and are as much as 200 feet thick. Till is as much as 100 feet thick.

NEW JERSEY GEOLOGICAL SURVEY

Pamphlet containing tables 1 and 2 accompanies map

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-surface elevation contours and to infer the subsurface distribution of the deposits are provided in table 1 (in pamphlet). The composition of pebbles in the surficial deposits is shown in table 2 (in pamphlet). The age and chronologic 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 domestic and publicsupply wells in several areas and affect the movement of water and pollutants from the land surface into lakes, streams, and underlying bedrock and glacial aquifers. Yields and screened intervals for wells tapping glacial deposits are provided in table 1. The most-productive wells draw from lacustrine-fan gravel (unit Qrmf, sections AA', BB', CC') at the base of the valley-fill sediments in the Ramapo River valley. Here, several municipal wells screened in unit Qrmf (wells 415, 417, 418, 497, 498, 500, 507 in table 1) yield as much as 1200 gallons per minute (gpm). The lacustrine-fan deposits are overlain in much of the valley by less-permeable silt, fine sand, and clay lake-bottom sediments (unit Qrmlb, section AA') that may act as a semi-confining layer. In places along the valley walls (sections BB', CC') and in the reach of the valley for a mile north of Crystal Lake (section AA'), the lake-bottom sediments are absent and the fan deposits are in direct contact with overlying deltaic sand and gravel of units Qrm1 and Qrm2. These deltaic deposits may be recharge areas for the fan deposits, and streams flowing across or alongside the deltas may feed water to the aquifer. The floodplain (Qal) and meltwater-terrace (Qmt) deposits on the valley bottom north of the head of unit Qrm1 are thin and overlie lake-bottom sediment, and so are generally not in contact with the lacustrine-fan deposits (section AA'). Detailed studies of the ground-water resources of the Ramapo River valley are provided by Vecchioli and Miller (1973), Canace and Hutchinson (1988), and Hill and others (1992).

Elsewhere in the quadrangle, several wells in Franklin Lakes and Mahwah (wells 90-92, 95, 256, 288, 289, 446 in table 1) draw water from glaciolacustrine or ice-contact sand and gravel deposits (units Qic, Qfl2, Qfl3, Qho3, Qho4, and Qmh1). Over most of this area there are no continuous or thick fine-grained lake-bottom sediments and the sand and gravel deposits are unconfined. One exception to this rule is the thick valley fill extending from Upper Blauvelt Lake to Smith Pond in the southwest corner of the quadrangle. Records of wells here (wells 95-98 in table 1) and records in the valley fill just to the south in the Paterson quadrangle (Stanford, 2003) show that a discontinuous layer of silt and fine sand separates an upper deltaic sand and gravel (Qfl2) from a basal lacustrine-fan sand and gravel in places. The basal sand and gravel may be a productive semi-confined aquifer. Abundant seepage from the base of the scarp on the northwest edge of unit Qfl2 indicates significant ground-water storage in this deposit.

Elsewhere, sand and gravel deposits are generally too thin to be productive aquifers. Till is not sufficiently thick or permeable to be an aquifer, although several wells (wells 128, 159, 301, 304, 335, 379, 451) withdraw water from either sandy till or sand and gravel beds (unit Qsp) beneath till in the cores of

Hydraulic conductivities of the surficial deposits may be estimated from laboratory and aquifer-test data on the Ramapo valley-fill deposits (Vecchioli and Miller, 1973; Hill and others, 1992), 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 Oho1, Oho3-Oho6, Ofl2-Ofl4, Omh1, Omh2, Qfb, Qdb1, Qdb2, Qbs1, Qbs2, Qcs2, Qrm1, Qrm2, Qrmf, Qpp, Qcp, Qic, Qmt, and parts of Qal and Qsp) are highly permeable, having estimated hydraulic conductivities that range from 10^1 to 10^3 feet per day (ft/d). Sandy till and silty sand till (Qn, Qnu, parts of Qr and Qb) are also permeable, having estimated hydraulic conductivities from 10^{-1} to 10^2 ft/d. Silt and clay lake-bottom deposits (part of unit Qrmlb) are of low permeability, having estimated hydraulic conductivities of 10⁻⁵ to 10⁻³ ft/d. Fine sand and silt lake-bottom, alluvial, and wetland deposits (most of unit Qrmlb and parts of units Qfl2, Qal, Qsp, and Qs) and sandy silt till (parts of units Qr and Qb, small parts of Qn) are somewhat more permeable, having estimated hydraulic conductivities of 10⁻³ to 10⁻¹ 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, stream deposits in fans (Qaf), 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 emplaced sand, gravel, silt, clay, and rock fragments, and man-made materials including cinders, ash, brick, concrete, wood, slag, asphalt, metal, glass, and trash. Color variable but generally dark brown, gray, or black. As much as 40 feet thick but generally less than 20 feet thick. Many small areas of fill are not mapped. Some areas of fill are inferred from the extent of swamps and alluvial deposits shown on manuscript geologic and topographic maps on file at the N. J. Geological Survey (ca. 1900).
- Qal ALLUVIUM--Sand, silt, pebble-to-cobble gravel, minor clay, locally includes boulder gravel or boulder lag; dark brown, brown, yellowishbrown, gray; moderately to well sorted, stratified to massive. Contains variable amounts of organic matter, demolition debris, and trash. As much as 20 feet thick.
- Qaf ALLUVIAL FAN DEPOSITS--Pebble-to-cobble gravel, sand, minor silt; brown to yellowish-brown; moderately sorted, stratified. As much as 20 feet thick (estimated).
- SWAMP DEPOSITS--Peat and organic silt, clay, and fine sand; black, dark brown, and gray. As much as 20 feet thick (estimated). Some of the small swamps on Ramapo Mountain are only seasonally wet and have less than 1-2 feet of organic sediment overlying till.

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 Qn, Qnu, Qr, Qb). The stratified sediments are generally well sorted. They include sand and gravel laid down by glacial meltwater in river plains (Qmt, Qmf, Qcs2) and in glacial-lake deltas and fans (Qho1, Qho3-Qho6, Qmh1, Qmh2, Qf12-Qf14, Qfb, Qdb1, Qdb2, Qbs1, Qbs2, Qrm1, Qrm2, Qrmf, Qpp, Qcp, Qsp). The stratified sediments also include silt, clay, and fine sand deposited on the bottoms of glacial lakes (Qrmlb) and moderately to poorly sorted sand and gravel deposited in ice-walled basins and ponds (Qic). All of these deposits are of late Wisconsinan age except Qb and parts of Qsp, which may be of Illinoian age. The orientation of striations and distribution of till indicates that late

Wisconsinan ice advanced as two lobes across the Ramsey quadrangle. A southflowing lobe, moving across the Hudson Highlands from the Wallkill Valley in New York state, advanced across Ramapo Mountain. A southwest-flowing lobe centered in the Hudson and Hackensack valleys east of the quadrangle advanced simultaneously across the area east of Ramapo Mountain. During advance the land surface was shaped by glacial erosion. Throughout most of the quadrangle older glacial deposits and soils were stripped off and the underlying sandstone, basalt, and gneiss bedrock was eroded. In the northeastern part of the quadrangle the sandstone was eroded into streamlined forms. Elevation contours of the bedrock surface, plotted at 50-foot interval on the map, show this streamlined topography. Some of this erosion was accomplished during the Illinoian glaciation, because in places the rock surface lies beneath Illinoian till. Sandstone and shale were eroded into closed-basin troughs beneath the Ramapo River valley. Glacial scour was in excess of 130 feet here, because the lowest bedrock-surface elevation of 50 feet in Oakland is 130 feet below the bedrock surface at Little Falls (about 10 miles south of Oakland), which is the local baselevel for the Ramapo basin. Where the ice did not erode deeply, for example, beneath the east-draining preglacial valley in the southeastern corner of the quadrangle and beneath the drumlins in the northeastern quarter of the quadrangle, earlier glacial deposits (Qb, Qsp) are preserved beneath late Wisconsinan till.

Glacial scour has altered the bedrock surface in the Ramapo River and Masonicus Brook valleys such that details of the preglacial drainage cannot be reconstructed. However, the bedrock surface in the Hohokus and Pond Brook basins is much less altered, in part because these valleys were east-west trending and so were roughly perpendicular to ice flow. The bedrock-surface contours in this area indicate that Pond Brook formerly drained northwesterly to the Ramapo River valley in the valley north of Hoppers Lake that is now filled with the Qfl2 lacustrine deposits. Pond Brook today flows in a former gap through a basalt ridge a mile to the east. Similarly, Hohokus Brook in the Waldwick-Wyckoff area is shifted about a half-mile north of its preglacial valley, which is filled with till. Also, the Hohokus basin upstream of Kells Pond probably drained westward to the Ramapo River valley before deposition of till and lacustrine deposits in the Shadow Lake-Campgaw area blocked the preglacial

Till was deposited discontinuously on the bedrock surface. It is thickest on the east-facing slope of Campgaw Mountain and on north- and northwest-facing slopes on Ramapo Mountain, which faced the advancing ice, and on sandstone uplands east of Campgaw Mountain, where it forms drumlins or contributes to the streamlined shape of bedrock ridges. It is thin and patchy on the top and west slopes of Campgaw Mountain and over most of Ramapo Mountain, where bedrock outcrop is abundant. Till is also less than 20 feet thick on basalt uplands south of Campgaw Mountain in Oakland and Franklin Lakes, although outcrops are sparse. The late Wisconsinan till includes a yellowish-brown to gray silty sand till (Netcong till, Qn) derived mostly from the gneiss bedrock of Ramapo Mountain and the Hudson Highlands, just north of the quadrangle, and a reddish-brown silty sand to sandy silt till (Rahway till, Qr) derived from the local red sandstone bedrock. Over much of the southeastern half of the quadrangle, Netcong till overlies Rahway till and, in some places, is only 1-3 feet thick over Rahway till, or absent entirely. This pattern reflects erosion of the local red sandstone by the base of the glacier while material eroded from gneiss bedrock was transported higher in the glacier and later deposited atop the basal

Late Wisconsinan ice advanced to its southernmost position at Perth Amboy, about 55 miles south of Ramsey. The ice front began to retreat from this position before 20,000 yrs B. P., and had likely retreated north of the Ramsey quadrangle by 18,000 yrs B. P. (Stanford and Harper, 1991). The retreating ice margin maintained a lobate form with an apex centered in the broad lowland east of the quadrangle (fig. 1). Recessional ice margins, which are marked by ice-contact deposits, trend north-south or slightly northwest-southeast east of the Ramapo River valley, and traverse westward across the Ramapo River valley and Ramapo Mountain (fig. 1). The retreating ice margin dammed east- or northdraining valleys to form the glacial lakes in which most of the recessional deposits were laid down. Some lakes also formed in valleys dammed by earlier deposits. Glacial-stream deposits were laid down in two valleys after lakes drained. Details of the history of glacial lakes and glacial streams are provided in the following description of map units. Names of the major lakes follow those of Stone and others (2002).

Glacial-Lake Deposits--These are stratified and generally well-sorted. They include sand and gravel laid down in deltas and lacustrine fans; and fine sand, silt, and clay 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 consists chiefly of quartz, feldspar, mica, and fragments of gray mudstone and gneiss, and, east of Ramapo Mountain, red-brown sandstone and mudstone and minor basalt. Gravel is chiefly whiteto-gray gneiss and gray mudstone and sandstone, with some reddish-brown sandstone and conglomerate, white quartz, purple quartzite, and basalt east of

Qcp CRANBERRY POND DEPOSITS--Sand, pebble-to-cobble gravel, and cobble-to-boulder diamicton. As much as 30 feet thick (estimated). Includes lacustrine and ice-contact deposits in ponded north-draining valley north of Bear Swamp on Ramapo Mountain. Outlet to south into Bear Swamp Brook at an elevation of 835 feet.

Ramapo Mountain.

- POTAKE POND DEPOSITS--Sand, pebble-to-cobble gravel, cobble-to-boulder diamicton. As much as 20 feet thick (estimated). Chiefly ice-contact deposits in ponded north-draining valley north of Glasmere Ponds on Ramapo Mountain. Outlet to south at an elevation of 700-720 feet.
- MAHWAH DEPOSITS--Deltaic, ice-contact, and lake-bottom sediments laid down in two stages of a lake in the north-draining lower Masonicus Brook valley. Spillway for earliest, high stage (Qmh1) was southward into the Valentine Brookvalley at an elevation of 340-350 feet. This stage lowered to stage 2 when the north end of the ridge on the west side of the valley was deglaciated. Stage 2 (Qmh2) was controlled by a spillway at an elevation of 325 feet westward into the Ramapo River valley. Stage 2 drained when the north end of the ridge at West Mahwah was deglaciated.
- Fine-to-coarse sand, pebble-to-cobble gravel, some silt and very fine sand. As much as 100 feet thick.

Fine-to-coarse sand, pebbly sand, pebble-to-cobble gravel, minor silt

- and very fine sand. As much as 100 feet thick. BEAR SWAMP DEPOSITS--Deltaic and ice-contact deposits laid down in two lake stages in the Bear Swamp Brook valley. The earlier, lower stage (Qbs1)
- was controlled by a spillway at an elevation of about 785 feet over a till or ice dam (now eroded) at the south end of present Bear Swamp Lake. The later, higher stage (Qbs2) was controlled by a spillway at an elevation of about 820 feet over a till or ice dam (now eroded) at the south end of Bear Swamp. **Qbs2** Pebble-to-cobble gravel, pebbly sand. As much as 30 feet thick.

Qbs1 Pebble-to-cobble gravel, pebbly sand. As much as 20 feet thick.

- DARLINGTON BROOK DEPOSITS--Deltaic deposits laid down in two lakes in the north-draining Darlington Brook valley. Unit Qdb1 includes deposits in a small lake in the valley north of Van Gelders Pond that was dammed by earlier ice-contact deposits around Van Gelders Pond and on the west side of the valley along Shadyside Road. This lake was controlled by a spillway at an elevation of 375 feet draining southward into the Hohokus Brook valley. The lake drained weatward into the Darlington Brook valley when the esker ridge on its west side collapsed or was eroded. Unit Qdb2 includes deposits laid down in an ice-dammed lake in the main Darlington Brook valley, controlled by a spillway to the south into the Hohokus Brook valley at an elevation of about 355 feet. The lake drained when the ice front retreated from the north end of the ridge at Immaculate Conception Seminary.
- Fine-to-medium sand, pebbly sand, pebble-to-cobble gravel. As much as 30 feet thick.
- Fine-to-coarse sand, pebbly sand, pebble-to-cobble gravel. As much
- Qfb FYKE BROOK DEPOSIT--Medium-to-coarse sand, pebbly sand, pebble-to-cobble gravel. As much as 30 feet thick. A small deltaic deposit laid down in the ponded north-draining valley of Fyke Brook, controlled by a spillway to the south into the Hohokus Brook valley at an elevation of 425 feet. The lake drained when the north end of Campgaw Mountain was deglaciated.

