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

DESCRIPTION OF MAP UNITS

af — **ARTIFICIAL FILL**--Excavated till, sand, gravel, and rock; and construction debris, cinders, and slag. In highway and railroad embankments, dams, and filled land. As much as 40 feet thick, generally less than 20 feet thick. Small areas of fill in urban areas are not mapped.

Postglacial Deposits--Sediment deposited along streams, in wetlands, and at the base of cliffs. These deposits have been accumulating since retreat of the late Wisconsinan glacier.

Qal — **ALLUVIUM**--Silt, clay, sand, and pebble-to-cobble gravel. Contains variable amounts of organic matter. Color of fine sediment is gray, brown, and yellowish brown. Fine sediment was deposited as overbank material on the floodplain and may be as much as 15 feet thick along major streams. It generally overlies gravel deposited in the stream channel. The gravel is generally less than 5 feet thick. In the valleys of Black, Pochuck, and Wawayanda Creeks, alluvium may overlie swamp and marsh deposits.

Qs — **SWAMP AND MARSH DEPOSITS**--Gray silt and clay overlain by dark-brown peat. May include some fine-grained alluvium along larger streams. As much as 25 feet thick (Waksman and others, 1943).

Qta — **TALUS**--Angular boulders and blocks of gneiss, with little or no matrix material, forming a steep apron at the base of cliffs on the west side of Wawayanda Mountain. Maximum thickness 20 feet (estimated).

Qst — **STREAM TERRACE DEPOSITS**--Sand, silt, and pebble gravel, minor cobble gravel, forming terraces 5 to 10 feet above the present floodplain. Fine sediment is brown to yellowish brown. Maximum thickness 15 feet (estimated).

Qf — **ALLUVIAL FAN DEPOSITS**--Cobble-to-boulder gravel, sand, and silt. Fine sediment is grayish brown, brown, and yellowish brown. Form fan-shaped deposits at the mouths of ravines and gullies eroded into thick glacial sediment. As much as 30 feet thick (estimated).

Glacial Deposits--Glacial deposits in the map area include till and stratified sand, gravel, silt, and clay. The till occurs in drumlins, moraines, and as a layer of variable thickness on the bedrock surface. It was deposited directly from glacial ice and is as much as 120 feet thick. The stratified sediment occurs discontinuously as knolls, ridges, and plains in valleys and lowlands. It was deposited by glacial meltwater in glacial lakes and river plains and is as much as 120 feet thick.

These sediments were deposited by the late Wisconsinan glacier. As indicated by the orientation of striations and drumlins, and the distribution of erratics, this glacier advanced southerly to southwesterly across the map area. It reached its maximum position about 20 miles south of the southern edge of the map area. During advance the glacier deposited till in drumlins and locally on hillslopes that faced the advancing ice; elsewhere, it eroded bedrock. The erosional features include scoured troughs in weak carbonate and shale bedrock in the vicinity of Black Creek and Upper Greenwood Lake, and extensive areas of abraded ledges (on slopes that faced toward advancing ice) and quarried cliffs (on slopes that faced away from advancing ice) on resistant gneiss and quartzite bedrock on Pochuck, Wawayanda, and Bearfort Mountains.

Late Wisconsinan ice began to melt back from its terminal position approximately 20,000 years ago. As the ice front retreated northward, glacial lakes formed in valleys that sloped toward the the glacier, and were thus dammed, or in valleys that were dammed by previously-deposited glacial sediment. Valleys that were not dammed carried rivers of glacial meltwater. In a few places till and related nonstratified sediment were deposited in small moraines along the ice front. The position and elevation of stratified deposits and lake spillways, and the trend of moraines, permit an approximate determination of the orientation of recessional ice margins. In the map area, the trend of the Mud Pond and Cherry Ridge moraines indicates generally east-west-trending recessional ice margins. Topographically-induced lobation was slight on Wawayanda Mountain, but probably more pronounced along the east and west walls of Vernon Valley. Details of the glacial lake elevations and spillways are provided in the map unit descriptions.

Deposits in Glacial Lakes--These deposits are stratified and generally well sorted. They include sand and gravel deposited in deltas and lacustrine fans, and clay, silt, and fine sand deposited on lake-bottom plains.

