DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER RESOURCES MANAGEMENT
NEW JERSEY GEOLOGICAL AND WATER SURVEY

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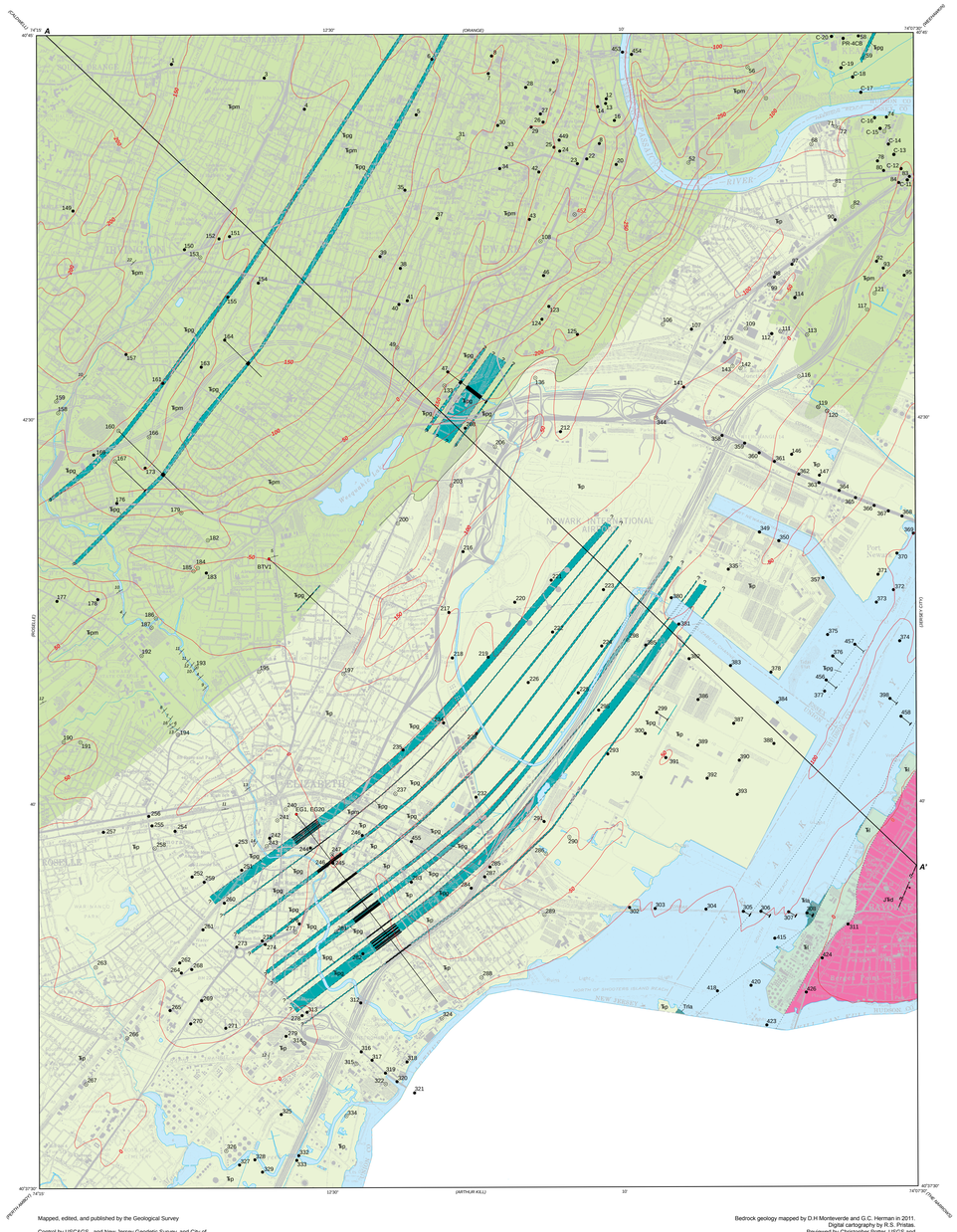
U.S. GEOLOGICAL SURVEY
NATIONAL GEOLOGIC MAPPING PROGRAM

BEDROCK GEOLOGIC MAP OF THE ELIZABETH QUADRANGLE
ESSEX, HUDSON AND UNION COUNTIES, NEW JERSEY
GEOLOGIC MAP SERIES GMS 15-4



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Culture and drainage in part compiled from aerial photographs taken 1953 and from USC&GS charts T-5106, T-5110, T-5111, T-5332, T5467, T-5468, and T-5469. Topography by planetable surveys 1955

Hydrography compiled from USC&GS charts 285 (1955), 287 (1954), and 369 (1954)

Polyconic projection. 1927 North American datum 10,000-foot grids based on New Jersey coordinate system, and New York coordinate system, Long Island zone1000-meter Universal Transverse Mercator grid ticks

SCALE 1:24,000

CONTOUR INTERVAL 20 FEET

Bedrock geology mapped by D.H.Monteverde and G.C. Herman in 2011.
Digital cartography by R.S. Protas.
Reviewed by Christopher Potter, USGS and Charles Merguerian, Duke Geological Labs.
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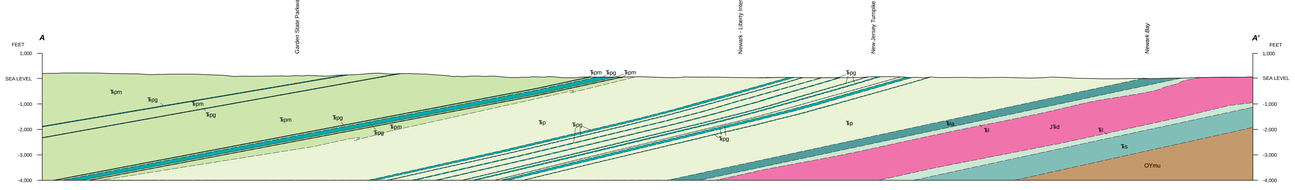
Bedrock Geologic Map of the Elizabeth Quadrangle Essex, Hudson and Union Counties, New Jersey

by
Donald H. Monteverde and Gregory C. Herman
2015

APPROXIMATE MEAN DECLINATION, 2005

LOCATION IN NEW JERSEY



INTRODUCTION

The Elizabeth 7.5-minute topographic quadrangle lies within the Piedmont Physiographic Province in northeastern New Jersey and part of Staten Island, New York. This geological investigation covers the New Jersey region of the quadrangle. Union and Essex counties cover most of the map's western and northern section while Hudson County lies to the east across Newark Bay. Staten Island occupies the southeastern quadrangle corner.

The northeasterly-trending Newark Bay is the major surface water feature in the quadrangle. The Passaic River snakes eastward across the northern section of the quadrangle before emptying into Newark Bay to the immediate northeast. Continuing southward, Newark Bay bifurcates into the south-trending Arthur Kill and the east-trending Kill Van Kull which together separate Staten Island from the New Jersey. Two smaller-order streams, the Elizabeth River and Orchard Brook/Morses Creek flow southeastward and drain into the Arthur Kill.

Bedrock exposures are rare owing to a relatively thick surficial cover. Bedrock can be examined where the surficial sediment thins near Kean University and the City of Elizabeth. Urbanization has further reduced some of the previously visible bedrock outcrops. However, historical data from Kümmel (1900) on these now covered outcrops were used as an aid in mapping the bedrock geology. Although masked by subsantial surficial cover, the regional bedrock strike controls the direction of the northeasterly-trending topography in the western part of the quadrangle.

Stratigraphy

Surficial cover dominates the quadrangle geology. The mapping of Stanford (2002) can be generalized into post glacial and glacial sediments with the glacial material further subdivided into till and fluvial-lacustrine deposits (fig. 1). Till deposits blanket the upland areas in the western mapped area. In addition a large amount of artificial fill rests upon mostly marsh deposits along the edge of major waterways (fig1). Stanford (2002) also created elevation contours of the bedrock surface based on an extensive well log inventory. A subsequent seismic refraction investigation in Newark Bay (fig. 2, D. Hall and J. Waldner, unpub. data, 2010) allows a higher resolution of the bedrock surface morphology in that region. This interpretation (fig. 2b) depicts a buried late Wisconsinan paleovalley (Stanford and Harper, 1991) that parallels the regional bedrock structural trend.

Late Triassic interbedded fluvial and lacustrine sedimentary rocks (Van Houten, 1969; Olsen, 1980; Olsen and others, 1996, 2011) dominate the bedrock geology. These rocks were deposited in a half graben called the Newark basin that developed during rifting of the breakup of the supercontinent Pangaea. These sediments entered the graben from three separate sources, across or between its western boundary faults, from the northeast along the graben's axis and finally the dominant eastern source. Previously the location of the Triassic–Jurassic boundary resided in the uppermost section of the Passaic Formation, the youngest of the sedimentary units mapped here. The selection of the Global Boundary Stratotype Section and Point (GSSP) of the Hettangian and therefore the Jurassic (Morton, 2008) moved the Passaic Formation beneath with the Triassic (Olsen and others, 2011). The Jurassic boundary now lies within the Feltville Formation above the Orange Mountain Basalt (Olsen and others, 2011).

The sedimentary rock units mapped here are, from oldest to youngest, the Stockton, Lockatong and Passaic Formations. The Stockton, not exposed at surface but represented on cross section, is a fluvial arkosic sandstone. Lacustrine conditions mark the deposition of the overlying Lockatong Formation. Elsewhere in the graben's deeper section along the Delaware River the Lockatong contains both chemical and detrital cycles based on mineralogy and lithologic changes and sedimentary structures (Van Houten, 1969, 1980). However, here along the graben's northeastern margin Olsen (1980a, 1980b, 1980c, 1989) suggests that the Lockatong cyclicity is only detrital in origin and contains a lower gray siltstone facies and an upper arkosic sandstone facies, both deposited in a lacustrine environment.

