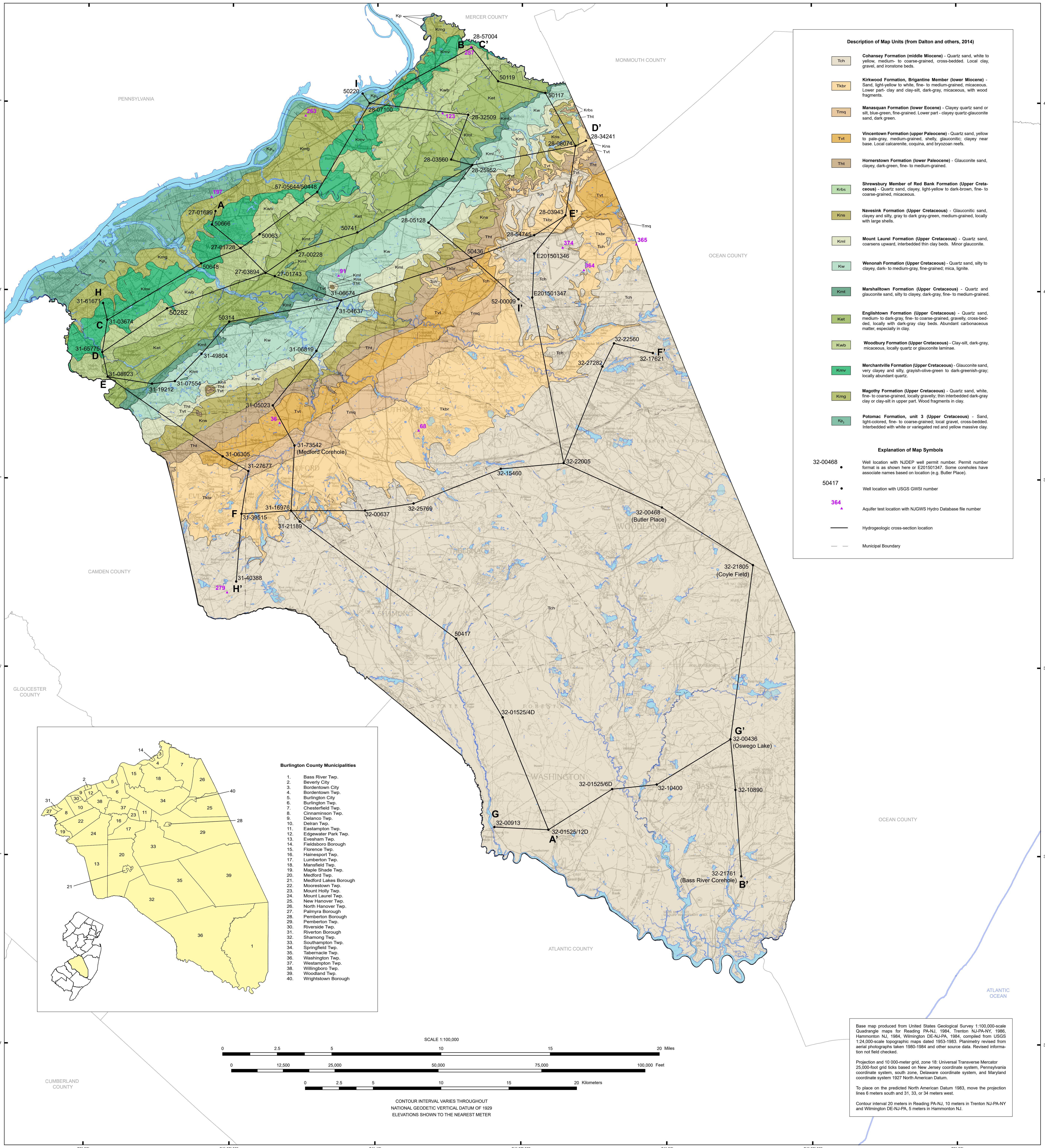

Figure 1. Geologic Map of Burlington County showing locations of hydrogeologic cross-sections, aquifer tests, and wells used in constructing the cross-sections. Geology from Owens and others, 1998.

Digital compilation by R.S. Pristas.
Cartography by R.S. Pristas and A.R. Carone.

FRAMEWORK AND PROPERTIES OF AQUIFERS IN BURLINGTON COUNTY, NEW JERSEY

by
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Introduction

Burlington County is the largest county by area (approximately 820 square miles) in New Jersey, and has a population of just under 450,000 people. It lies in the central part of the New Jersey Coastal Plain (NJCP), and borders the Delaware River to the northwest and Mercer, Monmouth, Ocean, Camden and Atlantic counties to the northeast and southwest (figure 1). In 2015 the population of Burlington County used approximately 44 billion gallons of groundwater (figures 2 and 3) of which about 80 percent was for drinking water. Surface water accounts for another roughly 55 billion gallons per year. Groundwater demand peaked in 1998 at just over 80 billion gallons and has shown a variable but steady decline since then (figure 3). The reason for this decline is partially from the implementation of Water Supply Critical Area 2, established under N.J.A.C. 7:19, Subchapter 8.

While the demand for additional groundwater supply has declined, water in the confined aquifers of the county is in good part non-renewable. There has been a need to evaluate Burlington's hydrogeologic framework to best manage groundwater resources in the replacement of existing water supply wells and the effects of groundwater contamination on potable supplies. The hydrogeologic framework (figure 6) consists of sand beds (aquifers) and clay-silt beds (confining units) within geologic formations.

Recent water supply development, and geologic and groundwater pollution investigations have included drilling of new water supply wells, monitoring wells, and deep test borings. While these provided new insights into local subsurface geologic and hydrostratigraphic conditions, there remained a need for a regional study of the confined aquifers beneath the county to improve understanding of their thickness, lateral extent, and water quality. Previous hydrogeologic investigations for the entire NJCP were completed by Rush (1968) and Zapecza (1989) for groundwater resources and Miller and others (2017) for carbon sequestration in deep formations bearing saline water. The focus of this study is to improve the mapping and correlation of major aquifers in Burlington County. Major aquifers and aquifer systems include the Kirkwood-Cohansey aquifer system, Wenonah-Mount Laurel aquifer, Magothy aquifer, and Potomac aquifer system. Minor aquifers include the Rio-Grande water-bearing zone, Atlantic City 800-foot sand, Piney Point, Vincentown, and Englishtown aquifers.

Methods

The improved understanding of the aquifer stratigraphy of Burlington County presented here is based on stratigraphic data from: 1) continuous coreholes at Bass River (Miller and others, 1998) and Medford (Sugarman and others, 2010), 2) geophysical logs from some of the water wells shown on table 2, and 3) recent geologic maps of the study area (Owens and others, 1998; Stanford and others, 2007). Elevations of basement rock are from Volkert and others (1996) and well records on file at the New Jersey Geological and Water Survey (NJGWS). Topographic profiles on cross-sections are from USGS Digital Elevation Model (DEM) 10-meter by 10-meter data spacing cast on the Universal Transverse Mercator (UTM) projection. Advances in the understanding of the water-bearing properties of the aquifers is based on aquifer test data submitted to the NJGWS in support of Water Allocation Permit applications. NJGWS evaluates this data based on: 1) hydrogeology of the area, 2) screen lengths of the pumping and observation wells, 3) test duration, 4) number of pumping and observation wells, 5) proximity of observation wells to the pumping wells, 6) influence of other pumping wells, and 7) data reliability. Results of the eleven aquifer tests available for Burlington County are summarized in table 1. Additional information for each test is in the NJGWS hydro database under the file numbers indicated in table 1 (Mennel and Canace, 2002).

Downhole geophysical logs have proven invaluable in the delineation and evaluation of Coastal Plain aquifers (Zapecza, 1989; Zapecza, 1992; Owens and others, 1998; Sugarman, 2001; Sugarman and others, 2005; Sugarman and Monteverde, 2008; Sugarman and others, 2013; and Sugarman and others, 2016). They are cost-effective, non-invasive, and allow correlation over long distances. Of the many kinds of downhole geophysical logs, natural gamma and electric have proven to be the most effective in subsurface mapping and, used in combination, are the work horses in the identification of lithologies encountered in boreholes. Thorough discussions of the relationship between borehole geophysical measurements and lithologies are in Keys (1990) and Rider (2002).