HOHOKUS DEPOSITS--Deltaic and ice-contact sand and gravel and minor

silty fine sand lake-bottom deposits laid down in six lakes in the ice-dammed east-draining Hohokus Brook valley. Spillways for the earliest, highest stages are southward across a sandstone escarpment in the Paterson quadrangle, 2 miles south of Wyckoff, into the Goffle Brook valley, at elevations of about 420 feet (stage 1, unit Qho1), 355 feet (stage 2, unit Qho2), and 330 feet (stage 3, unit Qho3). Deposits of stage 2 occur only in the Paterson quadrangle. When the Goffle Brook valley on the Wyckoff-Midland Park border was deglaciated the stage 3 lakedrained. Aggraded Qho3 deposits near Spring Lake in Wyckoff formed a dam for the stage 4 lake (unit Qho4), which was controlled by a spillway at an elevation of 375 feet draining southward into the Goffle Brook valley. The stage 4 lake lowered to stage 5 (unit Qho5) when the east side of the till ridge between Wyckoff and Waldwick was deglaciated, opening a lower spillway at an elevation of 315 feet, soon succeeded by an even lower one at 305 feet, into the Goffle Brook valley. The northernmost part of the stage 4 lake may have been maintained for a time by a sediment dam in the narrow part of the Valentine Brook valley after the southern part of the lake lowered to stage 5. Stage 5 lowered to stage 6 (unit Qho6) when the east side of the till ridge along the Midland Park-Ridgewood border was deglaciated, opening a still lower spillway at an elevation of about 295 feet into the Diamond Brook valley. This spillway is just south of the quadrangle boundary along North Monroe Street. Stage 6 drained when the Hohokus Brook valley along the Ridgewood-Hohokus border, about one mile east of the southeast corner of the quadrangle, was deglaciated.

- **Qho6** Fine-to-coarse sand, pebble-to-cobble gravel, laminated silt and very fine sand in places. As much as 50 feet thick.
- Fine-to-coarse sand, pebbly sand, pebble-to-cobble gravel. As much Qho5 as 30 feet thick.
- Fine-to-coarse sand, pebbly sand, pebble-to-cobble gravel, minor silt and very fine sand. As much as 40 feet thick
- **Qho3** Fine-to-coarse sand, pebbly sand, pebble-to-cobble gravel, minor silt and very fine sand. As much as 80 feet thick.
- **Qho1** Fine-to-coarse sand, pebble-to-cobble gravel. As much as 25 feet thick.

RAMAPO VALLEY DEPOSITS--Deltaic and minor ice-contact sand and gravel (Qrm1, Qrm2), lacustrine-fan sand and gravel (Qrmf), and lake-bottom silt, fine sand, and clay (Qrmlb) laid down in two glacial lakes in the Ramapo River valley. Unit Qrm1 was deposited in the Totowa stage of Lake Passaic (Stanford, 2003) which was controlled by a spillway at an elevation of 190-200 feet over a sediment dam that blocked the Passaic River valley at Totowa, about 10 miles south of Oakland. The level of this lake in the Oakland area, adjusted for postglacial rebound of 2 to 3 feet/mile to the north, was at an elevation of 220-230 feet, which agrees with the topset-foreset contact inferred from boring logs (borings 514 and 515 in table 1) that marks the lake level in unit Qrm1. Unit Qrm2 includes sediment deposited in a lake that was dammed by the head of unit Qrm1, which formerly filled the valley to an elevation of 290-300 feet. The spillway for this lake (now eroded by the Ramapo River)

Fine-to-coarse sand, pebbly sand, pebble-to-cobble gravel, minor cobble-to-boulder gravel in deposits along the west side of the valley. As much as 80 feet thick.

was across the Qrm1 deposit about a mile north of Crystal Lake.

- Pebble-to-cobble gravel, fine-to-coarse sand, pebbly sand. As much as 80 feet thick.
- Silt, very fine-to-fine sand, clay; thinly bedded to laminated. As Qrmlb much as 140 feet thick.
- Fine-to-coarse sand, pebble-to-cobble gravel. As much as 100 feet

FRANKLIN LAKES DEPOSITS--Deltaic and ice-contact sand and gravel (Qfl2, Qfl3, Qfl3a, Qfl4) laid down in four stages of a glacial lake occupying the Pond Brook valley. Lake-bottom silt and lacustrine-fan sand and gravel occur in subsurface parts of unit Qfl2. Deposits of stage 1 occur only in the Paterson quadrangle. The spillway for stage 2 (unit Qfl2) is at an elevation of 435 feet, across Preakness Mountain in Franklin Clove, about 2 miles south of Upper Blauvelt Lake, into the Preakness Valley. Stage 2 drained when the north end of Preakness Mountain, about a half mile west of Smith Pond, was deglaciated. The spillway for stage 3 (unit Qfl3) is at an elevation of 420 feet, across Qfl2 deposits about one mile southeast of Baker Pond, into the Molly Ann Brook valley. Stage 3 drained when the Pond Brook valley just east of

Oakland was deglaciated. Stage 3a (unit Qfl3a) is a small lake dammed by the ice front in a north-draining valley south of Campgaw. The spillway for this pond was to the west into the Pond Brook valley at an elevation of 450 feet. This lake lowered to the stage 3 level when the north slope of the hill northwest of the deposit was deglaciated. Stage 4 (unit Qfl4) occupied the headwaters of the Hohokus Brook valley and was controlled by a spillway at an elevation of 370 feet across Qfl3 deposits at Campgaw. Stage 4 drained into Lake Hohokus, stage 3, when the ice margin retreated east of the Hohokus Brook valley in the Cooks Pond area.

Fine-to-coarse sand, pebbly sand, pebble-to-cobble gravel. As much as 100 feet thick.

VERTICAL EXAGGERATION 20X

Qfl3a Fine-to-coarse sand, pebble-to-cobble gravel. As much as 60 feet thick.

Fine-to-coarse sand, pebble-to-cobble gravel, silt and very fine-to-

fine sand locally in subsurface. As much as 200 feet thick.

Qfl3 Fine-to-coarse sand, pebbly sand, pebble-to-cobble gravel. As much as 100 feet thick.

PRE-ADVANCE STRATIFIED DEPOSITS--Deltaic, lake-bottom, and possible fluvial deposits, undifferentiated. In subsurface only, beneath late Wisconsinan till. Deposits in the Hohokus and Pond Brook valleys (section CC') may be lacustrine sediments laid down in lakes in ice-dammed east- and north-draining preglacial valleys during the Illinoian deglaciation or late Wisconsinan advance, and then overrun by advancing late Wisconsinan ice. Deposits in the cores of drumlins in Ramsey and Mahwah are too high in elevation to have been laid down in a proglacial lake basin or fluvial plain and instead may be subglacial fluvial or lacustrine sediments, or overrun icecontact deposits.

Fine-to-coarse sand, pebble-to-cobble gravel, some silt and clay. As much as 50 feet thick.

ICE-CONTACT DEPOSITS-- These deposits form eskers and hummocky ridges and knolls above the level of adjacent lakes or fluvial plains. They were deposited in subglacial tunnels and ice-walled basins and ponds or by glacial pushing and deformation of previously deposited sediment.

Pebble-to-cobble gravel and sand, locally cobble-to-boulder gravel and sandy, cobbly diamicton; moderately sorted; variably stratified. As much as 100 feet thick.

Glacial Stream Deposits--These are stratified and generally well-sorted. They include sand and gravel forming terraces (unit Qmt) in the Ramapo River and Hohokus Brook valleys which were deposited after glacial lakes drained, andgravel in fans (unit Qmf) and an ice-contact head of outwash (unit Qcs2) on Ramapo Mountain. Color and sand and gravel composition similar to that of glacial-lake deposits. The terrace in the Ramapo River valley was deposited by meltwater from ice margins north of the quadrangle in the Ramapo and Mahwah River valleys. The terrace along Hohokus Brook was deposited in part from reworking of sediment in units Qho4, Qho5, and Qho6 by meltwater

draining from the spillways for Lake Mahwah and Lake Darlington. Qmt MELTWATER TERRACE DEPOSITS--Fine-to-coarse sand, pebbly sand, pebble-to-cobble gravel. As much as 40 feet thick in the Ramapo valley, less than 15 feet thick in the Hohokus Brook valley.

CUPSAW BROOK OUTWASH--Cobble-to-boulder gravel and sand.

As much as 30 feet thick. Qcs1 is an earlier deposit in the Wanaque

MELTWATER FAN DEPOSITS--Cobble-to-boulder gravel. As much as 20 feet thick.

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. Four tills are distinguished on the basis of color, grain-size, and age. The late Wisconsinan tills are in gradational contact with each other. Netcong till in

places grades downward into Rahway till.

On 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, nonplastic, nonsticky, 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 conglomerate, basalt, and purple-to-gray quartzite. Boulders are chiefly gneiss; very few are quartzite, and gray mudstone and sandstone and, southeast of the Ramapo River valley, a very few basalt and red sandstone. Clast composition reflects southerly glacial transport from the Wallkill and Hudson Valleys underlain by Paleozoic sedimentary rock, and from the Hudson Highlands and

Ramapo Mountain, underlain by Proterozoic gneiss. Ont delineates

areas where Qn is discontinuous and generally less than 20 feet thick.

Ont includes scattered bedrock outcrops and a few small deposits of

NETCONG TILL, UPLAND BASIN PHASE--Netcong till as above, but matrix is sandier and noncompact. As much as 50 feet thick. Forms low ridge, knoll, and basin topography in valley bottoms and on valley sides in upland areas. The topographic form, loose matrix, and, in places, increased content of far-travelled lithologies in the pebble fraction (for example, site 54, table 2), indicate that these deposits are superglacial till. They may have been laid down from masses of stagnant ice that became separated from the main glacier by bedrock ridges as the glacier surface melted down. Some of the deposits may have been laid down along active recessional margins of the main glacier.

talus at the base of steep slopes and cliffs.

- RAHWAY TILL--Reddish-brown, light reddish-brown, reddishyellow silty sand to sandy silt containing some to many subrounded and subangular pebbles and cobbles and few subrounded boulders. Matrix is compact, nonsticky, nonplastic to slightly plastic, nonjointed, and may have subhorizontal fissility. Gravel clasts include chiefly red and gray sandstone and siltstone, red-purple conglomerate, gray gneiss, white quartz, and a little purple quartzite and basalt. Boulders are chiefly gneiss; a very few are quartzite, gray and red sandstone, and basalt. As much as 50 feet thick.
- BERGEN TILL--Reddish-brown to reddish-yellow sandy clayey silt to sandy clay. Gravel content and composition similar to Rahway till. Matrix is compact, moderately sticky and plastic, and weakly jointed. Gneiss, sandstone, and mudstone clasts have weathering rinds or are fully decomposed. As much as 70 feet thick. In subsurface only. Observed in several cuts and streambanks beneath late Wisconsinan till, inferred elsewhere from well records (sections BB', CC').

MAP SYMBOLS

Contact--Long-dashed where approximately located, short-dashed

- where gradational or feather-edged, dotted where concealed by water. **Drumlin-**-Line along crest, symbol on summit.
- **Esker**-Line on crest. Dotted where destroyed by excavation or
- **Striation-**-Observation at dot. Arrow shows ice-flow direction.

Crescentic mark--Observation at intersection of symbols. Arrow

- shows approximate ice-flow direction. Meltwater channel--Line in base of channel, arrow indicates flow
- **Boulder field--**Concentration of boulders on surfaces eroded in till by meltwater. Alluvium (unit Qal), if mapped, is generally less than 3
- Scarp cut by glacial meltwater--Line at top, ticks on slope.
- **Excavation perimeter**--Line encloses excavated area. Outlines former sand and gravel pits. Topography within these areas may differ from that on the base map. Contacts within these areas are drawn to the base map topography and so show the original rather than the current distribution of materials.
- Spillway for glacial lake--Symbol in spillway area, arrow indicates direction of drainage. Label indicates associated deposit.
- 47 Well with log in table 1--Location accurate within 100 feet. **⊙74 Well with log in table 1-**Location accurate within 500 feet.
- Thickness of glacial sediment from seismic survey--In feet, from Canace and Hutchinson (1988).
- **▼**—Qrmlb **Subsurface unit exposed**—In streambanks or cuts, observed in 1990 •47 Site of pebble lithology count--Data in table 2.

Elevation of bedrock surface--Contour interval 50 feet. Shown only

where deposits are generally greater than 20 feet thick in and southeast of the Ramapo River valley. Bedrock outcrop--Many small outcrops on Ramapo and Campgaw Mountains, within unit Qnt, are not shown. Notation "r" indicates unweathered bedrock, "wr" indicates weathered bedrock.

Well on sections--Projected to line of section.

Unit to left of slash overlies unit to right--Shows extent of Netcong till less than 5 feet thick over Rahway till.