The Passaic Formation, the youngest sedimentary formation on the map, alternates between a thick assemblage of red brown sandstone, mudstone to shale and less common thin gray siltstone to shale. The red beds represent shallow lake deposition while the gray cycles, important formation member marker beds, define deeper water lacustrine environments. Passaic sedimentation in the Elizabeth quadrangle is influenced by sediment supply from the northeast along-axis of the graben. Parker and others (1988) and Parker (1993) subdivided the Passaic Formation into several facies: a mudstone facies in the southwest through a sandy mudstone facies into the sandstone and minor siltstone facies towards the northeast. In the Elizabeth quadrangle insufficient sedimentological descriptions exist from drilling logs to differentiate the Passaic Formation into the different facies as discussed in Parker and others (1988) and Parker (1993). However sufficient data existed to allow a broader subdivision into only two different facies consisting of a mudstone facies and a facies where siltstone dominates over mudstone.

Along the eastern boundary of the map a diabase of Upper Triassic to Lower Jurassic age intruded into the Lockatong Formation forming the Palisades Sill. Puffer (1984) and Puffer and others (2009) suggest the sill inflated several times forming the magmatic conduit to the surface basalt flows of the Orange Mountain and Preakness Basalts to the west of the mapped area.

A lithologic description of the Manhatten prong rocks can be found in Volkert (2015).

Well logs

A large well database (table 1) was used for mapping the various lithologies and formations in the map area due to the extensive surficial cover. Stanford (2002) assembled a large well database to delineate the extent of different surficial units. This same well database with an expansion of the bedrock lithologic descriptions as well as several additional wells was used to define geologic formational boundaries and delineation of several gray bed units within the Passaic Formation. Well logs containing descriptions and thickness of gray beds were projected to the surface using the regional strike and dip.

Three wells have borehole televiewer (BTV) records of the subsurface geology that cover depth intervals of 130 to 1800 ft below land surface (bls). These wells are identified on the map as wells BTV1, EG1, EG20 and were logged as part of the New Jersey Geological and Water Survey (NJGWS) fractured-bedrock aquifer research program. Each record has an oriented, continuous photographic image of sedimentary beds (primary structures) and secondary fractures and veins penetrated by the borehole that are on-file at the NJGWS offices as part of their digital data library. Geological details for the wells include hydrogeological profiles prepared at each site (Herman and Curran, 2012; Herman and others, 2015).

Well BTV1 is located at the Hillside Car Wash on North Broad St in Elizabeth. It is a 6-inch diameter well approximately 400 ft deep with 133.5 ft of 6 in casing. The BTV record shows that most of the strata are red-brown, thin- to medium beds of mudstone and siltstone in about equal proportion. Mudstone and siltstone units are thin- to thick-bedded and a solitary 2-ft-thick gray bed occurs as a depth of 200 – 201 ft bls that is projected to the surface using the average dip and dip azimuth (direction) of bedding.

Wells EG1 and EG20 are located in downtown Elizabeth near the corner of East Jersey St. and Jefferson Ave and shown as a single location on the map. These wells are part of a deep closed-loop geothermal heat-pump system including an irregular array of 20 deep wells, two of which were made available in April 2012 during the site construction phase for logging. Each borehole was drilled using an air-rotary rig using 10- and 7-inch-diameter drill bits. The larger bit was used for installing temporary, 10-inch-diameter steel casing from land surface to about 280 ft bls. The casing was used to help stabilize and guide drilling to greater depths when using the smaller-diameter bit. Temporary casing was installed to 280 ft in EG1 and to 275 ft in EG20. However, the temporary casing in EG1 was pulled and replaced by approximately 11 ft of casing prior to logging. Two suites of geophysical logs were collected in the boreholes. A traditional suite of logs were collected using caliper (borehole-diameter), natural gamma, fluid temperature and electrical conductivity/resistivity, formation single-point electrical resistance, and formation self-potential tools. A second suite of logs were collected using the optical BTV and heat pulse flow meter (HPFM) tools. An unstable power source used during BTV logging resulted in the need to collect overlapping, upper and lower log segments in each hole rather than having one, continuous record of each borehole. However, the log segments for each hole were successfully joined during subsequent data processing.

The bulk of the stratigraphic section in the geothermal boreholes consists of varying types of brownish-red mudstone. Many different types of red mudstones occur within the Newark Basin (Smoot and Olsen, 1985; 1994). These are commonly referred to as 'massive', where the term 'massive' is used in a broad sense, for rocks that tend to have a blocky or hackly appearance in a weathered outcrop and that show little obvious internal structure on superficial examination (Smoot and Olsen, 1985). In contrast, BTV records provide a continuous, subsurface scan of a rock section not subject to surface-weathering and therefore clearly show stratigraphic features such as unconformities and cross beds. Root-disrupted, vesicular, and 'featureless' types of mudstones are the most abundant in this section (Herman and others, 2015), whereas mud-cracked, burrowed, and sand-patch types are more scarce. It is likely that the featureless mudstones are burrowed and/or desiccated mudstone whose telltale features are beyond image resolution. The composite section formed by these wells contains about eight sets of gray shale beds that are rhythmically distributed throughout the section otherwise dominated by red beds (fig. 3). These 'gray bed' marker beds reflect late Triassic cyclic sedimentation noted by Van Houten (1965) and Olsen and others (1996). Most of these beds are only 1 or 2 ft thick, but some are as much as 11 ft thick (fig. 3). The thickest sections of gray beds are projected up dip along bedding to the surface on the map.

The stratigraphic section penetrated by the Elizabeth wells was correlated with a detailed stratigraphic reference section of the Newark Basin compiled from overlapping, deep rock cores (Olsen and others, 1996). The penetrated stratigraphic section here covers part of the lower Passaic Formation that correlates to the lower gray zone of the Brunswick aquifer (Herman 2001; 2010). Specifically, this section of the Passaic Formation is correlated with the Perkasie Member downward through member C from the Titusville core described in Olsen and others, 1996) (fig. 5). Although the Titusville section is located about 40 miles southwest and closer to the basin center where formations are thicker, the gray beds in the Elizabeth section closely match those of Titusville. This correlation is constrained at the surface by the well-field location with respect to outcrops of the Perkasie Member occurring southwest along projected bed strike and in the subsurface by correlation of gray-bed cycles. The EF and GH members in the Titusville core have multiple gray and black shale beds near the base of each section (Olsen and others, 1996). Only the section at EG1 from 800 ft to 1200 ft bls has similar, multiple gray units thereby making the correlation depicted in figure 3 likely. However, based on correlation of gray-bed sections, the Titusville section is about 50 percent thicker than that of the Elizabeth throughout the correlated interval (1600 ft at Titusville compared to 1040 ft at Elizabeth). This thickening is expected from a position in the basin close to the current, hinged, southeast margin relative to a location closer to the basin keel and the border faults. A comparison of the relative abundance of mudstone versus siltstone at the two locations having BTV coverage shows that siltstone becomes more abundant up section and to the north in the quadrangle.

Structure

Surface outcrops are extremely limited but do suggest that the general structure fits the basin's half graben configuration with a gentle homoclinal dip towards the northwest.

The sets of structural readings for sedimentary bedding, fractures, and veins (mineralized fractures) were identified and catalogued for each well logged. A structural BTV record were sorted, parsed, and plotted using circular histograms and stereographic-projection diagrams of plane orientation (Allmendinger and others, 2013; Cardozo and Allmendinger, 2013). One circular histogram and two, lower-hemisphere, equal-angle stereonets were plotted for each data set (fig. 4). Circular histograms utilize 10° sectors for determining dip-azimuth frequencies based on the polar-lines plot option. The stereonet diagrams depict density contours of poles-to-planes that show the most common planes in a set, and, the second diagram shows cyclographic plots of all measured planes (fig. 4).

The stereonet analysis from the BTV data shows bedding dipping toward the northwest at approximately 9° (9/326 mean dip/dip azimuth; fig. 4). A few beds show gentle dips towards all quadrants, but the cyclographic plot show a tight clustering around the mean-plane direction. The moderate- to steeply-dipping fractures (fractures that dip greater than 30°) show a strong correlation with the S1 fracture set of Herman (2005; 2009) striking parallel to the border faults in this part of the basin at about N40°E and mostly dipping steeply northwest at approximately 77°. Three subordinate, fracture sets are evident in the data. Two sets dipping 70° and 36° (70/127, 34/133 dip/dip azimuth) to the southeast have similar strikes to the dominant set. A final set dips at more moderate angle of approximately 36° northwest (36/308, fig. 4). The gently-dipping fractures (fractures that dip less than 30°) dominantly dip northwest and are nearly subparallel to the trend of bedding. Two main trends displayed in the data have a dip and dip azimuth of 1/315 and 25/313). More than 70 percent of the fractures measured dip less than 20°.

All borehole data contain abundant, sub-horizontal, mineral-filled fractures (veins) resembling the gypsum veins reported by El Tabakh and others (1997), Simonson and others (2010), Herman (2010), and Herman and Curran (2010). The BTV images show that in many places, the gently-dipping veins parallel bedding planes but cut them at acute angles elsewhere. In the steepest fractures locally, they appear apparent, normal dip-slip offset of mineralized sub-horizontal planes (fig. 5).

