

INTRODUCTION

Surficial deposits in the Park Ridge quadrangle include artificial fill, alluvial, alluvial-fan, swamp, and stream-terrace deposits, all of postglacial age; glaciolacustrine and glaciofluvial deposits of late Wisconsinan and, possibly, Illinoian age; and till of late Wisconsinan and possible Illinoian age. Postglacial deposits are generally less than 10 feet thick. The glaciolacustrine and glaciofluvial deposits include stratified sand, gravel, silt, and clay and are as much as 100 feet thick. Till is as much as 120 feet thick.

The accompanying map and sections show the surface extent and subsurface relations of these deposits. The composition and thickness of the deposits, and the glacial and postglacial events they record, are described in the "Description of Map Units." Well and boring data used to construct bedrock-surfaces contours and to infer the subsurface distribution of the deposits are provided in table 1. The composition of pebbles in the glacial deposits is shown in table 2. The chronological relationships of the deposits are shown in the "Correlation of Map Units." Aquifer properties of the deposits are briefly described below.

AQUIFER PROPERTIES

Surficial deposits in the quadrangle yield ground water to several public-supply wells and affect the movement of water and pollutants from the land surface into lakes, streams, and underlying bedrock and glacial aquifers. Glacial aquifers are tapped by wells at several places. Yields and screened intervals for these wells are provided in table 1. In the Saddle River and Pasack Brook valleys, several wells (79, 80, 117, 299-304) draw water from glaciofluvial sand and gravel, with yields of as much as 100 gallons per minute. These are relatively shallow wells that are likely in close hydraulic connection with nearby streams. Some water may also be available from glaciolacustrine sand and gravel (units Qh1 and Qh2) in the southeastern part of the quadrangle (for example, well 230), although they are generally too thin or fine-grained for high-yield wells. These deposits may be locally confined by overlying silt and clay (unit Qh1).

Hydraulic conductivities of the surficial deposits may be estimated from statewide glacial aquifer-test data on file at the N. J. Geological Survey (Mennel and Canace, 2002) and published aquifer-test and laboratory data summarized by Stanford and Witte (in press). Sand and gravel deposits (units Qm, Qs, Qp, Qr, Qs1, Qs2, Qp1, Qp2, Qm, Qs1, Qh2, Qc, Qst, Qst, and parts of Qal and Qp) are highly permeable, having estimated hydraulic conductivities that range from 10<sup>-1</sup> to 10<sup>1</sup> feet per day (ft/d). Silty sand till (Qp), parts of Qr and Qh) are also permeable, having estimated hydraulic conductivities from 10<sup>-1</sup> to 10<sup>1</sup> ft/d. Silt and clay lake-bottom deposits (parts of units Qh1, Qh2) are of low permeability, having estimated hydraulic conductivities of 10<sup>-2</sup> to 10<sup>-1</sup> ft/d. Fine sand and silt lacustrine, alluvial, and wetland deposits (parts of units Qh1, Qh2, Qal, Qst, Qp, and Qs) and sandy silt till (parts of units Qr and Qh) are somewhat more permeable, having estimated hydraulic conductivities of 10<sup>-1</sup> to 10<sup>1</sup> ft/d. Swamp deposits (Qs) and fill (af) have variable hydraulic conductivities that depend on the clay and silt content of the material. Peats with little mineral soil, and fill composed of sand, cinders, gravel, demolition debris, slag, and trash, may be highly permeable.

DESCRIPTION OF MAP UNITS

**Postglacial Deposits**—These include man-made fill material, stream deposits in fans (Qaf), terraces (Qst), and modern channels and floodplains (Qal) and wetland deposits in swamps (Qs). They were all deposited since retreat of the late Wisconsinan glacier about 18,000 yrs B. P. (years before present).

**ARTIFICIAL FILL**—Artificially placed sand, gravel, silt, clay, and rock, and man-made materials including demolition debris, cinders, ash, and trash. Color variable but generally dark brown, gray, or black. As much as 20 feet thick.

**TRASH FILL**—Trash mixed and covered with sand, silt, clay, and gravel. As much as 20 feet thick.

**ALLUVIUM**—Sand, silt, pebble-to-cobble gravel, minor clay, dark brown, brown, reddish-brown, gray, moderately to well sorted, stratified to massive. Contains variable amounts of organic matter. As much as 10 feet thick.

**ALLUVIAL FAN DEPOSITS**—Sand, silt, and pebble-to-cobble gravel, brown to reddish-brown, moderately sorted, stratified. As much as 15 feet thick (estimated).

**STREAM TERRACE DEPOSITS**—Pebble-to-cobble gravel, sand, minor silt, brown, yellowish-brown, reddish-brown, moderately to well sorted, stratified. As much as 15 feet thick (estimated).

**SWAMP DEPOSITS**—Peat and organic silt, clay, and fine sand, black, dark brown, and gray. As much as 10 feet thick. Basal peat at a depth of 5 feet in boring 325 yielded a radiocarbon date of 10,135±180 yrs B. P. (laboratory reference number QC-507) (Averill and others, 1980).

**Glacial Deposits**—These include till and stratified sediments. Till is a poorly sorted, nonstratified sediment containing gravel clasts and boulders, deposited directly from glacial ice (units Qr, Qs). The stratified sediments are generally well sorted. They include sand and gravel laid down by glacial meltwater in river plains (Qm, Qp, Qp1, Qp2) and in glacial-lake deltas (Qpr, Qho, Qh1, Qh2, Qh3) and fans (Qh4). The stratified sediments also include silt, clay, and fine sand deposited on the bottoms of glacial lakes (Qh1, Qh2) and moderately to poorly sorted sand and gravel deposited in ice-walled basins and ponds (Qsp, Qsc). All of these deposits are of late Wisconsinan age except Qp and Qsp, which may be of Illinoian age.

The orientation of striations and drumlins indicates that late Wisconsinan ice advanced in a slightly west-to-south direction across the Park Ridge quadrangle. This ice was in the center of an advancing lobe channeled between the Palisades Ridge to the east and Campgaw and Ramapo Mountain to the west (Salisbury, 1902; Stanford and Harper, 1991). During advance the land surface was shaped by glacial erosion. Throughout most of the quadrangle, older glacial deposits (units Qs, Qp) were stripped off and the underlying sandstone and conglomerate bedrock was eroded into streamlined forms. Elevation contours of the bedrock surface, plotted at 50-foot intervals on the map, show this streamlined topography. In places, particularly in the cores of drumlins, the earlier glacial deposits were not completely eroded. Locally, they may have been deformed during drumlin formation. Most drumlins are situated on top of bedrock ridges, suggesting that bedrock erosion and drumlin formation were part of the same streamlining process. In some cases the surface of the Illinoian deposits within the drumlins resembles ice-drumlin shape (sections A-A', B-B', C-C'), suggesting that some streamlining occurred during Illinoian advance, when the flow direction was similar to that of the late Wisconsinan advance.

Till was deposited over almost all of the streamlined surface. In the cores of some drumlins it is as much as 80 feet thick but generally it is 30 to 40 feet thick. It is sparse on valley bottoms, either because it was never deposited there or because it was later eroded by meltwater. The late Wisconsinan till includes two varieties: a yellowish-brown to gray silty sand till (Netcong till, Qn) derived from the gneiss bedrock of the Hudson Highlands, just north of the quadrangle, and a reddish-brown silty sand to sandy silt till (Railway till, Qr) derived from the local red sandstone and conglomerate bedrock. Netcong till was deposited chiefly on uplands where the base of the glacier was not in extensive contact with the local bedrock, whereas Railway till was deposited in valleys and along the southern border of the quadrangle, where ice was in contact with local bedrock.

Late Wisconsinan ice advanced to its southernmost position at Peth Arnoy, about 40 miles south of Park Ridge. The ice front began to retreat from this position about 18,000 yrs B. P., and had likely retreated north of the Park Ridge quadrangle by 18,000 yrs B. P. (Stanford and Harper, 1991). The retreating ice margin maintained a lobate form, its apex centered on the Hackensack Valley, just east of the quadrangle (fig. 1). In the Park Ridge quadrangle recessional ice-margin positions are marked by ice-contact deltas deposited in glacial lakes Paramus and Hackensack, and by the ice-contact heads of glaciofluvial plains in the Saddle River and Pasack Brook valleys (fig. 1). On uplands between the main valleys, ice-contact deltas in smaller glacial lakes in the Hobokus and Bear Brook Valleys, and a small glaciofluvial plain in the headwaters of the Musquapsink Valley, mark ice margins (fig. 1).

Lakes Paramus and Hackensack were large proglacial lakes that occupied the lower reaches of the Saddle and Hackensack river valleys, respectively (Stanford and Harper, 1991). Lake Paramus drained when the retreating ice margin uncovered the downstream end of the Musquapsink Valley in the Hackensack quadrangle, just south of Hilldale (fig. 1). At this time meltwater draining down the Saddle River Valley could move into the Lake Paramus fluvial plain at Hobokus, cutting the channels near the Hobokus-Waldwick border (symbolized on map), and initiating deposition of unit Qr. Lake Hackensack drained eastward into the Hudson Valley when Sparkill Gap, a low point in the Palisades Ridge about 6 miles east of Park Ridge, was uncovered by the retreating ice margin. In the Pasack Valley the main glaciofluvial plain (Qp1) was deposited before this event, and so grades downvalley to Lake Hackensack. An inset glaciofluvial terrace (Qp2) was deposited after Lake Hackensack drained.

**Glacial-Stream Deposits**—Stratified, generally well sorted gravel and sand forming valley-bottom plains and terraces in valleys not occupied by glacial lakes. Bedding is generally horizontal, varying from massive, thick beds in cobble gravel to cross-beds and thin horizontal beds in sand to pebbly sand. Nongravel sediment is yellowish-brown, reddish-brown, and light gray. Sand consists chiefly of quartz, feldspar, mica, and fragments of gray and red-brown sandstone and mudstone, gray gneiss, and gray quartzite. Gravel is chiefly white-to-gray gneiss and gray mudstone and sandstone, with some reddish-brown sandstone, black chert, white quartz, white-to-gray quartzite, and yellow-weathered carbonate rock.

**PASCACK VALLEY DEPOSITS**—Glaciofluvial sand and gravel deposited in the Pasack Valley. Qp1 is graded downvalley to glacial Lake Hackensack and is locally collapsed. Qp2 is a terrace deposit inset into Qp1 and was laid down after Lake Hackensack drained.

- Qp1** Cobble gravel with pebble gravel and sand, in Montvale-Park Ridge area, fining southward to pebbly sand with some pebble-to-cobble gravel in Woodcliff Lake-Hilldale area. As much as 50 feet thick.
- Qp2** Pebble-to-cobble gravel and sand. As much as 20 feet thick.
- Qm** MUSQUAPSINK DEPOSIT—Sand and pebble-to-cobble gravel. As much as 15 feet thick (estimated).
- Qr** SADDLE RIVER DEPOSIT—Pebble-to-cobble gravel and sand, cobble-to-boulder gravel at head of deposit around Penners and Connelly Lake. As much as 50 feet thick.

**Glacial-Lake Deposits**—These are stratified and generally well-sorted. They include sand and gravel laid down in deltas and lacustrine fans, and clay, silt, and fine sand laid down on lake-bottom plains and in the basal parts of deltas. Bedding in the deltas includes inclined foreset beds of sand, pebbly sand, and minor pebble-to-cobble gravel, overlain at the surface of some deltas by horizontal topset beds of sand and pebble-to-cobble gravel. Lacustrine fans contain gently dipping beds of sand and pebble-to-cobble gravel. Bedding in deltas and fans may be deformed locally by collapse, slumping, or shoving by glacial ice. Bedding in lake-bottom deposits is generally horizontal, laminated to thin-bedded, and undeformed. Nongravel sediment is yellowish-brown, light reddish-brown, and light gray. Sand and gravel composition similar to that of glacial-stream deposits (see above).