GLACIAL LAKE WALLKILL DEPOSITS--Deltaic (Qwkd), lacustrine-fan (Qwk), and lake-bottom (Qwkl) sediment deposited in glacial Lake Wallkill. Lake Wallkill occupied the north-draining Wallkill basin. It was controlled by a spillway at an elevation of 500 feet at the low point on the Delaware-Wallkill divide near Augusta, New Jersey (14 miles southwest of Vernon). It lowered when three successively-lower spillways on the Wallkill-Hudson divide, declining in elevation from 440 to 370 to 350 feet, were uncovered by the retreating ice front at and north of Goshen, New York, about 20 miles north of Vernon. The 440-foot level may have extended into the map area as a shallow lake in the lowest parts of Vernon Valley; the lower levels did not. As the ice front retreated farther north, Lake Wallkill fell to even lower levels (Connally and Sirkin, 1967).

Qwkd — **Sand, pebble-to-cobble gravel, minor silt.** As much as 120 feet thick.

Qwk — **Sand, pebble-to-cobble gravel, minor cobble-to-boulder gravel.** As much as 50 feet thick.

Qwkl — **Silt, clay, and fine sand.** As much as 100 feet thick.

WAWAYANDA DEPOSITS--Deltaic sediment deposited in six separate glacial lakes ponded in north-draining valleys on Wawayanda Mountain. Lake-bottom deposits are not exposed but are probably present beneath the extensive swamp and marsh deposits (unit Qs) covering the bottoms of the former lake basins.

Qww6 — **Pebble-to-cobble gravel and sand.** As much as 40 feet thick (estimated). Spillway drained eastward into Lake Wallkill at an elevation of about 770 to 800 feet.

Qww5 — **Pebble gravel and sand, minor fine cobble gravel.** As much as 20 feet thick (estimated). Spillway drained southward into glacial Lake Bearfort at an elevation of 1130 feet.

Qww4 — **Pebble-to-cobble gravel and sand.** As much as 50 feet thick. Spillway drained eastward into glacial Lake Bearfort at an elevation of 1150 feet.

Qww3 — **Pebble-to-cobble gravel and sand.** Maximum thickness 30 feet. Spillway drained eastward into glacial Lake Bearfort at an elevation of 1170 feet.

Qww2 — **Pebble gravel and sand.** Maximum thickness 60 feet (estimated). Spillway drained southward into glacial Lake Bearfort at an elevation of 1230 feet.

Qww1 — **Pebble gravel and sand.** Maximum thickness 60 feet (estimated). Spillway drained eastward into the Mossmans Brook valley at an elevation of 1250 feet.

GLACIAL LAKE BEARFORT DEPOSITS--Deltaic (Qbf1, Qbf2) and lake-bottom (Qbfl) sediment deposited in glacial Lake Bearfort. Lake Bearfort occupied the north-draining valley of Longhouse Creek. It was controlled by an early spillway to the south draining into Mossmans Brook (the Qbf1 deposits), and, later, by a lower spillway draining eastward into the Wanaque basin (the Qbf2 deposits). The lake lowered and drained as lower spillways draining westward into the Wallkill basin were uncovered by the retreating ice margin in New York state, north of the map area.

Qbf2 — **Pebble-to-cobble gravel, minor boulder gravel, overlying sand.** As much as 120 feet thick. Spillway drained eastward into the Wanaque valley at an elevation of 1090 feet.

Qbf1 — **Pebble-to-cobble gravel and boulder gravel overlying sand.** As much as 80 feet thick. Spillway drained southward into the Mossmans Brook valley at an elevation of 1140 feet.

Qbfl — **Fine sand, silt, minor clay.** As much as 50 feet thick. Deposited in both stages of Lake Bearfort; generally underlies deltaic sand and gravel.

Qx — **UNNAMED DEPOSIT**--Sand and pebble gravel in small ponded valley 2 miles south of Vernon. Maximum thickness 15 feet.

Qmp — **MARSHALL POND DEPOSIT**--Pebble-to-cobble gravel and sand, minor boulder gravel. Maximum thickness 20 feet (estimated). Spillway drained to south at an elevation of approximately 1220 feet, either over stagnant ice or moraine deposits of unit Qnmp.

Quv3 — **UNION VALLEY DEPOSIT**--Deltaic sand and pebble gravel. Maximum thickness in map area 20 feet (estimated). Deposited in a glacial lake occupying the north-draining valley of Belcher Creek. Controlled by a spillway on the Wanaque-Pequannock divide at an elevation of 850 feet near Postville, approximately 2 miles southwest of Pinecliff Lake (Stanford, 1991). Quv1 and Quv2 are restricted to the Newfoundland quadrangle.

Deposits of Glacial Streams--Stratified, generally well sorted gravel and sand forming valley-bottom plains, terraces, and fans in valleys not occupied by glacial lakes.