DESCRIPTION OF MAP UNITS

Jfd **Diabase** (Lower Jurassic to Upper Triassic) – Medium-grained, discordant, sheet-like intrusion of dark-gray to dark greenish-gray, sub-ophitic diabase; massive-textured, hard, and sparsely fractured. Composed dominantly of plagioclase, clinopyroxene, and opaque minerals. Contacts are typically fine-grained, display chilled, sharp margins and may be vesicular adjacent to enclosing sedimentary rock. Not presently exposed on the quadrangle but Kümmel (1898) describes exposures at the tidal zone along the eastern edge of Newark Bay that is now covered by artificial fill. The Palisades sill has a thickness is approximately 1312 ft based on mapped contacts on the Elizabeth and Jersey City quadrangle (Olsen, 1980c; R. Parker, unpub. data, 1985).

Tpm, Tp, Tpg **Passaic Formation** (Upper Triassic) (Olsen, 1980) – Interbedded sequence of red-dish-brown, and less often maroon or purple and gray, fine-grained sandstone, siltstone, shaly siltstone, silty mudstone, and mudstone. Reddish-brown sandstone and siltstone are thin- to medium-bedded, planar to cross-bedded, micaceous, and locally mudcracked and ripple cross-laminated. Root casts and load casts are common. Shaly siltstone, silty mudstone, and mudstone are fine-grained, very thin to thin-bedded, planar to ripple cross-laminated, locally fissile, bioturbated, and contain evaporite minerals. They form rhythmically fining-upward sequences as much as 15 ft thick. Unit was subdivided into a siltstone, silty mudstone and shale of classic Passaic to the south (Tp) and sandstone, siltstone and mudstone facies (Tpm) and gray facies (Tpg) from driller's logs, BTV data and outcrops. Unit is only exposed in two streams on the Kean University (shown as Newark State College campus in the central western part of the map area, but regionally is as much as 11,480 ft thick.

Trs, Trk **Lockatong Formation** (Upper Triassic) (Kümmel, 1898) – Cyclically deposited sequences of mainly gray to greenish-gray, siltstone and white to buff arkosic sandstone. Siltstone is medium- to fine-grained, thin-bedded, laminated, platy to massive. Arkose (Trks) has affinities for the Stockton Formation (Olsen, 1989) and is massive to cross-bedded. Occurs in the middle to upper section of cycles. Thermally altered where intruded by Palisades sill to dark gray to black hornfels consisting of plagioclase, orthoclase and recrystalized diopside-rich arkose and calc-silicate minerals such as grossularite, diopside and prehnite in siltstone beds and biotite and albite in finer grained beds (Olsen 1980c, Van Houten, 1969). Hornfels thickness unknown due to lack of exposure and poor well log descriptions (see table 1). Lower contact gradational into Stockton Formation and placed at base of lowest continuous black siltstone bed (Olsen, 1980). Maximum thickness of unit regionally is about 700 ft (Parker, 1993).

Trs **Stockton Formation** (Upper Triassic) (Kümmel, 1898) – In cross section only. Unit is interbedded sequence of gray, grayish-brown, or slightly reddish-brown, medium- to fine-grained, thin- to thick-bedded, poorly sorted, to clast imbricated conglomeratic, planar to trough cross-bedded, and ripple cross laminated arkosic sandstone, and reddish-brown clayey fine-grained, sandstone, siltstone and mudstone . Coarser units commonly occur as lenses and are locally graded. Finer units are bioturbated sequences and are fining upward. Conglomeratic and sandstone units are deeply weathered and more common in the lower half; siltstone and mudstone are generally less weathered and more common in upper half. Lower contact is an erosional unconformity. Thickness is approximately 820 ft (Olsen 1980b).

OYmu **Manhattan prong, undivided** (Mesoproterozoic to Middle Ordovician) – unit may contain autochthonous rocks of the Walloomsac Formation and/or allochthonous rocks of the Hartland Formation and Serpentinite (Volkert, 2015). Shown in cross section only.

EXPLANATION OF MAP SYMBOLS

Contact – Dashed where covered. Dotted where concealed by water. Queried where uncertain

Normal fault – Identity or existence questionable, location accurate. Ball and bar on downthrown block

Planar features

Strike and dip of inclined beds

10 — **Well with log in table 1** - Location accurate to within 100 feet.

240 — **Well with log in table 1** - Location accurate to within 500 feet.

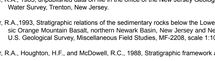
190 — **Elevation of bedrock surface** - contour interval 50 feet.

Other features

Downhole Optical Televiewer interpretation - Shows marker beds identified in borehole projected to land surface using bed orientation identified in well. Red dot shows well location. Data from Herman and Curran (2010) and Herman and others (2015).

BTV 1 — **Driller's log** - Used to project gray bed to surfaces and other characteristic beds. Solid circle accurate to within 100 feet. Open circle accurate to within 500 feet.

CORRELATION OF MAP UNITS



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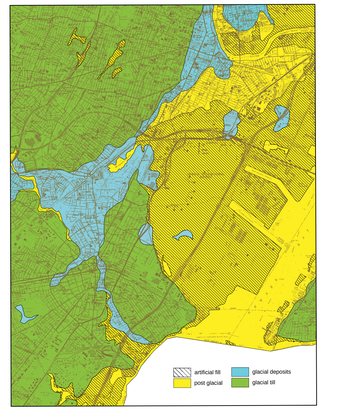

Figure 1: Simplified surficial geology of the Elizabeth quadrangle, Stanford (2002).

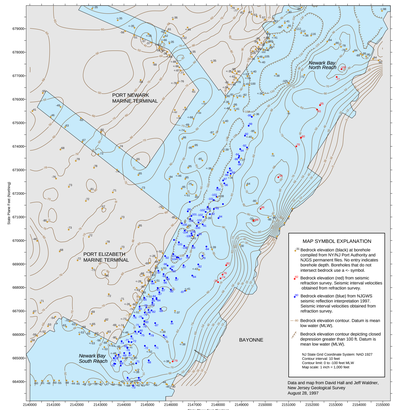

Figure 2a. Bedrock surface contours of the Newark Bay region from Stanford (2002) supplemented by seismic refraction data of David Hall and Jeffery Waldner (unpublished data, 2010).

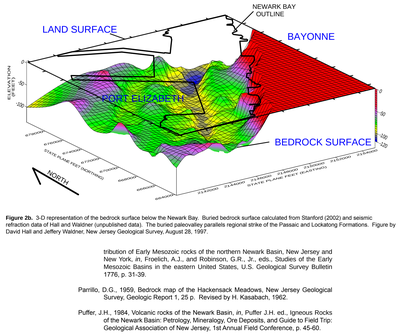

Figure 2b. 3-D representation of the bedrock surface below the Newark Bay. Buried bedrock surface calculated from Stanford (2002) and seismic refraction data of Hall and Waldner (unpublished data). The buried paleovalley parallels regional strike of the Passaic and Lockatong Formations. Figure by David Hall and Jeffery Waldner, New Jersey Geological Survey, August 28, 1997.

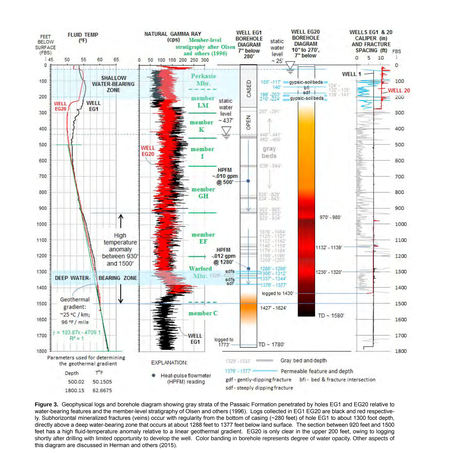

Figure 3. Geophysical logs and borehole diagram showing gray strata of the Passaic Formation penetrated by holes EG1 and EG20 relative to water-bearing features and the member-level stratigraphy of Olsen and others (1996). Logs collected in EG1 EG20 are black and red respectively. Subhorizontal mineralized fractures (veins) occur with regularity from the bottom of casing (~280 feet) of hole EG1 to about 1300 foot depth, directly above a deep water-bearing zone that occurs at about 1298 feet to 1377 feet below land surface. The section between 920 feet and 1500 feet has a high fluid-temperature anomaly relative to a linear geothermal gradient. EG20 is only clear in the upper 200 feet, owing to logging shortly after drilling with limited opportunity to develop the well. Color banding in borehole represents degree of water opacity. Other aspects of this diagram are discussed in Herman and others (2015).

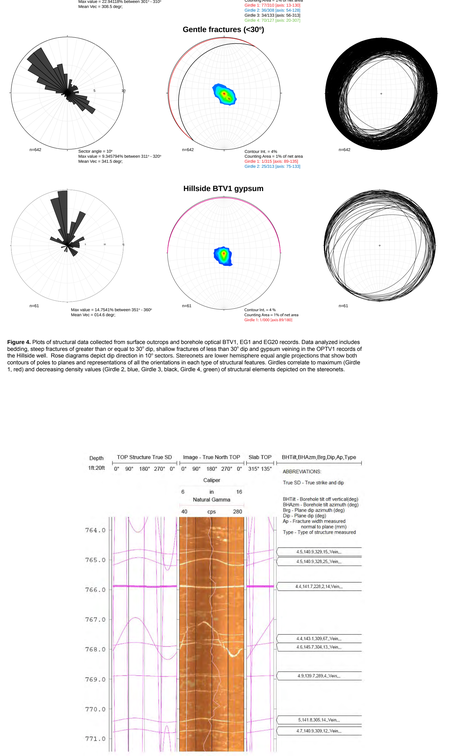

Figure 4. Plots of structural data collected from surface outcrops and borehole optical BTV1, EG1 and EG20 records. Data analyzed includes bedding, steep fractures of greater than or equal to 30° dip, shallow fractures of less than 30° dip and gypsum veining in the OPTV1 records of the Hillside well. Rose diagrams depict dip direction in 10° sectors. Stereonets are lower hemisphere equal angle projections that show both contours of poles to planes and representations of all the orientations in each type of structural features. Girdles correlate to maximum (Girdle 1, red) and decreasing density values (Girdle 2, blue, Girdle 3, black, Girdle 4, green) of structural elements depicted on the stereonets.