The natural gamma tool measures gamma radiation from radioactive minerals in the surrounding sediments and is especially useful because it can measure through well casings. Elevated gamma readings generally correlate well with the clays of confining units due to the higher concentration of potassium, uranium and thorium in clays than in quartz sands (Keys and MacCary, 1971). Care must be taken to differentiate the increased gamma levels in clay layers from unusually high levels in some sands due to potassium-bearing feldspars (a common mineral in arkosic sandstone), and glauconite (a sand-to-clay size mineral). Rider (1990) warned against the use of gamma logs to characterize grain-size variations because of the variations in the response of sands due to variations in mineralogy. He further noted that in fluvio-deltaic sediments (like those of Burlington County), the sand tends to be predominantly quartz, and gamma activity is thus directly related to the clay content. In sediments from these environments, gamma logs are reliable indicators of grain size. Confirming the applicability of gamma logs to New Jersey Coastal Plain sediments, Lanci and others (2002) showed that the radioactive signatures of the Coastal Plain clay and sand mixtures and, where present, glauconite are consistent with those observed in gamma logs. Two different units of measurement are used for gamma response: American Petroleum Institute (API) units and counts per second (cps). CPS units are more commonly used in local investigations where curve matching allows unit identification, and were used in this study.

Electric logs are commonly used in combination with natural gamma logs in groundwater studies (Keys,1990). Combining gamma and electrical data enables one to decipher the lithological makeup and therefore differentiate between aquifers and confining units. The single point resistance logs shown on the cross sections measure the electrical potential drop between two electrodes, one at the surface and the second within the tool. Results are measured in millivolts and subsequently converted to ohms (Keys and MacCary, 1971; Keys, 1990). Values recorded by the single-point resistance probe correlate to a volume of borehole and rock material that is five to ten times the diameter of the probe's. Resistivity values decrease as porosity and formation water content increase. In contrast to natural gamma values, which are generally higher in clays, resistivity values are generally lower in clays because the clays have higher overall conductivity. Quantitative measurements of porosity and/or salinity, though, cannot be calculated from single-point resistance probes because current's travel path parameters are not defined (Keys, 1990). If borehole fluid is homogeneous, variations in resistance are caused by lithology. Increasing pore water salinity will cause a decrease in resistance.

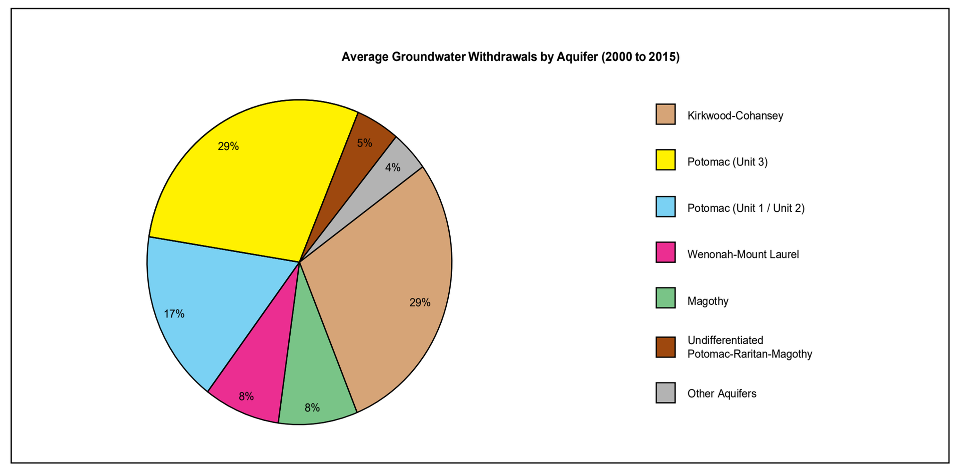


Figure 2. 2000 to 2015 Average Groundwater Withdrawals by Aquifer in Burlington County. Data sourced from the New Jersey Water Transfer Data Model (NJWaTr), a database managed by NJGWS that contains measured and estimated monthly withdrawals, use, and return volumes. Data summarized in Digital Geodata Series (DGS) 10-3 (see references).

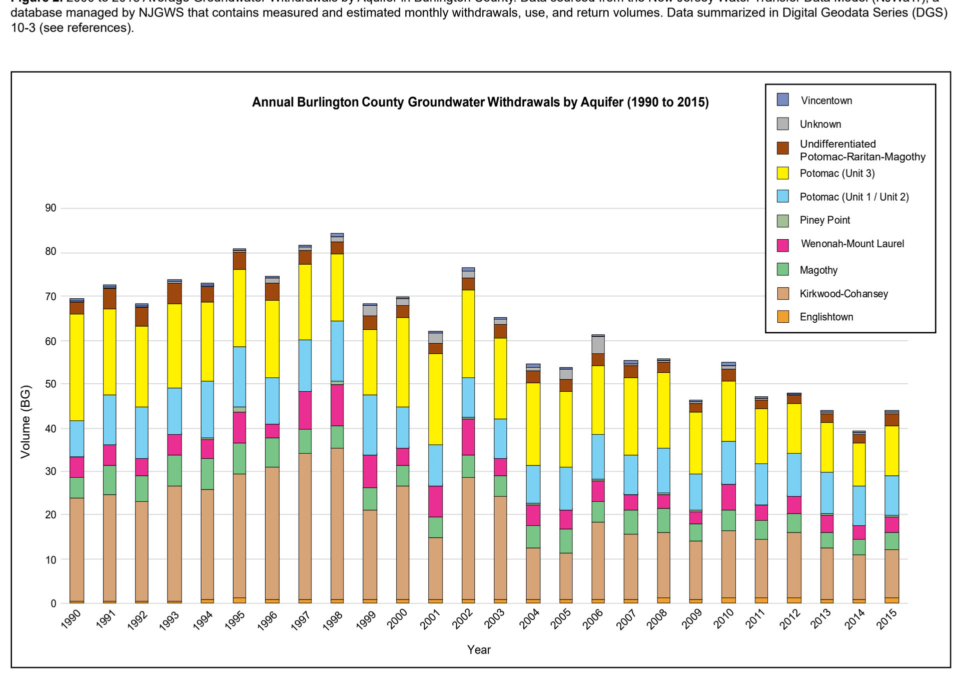


Figure 3. Annual Burlington County Groundwater Withdrawals by Aquifer. Data sourced from the New Jersey Water Transfer Data Model (NJWaTr), a database managed by NJGWS that contains measured and estimated monthly withdrawals, use, and return volumes. Data summarized in Digital Geodata Series (DGS) 10-3 (see references).

NJGWS Hydro Database File Number	NJDEP Permit Number	Aquifer	Aquifer Hydrogeologic Characterization	Test Length (minutes)	Aquifer Properties
36	31-31088	Wenonah-Mt. Laurel	Leaky Semi-confined	1,437	S_c= 3.2 gpm/ft, T= 1,059.93 ft²/day, S= 8.68E-04, L= 1.24E-03/day
68	32-16498	Wenonah-Mt. Laurel	Leaky Confined	4,320	S_c= 4.2 gpm/ft, T= 1,285.76 ft²/day, S= 3.79E-04, L= 3.17E-05/day
91	27-11976	Englishtown	Leaky Semi-confined	4,320	S_c= 6.12 gpm/ft, T= 1,071.79 ft²/day, S= 1.29E-03, L= 7.20E-03/day
123	28-32509	Potomac, Unit 3	Leaky Confined	4,296	S_c= 14.8 gpm/ft, T= 3,696 ft²/day, S= 7.43E-05, L= 1.85E-05/day
197	27-15057	Potomac, Unit 3	Leaky Semi-Confined	4,320	S_c= 18.9 gpm/ft, T= 1,957 ft²/day, S= 1.63E-04, L= 2.04E-02/day
257	28-57004	Potomac, Unit 3	Leaky Confined	4,320	S_c= 14.9 gpm/ft, T= 3,017 ft²/day, S= 1.03E-04, L= 1.24E-04/day
263	27-13235	Potomac, Unit 3	Leaky Semi-confined	1,440	S_c= 18.2 gpm/ft, T= 4,056.78 ft²/day, S= 2.73E-04, L= 2.33E-03/day
279	31-40388	Wenonah-Mt. Laurel	Leaky Confined	4,320	S_c= 5.6 gpm/ft, T= 771.4 ft²/day, S= 2.34E-04, L= 7.13E-06/day
364*	28-47160	Wenonah-Mt .Laurel	Confined	4,265	S_c= 0.6 gpm/ft, T= 278 ft²/day, S= 1.20E-04
365*	28-51505	Wenonah-Mt. Laurel	Confined	4,260	S_c= 0.5 gpm/ft, T= 250 ft²/day, S= 4.34E-04
374	28-00797	Potomac, Unit 2	Leaky Confined	4,380	S_c= 18.9 gpm/ft, T= 3771.9 ft²/day, S= 8.88E-05, L= 7.04E-06/day

*Testing completed at a low pumping rate.

Table 1. Summary of aquifer tests in Burlington County on file at the New Jersey Geological and Water Survey. File numbers identify a particular aquifer test in the NJGWS hydro database. Aquifer designation is the name of the aquifer in which the test was completed. Aquifer properties are values obtained from or used in the analysis of the time-drawdown data: S_c is Specific Capacity in gpm/ft; T is Transmissivity in ft²/day; S is Storativity (dimensionless); L is Leakance in day-1. Test locations are shown in Figure 1.