Qmf — **MELTWATER FAN DEPOSITS**--Cobble-to-boulder gravel and sand in fan-shaped deposits at mouths of meltwater channels. Maximum thickness 30 feet (estimated).

Qcl — **CLINTON BROOK OUTWASH**--Boulder-to-cobble gravel. Maximum thickness 20 feet (estimated).

Qpc — **PACACK BROOK OUTWASH**--Boulder-to-cobble gravel. Maximum thickness 20 feet (estimated).

Qpq — **PEQUANNOCK OUTWASH**--Boulder-to-cobble gravel. Maximum thickness 20 feet (estimated).

Deposits by Glacial Ice--Till and related poorly-sorted, nonstratified sediment deposited directly by glacial ice or by flow of sediment from the ice. Occur in drumlins, as a layer overlying bedrock, in moraines, and in small, hummocky ice-contact hills.

Qk / **Qkt** — **KITTATINNY TILL**--Light-brownish-gray to very-pale brown silt to sandy silt with some to many subrounded to subangular pebbles and cobbles and few to some subrounded boulders. Gravel includes gray carbonate rock and gray mudstone and sandstone, with minor white-to-gray quartzite and quartzite conglomerate and a trace of gneiss. The gneiss becomes more abundant near contact with unit Qn. The carbonate, mudstone, and sandstone clasts are derived from Paleozoic sedimentary rocks of the Wallkill valley. The quartzite and quartzite conglomerate are derived from the Shawangunk Formation to the north and west of the Wallkill valley, and to a lesser extent from local outcrops of the Hardyston Formation. Boulders are generally quartzite and carbonate rock. Unit Qk is as much as 120 feet thick but is generally between 20 and 50 feet thick. Unit Qkt delineates areas where the till is discontinuous and generally less than 20 feet thick over bedrock.

Qn / **Qnt** — **NETCONG TILL**--Yellow to yellowish-brown silty sand to sand with many subrounded to subangular pebbles and cobbles and some to many subrounded boulders. Gravel includes chiefly gneiss and gray mudstone and sandstone, with minor gray carbonate rock and white-to-gray quartzite. Gneiss is the local bedrock; the other clasts are derived from bedrock in the Wallkill valley and on Shawangunk Mountain to the north of the map area. Boulders are chiefly gneiss, with a few scattered carbonate boulders, some of which are shown by a special symbol on the map. East of the Mossmans Brook-Longhouse Creek valley, the till matrix is somewhat siltier and redder; here, gray and red shale and siltstone are abundant in the gravel fraction. On Bearfort Mountain, purple quartzite and quartzite-conglomerate are abundant in both the gravel and boulder fraction. These differences reflect incorporation of material derived from the underlying Bellvale Sandstone and Skunnemunk Conglomerate, which crop out in the valleys and on Bearfort Mountain (Herman and Mitchell, 1991). Unit Qn is as much as 90 feet thick, but is generally 20 to 50 feet thick. Unit Qnt delineates areas where the till is discontinuous and generally less than 20 feet thick over bedrock.

Qncr — **CHERRY RIDGE MORAINE**--Netcong till, generally with a sandy matrix and containing many to very many subangular cobbles and boulders of gneiss. Forms a discontinuous linear belt of low hummocks, shallow basins, and arcuate ridges extending from Highland Lake eastward to Lookover Lake. The hummocky topography generally has a relief of less than 15 feet but relief may be as much as 30 feet. The arcuate ridges are 10 to 40 feet high. Several of them, shown by a special symbol on the map, are asymmetric in profile, with gentle north slopes and steeper south slopes. This suggests that they formed at an active ice front. Maximum thickness of till in the moraine is estimated to be 50 feet.

Qnmp — **MUD POND MORAINE**--Netcong till as in unit Qncr, although in places, particularly just east of the Sussex-Passaic county line, the deposit is extremely bouldery and contains little or no matrix material. Forms a discontinuous belt of low hummocks, shallow basins, and a few arcuate ridges extending from west of Canistear Reservoir eastward to Uttertown. The hummocky topography generally has a relief of less than 15 feet but relief may be as much as 40 feet. The ridges are 10 to 20 feet high. One small ridge near Uttertown has an asymmetric profile as described in unit Qncr. Maximum thickness of till in the moraine is estimated to be 50 feet.

Qic — **ICE-CONTACT DEPOSITS**--Three small deposits of nonstratified, noncompact sand and silty sand with much subangular gravel, locally bouldery. Forms low ridges or knolls less than 20 feet tall. These deposits may be sediment flows from the glacier surface deposited during glacial recession.