Figure 5. A section of the EG1 optical BTV log shows that in some places, steeply dipping, mineralized extension fractures apparently cross cut and offset sub horizontal, mineralized fractures. The sub horizontal fractures are commonly reported as being the youngest, mineralized fractures in the basin, and therefore, such localized effects may signal reactivation of older extension fractures (Herman and others, 2015).

Bedrock Geology of the Elizabeth Quadrangle, Essex, Hudson, and Union Counties, New Jersey

New Jersey Geological Survey
Geological Map Series GMS 15-4
2015
text to accompany map

Table 1.--Selected well and boring logs from Stanford (2002) with several additions and more detailed bedrock information.

Well No.	Identifier[1]	Driller's Log	
		Depth[2]	Description[3]
1	26-672	0-25	clay and boulders
		25-312	red sandstone rock
3	26-1334	0-21	hardpan
		21-214	red rock
4	BWA files	0-58	red clay, stones and boulders
	26-12-785	58-304	red sandstone rock
5	26-22852	0-20	red-brown clay silt, trace gravel
		20-50	brown weathered sandstone
6	26-22335	0-15	red-brown sand and silt
		15-30	weathered sandstone
7	26-25843	0-3	red-brown medium-to-fine sand and gravel
		3-51	red shale
8	26-28623	abbreviated log	
		0-26	red-brown silty clay with rock fragments
		26-35	red-brown rock fragments
9	26-19805	0-6	brown to black sand and gravel
		6-18	red-brown shale
12	26-3173	0-50	sand and gravel
		50-70	red rock
		70-215	red shale
13	26-3532	0-30	sand and dirt
		30-44	fine sand
		44-300	red rock
14	26-24369	abbreviated log	
		0-12	red-brown silty sand
		12-22	red-brown clay silt
		22-36	red-brown silty sand
		36-56	red-brown sandy silt
		56-65	red-brown silty sand
		65-71	red shale, highly weathered red rock
16	26-25763	abbreviated log	
		0-4	fill
		4-28	red-brown fine-to-medium sand, trace silt
		28-43	red-brown very fine sand and silt
		43-54	red-brown sand, trace silt, some gravel

		54-61	weathered siltstone
18	26-4930	0-56	sand, gravel
		56-308	red shale
20	26-1053	0-147	sandy clay, clay
		147-700	shale
21	NJGS files	0-6	sand, brick, cinder fill
		6-13	fine red sand and gravel
		13-25	red sand and coarse gravel
		25-35	fine red sand
		35-45	red silt
		45-58	red sand, gravel, clay binder
		58-63	shale
22	26-3924	0-10	basement
		10-65	gravel, sand, clay
		65-280	red rock
23	26-3194	0-75	red sandy clay
		75-300	red shale
24	26-28483	0-50	brown fine sand
		50-53	fine-to-coarse sand and gravel
		53-55	broken shale
25	26-28481	0-7	fill
		7-28	sand and gravel, silt
		28-40	red shale
26	26-22996	0-3	fill
		3-6	red-brown clay silt
		6-8	weathered shale
		8-28	red shale
27	26-19107	0-3	red-brown fine sand, some silt, little cobbles and gravel
		3-52	red-brown siltstone
28	26-9762	0-14	gravel till
		14-19	shale bedrock
29	26-25529	0-4	sand, gravel, brick fill
		4-19	red-brown clay, silt, gravel
		19-54	red shale
30	26-22996	0-3	sand, gravel, wood fill
		3-6	red-brown clay silt
		6-8	weathered shale
		8-28	red shale
31	26-16549	0-30	red-brown silty fine sand, trace gravel
		30-35	red-brown decomposed shale
33	26-3864	0-8	fill
		8-19	clay and stone
		19-32	red hardpan with clay and sand
		32-500	red shale
34	26-17979	0-8	sand, cement, brick, glass fill
		8-24	Brunswick Formation
35	26-29971	abbreviated log	
		0-6	silt, sand, gravel, crushed stone, brick, wood fill
		6-17	red-brown silt, clay, trace sand and gravel

		17-29	weathered siltstone
37	26-7998	abbreviated log	
		0-22	reddish to gray-reddish sandy clayey silt with gravel
		22-24	micaceous laminated red shale
38	26-22287	abbreviated log	
		0-14	red-brown sandy clayey silt
		14-18	red-brown weathered shale
39	NJGS files	0-21	red sand, clay, gravel, boulders
		21-26	shale
40	26-968	0-35	fill
		35-298	red rock
41	26-156	0-20	earth
		20-496	red rock
42	26-29462	0-13	red-brown medium-to-fine silty sand
		13-34	red shale
43	26-6962	0-55	sand, gravel, clay
		55-200	shale
46	26-315	0-78	earth and clay
		78-303	red shale rock
47	BWA files	0-30	sand and gravel
	26-22-254	30-104	gravel
		104-107	clay, sand, and stones
		107-119	soft gray rock, yellow clay
		119-123	soft gray rock and a little clay
		123-129	gray shale
		129-131	black shale
		131-143	gray shale
		143-187	red sandstone
		187-330	gray rock
		330-335	black rock
		335-370	red rock
		370-389	gray rock
49	26-28999	0-10	brown clayey silt
		10-26	red shale
52	BWA files	abbreviated log	
	26-12-979	0-15	fill
		15-35	dark fine sand, some gravel at base
		35-45	sticky clay
		45-65	fine reddish brown sand and some stone
		65-145	sandy clay and soft brownstone
		145-180	sticky clay
		180-193	coarse brown sand
		193-212	brownstone
		212-218	water-bearing gravel
		218-699	brownstone
56	26-4982	0-176	sand and gravel
		176-194	red shale
58	26-20605	abbreviated log	
		0-20	no log
		20-40	brownish gray medium-to-coarse sand
		40-113	laminated fat clay and sandy silt
		113-151	reddish brown gravel with sand and silt

		151-404	reddish brown shale
59	26-20606	0-90	overburden, no log
		90-112	till or gravel
		112-431	shale
61	26-537	0-90	sand and red clay
		90-112	soft red shale
		112-225	harder red shale
66	26-2926	0-11	fill
		11-33	sandy shale
		33-55	sand with little gravel
		55-73	sand with red shale
		73-406	hard red shale
68	26-2130	0-10	fill
		10-30	sandy clay
		30-45	clay
		45-55	sandy clay
		55-70	clay and gravel
		70-90	sandy clay
		90-140	clay matrix
		140-144	soft shale
		144-500	red shale
71	26-355	0-8	fill
		8-35	gray clay
		35-116	sand, gravel, and clay
		116-208	red rock
72	26-94	0-6	fill
		6-24	river bottom muck
		24-42	sand and gravel
		42-67	fine silt
		67-78	sand and gravel
		78-87	fine silt
		87-359	red shale rock
74	26-1940	0-90	clay, sand
		90-500	red rock and shale
75	26-3293	0-55	overburden
		55-300	sandstone
78	26-1783	0-65	clay and stones
		65-503	shale
80	26-4947	0-72	silt, clay
		72-400	red shale, sandstone
81	26-5082	abbreviated log	
		0-20	black muck
		20-40	red fine sand and muck
		40-45	red fine sand
		45-70	red clay and pieces of shale
		70-85	red clay
		85-300	red shale
82	26-2141	0-82	clay and dead sand
		82-500	red rock
83	NJGS files	0-10	fill
	Pulaski Skyway	10-20	river mud
	boring 91	20-50	red sand
		50-61	soft red shale

		61-81	red shale
84	NJGS files Pulaski Skyway boring 97	0-10 10-30 30-50 50-60 60-80	cinder fill brown sand fine red sand and clay coarse red sand and clay red shale
90	26-4514	0-82 82-300	sand and gravel red shale
92	NJGS files Central Railroad of New Jersey boring 47	0-6 6-15 15-17 17-31 31-34 34-45 45-50 50-51	fill sand and ashes coarse sand sand gravel sand and clay sand red shale
93	26-28979	0-20 20-22 22-24 24-50 50-55 55-57	miscellaneous fill--ash, sand chemical residue black peat brown-red medium-to-fine sand with silt brown-red shale till weathered shale
95	NJGS files Central Railroad of New Jersey boring 45	0-5 5-24 24-34 34-44 44-54 at 54	fill red sand and clay gray sand and clay fine sand red sand and clay red shale
97	NJGS files Route 25 viaduct boring 52	0-5 5-25 25-46 46-55 55-67 67-68	fill red medium-to-coarse sand red clayey fine sand red sandy clay gravelly and sandy clay red shale
98	NJGS files Route 25 viaduct boring 48	0-6 6-32 32-76 76-82 82-83	sand and gravel fill red fine-to-coarse silty sand, little clay stiff red clay and sandy clay red gravelly clay red shale
99	26-1180	0-NR NR-500	clay, silty clay, quicksand red shale
105	NJGS files Route 25 viaduct boring 23	0-21 21-61 61-67 67-74	cinder fill red clay red clay with gravel red shale
106	26-2977	0-20 20-77 77-306	fill--dirt, wood, sand clay, sand, and gravel mix red shale
107	26-2053	0-95 95-400	silt, clay sediments shale
108	Woolman, 1896, p. 183, Unger well	0-80 at 80	clay and quicksand red rock
109	26-4345	0-20	garbage