Aquifer Units

The generalized hydrogeologic framework of aquifers and confining units (figure 6) consists of major sand beds (aquifers) and clay-silt beds (confining units). Aquifer boundaries do not in most cases correspond directly to the boundaries of the geologic formations. In some cases, aquifer units lie within the boundaries of a single formation. Within Burlington County, for example, the Shark River Formation encompasses the Piney Point confined aquifer, and the Vincentown, Mount Laurel, Englishtown, and Magothy aquifers correspond closely to the Vincentown, Mount Laurel (and in places the upper Wenonah), Englishtown, and Magothy Formations. By contrast the Potomac and Kirkwood formations include more than one distinct aquifer, and the Kirkwood-Cohansey aquifer system extends beyond the Kirkwood and Cohansey geologic formations. Still other formations, such as the Woodbury and Merchantville, are predominantly silt and clay and do not include any significant aquifers. In some cases, distinct sand units are close enough vertically to act as a single aquifer, and the sands are combined in the mapping as a single aquifer. Surface distribution of the geologic formations is shown on figure 1 (sheet 1). Subsurface distributions of the aquifers and confining units are shown on nine cross-sections (figures 7 to 15) on sheet 2. Cross section locations are shown on figure 1.

KwC **Kirkwood-Cohansey Aquifer System** – Spans several geologic units, and behaves as both an aquifer system (e.g. figure 7) and single aquifer (e.g. figure 9). Geologic units which include sand beds include the Miocene Kirkwood Formation (including the Brigantine, Shiloh Marl, and Wildwood Members), the Miocene Cohansey Formation, and younger surficial deposits (Zapecza, 1989; Rhodehamel, 1973). The surficial deposits are thickest, in some places over 100 feet thick, along the Delaware River and along the stretch of the Mullica River system where Burlington County borders Atlantic and Ocean Counties (Stanford and others, 2007). In these places they may be significant parts of the aquifer system. Aquifers within the system consist of fine to coarse sand, locally silty, with sparse gravel lenses, and, in places, thin-to-thick interbeds of clay-silt. The system behaves as a water table aquifer through most of the county, but locally may be semi-confined. In the most down-dip well (32-21761 on section B-B'), the Rio Grande Water Bearing Zone and Atlantic City 800-Foot Sand are bounded above and below by less permeable sediments and can be differentiated as distinct aquifers. Still further down-dip, both are major confined aquifers, primarily along the coastal barrier islands. Further up-dip, the confining units above the aquifers pinch out, and they become part of the water table system. The maximum thickness of the Kirkwood-Cohansey aquifer system in the county is 350 feet in wells 32-01525/12D (sections A-A' and G-G'), 32-00436 (sections B-B' and G-G') and 32-21761 (section B-B'). Zapecza (1989) gives the maximum thickness of the system within the NJCP as 400 feet. Both the Rio Grande and 800-Foot Sand aquifers are further described below.

RG **Rio Grande Water-Bearing Zone** – A thin aquifer in southernmost Burlington County. The unit reaches a maximum thickness of 35 feet at the Bass River corehole (Miller and others, 1998), where it is within the confining unit overlying the 800-Foot Sand and underlying the Kirkwood-Cohansey aquifer system (section B-B'). Through most of its extent, it is within the Wildwood Member of the Kirkwood Formation. As typified at Bass River (Miller and others, 1998), the unit is dark gray, medium-to-coarse quartz sand with a few thin interbeds of silt and clay. It is unclear whether the unit is semi-confined or confined in southeastern Burlington County.

800 ft Sand **Atlantic City 800-Foot Sand** – A major, confined water-supply aquifer in southern Ocean County, primarily along the barrier islands. In Burlington County, it is a distinct, confined aquifer in the southernmost part of the county as shown best on section B-B'. Up-dip between well 32-10890 and Oswego Lake (32-00436), approximately 9 miles north of the southeastern tip of the county, the overlying confining layer pinches out and the unit becomes the lower part of the Kirkwood-Cohansey aquifer system. In Burlington County, the aquifer consists of sands primarily from the Brigantine Member, and to a lesser extent the Shiloh Marl Member, of the Kirkwood Formation (Sugarman, 2001). The aquifer is generally a gray, massive, medium-grained quartz sand with sparse, thin interbeds of clay.

PP **Piney Point Aquifer** – A confined aquifer (Nemickas and Carswell, 1976) that correlates with the Middle-to-Upper Eocene Toms River Member of the Shark River Formation (Browning and others, 2011). The aquifer consists of fine-to-coarse glauconitic quartz sand and fines downward. Zapecza (1989) shows the Piney Point to be over 120 feet thick in southeastern Burlington County, and pinching out up-dip in the central part of the county. The Bass River corehole (figure 8) gamma-log signature indicates 120 feet of sand, similar to the thickness shown by Zapecza (1989). The actual lithology, though, determined from continuous core samples, is glauconitic sandy clay (Miller and others, 1998). At Coyle Field (32-21805, section B-B'), the Piney Point aquifer is 138 feet thick (Mullikin, 2011). At Oswego Lake (32-00436) it is 120 feet thick. Further study is necessary to see if the Piney Point is a viable aquifer for water supply in Burlington County.

Vt **Vincentown Aquifer** – A minor aquifer limited to approximately 3 miles down-dip of its outcrop area. Further down-dip it grades into a clay-silt confining bed. The aquifer is used primarily for domestic wells. It is predominantly quartz sand with minor amounts of glauconite sand and shells. It is typically 20 to 40 feet thick (cross sections E-E' and I-I'), but reaches a maximum of 80 feet thick 10 miles northeast of Mount Holly (Zapecza, 1989). The unit thickens to 140 feet and becomes a more extensive sand in Ocean and Monmouth Counties where it is a more widely used aquifer. Rush (1968) reports a McGuire Air Force Base well yielding 35 gallons per minute.

W-MtL **Wenonah-Mount Laurel Aquifer** – A major aquifer in Burlington County ranging in thickness from 60 to 90 feet. It is composed primarily of medium-to-coarse grained sand of the Mount Laurel Formation and mostly fine-to-medium sands of the Wenonah Formation. The Mount Laurel sand coarsens upwards and is the major component of the aquifer (Zapecza, 1989). In the Medford corehole (31-73542, section A-A'), the aquifer is exclusively within the Mount Laurel Formation, which is typically a shelly, medium-grained sand about 80 feet thick. It is tapped by public supply wells within 10 miles down-dip of its outcrop in the townships of Evesham, Medford, Southampton, Pemberton, and New Hanover. The aquifer is separated from the underlying Englishtown aquifer system by fine-grained beds in the lower part of the Wenonah Formation and the thin confining unit of the Marshalltown Formation (Zapecza, 1989).

Aquifer test analyses and drillers' logs indicate that the aquifer system ranges from leaky-confined to confined. The five aquifer tests available for the Wenonah-Mount Laurel in Burlington County show transmissivities from 771 ft²/day to 1,286 ft²/day and storativity ranging from 2.34E-04 to 8.68E-04 (table 1). The leakance values for tests that characterized the unit as leaky (file numbers 36, 68 and 279) range from 1.24E-03 to 7.130E-06, with the largest leakance value where clay layers are thin or nonexistent (file number 36). At test site 279, the underlying Englishtown Formation provides induced leakage to the Wenonah-Mount Laurel aquifer in response to pumping. Observation wells in the Englishtown aquifer responded to pumping in the Mount Laurel-Wenonah with 9 feet of drawdown. Specific capacities of production wells in Wenonah-Mount Laurel aquifer range from 0.5 to 5.6 gpm/ft.

Water of the Wenonah-Mount Laurel ranges in pH from 4.6 to 8.1* based on 5 wells from the U.S. Geological Survey database (https://waterdata.usgs.gov/nj/nwis/inventory), and is consistent with data from other wells in the aquifer previously measured by Rush (1968). Total dissolved solids (TDS) range from 74 to 168 mg/L*. Water from the Wenonah-Mount Laurel aquifer is predominantly of very good quality, except for hardness. Limited water quality data show $Ca-SO_4$, $Ca-Mg-HCO_3$ and Ca-Mg-Na-Cl type waters (figure 4). Elevated iron concentrations in the outcrop area were documented by Rush (1968). The variable characteristics of the Wenonah-Mount Laurel water have been attributed to variability of the mineral constituents of the aquifer material and confining units, characteristics of precipitation, and the residence time of groundwater.

Etu/Etl **Englishtown Aquifer** – A single aquifer through most of Burlington County and in up-dip areas of Monmouth and Ocean Counties (Sugarman and others, 2013). Down-dip in northeastern Ocean County and southeastern Monmouth County, two distinct aquifers have been identified in the Englishtown separated by a clay-silt confining bed (Nichols, 1977; Zapecza, 1989). In Burlington County, both aquifers have been found at the Medford corehole (section A-A') (Sugarman and others, 2010). Where both aquifers are present, the upper sand is usually the more productive. Where there is only a single sand bed, it appears to correlate with the upper aquifer and have a maximum thickness of 60 feet. The aquifer material is predominantly silty, fine quartz sand. The moderate thickness of the sands and their predominantly fine-grained texture seem to limit the aquifer productivity in Burlington County.