MAP SYMBOLS

Contact--Dashed where gradational or feathering, dotted where concealed or excavated.

Striation--Location at dot. Where two sets of striae occur the earlier set is indicated by a broken arrow.

Meltwater channel--Narrow, linear, bouldery drainageway in which present streams are nonexistent or underfit.

Scarp cut by meltwater--Line at top of scarp, ticks on slope.

Scarp cut by postglacial streams--Line at top of scarp, blocks on slope.

Artificial excavation scarp--Line at top of slope, ticks on slope.

Crest of asymmetric ice-contact ridge--Barbs on gentle, ice-contact slope.

Esker

Drumlin

Erratic boulder of carbonate rock--Indicates southerly glacial transport from outcrops of carbonate bedrock in Vernon Valley and in the Wallkill valley north of the map area. Not all occurrences are shown.

Qbf2 — **Spillway for glacial lake**--Lettering indicates associated deposit.

Gravel pit--Active in 1990.

Gravel pit--Inactive in 1990.

400 / 300 — **Elevation of the bedrock surface**--Contour interval 50 feet, 100 feet where data are sparse. Shown only in major valleys. Hachures indicate closed contours in glacially-scoured basins.

47 — **Well on section**--Number refers to well number in table 1.

●47 — **Well with log in table 1**

r — **Area of extensive bedrock outcrop**--surficial sediment generally absent.

w — **Bodies of water**--not shown on base map.

(Qk)/Qwk — **Unit on left is thin and overlies unit on right**

(Qal- Qs) — **Both map units are alternately present and thin**

Surface accumulation of boulders--Till surfaces washed by subglacial, proglacial, or ice-marginal meltwater. Does not include talus or bouldery moraines.

REFERENCES

Connally, G. G., and Sirkin, L. A., 1967, The Pleistocene geology of the Wallkill valley: New York State Geological Association Guide Book, 39th Annual Meeting, p. A1-A16.

Herman, G. C., and Mitchell, J. P., 1991, Bedrock geologic map of the Green Pond Mountain region from Dover to Greenwood Lake, New Jersey: N. J. Geological Survey Geologic Map Series 91-2, scale 1:24,000.

Stanford, S. D., 1991, Surficial geologic map of the Newfoundland quadrangle, Passaic, Morris, and Sussex Counties, New Jersey: N. J. Geological Survey Geologic Map Series 91-3, scale 1:24,000.

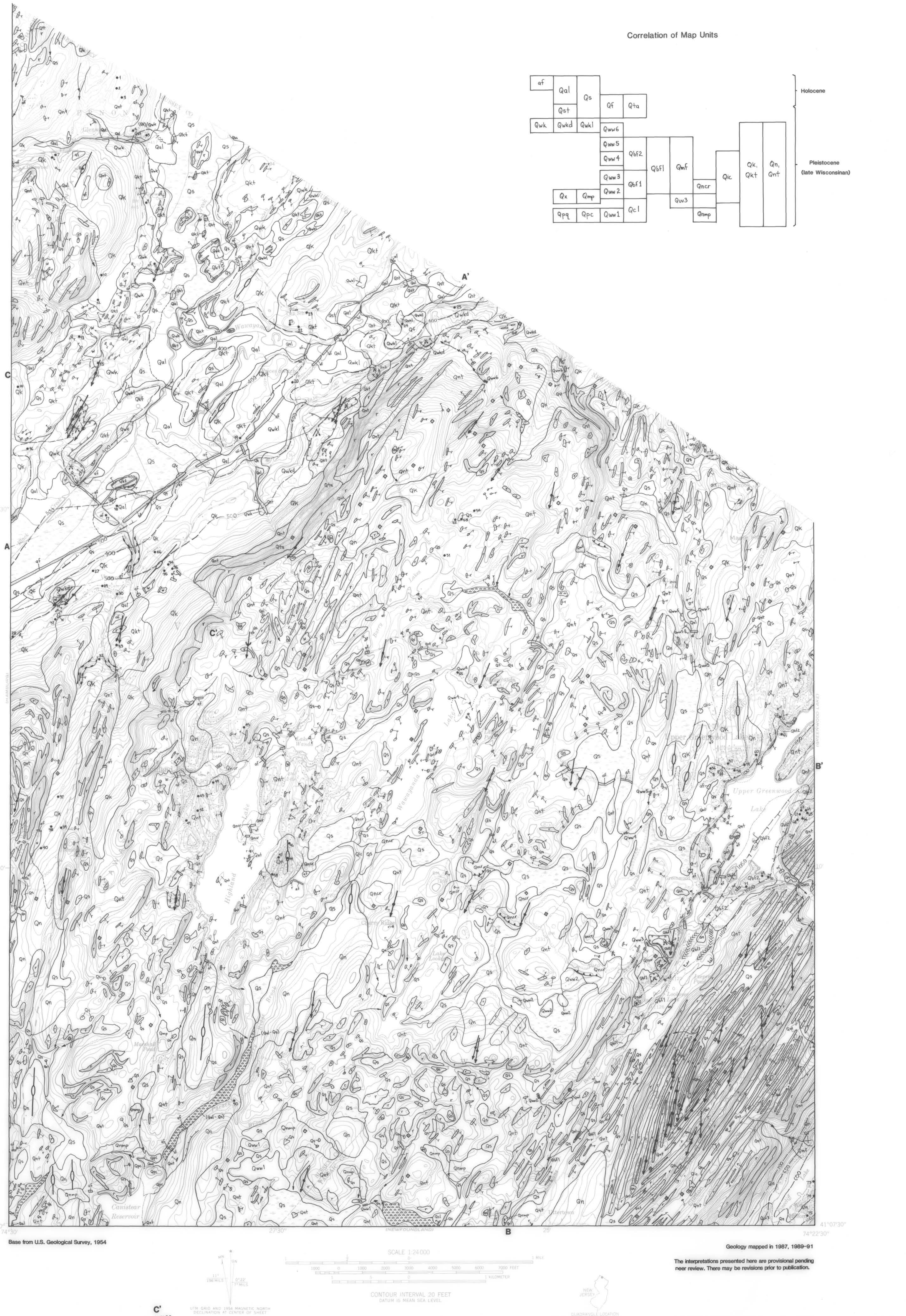
Waksman, S. A., Schulhoff, H., Hickman, C. A., Cordon, T. C., and Stevens, S. C., 1943, The peats of New Jersey and their utilization: N. J. Department of Conservation and Development Geologic Series, Bulletin 55, Part B, 278 p.

