravel, yellow clay (TQb)
		54-58	brown clay (Qscw)
		58-65	brown clay rotten rock (Qscw)
		65-88	gray sandstone rock (gneiss or schist bedrock)
		88-89	blue rock (gneiss or schist bedrock)
		89-120	hard gray rock (gneiss or schist bedrock)
34	28-13497	0-13	yellow sand and gravel (Qtc)
		13-26	green clay (Qsw or Qscw)
		26-40	sandstone, soft (Qsw or Qscw)
		40-86	Precambrian (gneiss or schist bedrock)
35	28-9989	0-12	white sand and gravel (Qtc)
		12-18	yellow sand, fine (Qtc)
		18-30	yellow sand and clay mixed (Qsw or K)
		30-42	white clay (Qsw or K)
		42-45	yellow clay (Qsw or K)
		45-47	brown sand, coarse (Qsw or K)
36	28-14213	0-56	sand and gravel (thin TQb over Qsw)
		56-125	granite
37	28-15828	0-55	sand and gravel (thin TQb over Qsw)
		55-300	granite
38	28-9064	0-18	yellow sand and gravel (TQb)
		18-40	green clay (Qsw)
		40-42	fine white sand (Qsw)
		42-47	white sand, coarse, and gravel (Qsw)
39	28-7457	0-7	brown fine sand, layers of brown clay, trace of medium gravel (Qtc)
		7-14	brown sand and gravel (Qtc)
		14-23	brown silty clay (TQb)
		23-36	brown medium to fine sand (TQb)
		36-40	brown sand (TQb)
		40-55	brown coarse sand (TQb)
		55-56	brown silty sandy clay, trace of gravel (TQb)
		at 56	decomposed rock (Qscw)
40	28-6936	0-10	brown medium-fine sand (Qtc)
		10-17	brown medium-coarse sand (Qtc)
		17-20	yellow brown clay (TQb)
		20-53	brown medium-coarse sand (TQb)
		53-55	decomposed red shale (ironstone in TQb or K)
41	28-7584	0-20	brown medium-fine sand and gravel (Qtc)
		20-36	brown coarse-medium sand (TQb)
		36-38	brown silty clay (TQb)
		38-55	brown coarse-medium sand (TQb)
		55-60	decomposed red shale (ironstone in TQb or K)
42	28-9016	0-20	brown medium-fine sand (TQb)
		20-40	brown fine sand (TQb)
		40-60	brown medium-coarse sand (TQb)
		60-62	white clay (Qscw or K)
		62-65	green gray clay (Qscw or K)
43	28-6675	0-6	brown fine-medium sand (TQb)
		6-14	brown fine-medium sand in medium gravel (TQb)
		14-22	gray silty clay (TQb)
		22-40	brown medium-coarse sand (TQb)
		40-45	decomposed siltstone, red (ironstone in TQb or K)
44	28-3777	0-39	yellow sand and gravel, clay (thin Qtc over TQb)
		39-45	white clay (TQb)
		45-61	yellow sand and gravel (TQb)
		at 61	green clay (Qscw or K)
45	28-11378	0-8	sandy clay (Qtc)
		8-27	medium yellow sand (TQb)
		27-40	coarse yellow sand (TQb)
		40-55	coarse white sand (TQb or K)
		55-65	clay (K)
46	28-19399	abbreviated log	
		0-5	red-brown silt and medium sand, some coarse sand and pebbles (Qsw)
		5-22	coarse sand, some pebbles, trace red clay (Qsw)
		22-25	dense mottled orange, yellow, red clay (Qsw)
47	28-5062	abbreviated log	
		0-15	black sand and gravel (Qtc)
		15-20	yellow clay (Qsw)
		20-118	yellow, gray, red sandstone and red shale
48	28-2115	log by D. G. Parillo, N. J. Geological Survey, abbreviated here	
		0-15	yellowish brown fine-medium slightly clayey sand with grains of quartz, sandstone, shale, and chert (Qtc)
		15-162	reddish brown, brown, light gray sandstone and shale
49	28-28628	split-spoon samples logged by author	
		0-2	black peat (Qs)
		2-4	brown peat (Qs)
		4-22	light gray to reddish brown coarse quartz sand, arkosic and lithic, and pebble-to-fine-cobble gravel, more gravelly near base; pebbles include quartz, gray mudstone, chert, and some reddish brown shale and sandstone (Qtt)
		22-25	reddish brown sandstone and siltstone
50	28-8371	0-12	yellow sand and gravel and clay mixed (Qsw and thin colluvium derived from TQb upslope)