The NJGWS hydro database (Mennel and Canace, 2002) includes one Burlington County aquifer test in the Englishtown aquifer (table 1, well 27-11976). Time-drawdown data showed a transmissivity of 1,071 ft²/day, a storativity of 1.29E-03, and a leakance of 7.2E-03. The test results reflect the proximity of the test site to the outcrop belt (cross section E-E'). These are consistent with values previously reported in the Englishtown aquifer from other counties in New Jersey (Sugarman and Johnson 2014). As shown on cross section B-B', the aquifer pinches out between Butler Place and Coyle Field, approximately 20 miles down-dip from its outcrop area. The Englishtown aquifer system is separated from the Magothy aquifer by a thick clay-silt confining bed composed primarily of the Woodbury and Merchantville Formations. The confining unit is 100 to 250 feet thick near its outcrop belt, and 250 to 400 feet thick in southeasternmost Burlington County (Zapecza, 1989).

Mag **Magothy Aquifer** – Fine-to-coarse sand interstratified with thin, dark, carbonaceous clay-silt. The aquifer is thick, reaching 130 feet at the Medford corehole (31-73547, section A-A'), and is continuous across Burlington County. It is correlative with the Magothy Formation and constitutes the upper aquifer of the Potomac-Raritan-Magothy aquifer system. Across the New Jersey Coastal Plain, the Magothy aquifer is thickest in Monmouth County. The Magothy Formation includes several informal members including the Cliffwood and Morgan Beds, Amboy Stoneware Clay, Old Bridge Sand, South Amboy Fire Clay, and Sayreville Sand (formerly assigned to the Raritan Formation). While the Magothy aquifer has been considered equivalent to the Old Bridge Sand (Zapecza, 1989), at least two and sometimes three sand beds can be mapped within the aquifer (section A-A'). In the northeastern third of the county, the Magothy is used for water supply. It is separated from the upper Potomac sand aquifer (Potomac Unit 3) by a confining unit which in Burlington County can be as thin as 20 feet. The confining unit is composed of the Woodbridge Clay Member of the Raritan Formation and sometimes includes fine-grained material in the upper part of the Potomac Formation, Unit 3. Zapecza (1989) shows a maximum thickness of 200 feet near Mount Holly for this confining bed. In updip areas, the confining unit thins, in some places to 20 feet or less. In these places, the Magothy and Potomac aquifers may be hydrologically interconnected and are parts of a single aquifer system.

Potomac Aquifer System – The Potomac Formation was subdivided by Owens and others (1998) based on the pollen zones of Doyle and Robbins (1977) into three informal units. From youngest to oldest these are Unit 3, Unit 2, and Unit 1. To improve aquifer identification and correlation with geologic mapping, Sugarman and Monteverde (2008) and Sugarman and others (2013) used a similar approach to Owens and others (1998) in mapping aquifer sands within the three Potomac units. Where pollen data are available, as at the Medford site (Sugarman and others, 2010), correlation of aquifers within the Potomac aquifer system can be done with confidence. Elsewhere, where pollen data are lacking, correlations are based on geophysical log patterns and superposition (for example Unit 3 is above Unit 2). Continuity of the Potomac aquifer sands is another factor which must be considered when evaluating correlations between geophysical logs. The Potomac sands have been interpreted as deposited in fluvial and deltaic environments. In these environments some sand beds are localized and discontinuous (river point bar sands, for example). Others are regional and continuous (delta front sands, for example).

P_3 **Potomac Unit 3 Aquifer** – Fine-to-coarse sand and sparse gravel, interbedded with white or variegated clay (Owens and others, 1998; Sugarman and others, 2010). Thickness is variable, reaching approximately 200 feet. Sand units assigned to Potomac Unit 3 in this mapping have previously been correlated with the Farrington Sand aquifer (Farlekas, 1979) and the Middle aquifer of the Potomac-Raritan-Magothy aquifer system (Zapecza, 1989). In the study area, unit 3 is a major aquifer, and its use is limited mainly by its depth.

P_2 **Potomac Unit 2 Aquifer** – Medium-to-coarse sand, some fine sand, and sparse gravel, interbedded with white or variegated clay (Owens and others, 1998). At the Medford corehole, the Potomac Unit 2 had less fine-grained material, thicker sand beds, and coarser material (including medium to coarse sand) than the Potomac Unit 3. Thickness of the aquifer sands is variable, ranging from 50 to 70 feet up-dip to over 150 feet down-dip.

P_1 **Potomac Unit 1 Aquifer** – Coarse to very coarse sands, occasionally interbedded with fine sand and gravel, pebbly zones, and thin clay beds. Coarsest of the three Potomac aquifer sands. Only mapped at wells 31-05023 and 31-73542 (both on section A-A') where it is approximately 100 feet thick, and well E201501364 (section B-B') where it is approximately 50 feet thick.

Based on tests at five sites (table 1), the Potomac aquifer acts as a leaky semi-confined aquifer near the outcrop area (file numbers 197 and 263) and becomes confined down-dip to the southeast (file numbers 123, 257, and 374). Time-drawdown and recovery data analyses yield transmissivities from 1,950 ft²/day to 4,047 ft²/day, storativity from 9.26E-05 to 2.75E-04, and leakance from 2.04E-02 to 2.18E-08. The larger leakance values are from areas where the clay layers within and above the Potomac are thin (file numbers 197 and 263). These hydraulic properties confirm previously reported values for the aquifer (Rush, 1968; Martin, 1998; Pucci and others, 1989). Specific capacities of wells ranged from 14 to 18 gpm/ft.

Based on water analysis from 12 wells screened in the Potomac aquifer from the USGS water quality inventory website and unpublished data on file at the New Jersey Geological and Water Survey, the pH ranges from 5.6 to 7.2*. Water from aquifer test locations 197 and 263 had low pH values (5.6 to 5.7). Total Dissolved Solids (TDS) ranges from 60 to 120 mg/L*. Based on the water quality data from the USGS water quality inventory website, water from the Potomac aquifer is characteristically a $Ca-HCO_3$ type with a few samples having a $Ca-Mg-SO_4$ water type (figure 5). Elevated iron concentrations reported in groundwater from the Potomac aquifer range from 5.3 to 9.7 mg/L. These iron concentrations exceed the New Jersey Safe Drinking Water secondary standard of 0.3 mg/L, and the water would need treatment before delivery to the public.

There is no known evidence of salt-water intrusion in the Potomac aquifer in Burlington County. However, the aquifer system has natural chloride concentrations of 250 ppm or more across the lower third of the County (DePaul and Rossman, 2015).

* The New Jersey Safe Drinking Water secondary standard for pH is 6.5 to 8.5. Water with a pH lower than 6.5 must be adjusted to the standard pH before being delivered to the public. The New Jersey Total Dissolved Solids Concentration (TDS) secondary standard is 500 mg/L.

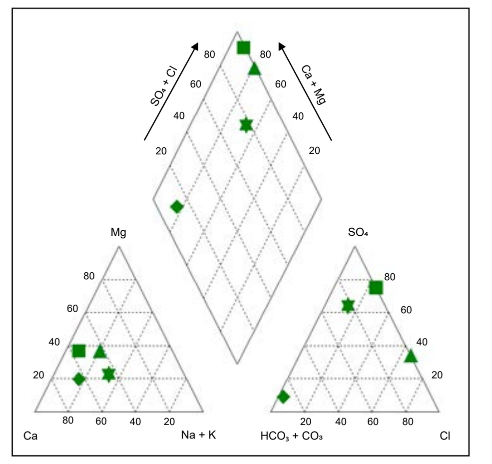


Figure 4. Piper diagram showing water chemistry of the Wenonah-Mount Laurel Aquifer. Each symbol identifies a different well. Data sourced from United States Geological Survey (USGS) National Water Information System (NWIS) site information for New Jersey and hydrogeologic reports submitted to the New Jersey Department of Environmental Protection by consulting agencies.