Table 1.--Selected Well Logs

Well No.	Permit No. (1)	Depth (feet)	Driller's Log Description (2)
1	22-20384	0-29 29-180	clay and gravel (Qnt, weathered rock) granite
2	22-20803	0-48 48-200	clay overburden (Qnt, weathered rock) rotten rock
3	22-19423	0-70 70-230	sand and gravel (Qnt, weathered rock) granite
4	22-19128	0-25 25-180	clay and gravel (Qk over Qwk) lime rock
5	22-3613	0-57 57-140	hardpan and cobble gravel (Qk over Qwk) blue limestone
6	22-21553	0-79 79-100	clay and gravel (Qk) granite
7	22-18881	0-50 50-249	clay and gravel (Qk) granite
8	22-13363	0-71 71-303	hardpan, boulders (Qk) granite
9	22-6581	not reported	sand, gravel, hardpan, and finally conglomerate and rotten gneiss, cased to 95 feet, total depth 130 feet (Qwk over Qk over weathered rock)
10	22-18930	0-50 50-100 100-124	clay and gravel (Qk) rotten rock lime rock
11	22-18068	0-50 50-124	sand and gravel (Qwk) lime rock
12	22-18696	0-47 47-95	hardpan (Qk) granite
13	22-18554	0-50 50-140 140-175	sand and gravel (Qk, weathered rock) rotten rock broken limestone
14	22-18793	0-108 108-239 at 239	clay and gravel (Qk) rotten rock lime rock
15	22-19589	0-30 30-174	sand and gravel (Qwk) lime rock
16	22-17863	0-75 75-174	clay and gravel (Qk) limestone
17	22-21151	0-70	sand and gravel (Qal over Qwkl over Qwk)
18	22-17426	0-5 5-30 30-50 50-80 80-84	gravel (Qal) gray silt (Qwkl) large gravel (Qwk) gravel, sand (Qwk) gravel, water (Qwk)
19	22-21837	0-38 38-100	clay and gravel (Qkt) lime rock
20	22-19046	0-40 40-81	clay and gravel (Qkt) lime rock
21	22-20177	0-61 61-300	clay and gravel (Qkt, weathered rock) lime rock
22	22-22667	0-2 2-80	overburden sand and gravel (Qkt, weathered rock)
23	22-19467	0-14 14-305	clay and gravel (Qkt) lime rock
24	on file at N. J. Geological Survey	0-85 85-155	sand, gravel, silt (Qaf over Qwkl) dolomite
25	22-9463	0-42 42-210	sand, gravel, silt (Qwk) gneiss
26	22-22685	0-112 112- 230	clay and gravel (Qk) rotten rock
27	22-18584	0-110 110-400	sand, gravel, clay (Qk) limestone and granite
28	22-9607	0-115 115-258	overburden (Qk) dolomite
29	22-4287	0-30 30-88	boulders, sand, clay (Qk) blue limestone and conglomerate
30	on file at N. J. Geological Survey	ABBREVIATED LOG 0-16	 yellowish brown silty sand to sandy silt, some gravel (Qk)
31	22-20407	0-26 26-355	clay and gravel (Qk) granite
32	22-4740	0-46 46-105	hardpan, clay (Qk) conglomerate, granite
33	22-6696	0-40 40-95 95-113	hardpan and boulders (Qkt) blue limestone gneiss
34	22-19131	0-20 20-90 90-172 172-205	clay (Qk) gravel (Qk) rotten rock soft granite rock
35	22-22071	0-55 55-65 65-225	overburden (Qk) soft limestone limestone
36	22-20524	0-86 86-160	clay and boulders (Qk) granite
37	22-19362	0-110 110-173	sand and gravel (Qk over weathered rock) granite
38	22-22621	0-55 55-150	clay and gravel (Qk) granite
39	22-9364	0-70 70-103	hardpan and boulders (Qk) gneiss