		12-18	red clay (Qsw)
		18-90	red and brown sandstone
51	28-9593	0-18	sand and gravel (Qtt)
		18-24	red clay (Qsw)
		24-33	red sandstone
		33-35	red clay (Qsw)
		35-100	red sandstone
52	28-2470	abbreviated log	
		0-18	red soil (TQb)
		18-19	gravel (TQb)
		19-30	red clay (Qsw)
		30-31	gravel (Qsw)
		31-53	brown clay (Qsw)
		53-63	brown sand (Qsw)
		63-67	yellow brown sand (Qsw)
		67-70	coarse brown sand (Qsw)
		70-202	brown, gray, white, red sandstone and red shale
53	28-2450	log by M. E. Johnson, N. J. Geological Survey	
		0-14	brown sand and gravel (Qsw)
		14-46	light brown sand and fine gravel (Qsw)
		46-54	greenish-gray shale
		54-150	red shale and sandstone
		150-300	red and gray sandstone
54	28-18504	abbreviated log	
		0-10	mottled brown and orange clay, some fine sand and a few pebbles (Qsw)
		10-19	very dense orange to green clay, some sand and pebbles (Qsw)
		19-30	decomposed blue-green rock (Qsw or Qscw)
55	28-3541	log by Russell Mayer, N. J. Geological Survey	
		0-40	yellowish brown fine to medium sand (TQb)
		40-80	yellowish brown, gray, reddish sandy clay to clay containing fragments of gray argillite and purplish quartz pebbles (Qsw)
		80-120	olive-gray weathered biotite gneiss, decomposition of feldspars gives a reddish coloring to sample from 80-85 feet (Qscw)
56	28-13208	0-46	yellow sand and gravel (TQb)
		46-95	green clay (Qscw)
		95-140	Precambrian (gneiss or schist bedrock)
57	28-8896	0-15	yellow fine sand (TQb)
		15-17	yellow clay (TQb)
		17-33	yellow sand and gravel (TQb)
		33-45	yellow sand, fine (TQb)
		45-53	white sand and gravel (Qsw or TQb) screened 45-53, yield 70 gpm
58	28-12344	0-28	yellow gravel with clay mixed with some sand (TQb)
		28-77	yellow, gray, white clay (Qsw or K)
		77-102	green clay (Qscw)
		102-112	soft green sandstone (Qscw)
		112-180	Precambrian (gneiss or schist bedrock)
59	28-10640	0-25	yellow sand and gravel (TQb)
		25-35	yellow clay (K)
		35-50	gray clay (K)
		50-62	yellow sand (K)
60	28-8242	0-15	yellow sand and gravel (TQb)
		15-30	yellow clay (K)
		30-45	gray clay (K)
		45-48	gray sand and clay (K)
		48-50	yellow clay (K)
		50-58	yellow sand (K)
		at 58	yellow clay (K)
61	28-8106	0-14	yellow sand and gravel (TQb)
		14-21	brown clay and sand (K)
		21-25	yellow clay and pyrite (K)
		25-35	yellow clay (K)
		35-57	blue clay (K)
		57-70	yellow sand (K)
62	N.J. Geological Survey test boring	split-spoon samples logged by author	
		0-10	yellow to light yellowish brown silt and arkosic medium to coarse sand (TQb)
		10-12	very pale brown arkosic medium to coarse sand and granule gravel
		12-71	yellow to brownish yellow arkosic medium to coarse sand, minor silt and granule to pebble gravel (TQb)
		71-82	olive to pale yellow micaceous silty granular weathered schist (Qscw)
63	28-17283	0-2	red medium sand (TQb)
		2-6	gray clay with sand (TQb)
		6-9	white clay (TQb or K)
		9-12	gray clay (TQB or K)
		12-14	brown clay TQb or K)
		14-18	brown medium sand (TQb or K)
		18-21	brown clay (TQB or K)
		21-24	white clay (K or Qsw)
		24-45	white clay with coarse sand (K or Qsw)
		45-61	green decomposed rock (Qscw)
		61-73	gray sandstone (gneiss or schist bedrock)
		73-151	granite
64	28-2426	0-57	yellow white clay (Qscw)
		57-64	green rotten rock (Qscw)
		64-90	hard green sandstone (gneiss or schist bedrock)
65	N.J. Geological Survey permanent note 28-12-737	note by M.E. Johnson, N.J. Geological Survey: "test borings show highly weathered Baltimore gneiss from 2 to 9 feet below surface"	