		20-71	red hardpan
		71-405	red shale
111	26-25243	abbreviated log	
		0-6	fill--black cinders, gravel, ash, sand
		6-8	gray-brown clay, fine-to-medium sand
		8-60	red-brown silt and clay, trace gravel
		60-65	silt, gravel, weathered gravel
		65-67	red-brown weathered shale
112	26-5450	abbreviated log	
		0-6	fill--bricks, cinders, sand
		6-8	black, brown peat
		8-10	gray fine-to-coarse sand
		10-62	reddish brown silt and clay, little gravel
		62-71	red-brown silt and clay with gravel
		71-72	reddish brown shale
113	26-4784	0-5	stony fill
		5-38	gray clay
		38-50	red hardpan
		50-105	red shale
		105-170	red sandstone
114	26-24406	0-48	red-brown sand and silt
		48-72	red-brown till
		72-78	red-brown sandstone
116	26-1420	0-42	fill-clay-sand-clay
		42-220	shale
117	26-20558	0-18	fill--black, brown sand, wood, brick, cement
		18-44	red-brown fine-to-medium sand, silt
		44-57	red shale, decomposed
119	26-17934	abbreviated log	
		0-27	brown, gray sand, silt; some cinders, wood, slag
		27-30	brown peat
		30-35	gray sand and silt, little peat
		35-65	red silt, clay, trace fine sand
		65-70	red dense sand and gravel, little silt, trace clay
		70-75	red weathered siltstone
		75-85	red siltstone
120	26-15459	abbreviated log	
		0-29	brown, gray silt, sand, cinders
		29-34	brown peat
		34-42	red fine sand, little silt
		42-55	red silt, some clay
		55-65	red very stiff silt, some clay, trace sand and gravel
		65-75	red weathered shale
121	26-20333	abbreviated log	
		0-19	fill--brown sand, silt, gravel, wood
		19-33	gray-brown organic silt and peat
		33-68	red-brown clayey silt, little sand, trace gravel
		68-73	red-brown fine-to-coarse sand with some gravel and silt
		73-76	red-brown fractured shale
123	26-4006	0-48	fill possible old well or pit)
		48-92	light brown sand Qpt over
		92-113	red clay
		113-203	red hardpan

		203-496	red shale
124	26-1302	0-4	fill
		4-11	sandy clay
		11-24	quick sand
		24-32	hardpan probably desiccated
		32-53	hard dry clay desiccated
		53-76	sandy clay
		76-98	clay-gravel matrix
		98-133	sandy clay
		133-181	clay-gravel matrix
		181-245	soft shale
		245-485	red shale
125	Herpers and Barksdale, 1951, p. 47	0-5	concrete and cinders
		5-15	yellow clay fill or
		15-27	fine red sand
		27-55	red quicksand
		55-80	tough red clay desiccated
		80-125	soft red clay
		125-190	red sandy clay
		190-210	soft red clay
		210-215	hardpan
		215-225	sand and clay
		225-408	red rock
133	26-5309	0-160	sand, clay
		160-190	red shale
136	26-13433	0-6	miscellaneous fill
		6-15	black silty sand, trace organics
		15-45	red-brown silty fine sand
		45-75	red-brown silty clay
		75-85	red-brown clayey silt
		85-100	decomposed shale
141	NJGS files Route 25 viaduct boring 1	0-7	cinder fill
		7-20	red sandy clay
		20-40	red clayey fine sand
		40-53	red-brown stiff clay with gravel
		53-54	decomposed red shale
142	26-3850	0-7	fill
		7-17	black muck
		17-60	red clay
		60-74	red clay and gravel
		74-495	red shale
143	26-3043	0-18	fill
		18-57	red clay
		57-400	red shale
146	29-12312	abbreviated log	
		0-10	brown silt, sand, gravel, wood
		10-23	brown peaty silt and peat
		23-27	brown-gray silty fine sand, trace peat
		27-37	red silt
		37-43	brown-red fine-to-medium gravel and sand
		43-71	brown-red clay and silt
		71-76	red clay and silt with little gravel
		76-80	red hard silty weathered shale
147	26-12311	abbreviated log	
		0-16	brown silt, sand, gravel, rubble
		16-23	brown-black peat
		23-25	gray fine sand

		25-46	brown-red silt and clay
		46-58	red-brown silt, some clay and gravel
		58-65	red silty weathered shale
148	26-6880	0-2	red-brown sandy clayey silt with gravel and brick fragments
		2-12	red-brown clayey silt and silty clay, some medium-to-fine sand and gravel
		12-51	red shale
149	26-7377	0-11	red-brown coarse-to-fine sand, some gravel and cobbles, trace silt
		11-14	red shale
150	26-1098	0-40	earth, clay, dirt
		40-250	red rock
151	26-286	0-45	earth
		45-402	red rock
152	26-686	0-79	mixture of hardpan, sand and streaks of clay
		79-213	red rock
153	26-1659	0-25	loose sand, stone, and clay
		25-230	red sandstone
154	26-4452	0-5	fill
		5-28	hardpan and clay
		28-46	fractured shale
		46-201	red shale and sandstone
155	26-622	0-6	fill
		6-19	clay and stone
		19-56	sand and gravel
		56-70	soft red rock
		70-209	red rock
157	26-10993	0-25	brown medium-to-fine sand, little coarse-to-fine gravel, trace silt, trace cobbles
		25-30	red-brown sandstone
158	26-4513	0-10	overburden
		10-300	red shale
159	26-1857	0-20	fill
		20-36	red clay
		36-425	red sandstone rock
160	26-453	0-12	boulders and clay
		12-48	sand, gravel and boulders
		48-53	red clay
		53-461	red rock
		461-480	gray rock
		480-903	red rock
161	26-2187	0-4	fill
		4-10	sandy clay
		10-25	clay matrix
		25-35	sandy clay
		35-50	hardpan
		50-80	sandy clay and clay matrix
		80-250	shale
163	26-132	0-76	red earth
		76-229	red shale

164	26-720	0-3	dirt
		3-38	sand, clay and some boulders
		38-245	red rock
		245-260	gray rock
		260-400	red rock
166	26-81	0-95	red dirt and some boulders
		95-200	red shale
167	26-57	0-29	reddish clay, sand, boulders
		29-42	fine red sand, some gravel, clay
		42-61	red hardpan with fine sand and broken rock
		61-63	fine red sand
		63-71	coarse gray and brown sand, broken rock
		71-83	red clay, hardpan
		83-210	red shale – red rock streaks,caving
		210-230	hard red rock
		230-246	red shale
		246-312	red shale and rock
		312-322	red and gray shale, lost cuttings
169	26-4453	0-40	sand and gravel
		40-536	red sandstone
173	26-1171	0-82	earth, clay, dirt
		82-183	red rock
176	26-25771	abbreviated log	
		0-8	silt, stone fill
		8-18	reddish silt and gravel
		18-27	shale
177	26-1984	0-18	clay and boulders
		18-241	red rock
178	26-5955	0-8	red-brown coarse-to-fine sand, some coarse-to-fine gravel, some silt, trace cobbles
		8-11	soft red shale
		11-26	red shale and sandstone
179	26-23969	0-10	fine-to-coarse sand fill
		10-35	fine-to-coarse sand and gravel, some silt, trace clay
		35-58	fine sand and silt
		58-64	boulder at 58
		64-69	red shale
181	26-4624	0-100	sand, gravel (Qez)
		100-250	sandstone
182	26-4309	0-50	overburden
		50-225	red shale and red sandstone
183	26-3615	0-18	red sand
		18-21	gravel
		21-77	fine red sand
		77-84	sand and gravel
		84-461	red rock
184	26-237	0-6	fill
		6-11	red clay
		11-54	red sandy clay
		54-79	clay, stones and gravel
		79-379	red shale rock
185	26-55	0-7	soft red dirt
		7-92	red dirt and clay

		92-352	red rock
186	26-201	0-10	clay
		10-20	coarse sand
		20-24	small gravel
		24-90	soft red shale
		90-600	hard red shale
187	26-6780	abbreviated log	
		0-27	red-brown silty sand, some gravel
		27-31	red weathered shale
		at 31	refusal rock)
190	26-1782	0-22	red sand and gravel
		22-420	red rock
191	26-117	0-17	red earth
		17-125	red shale
192	26-852	0-23	clay, gravel, fine sand
		23-475	red shale
193	26-221	0-19	top soil, brown dirt and silt
		19-22	boulders
		22-400	shale
194	26-45	0-22	dirt, gravel, hardpan
		22-151	red shale
195	26-697	0-29	red sandy clay
		29-100	red shale with clay streaks
		100-120	red sandstone
		120-202	reddish brown shale
197	26-696	0-7	cinders and fill
		7-19	blue clay fill
		19-49	red clay
		49-50	sand and gravel
		50-76	red soupy sand and clay
		76-88	reddish brown hardpan
		88-89	dirty sand and gravel
		89-93	soupy red clay
		93-203	clay and red shale
200	26-912	0-3	cinders and fill
		3-7	blue gray clay
		7-40	red clay
		40-41	red sandstone
		41-322	red shale and red clay
		322-500	red rock, clay and shale
203	26-20060	abbreviated log	
		0-6	black sand and cinders (fill)
		6-8	red-brown clayey sand, some silt (fill)
		8-16	gray organic clay with peat fibers
		16-20	brown fine-to-medium sand, trace clay and silt
		20-60	red-brown clayey silt to silty clay
		60-104	red-brown fine-to-medium sand, some silt and gravel
		104-105	red-brown till
		105-110	shale
206	26-137	0-115	earth
		115-603	red rock
208	26-7486	abbreviated log	
		0-8	cinder fill