40	22-17990	0-20 20-155	sand and gravel (Qk) granite
Note: There are numerous wells in the Highland Lakes, Lake Wanda, Barry Lakes, and Upper Greenwood Lake subdivisions. Almost all of the driller's logs report less than 20 feet of till over bedrock. Only those wells reporting more than 20 feet of surficial material are listed here (wells 41-71).			
41	22-4327	0-51 51-95	hardpan, some clay and gravel (Qnt, weathered rock?) red rock
42	22-1420	0-62 62-84	clay, gravel, boulders (Qnt, weathered rock?) bedrock
43	22-20540	0-32	clay and gravel overburden (Qnt, weathered rock?)
44	22-18092	0-50 50-124	clay and gravel (Qnt, weathered rock?) granite
45	22-18694	0-50 50-225	hardpan, gravel (Qnt, weathered rock?) granite
46	22-20692	0-27 27-125	clay overburden (Qn) granite
47	22-20544	0-28 28-125	earth (Qn) granite
48	22-18020	0-26 26-149	clay and gravel (Qn) granite
49	22-22496	0-53 53-250	clay and gravel overburden (Qn) granite
50	22-20559	0-21 21-150	clay and gravel overburden (Qn) granite
51	22-20356	0-32 32-200	overburden (Qnt, weathered rock) granite
52	22-19878	0-20 20-175	dirt (Qnt) rock
53	22-21332	0-22 22-30 30-38 38-203	swamp, black mud, water (Qs) gravel and gray silt (Qnt) gravel and sand (Qnt) granite
54	22-19968	0-30 30-498	swamp, mud, boulders, gravel, sand (thin Qs over Qnt) granite
55	22-16460	0-45 45-395	sand and gravel (Qww4) granite
56	22-965	0-10 10-40	sand and clay (Qnt) bedrock
57	22-538	0-76 76-135	hardpan, boulders (Qk) granite
58	22-460	0-72 72-120	hardpan, boulders (Qn) granite
59	22-626	0-85 85-135	hardpan, boulders (Qn) bedrock
60	22-3148	0-65 65-101	gravel, clay, hardpan (Qn) bedrock
61	22-22912	0-15 15-70 70-475	overburden (Qbf2) sand and gravel (Qbf2) granite
62	22-1294	0-80 80-100	hardpan and boulders (Qnt, weathered rock) bedrock
63	22-2329	0-72 72-112	hardpan, clay, gravel, boulders (Qn) bedrock
64	22-2973	0-62 62-125	boulders, hardpan (Qn) bedrock
65	22-2206	0-60 60-120	hardpan, boulders (Qn) bedrock
66	22-436	0-81 81-124	boulders, hardpan (Qn) red sandstone
67	22-4114	0-81 81-127	hardpan, boulders (Qn) bedrock
68	22-1743	0-68 68-120	boulders, hardpan (Qn) bedrock
69	22-18481	0-2 2-6 6-20 20-40 40-55 55-60 60-85	topsoil sand and gravel (Qbf2) medium sand (Qbf2) gray fine sand (Qbf2) blue clay (Qbfl) gravel (Qn or Qbf2) red shale
70	22-19271	0-20 20-107 107-110	overburden (Qbf2) sand and gravel (Qbf2) gravel (Qbf2)
71	22-2125	0-68 68-95	boulders, hardpan (Qbf2 over Qn?) bedrock
72	on file at N. J. Geological Survey	0-180 180-216	glacial drift, including a layer of dry blue clay (Qncr, possible weathered rock) granite gneiss
73	22-10149	0-71 71-141	clay and hardpan (Qn) slate
74	22-1860	0-30 30-50 50-80	yellow clay, hardpan, and boulders (oxidized Qn) blue clay, hardpan, and boulders (unoxidized Qn) brown sandstone
75	22-22673	0-140 140-175	clay and gravel (Qn, weathered rock?) red sandstone