66	28-13776	0-11	yellow clay and sand (TQb)
		11-63	yellow-white rock, clay, green mixed clay (Qscw)
		at 63	gray-white rock (gneiss or schist bedrock)
67	28-11152	0-11	brown medium-fine sand (TQb)
		11-21	white coarse sand (Qsw)
		21-59	white clay with coarse sand (Qsw)
		59-73	green and black clay with layers of stiff sand (Qsw)
		73-94	brown coarse sand (Qsw)
		94-96	bedrock, very hard (sandstone, schist, or gneiss bedrock)
68	27-2475	0-6	subsoil (Qtt)
		6-12	sand and gravel (Qtt)
		12-24	hard sandstone mixed with boulders
		24-53	yellow sandstone
		53-75	white sandstone
		75-82	red clay (Qsw)
69	28-11242	0-16	yellow sand and gravel (TQb)
		16-40	green clay (Qscw)
		40-50	broken soft sandstone, green (Qscw)
		50-80	hard green gneiss rock
70	28-6588	0-3	brown clay (TQb)
		3-18	wet sand and gravel (TQb)
		18-27	gray clay (Qscw)
		27-70	gray rock (gneiss or schist bedrock)
71	28-6461	0-4	brown sandy clay (TQb)
		4-12	brown sand (TQb)
		12-22	brown sand and gravel and water (TQb)
		22-26	drilled hard no sample (bedrock)
		26-70	gray and green rock (gneiss or schist bedrock)
72	28-6573	0-6	black and brown clay (TQb)
		6-15	wet sand and gravel (TQb)
		15-45	gray clay (K or Qscw)
		45-49	soft black and green rock (Qscw)
		49-85	gray and green rock (gneiss or schist bedrock)
73	28-6587	0-12	brown clay (TQb)
		12-27	wet sand and gravel (TQb)
		27-45	gray clay (K or Qscw)
		45-80	gray rock (gneiss or schist bedrock)
74	28-6586	0-5	black and brown clay (TQb)
		5-19	wet sand and large gravel (TQb)
		19-150	gray and green rock (gneiss or schist bedrock)
75	28-6585	0-3	brown clay (TQb)
		3-12	gray clay (TQb)
		12-21	sand and large gravel and water (TQb)
		21-70	gray rock (gneiss or schist bedrock)
76	28-5430	0-18	yellow brown sand and clay (TQb)
		18-83	blue rock (gneiss or schist bedrock)
77	28-6254	0-35	clayey gravels: gravel-sand-clay mixtures, gray and brown in color (TQb)
		35-41	decomposed rock (Qscw)
		41-63	very hard rock (gneiss or schist bedrock)
78	N. J. Geological Survey permanent note 28-12-572	well log by M. E. Johnson, N. J. Geological Survey	
		0-35	brown clayey sand with a little gravel (TQb overlying Qsw)
		35-50	green clay and sand--decomposed Wissahickon (Qscw)
		50-306	granite gneiss
79	N. J. Geological Survey test boring	split-spoon samples logged by author	
		0-3	fill and peat (Qs)
		3-8	light gray medium quartz sand, slightly arkosic, and pebble gravel (Qtt)
		8-17	yellow to yellowish brown medium to coarse quartz sand, arkosic and slightly micaceous and lithic; and granule to pebble gravel, chiefly quartz but includes some red mudstone, chert, and brown and gray sandstone (Qtt)
		17-22	white, very pale brown, yellow, and yellowish brown weathered coarse-grained arkosic sandstone
80	N. J. Geological Survey permanent note 28-12-541	0-24	sand and gravel (Qtt)
		24-432	sandstone
		432-518	gneiss
81	N. J. Geological Survey permanent note 28-12-542	0-25	sand and gravel (Qtt)
		at 25	bedrock (sandstone bedrock)
82	28-4371	0-15	top soil (Qtt)
		15-20	fine sand (Qtt)
		20-25	broken sandstone, fine sandstone (Qsw)
		25-34	sandstone
		34-301	red sandstone and shale
83	28-4999	abbreviated log	
		0-15	overburden clay and fine sand, very little gravel (Qal over Qtt)
		15-26	brown sandstone, soft (Qsw)
		26-33	soft red shale (Qsw)
		33-300	red shale and sandstone, alternating hard and soft (Qsw and bedrock)