REFERENCES Canace, Robert, and Hutchinson, W. R., 1988, Bedrock topography and Scott D. Stanford

Prepared in cooperation with the

U. S. GEOLOGICAL SURVEY

NATIONAL GEOLOGIC MAPPING PROGRAM

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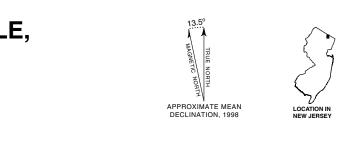
Base map from U. S. Geological Survey, 1955

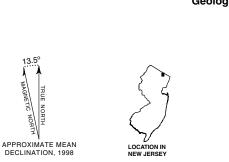
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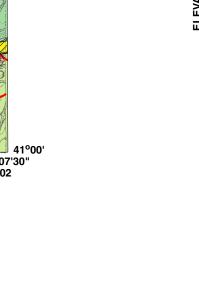
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SURFICIAL GEOLOGY OF THE RAMSEY QUADRANGLE. BERGEN AND PASSAIC COUNTIES, NEW JERSEY







CORRELATION OF MAP UNITS

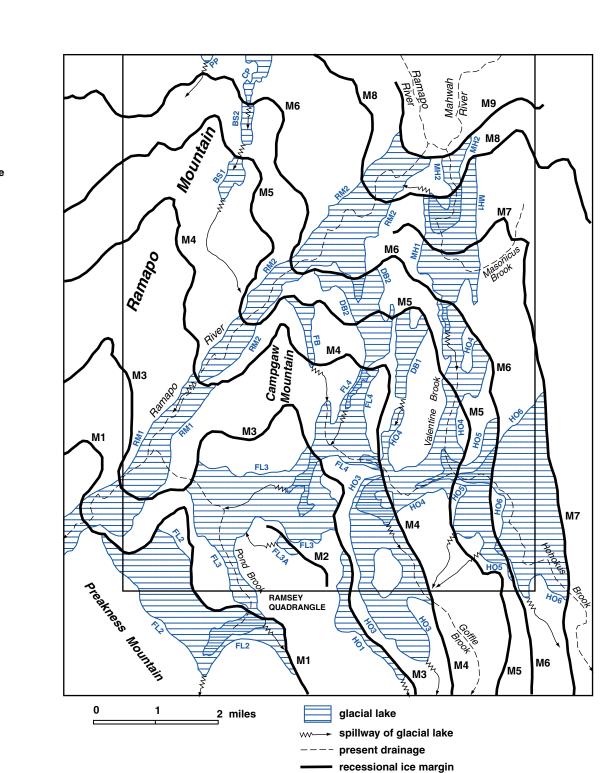
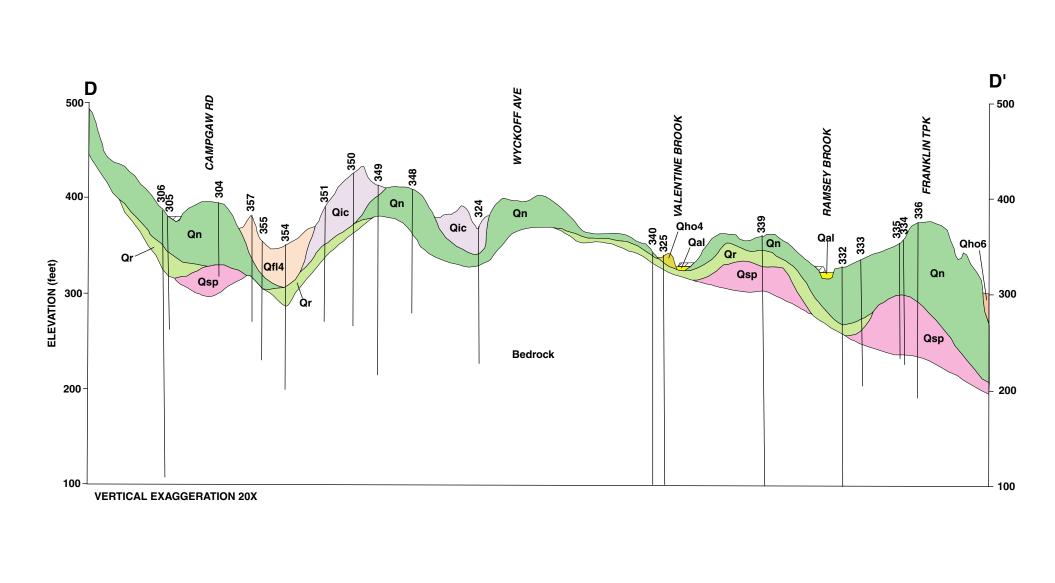
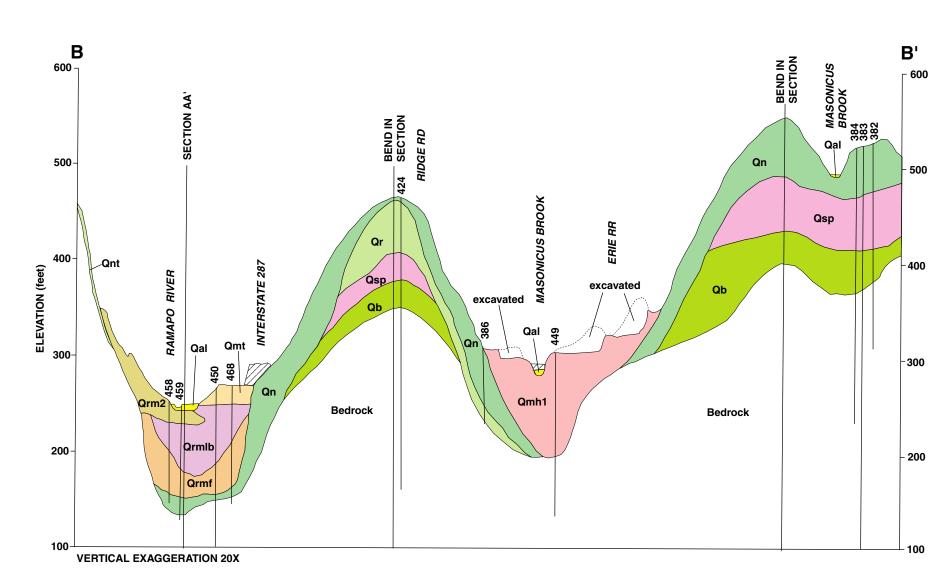
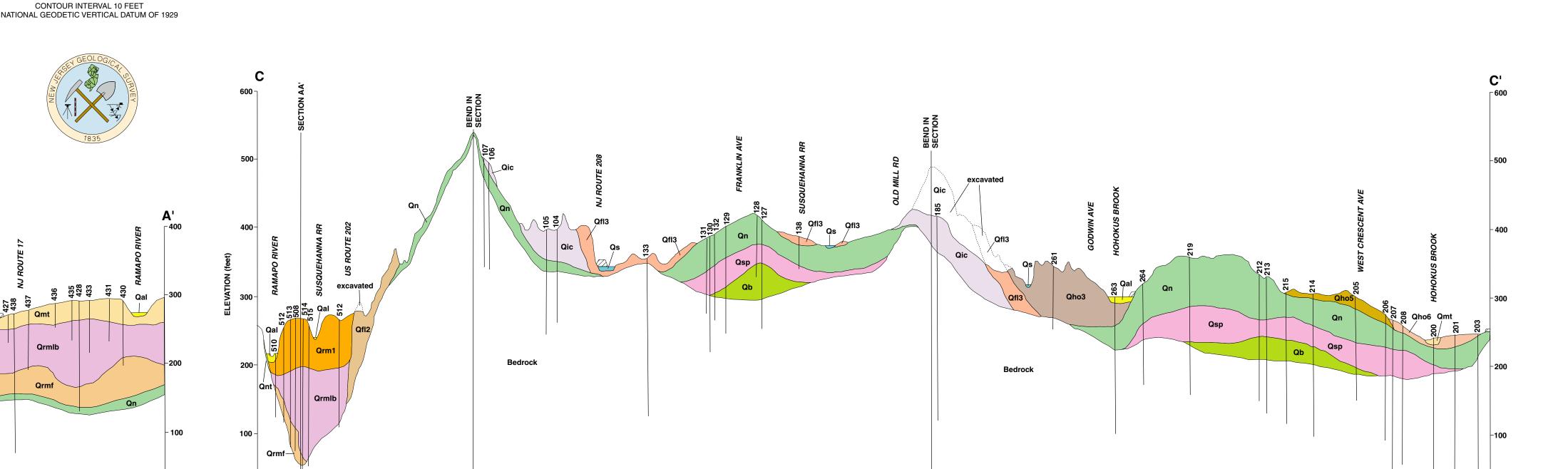
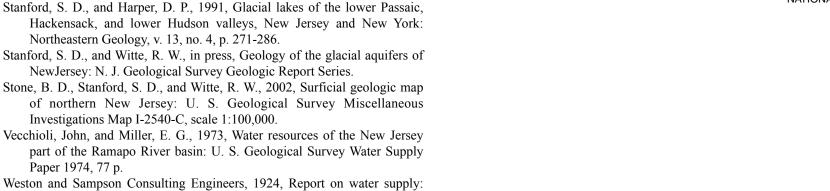


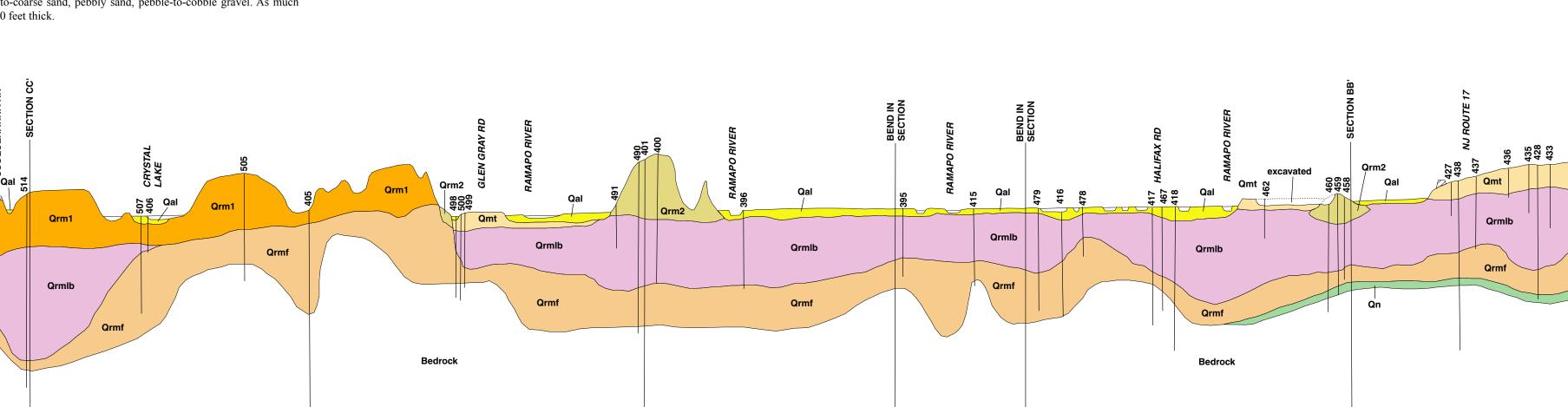
Figure 1.--Recessional ice margins, glacial lakes, and meltwater drainage routes. Lakes are identified by the following abbreviations on their shorelines: FL 2, FL3, FL3a, FL4 = stages 2, 3, 3a, and 4, respectively, of Franklin Lake; HO1, HO3, HO4, HO5, HO 6 = stages 1, 3, 4, 5, and 6, respectively, of Lake Hohokus; DB1, DB2 = lakes 1 and 2, respectively, in the Darlington Brook valley; FB = lake in Fyke Brook valley; MH1, MH2 = stages 1 and 2 of Lake Mahwah; RM1 = Totowa stage of Lake Passaic; RM2 = lake 2 in Ramapo River valley; BS1, BS2 = stages 1 and 2 of Bear Swamp Lake; CP = lake in Cranberry Pond valley; PP = lake in Potake Pond valley. Ice margins are: M1=last margin before draining of Franklin Lake, stage 2. M2=margin before draining of Franklin Lake, stage 3a. M3=last margin before draining of Franklin Lake, stage 3. M4=last margin before draining of Franklin Lake, stage 4, and before lowering of stage 3 of Lake Hohokus to stage 4. Large delta (Qrm1) deposited in Totowa stage of Lake Passaic in Ramapo River valley. M5=last margin before Lake Hohokus, stage 4, lowers to stage 5, and before drainage of lake in Fyke Brook valley. M6=last margin before lowering of Lake Hohokus, stage 5, to stage 6 and before drainage of lake 2 in Darlington Brook valley. M7=last margin before drainage of Lake Hohokus stage 6. M8=last margin before Lake Mahwah, stage 1, lowers to stage 2. M9=last margin before draining of Lake Mahwah, stage 2, and lowering of lake 2 in Ramapo River valley.











Paper 1974, 77 p.

Surficial Geology of the Ramsey Quadrangle Bergen and Passaic Counties, New Jersey

New Jersey Geological Survey Open-File Map 62 2004

pamphlet to accompany map

Table 1.--Selected well and boring records.