(1.) Well permit issued by the New Jersey Department of Environmental Protection and Energy, Bureau of Water Allocation.

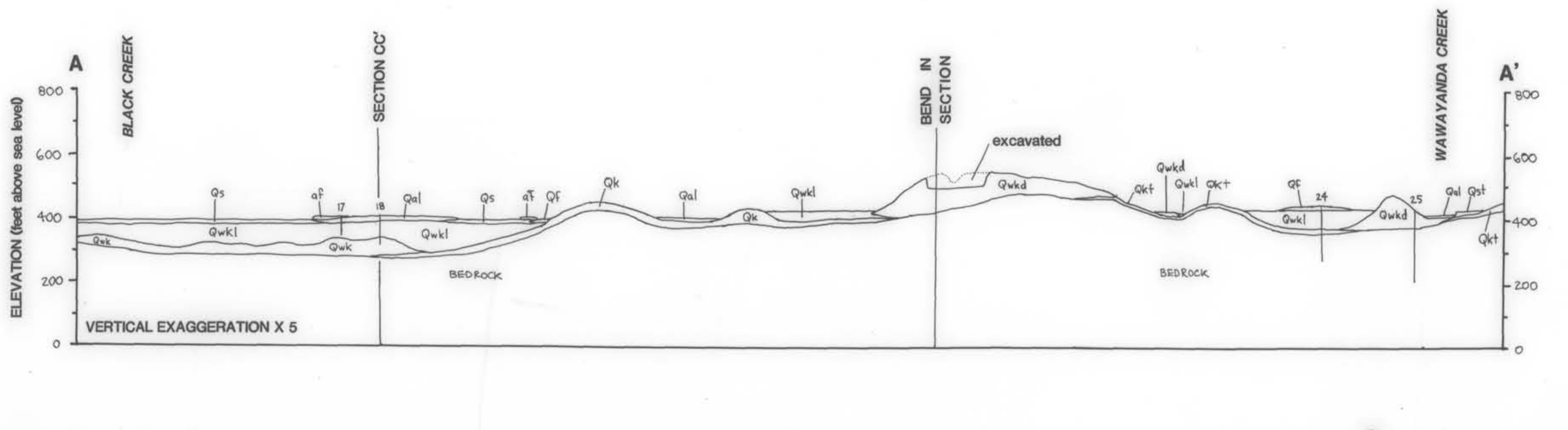
(2.) Inferred map units and comments in parentheses.