**GLACIAL LAKE HACKENSACK DEPOSITS**—Deltaic, lake-bottom, and lacustrine-fan deposits laid down in glacial Lake Hackensack. Lake level in the Park Ridge quadrangle, as marked by delta-front and delta-top landforms, was at an elevation of about 60-65 feet (Stanford and Harper, 1991).

- Qh1** Deltaic deposits—Pebbly sand, sand, and pebble-to-cobble gravel. As much as 80 feet thick.
- Qh2** Lake-bottom deposits—Silt, clay, fine sand. As much as 40 feet thick.
- Qh3** Lacustrine-fan deposits—Pebble-to-cobble gravel and sand. As much as 60 feet thick.

**BEAR BROOK DEPOSITS**—Two small collapsed deltaic deposits in the Bear Brook Valley, laid down in a proglacial lake that formed when the ice margin dammed the east end of the valley (fig. 1). The lake was controlled by three successively lower spillways that led south into the Musquapsink and, later, Pasack valleys, at elevations between 205 and 205 feet.

- Qh1** Pebble-to-cobble gravel and sand. As much as 25 feet thick. Deposited in the earliest, highest lake stage, with a spillway at an altitude of 315 feet.
- Qh2** Pebble sand and pebble-to-cobble gravel. As much as 20 feet thick. Deposited in the latest, lowest lake stage, with a spillway at an altitude of 265 feet.

**GLACIAL LAKE PARAMUS DEPOSITS**—Pebbly sand and pebble-to-cobble gravel. As much as 70 feet thick. Includes partially collapsed, sandy deltaic deposits in Hilldale laid down in Lake Paramus; and partially collapsed fluvial sand and gravel in Hobokus that forms a plain graded down the Saddle River Valley to Lake Paramus (Stanford, 1994). The level of Lake Paramus in the quadrangle was at an elevation of about 70-75 feet (Stanford and Harper, 1991).

- Qpr** Pebble-to-cobble gravel and sand, with a spillway at an altitude of 290 feet (fig. 1).

**HOBOKUS DEPOSITS**—Collapsing deltaic and ice-contact deposits (Qho) and lake-bottom deposits (Qh1) laid down in a proglacial lake that formed when the ice margin dammed the east end of the Hobokus Brook Valley at Ridgewood. The deposits in the Park Ridge quadrangle were probably laid down in the lowest stage of this lake, controlled by a spillway that drained into the Pasack River basin at an altitude of about 290 feet (fig. 1).

- Qho** Pebble-to-cobble gravel, sand, and sandy, cobbly diamictic. As much as 50 feet thick.
- Qh1** Sand, silt, clay. As much as 45 feet thick.

**PRE-ADVANCE STRATIFIED DEPOSITS**—Sand, some clay and gravel. As much as 40 feet thick. In subsurface only, either between late Wisconsinan and Illinoian till in drumlins, or between till and the bedrock surface. In the former setting, the deposits are too high in elevation to have been laid down in any lake basin or fluvial plain and instead may be subglacial fluvial or lacustrine sediments. In the latter setting, the deposits occur where the bedrock surface slopes toward the advancing ice. In these instances, the deposits may be lacustrine sediments laid down in proglacial ponds that were dammed, and then overtop, by the advancing ice.

- Qsp** ICE-CONTACT DEPOSITS—Pebble-to-cobble gravel and sand, locally cobble-to-boulder gravel and sandy, cobbly diamictic, moderately sorted, variably stratified. As much as 100 feet thick. These deposits form hummocky ridges or benches above the level of adjacent lakes or fluvial plains. They may have been deposited in ice-walled basins or by glacial pushing of previously deposited sediment.

**Till**—Poorly sorted, nonstratified sediment deposited directly by glacial ice or by sediment flows from glacial ice. Sediment is matrix-supported and is generally compact below the soil zone due to consolidation by the weight of overlying ice. The matrix may show a coarse subhorizontal platy structure. Three tills are distinguished on the basis of color, grain-size, and age. Netcong till is a gradational contact with Railway till, and areas mapped as Netcong till may contain small inclusions of unmapped Railway till.

- Qn** NETCONG TILL—Yellow, yellowish-brown, reddish-yellow, very pale brown (oxidized) to grayish-brown and brown (unoxidized) silty sand to sandy silt with many (10-40 percent by volume) subrounded to subangular pebbles and cobbles, and few (less than 5 percent) to some (5-10 percent) boulders. Depth of oxidation ranges from 10 to about 50 feet. Till matrix is generally compact, nonstony, nonjointed, and may have subhorizontal fissility. As much as 80 feet thick. Gravel is chiefly gray-to-white gneiss and gray mudstone and sandstone, with a little red sandstone and white-to-gray quartz and quartzite. Boulders are chiefly gneiss; very few are quartzite or gray and red sandstone. Clast composition reflects southerly glacial transport from the Wallkill and Hudson Valleys underlain by Palaeozoic sedimentary rock, and from the Hudson Highlands, underlain by Proterozoic gneiss.

**RAHWAY TILL**—Reddish-brown, light reddish-brown, reddish-yellow silty sand to sandy silt containing some to many subrounded and subangular pebbles and cobbles and few subrounded boulders. Matrix is compact, nonstony, nonplastic to slightly plastic, nonjointed, and may show a coarse subhorizontal fissile structure. Gravel clasts include chiefly red and gray sandstone and siltstone, gray gneiss, and a little white-to-gray quartz and quartzite. Boulders are chiefly gneiss, a very few are quartzite or gray and red sandstone. As much as 50 feet thick. Unit Qr delineates areas where Qr is discontinuous and generally less than 10 feet thick.

**BERGEN TILL**—Reddish-brown to reddish-yellow sandy clayey silt to sandy clay. Gravel and boulder content and composition similar to Railway till. Matrix is compact, moderately sticky and plastic, and weakly jointed. Gneiss, sandstone, and mudstone clasts may have weathering rinds or be decomposed. As much as 30 feet thick. In subsurface only. Of pre-Wisconsinan (possible Illinoian) age.

**MAP SYMBOLS**

- Contact—Dashed where approximate, gradational, or feather-edged; dotted where concealed by fill or water.
- Drumlin—Line along crest, symbol on summit.
- Striation—From Salisbury (1902), no longer exposed.
- Melow channel—Line in base of channel, arrow indicates flow direction.
- Scarp cut by glacial meltwater—Line at top, ticks on slope.
- Spillway for glacial lake—Symbol in spillway area, arrow indicates direction of drainage. Lettering indicates associated deposit.
- Well with log in table 1—Location accurate within 100 feet.
- Well with log in table 1—Location accurate within 500 feet.
- Site of pebble lithology count—Data in table 2.
- Elevation of bedrock surface—Contour interval 50 feet.
- Bedrock outcrop.
- Former bedrock outcrop—Shown on manuscript field maps (ca. 1900) on file at the N. J. Geological Survey, but no longer exposed.
- Well on sections—Projected to line of section.
- Body of water—Shows lakes that are not on base map.

REFERENCES

Averill, S. P., Pardi, R. R., Newman, W. S., and Dineen, R. J., 1980, Late Wisconsinan-Holocene history of the lower Hudson region: new evidence from the Hackensack and Hudson river valleys, in Manspeizer, Warren (ed.), Field studies of New Jersey geology and guide to field trips: field guide of the 52<sup>nd</sup> annual meeting of the New York State Geological Association, Rutgers University, Newark, N. J., p. 160-186.

Mennel, W. J., and Canace, Robert, 2002, N. J. Geological Survey Hydro Database: N. J. Geological Survey Digital Geodata Series DGS 02-1, www.state.nj.us/de/p/njgs/geodata/dgs02-1.zip.

Salisbury, R. D., 1902, The glacial geology of New Jersey. N. J. Geological Survey Final Report v. 5, 802 p.

Stanford, S. D., and Harper, D. P., 1991, Glacial lakes of the lower Passaic, Hackensack, and lower Hudson valleys, New Jersey and New York: Northeastern Geologist, v. 13, no. 4, p. 271-286.

Stanford, S. D., and Witte, R. W., in press, Geology of the glacial aquifers of New Jersey. N. J. Geological Survey Geologic Report Series.

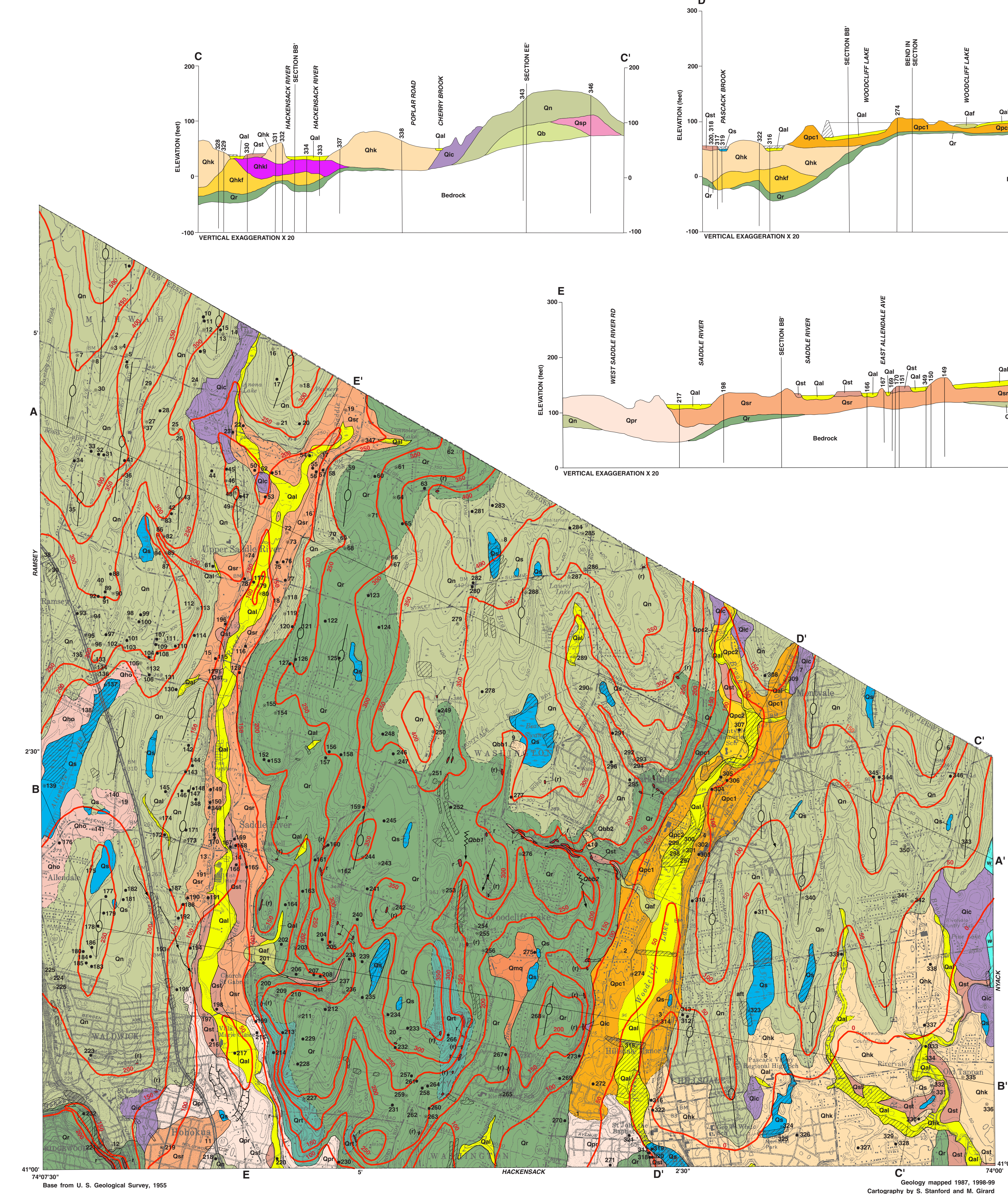
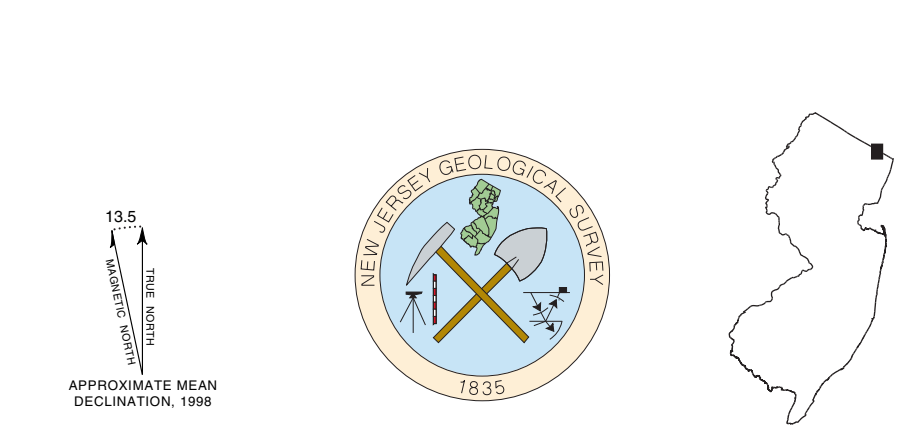
Table 2.—Composition of pebbles in surficial deposits