		8-16	dark-brown peat and organic silt
		16-90	brown fine-to-coarse sand, trace silt
		90-100	red decomposed sandstone, shale and siltstone
212	NJGS files	abbreviated log	
	Newark Airport	0-10	cinder and ash fill
	boring NA-1-2	10-25	gray peaty organic silt
		25-41	red fine-to-very-fine silty sand
		41-110	red clayey silt
		110-111	fine red sandy silt
		111-120	red shale
216	NJGS files	abbreviated log	
	Newark Airport	0-3	black peaty organic silt
	boring NA-4-41	3-66	red fine-to-coarse sand, trace gravel
		66-75	red silty fine sand
		75-91	red clayey silt and clayey silt
		91-93	red silty clay and shale fragments
		93-98	red shale rock
217	NJGS files	abbreviated log	
	Newark Airport	0-6	peat
	boring NA-4-44	6-8	brown silty fine sand
		8-23	red very fine sandy silt
		23-27	red clayey silt
		27-44	red silty fine sand, some shale gravel
		44-51	red clayey silt to silty sand, some shale gravel
		51-56	red shale rock
218	NJGS files	abbreviated log	
	Newark Airport	0-7	peaty organic silt to silty sand
	boring NA-4-46	7-32	red silty coarse-to-fine sand, some gravel
		32-37	red clayey silt
		37-42	red silty very fine sand
		42-64	red silty clay, some shale gravel and granite boulders
		64-69	red shale rock
219	NJGS files	abbreviated log	
	Newark Airport	0-7	garbage and ash fill
	boring NA-4-50	7-10	peaty organic silt
		10-15	gray very fine sandy silt
		15-19	fine red sand
		19-53	red clayey silt
		53-61	red shale rock
221	NJGS files	abbreviated log	
	Newark Airport	0-1	red silty sand and gravel fill
	boring NA-4-22	1-18	gray peaty organic silt
		18-20	gray medium-to-fine silty sand
		20-40	red clayey silt and shale fragments
		40-43	highly compressed red silty clay and some shale fragments
		43-48	red shale rock
222	NJGS files	abbreviated log	
	Newark Airport	0-16	gray peaty organic silt to fine sand
	boring NA-4-21	16-41	red silt, trace red clay and quartz gravel
		41-47	highly compressed red silty clay and decomposed shale fragments
		47-52	red shale rock
223	NJGS files	abbreviated log	
	Newark Airport	0-24	gray peaty organic silt
	boring NA-4-24	24-49	red silty clay
		49-54	red shale rock

224	NJGS files	abbreviated log	
	Newark Airport	0-9	peaty organic silt
	boring NA-4-38	9-14	gray silty very fine sand
		14-29	red clayey silt
		29-37	red silty clay and some shale fragments
		37-42	red shale rock
225	NJGS files	abbreviated log	
	Newark Airport	0-2	peaty organic silt
	boring NA-4-35	2-9	gray silty fine sand
		9-20	red fine-sandy silt
		20-41	red silt
		41-44	red silty clay, some decomposed shale fragments
		44-49	red shale rock
226	NJGS files	abbreviated log	
	Newark Airport	0-1	peat
	boring NA-4-28	1-19	brown to gray silty very-fine-to-fine sand
		19-35	red clayey silt
		35-38	red silty clay, some shale gravel
		38-43	red shale rock
232	26-26105	0-4	cinder fill
		4-6	black organic silt
		6-20	red-brown sandy silt and clay
		20-45	red-brown decomposed shale
		45-50	red-brown shale
234	26-8310	0-51	sand
		51-600	red shale
235	26-6867	0-55	overburden
		55-420	red sandstone
237	26-65	0-40	sand and gravel
		40-49	clay and hardpan
		49-101	shale
240	26-23034	abbreviated log	
		0-5	sand and gravel fill
		5-11	brown, red fine sand and silt, trace clay
		11-30	red-brown shale
241	NJGS files	0-4	fill
		4-7	reddish brown fine sand
		7-20	reddish brown medium-to-fine sand with trace clay and gravel
		20-21	red shale
242	NJGS files	0-3	crushed stone, sand, gravel fill
		3-13	red sand, clay, gravel
		13-18	shale rock
243	26-14742	0-12	dark-brown medium-to-coarse sand, little silt, some medium gravel
		12-15	red siltstone
244	26-6387	0-3	red clayey silt and gravel
		3-18	soft red shale
245	26-14148	0-3	sand fill
		3-8	silty clay, shale
		8-18	weathered shale
246	26=19640	0-7	sand and gravel fill
		7-20	brown clay-silt

		20-58	brown sandy silt
		58-68	glacial till, some layers of silty sand
		68-70	shale bedrock
247	26-18320	abbreviated log	
		0-8	sand, silt fill
		8-25	red-brown coarse-to-fine sand with clayey silt and gravel
		25-27	red-brown to gray weathered shale
248	26-18219	abbreviated log	
		0-15	red-brown fine-to-coarse sand, trace silt
		15-20	red-brown coarse-to-fine sand with gravel, trace silt and clay
		20-23	red-brown weathered shale
		23-30	shale
251	NJGS files	0-3	fine red and brown clay and sand
		3-14	fine red sand, clay, gravel
		14-16	soft red shale
252	26-138	0-10	earth, clay, soft rock
		10-255	red shale rock
253	26-5144	0-20	clay
		20-235	shale
254	26-2363	0-33	red clay
		33-250	red rock
255	26-30364	0-5	fill--sandy clay and gravels, brick, etc.
		5-20	red-brown silty sand and clay, some gravels and small cobbles throughout
		20-26	weathered red-brown shale
256	26-8367	0-9	decomposed red shale, coarse-to-fine angular sand, little medium-to-fine gravel, trace clay
		9-17	red shale
257	26-3384	0-24	overburden
		24-500	hard and soft red rock
258	26-25592	0-8	some fill, hard-packed sand and gravel
		8-180	soft to medium red shale
259	26-20132	0-4	fill--red-brown clay, trace fine-to-medium gravel
		4-9	reddish brown clay, trace gravel
		9-20	shale rock
260	26-5807	0-15	overburden
		15-200	shale
261	26-21150	0-4	gray clay fill
		4-13	red-brown silty clay
		13-41	red shale
262	26-13124	0-14	red clayey silt with red shale fragments
		at 14	decomposed red shale
263	26-4055	0-10	hardpan
		10-290	red shale
264	26-13121	0-4	red clayey silt with red shale fragments
		4-14	decomposed red shale
265	26-5674	abbreviated log	
		0-2	fill

		2-14	red-brown clayey silt with gravel and sand
		14-16	red shale
266	26-2969	0-27	clay
		27-360	shale
267	26-1282	0-40	red clay and shale
		40-202	more solid shale
268	26-24634	0-6	fill
		6-30	red shale
269	26-22909	0-8	coarse sand
		8-15	red shale
270	26-27833	0-2	fill
		2-11	red, brown silty clay
		11-14	brown shale
271	26-179	0-15	earth and clay
		15-255	red shale rock
273	26-22736	abbreviated log	
		0-12	silt and clay with some sand, gravel, and rock fragments
		12-13	red and green siltstone and shale
274	26-9343	0-4	sand, cinder fill
		4-7	red silty clay, trace coarse-to-fine sand and fine gravel
		7-9	weathered shale
		9-18	red shale
275	26-19987	0-4	fine-to-coarse sand, gravel, trace silt
		4-12	decomposed shale
276	26-23157	abbreviated log	
		0-12	reddish brown clays and silts, some fine sands
		12-16	red shale
277	26-562	0-5	earth and clay
		5-400	red shale rock
278	26-13613	abbreviated log	
		0-22	red clayey silt and fine gravel, trace fine-to-coarse sand
		at 22	red shale bedrock
279	26-6947	abbreviated log	
		0-2	brown to black sand and gravel fill
		2-8	red clayey sandy silt, trace shale fragments
		8-55	red shale and sandstone rock
281	26-20752	abbreviated log	
		0-6	brown fine-to-medium sand, some fine gravel and silt
		6-37	brown, red-brown clayey silt with some gravel and trace sand and boulders
		37-45	red shale rock
282	26-1870	0-31	clay
		31-92	shale
283	26-1661	0-45	clay
		45-264	red shale
284	26-10953	abbreviated log	
	boring 73	0-50	brown clayey silt, trace sand, little gravel
		50-56	red shale

285	26-10953	abbreviated log	
	boring 27	0-40	brown sand fill
		40-49	brown to brown-red clayey silt, little gravel and sand
		49-65	brown fine sand and silt
		65-75	brown-red clayey silt with gravel and sand
		75-80	red shale
286	26-8211	0-10	silty sand
		10-19	meadow mat
		19-24	gray fine sand, little coarse sand and fine gravel, trace silt and clay
		24-50	brown silty clay, little fine sand to fine gravel
		50-76	brown silty clay, little fine sand to coarse gravel
		76-90	red shale
287	26-10981	abbreviated log	
		0-4	brown silty sand fill?)
		4-19	brown clayey silt, little sand and gravel
		19-30	brown fine sand, little silt
		30-44	red clayey silt, some to little sand and gravel
		44-49	red shale
288	26-3156	0-66	red clay and red fine sand
		66-467	red rock
289	26-21943	0-70	overburden
		70-550	red shale
290	26-8210	abbreviated log	
		0-19	brown sand, silt, wood, metal--fill
		19-21	red-brown fine-to-coarse sand and silt, little fine gravel
		21-47	red-brown silt, trace clay, little fine -to-coarse sand, trace rock fragments
		47-55	decomposed red shale
		55-65	red shale
291	26-8216	0-24	fill--dark-brown silt, metal, concrete, paper, wood
		24-42	red-brown fine sand, some silt
		42-61	red-brown silt, little fine-to-coarse sand, trace clay
		61-80	red shale
293	26-5473	0-8	medium-to-fine brown sand
		8-14	miscellaneous fill
		14-20	brown organic silt
		20-24	dark gray silt-clay
		24-30	red-brown fine silty sand
		30-54	red-brown silt, trace sand
		54-64	red-brown silty clay
		64-73	red shale
295	26-5469	abbreviated log	
		0-18	red-brown sand and gravel
		18-30	wood, metal, sand, gravel--refuse fill
		30-32	gray fine-to-medium sand and organic silty clay
		32-38	red-brown fine sand, trace silt and gravel
		38-53	red-brown silty clay, trace fine sand and gravel
		53-56	red-brown sandy silty clay and gravel
		56-67	red shale
298	26-30045	0-5	gray top soil, trace organics
		5-10	red-gray sand and gravel, trace clay
		10-20	gray clay
		20-40	red-brown clay
		40-42	red decomposed shale
		42-45	red shale