Well No.	Identifier ¹	Depth to be	edrock or driller's log with depth and description ²
1	23-6929	10	
2	23-6750	8	
3	23-3806	35	
4	23-3682	0-34 34-130	hardpan and boulders (Qn) red sandstone
5	23-4179	0-26 26-115	hardpan overburden (Qn) red rock
6	23-3377	0-44 44-115	hardpan and boulders (Qn) red sandstone
7	23-3724	35	
8	23-3923	0-39 39-90	hardpan overburden (Qn) red sandstone
9	23-4943	36	
10	23-4286	0-36 36-125	hardpan with layers of sand (Qn) red sandstone
11	23-4028	24	
12	23-5069	20	
13	23-5168	0-14 14-197	hardpan and boulders (Qn) trap rock
14	23-5171	19	
15	23-3953	0-10 10-75	dirt overburden (af over Qs) hardpan and layers of sand (Qfl3a over Qn)
16	23-3879	39	
17	23-3654	0-36 36-120	hardpan and boulders (Qn) red sandstone
18	23-3674	0-27 27-105	red hardpan (Qn over Qr?) red sandstone
19	23-3944	22	
20	23-3880	39	
21	23-3986	27	

22	23-3583	29	
23	23-3582	0-52 52-105	hardpan (Qn) red rock
24	23-3226	0-37 37-130	red hardpan (Qn over Qr?) red sandstone
25	23-3126	0-37 37-105	red hardpan (Qn over Qr?) red sandstone
26	23-3317	27	
27	23-3291	0-44 44-108	sand and boulder overburden (Qn) red sandstone
28	23-3288	0-37 37-105	overburden: hardpan with boulders (Qn) red sandstone
29	23-4077	53	
30	23-3447	0-45 45-126	red hardpan with boulders (Qn over Qr) red sandstone
31	23-3544	0-47 47-105	hardpan and boulders (Qn) red sandstone
32	23-6279	0-5 5-10 10-25 25-100	brown hardpan with boulders (Qn) red sandy hardpan (Qr) soft red sandstone hard red sandstone
33	23-5145	10	
34	23-8134	3	
35	23-5229	14	
36	23-7340	0-5 5-160 160-600	red hardpan (Qn over Qr) trap rock red sandstone
37	23-131	30	
38	23-3655	0-19 19-105	red hardpan (Qn over Qr) red sandstone
39	23-3035	0-29 29-106	overburden of hardpan and boulders (Qn) red sandstone
40	23-1920	20	
41	23-2873	0-75 75-130	overburden of sand, gravel, and hardpan with boulders (Qfl3a over Qn) red sandstone
42	23-328	0-20 20-78 78-NR	coarse gravel (Qfl3a) sandy hardpan and boulders (Qn) red sandstone
43	23-340	0-78 78-133	dead sand (Qn) red rock
44	23-772	0-62 62-125	sandy hardpan (Qn) red rock
45	23-350	10	

46	23-4945	10	
47	23-5289	38	
48	23-1076	0-67 67-130	sandy hardpan (Qn) red sandstone
49	23-4772	10	
50	23-4770	7	
51	23-4475	14	
52	23-3392	0-17 17-107	hardpan and boulders (Qfl3 over Qn) trap rock
53	23-3154	0-18 18-105	hardpan with boulders (Qfl3 over Qn) trap rock
54	23-3529	0-29 29-103	bouldery hardpan (Qfl3 over Qn) trap rock
55	23-3490	0-28 28-150	hardpan, boulders, broken trap rock (Qfl3 over Qn) trap rock
56	23-5367	14	
57	23-1634	0-28 28-51 51-67 67-127	hardpan (Qn) broken trap rock trap red sandstone
58	23-161	7	
59	23-7931	0-8 8-24 24-44 44-155	hardpan (Qn) clay (Qn or weathered basalt) trap red rock
60	23-5297	0-16 16-225	hardpan and boulders (Qn) trap rock
61	23-5360	16	
62	23-5481	14	
63	23-5562	5	
64	23-5317	12	
65	25-6633	0-30 30-115 115-161	clay and hardpan (Qfl2) trap rock red sandstone
66	23-3115	6	
67	23-351	0-61	extremely hard hardpan with stone throughout, gravel bed and surface water, yellowish brown sandy hardpan (Qic over Qn)
		61-120	trap rock
68	23-7747	0-68 68-188 188-320	clay, boulders, sand (Qn) trap rock red rock
69	23-860	0-18 18-29 29-80 80-105 105-120	hardpan (Qic) rotten trap rock trap red sandstone trap

		120-121	red sandstone
70	23-1153	0-22 22-122 122-200	hardpan (Qic) trap rock red sandstone
71	23-5211	22	
72	23-765	0-54 54-112	brown hardpan, layers of sand and boulders (Qn) red rock
73	23-95	56	
74	23-521	0-16 16-97	yellow clay overburden (Qn) fine grained igneous rock
75	23-5344	7	
76	23-4149	15	
77	23-6813	32c	
78	23-4062	15	
79	23-5983	0-30 30-75	gravel (Qfl2) trap rock
80	23-4173	20	
81	23-3945	27	
82	23-3621	0-10 10-21 21-103	boulders in overburden (Qn) broken trap rock trap rock
83	23-3937	0-52 52-167	hardpan with boulders and some sand (Qn) bedrock
84	23-4413	24	
85	23-8742	0-31 31-155	gravel, sand, clay (Qfl2) trap rock
86	23-3911	30	
87	23-4609	0-116 116-365	sand and boulders (Qfl2) bedrock
88	23-177	0-48 48-96 96-125	coarse gravel (Qfl2) sand and gravel (Qfl2) red rock
89	23-3892	0-72 72-120	sand, gravel, clay (Qfl2) trap rock
90	23-5684	0-63 cased to 63	gravel (Qfl2) , yield 30 gpm
91	23-3160	0-87 cased to 83	sand and gravel (Qfl2) , yield 30 gpm
92	23-4007	0-63 cased to 63	clay, sand and gravel , yield 10 gpm
93	23-5318	38	
94	23-5227	35	

95	23-7044	0-23 23-50 50-110 cased to 10	sand, gravel and boulders (Qf12, delta deposits) fine sand and clay (Qf12, lake-bottom deposits) sand and gravel (Qf12, lacustrine-fan deposits) 0, yield 10-15 gpm
96	23-7286	0-25 25-55	sand and gravel, up to cobbles (Qf12, delta deposits) very fine sand, silt, clay (Qf12, lake-bottom deposits)
97	23-7266	0-37 37-51 51-71	very fine-to-medium sand, some silt (Qfl2, delta deposits) silt, some fine sand (Qfl2, lake-bottom deposits) sand, some small gravel, some silt (Qfl2, lacustrine-fan deposits)
98	23-7267	0-21 21-51 51-53 53-71	fine-to-medium sand (Qfl2, delta deposits) very fine sand, silt, some clay (Qfl2, lake-bottom deposits) cobbles and gravel (Qfl2, lacustrine-fan deposits) sand and gravel (Qfl2, lacustrine-fan deposits)
99	23-4062	15	
100	23-4893	50	
101	23-5027	31	
102	23-4507	40	
103	23-4727	29	
104	23-3979	0-10 10-15 15-43 43-59 59-136	hardpan and boulders (Qfl3) fine sand (Qfl3) sand and gravel with cobbles (Qic) hardpan (Qn) trap rock
105	23-6580	0-58 58-60 60-151	sand, boulders (Qic) broken rock trap
106	23-5035	0-33 33-150	boulders, hardpan (Qic over Qn) red rock
107	23-5543	0-25 25-125 125-158	hardpan (Qn) trap red rock
108	23-3595	0-40 40-214	bouldery hardpan (Qn) red rock
109	23-6606	0-28 28-395	clay, boulders (Qic over Qn) trap rock
110	23-1441	0-20 20-150 150-220	hardpan (Qn) trap rock red sandstone
111	23-5006	abbreviated 0-3 3-23 23-31 31-64 64-79 79-90 90-93 93-150	log fill gravel, large boulders (Qal over Qn) brown sand (Qn or Qsp) red sand, little gravel and silt (Qsp) greenish, gray, brown clay (Qsp) red and brown sand and fine gravel (Qsp or weathered sandstone) broken rock, sand and gravel (Qsp or weathered sandstone) red rock
112	23-5246	abbreviated 0-30 30-70 70-110 110-140	l log hardpan and boulders (Qrm1) sand and gravel (Qrm1) sand (Qrm1 over Qrmlb) fine sand (Qrmlb)

		140-150 150-157	fine sand, rock pieces (Qrmlb over bedrock) red sandstone
113	23-5281	abbreviate 0-28 28-36 36-61 61-75 75-116 116-122 122-146 146-149 149-160	d log clay, sand and gravel (af over Qrm1) coarse sand and gravel (Qrm1) medium sand, fine gravel, clay (Qrm1 over Qrmlb) silt, fine sand (Qrmlb) hardpan, streaks of sand and silt (Qrmlb) silt, sand, fine gravel, clay (Qrmlb) sand and fine gravel (Qrmf) sand, gravel, clay (Qrmf or Qn) red shale
114	23-5408	0-75 75-110 110-170	sand, boulder (Qrm1) sand (Qrmlb) red rock
115	23-5967	0-40 40-58 58-160	boulders (Qic) clay (Qn) brown stone
116	23-5085	120	
117	23-4995	82	
118	23-1045	0-24 24-94 94-128	old dug well fine sandy gravel and red hardpan (Qic over Qn or Qr) rock
119	23-408	0-20 20-60 60-70 70-135	boulders (Qn) gravel (Qn or Qsp) hardpan (Qn or Qb) red rock
120	23-5833	0-67 67-400	hardpan, boulders (Qic) red rock
121	23-4461	abbreviate 0-35 35-45 45-55 55-90 90-115 115-275	d log sand, gravel, boulders, with clay binders (Qic) very fine sandy hardpan (Qic or Qn) very fine sandy clay (Qic or Qn) yellow weathered rock with clay (weathered sandstone or Qb) brownish sandy clay (weathered sandstone) red sandstone
		275-330	trap rock
122	23-3358	0-58 58-120 120-141	
122	23-3358	0-58 58-120	trap rock sand and gravel (Qfl3) trap rock
		0-58 58-120 120-141	sand and gravel (Qfl3) trap rock red rock hardpan and boulders (Qfl3 over Qn)
123	23-2300	0-58 58-120 120-141 0-77 77-109 0-73 73-115	sand and gravel (Qfl3) trap rock red rock hardpan and boulders (Qfl3 over Qn) trap rock and red rock hardpan with boulders (Qfl3 over Qn)
123	23-2300	0-58 58-120 120-141 0-77 77-109 0-73 73-115	sand and gravel (Qfl3) trap rock red rock hardpan and boulders (Qfl3 over Qn) trap rock and red rock hardpan with boulders (Qfl3 over Qn) red rock layers of sand, gravel, boulders, and hardpan (Qfl3 over Qn)

		126-155	trap rock
128	23-218	0-84 84-87 cased to 84	sand and clay (Qn over Qsp) gravel (Qsp) 4, yield 4 gpm
129	23-1412	0-102 102-157	hardpan, boulders (Qn) trap rock
130	23-272	0-71 71-166	glacial fill, with water-bearing gravel at 30 feet and quicksand from 40 to 71 (Qn over Qsp) igneous rock
131	23-666	0-79 79-110	bouldery overburden (Qn) trap rock
132	23-841	0-81 81-127	boulders (Qn) trap rock
133	23-2902	0-6 6-66 66-230	hardpan (Qfl3) broken trap red sandstone
134	23-3865	0-25 25-100 100-105	hardpan overburden (Qn) trap rock red sandstone
135	23-2901	33	
136	23-4047	0-34 34-120	hardpan, boulders (Qn) trap rock
137	23-344	abbreviated 0-58 58-68 68-NR	d log sand and gravel (Qfl3) granite boulders (Qn) red sandstone
138	23-4132	0-40 40-47	sandy clay and boulders (Qfl3 over Qn) trap rock
139	23-32-815	40	
140	23-2008	0-99 99-130	hardpan and layers of sand (Qfl3 over Qn) red sandstone
140 141			red sandstone
	23-2008	99-130 abbreviated 0-6 6-10 10-20	red sandstone d log brown-red sand, gravel, rock fragments (fill) gray silt and fine sand, trace organic matter (Qs) gray, brown silty sand, trace gravel (Qfl3)
141	23-2008	abbreviated 0-6 6-10 10-20 20-24	red sandstone d log brown-red sand, gravel, rock fragments (fill) gray silt and fine sand, trace organic matter (Qs) gray, brown silty sand, trace gravel (Qfl3)
141	23-2008 23-8947 23-162	abbreviated 0-6 6-10 10-20 20-24 85	red sandstone d log brown-red sand, gravel, rock fragments (fill) gray silt and fine sand, trace organic matter (Qs) gray, brown silty sand, trace gravel (Qfl3) rock (bedrock or boulder) boulders and hardpan (Qn)
141 142 143	23-2008 23-8947 23-162 23-2279	abbreviated 0-6 6-10 10-20 20-24 85 0-76 76-130	red sandstone d log brown-red sand, gravel, rock fragments (fill) gray silt and fine sand, trace organic matter (Qs) gray, brown silty sand, trace gravel (Qfl3) rock (bedrock or boulder) boulders and hardpan (Qn) red sandstone overburden with boulders (Qn)
141 142 143 	23-2008 23-8947 23-162 23-2279 23-5560	abbreviated 0-6 6-10 10-20 20-24 85 0-76 76-130 0-49 49-118	red sandstone d log brown-red sand, gravel, rock fragments (fill) gray silt and fine sand, trace organic matter (Qs) gray, brown silty sand, trace gravel (Qfl3) rock (bedrock or boulder) boulders and hardpan (Qn) red sandstone overburden with boulders (Qn) red sandstone sand and gravel (Qic)
141 142 143 144 145	23-2008 23-8947 23-162 23-2279 23-5560 23-7758	abbreviated 0-6 6-10 10-20 20-24 85 0-76 76-130 0-49 49-118 0-45 45-155	red sandstone d log brown-red sand, gravel, rock fragments (fill) gray silt and fine sand, trace organic matter (Qs) gray, brown silty sand, trace gravel (Qfl3) rock (bedrock or boulder) boulders and hardpan (Qn) red sandstone overburden with boulders (Qn) red sandstone sand and gravel (Qic) red rock sand and gravel, boulders (Qic)

149			45-100	brown sandstone
Section February February	149	23-4052		
152 23-7843 5 153 23-6915 0-17 clay overburden (Qn) 17-120 trap rock 120-405 red rock 154 23-6931 0-12 clay overburden (Qn) 122-150 trap rock 159-330 red rock 155 23-2583 0-79 hardpan and boulders (Qfl3 over Qn) 120-130 red sandstone 156 23-5371 0-79 bouldery hardpan (Qfl3 over Qn) 157 23-2876 0-80 sand and gravel, huge boulders encountered all the way down (Qfl3 over Qn) 158 23-5057 0-69 boulders (Qfl3 over Qn)	150	23-4057		
153	151	23-7095	20	
17-120	152	23-7843	5	
12-150	153	23-6915	17-120	trap rock
156	154	23-6931	12-150	trap rock
Total Part	155	23-2583	79-120	trap rock
80-182 red rock 182-185 trap rock	156	23-5371		
69-228	157	23-2876	80-182	red rock
160 23-3228 0-71	158	23-5057	69-228	trap
71-185 trap rock 161 23-4824	159	23-863	55-60	gravel (Qn or Qsp)
38-194 trap rock 194-309 red sandstone 162 23-5303 0-15 overburden clay and fine sand (Qfl4) 15-120 trap rock 163 23-5327 0-21 hardpan with boulders (Qfl3 over Qn) red sandstone 164 23-4810 28 165 23-5712 0-56 sand and gravel (Qic) 56-300 red shale and sandstone 166 23-3310 0-44c sand, gravel, boulders (Qfl3) 44-183 red rock 167 23-401 32c 168 23-2792 0-32c gravel, boulders (Qfl3) red rock 169 23-4767 0-35 sand, boulders (Qfl3)	160	23-3228		
15-120 trap rock	161	23-4824	38-194	trap rock
21-108 red sandstone	162	23-5303		
165 23-5712 0-56 sand and gravel (Qic) 56-300 red shale and sandstone 166 23-3310 0-44c sand, gravel, boulders (Qfl3) 44-183 red rock 167 23-401 32c 168 23-2792 0-32c gravel, boulders (Qfl3) 32-110 red rock 169 23-4767 0-35 sand, boulders (Qfl3)	163	23-5327		
56-300 red shale and sandstone 166 23-3310 0-44c sand, gravel, boulders (Qfl3) 44-183 red rock 167 23-401 32c 168 23-2792 0-32c gravel, boulders (Qfl3) 169 23-4767 0-35 sand, boulders (Qfl3)	164	23-4810	28	
44-183 red rock 167 23-401 32c 168 23-2792 0-32c gravel, boulders (Qfl3) 32-110 red rock 169 23-4767 0-35 sand, boulders (Qfl3)	165	23-5712		
168 23-2792 0-32c gravel, boulders (Qfl3) 32-110 red rock 169 23-4767 0-35 sand, boulders (Qfl3)	166	23-3310		· ·
32-110 red rock 169 23-4767 0-35 sand, boulders (Qfl3)	167	23-401	32c	
	168	23-2792		· · · · · · · · · · · · · · · · · · ·
	169	23-4767		