Site	Unit	Number of pebbles	Percentage of pebbles						
			gneiss	gray sandstone	red sandstone	quartz	quartzite	carbonate chert	mudstone
1	Qp1	104	48	44	3	3	2	1	
2	Qp1	180	51	44	3	1	2	1	
3	Qp1	165	47	47	3	1	2	1	
4	Qp1	165	56	37	2	2	2	2	
5	Qh1	168	60	38	1	1	2	1	
6	Qr	156	51	42	4	1	2	1	
7	Qr	157	58	38	1	1	1	1	
8	Qr	143	33	63	3	1	1	1	
9	Qh1	134	28	67	3	1	1	1	
10	Qh2	143	35	70	4	1	1	1	
11	Qr	160	29	63	4	1	1	1	
12	Qr	147	34	61	4	1	1	1	
13	Qr	127	27	63	4	1	2	1	1
14	Qr	111	30	63	3	1	2	1	1
15	Qr	138	22	66	6	3	2	1	1
16	Qr	133	25	63	8	2	1	1	1
17	Qr	110	27	64	9	5	1	1	1
18	Qr	127	26	63	6	1	2	1	1
19	Qr	112	42	45	11	1	2	1	1
20	Qr	118	20	54	23	3			

<sup>1</sup>Includes white rounded quartz pebbles from a proglacial fluvial deposit that formerly covered the Hudson Valley (Piscataway formation). Some quartz pebbles may also have washed out from local conglomerate bedrock of the Newark Basin.

<sup>2</sup>Includes white and gray quartzite and quartzite-conglomerate from Palaeozoic bedrock in the Hudson-Wallkill Valleys.

<sup>3</sup>Includes mostly weathered dolomite and limestone from Palaeozoic bedrock in the Hudson-Wallkill Valleys.



CORRELATION OF MAP UNITS

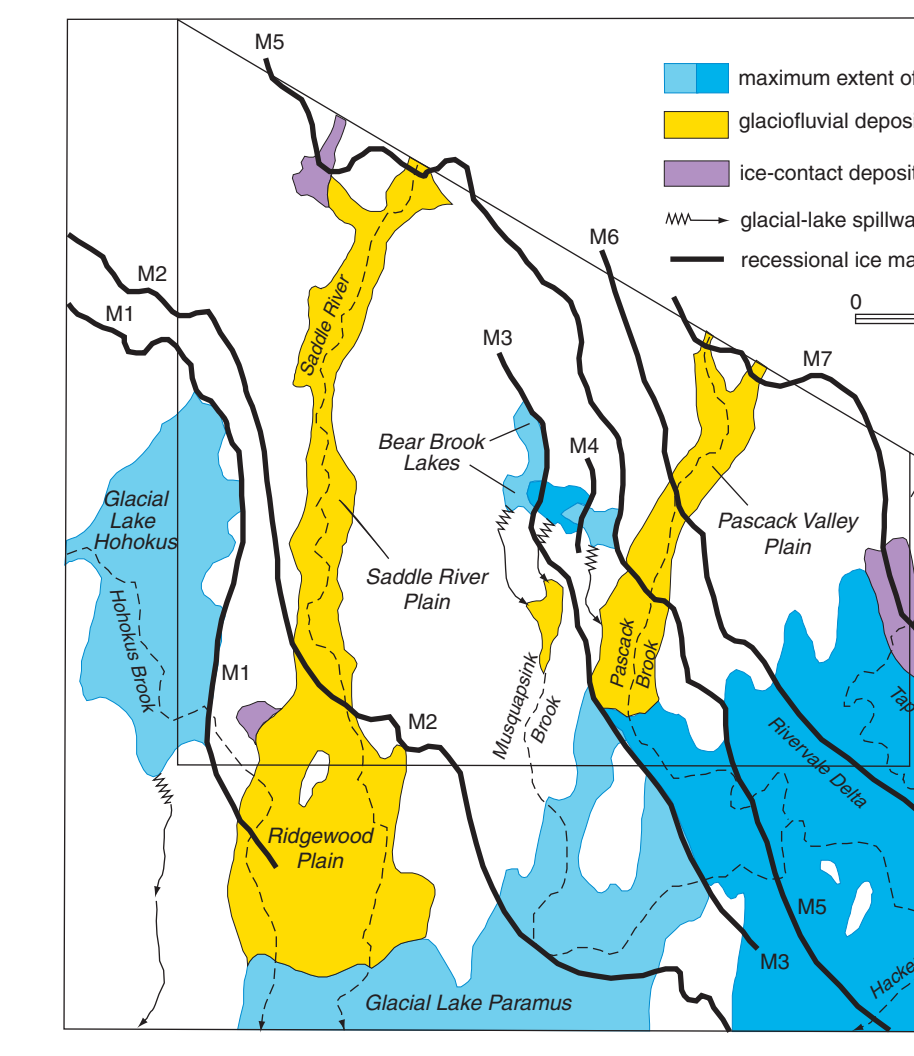
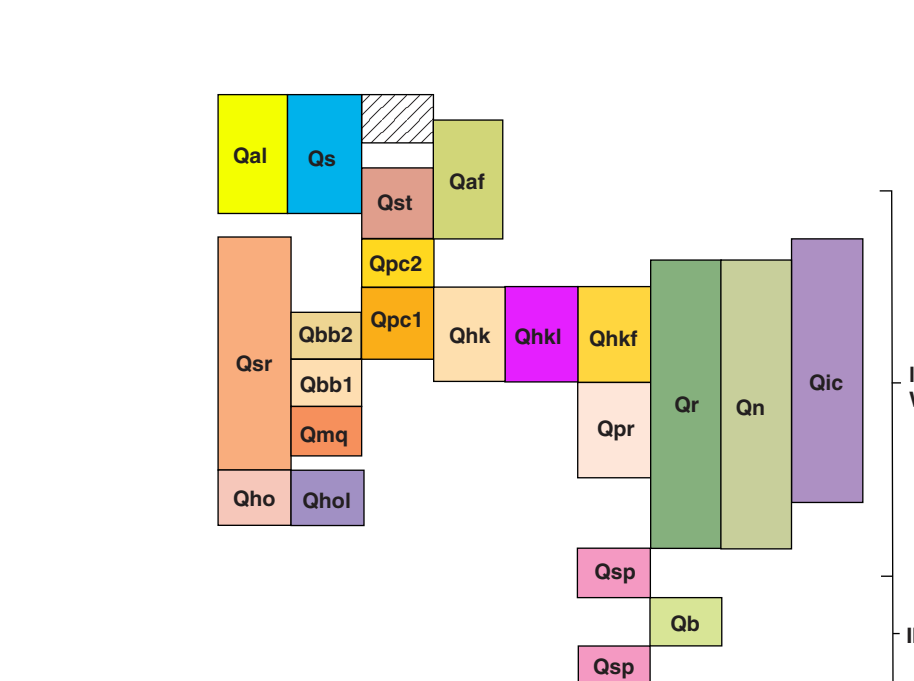
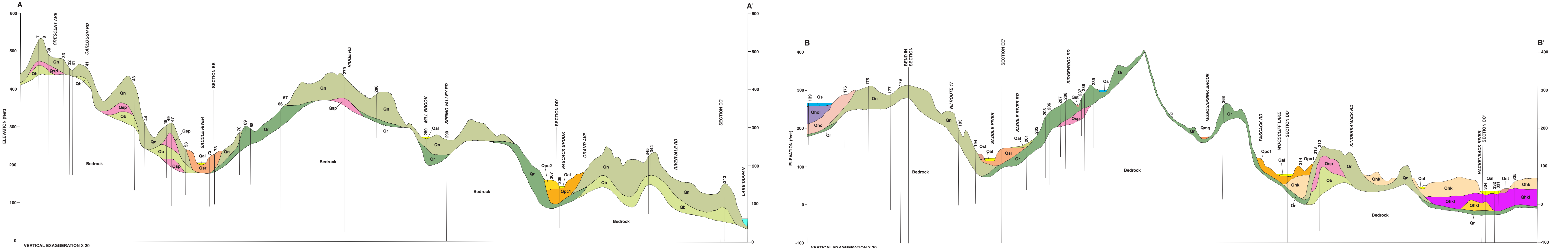


Figure 1.—Recessional ice margins, glacial lakes, and glaciofluvial plains in the Park Ridge quadrangle. Ice margins are: M1—last ice margin before Lake Hobokus drains. M2—ice margin at head of the Ridgewood fluvial plain in the Saddle River Valley. This plain is graded to Lake Paramus. M3—last ice margin before Lake Paramus drains. This margin also dams the high stage of the small lake in the Bear Brook Valley. M4—margin that dams the intermediate lake stage in the Bear Brook Valley. M5—margin during deposition of deltaic deposits in Lake Hackensack in the Hilldale area, and of a glaciofluvial plain and associated ice-contact deposits in the Saddle River Valley. M6—margin during deposition of the Rivervale delta, which is that part of unit Qh1 south and east of Pasack Valley Regional High School, in Lake Hackensack. M7—ice margin during deposition of the Tappan delta, which is that part of unit Qh1 to the north of Old Tappan and to the east of Greenwood Country Club, in Lake Hackensack. The main glaciofluvial plain in the Pasack Brook Valley (unit Qp1) and associated ice-contact deposits at the head of the plain in Montvale were also deposited from this margin.