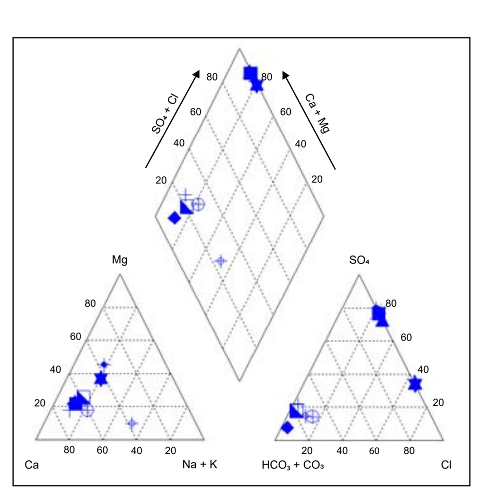
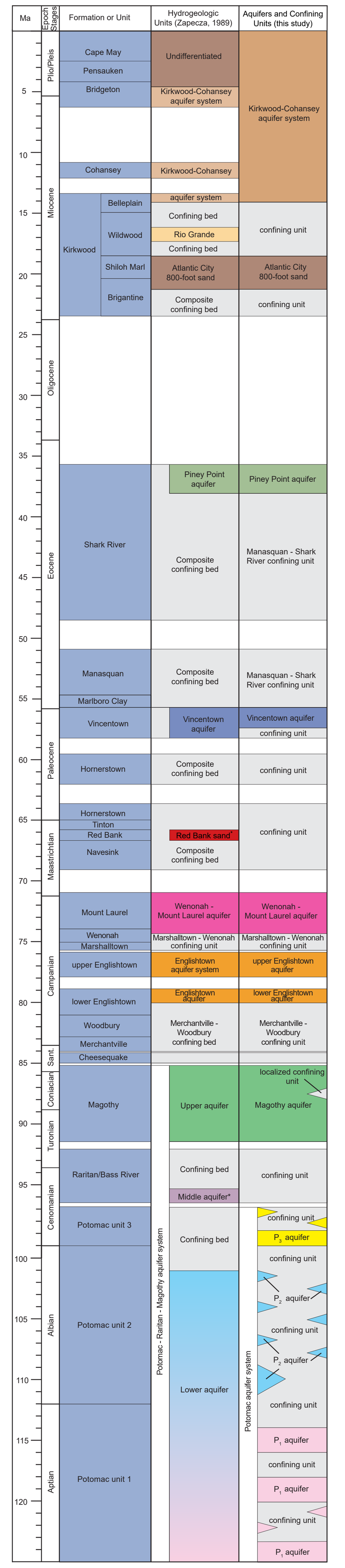


Figure 5. Piper diagram showing water chemistry of the Potomac Aquifer. Each symbol identifies a different well. Data sourced from United States Geological Survey (USGS) National Water Information System (NWIS) site information for New Jersey and hydrogeologic reports submitted to the New Jersey Department of Environmental Protection by consulting agencies.



*Red Bank sand and Middle aquifer of the Raritan/Bass River Formation are not mapped in this report.

Figure 6. Generalized comparison of geologic formations, aquifers, and confining units in the study area. Also shown is the hydrogeologic framework modified from Zapecza (1989). Breaks in the column are due to undepositional unconformities.

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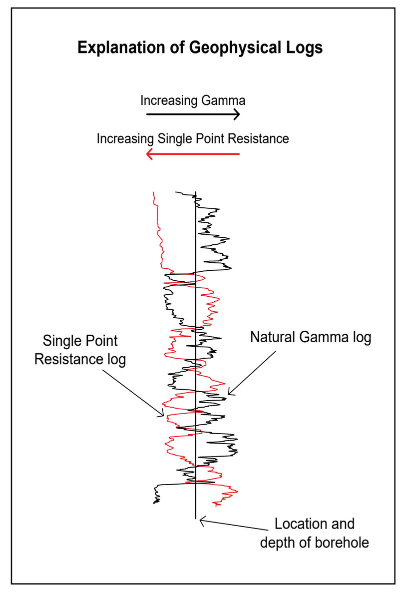


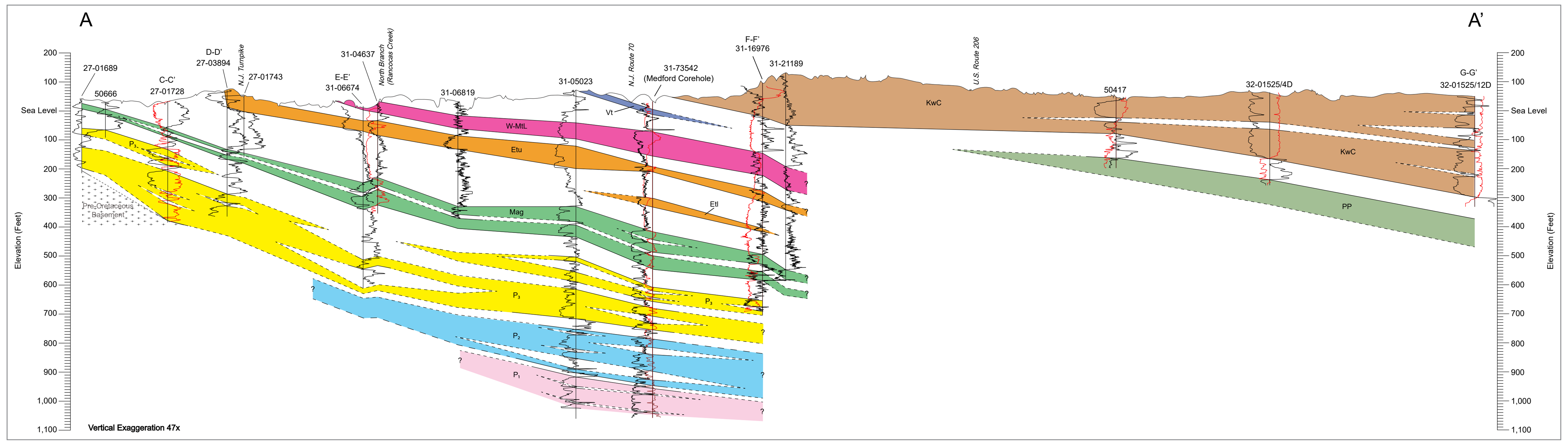


Figure 7. Hydrogeologic cross-section A-A'.

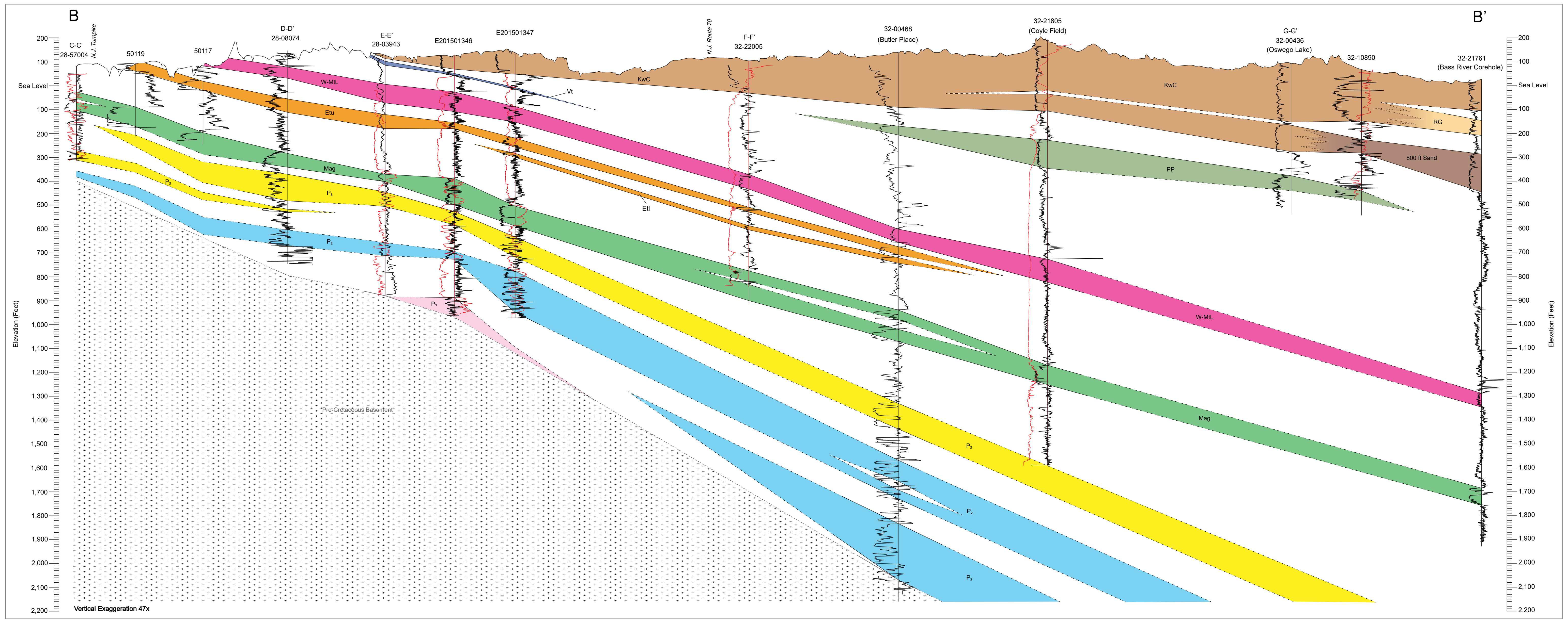


Figure 8. Hydrogeologic cross-section B-B'.

