New Jersey NGWMN Statement of Interest

Submitted by the New Jersey Geological Survey

Introduction

New Jersey's ground-water resources are increasingly being utilized to meet the needs of the nation's most densely populated state. These ground-water resources are also critical in supporting stream flow and in-stream and related wetland habitats and the diverse aquatic ecologies associated with them. Despite plentiful average precipitation (roughly 45 inches per year) and significant public and private investment in water-supply infrastructure, the state's water resource managers must continuously balance increased use with environmental protection in the context of periodic drought and climate change. Key to the successful long-term management of New Jersey's ground-water resources is a viable ground-water quality and quantity monitoring network.

New Jersey uses roughly 1 trillion gallons of water per year. Of that trillion gallons, approximately 25% or 250 billion gallons per year comes from ground-water sources; with 75% coming from unconfined aquifers and 25% from confined aquifers. Figure 1 shows the average ground-water withdrawal by use category for the 1990s and indicates that over three quarters of all the ground-water withdrawals were for potable supply.

The New Jersey Department of Environmental Protection (NJDEP) and the New Jersey Geological Survey (NJGS), provide for the regulation and management of the state's water resources. In order to ensure the long-term viability of water resources the 1981 New Jersey Water Supply Management Act (N.J.S.A. 58:1A-1 et. seq.) mandated the development and completion of periodic revisions to the New Jersey Statewide Water Supply Plan (NJSWSP). The NJWSP provides a statewide framework for quantifying the availability of New Jersey's surface and ground waters to meet current and projected water supply demands within sustainable limits. Water availability considers approved allocations, infrastructure capacity and the "sustainability" to determine whether the water resource is stressed or unstressed. Key to the success in determining and evaluating the effectiveness of the sustainability limits is the long-term collection, maintenance, and analysis of ground water quality and quantity data-monitoring networks.

Proposed Project Area

The proposed project area would encompass the entire state of New Jersey which includes the Coastal Plain physiographic province in the Southern part of the state and the Valley and Ridge, Highlands, and Piedmont provinces in the north. A map of the principle aquifers commonly recognized in New Jersey is shown in Figure 2.

Principal Aquifers

The five principal Coastal Plain aquifers are the Kirkwood-Cohansey aquifer system, the Atlantic City 800-foot sand, the Wenonah-Mount Laurel aquifer, the Englishtown aquifer, and the Potomac-Raritan-Magothy aquifer system. All but the Kirkwood-Cohansey are confined over much of their extent. The aquifers are recharged directly by precipitation in outcrop areas, by vertical leakage through confining beds, and by seepage from surface-water bodies. A conceptual model of the hydrogeologic framework for the Coastal Plain aquifers has been developed by the USGS as part of the RASA program. The conceptual model is documented in Zapecza, 1989. These aquifers are all contained within the Northern Atlantic Coastal Plain aquifer system as defined in the National Atlas.

North of the Fall Line, the principal aquifers consist of glacial valley-fill deposits; fractured shale, limestone, sandstone, conglomerate, and crystalline rocks. These aquifers include the glacial valley-fill aquifers, the Newark Group aquifers (corresponding to the Early Mesozoic basin aquifer), the carbonate aquifers within the valley and ridge sedimentary units (corresponding to the Valley and Ridge aquifers and the Valley and Ridge carbonate-rock aquifers), and the igneous and metamorphic crystalline rocks of the Highlands crystalline units (corresponding to the Piedmont and Blue Ridge crystalline-rock aquifers and the Piedmont and Blue Ridge carbonate-rock aquifers).

Monitoring network goals

The current NJSWSP (draft as of 10-2009) defines both confined and unconfined aquifer availability and determines whether the resource is stressed or unstressed. Both availability methods rely on surface and ground water data collected by federal, state, inter-state, and local governments, as well as private agencies. HUC11 basins and the stream low flow margin availability method are used to define the status of the unconfined aquifer. The stream low flow margin method uses stream base flow statistics to estimate availability. Unconfined ground water data is used to develop the relationship between ground water diversions and stream flow depletion. The ideal network would have ground and surface water monitoring stations in each HUC11. Confined aquifer availability limits are primarily derived using ground-water models and the criteria designated by the Critical Area Rules contained in the1981 New Jersey Water Supply Management Act (N.J.S.A. 58:1A-1 et. seq.) and related regulations . These models are calibrated using long-term monitoring wells and water quality data. The confined aquifer monitoring wells are also used to evaluate the effectiveness of management. Key metrics are (1) water levels and (2) position of the saltwater interface (250 mg/l Cl and 50 mg/l Na).