299	26-5471	0-12	miscellaneous refuse
		12-14	gray organic clay and silt
		14-17	gray silty fine sand
		17-24	gray clay and silt
		24-28	gray silty fine sand
		28-73	red-brown silt, trace sand
		73-88	red silty clay, shale fragments
		88-93	red shale, some gray silt and sand
		93-103	red shale
300	26-18486	0-4	brown fine sand and gravel
		4-10	red-brown fine sandy silt, trace clay
		10-16	layered red-brown silt and sand
		16-31	gray-green organic silt, trace fine sand
		31-70	layered red-brown sandy silt to silty sand and clay
		70-90	red-brown till
		90-100	red-brown sandy shale
301	26-5474	abbreviated log	
		0-9	brown sand fill
		9-16	garbage fill
		16-23	gray clay and silt
		23-27	fine gray sand, trace of silt
		27-44	red fine silty sand
		44-62	red-brown varved silty clay
		62-72	red glacial till
		72-82	red shale
302	NJGS files	0-11	water
	Central RR of NJ	11-13	mud
	Newark Bay bridge	13-19	gray sand
	boring 30	19-37	red clay with sand
		37-50	red clay
		50-61	red sandstone
303	NJGS files	0-9	water
	Central RR of NJ	9-16	mud
	Newark Bay bridge	16-28	gray sand
	boring 26	28-55	red clay
		55-64	red sandstone
304	NJGS files	0-9	water
	Central RR of NJ	9-13	mud and shells
	Newark Bay bridge	13-19	gray sand and gravel
	boring 18	19-27	gray sand
		27-38	red clay
		38-47	gravel with clay
		47-55	red sandstone
305	NJGS files	0-10	water
	Central RR of NJ	10-15	mud
	Newark Bay bridge	15-29	gray sand
	boring 12	29-40	red clay
		40-54	clay and gravel
		54-64	gray sandstone
306	NJGS files	0-27	water
	Central RR of NJ	27-31	mud
	Newark Bay bridge	31-37	red clay with gravel
	boring 9B	37-65	red clay
		65-71	red sand
		71-81	gray sandstone
307	NJGS files	0-18	water
	Central RR of NJ	18-24	mud
	Newark Bay bridge	24-28	clay with gravel

	boring 4A	28-54	red clay
		54-59	red sandstone
		59-67	gray sandstone
308	NJGS files	0-8	water
	Central RR of NJ	8-13	mud
	Newark Bay bridge	13-15	sand and mud
	boring 1	15-20	coarse gray sand
		20-42	red clay with gravel
		42-54	gray sandstone
311	26-19191	abbreviated log	
		0-17	green-brown to red medium-to-fine sand and clayey silt, little gravel
		17-19	light-brown siltstone
312	26-10958	0-7	black silt, trace gravel, trace sand
		7-9	brown clayey silt, little gravel and coarse sand
		9-12	red gravel, little silt and sand
		12-27	red shale
313	26-14102	abbreviated log	
		0-27	red-brown very-fine-sand and silt to clayey silt, little gravel
		27-30	red-brown shale--highly weathered
314	26-21712	0-20	brown to red-brown medium-to-fine silty sand with gravel
		20-22	shale
315	26-24201	abbreviated log	
		0-30	silty clay with little fine-to-coarse sand and fine-to-medium gravel
		at 30	shale
316	NJGS files	0-18	brown dirt or soil
	Goethals Bridge	18-25	red clay and sand
	boring 24+79.33	at 25	red shale
317	NJGS files	0-23	red clay
	Goethals Bridge	23-34	red shale
	boring 27+42		
318	26-15643	0-35	red-brown silty clayey coarse-to-fine sand
		35-40	red shale
319	NJGS files	0-31	red clay
	Goethals Bridge	31-41	gneiss and shale boulders
	boring 35+34	41-51	red shale
320	NJGS files	0-11	ash and sand
	Goethals Bridge	11-22	red sand and clay
	boring 40+81	22-60	red shale and sandstone
321	NJGS files	0-9	water
	Goethals Bridge	9-36	silt
	boring 49+96	36-41	sand, gravel
		41-45	broken shale
		45-53	red shale
322	26-30240	0-10	sand, cinder, wood, gravel fill
		10-18	dark brown peat and dark gray organic silt
		18-24	reddish brown silt, clay, sand, gravel
		24-26	reddish brown shale
324	26-29715	abbreviated log	
		0-13	black to red-brown gravel, clay, sand fill

		13-17	brown-gray meadow mat, little clay, trace silt
		17- 29	brown to gray clay and organics
		29-32	red-brown fine-to-coarse gravel and clay
		at 32	red-brown siltstone
325	26-20380	0-9	red silty clay with fine sand and shale
		9-14	brown and black peat
		14-23	red silty fine sand trace medium-to-fine gravel
		23-35	decomposed shale and rock fragments
		35-40	red shale rock
326	26-26040	abbreviated log	
		0-10	dark brown cinders, construction debris
		10-19	greenish, yellow, red silty clay, little sand, some gravel
		19-20	red-brown silt and shale
327	26-29456	0-6	brown to black sand and cinder fill
		6-15	red-brown clayey sand
		15-44	red-brown shale
328	26-29444	abbreviated log	
		0-11	light gray to reddish brown silty clay and sand, some gravel and pebbles (fill)
		11-19	meadow mat and gray clay
		19-22	reddish brown fine sand
		at 22	shale
329	26-29443	0-7	red-brown to black silty clay and sand fill
		7-14	brown silty fine sand
		14-21	red-brown clay with gravel
		21-49	red-brown fractured shale
332	26-20126	abbreviated log	
		0-12	brown, black, red-brown gravel, sand, silt, cinders, clay
		12-25	gray-black organic silt
		25-34	red-brown silt, some fine-to-coarse gravel, little fine-to-coarse sand, trace clay
		34-40	red siltstone
333	26-20122	abbreviated log	
		0-13	black, brown, red-brown cinders, sand, gravel, silt, ashes
		13-26	gray organic silt
		26-35	red-brown silt, some fine-to-medium gravel, little fine-to-coarse sand
		35-45	red siltstone
334	26-6308	0-10	fill--concrete, sand, gravel, bricks
		10-17	black organic silt and peat
		17-18	weathered shale
344	N 26-22-372	0-5	fill
		5-19	fine red sand, some clay
		19-28	red clay with sand and gravel
		28-36	red clay
		36-46	red clayey fine-to-medium sand and gravel
		46-50	red clay, some shale fragments
		50-68	red shale
349	NJGS files	0-9	soft meadow muck
	Port Newark	9-17	sand and clay
	boring 4B	17-56	red clay
		at 56	shale
350	NJGS files	0-10	soft meadow muck
	Port Newark	10-16	sand and clay

	boring 20B	16-37	red clay
		at 37	shale
351	NJGS files	0-9	cinders and sand (fill)
	Port Newark	9-18	organic silt
	boring 284	18-28	sand
		28-33	sandy silt
		33-63	clay
		63-72	till
		72-82	shale
352	NJGS files	0-39	water
	Port Newark	39-41	organic silt
	boring 363	41-50	clay with gravel
		50-62	clay
		62-67	shale
353	NJGS files	0-18	cinders, silt, clay
	Port Newark	18-29	sand
	boring 280	29-38	silt and clay
		38-65	clay
		65-79	sandy silty clay
		79-87	till
		87-97	shale
357	NJGS files	0-5	water
	Port Newark	5-48	silty clay
	boring 223	48-53	silt
		53-77	silty clay
		77-83	shale
358	Lovegreen, 1974	0-9	gray organic silt
	fig. 17	9-15	brown sand
		15-53	reddish brown varved clay and silt
		53-55	red sandstone
359	Lovegreen, 1974	0-15	gray organic silt
	fig. 17	15-25	reddish brown varved clay and silt
		25-39	red sandstone
360	Lovegreen, 1974	0-9	fill
	fig. 17	9-18	gray organic silt
		18-54	reddish brown varved clay and silt
		54-59	red sandstone
361	Lovegreen, 1974	0-18	fill
	fig. 17	18-26	brown sand
		26-60	reddish brown varved clay and silt
		60-61	red sandstone
362	Lovegreen, 1974	0-14	gray organic silt
	fig. 17	14-18	brown sand
		18-53	reddish brown varved clay and silt
		53-55	red sandstone
363	Lovegreen, 1974	0-8	fill
	fig. 17	8-15	gray organic silt
		15-35	brown sand
		35-38	reddish brown varved clay and silt
		38-41	red sandstone
364	Lovegreen, 1974	0-11	gray organic silt
	fig. 17	11-42	brown sand
		42-45	reddish brown varved clay and silt
		45-50	red sandstone