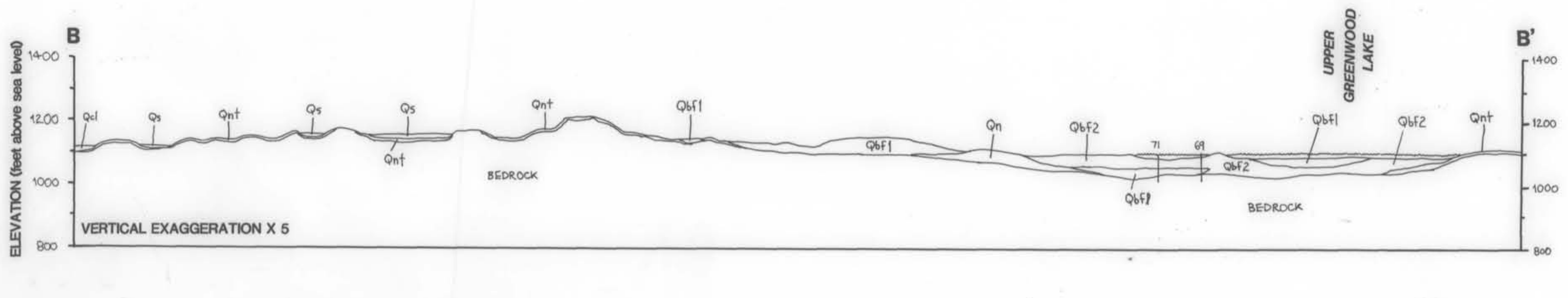


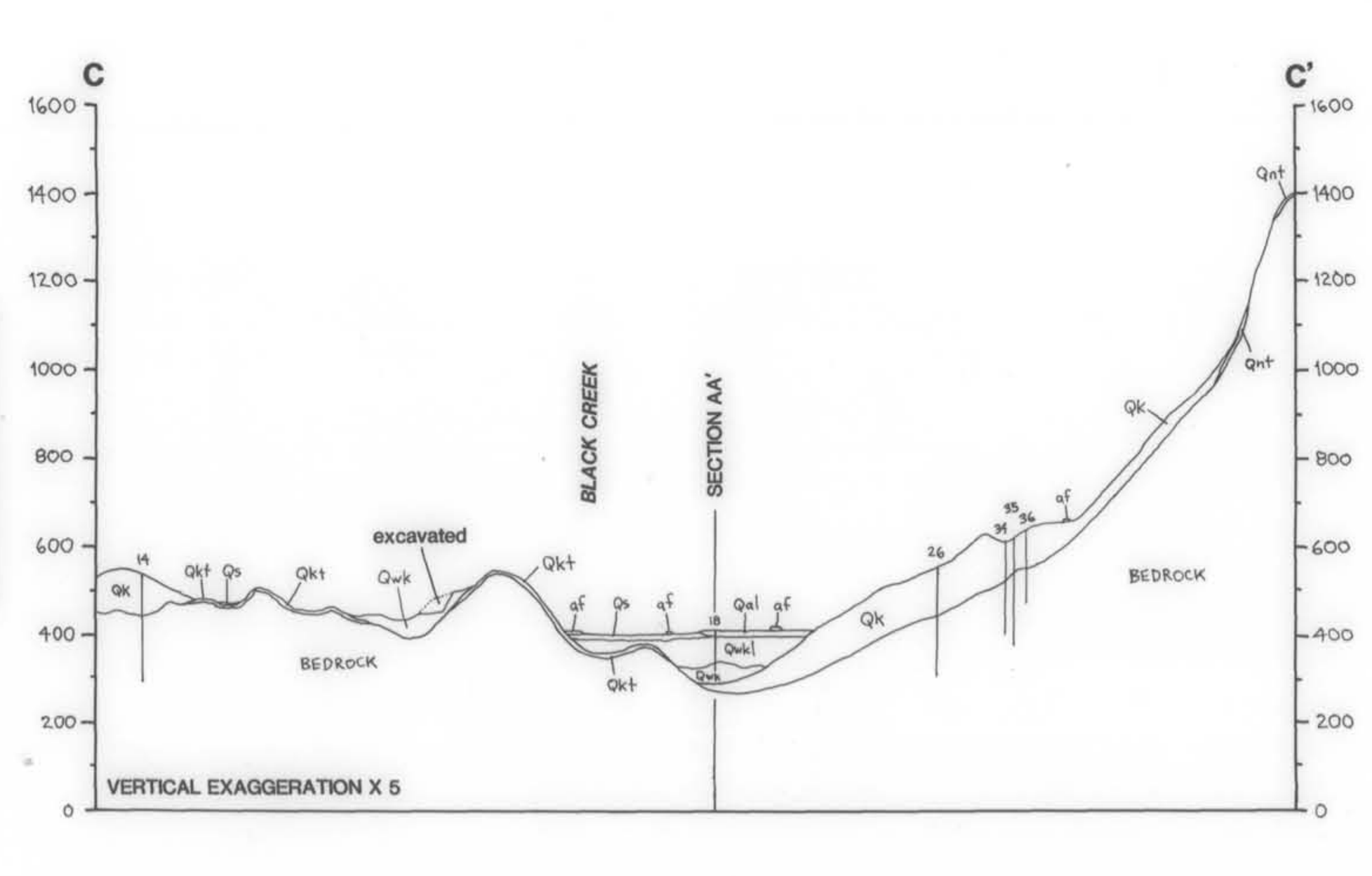
Base from U.S. Geological Survey, 1954

Geology mapped in 1987, 1989-91

The interpretations presented here are provisional pending peer review. There may be revisions prior to publication.







SURFICIAL GEOLOGY OF THE WAWAYANDA AND PINE ISLAND QUADRANGLES, SUSSEX AND PASSAIC COUNTIES, NEW JERSEY

by
Scott D. Stanford
1992