SURFICIAL GEOLOGY OF THE PARK RIDGE QUADRANGLE,  
BERGEN COUNTY, NEW JERSEY

by  
Scott D. Stanford  
2002



Surficial Geology of the Park Ridge Quadrangle,  
Bergen County, New Jersey

New Jersey Geological Survey  
Open-File Map 49  
2002

pamphlet to accompany map

Table 1.--Selected Well and Boring Logs

Well No.	Identifier <sup>1</sup>	Driller's Log	
		Depth <sup>2</sup>	Description <sup>3</sup>
1	23-5337	0-61 61-230	brown hardpan (Qn) red sandstone
2	23-3020	0-65 65-105 105-182	sand with boulders (Qn) hardpan (Qn or Qb) red rock
3	23-3378	0-45 45-93 93-205	hardpan with boulders (Qn) sand and gravel (Qsp) red rock
4	23-3209	0-60 60-108 108-181	hardpan (Qn) sand and gravel (Qsp) red rock
5	23-4167	0-100 100-110 110-124 124-215	hardpan with boulders (Qn) sand and gravel (Qsp) red hardpan (Qb) red rock
6	23-1106	0-123 123-205	fill, boulders (Qn) red rock
7	23-2240	0-19 19-33 33-48 48-60 60-67 67-72 72-247	light brown hardpan (Qn) dark brown hardpan (Qn) gray hardpan (Qn) dark gray hardpan (Qn) gray sand (Qsp) red hardpan (Qb) red sandstone
8	23-4137	0-80 80-100 100-110 110-204	hardpan with boulders (Qn) sand and gravel (Qsp) red hardpan (Qb) red rock
9	23-2717	0-102 102-220	hardpan and boulders (Qn) red sandstone
10	23-3676	0-50 50-65 65-77 77-183	hardpan (Qn) sand and gravel (Qsp) red hardpan (Qb) red sandstone
11	23-3762	0-15 15-48	brown hardpan with boulders (Qn) gray hardpan with boulders (Qn)

		48-66	red hardpan (Qb)
		66-82	soft red sandstone
		82-120	hard red sandstone
12	23-2087	0-22	yellow hardpan (Qn)
		22-37	yellowish-brown hardpan (Qn)
		37-59	brown hardpan (Qn)
		59-68	gray hardpan (Qn)
		68-72	fine brown sand (Qsp)
		72-84	red hardpan (Qb)
		84-190	red sandstone
13	23-1639	0-35	gravel (Qn)
		35-80	hardpan (Qn)
		80-130	gravel (Qsp)
		130-147	red gravel (Qb)
		147-225	red rock
14	23-2048	0-26	brown hardpan (Qn)
		26-41	yellow-brown hardpan (Qn)
		41-63	yellow hardpan (Qn)
		63-85	yellow hardpan and boulders (Qn)
		85-96	reddish-brown hardpan and boulders (Qb)
		96-105	red hardpan (Qb)
		105-200	red sandstone
15	23-3738	0-130	hardpan (Qn)
		130-140	sand (Qsp)
		140-240	red rock
16	23-2859	0-8	brown hardpan (Qn)
		8-17	yellow-brown hardpan and sand (Qn)
		17-33	yellow hardpan (Qn)
		33-48	gray hardpan (Qn)
		48-63	gray clay (Qsp)
		63-72	red hardpan (Qb)
		72-160	red sandstone
17	23-3223	0-80	hardpan and boulders (Qn)
		80-197	red rock
18	23-3636	0-51	brown hardpan (Qn)
		51-163	red rock
19	23-3189	0-50	hardpan with boulders (Qsr over Qn)
		50-185	red rock
20	23-4027	0-72	sand, gravel, boulders, clay (Qn)
		72-151	red rock, layers of shale
21	23-2217	0-17	yellow hardpan (Qn)
		17-28	yellowish-brown hardpan (Qn)
		28-37	dark gray hardpan (Qn)
		37-46	light gray hardpan (Qn)
		46-53	gray sand (Qsp)
		53-60	red hardpan (Qb)
		60-175	red sandstone
22	23-7159	0-15	gravel and boulders (Qsr)
		15-20	larger gravel in hardpan (Qn)
		20-41	red rock
		41-205	red rock and red sandstone
23	23-5859	0-30	sand (Qsr)
		30-45	red clay (Qr or weathered bedrock)
		45-85	red sandstone

24	23-3312	0-85 85-101 101-240	hardpan (Qn) sand and gravel (Qsp) red rock
25	23-2716	0-92 92-183	hardpan and boulders (Qn) red sandstone
26	23-3776	0-75 75-240	hardpan and boulders (Qn) red sandstone
27	23-4425	0-50 50-120 120-220	hardpan (Qn) boulders and sand (Qsp over Qb?) red rock
28	23-3695	0-20 20-90 90-165	hardpan, boulders (Qn) sand (Qsp) red rock
29	23-3790	0-34 34-59 59-74 74-92 92-105 105-205	brown sandy hardpan with boulders (Qn) grayish-brown hardpan (Qn) brown sandy hardpan with boulders (Qn) red sandy hardpan (Qb) soft red sandstone hard red sandstone
30	23-6017	0-112 112-400	hardpan and boulders (Qn) red rock
31	23-6741	0-15 15-31 31-275	sand and gravel (Qn) brown sandstone red sandstone
32	23-6435	0-15 15-25 25-41 41-280	hardpan (Qn) gravel (Qn or Qsp) soft sandstone sandstone and red rock
33	23-5855	0-30 30-33 33-41 41-220	gravel, boulders (Qn) fine sand and gravel (Qsp) sandstone red rock and sandstone
34	23-1881	0-20 20-400	sand and clay (Qn) red rock
35	23-1753	0-68 68-200	hardpan (Qn) red rock
36	23-2940	0-6 6-17 17-39 39-67 67-83 83-91 91-164	brown hardpan (Qn) brown sand (Qn or Qsp) yellowish-brown hardpan (Qn) yellow hardpan (Qn) gray hardpan (Qn) red hardpan (Qb) red sandstone
37	23-3031	0-102 102-137	hardpan with granite boulders (Qn) red rock
38	23-916	0-40 40-104 104-150	hardpan with boulders (Qn) sandy hardpan with boulders (Qn) red sandstone
39	23-2376	0-17 17-38	brown hardpan (Qn) yellowish-brown hardpan (Qn)

		38-71	yellow hardpan and boulders (Qn)
		71-102	gray hardpan (Qn)
		102-117	fine gray sand (Qsp)
		117-128	gray clay (Qsp)
		128-133	red hardpan (Qb)
		133-139	soft red sandstone
		139-350	hard red sandstone
40	23-3825	0-8	brown sandy hardpan with boulders (Qn)
		8-48	gray sandy hardpan with boulders (Qn)
		48-76	brown sand and gravel (Qsp)
		76-82	soft red sandstone
		82-180	hard red sandstone
41	23-3821	0-28	brown sandy hardpan with boulders (Qn)
		28-41	red sandy hardpan (Qr or Qb)
		41-63	soft red sandstone
		63-105	hard red sandstone
42	23-3553	0-108	no log, cased to rock (Qn)
		108-295	hard red sandstone
43	23-4177	0-15	brown sandy hardpan (Qn)
		15-49	light gray sandy hardpan (Qn)
		49-85	grayish-brown hardpan with boulders (Qn)
		85-103	reddish-brown sandy hardpan with boulders (Qr or Qb)
		103-127	reddish-brown sandy hardpan with boulders (Qr or Qb)
		127-140	soft red sandstone
		140-273	hard red sandstone
44	23-426	0-61	sand and gravel (Qn)
		61-127	sandstone
45	23-566	0-35	boulders (Qn)
		35-60	sand and gravel (Qsp)
		60-86	red sand (Qsp or Qb)
		86-140	red rock
46	23-1311	0-19	yellow hardpan (Qn)
		19-30	yellow-brown hardpan (Qn)
		30-52	brown hardpan (Qn)
		52-68	gray hardpan (Qn)
		68-82	dark gray hardpan (Qn)
		82-96	reddish-brown hardpan (Qb)
		96-106	red hardpan (Qb)
		106-155	red sandstone
47	23-434	0-30	hardpan (Qn)
		30-70	sand (Qsp)
		70-90	hardpan (Qb)
		90-135	sand and gravel (Qsp)
		135-220	red rock
48	23-441	0-30	hardpan (Qn)
		30-80	gravel (Qsp)
		80-138	red sandstone
49	23-4093	0-20	brown hardpan with boulders (Qn)
		20-62	reddish-brown sandy hardpan with boulders (Qb or Qsp)
		62-100	red hardpan, sandy, with boulders (Qb or Qsp)
		100-123	soft red sandstone
		123-223	hard red sandstone
50	23-3464	0-43	sand and gravel (Qsr over Qn)
		43-100	red rock

51	23-2989	0-16 16-33 33-44 44-51 51-131	sand and gravel (Qsr) gray hardpan (Qn) red hardpan (Qr or Qb) soft red sandstone hard red sandstone
52	23-3788	0-20 20-30 30-75	brown hardpan with boulders (Qsr over Qn) soft red sandstone hard red sandstone
53	23-3974	0-15 15-28 28-34 34-42 42-125	brown sandy hardpan (Qsr over Qn) reddish-brown hardpan (Qb) red hardpan (Qb) soft red sandstone hard red sandstone
54	23-5537	0-47 47-141	sand, boulders, and hardpan (Qal over Qsr over Qr) red rock
55	23-7169	0-25 25-30 30-205	sand (Qal over Qsr) sand and fine gravel (Qsr) red sandstone
56	23-6644	0-23 23-40 40-50 50-215	sand and coarse gravel (Qsr) fine sand and fine gravel (Qsr) hard brown sandstone red sandstone
57	23-7175	0-8 8-15 15-20 20-28 28-50 50-360	sand (Qsr) boulders (Qsr) large gravel (Qsr) red hardpan and clay (Qr) brown sandstone sandstone
58	23-1848	0-4 4-9 9-14 14-16 16-150	yellow hardpan (Qn) yellowish-brown hardpan (Qn) brown hardpan (Qn) red hardpan (Qr) red sandstone
59	23-7	0-26 26-166	dirt and boulders (Qr) red rock
60	23-6896	0-50 50-220	hardpan, boulders (Qr) red rock
61	23-3605	0-12 12-27 27-130	brown sandy hardpan (Qr) soft red sandstone hard red sandstone
62	23-3104	0-22 22-105	red hardpan (Qr) red rock
63	23-3137	0-19 19-145	red hardpan (Qr) red rock
64	23-3425	0-22 22-185	hardpan (Qr) red rock
65	23-3678	0-30 30-115	red hardpan (Qr) red rock
66	23-1758	0-23 23-41 41-68	yellowish-brown hardpan (Qn) yellow hardpan and boulders (Qn) dark gray hardpan (Qn)

		68-90	gray hardpan (Qn)
		90-117	reddish-brown hardpan (Qr)
		117-123	red hardpan (Qr)
		123-300	red sandstone
67	23-1716	0-14	yellow hardpan (Qn)
		14-22	yellowish-brown hardpan (Qn)
		22-31	brown hardpan (Qn)
		31-43	reddish-brown hardpan (Qr)
		43-46	red hardpan (Qr)
		46-82	red sandstone
68	23-1803	0-12	hardpan (Qr)
		12-30	boulders and hardpan (Qr)
		30-36	gravel and fine sand (Qsp or weathered bedrock)
		36-144	sandstone
69	23-1313	0-15	yellowish-brown hardpan (Qn)
		15-27	gray hardpan (Qn)
		27-39	reddish-brown hardpan (Qr)
		39-51	red hardpan (Qr)
		51-55	red sandstone
70	23-1314	0-10	yellowish-brown hardpan (Qn)
		10-19	brown hardpan (Qn)
		19-36	gray hardpan (Qn)
		36-44	gray hardpan with some gravel (Qn)
		44-52	reddish hardpan (Qr)
		52-115	red sandstone
71	23-5019	0-15	brown hardpan (Qr)
		15-32	soft red sandstone
		32-120	hard red sandstone
72	23-3817	0-20	brown sandy hardpan (Qsr)
		20-38	grayish-brown sand (Qsr)
		38-52	soft red sandstone
		52-130	hard red sandstone
73	23-2578	0-18	brown sand and gravel (Qsr)
		18-33	gray sandy clay (Qsr)
		33-44	red sand (Qsr)
		44-50	red hardpan and soft sandstone (Qr)
		50-130	red sandstone
74	23-981	0-33	sand and boulders (Qsr)
		33-125	red sandstone
75	23-6382	0-57	sand, gravel (Qsr)
		57-200	red rock
76	23-6295	0-40	sand, boulders, clay (Qsr)
		40-200	red rock
77	23-4965	0-37	hardpan, boulders (Qr)
		37-110	red rock
78	23-8065	0-12	sand, gravel (Qsr)
		12-20	loose gravel and boulders (Qsr)
		20-30	boulders in hardpan (Qn)
		30-105	brown sandstone
79	23-2034	0-7	yellow clay and hardpan (fill or Qal)
		7-12	yellow sand, clay, and gravel (Qal)
		12-64	clean coarse sand and gravel (Qsr)
		64-76	brown and gray hardpan (Qn)