170	23-6962	abbreviated 0-24 24-32 32-32.4	al log sand and gravel (Qho3) red-brown silt and fine sand, very dense, little gravel (Qr) rock (penetrated to 110 feet in adjacent boring)
171	23-6756	0-30 30-50 50-830	fine sand (Qho3) fine sand and coarse gravel (Qho3) brown and red sandstone
172	23-2231	0-73c 73-370	sand, gravel, hardpan (Qho3 over Qn) red rock
173	23-2196	0-40 40-60 60-220	dirt and boulders (Qho3) sand (Qho3) red rock
174	23-8408	abbreviated 0-36 at 36	l log brown fine-to-coarse sand and gravel (Qho3) refusal on bedrock
175	23-5582	0-45 45-55 55-59 59-205	sand (Qho3) red clay (Qr) red claysand (Qr) red sandstone
176	23-1838	0-18 18-85	hardpan (Qn) red sandstone
177	23-1207	0-17 17-115	hardpan and sand (Qn) red sandstone
178	23-1151	0-20c 20-155	sand, hardpan (Qn) red rock
179	23-7181	0-17 17-202	hardpan, boulders (Qn) red rock
180	23-639	0-10 10-15 15-95	gravel (Qr) hardpan (Qr) red rock
181	23-1766	0-18 18-145	sand (Qn) sandstone
182	23-1240	0-13 13-105	red hardpan (Qn over Qr) red sandstone
183	23-1767	0-30 30-50 50-67 67-125	sand and gravel (Qho3 over Qn) boulders (Qn) gravel and fine sand (Qsp) sandstone
184	23-4823	32	
185	23-2230	0-51c 51-301	hardpan, boulders (Qn) shale and sandstone
186	23-2228	0-30c 30-400	hardpan (Qho3 over Qn) red rock
187	23-3687	0-34 34-110	red hardpan (Qho3 over Qr) red rock
188	23-232	35	
189	23-2278	21	
190	23-1345	16	

191	23-1046	0-9 9-17 17-28 28-37 37-41 41-51 51-68 68-416	loam, boulders (Qn) brown sand and gravel (Qsp) gravel and sand (Qsp) hardpan (Qsp or Qb?) clay (Qsp) hardpan (Qb?) red hardpan (Qb) red rock
192	23-3025	0-21c 21-150	hardpan (Qn) red shale and sandstone
193	23-4246	65	
194	23-1047	0-10 10-67 67-77 77-87 87-97 97-103 103-113 113-420	sandy brown clay (Qn) clay, sand and gravel (Qsp) hardpan (Qsp or Qb) sandy clay (Qsp) hardpan (Qb) red sandy clay (Qb) soft red rock red rock
195	23-1922	0-34 34-302	sand and boulders (Qn) red sandstone
196	23-2178	0-98c 98-170	boulders, sand, gravel, hardpan (Qn over Qsp over Qb?) red rock
197	23-2349	0-30 30-40 40-45 45-65 65-300	sand and clay, gravel (Qho6) sand and gravel (Qho6) sand and gravel with gray silt (Qho6) sand and gravel with water (Qho6) red sandstone
198	23-143	65	
198 1	23-143	65 0-70c 70-300	clay (Qho6 over Qn) red shale, sandstone
		0-70c	
199	23-3169	0-70c 70-300 0-50 50-180	red shale, sandstone gravel and sand (Qmt over Qho6 over Qn) red shale
199 200	23-3169	0-70c 70-300 0-50 50-180 180-300 0-14 14-50	red shale, sandstone gravel and sand (Qmt over Qho6 over Qn) red shale sandstone boulders (Qho6) hardpan (Qn)
199 200 	23-3169 23-1673 23-6378	0-70c 70-300 0-50 50-180 180-300 0-14 14-50 50-300	red shale, sandstone gravel and sand (Qmt over Qho6 over Qn) red shale sandstone boulders (Qho6) hardpan (Qn) red rock red hardpan (Qn over Qr)
199 200 201 201	23-3169 23-1673 23-6378 23-3843	0-70c 70-300 0-50 50-180 180-300 0-14 14-50 50-300 0-21 21-162 0-4 4-16 16-23	red shale, sandstone gravel and sand (Qmt over Qho6 over Qn) red shale sandstone boulders (Qho6) hardpan (Qn) red rock red hardpan (Qn over Qr) red rock fill clay (Qn) sand (Qn)
199 200 201 202 203	23-3169 23-1673 23-6378 23-3843 23-4811	0-70c 70-300 0-50 50-180 180-300 0-14 14-50 50-300 0-21 21-162 0-4 4-16 16-23 23-300	red shale, sandstone gravel and sand (Qmt over Qho6 over Qn) red shale sandstone boulders (Qho6) hardpan (Qn) red rock red hardpan (Qn over Qr) red rock fill clay (Qn) sand (Qn) red rock sandy soil with boulders (Qn) red hardpan (Qr)
199 200 201 201 202 203	23-3169 23-1673 23-6378 23-3843 23-4811	0-70c 70-300 0-50 50-180 180-300 0-14 14-50 50-300 0-21 21-162 0-4 4-16 16-23 23-300 0-24 24-31 31-205	red shale, sandstone gravel and sand (Qmt over Qho6 over Qn) red shale sandstone boulders (Qho6) hardpan (Qn) red rock red hardpan (Qn over Qr) red rock fill clay (Qn) sand (Qn) red rock sandy soil with boulders (Qn) red shale hardpan, boulders (Qn)

208	23-4793	0-5 5-30 30-60 60-75 75-200	clay and boulders (Qn) sand and boulders (Qn) gray clay (Qsp) red clay (Qsp or Qb) red sandstone
209	23-2470	0-62 62-75 75-169	sand and gravel with boulders (Qn) brown hardpan (Qb?) red rock
210	23-4197	0-52 52-125 125-215	boulders (Qn) sand, gravel (Qsp) red rock
211	23-2598	0-107 107-150	red hardpan and layers of sand (Qn over Qsp) red sandstone
212	23-3222	0-130 130-184	hardpan with boulders (Qn) red rock
213	23-4004	0-20 20-63 63-85 85-120 120-138 138-200	brown sandy hardpan (Qn) gray hardpan (Qn) brown sand (Qsp) red, sandy hardpan (Qb) soft red sandstone hard red sandstone
214	23-4216	0-20 20-27 27-35 35-60 60-78 78-97 97-205	brown sandy hardpan (Qho5) gray hardpan (Qn) brown hardpan (Qn) light gray hardpan (Qn) red sandy hardpan (Qb or Qr) soft red sandstone hard red sandstone
215	23-4133	0-30 30-50 50-65 65-69 69-86 86-190	brown sandy hardpan (Qn) reddish sand (Qsp) brown sand (Qsp) reddish brown sand (Qsp) soft red sandstone hard red sandstone
216	23-4214	0-30 30-140	boulders, hardpan (Qn) red rock
217	23-4215	0-30 30-183	hardpan, boulders (Qn) red rock
218	23-3181	0-32 screened 2	sand and gravel (Qho4) 29-32, yield 60 gpm
219	23-1811	0-95c 95-200	gravel, boulders, hardpan (Qn) red rock
220	23-2282	0-5 5-300	hardpan (Qho5) hard red rock
221	23-3224	25	
222	23-2365	0-15 15-300	topsoil and sand (Qho5) red rock
223	23-2786	0-17 17-35 35-300	boulders in hardpan (Qho5) very hard and rocky hardpan (Qn) brown sandstone and red shale
224	23-3997	0-16 16-33	hard sandy soil with small stones mixed (Qho6) gray hardpan with a lot of boulders at 30 feet (Qn)

		33-51 51-60 60-300	gray hardpan with streaks of gravel (Qn over Qsp) red hardpan with layers of red sandstone (Qb over bedrock) red and brown sandstone
225	23-3857	0-42 42-48 48-52 52-58 58-63 63-300	hardpan and boulders (Qmt over Qho5) gray hardpan (Qn) gravel (Qsp) reddish hardpan (Qb) gravel (Qsp or weathered sandstone) sandstone, shale
226	23-2787	16	
227	25-23625	0-10 10-15	olive fine-to-medium sand, fine gravel, trace silt (Qho6) brown coarse sand, fine gravel (Qho6)
228	23-1414	abbreviate 0-7 7-22 22-30 30-39 39-57 57-71 71-74 74-77 77-97 97-504	d log sand, gravel, boulders (Qho6) gray hardpan, boulders (Qn) gray sand and clay (Qn or Qsp) hardpan and boulders (Qn) clay bound gray sand and gravel (Qsp) clay and heavy stone (Qsp or Qb) brown clay, large gravel, hardpan (Qb) brown coarse sand (Qsp or weathered sandstone) conglomeration of quartz, shale, sandstone, and clay (weathered rock) sandstone and shale
229	23-4257	0-50c 50-348	sand, hardpan (Qho5 over Qn) red rock
230	23-6784	0-40 40-44 44-325	hardpan with boulders (Qn over Qr) some sand (Qsp or weathered sandstone) red shale
231	23-7398	0-40 40-162	hardpan, boulders (Qho5 over Qn) red rock
232	23-1844	0-5 5-300	boulders and dirt (Qn over Qr) shale and sandstone
233	23-5210	0-6 6-19 19-300	fill dirt and boulders (af) sand, gravel (Qho4) shale and sandstone
234	23-3711	0-74 74-215	sand and gravel (Qho4) red rock
235	23-3715	0-38 38-135	sand (Qho4) red rock
236	23-16	30	
237	23-5929	30	
238	23-4465	65	
239	23-6318	0-70 70-300	sand and gravel (Qn) red rock
240	23-1790	0-40 40-110	red hardpan (Qn over Qr) red sandstone
241	23-130	66	
242	23-4085	0-71 71-255	hardpan with boulders (Qn) red rock

243	23-2628	0-51 51-174	sand and gravel (Qic over Qn) red sandstone
244	23-999	0-70 70-141	sandy glacial fill (Qic over Qn) red rock
245	23-26	62	
246	23-7249	65	
247	23-5504	80	
248	23-6105	0-73 73-93 93-200	sand, boulders (Qic) broken rock red rock
249	23-7740	0-40 40-62 62-205	light color sand (Qic) soft red sandstone red sandstone
250	23-7736	0-60 60-234	sand and gravel (Qho4 over Qic) red rock and trap rock
251	23-8859	0-15 15-30 30-307	medium sand (Qho4) gravel, boulders, fine sand (Qic) brown and red sandstone
252	23-8191	0-35 35-50 50-52 52-200	medium brown sand (Qic) brown hardpan (Qic or Qn) fine sand (Qic or Qn) sandstone
253	23-5536	60	
254	23-6926	10	
255	23-5474	0-55 55-57 57-180	sand (Qmt over Qic) gravel, red clay (Qr or weathered sandstone) red sandstone
256	23-5466	0-72 72-76 cased to 73	sand (Qmt over Qic) coarse gravel (Qic) s, yield >50 gpm
257	23-5573	0-61 61-390	sand and large gravel (Qic) red rock
258	23-5574	0-73 73-214	sand (Qic) red rock
259	23-5571	0-81 81-500	sand and gravel (Qic) soft red rock
260	23-5472	0-15 15-32 32-39 39-52 52-60 60-302	hardpan and boulders (Qic) sandy hardpan and rocks (Qic) dirty sand and gravel (Qic) sandy clay, hardpan (Qn) hardpan, some conglomerate (Qn over bedrock) sandstone
261	23-1101	0-75 75-92	sand and gravel overburden (Qho3) red sandstone
262	23-1084	0-74 74-93	sand and gravel overburden (Qho3) red sandstone
263	23-6220	0-42 42-80 80-200	sand (Qho4) boulders (Qn) red rock

264	23-2039	0-76 76-146	sand and gravel (Qn) red rock
265	23-2890	0-65 65-141	sand and gravel (Qho4) red rock
266	23-1630	0-16 16-82	red hardpan (Qn over Qr) red sandstone
267	23-2420	5	
268	23-4643	0-76c 76-143	hardpan and boulders, gravel and sand (Qho3 over Qn) sandstone
269	23-5491	0-102 102-270	coarse sand and gravel (Qic) red rock
270	23-5580	0-122 122-360	sand and gravel (Qie) red rock
271	23-5497	0-112 112-400	coarse sand and gravel (Qic) red rock
272	23-8339	0-7 7-47 47-70 70-300	clay, sand, small gravel (Qic) boulders, sand, clay, gravel (Qic over Qn) clay, small boulders, gravel (Qn) red shale and sandstone
273	23-5307	0-82 82-157	hardpan with boulders (Qfl4 over Qn) red sandstone
274	23-8769	0-15 15-65 65-75 75-95 95-245	brown hardpan (Qic over Qn) large boulders in hardpan (Qn) sand and gravel (Qsp) very soft sandstone red sandstone
275	23-3521	0-62 62-70	hardpan overburden (Qn) red rock
276	23-19	56	
277	23-317	0-38 38-130	gravel fill (Qn) red rock
278	23-6178	0-57c 57-145	sand and gravel (Qmt over Qic) red shale
279	23-3992	0-90c 90-165	sand, boulders, hardpan, gravel (Qr over Qsp or Qfl4?) red rock
280	23-7255	0-40 40-60 60-104 104-305	brown sand (Qfl4) sand and gravel (Qfl4) soft red rock red rock
281	23-7671	0-40 40-50 50-245	fine sand (Qfl4) red sand and gravel (Qfl4) red shale and sandstone
282	23-1980	0-88 88-140	layers of hardpan and clay with a few boulders (Qfl4) red rock
283	23-6737	0-45 45-60 60-175	sand (Qfl4) sand and gravel (Qfl4) red shale and sandstone