365	Lovegreen, 1974	0-38	gray organic silt
	fig. 17	38-55	reddish brown varved clay and silt
		55-65	red sandstone
366	Lovegreen, 1974	0-30	gray organic silt
	fig. 17	30-47	gray sand
		47-92	reddish brown varved silt and clay
		92-101	red sandstone
367	Lovegreen, 1974	0-8	fill
	fig. 17	8-39	gray organic silt
		39-94	reddish brown varved silt and clay
		94-110	red sandstone
368	Lovegreen, 1974	0-21	gray organic silt
	fig. 17	21-60	reddish brown varved silt and clay
		60-70	red sandstone
369	NJGS files	abbreviated log	
	Newark Bay	0-20	black organic silty clay and peat
	boring 3025	20-27	gray to reddish brown fine sand, trace silt and gravel
		27-88	red-brown varved silty clay
		88-95	red-brown silty clay, some gravel
		95-105	red shale
370	NJGS files	abbreviated log	
	Newark Bay	0-30	brown fine sand fill
	boring 3136	30-43	brown to gray fine sand, little silt, trace gravel
		43-105	red-brown varved clayey silt to silty clay
		105-114	red shale
371	NJGS files	abbreviated log	
	Newark Bay	0-20	brown sand to black silty clay fill
	boring 3023	20-40	gray organic silty clay, trace fine sand, trace shells
		40-90	red-brown varved silty clay
		90-93	red-brown clayey silt, trace gravel, trace red shale
		93-113	red shale
372	NJGS files	abbreviated log	
	Newark Bay	0-2	water
	boring 3103	2-17	gray organic silty clay
		17-30	gray fine sand, little silt
		30-95	red-brown varved clayey silt
		95-101	red-brown clayey silt, trace red shale fragments
		101-106	red shale
373	NJGS files	abbreviated log	
	Newark Bay	0-4	water
	boring 3098	4-17	black to dark gray organic silty clay, trace fine sand, trace shells
		17-30	gray fine sand, trace silt and gravel
		30-85	red-brown varved silty clay
		85-91	red-brown clayey silt, trace gravel, little red shale
		91-101	red shale
374	NJGS files	abbreviated log	
	Newark Bay	0-10	water
	boring 3042	10-30	gray to black organic silty clay, little shells and fine sand
		30-35	brown coarse-to-fine sand, some gravel
		35-95	red-brown varved silty clay
		95-105	red shale
375	NJGS files	0-7	water
	Port Newark	7-24	organic silt and sandy silt
	boring 262	24-43	clayey silt
		43-61	sandy silty clay

		61-70	till
		70-75	shale
376	NJGS files	abbreviated log	
	Newark Bay	0-3	water
	boring 3021	3-24	black, gray organic silty clay, trace fine sand
		24-95	red-brown varved silty clay
		95-100	gray sandstone, red shale, seamy
377	NJGS files	abbreviated log	
	Newark Bay	0-2	water
	boring 3091	2-20	black organic silty clay, trace fine sand
		20-25	brown fine sand, trace silt and gravel
		25-89	red-brown varved silty clay
		89-96	red shale
378	NJGS files	abbreviated log	
	Port Newark	0-21	organic silt
	boring 27	21-27	silty sand
		27-58	silty clay
		58-63	shale
380	NJGS files	0-7	clayey silt
	Port Newark	7-18	organic silt and peat
	boring 4	18-22	silty sand
		22-34	silt
		34-39	silty clay
		39-54	sandy silty clay
		54-63	till
		63-69	shale
381	NJGS files	0-11	organic silt
	Port Elizabeth	11-14	organic sand
	boring 38	14-20	sandy silt
		20-40	silty clay
		40-52	till
		52-57	shale
382	NJGS files	0-12	organic silt
	Port Elizabeth	12-20	silty sand
	boring 6	20-43	sandy silt
		43-62	sandy silty clay
		62-72	till
		72-77	shale
383	NJGS files	0-18	peat and organic silt
	Port Elizabeth	18-29	sand
	boring 20	29-36	silty sand
		36-49	silty clay
		49-53	clayey silt
		53-63	sandy silty clay
		63-72	silty clay
		72-79	till
		79-84	shale
384	NJGS files	0-13	organic silt
	Port Elizabeth	13-23	silty sand
	boring 28	23-29	sandy silt
		29-69	sandy silty clay
		69-71	silty clay
		71-74	till
		74-84	shale
385	NJGS files	0-8	organic silt and peat
	Port Elizabeth	8-18	silty sand
	boring 2	18-27	silty clay

		27-32	shale
386	NJGS files	abbreviated log	
	Port Elizabeth	0-15	organic silt and peat
	boring 11	15-27	silty sand
		27-33	sandy silt
		33-71	silty clay
		71-77	till
		77-85	shale
387	NJGS files	abbreviated log	
	Port Elizabeth	0-9	organic silt
	boring 24	9-25	silty sand
		25-33	sandy silt
		33-60	silty clay
		60-61	till
		61-66	shale
388	NJGS files	0-13	organic silt and peat
	Port Elizabeth	13-28	silty sand
	boring 34	28-39	sandy silt
		39-71	silty clay
		71-81	till
		81-101	shale
389	NJGS files	abbreviated log	
	Port Elizabeth	0-15	organic silt and peat
	boring 16	15-25	silty sand
		25-38	sandy silt
		38-77	sandy silty clay
		77-79	decomposed shale
		79-89	shale
390	NJGS files	abbreviated log	
	Port Elizabeth	0-11	organic silt, sand, peat
	boring 32	11-23	silty sand
		23-35	sandy silt
		35-70	silty clay
		70-74	till
		74-79	shale
391	NJGS files	abbreviated log	
	Port Elizabeth	0-12	organic silt and peat
	boring 9	12-37	silty sand, sand
		37-53	silty clay
		53-54	decomposed shale
392	NJGS files	abbreviated log	
	Port Elizabeth	0-16	organic silt and peat
	boring 22	16-38	silty sand to sandy silt
		38-76	silty clay
		76-77	decomposed shale
		77-82	shale
393	NJGS files	abbreviated log	
	Port Elizabeth	0-11	organic silt and peat
	boring 36	11-40	sand, silty sand
		40-84	silty clay
		84-95	till
		95-110	shale
398	NJGS files	abbreviated log	
	Newark Bay	0-7	water
	boring 3107	7-22	gray organic silty clay, trace fine sand, trace shells
		22-29	gray fine sand, trace silt, trace gravel
		29-66	red-brown varved silty clay

		66-71	brown and white sandstone, red shale
415	NJGS files	0-7	water
	U. S. Army	7-16	sand and shells
	Corps of Engineers	16-26	clay and shale
	boring 181	at 26	shale
418	NJGS files	0-28	water
	U. S. Army	28-32	sand (Qm or Qal)
	Corps of Engineers	32-34	hard gravel
	boring 178	34-35	hard clay and shale
		at 35	shale rock
420	NJGS files	0-18	water
	U. S. Army	18-32	mud, sand, shells
	Corps of Engineers	32-34	sand
	boring 183	34-37	clay and shale
		at 37	shale
423	NJGS files	0-4	water
	U. S. Army	4-9	sand
	Corps of Engineers	9-12	clay
	boring 199	12-13	clay and shale
		at 13	shale rock
424	NJGS files	abbreviated log	
	Bayonne bridge	0-24	red clay, sand, gravel
	boring 70	24-30	trap rock
426	NJGS files	abbreviated log	
	Bayonne bridge	0-8	cinders
	boring 37	8-14	mud and silt
		14-16	gray fine sand
		16-19	sand and gravel
		19-29	trap rock
449	NJGS files	0-35	sand, gravel
	Newark subway	at 35	red shale and sandstone
	boring 7A		
452	N 26-22-232	foundation exposure shows	
		0-25	glacial sand and gravel
		25-39	very compact, tough red stony clay till
		at 39	red sandstone
453	NJGS files	0-8	water
	Stickle bridge	8-30	no log
	boring 22	30-37	red silty sand and gravel
		37-39	red clay with fragments of red shale
		39-49	red sandy shale and argillaceous red sandstone
454	NJGS files	0-15	no log, probably fill over
	Stickle bridge	15-37	red clayey sand and gravel
	boring 31	37-76	red clayey silty very fine sand
		76-86	red shale and sandstone
455	26-10495	abbreviated log	
		0-66	red hard silt, little fine-to-coarse sand, little gravel, trace clay
		66-69	red weathered shale
456	NJGS files	abbreviated log	
	Newark Bay	0-95.7	surficial material
	boring 3094	95.7-100.7	brown sandstone

457	NJGS files	abbreviated log	
	Newark Bay	0-87	surficial material
	boring 3020	87-92	brown and gray sandstone – top of run red shale, seamy bottom of run
458	NJGS files	abbreviated log	
	Newark Bay	0-91	surficial material
	boring 3038	91-101.3	gray sandstone

[1]Numbers of the form 26-xxxx are well permit numbers issued by the N. J. Department of Environmental Protection, Bureau of Water Allocation. Numbers of the form N 26-xx-xxx are N. J. Atlas Sheet grid locations of entries in the N. J. Geological Survey permanent note collection. The notation “NJGS files” indicates borings from various construction or dredging projects that are on file at the N. J. Geological Survey but that are not entered into the permanent note collection. The notation “BWA files” followed by a N. J. Atlas Sheet grid location indicates borings with logs in the Bureau of Water Allocation files that do not have well permit numbers. Notations of the form “Lovegreen, 1974" refer to logs provided in the cited publications.

[2]Depth in feet below ground or water surface.

[3]Inferred map units and comments by author in parentheses. All descriptions are reproduced as they appear in the original source, except for minor format, spelling, and punctuation changes. Notation “NR” indicates “not reported’. Logs identified as abbreviated have been condensed for brevity. Map units are inferred from the known extent of materials at the surface and from known depositional settings, in addition to the driller’s descriptions.