		76-95	red hardpan (Qr)
		95-97	red rock
		screened for 20 feet, interval not reported, yield 450 gpm	
80	23-2022	0-10	hardpan, clay, boulders (fill or Qal)
		10-30	yellow sand and clay (Qal over Qsr)
		30-64	sand and gravel (Qsr)
		64-72	sand and gravel, but shows more clay and less gravel (Qsr)
		72-74	red hardpan with medium-sized gravel embedded in clay (Qr)
		74-84	red rock
		screened 48-68, yield 450 gpm	
81	23-7756	0-8	sand, gravel (fill or Qn)
		8-10	red hardpan (Qr)
		10-155	red sandstone
82	23-1611	0-21	yellow hardpan (Qn)
		21-48	yellowish-brown hardpan and boulders (Qn)
		48-63	brown hardpan and boulders (Qn)
		63-86	gray hardpan (Qn)
		86-97	gray fine sand (Qsp)
		97-110	red hardpan (Qb)
		110-250	red sandstone
83	23-1615	0-8	yellowish-brown hardpan (Qn)
		8-31	brown hardpan and boulders (Qn)
		31-47	gray hardpan and boulders (Qn)
		47-61	fine brown sand (Qsp)
		61-80	red hardpan (Qb)
		80-235	red sandstone
84	23-2221	0-21	yellow hardpan (Qn)
		21-38	yellowish-brown hardpan (Qn)
		38-47	brown hardpan (Qn)
		47-55	gray hardpan (Qn)
		55-67	dark gray hardpan (Qn)
		67-75	red hardpan (Qb)
		75-230	red sandstone
85	23-1734	0-22	brown hardpan and boulders (Qn)
		22-41	yellowish-brown hardpan and boulders (Qn)
		41-68	yellow hardpan (Qn)
		68-92	gray hardpan and sand (Qn)
		92-119	dark gray hardpan (Qn)
		119-147	reddish-brown hardpan (Qb)
		147-169	red hardpan (Qb)
		169-285	red sandstone
86	23-1757	0-26	yellow hardpan and boulders (Qn)
		26-47	yellowish-brown hardpan (Qn)
		47-81	brown hardpan and boulders (Qn)
		81-107	dark gray hardpan (Qn)
		107-133	light gray hardpan (Qn)
		133-155	reddish-brown hardpan (Qb)
		155-169	red hardpan (Qb)
		169-290	red sandstone
87	23-1612	0-28	yellow hardpan (Qn)
		28-51	brown hardpan (Qn)
		51-63	gray hardpan (Qn)
		63-71	red hardpan (Qb)
		71-201	red sandstone



88	23-2530	0-90 90-173	overburden (Qn) sandstone
89	23-2990	0-73 73-180	overburden (Qn) sandstone
90	23-2137	0-9 9-21 21-39 29-47 47-50 50-131	yellow-brown hardpan (Qn) brown hardpan (Qn) gray hardpan (Qn) fine sand (Qsp) red hardpan (Qb) red sandstone
91	23-3075	0-60 60-95 95-102 102-145	hardpan with granite boulders (Qn) sand and gravel (Qsp) red hardpan (Qb) red rock
92	23-3804	0-30 30-74 74-86 86-180	brown hardpan with boulders (Qn) gray hardpan (Qn) soft red sandstone hard red sandstone
93	23-1711	0-23 23-41 41-63 63-84 84-107 107-127 127-200	yellow hardpan (Qn) yellowish-brown hardpan (Qn) brown hardpan (Qn) gray hardpan and boulders (Qn) reddish-brown hardpan (Qb) red hardpan (Qb) red sandstone
94	23-1717	0-16 16-30 30-48 48-63 63-79 79-86 86-195	brown hardpan (Qn) yellowish-brown hardpan and boulders (Qn) yellow hardpan (Qn) gray hardpan (Qn) reddish-brown hardpan (Qb) red hardpan (Qb) red sandstone
95	23-1712	0-21 21-33 33-55 55-70 70-83 83-190	yellow hardpan (Qn) yellowish-brown hardpan (Qn) brown hardpan (Qn) reddish-brown hardpan (Qb) red hardpan (Qb) red sandstone
96	23-5285	0-70 70-315	overburden (Qn) red rock
97	23-1312	0-18 18-30 30-47 47-61 61-72 72-83 83-190	brown hardpan, some boulders (Qn) yellowish-brown hardpan (Qn) yellow hardpan (Qn) dark gray hardpan (Qn) gray hardpan (Qn) red hardpan (Qb) red sandstone
98	23-1619	0-19 19-27 27-39 39-46 46-135	yellow hardpan (Qn) brown hardpan (Qn) gray hardpan (Qn) red hardpan (Qb) red sandstone
99	23-1608	0-18 18-31 31-43	yellow-brown hardpan (Qn) brown hardpan (Qn) gray hardpan (Qn)

		43-50	red hardpan (Qb)
		50-129	red sandstone
100	23-1609	0-8	yellow hardpan (Qn)
		8-19	brown hardpan (Qn)
		19-33	gray hardpan (Qn)
		33-42	red hardpan (Qb)
		42-130	red sandstone
101	23-1714	0-11	yellow hardpan (Qn)
		11-19	yellow brown hardpan (Qn)
		19-27	red hardpan (Qb)
		27-87	red sandstone
102	23-1733	0-9	brown hardpan (Qn)
		9-17	reddish-brown hardpan (Qb)
		17-23	reddish-hardpan (Qb)
		23-90	red sandstone
103	23-1738	0-12	brown hardpan (Qn)
		12-28	gray hardpan (Qn)
		28-34	reddish-brown hardpan (Qb)
		34-40	red hardpan (Qb)
		40-109	red sandstone
104	23-479	0-8	yellowish clay and boulders (Qn)
		8-20	red hardpan (Qb)
		20-111	red sandstone
105	23-2514	0-7	brown hardpan (Qn)
		7-19	yellowish-brown hardpan (Qn)
		19-25	gray hardpan (Qn)
		25-30	red hardpan (Qb)
		30-130	red sandstone
106	23-462	0-10	boulders, yellow clay (Qn)
		10-30	red sandy clay (Qb)
		30-34	soft red sandstone
		34-103	hard red sandstone
107	23-1310	0-9	brown hardpan (Qn)
		9-18	yellow hardpan (Qn)
		18-23	gray hardpan (Qn)
		23-28	red hardpan (Qb)
		28-78	red sandstone
108	23-7787	0-25	soil with boulders (Qn)
		25-30	red sandy hardpan (Qb)
		30-103	red shale
109	23-1309	0-5	brown hardpan (Qn)
		5-11	yellow hardpan (Qn)
		11-15	gray hardpan (Qn)
		15-88	red sandstone
110	23-1535	0-5	hardpan (Qn)
		5-13	red rock
		13-22	gravel (probably weathered conglomerate)
		22-191	sandstone
111	23-1604	0-16	yellow hardpan (Qn)
		16-23	brown hardpan (Qn)
		23-32	gray hardpan (Qn)
		32-37	red hardpan (Qb)
		37-125	red sandstone

112	23-3789	0-24 24-55 55-81 81-86 86-185	brown hardpan (Qn) light gray hardpan with boulders (Qn) reddish-brown sandy hardpan (Qb or Qr) soft red sandstone hard red sandstone
113	23-3141	0-60 60-115	sand and gravel (Qn) red rock
114	23-3763	0-10 10-18 18-44 44-52 52-145	brown sandy hardpan with boulders (Qn) gray hardpan (Qn) red hardpan (Qr or Qb) soft red sandstone hard red sandstone
115	23-3842	0-12 12-24 24-37 37-63 63-200	brown sandy hardpan (Qsr) grayish-brown hardpan with boulders (Qn) red sandy hardpan (Qr) soft red sandstone hard red sandstone
116	23-608	0-48 48-120	sandy gravel overburden (Qsr) red sandstone
117	23-5941	0-17 17-68 screened 48-68, yield 1000 gpm	sand, boulders (fill over Qal) gravel (Qsr)
118	23-2223	0-9 9-17 17-28 28-33 33-35 35-150	yellow hardpan (Qn) brown hardpan (Qn) gray hardpan (Qn) dark gray hardpan (Qn) red hardpan (Qr) red sandstone
119	23-3501	0-25 25-39 39-55 55-65 65-82 82-160	brown sandy hardpan with boulders (Qn) light gray hardpan (Qn) grayish-brown sand with boulders (Qn) red hardpan (Qr) soft red sandstone hard red sandstone
120	23-3973	0-15 15-40 40-69 69-82 82-97 97-190	brown hardpan (Qn) light gray sandy hardpan (Qn) reddish-brown hardpan (Qr) red hardpan (Qr) soft red sandstone hard red sandstone
121	23-3694	0-29 29-85 85-92	brown sandy hardpan with boulders (Qn) gray hardpan (Qn) soft red sandstone
122	23-3167	0-50 50-185	hardpan (Qr) red rock
123	23-7640	0-10 10-400	red hardpan (Qr) red sandstone
124	23-3320	0-70 70-205	sand with coarse gravel (Qr) red rock
125	23-3381	0-40 40-76 76-86 86-165	hardpan with boulders (Qr) red hardpan (Qr) sand and gravel (Qsp) red rock

126	23-1508	0-25 25-80 80-92 92-125	boulders (Qr) hardpan (Qr) gravel (Qsp) sandstone
127	23-7173	0-25 25-40 40-60 60-400	hardpan (Qr) hardpan and boulders (Qr) coarse gravel (Qsp) red sandstone
128	23-357	0-24 24-136	coarse sand and large gravel (Qsr) red sandstone
129	23-2808	0-9 9-15 15-31 31-52 52-60 60-63 63-130	reddish-brown fill brown sandy soil (Qal) yellowish-brown hardpan (Qn or Qsr) yellowish hardpan (Qn) gray hardpan (Qn) red hardpan (Qr) red sandstone
130	23-7744	0-6 6-30 30-36 36-157	sandy soil with cobblestones (Qn) stony hardpan (Qn) red sandy hardpan (Qr) red sandstone
131	23-2919	0-5 5-14 14-38 38-47 47-130	yellow-brown hardpan (Qn) brown sand and gravel (Qn or Qsp) gray hardpan (Qn) red hardpan (Qr or Qb) red sandstone
132	23-540	0-8 8-20 20-22 22-110	boulders and yellowish-clay (Qn) red hardpan (Qr or Qb) little sand and gravel (Qsp) red sandstone
133	23-2674	0-12 12-21 21-26 26-29 29-100	brown sandy hardpan (Qn) yellow hardpan (Qn) gray hardpan (Qn) red hardpan (Qr or Qb) red sandstone
134	23-7314	0-4 4-54 54-200	fill hardpan with lenses of sand and gravel and a lot of very large boulders (Qn) red and brown sandstone with small layers of shale
135	23-3698	0-15 15-65 65-72 72-90 90-110 110-285	brown sandy hardpan with boulders (Qn) gray sandy hardpan with boulders (Qn) yellowish-brown sandy hardpan (Qn) red sandy gravel (Qsp) soft red sandstone hard red sandstone
136	23-3374	0-4 4-25 25-36 36-53 53-76 76-80 80-150	sandy fill brown hardpan (Qn) gray hardpan (Qn) gray clay (Qsp or Qn) reddish-brown hardpan (Qr) soft red sandstone hard red sandstone
137	23-3366	0-10 10-60	muck (Qs) sand and gravel (Qho)