284	23-1629	0-50 50-84 84-120	sand (Qfl4) red hardpan (Qr) red sandstone
285	23-2820	0-83 83-120	layers of hardpan and gravel (Qfl4) red sandstone
286	23-7428	0-50 50-205	coarse brown sand (Qfl4) brown and red sandstone
287	23-5276	0-90 90-130	sand (Qfl4) red rock
288	23-4666	0-90 cased to 55	gravel (Qfl4) , yield 20 gpm
289	23-4668	0-100 cased to 60	gravel (Qfl4) , yield 20 gpm
290	23-3246	0-50 50-82 82-130	sand and silt (Qfl4) red hardpan (Qr) bedrock
291	23-3703	0-75 75-115	boulders and hardpan with layers of sand and gravel (Qfl4 over Qn) red rock
292	23-7617	0-55 55-62 62-265	brown medium sand (Qfl4) gravel (Qfl4) red sandstone
293	23-2439	0-93 93-225	hardpan, sand, gravel (Qfl4 over Qn) red sandstone
294	23-2009	0-67 67-110	red hardpan and boulders (Qfl4 over Qr) red rock
295	23-2795	0-67 67-115	sand, gravel, boulders, hardpan (Qfl4 over Qr) trap rock and red sandstone
296	23-6796	0-50 50-70 70-200	sand (Qfl4) broken rock (Qn?) trap rock
297	25-14864	0-57 57-93	sand hardpan (Qfl4 over Qn) rock gravel (weathered basalt?)
298	23-4204	0-41 41-90	hardpan and boulders (Qn) trap rock
299	23-5214	30	
300	23-7245	0-23 23-35 35-71 71-330	hardpan and boulders (Qn) coarse gravel (Qsp or weathered bedrock) soft red rock red sandstone
301	23-4973	0-57 cased to 57	hardpan and boulders, gravel formation with water at 57 feet (Qn over Qsp) , yield 10 gpm
302	23-4311	0-67 67-87 87-410	hardpan (Qn) sand and gravel (Qsp) red rock
303	23-3244	0-85c 85-183	sand, boulders, hardpan (Qn over Qsp) red rock
304	23-5490	0-70 70-78 cased to 71	sand, sand and gravel, fine sand (Qn over Qsp) gravel (Qsp) , yield >50 gpm

305	23-2794	0-35 35-49 49-120	sand and boulders (Qn) red hardpan (Qr) red sandstone
306	23-3918	0-61 61-275	hardpan with boulders (Qn) red rock
307	23-4310	0-50 50-70 70-204	hardpan (Qn) sand and gravel (Qsp) red rock
308	23-3232	0-86 86-175	sand and gravel (Qfl4) red rock
309	23-3617	0-70 70-88 88-195	sand and gravel (Qfl4) red hardpan (Qr) red rock
310	23-3359	0-70 70-86 86-165	sand and gravel (Qfl4) hardpan (Qr) red rock
311	23-3284	0-56 56-170	sand and gravel (Qfl4) red rock
312	23-3230	0-70 70-265	sand and gravel (Qfl4) red rock
313	23-3286	0-56 56-170	sand and gravel (Qfl4) red rock
314	23-4857	0-52 52-205	sand and gravel (Qfl4) red rock
315	23-1052	0-40 40-114	clay, sand, red hardpan, and unconformed [sic] rock (Qic over Qr over weathered sandstone) red sandstone
316	23-6331	0-35 35-45 45-160	sand and gravel (Qic) red hardpan (Qr) red sandstone
317	23-3218	0-41 41-145	sand and gravel (Qic) red rock
318	23-3234	0-33 33-105	sand, gravel, boulders (Qic) red rock
319	23-4634	0-61 61-186	sand, gravel, boulders (Qic over Qn) red rock
320	23-4472	0-50 50-195	sand and gravel with boulders (Qic over Qn) red rock
321	23-4625	0-61 61-204	sand and gravel (Qic) red rock
322	23-3987	30	
323	23-6432	0-10	clay (Qn) sand and boulders (Qn)
		10-20 20-40 40-300	soft sandstone red sandstone

325	23-3742	0-3 3-400	boulders and hardpan (Qn) red rock
326	23-4205	0-25 25-250	sandy overburden mixed with boulders (Qn) red shale and sandstone
327	23-5305	0-10 10-25 25-200	clay (Qn) gravel (Qn or Qsp) red rock
328	23-5284	29c	
329	23-8185	0-20 20-22 22-23 23-500	glacial till with boulders (Qn) boulders, sand and gravel with water (Qn or Qsp) red clay and sand (Qr or Qsp) sandstone
330	23-4140	0-35 35-348	hardpan (Qn) red rock
331	23-2606	0-25c 25-330	sand, gravel (Qho5) red rock
332	23-7257	0-12 12-30 30-68 68-71 71-300	fine sand with small cobbles (Qn) sandy hardpan with streaks of gravel (Qn) hardpan with boulders and cobbles (Qn) red hardpan with red sticky clay (Qr or Qb) red sandstone
334	23-3700	0-50 50-118 118-130	hardpan (Qn) gravel, sand (Qsp) red rock
335	32-4253	0-95 95-115 115-120	hardpan (Qn) boulders, gravel (Qsp) red rock
336	23-1776	0-85 85-130 130-180	sandy hardpan with boulders (Qn) fine sand with some water (Qsp) red sandstone
337	23-4500	0-25 25-84 84-119 119-132 132-348	brown sandy hardpan with boulders (Qn) gray sandy hardpan (Qn) reddish brown sandy hardpan (Qb or Qr) soft red sandstone hard red sandstone
338	23-903	0-27 27-35 35-40 40-51 51-76 76-77 77-98 98-101 at 101	boulders (Qn) yellow sand, boulders (Qn or Qsp) coarse brown sand (Qsp) gray sand (Qsp) very fine sand (Qsp) coarse gray sand (Qsp) very fine gray sand (Qsp) fine red sand (Qsp) red shale
339	23-1882	0-52 52-400	boulders, sand, hardpan (Qn) red rock
340	43-42	0-4 4-25 25-33 33-297	silt, clay (Qn) sandy clay, soupy (Qn) red hardpan (Qr) red shale
341	23-32-655	20	
342	23-938	26	

343	23-1025	30	
344	23-3701	0-6 6-19 19-47 47-84	brown sandy hardpan (Qic) gray sandy hardpan with boulders (Qn) soft red sandstone hard red sandstone
345	23-4126	0-105 105-155 155-400	boulders and hardpan (Qn) unconsolidated rock red sandstone
346	23-2015	0-80 80-140 140-190	boulders, hardpan (Qn) red sand (Qsp) red rock
347	23-659	0-50 50-58 58-155	hardpan and boulders (Qn) fine sand and small gravel (Qsp) red sandstone
348	23-4023	0-45 45-130	hardpan and boulders, reddish hardpan (Qn over Qr) red shale
349	23-6274	0-31 31-200	hardpan (Qic over Qn) red rock
350	23-4002	0-55 55-61 61-160	sand and gravel (Qic over Qn) red hardpan (Qr) red rock
351	23-4350	0-40 40-50 50-122	sand (Qic) red hardpan (Qr) red rock
352	23-3978	0-41 41-286	sand and gravel (Qfl4 over Qic) red rock
353	23-4182	0-50 50-76 76-162	hardpan (Qfl4) sand and gravel (Qfl4) red rock
354	23-1839	61	
355	23-3958	0-44 44-120	hardpan with boulders (Qfl4 over Qn) red rock
356	23-4074	0-40 40-255	hardpan (Qfl4 over Qn) red rock
357	23-4764	0-48 48-110	sand and gravel (Qfl4 over Qn) red rock
358	23-3976	0-72 72-175	hardpan with boulders (Qn) red rock
359	23-4096	0-30 30-60 60-320	hardpan and boulders (Qn) hardpan (Qn or Qr) red rock
360	23-3575	0-15 15-20 20-24 24-65	brown sandy hardpan with boulders (Qn) red sandy hardpan(Qr) soft red sandstone hard red sandstone
361	23-821	0-25 25-35 35-40 40-42 42-45	sand and gravel, boulders (Qdb1) gray sand (Qdb1) brown sand (Qdb1) red very fine sand (Qdb1 or Qr) red rock

362	23-3706	0-20 20-70 70-278	hardpan (Qn) trap red shale
363	23-5346	0-50 50-311 311-513	hardpan (Qn) trap red rock
364	23-6030	0-7 7-51 51-300	boulders (Qn) hardpan (Qn over Qr) red rock
365	23-1016	0-10 10-20 20-33 33-43 43-150	gravel (Qic) hardpan (Qn) sand (Qn or Qsp) boulders (Qn or Qr) red rock
366	23-4107	0-26 26-155	hardpan, boulders (Qdb1 over Qn) red rock
367	23-939	32	
368	23-846	0-47c 47-150	boulders, gravel (Qn) red rock
369	23-638	0-20 20-36 36-38 38-46 46-140	sandy hardpan and boulders (Qn) brown hardpan (Qn) gravel and sand (Qsp) red hardpan (Qr or Qb) red rock
370	23-4125	0-4 4-6 6-10 10-23 23-30 30-51 51-62 62-81 81-82 82-400	fill (af) black muck (Qs) gray hardpan(Qmh1) some sand and gravel (Qmh1) gray hardpan, some small stones (Qn) sandy hardpan (Qn) yellow hardpan (Qn) hard yellow sand, small stones (Qn) brown hardpan (Qr) red sandstone
371	23-788	0-100 100-270	sand, gravel, boulders (Qmh1 over Qn) red rock
372	23-8450	0-10 10-12 12-32 32-155	clay and boulders (Qn) sand, clay, and boulders (Qn) clay and boulders (Qn) red shale and sandstone
373	23-2797	0-20 20-88 88-132	topsoil and dirt (Qn) sand and gravel (Qsp) red rock
374	23-2317	0-17 17-32 32-41 41-52 52-62 62-170	brown hardpan (Qn) gray hardpan (Qn) light gray hardpan (Qn) gray sand (Qsp) red hardpan (Qb) red sandstone
375	23-2316	0-19 19-36 36-44 44-50 50-54 54-170	brown hardpan (Qn) light gray hardpan (Qn) dark gray hardpan (Qn) very sandy gray hardpan (Qn or Qsp) red hardpan (Qb) red sandstone

376	23-5682	30	
377	23-2219	0-13 13-26 26-38 38-44 44-49	brown hardpan (Qmh1 over Qn) gray hardpan (Qn) dark gray hardpan (Qn) gray sand (Qsp) red sandstone
378	23-1033	0-40c 40-475	sand, boulders, fine sand (Qn over Qsp) red rock
379	23-889	0-50 50-65 65-75 75-90 90-100 100-105 screened fr	hardpan (Qn) fine sand to coarse washed sand and gravel (Qsp) hardpan (Qn or Qsp) sand (Qsp) silt (Qsp) hardpan (Qb) om 55-60, yield 11 gpm
380	23-5294	0-115 115-315	hardpan, boulders (Qn) red rock
381	23-4865	0-172 172-295	hardpan with boulders overburden (Qn) red sandstone
382	23-3947	0-25 25-50 50-70 71-109 109-148 149-160 160-215	brown, sandy hardpan (Qn) light gray hardpan with boulders (Qn) brown sand with boulders (Qn) yellowish brown sand with boulders (Qn over Qsp) reddish brown sand (Qsp) soft red sandstone hard red sandstone
383	23-8133	0-150 150-500	hardpan, boulders (Qn) red rock
384	23-6664	0-152 152-290	hardpan, boulders (Qn) red rock
385	23-6242	0-35 35-45 45-75 75-80 80-100 100-105	reddish sandy hardpan with boulders (Qn over Qr) brown hardpan with boulders (Qn) yellow sandy hardpan with boulders (Qn or Qsp) gray sandy hardpan with boulders (Qn or Qsp) brown sandy hardpan with boulders (Qn or Qsp) red sandy hardpan (Qb)
386	23-8852	abbreviated 0-34 34-65 65-76	l log brown silt, fine-to-medium sand, trace gravel (Qn) gray and tan fine-to-medium sand, some silt (Qsp) red-brown coarse-to-fine sand, some silt, trace gravel (Qb)
387	23-2457	0-20 20-60	hardpan (Qn) red rock
388	23-6155A	0-30 30-125	hardpan, boulders (Qn) red rock
389	23-6158	0-30 30-120	boulders and sand (Qn) red rock
390	23-4056	0-38 38-122	red hardpan with boulders (Qn over Qr) red rock
391	23-3451	0-26 26-86	red hardpan (Qn over Qr) red rock
392	23-6301	0-30 30-50	hardpan and boulders (Qn) sand and gravel (Qsp)