84	28-17627	0-15	fine orange gravel, trace orange clay, some iron ore (TQb)
		15-45	fine orange gravel, iron ore, orange clay, soft red shale, some orange sand (TQb)
		45-60	clean uniform fine orange gravel, some iron ore, mica, some orange sand, trace of wood (TQb) screened 50-60, yield 30 gpm
85	28-5728	0-55	yellow sand and gravel (TQb) screened 51-54, yield 15 gpm
86	28-2918	0-60	dry sand and clay
		60-65	yellow sand screened 62-65, yield 15 gpm
87	28-10061	0-5	brown silty clay (TQb)
		5-27	brown fine sand (TQb)
		27-40	brown medium sand with traces of gravel (TQb)
		40-50	brown medium sand (K)
		50-60	brown red medium sand (K)
88	28-21958	0-24	brown and yellow silt and clay, layers of coarse sand with gravel (TQb)
		24-26	ironstone with heavy gravel (TQb)
		26-40	brown coarse and medium sand and gravel (TQb)
		40-50	light yellow silty clay (K)
		50-52	gray and pink silty clay (K)
		52-75	light brown medium and coarse sand (K)
		75-80	light brown sand with layers of white clay (K)
		80-90	white, pink, reddish, gray clay (K)
89	28-6661	0-15	brown silty sandy clay, trace of gravel (TQb)
		15-40	brown coarse to medium fine sand (TQb)
		40-45	white clay (K)
		45-60	gray clay, layers of petrified wood (K)
		60-77	brown medium to fine sand (K)
		77-85	brown coarse to medium sand, water-bearing (K)
90	28-4350	0-42	yellow sand, gravel and clay (TQb)
		42-55	brown clay (K)
		55-86	fine yellow sand (K)
91	28-845	0-38	brown sand and clay (TQb)
		38-43	brown clay (TQb or K)
		43-47	light blue and white clay (K)
		47-51	brown clay (K)
		51-68	brown clay, some fine sand (K)
		68-69	fine brown sand and clay (K)
		69-70	brown sand (K)
		70-78	coarse white and brown sand (K)
		78-84	coarse brown and white sand (K)
92	ND	0-15	gray sand and clay (TQb)
		15-35	yellow sand and clay (TQb)
		35-55	white clay (K)
		55-85	gray clay (K)
		85-104	sand, fine to coarse (K)
93	28-5252	0-10	white clay (TQb)
		10-20	yellow sand (TQb)
		20-30	gray clay (K)
		30-40	brown clay (K)
		40-45	white sand (K)
		45-55	brown white clay (K)
		55-73	white sand (K)
94	28-5854	0-4	top soil
		4-15	yellow clay (TQb)
		15-28	yellow sand (TQb)
		28-29	white clay (K)
		29-38	yellow sand (K)
		38-55	white clay (K)
		55-56	yellow clay (K)
		56-70	yellow sand (K)
95	28-844	0-59	yellow clay and sand (TQb)
		59-65	yellow sand and gravel (TQb)
		at 65	white clay (K)
96	28-5818	0-7	brown silty clay (TQb)
		7-68	light brown coarse to fine sand, and fine to coarse gravel, trace silt (TQb)
		68-71	white silty clay, trace fine sand (K)
		71-76	brown coarse to fine sand, and medium to fine gravel, trace silt (K)
		76-85	brown silty clay (K)
		85-100	brown coarse to fine sand, some fine gravel (K)
		100-116	brown silty clay, little medium to fine sand and trace fine gravel (K)
97	N. J. Geological Survey permanent note 28-21-263	0-30	brown sand and small gravel (TQp)
		30-54	brown arkosic sand and gravel, sandy clay (TQp)
		54-62	clayey arkosic sand (TQp)
		62-80	decomposed Wissahickon (Qscw)
		at 80	fresh Wissahickon (schist bedrock)

(1) Well permit number issued by N. J. Department of Environmental Protection and Energy, Bureau of Water Allocation. "ND" indicates that permit number is not decipherable on well log.

(2) Inferred map units and comments in parentheses. Depth of screened interval and reported yield of well in gallons per minute (gpm) are listed below the lithologic log for wells completed in surficial deposits.