		60-79	hardpan (Qn)
		79-400	soft red rock
138	BWA files 23-33-482	0-23 23-35 35-47 47-80 80-218	sand and loam (Qho) sand, gravel, and clay (Qho) large gravel (Qho) hardpan, large boulders (Qn) bedrock
139	23-6752	abbreviated log 0-5 5-10 10-50 50-55 55-83 83-85 85-110	topsoil, brown sand (fill or Qs) gray clay and big stones (fill and Qs) brown medium-to-coarse sand and silt, some clay (Qho) red clay, sticky (Qho) brown to reddish-brown sand and gravel, some silt (Qho) hard red clay and reddish sand (Qr) red rock, coarse-grained
140	23-220	0-56 56-106 106-128 128-145	gravel (Qho) gravel and boulders (Qn) red gravel (Qsp or Qr or Qb) red rock
141	23-4238	0-14 14-47 47-57 57-180	brown sandy hardpan (Qho) light gray hardpan (Qn) soft red sandstone hard red sandstone
142	23-4948	0-108 108-240	hardpan, boulders (Qn) red rock
143	23-7223	0-30 30-100 100-205	hardpan, small boulders (Qn) large boulders in hardpan (Qn) red sandstone
144	23-7196	0-35 35-125 125-135 135-285	hardpan with gravel (Qn) boulders in hardpan (Qn) fine gravel (Qsp) red sandstone
145	23-8055	0-23 23-55 55-75 75-90 90-113 113-205	brown hardpan (Qn) hardpan with boulders (Qn) coarse sand and gravel (Qsp) red hardpan and gravel (Qb) soft red sandstone red sandstone
146	23-7751	0-30 30-100 100-122 122-265	hardpan and gravel (Qn) hardpan with boulders (Qn) soft red sandstone red rock and red sandstone
147	23-7713	0-35 35-80 80-105 105-120 120-205	brown hardpan (Qn) hardpan with boulders coarse gravel (Qsp) fine gravel (Qsp) brownish sandstone
148	23-7693	0-40 40-90 90-120 120-140 140-205	hardpan (Qn) large boulders in hardpan (Qn) mixed gravel (Qsp) soft red rock red sandstone
149	23-7859	0-15 15-45	compact sand and gravel (Qsr) coarse sand (Qsr)

		45-60	gravel and boulders (Qn or Qsr)
		60-82	brown sandstone
		82-145	red sandstone
150	23-7642	0-30	brown hardpan with sand and gravel (Qsr)
		30-65	boulders in hardpan (Qn)
		65-70	red sand and fine gravel (Qsp or weathered conglomerate)
		70-92	brown sandstone
		92-285	sandstone
151	23-7282	0-25	sand (Qsr)
		25-51	brown sandstone
		51-205	dark sandstone
152	23-6480	0-15	hard red clay (Qr)
		15-31	red sandstone
		31-420	red sandstone and red rock
153	23-6481	0-15	hardpan (Qr)
		15-25	boulders and gravel (Qr)
		25-35	hard red sandstone
		35-440	red rock and red sandstone
154	23-796	0-12	dirt (Qr)
		12-35	hardpan (Qr)
		35-109	red sandstone
155	23-3893	0-62	sand and gravel (Qr)
		62-300	red rock
156	23-6482	0-20	hardpan, gravel (Qr)
		20-35	boulders in hardpan (Qr)
		35-50	gray clay (Qsp?)
		50-62	red rock
		62-280	red rock and red sandstone
157	23-5054	0-70	hardpan, boulders (Qr)
		70-265	red rock
158	23-6739	0-35	hardpan and boulders (Qr)
		35-70	gravel and boulders (Qr)
		70-82	sandstone
		82-360	red sandstone
159	23-2162	0-68	brown hardpan with boulders (Qr)
		68-80	sand and gravel (Qsp or weathered rock)
		80-185	red sandstone
160	23-7283	0-6	red hardpan (Qr)
		6-50	sandstone
		50-205	red sandstone
161	23-5498	0-15	brown sandy hardpan (Qr)
		15-23	soft red sandstone
		23-75	hard red sandstone
162	23-3579	0-12	hardpan (Qr)
		12-400	red rock
163	23-5345	0-25	overburden (Qr)
		25-265	red sandstone
164	23-5804	0-24	dirt and sand (Qr)
		24-100	sandstone
165	23-3527	0-40	sand and gravel (Qsr)

		40-110	red rock
166	26-4143	0-13 13-500	heavy gravel and clay (Qst over Qsr) red and brown sandstone
167	23-1878	0-20 20-30 30-70 70-93	sand (Qst over Qsr) gravel (Qsr) hard sandstone red rock
168	23-500	0-45 45-111	sand and large gravel (Qst over Qsr) red rock
169	23-6272	0-30 30-41 41-113	sand, gravel (Qst over Qsr) hardpan (Qr) red rock
170	23-5933	0-40 40-150	sand (Qsr) red rock
171	23-208	0-70 70-82 82-84 84-86 86-201	hardpan with many boulders (Qn) hard sand (Qsp) gravel (Qsp) liver sand (Qsp) sandstone
172	23-876	0-65 65-145	hardpan with boulders (Qn) red sandstone
173	23-35	0-55 55-92 92-97 97-198	hardpan and large boulders (Qn) sand (Qsp) red hardpan (Qb) red rock
174	23-3651	0-19 19-29 29-45 45-55 55-68 69-74 74-156	brown hardpan with boulders (Qn) brown sand with boulders (Qn) light gray hardpan (Qn) dark gray hardpan (Qn) red hardpan (Qr) soft red sandstone hard red sandstone
175	23-2687	0-38 38-40 40-300	hardpan (Qn) gravel (Qn or Qsp) red rock
176	23-1536	0-25 25-42 42-140	boulders (Qho) sand and gravel (Qho) sandstone
177	23-7918	0-10 10-307	clay (Qn) red sandstone
178	23-7832	0-25 25-40 40-245	sand and gravel (Qn) hardpan and boulders (Qn) red sandstone
179	23-7627	0-18 18-30 30-51 51-400	boulders in hardpan (Qn) packed gravel in hardpan (Qn) red shale red sandstone
180	23-7191	0-12 12-20 20-225	hardpan and gravel (Qn) hardpan and boulders (Qn) red sandstone

181	23-7715	0-35 35-68 68-92 92-255	hardpan and boulders (Qn) various type gravels (Qsp) red rock, soft red sandstone
182	23-7682	0-30 30-65 65-80 80-102 102-500	brown hardpan with boulders (Qn) coarse sand and loose gray gravel (Qsp) fine sand with gravel (Qsp) red rock mixture red sandstone and red shale
183	23-7833	0-8 8-15 15-20 20-225	gray clay (Qn) loose boulders (Qn) gravel (Qn) red sandstone
184	23-7683	0-25 25-40 40-62 62-245	sand and gravel (Qn) gravel and hardpan (Qn) soft red rock red rock and sandstone
185	23-7632	0-15 15-20 20-205	boulders in hardpan (Qn) red hardpan (Qr) red sandstone
186	23-7631	0-20 20-35 35-45 45-65	hardpan and boulders (Qn) red hardpan and coarse sand (Qr) sand and gravel (Qsp) red shale
187	23-3853	0-15 15-23 23-42 42-52 52-180	brown hardpan (Qn) reddish-brown sandy hardpan (Qr) red hardpan (Qr) soft red sandstone hard red sandstone
188	23-7917	0-15 15-205	red hardpan (Qr) red sandstone
189	23-2312	0-18 18-101	coarse sand with large gravel (Qsr) red rock
190	23-725	0-18 18-19 19-100	gravel (Qsr) hardpan (Qr) red rock
191	23-4206	0-12 12-30 30-150	brown sandy hardpan (Qsr) soft red sandstone hard red sandstone
192	23-7939	0-22 22-38 38-205	compacted sand and large gravel (Qn) brown sand and coarse gravel (Qsp) red-brown sandstone
193	23-3021	0-70 70-76 76-78 78-203	sand and boulders (Qn) red rock fine sand (weathered rock) red rock
194	23-2602	0-62 62-143	sand and gravel (Qn) red sandstone
195	23-5110	0-30 30-42 42-46	sand (Qn) sandy clay (Qn) red clay (Qr)



		46-150	red sandstone
196	23-7264	0-10 10-18 18-30 30-40 40-205	gravel and sand (Qsr) medium sand (Qsr) coarse sand and gravel (Qsr) fine gravel and hardpan (Qn) brown sandstone
197	23-2840	0-20 20-41 41-63 63-79 79-145	reddish-brown sand (Qst over Qsr) brown sand and fine gravel (Qpr) gray sand (Qsr) soft red sandstone hard red sandstone
198	26-4491	0-15 15-45 40-59 59-125	gravel (Qst) large gravel (Qsr) boulders (Qr) red rock
199	23-7252	0-15 15-20 20-205	fine sand (Qsr) red hardpan (Qr) red sandstone
200	23-315	0-25 25-160	glacial fill (Qr) red rock
201	23-348	0-5 5-123	fill (Qaf) red rock
202	23-2360	0-18 18-33 33-140	sand with coarse gravel (Qr) brown hardpan (Qr) red rock
203	23-745	0-6 6-14 14-140	dirt (Qr) hardpan (Qr) red rock
204	23-154	0-12 12-182	dirt (Qr) red rock
205	23-1847	0-5 5-12 12-175	brown hardpan (Qr) gray hardpan (Qr) red sandstone
206	23-93	0-70 70-90 90-189	sand and gravel (Qr) large gravel (Qsp or Qr) NR (uncased, probably sandstone bedrock)
207	23-383	0-86 86-137	sandy clay (Qr) red sandstone
208	23-268	0-46 56-72 72-92 92-178	dirt and boulders (Qr) hardpan (Qr) sand and gravel (Qsp) red sandstone
209	23-102	0-28 28-143	glacial fill (Qr) red sandstone
210	23-46	0-6 6-175	dirt (Qr) red rock
211	23-483	0-25 25-193	dirt (Qr) red sandstone
212	23-626	0-12	dirt (Qr)

		12-43 43-208	soft hardpan (Qr) red rock
213	23-7913	0-10 10-185	red hardpan (Qr) red sandstone
214	23-7806	0-12 12-16 16-50 50-200	sandstone, stony soil (Qr) sandstone slab (boulder in Qr) stony soil (Qr) sandstone rock
215	23-6386	0-17 17-37 37-300	clay (Qsr) sand (Qsr) red rock
216	23-6643	0-30 30-40 40-50 50-95	medium sand (Qst over Qsr) coarse gravel (Qpr) fine gravel (Qpr) brown sandstone
217	23-2349	0-30 30-40 40-45 45-65 65-300	sand and clay, gravel (Qal over Qsr) sand and gravel (Qsr) sand and gravel with gray silt (Qsr) sand and gravel (Qpr) red sandstone
218	23-1592	0-39 39-301	sand and gravel (Qn) red sandstone
219	23-7358	0-6 6-14 14-20 20-300	sandy white and gray clay (fill or Qsr) sand (Qsr) sand and gravel, small cobbles throughout (Qsr) red sandstone
220	23-392	0-22 22-412	sand and gravel (Qst over Qpr) red shale and sandstone
221	23-4488	0-8 8-30 30-50 50-300	dumps (fill) gray clay (fill over Qal) red hardpan (Qr) red sandstone
222	23-4640	0-55 55-280	hardpan, boulders (fill over Qr) sandstone
223	23-5009	0-25 25-32 32-54 54-300	hardpan (Qn) clay (Qn) clay, gravel (Qn) red rock
224	23-7770	0-2 2-15 15-25 25-35	fill brown fine-to-coarse sand, little clay (Qn) brown fine-to-coarse sand, some clay, trace gravel (Qn) bedrock
225	23-4940	0-31 31-400	sand with coarse gravel (Qn) red rock
226	23-1178	0-32 32-204	boulders and sandy clay (Qn) red sandstone rock
227	23-969	0-11 11-109	sand and gravel (Qr) red rock
228	23-7141	0-8 8-510	hardpan (Qr) red sandstone