		50-70 70-300	soft red rock sandstone
393	23-2251	0-55c 55-110	sand, boulders trap rock
394	23-3996	0-90 90-97 97-300	sand and gravel (Qrm2 over Qn?) gravel (Qn or Qsp) trap rock
395	23-8423	0-29 29-53 53-55 55-69 69-80	sand, gravel, clay (Qal over Qrmlb) medium gravel and sand (Qrmf) heavy clay and gravel (Qrmf) hardpan and gravel (Qrmf) dark gray slate
396	23-2179	0-93 cased to 92	gravel, sand, boulders (Qrm2 over Qrmf) g, yield 10 gpm
397	23-1517	0-11 11-85 85-105	stony dirt (Qn) gray trap rock black shale
398	23-282	0-12 12-152	buff-gray clay, sand, gravel, with gneiss boulders (Qrm2 over Qn) conglomerate and sandstone
399	23-7674	47	
400	23-6599	>152 cased to 15	2, yield 8 gpm from gravel (Qrmf)
401	23-8436	abbreviated 0-40 40-130 130-160 160-485	l log brown sand and gravel (Qrm2) gray fine sand (Qrmlb) brown sand and gravel (Qrmf) shale, sandstone, slate
402	23-5519	100	
403	23-5547	30c	
404	23-7851	0-20 20-37 37-60 60-265	coarse compacted sand and gravel (Qrm2) fine sand with large gravel (Qrm2) hard trap rock trap and granitic gray rock
405	23-8479	abbreviated 0-129 129-258	brown sand and gravel (Qrm1 over Qrmf) slate
406	23-8217	abbreviated	l log fine-to-coarse silty sand and gravel (Qal over Qrm1)
407	23-7600	0-72 screened 6	sand, boulders, little gravel (Qrm1) 2-72, yield 0.25 gpm
408	23-2594	0-3 3-125	dirt (Qn) granite
409	23-3556	0-22c 22-107	hardpan, boulders (Qn) granite
410	23-4903	0-16 16-236	gravel, sand, boulders (Qn) granite
411	23-5410	30	
412	23-6230	0-20 20-200	clay, gravel, and boulders (Qn) granite

413	23-677	0-30	boulders (Qn)
		30-43	hardpan (Qn)
		43-155	rock
414	23-1242	0-17	bouldery hardpan (Qn)
		17-75	granite
415	22 0020	- 1.1	
415	23-8939	abbreviate	e
		0-50	sand and gravel and clay (Qal over Qrmlb)
		50-60 60-80	fine-to-medium sand and silt (Qrmlb) fine-to-coarse sand and gravel (Qrmf)
		80-85	broken rock, slate and quartz rock
			70-85, yield 901 gpm
416	23-11423	0-15	dirty sand and gravel (Qal)
		15-75	soft clay, silt (Qrmlb)
		75-95	dirty fine sand, silty clay (Qrmlb)
		95-105	silty clay (Qrmlb)
		105-125	dirty sand and gravel (Qrmf)
		125-130	rockgranite
417	23-6668	0.5	harring along (Oal)
417	23-0008	0-5 5-10	brown clay (Qal) sand-silt, clay (Qal)
		10-15	brown clay, sand, gravel (Qal)
		15-25	gray clay, soft (Qrmlb)
		25-85	gray clay (Qrmlb)
		85-86	gray clay, sand, slate rocks (Qrmlb)
		86-95	gray clay (Qrmlb)
		95-105	sandy gray clay (Qrmlb)
		105-120	gray fine sandy clay (Qrmlb)
		120-124	gray sand (Qrmf)
		124-126	gray sand, small gravel (Qrmf)
		126-147	gray sand, small gravel, silt (Qrmf)
		147-149	gray sand, clay, small gravel, rock chips (Qrmf)
		screened	116-149, yield 900 gpm
410	22 (022	0.4	
418	23-6933	0-4	top soil and gravel (Qal)
		4-20	silty yellow-brown sand and gravel (Qal)
		20-30 30-50	sandy gray clay (Qrmlb)
		50-60	fine gray sandy clay (Qrmlb) fine sand and gray clay (Qrmlb)
		60-70	fine sand and gray clay (Qrmlb)
		70-80	fine sand with chunks of gray clay throughout (Qrmlb)
		80-100	silty fine gray sand (Qrmlb)
		100-115	very fine gray sand and gray clay (Qrmlb)
		115-135	fine gray sand with gravel throughout (Qrmf)
		135-138	silty gray sand with coarse gravel (Qrmf)
		138-142	silty gray sand with gravel (Qrmf)
		142-164	varying layers of sand and gravel, some gravel quite coarse (Qrmf)
		164-168	sandy clay hardpan, light pink in color (Qr)
		at 168	red sandstone
			137-169, yield 465 gpm
419	23-450	0-90	stratified drift (Qmt over Qrmlb)
		90-404	red sandstone
420	23-634	0-30	sand (Qmt)
120	25 057	30-85	gray clay (Qrmlb)
		85-115	fine gray silt (Qrmlb)
		115-136	fine sand (Qrmlb)
		136-138	gravel and sand with water (Qrmf)
			-
421	23-2190	0-85c	sand, gravel, boulders (Qn)
		85-290	red rock
422	23-5658	90	
422	22 2409	0.11	brown hardnan and houldars (On)
423	23-2408	0-11	brown hardpan and boulders (Qn)

		11-20 22-75	gray hardpan and boulders (Qn) granite
424	23-3876	0-90 90-100 100-116 116-305	sand and gravel with boulders (Qn over Qr) hardpan (Qr or Qsp) gravel (Qsp) broken trap and red rock mixed
425	23-3875	0-80 80-100 100-104 104-215	sand and gravel (Qn) hardpan (Qno or Qsp) gravel (Qsp) trap and red mixed
426	23-8162	0-40 40-50 screened 4	sand, boulders (Qn) sand, gravel (Qsp) 60-50, yield 5 gpm
427	23-8637	0-12 12-40	stones and sand (Qmt) clay (Qrmlb)
428	23-7868	abbreviate 0-22 22-107 107-128 128-161	d log tan fine-to-coarse sand, some fine-to-coarse gravel, trace silt and clay (Qmt) brown silty fine sand (Qrmlb) gray clayey silt (Qrmlb) gray fine sand (Qrmlb or Qrmf)
429	23-7042	0-36 36-50	fine silty sand (Qmt over Qrmlb) fine silty sand with clay (Qrmlb)
430	23-54	0-35 35-80 80-95	sand (Qmt) quicksand (Qrmlb) sand and gravel (Qrmf)
431	23-7651	abbreviate 0-28 28-60	d log fine-to-coarse sand, some fine gravel (Qmt) gray, grayish brown silt, fine sand, trace clay and medium sand (Qrmlb)
432	23-789	0-51 51-80	layers of red hardpan and sand (Qmh1 over Qr) red sandstone
433	23-7009 and 23-7649	abbreviate 0-3 3-8 8-21 21-25 25-35 32-55 55-72	d log silty, gravelly coarse-to-fine sand (Qmt) sandy coarse gravel (Qmt) gravelly coarse-to-fine sand (Qmt) coarse-to-fine sand (Qmt) silty coarse-to-fine sand (Qmt) silty fine sand (Qrmlb) silt with some clay, trace fine sand (Qrmlb)
434	23-7011	0-5 5-13 13-30	medium to fine silty sandy gravel (Qmt) silty clay (Qmt) silty coarse-to-fine sand (Qmt)
435	23-7012 and 23-7647	abbreviate 0-3 3-6 6-13 13-24 24-28 28-30 29-35 35-60	fill: clayey gravelly sand silty medium-to-fine sand (Qmt) clayey fine sand (Qmt) silty coarse-to-fine sand (Qmt) silt with sand seams (Qmt) silty sand (Qmt) brown silty fine-to-medium sand (Qmt) silt, with some thin layers of clay and fine sand (Qrmlb)
436	23-7013	0-2 2-8 8-14 14-32	sandy clay (af) sandy silt (af) silty coarse-to-fine sand (Qal) coarse gravelly clay (Qmt)
437	23-7366	abbreviate	d log

438	23-2845	0-8 8-12 12-25 25-63 63-75 75-80 80-86	sand, silt, cobblesfill sand and gravel, no cobbles (Qmt) grayish brown silt and very fine sand, with interbeds of pink clay (Qrmlb) gray soft silt, a few thin laminae of clay (Qrmlb) (not reported) loose till (maybe gravel, Qrmf) harder till (Qrmf) coarse sand and gravel (Qmt)
	23-2043	20-45 45-90 90-116 116-200	quick sand (Qrmlb) gray hardpan (Qrmlb) reddish sand and gravel, yield 20 gpm (Qrmf) red and gray shale
439	23-828	0-25 25-61 61-120c 120-500	yellow hardpan and boulders (Qn) fine yellow sand, some fine gravel (Qsp) clay (Qsp over Qb?) red rock
440	23-7310	abbreviated 0-30 30-45 45-55 55-70 70-95 95-404	and and gravel (Qmh2) gray sticky clay (Qmh2) fine brown sand, clay (Qmh2) brown fine sand (Qmh2) fine brown sand, big to medium gravel (Qmh2) red sandstone and conglomerate
441	23-7368	abbreviated 0-17 17-23 23-27 at 27	l log gray, olive, brown silty sand (af over Qal) brown, grayish brown silt (Qal or Qn) brown till, loose, sandy (Qn) rocks, probable bedrock
442	23-884	0-24 24-25 25-40 40-68 68-71	fill sand and gravel (Qmh2) silt with some gravel (Qmh2) gray clay (Qmh2) clay and gravel (Qmh2 or Qr)
443	23-862	0-4 4-6 6-30 30-45 45-55 55-78 78-83 83-203	sand (Qmh2) boulders (Qmh2) fine sand some clay (Qmh2) clay (Qmh2) clay with some sand (Qmh2) fine sand (Qmh2) red gravel with some red clay (Qr) red sandstone rock
444	23-932	0-12 12-26 26-39 39-42	fill sand and gravel with traces of clay (Qmh2) coarse sand and gravel (Qmh2) red rock
445	23-7214	abbreviated 0-40 40-48 48-59	tl log coarse-to-fine sand and coarse-to-fine gravel (Qmh1) boulders and cobbles (Qmh1) tan silt and cobbles (Qn)
446	23-5533	0-5 5-13 13-24 24-44 44-61 61-76 76-88 screened 75	clean sand (Qmh1) hard-packed dead sand (Qmh1) loose water-bearing sand (Qmh1) hard-packed silty sand (Qmh1) reddish sand with pea gravel (Qmh1) hard silty sticky sand (Qmh1) coarse sand and gravel (Qmh1) 8-88, yield 115 gpm
447	23-5532	0-1.5	topsoil

		1.5-11 11-21 21-56 56-61 61-77 77-102 102-107	fine sand (Qmh1) fine sand with gravel (Qmh1) good clean sand and gravel (Qmh1) very fine sand (Qmh1) fine sand but clean (Qmh1) sand and pea gravel (Qmh1, log says rock at 95 but layers add up to 102) rock
448	23-7202	0-15 15-25 25-47 47-185	hard sand (Qmh1) gravel and boulders (Qmh1) soft red sandstone (Qmh1) brown sandstone
449	23-988	0-100 100-170	sand, gravel, boulders (Qmh1) red rock
450	23-829	0-5 5-26 26-30 30-35 35-41 41-47 47-105 105-107	fill (af) black muck (Qs) gray sand (Qho4) gray sand, fine grained (Qho4) fine-to-coarse varicolored sand and pea gravel (Qho4) similar, but chiefly coarse sand (Qho4) fine yellow sand, no good water-bearing sand (Qn?) red sandstone
451	23-819	0-45 45-55 55-60 60-100 100-115 cased to 1	hardpan (Qic) fine sand, clay, small gravel (Qic) sand and gravel (Qic) yellow clay (Qn?) sand, yellow, with water (Qsp?) 15, yield 15 gpm
452	23-1691	0-40 40-65 65-105 105-125 125-275	sand (Qic) sand and gravel (Qic) boulders (Qic or Qn) gravel (Qic or Qsp) sandstone
453	23-1883	0-21 21-400	hardpan and boulders (Qn) red rock
454	23-2245	0-7 7-19 19-24 24-42 42-100	light-brown sand and gravel (Qn) brown hardpan (Qn) red hardpan (Qrl) crumbly red sandstone good red sandstone
455	23-6504	0-40 40-55 55-70 70-81 81-260	sand (Qn) boulders (Qn) gravel (Qsp) sandstone red sandstone
456	23-1335	0-34 34-90	bouldery hardpan (Qn) red sandstone
457	23-990	>95	
458	23-991	>95	
459	well 53, Canace and Hutchinson (1988)	0-10 10-40 40-50 50-60 60-70 70-90 90-100 100-115 115-116	sand, gravel, fill dirt sand, gravel (Qrm2) sand and silt (Qrm2) sand, silt, fine gravel (Qrm2) sand, gravel, silt (Qrm2) sand and silt (Qrmlb) sand and mud (Qrmlb) sand, silt, gravel (Qrmf) slate rock

460	23-940	abbreviate	e
		0-3	brown loamy sand with plant roots
		3-36	slightly clayey brown to olive sand and gravel (Qrm2) fine-to-coarse sand with an occasional small pebble (Qrm2)
		36-49 49-140	slightly clayey fine-to-coarse sand and gravel (Qrmlb over Qrmf)
461	DOT 43	abbreviate	· ·
		0-13	brown and gray gravel and sand, trace silt (Qal)
		13-61	gray to grayish brown silt and clay, some fine sand (Qrmlb)
462	DOT 50	abbreviate	
		0-10	brown sand and gravel, little silt (Qmt)
		10-41	brownish gray silt, trace to some fine sand (Qrmlb)
463	DOT 51	abbreviate	d log
		0-15	gray and brown sand, some gravel, little silt (Qal)
		15-30	brown coarse-to-fine sand, trace silt and clay (Qal over Qrmlb)
464	23-7418	abbreviate	d log
		0-5	silty brown sand (Qmt)
		5-20	(not reported)
		20-48	yellowish brown medium-to-coarse sand (Qrm2)
		48-60	yellowish brown fine sand (Qrmlb)
465	DOT 55	abbreviate	d log
		0-12	brown and gray sand and gravel (Qmt)
		12-26	brownish gray silt and clay, trace fine sand (Qrmlb)
466	23-7794	0-75	sand and gravel (Qrm2)
		75-75.5	granite
		screened 5	22-73, yield 578 gpm
467	23-5240	0-105	sand, gravel, clay, hardpan (Qal over Qrmlb)
.07	23 52 10	105-125	red sandstone
468	23-926	0-26	sand and coarse gravel (Qmt)
100	23-720	26-60	fine sand with clay (Qrmlb)
		60-108	fine sand (Qrmlb)
		108-112	sand with some water (Qrmf)
		112-115	stony hardpan (Qn)
		115-126	mixture of red, black, gray sandstone
469	23-7367	abbreviate	d log
		0-10	sand and gravel, brown (Qmt)
		10-12	silt, brown (Qrmlb)
		12-20	silt and clay, gray, with layers of very fine sand to fine sand, some pebbles
		20.27	(Qrmlb)
		20-27	sand, brown, very fine to fine (Qrmlb)
		27-35 35-37	silt, gray to brownish gray, with some very fine sand and clay (Qrmlb)
		35-37 37-41	sand, grayish brown, very fine (Qrmlb) silty sand, brown, some fine gravel (Qrmf or Qn)
		41-42	till, sandy, not compact (Qn)
		at 42	refusal on boulder
470	23-5675	0-50	sand and gravel (Qmt over Qn)
1,0	23 3013	50-80	fine sand (Qsp)
		80-90	hardpan (Qb)
		90-210	red rock
471	23-975	0-24	hardpan and boulders (Qn)
T / I	43-713	24-63	gray sand (Qsp)
		63-75	brown sand (Qsp)
		75-82	red sand and 3/4 inch gravel (Qsp)
		82-147	red shale
		147-252	red and gray slate
472	23-4813	83	
	23-7013		