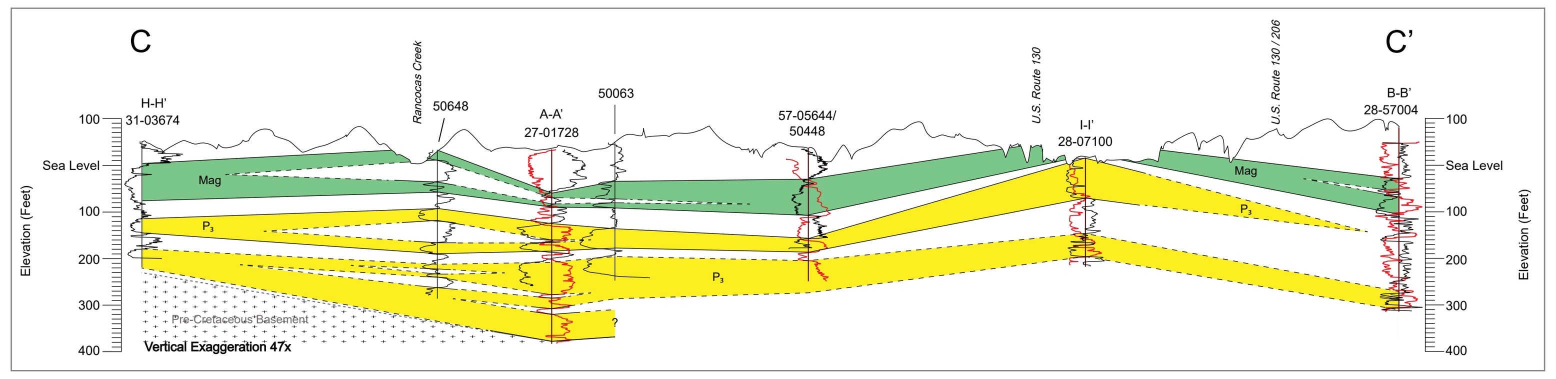


Figure 11. Hydrogeologic cross-section C-C'.

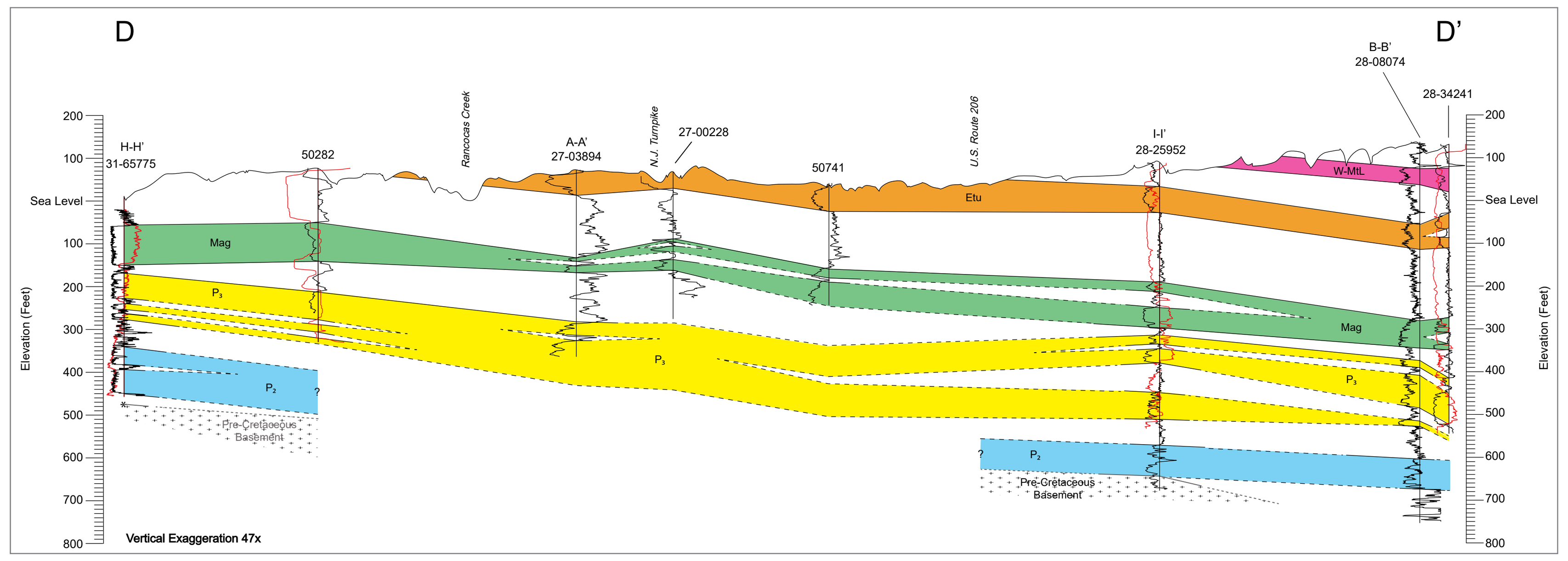


Figure 12. Hydrogeologic cross-section D-D'. Single Point Resistance log shown at well 28-25952 was collected from well 28-25950, approximately 200 feet to the southeast. Asterisk indicates depth to bedrock inferred from Volkert and others (1996).

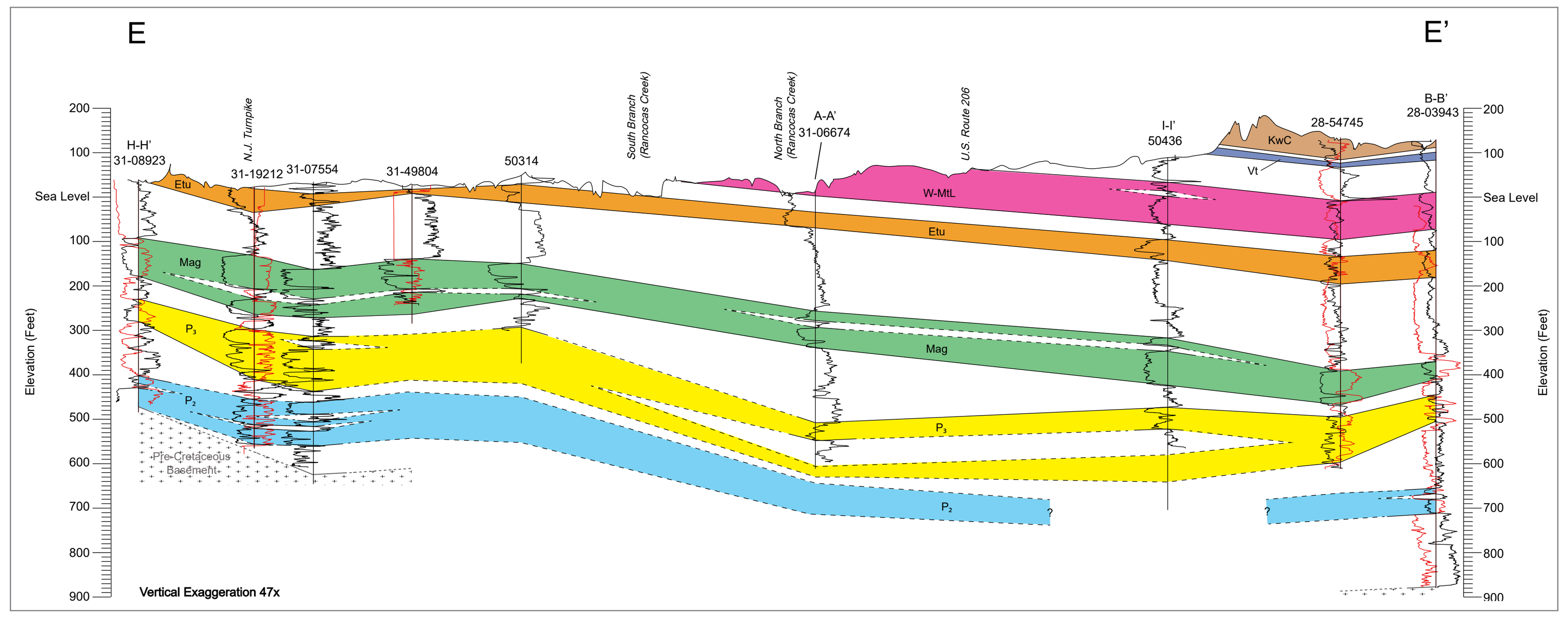
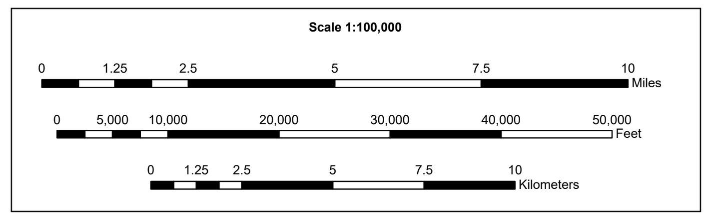


Figure 13. Hydrogeologic cross-section E-E'.