229	23-7276	0-45 45-84 84-325	brown hardpan (Qr) soft red sandstone hard red sandstone
230	23-4271	0-15 15-197	fine sand, gravel, boulders (Qr) red sandstone
231	23-7193	0-12 12-205	red hardpan (Qr) red sandstone
232	23-5764	0-4 4-175	overburden (Qr) red rock
233	23-5544	0-20 20-180	gravel and sand overburden (Qr) red sandstone
234	23-1513	0-30 30-156	red hardpan (Qr) hard sandstone
235	23-3071	0-34 34-165	red hardpan with gravel (Qr) red rock
236	23-3791	0-8 8-21 21-135	brown sandy hardpan (Qr) soft red sandstone hard red sandstone
237	23-3481	0-12 12-40 40-55 55-67 67-105	brown sandy hardpan (Qr) red sand (Qsp or Qr) red sandy hardpan (Qr) soft red sandstone hard red sandstone
238	23-1888	0-60 60-201	red hardpan (Qr) red sandstone
239	23-7198	0-40 40-165	overburden (Qr) red rock
240	23-5316	0-8 8-230	clay overburden (Qr) red sandstone
241	23-6855	0-25 25-42 42-50 50-51 51-135	glacial till (Qr) silty sand, some cobbles (Qsp or Qr) sand, some boulders (Qsp or Qr) red hardpan (Qr) sandstone
242	23-7830	0-8 8-205	red hardpan (Qr) red sandstone
243	23-3697	0-10 10-20 20-33 33-100	brown sandy hardpan (Qr) red sandy hardpan (Qr) soft red sandstone hard red sandstone
244	23-4039	0-9 9-15 15-25 25-30 30-38 38-108	brown sandy hardpan (Qr) reddish-brown hardpan (Qr) gray hardpan (Qr) red hardpan (Qr) soft red sandstone hard red sandstone
245	23-7973	0-180 180-305	clay, boulders, red clay (Qr) red rock

246	23-3150	0-70 70-165	hardpan with boulders (Qr) red rock
247	23-6685	0-73 73-94 94-198	overburden (Qr) sand, gravel (Qsp) red sandstone
248	23-6695	0-20 20-650	red hardpan (Qr) red sandstone with some streaks of shale
249	23-6729	0-12 12-500	red hardpan (Qr) red sandstone
250	23-7386	0-14 14-300	clay, sand (Qn) red shale, red rock
251	23-7638	0-30 30-40 40-258	sandy dirt with boulders (Qr) gravel and sand (Qsp) red sandstone
252	23-3748	0-18 18-303	glacial fill, sand and boulders (Qr) red sandstone
253	23-5672	0-22 22-305	hardpan (Qr) red rock
254	23-135	0-15 15-21 21-100	boulders (Qr) gravel (Qsp) red rock
255	23-657	0-24 24-110	red hardpan (Qr) red sandstone
256	23-7327	0-6 6-300	overburden (Qr) sandstone
257	23-3322	0-18 18-105	red hardpan (Qr) red rock
258	23-3321	0-23 23-105	brown hardpan (Qr) red sandstone
259	23-2332	0-34 34-51 51-166	hardpan (Qr) sand and gravel (Qsp) red rock
260	23-3006	0-25 25-136	brown hardpan (Qr) red rock
261	23-3027	0-43 43-245	hardpan (Qr) red rock
262	23-624	0-15 15-28 28-150	hardpan (Qr) boulders and sand (Qr) red rock
263	23-1448	0-3 3-15 15-85 85-105 105-145 145-165 165-185	yellow sandy clay (Qr) red hardpan (Qr) red sandstone grayish sandstone grayish sandstone mixed with red sandstone red sandstone red sandstone mixed with some shale streaks
264	26-2392	0-24 24-145	red hardpan (Qr) red rock

265	23-6648	0-18 18-22 22-163	stony red soil (Qr) soft red sandstone red sandstone
266	23-6494	0-22 22-200	hardpan (Qr) red rock
267	23-7472	0-12 12-137	red hardpan (Qr) red sandstone
268	23-629	0-48 48-250	hardpan and boulders (Qr) soft red rock
269	23-6994	0-12 12-170	red hardpan (Qr) red sandstone
270	23-4629	0-20 20-31 31-175	sand (Qpr) hardpan (Qr) red rock
271	23-5959	0-35 35-348	overburden (Qpr) red rock
272	23-7293	0-15 15-165	red hardpan (Qpc1) red sandstone
273	23-7305	0-7 7-41 41-190	hardpan (Qr) soft to medium red rock red rock
274	23-4083	abbreviated log 0-24 24-29 29-440	sand, gravel, yellow clay (Qpc1) sand, clay, hardpan (Qr) red shale and sandstone
275	23-7194	0-10 10-20 20-205	sand and gravel with boulders (Qmq) hardpan (Qr) red rock
276	23-432	0-20 20-40 40-125	gravel (Qr) hardpan (Qr) red rock
277	23-7608	0-9 9-307	red hardpan (Qr) red sandstone
278	23-8149	abbreviated log 0-30 30-35	tan-to-brown, silty, coarse-to-fine sand and gravel (Qn) rock
279	23-5902	0-50 50-69 69-400	hardpan (Qn) sand (Qsp) red rock
280	23-2183	0-35 35-65 65-85 85-150	hardpan (Qn) hardpan with boulders (Qn) sand and gravel (Qsp) red rock
281	23-6560	0-11 11-150	clay and boulders (Qn) red rock
282	23-1816	0-35 35-110	hardpan (Qn) red sandstone

283	23-3323	0-21 21-125	brown hardpan (Qn) red rock
284	23-7629	0-15 15-30 30-185	hardpan with gravel (Qn) red hardpan (Qr) red sandstone
285	23-3147	0-12 12-23 23-29 29-39 39-166	sandy brown hardpan (Qn) sand and gravel (Qsp) red hardpan (Qr) soft red sandstone hard red sandstone
286	23-2601	0-13 13-195	fill (Qn) red rock
287	23-2984	0-24 24-285	stony hardpan (Qn) sandstone, quite abrasive
288	23-583	0-14 14-65 65-74 74-118	dirt (Qn) hardpan with boulders (Qn) red hardpan (Qr) red rock
289	23-7383	0-28 28-76 76-305	soil with stones and boulders (Qn) red hardpan (Qr) red shale
290	23-4628	0-30 30-45 45-300	hardpan (Qn) boulders (Qn) sandstone
291	23-4371	0-42 42-450	glacial fill with boulders (Qn) red sandstone
292	23-5406	0-20 20-33 33-300	glacial fill (Qn) hardpan (Qn) red sandstone
293	23-4806	0-11 11-305	black muck, sand just before rock (fill over Qn) sandstone
294	23-5487	0-30 30-360	hardpan (Qn) red shale and sandstone
295	23-7256	0-6 6-205	red hardpan (Qr) red sandstone
296	23-5891	0-40 40-63 63-165	hardpan (Qn) gray hardpan (Qn) red rock
297	23-2413	0-4 4-8 8-12 12-16 16-23 23-27 at 27	loam and sand (Qal) sand, gravel with stones, silty, brown (Qal) sand with some gravel, very silty, gray-brown (Qpc) sand, gravel, silty (Qpc) sandy clay, red (Qr?) sand with some gravel, red (Qr?) bedrock
298	23-2181	abbreviated log 0-43 43-45 45-665	abbreviated log sand and gravel (Qpc2) red clay (Qr) rock
299	23-1013	0-4	loam, sand, clay (Qal)

		4-25	silty sand, gravel, gray (Qpc1)
		25-36	silty sand and gravel, red-brown, considerably larger percentage of silt (Qr)
		at 36	bedrock
		screened 20-26, yield 80 gpm	
300	23-1057	0-4	sand, loam, silt (Qal)
		4-11	silty sand, gravel, boulders, light brown (Qpc1)
		11-18	silty sand, gravel, light brown (Qpc1)
		18-20	sand, gravel, light brown, relatively clean (Qpc1)
		20-32	very silty sand, gravel, light brown (Qr)
		at 32	bedrock
		screened 10-20, yield 30 gpm	
301	23-1058	0-6	sand, loam, silt, gray (Qal)
		6-17	silty sand, gravel, and boulders, light brown (Qpc1)
		17-31	silty sand, gravel, light brown (Qpc1)
		31-33	clayey gravel, reddish brown (Qr)
		at 33	bedrock
		screened 21-31, yield 84 gpm	
302	23-1280	0-5	topsoil (Qal)
		5-10	coarse sand and boulders (Qpc1)
		10-15	sand and gravel with a lot of clay (Qpc1)
		15-20	sand, gravel, clay (Qpc1)
		20-25	coarse sand, large gravel with clay (Qpc1)
		25-27	red clay mixed with sand and gravel (Qr)
		27-40	red sandy clay (Qr)
		at 41	red shale
		10 foot screen, interval not reported, yield 207 gpm	
303	23-7780	abbreviated log	
		0-36	reddish-brown to gray medium-to-coarse sand and gravel (Qpc1)
		36-38	till (Qr)
304	23-1012	0-14	silty sand, gravel, gray (Qpc1)
		14-17	very silty sand, gravel, gray (Qpc1)
		17-22	silty sand, gravel, gray (Qpc1)
		22-28	clean sand, gravel, red (Qpc1)
		at 28	bedrock
		screened 18-28, yield 100 gpm	
305	23-5288	0-30	sand (Qpc1)
		30-50	coarse sand and gravel (Qpc1)
		50-60	red clay (Qr)
		60-110	red sandstone
306	23-7907	0-18	light sand and gravel (Qpc1)
		18-35	boulders and gravel (Qpc1)
		35-40	red sand, fine gravel (Qr)
		40-105	red sandstone
307	23-5646	0-20	fill (Qpc2?)
		20-40	sand (Qpc2)
		40-65	gravel (Qpc1)
		65-170	red rock
308	23-7316	abbreviated log	
		0-30	brown coarse-to-fine sand, little gravel and silt, occasional cobbles and boulders (Qn)
309	23-6036	0-3	fill
		3-15	boulders (Qpc1)
		15-47	sand, boulders (Qpc1)
		47-395	red rock