473	23-7369	abbreviated 0-12 12-30 30-35 at 35	log brown sand and gravel (Qmt) interbedded silt and very fine sand with thin clay laminae (Qrmlb) brown very loose sandy gravelly till (Qn or Qrmf) refusal
474	23-5102	0-55 55-75 75-400	sand and gravel (Qmt over Qn) red hardpan (Qr or Qb) red rock
475	23-2524	36	
476	23-6430	0-5 5-400 400-580	hardpan (Qn) igneous, granitic rock sandstone
477	23-7417	abbreviated 0-35 at 35	log yellowish brown to dark yellowish brown silty sand and gravel (Qrm2) weathered bedrock
478	23-7415	abbreviated 0-2 2-13 13-18 18-30 30-53 at 53	log sand and gravel, yellowish brown (Qal) gray, brown clayey silt, laminated from 8-10 (Qal over Qrmlb) silty sand, grayish brown, fine (Qrmlb) sand, grayish brown, fine (Qrmlb) sand, grayish brown, fine (Qrmlb) till, red, sandy, with cobbles (Qrmf)
479	23-11424	0-74 74-104 104-123	sandy clayey silt (Qal over Qrmlb) sand and gravel, screened 75-103 for future production (Qrmf) granite
480	23-12284	0-7 7-25 25-123 123-124	clay and silt with a little gravel (Qal) silty sand and gravel (Qrm2 over Qrmlb) sand and gravel, screened 51-123 (Qrmf) granite
481	23-12283	0-27 27-40 40-53 53-58 58-80 80-81 at 81	coarse-to-fine sand (Qrm2) fine-to-very fine sand (Qrm2) silt and clay (Qrmlb) silt, traces fine-to-coarse sand (Qrmlb) fine-to-coarse sand with gravel (Qrmf) compact sand and gravel (Qrmf or Qn) weathered rock
482	23-4227	0-43 43-100	sand and gravel with boulders (Qrm2) trap rock
483	23-3294	0-69 69-89	hardpan and big boulders (Qrm2 over Qn) rock
484	23-2851	0-90 cased to 90	sand and gravel and boulders mixed (Qrm2 over Qn) , yield 20 gpm
485	23-3663	0-42 42-133	gravel with boulders (Qrm2 over Qn) granite
486	23-4600	0-83 83-122	sand and gravel (Qrm2) granite
487	23-440	0-42 42-136	gravelly sand (Qrm2) trap
488	23-5101	0-123 123-225	sand and gravel (Qrm2 over Qrmf) red rock
489	23-307	0-35 35-106	Wisconsin drift (Qrm2) alternating layers of quicksand and heaving sand (Qrmlb)

		106-115	gray sandstone
490	23-5885	0-20	hardpan (Qal or Qrm2)
		20-103	sand (Qrmlb)
		103-160	trap rock
491	23-2186	0-5	hardpan (Qal)
		5-35	sand with clay (Qrmlb)
		35-50	coarse sand (Qrmf)
		50-52	pea gravel (Qrmf)
		cased to 52	z, yield 25 gpm
492	23-3810	0-50	hardpan with boulders (Orm2)
		50-60	sand and gravel (Qrm2)
493	23-3769	0-14	sandy gravel (Qrm2)
		14-91 91-97	hardpan and clay (Qrmlb over Qn) coarse sand and gravel (Qsp?)
494	23-3860	0-103	sand, gravel, boulders (Qrm2 over Qn)
		103-265	trap rock
495	23-8311	a bbraviata	
493	23-6311	abbreviated 0-5	fill
		5-25	brown sand, gravel (Qn)
		25-35	brown sand and clay (Qn)
		35-53	brown sand and gravel (Qn or Qsp)
		53-128	red shale
		128-200	blue to black slate
496	23-5338	0-40	clay (Qal over Qn)
		40-60	sand and gravel (Qn or Qsp)
		60-210	red rock
497	23-2507	0-10	overburden
777	23-2307	10-25	sand and gravel (Qmt)
		25-45	gray clay (Qrmlb)
		45-70	brown sand and silt (Qrmlb)
		70-80	brown sand, silt, fine gravel (Qrmf)
		80-85	brown sand, silt, small gravel (Qrmf)
		85-95 95-97	brown sand, medium gravel (Qrmf) sand, gravel, sharp gravel (Qrmf)
		97-110	sand, gravel, medium size (Qrmf)
		110-112	hardpan, no water (Qrmf or Qn)
		screened 8	5-110, yield 970 gpm
400	22 1020	0.2	handrag (Ourt)
498	23-1929	0-3 3-16	hardpan (Qmt) hardpan, boulders (Qmt)
		16-31	coarse sand, gravel, clay (Qmt over Qrmlb)
		31-80	gray silt (Qrmlb)
		80-85	fine brown sand, fine gravel (Qrmf)
		85-88	coarse brown sand with gravel (Qrmf)
		88-93 93-96	medium gravel, brown sand, coarse sand (Qrmf)
			granite gneiss rock 3-96, yield 308 gpm
499	Oakland	0-10	sand, gravel (Qmt)
	Soons wellfield #9	10-20	(not reported) fine brown and and ait (Ormile)
	weinield #9	20-30 30-70	fine brown sand and silt (Qrmlb) fine gray sand and silt (Qrmlb)
		70-77	fine gray sand and gravel (Qrmf)
		77-84	fine brown sand, silt, gravel (Qrmf)
		84-88	red rock
500	22 2107	0.18	fine cond (Omt)
500	23-2197	0-18 18-47	fine sand (Qmt) sand, little gravel (Qrmlb over Qrmf)
		47-67	sand, gravel, little water (Qrmf)
		67-76	coarse gravel, little clay (Qrmf)

76-100 red rock screened 56-76, yield 419 gpm

		Serection .	
501	23-2105	42	
502	TH 3.1	0-41 41-44 44-48 48-69	sand and gravel and boulders (Qrm1) fine sand (Qrm1) sand and gravel (Qrmf) gneiss
503	TH 3.2	0-37 37-51 51-61 61-71 71-136 136-144 144-165	sand and gravel and boulders (Qrm1) fine sand (Qrm1) sand and gravel and boulders (Qrmf) coarse and fine sand (Qrmf) fine sand (Qrmf) coarse and fine sand (Qrmf) gneiss
504	TH 3.5	0-25 25-90 90-127 127-147	sand and gravel and boulders (Qrm1) coarse and fine sand (Qrm1 over Qrmf) fine sand (Qrmf) trap rock
505	TH 3.3	0-59 59-108 108-128	sand and gravel and boulders (Qrm1) coarse and fine sand (Qrm1 over Qrmf) trap rock
506	TH 3.4	0-60 60-70 70-88 88-108	sand and gravel and boulders (Qrm1) fine sand (Qrm1) gravel and sand (Qrmf) trap rock
507	23-7790	0-35 35-40 40-117 screened 8	sand and gravel (Qal over Qrm1) clay (Qrmlb) gravel (Qrmf) 35-117, yield 1227 gpm
508	23-373	0-60 60-160 160-190	gravel and small boulders (Qrm1) fine sand (Qrmlb) fine sand and gravel (Qrmf)
509	23-7519	0-8 8-17 17-22 22-32 32-50 50-55 55-63 63-67 67-70	sand, boulders, gravel, clay (Qrm1) sand and gravel (Qrm1) coarse and fine sand with clay (Qrm1) medium and fine sand and clay (Qrm1) fine sand, silt, clay (Qrmlb) silt, fine sand, clay (Qrmlb) silt, fine sand, clay, boulders, small stone (Qrmlb over Qn) clay and broken granite rock, silt (Qn) rock, granite
510	TH 1.1	0-31 31-40 40-53 53-67 67-92	coarse and fine sand (Qal over Qrm1) fine sand (Qrmlb) silt (Qrmlb) gravel and sand (Qrmf) gneiss
511	TH 1.3	0-11 11-23 23-63 63-67 67-87	sand and gravel (Qrm1) fine sand (Qrmlb) silt (Qrmlb) sand and gravel (Qrmf) gneiss
512	TH 1.2	0-75 75-117 117-121 121-141	sand and gravel (Qrml) fine sand (Qrmlb) sand and gravel (Qrmf) gneiss
513	TH 1.4	0-78	sand and gravel (Qrm1)

		78-170 170-180 180-191	fine sand (Qrmlb) silt (Qrmlb) fine sand (Qrmf)
514	TH 1.5	0-61 61-212 212-233	sand and gravel (Qrm1) fine sand (Qrmlb) red sandstone
515	TH 1.6	0-60 60-175 175-197	sand and gravel (Qrm1) fine sand (Qrmlb) red sandstone
516	23-4818	0-51 51-84 84-400 400-600	hardpan, large boulders (Qmh1 over Qn) hardpan (Qn) red sandstone red shale and sandstone

¹Identifiers of the form 26-xxxx and 46-xxxx are well permit numbers issued by the N. J. Department of Environmental Protection, Bureau of Water Allocation. Identifiers of the form Nxx-xx-xxx are N. J. Atlas Sheet grid coordinates of wells in the Bureau of Water Allocation files that do not have permit numbers. Identifiers of the form DOT xx are borings drilled for the N. J. Department of Transportation with logs on file at the N. J. Geological Survey. Identifiers of the form TH 1.x or TH 3.x are dam borings from Weston and Sampson (1924).

²A number without a log is the depth, in feet below land surface, to bedrock reported for wells where the surficial material is either not identified or identified only as "overburden" or "glacial fill". For wells and borings with logs of the surficial materials, the depth (in feet below land surface) and driller's or logger's description is provided. Depths followed by "c" are reported lengths of well casing for wells where the depth is not otherwise reported; typically, casing extends several feet into the top of bedrock, so these are maximum values. Inferred map units and comments by author are in parentheses. All descriptions are reproduced as they appear in the original source, except for minor format, punctuation, and spelling changes. Logs identified as "abbreviated" have been condensed for brevity. Many bedrock descriptions have been condensed; these are not identified as abbreviated. The notation "NR" indicates "not reported". For wells completed in surficial materials, the screened interval or length of well casing and yield (in gallons per minute, gpm) are reported beneath the log. Map units are inferred from the known extent of materials at the surface and from known depositional settings, in addition to the drillers' descriptions.

Table 2.--Composition of pebbles in surficial deposits

Site	Unit	Number			Percentages	s of pebbles		
		of pebbles	gneiss ¹	gray mudstone ²	red sandstone, mudstone, conglomerate ³	purple quartzite ⁴	basalt ⁵	white quartz pebbles ⁶
1	Qbs2	111	90	8		2		
2	Qmh1	158	63	25	12			
3	Qmh1	104	33	19	48			
4	Qrm1	117	73	20	7			
5	Qn	147	61	38 ⁷	1			
6	Qrm1	120	83	14	3			
7	Qrm2	123	81	16	4			
8	Qmt	120	83	17				
9	Qrm2	108	74	25		1		
10	Qr	129	39	8	44			9
11	Qn	115	87	12 ⁷		1		
12	Qfl2	158	70	23	7			
13	Qfl2	183	55	31	8			6
14	Qfl2	161	62	25	6		1	6
15	Qfl2	150	67	25	4			4
16	Qfl2	133	75	18	2	2		3
17	Qfl2	114	79	18	3			
18	Qfl2	122	74	23				3
19	Qfl2	128	78	18	3			1
20	Qic	176	76	17	3	1	2	1
21	Qn	118	73	25		2		
22	Qfl3	110	64	27		5	4	
23	Qn	129	77	20		2		1
24	Qn	149	60	21	7	7		5
25	Qfl3	128	70	16	5	3		6
26	Qfl3	187	70	22	1	3		4
27	Qfl3	135	74	19	4			3
28	Qic	133	75	14	7			4
29	Qic	138	72	17	7			4
30	Qn	129	87	11		2		

31	Qho3	124	64	25	6		5
32	Qho3	146	56	23	13		8
33	Qfl3	122	61	28	7		4
34	Qfl3	176	57	27	8		8
35	Qho3	143	60	24	11		5
36	Qfl3	113	66	20	9		5
37	Qho3	116	42	21	23		14
38	Qho3	218	46	26	17		11
39	Qho3	187	53	27	11		9
40	Qn	143	70	29		1	
41	Qho4	150	67	19	7		7
42	Qho4	147	68	16	4		12
43	Qho4	194	51	17	11		21
44	Qho4	152	66	19 ⁷	3		12
45	Qic	167	60	227	14		2
46	Qho4	149	67	26	3		4
47	Qic	148	67	26	5		2
48	Qfl4	151	66	24	6		4
49	Qic	154	65	29 ⁷	6		
50	Qn	111	63	33	2		2
518	Qn	103	87	11		2	
52	Qn	132	72	26		2	
53	Qn	152	46	54			
54	Qn	112	8	91 ⁷		1	
55	Qn	141	71	29 ⁷			

¹Proterozoic gneiss from the Hudson Highlands and Ramapo Mountain.

²Paleozoic sedimentary rocks from the Wallkill and Hudson valleys.

³Local sedimentary rocks from the Newark Basin.

⁴Quartzite-conglomerate from the Green Pond and Skunnemunk formations in the Hudson Highlands.

⁵Local basalt from the Watchung basalt flows of the Newark Basin.

⁶Quartz pebbles are chiefly from local weathered conglomerates of the Newark Basin. Some may be from the Pensauken Formation, a preglacial fluvial deposit that formerly occupied lowland areas of the Newark Basin.

⁷Includes 1% chert from Paleozoic carbonate rocks in the Wallkill Valley or Hudson Highlands.

⁸Count is of boulders.