Explanation of Aquifer Unit Symbols

Symbol	Unit
KwC	Kirkwood-Cohansey aquifer system
RG	Rio Grande water-bearing zone
800 ft Sand	Atlantic City 800 ft sand
PP	Piney Point aquifer
Vt	Vincentown aquifer
W-MtL	Wenonah-Mt. Laurel aquifer
Etu/Etl	Englishtown aquifer (upper = Etu; lower = Etl)
Mag	Magothy aquifer
P_3	Potomac, Unit 3 aquifer
P_2	Potomac, Unit 2 aquifer
P_1	Potomac, Unit 1 aquifer

Explanation of Symbols

- Contact
- Inferred aquifer contact
- Inferred basement elevation

NJDEP Permit Number or USGS GWSI Number*	Municipality	USGS Quadrangle Name	Total Depth (ft)	Hydrogeologic Cross-Section
50063*	Burlington Twp.	Bristol, PA-NJ	294	C-C'
50117*	Chesterfield Twp.	Allentown, NJ	329	B-B'
50119*	Chesterfield Twp.	Trenton East, NJ-PA	305	B-B'
50220*	Bordentown Twp.	Trenton West, PA-NJ	252	I-I'
50282*	Moorestown Twp.	Moorestown, NJ	407	D-D'
50314*	Mount Laurel Twp.	Moorestown, NJ	420	E-E'
50417*	Shamong Twp.	Indian Mills, NJ	244	A-A'
50436*	Springfield Twp.	Columbus, NJ	800	I-I', E-E'
50648*	Willingboro Twp.	Beverly, PA-NJ	318	C-C'
50666*	Willingboro Twp.	Beverly, PA-NJ	121	A-A'
50741*	Springfield Twp.	Bristol, PA-NJ	285	D-D'
27-00228	Westampton Twp.	Bristol, PA-NJ	345	D-D'
27-01689	Willingboro Twp.	Beverly, PA-NJ	258	A-A'
27-01728	Willingboro Twp.	Bristol, PA-NJ	416	A-A', C-C'
27-01743	Westampton Twp.	Bristol, PA-NJ	215	A-A'
27-03894	Westampton Twp.	Bristol, PA-NJ	436	A-A', D-D'
28-03560	Mansfield Twp.	Columbus, NJ	310	I-I'
28-03943	North Hanover Twp.	New Egypt, NJ	1008	B-B', E-E'
28-05128	Springfield Twp.	Columbus, NJ	641	I-I'
28-07100	Bordentown Twp.	Bristol, PA-NJ	233	I-I', C-C'
28-08074	North Hanover Twp.	New Egypt, NJ	891	B-B', D-D'
28-25950	Mansfield Twp.	Columbus, NJ	624	D-D', I-I'
28-25952	Mansfield Twp.	Columbus, NJ	766	D-D', I-I'
28-32509	Chesterfield Twp.	Columbus, NJ	348	I-I'
28-34241	North Hanover Twp.	New Egypt, NJ	675	D-D'
28-54745	Wrightstown Boro.	New Egypt, NJ	746	E-E'
28-57004	Chesterfield Twp.	Trenton East, NJ-PA	397	B-B', C-C'
31-03674	Moorestown Twp.	Moorestown, NJ	270	H-H', C-C'
31-04637	Mount Holly Twp.	Mount Holly, NJ	380	A-A'
31-05023	Medford Twp.	Mount Holly, NJ	1132	A-A'
31-06305	Evesham Twp.	Moorestown, NJ	601	H-H'
31-06674	Mount Holly Twp.	Mount Holly, NJ	627	A-A', E-E'
31-06819	Lumberton Twp.	Mount Holly, NJ	401	A-A'
31-07554	Mount Laurel Twp.	Moorestown, NJ	681	E-E'
31-08923	Maple Shade Twp.	Moorestown, NJ	523	H-H', E-E'
31-16976	Medford Twp.	Medford Lakes, NJ	801	A-A', F-F'
31-19212	Mount Laurel Twp.	Moorestown, NJ	591	E-E'
31-21189	Medford Twp.	Medford Lakes, NJ	716	A-A'
31-27677	Medford Twp.	Mount Holly, NJ	191	H-H'
31-39515	Evesham Twp.	Medford Lakes, NJ	900	H-H', F-F'
31-40388	Evesham Twp.	Medford Lakes, NJ	515	H-H'
31-49804	Mount Laurel Twp.	Moorestown, NJ	310	E-E'
31-61671	Cinnaminson Twp.	Moorestown, NJ	267	H-H'
31-65775	Maple Shade Twp.	Moorestown, NJ	468	H-H', D-D'
31-73542	Medford Twp.	Mount Holly, NJ	1090	A-A'
32-00436	Bass River Twp.	Oswego Lake, NJ	625	B-B', G-G'
32-00468	Woodland Twp.	Chatsworth, NJ	2297	B-B'
32-00637	Tabernacle Twp.	Medford Lakes, NJ	381	F-F'
32-00913	Washington Twp.	Atsion, NJ	546	G-G'
32-01525/12D	Washington Twp.	Jenkins, NJ	380	A-A', G-G'
32-01525/4D	Washington Twp.	Atsion, NJ	320	A-A'
32-01525/6D	Washington Twp.	Jenkins, NJ	265	G-G'
32-10400	Bass River Twp.	Jenkins, NJ	246	G-G'
32-10890	Bass River Twp.	Oswego Lake, NJ	610	B-B'
32-15460	Woodland Twp.	Pemberton, NJ	110	F-F'
32-17621	Pemberton Twp.	Browns Mills, NJ	440	F-F'
32-21761	Bass River Twp.	New Gretna, NJ	1957	B-B'
32-21805	Woodland Twp.	Woodmansie, NJ	1780	B-B'
32-22005	Woodland Twp.	Browns Mills, NJ	1016	B-B', F-F'
32-22560	Pemberton Twp.	Browns Mills, NJ	500	F-F'
32-25769	Tabernacle Twp.	Indian Mills, NJ	420	F-F'
32-27282	Pemberton Twp.	Browns Mills, NJ	544	F-F'
52-00009	Pemberton Twp.	Pemberton, NJ	1155	I-I'
57-05644/ 50448*	Springfield Twp.	Bristol, PA-NJ	284	C-C'
E201501346	New Hanover Twp.	New Egypt, NJ	1089	B-B'
E201501347	New Hanover Twp.	Browns Mills, NJ	1110	B-B'

*United States Geological Survey Groundwater Site Inventory (GWSI) number.

Table 2. Identification number, location, and total depth of wells used in hydrogeologic cross-sections. Well 28-25950 is not located on hydrogeologic cross-sections D-D' and I-I' due to its close proximity to well 28-25952 but was still used in the construction of such hydrogeologic cross-sections. See figure captions.

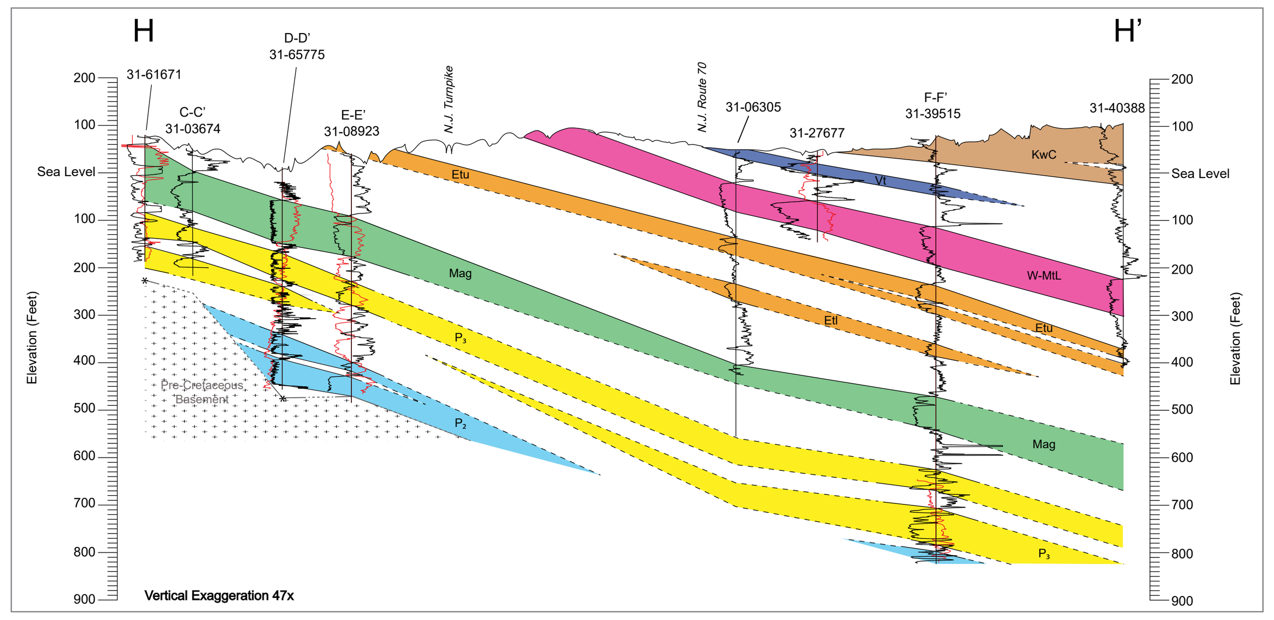


Figure 9. Hydrogeologic cross-section H-H'. Asterisk indicates depth to bedrock obtained from Volkert and others (1996).