310	23-6734	0-20 20-50 50-65 65-175	hardpan and boulders (Qn) gravel and fine sand (Qsp) red hardpan (Qb or Qr) red sandstone
311	23-4972	0-48 48-350	hardpan, large boulders (Qn) red rock
312	23-6819	0-18 18-40 40-120 120-210	brown dirt with boulders (Qn) sandy soil (Qsp) red hardpan (Qr or Qb) red sandstone
313	23-7054	0-25 25-100 100-108 108-171	sandy soil with boulders (Qn) sandy hardpan (Qn or Qsp) sand with some gravel (Qsp) red sandstone
314	23-211	0-20 20-80 80-87 87-170	gravel (Qpc1) sand (Qhk) gravel (Qhkf or Qr) red rock
315	23-4102	0-3 3-32  32-40 40-42 42-44 44-456	fill cemented sand and gravel, coarse and medium (Qal over Qhk) clean coarse sand and gravel (Qhk) blue-gray silty clay (Qhkl) brown hardpan (Qr) red sandstone
316	23-5932	0-40 40-70 70-85 85-100 100-170	sand (Qhk) sand, gravel (Qhkf) gravel (Qhkf or Qr) clay (Qr) rock
317	23-7357	0-8 8-75 75-80 80-116	stony soil (Qst) sand (Qhk) sand with coarse cobble stones (Qr) red sandstone
318	23-7265	0-30 30-45 45-85	sand and gravel (Qst over Qhk) red hardpan (Qr) red sandstone
319	23-8220	0-2 2-32 32-46 46-76 76-100	topsoil sand with some water (Qal over Qhk) packed sand (Qhk) red coarse sand with gravel and some water (Qhkf) red sandstone
320	23-6224	0-38 38-42	fine sand (Qal over Qhk) coarse sand with some gravel (Qhkf) cased to 42, yield 15 gpm
321	BWA files	0-12 12-32 32-110	dirt (Qpr) coarse sand and gravel (Qpr) sandstone
322	23-6374	0-6 6-20 20-38 38-60 60-152	fill red hardpan with some sand (Qhk) water-bearing sand (Qhk) red hardpan (Qr) red sandstone



323	23-8047	abbreviated log	
		0-11	brown medium-fine sand, little silt, trace gravel, plastic, cinders (af)
		11-21	light-brown silty clay, trace fine sand (Qs over Qhkl)
		21-31	light-brown-to-gray coarse-to-fine gravel and fine sand, little silt (Qn)
324	Averill and others, 1980, core BP1	0-3	tan to brown coarse sand, some gravel (fill)
		3-5	gray and tan silt with two peat layers (Qs)
		5-8	gray clay (Qs)
		8-15	red varves (Qhkl)
		15-22	silty sand rhythmites (Qhkl)
		22-27	coarse sand and gravel (Qhkf)
		at 27	red shale
325	Averill and others, 1980, core BP2	0-5	black peat (Qs)
		5-14	brown silty clay (Qs over Qhkl)
326	BWA files 23-34-775	0-14	stony hardpan, some boulders (Qhk)
		14-72	gravel hardpan (Qhk)
		72-119	red sandstone
327	23-4387	0-72	brown sand to gravel and water (Qhk over Qhkf)
		72-97	red rock
328	23-3161	0-122	sand and gravel (Qhk over Qhkf)
		122-145	red rock
329	23-6212	0-58	sand (Qhk)
		58-92	stony red hardpan (Qr)
		92-120	red shale
		120-152	red sandstone
330	23-6845	0-72	sandy soil (Qhk)
		72-85	red stony hardpan (Qr)
		85-295	red shale with streaks of sandstone
331	23-127A	0-40	fine brown sand (Qst over Qhk)
		40-63	red hardpan (Qr)
		63-312	red shale
332	23-127B	0-54	fine brown sand (Qhk)
		54-60	red hardpan (Qr)
		60-300	red shale
333	23-1304	0-5	brown sandy clay (Qal)
		5-13	brown sand and small gravel, clay binder (Qal)
		13-33	reddish clay with gray clay streaks (Qhkl)
		33-40	clay with small and large gravel (Qhkl over Qhkf)
		40-42	large and small gravel (Qhkf)
		42-69	hardpan (Qr)
		69-75	red shale rock
334	23-1215	0-5	fill, wood, iron
		5-9	sandy gray clay (Qal)
		9-20	clay, brown sand (Qal over Qhkl)
		20-27	red sandy clay, streaks of gray clay (Qhkl)
		27-35	hardpan with large gravel (Qhkf)
		35-45	hardpan, small stones (Qhkf)
		45-47	sandy clay and stones (Qhkf)
		47-51	small gravel and clay, water bearing (Qhkf)
		51-64	sandy hardpan (Qr)
		64-451	red shale and sandstone
335	23-1303	0-13	sand and brown clay (Qhk)

		13-42	brown livery sandy clay (Qhk over Qhkl)
		42-61	brown clay (Qhkl)
		61-64	gray clay (Qhkl)
		64-70	clay, gravel, hardpan (Qr)
		70-75	sandstone
336	23-1332	log by Frank J. Markewicz, NJGS, abbreviated here	
		0-6	light brown earthy silt and pebbles (Qhk)
		6-4	yellowish-brown silt with coarse sand to pebbles (Qhk)
		4-24	very pale red, very fine sand (Qhk)
		24-56	pale red silt and very fine sand, small percent of clay (Qhkl)
		56-68	red micaceous sandstone
337	23-6746	0-2	fill
		2-35	sand with some water (Qhk)
		35-40	red hardpan (Qr)
		40-127	red rock, red sandstone
338	23-6326	0-60	sand, boulders (Qhk)
		60-70	sand (Qhk)
		70-166	red rock
339	23-6669	0-3	sandy rocky fill
		3-14	gray hardpan, some small boulders (Qn)
		14-20	brown hardpan with small cobbles (Qn)
		20-26	streaks of fine red sand, layers of hardpan, some small cobbles (Qr)
		26-160	red sandstone
		160-325	red shale
340	23-541	0-27	yellowish hardpan (Qn)
		27-50	gray hardpan (Qn)
		50-97	brown hardpan (Qb or Qr)
		97-150	red sandstone
341	23-6728	0-35	stony dirt with boulders (Qn)
		35-54	red hardpan (Qb or Qr)
		54-124	red shale with streaks of red sandstone
342	23-7458	0-35	red soil with boulders (Qr)
		35-55	red hardpan (Qr)
		55-306	red shale with streaks of sandstone
343	23-690	0-97	conglomerate of sand and gravel (Qn)
		97-181	red shale
344	23-5452	0-4	clay (Qn)
		4-28	sand (Qn or Qsp)
		28-35	red clay (Qr or Qb)
		35-135	sandstone
345	23-5453	0-50	sand (Qn)
		50-70	red clay (Qr or Qb)
		70-155	red sandstone
346	23-7588	0-3	black loam (soil)
		3-35	sandy soil with boulders (Qn)
		35-75	sand and gravel (Qsp)
		75-298	red sandstone, some very soft streaks
347	23-7385	0-50	boulders and sand (Qsr over Qn)
		50-150	red rock
348	23-7164	0-60	boulders in brown hardpan (Qn)
		60-80	fine gravel (Qsp)
		80-225	red sandstone

349	23-7131	0-30	sand and gravel (Qsr)
		30-60	hardpan and gravel (Qn)
		60-82	soft red rock
		82-260	red sandstone
350	23-573	0-24	yellowish-brown hardpan with some boulders (Qn)
		24-50	brown hardpan (Qn)
		50-76	gray hardpan (Qn)
		76-100	brown hardpan (Qn or Qb)
		100-112	gray hardpan (Qn or Qb)
		112-174	red sandstone

<sup>1</sup>Numbers of the form 23-xxxx are well permit numbers issued by the N.J. Department of Environmental Protection, Bureau of Water Allocation. The notation "BWA files" followed by a number of the form 23-xx-xxx indicates N. J. Atlas Sheet grid locations of logs in the Bureau of Water Allocation files that do not have permit numbers. Notations of the form "Averill and others, 1980" refer to logs provided in the cited publications.

<sup>2</sup>Depth in feet below land surface.

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326	BWA files 23-34-775	0-14 14-72 72-119	stony hardpan, some boulders (Qhk) gravel hardpan (Qhk) red sandstone
327	23-4387	0-72 72-97	brown sand to gravel and water (Qhk over Qhkf) red rock
328	23-3161	0-122 122-145	sand and gravel (Qhk over Qhkf) red rock
329	23-6212	0-58 58-92 92-120 120-152	sand (Qhk) stony red hardpan (Qr) red shale red sandstone
330	23-6845	0-72 72-85 85-295	sandy soil (Qhk) red stony hardpan (Qr) red shale with streaks of sandstone
331	23-127A	0-40 40-63 63-312	fine brown sand (Qst over Qhk) red hardpan (Qr) red shale
332	23-127B	0-54 54-60 60-300	fine brown sand (Qhk) red hardpan (Qr) red shale
333	23-1304	0-5 5-13 13-33 33-40 40-42 42-69 69-75	brown sandy clay (Qal) brown sand and small gravel, clay binder (Qal) reddish clay with gray clay streaks (Qhkl) clay with small and large gravel (Qhkl over Qhkf) large and small gravel (Qhkf) hardpan (Qr) red shale rock
334	23-1215	0-5 5-9 9-20 20-27 27-35 35-45 45-47 47-51 51-64 64-451	fill, wood, iron sandy gray clay (Qal) clay, brown sand (Qal over Qhkl) red sandy clay, streaks of gray clay (Qhkl) hardpan with large gravel (Qhkf) hardpan, small stones (Qhkf) sandy clay and stones (Qhkf) small gravel and clay, water bearing (Qhkf) sandy hardpan (Qr) red shale and sandstone
335	23-1303	0-13 13-42 42-61 61-64 64-70 70-75	sand and brown clay (Qhk) brown livery sandy clay (Qhk over Qhkl) brown clay (Qhkl) gray clay (Qhkl) clay, gravel, hardpan (Qr) sandstone
336	23-1332		log by Frank J. Markewicz, NJGS, abbreviated here 0-6 light brown earthy silt and pebbles (Qhk) 6-4 yellowish-brown silt with coarse sand to pebbles (Qhk) 4-24 very pale red, very fine sand (Qhk) 24-56 pale red silt and very fine sand, small percent of clay (Qhkl)

		56-68	red micaceous sandstone
337	23-6746	0-2 2-35 35-40 40-127	fill sand with some water (Qhk) red hardpan (Qr) red rock, red sandstone
338	23-6326	0-60 60-70 70-166	sand, boulders (Qhk) sand (Qhk) red rock
339	23-6669	0-3 3-14 14-20 20-26  26-160 160-325	sandy rocky fill gray hardpan, some small boulders (Qn) brown hardpan with small cobbles (Qn) streaks of fine red sand, layers of hardpan, some small cobbles (Qr) red sandstone red shale
340	23-541	0-27 27-50 50-97 97-150	yellowish hardpan (Qn) gray hardpan (Qn) brown hardpan (Qb or Qr) red sandstone
341	23-6728	0-35 35-54 54-124	stony dirt with boulders (Qn) red hardpan (Qb or Qr) red shale with streaks of red sandstone
342	23-7458	0-35 35-55 55-306	red soil with boulders (Qr) red hardpan (Qr) red shale with streaks of sandstone
343	23-690	0-97 97-181	conglomerate of sand and gravel (Qn) red shale
344	23-5452	0-4 4-28 28-35 35-135	clay (Qn) sand (Qn or Qsp) red clay (Qr or Qb) sandstone
345	23-5453	0-50 50-70 70-155	sand (Qn) red clay (Qr or Qb) red sandstone
346	23-7588	0-3 3-35 35-75 75-298	black loam (soil) sandy soil with boulders (Qn) sand and gravel (Qsp) red sandstone, some very soft streaks
347	23-7385	0-50 50-150	boulders and sand (Qsr over Qn) red rock
348	23-7164	0-60 60-80 80-225	boulders in brown hardpan (Qn) fine gravel (Qsp) red sandstone
349	23-7131	0-30 30-60 60-82	sand and gravel (Qsr) hardpan and gravel (Qn) soft red rock

		82-260	red sandstone
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350	23-573	0-24	yellowish-brown hardpan with some boulders (Qn)
		24-50	brown hardpan (Qn)
		50-76	gray hardpan (Qn)
		76-100	brown hardpan (Qn or Qb)
		100-112	gray hardpan (Qn or Qb)
		112-174	red sandstone
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