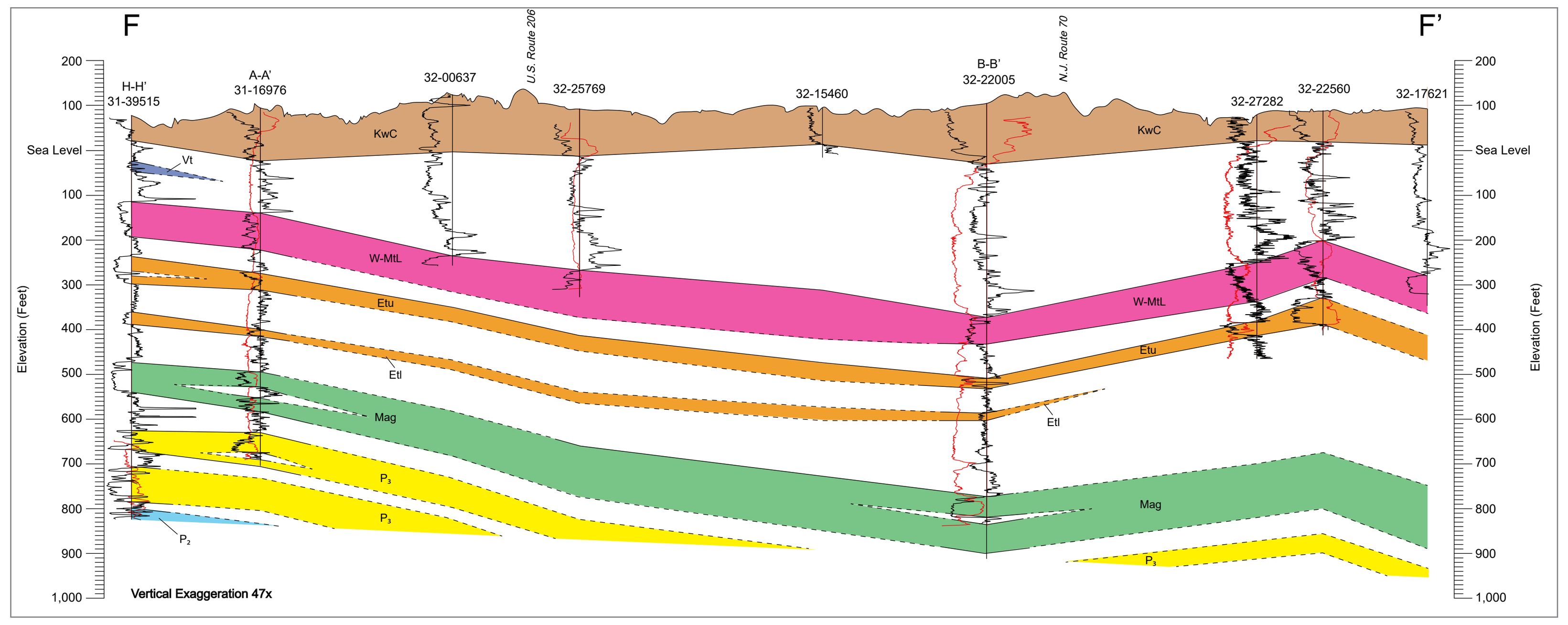


Figure 14. Hydrogeologic cross-section F-F'. Single Point Resistance log for well 31-39515 extends from 645 feet to 820 feet.

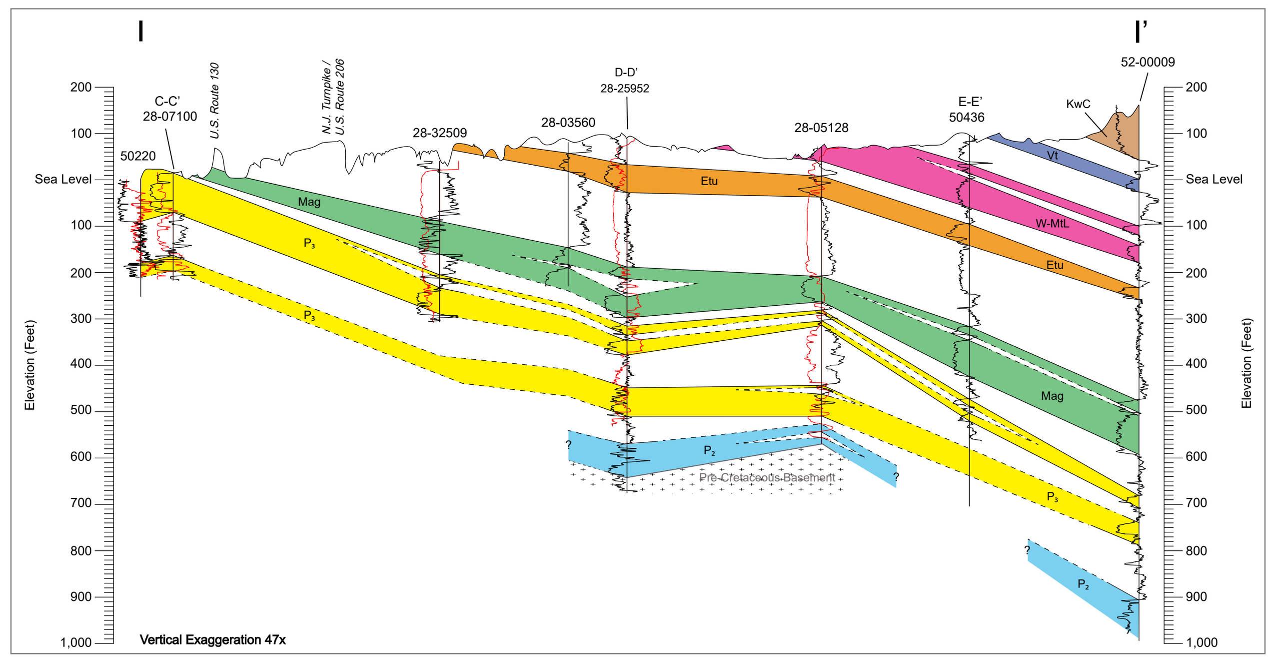


Figure 10. Hydrogeologic cross-section I-I'. Single Point Resistance log on well 28-25952 collected from well 28-25950, approximately 200 feet to the southeast.

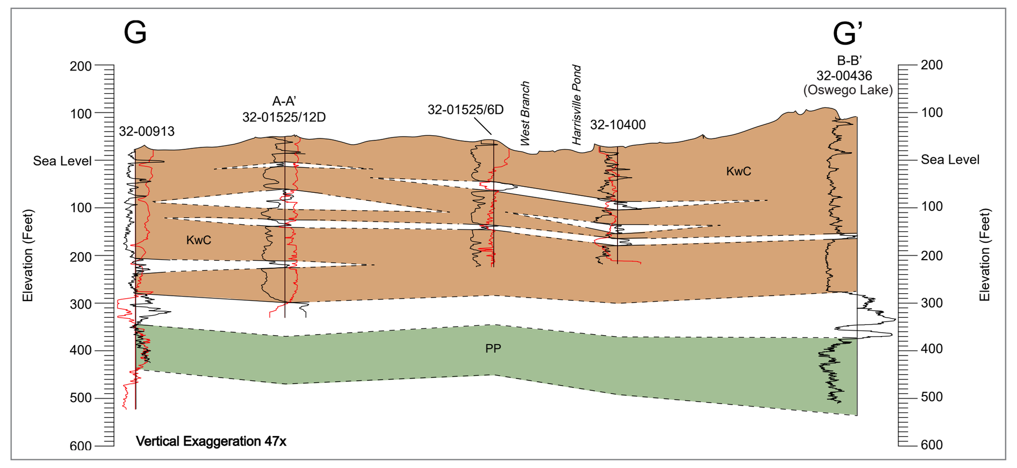


Figure 15. Hydrogeologic cross-section G-G'.

FRAMEWORK AND PROPERTIES OF AQUIFERS IN BURLINGTON COUNTY, NEW JERSEY

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2018