Unconfined groundwater level data is also utilized to monitor real-time drought conditions throughout the state. The real-time groundwater level data is compared to historic levels to determine a percentile ranking of current conditions. The results are used to in combination with a suite of indicators to actively monitor hydrologic conditions throughout the state. The data provide an invaluable tool to monitor short-term, but potentially severe hydrologic stresses.

Description of networks

There are several existing groundwater monitoring networks in New Jersey that are primarily operated on a coordinated and cooperative basis by NJGS and USGS. These networks constitute the “backbone” of available monitoring points for the pilot project. Sources for additional points to provide additional density and fill data gaps will be discussed further. An overview of these backbone networks follows.

Water-level monitoring

Water-level monitoring in New Jersey is composed of two networks. The long-term groundwater-level monitoring network is designed to measure trends in water levels in both confined and unconfined aquifers throughout the state. The synoptic groundwater-level monitoring is designed to observe long-term trends at a more detailed scale in the Coastal Plain aquifers.

Long-term groundwater-level monitoring network

There are 189 wells in the NJDEP/USGS long-term water-level monitoring network. (Figure 3, table 1). A subset of the unconfined wells is equipped with telemetry to provide real-time water-level data for drought monitoring. The objective of this network is to provide a continuous record of water levels in the major aquifers of the state. A selection of these wells is used to provide data for NJDEP’s drought monitoring system.

Synoptic groundwater-level monitoring network

There are 888 wells in the NJDEP/USGS Coastal Plain aquifer synoptic water level monitoring network. (Figure 4, table 2) The objective of this network is to provide a snapshot of confined Coastal Plain aquifer water levels. Data is collected every 5 years, and was started in 1978.

Water quality monitoring

Groundwater quality monitoring in New Jersey consists of two networks. The Chloride Monitoring Network is designed to monitor saltwater intrusion in the Coastal Plain aquifers. The New Jersey Ambient Ground Water Quality Monitoring Network provides information about land-use related water-quality in the shallow aquifers throughout the state.

Chloride Monitoring Network

There are 165 wells in the NJDEP/USGS chloride network. (Figure 5, table 3). While many of the sites are located in coastal areas for obvious reasons, the purpose of the inland sites (fig. 5) is to monitor the possible movement of deep, old saline water into parts of the aquifer used for water supply.

New Jersey Ambient Ground Water Quality Monitoring Network

The NJ Ambient Ground Water Quality Monitoring Network (AGWQMN) is a cooperative network between the NJGS/NJDEP and the USGS, which provides information about land-use-related nonpoint source contaminant affects on shallow ground water quality. The water table is the doorway into the ground water system and is most vulnerable to contamination. This shallow ground water then recharges deeper aquifers used for potable supplies and provides base flow to local streams and wetlands. The goals of the network are: (1) to assess the water quality status, (2) to assess water quality trends, (3) to evaluate contaminant transfer relations, and (4) to identify emerging issues.

The network consists of 150 wells statewide; with 60 wells in agricultural land use, 60 in urban land use, and 30 in undeveloped land use (Figure 6, table 4). Well sites were located using a stratified-random site selection process as outlined by Scott (1990). Land use designations were determined using 1986 and 1995 land use coverages, 1995 aerial photographs, site visits, and estimations of ground-water flow directions based on the local geologic framework and site-specific topographic controls. The 1986 and updated 1995 digital land-use data categories were interpreted from 1986 and 1995 color infrared aerial photography (NJDEP, 2000). Since this network is set up to cover the whole state, there are monitoring wells located in the following national principal aquifers: Northern Atlantic Coastal Plain Aquifer system, Piedmont and Blue Ridge Aquifer system, and the Valley and Ridge Aquifer system.

Thirty network wells are sampled per year on a 5-year cycle. The monitoring wells are screened just below the ground-water table. The NJGS manages the network design, well installation, well maintenance, collects ground water samples, data interpretation, and reporting. The NJDEP Bureau of Fresh Water and Biological Monitoring and the USGS also assist in the collection ground-water samples, and all the samples are analyzed at the USGS laboratory in Denver, Colorado. Chemical and physical characteristics determined (or measured) for each well water sample include: field parameters such as pH, specific conductivity, dissolved oxygen, temperature, ground water level and alkalinity; major ions, trace elements, gross-alpha particle activity, volatile organic compounds (VOC), and pesticides.

To date the entire network has been sampled twice, and the third round of sampling has begun. Total dissolved solids concentrations, as well as the concentration, frequency, and variety of trace elements, nutrients, volatile organic compounds and pesticides are found at significantly higher levels in wells located in agricultural and urban areas than from wells in undeveloped areas. Though each well has only been sampled twice, a decrease in the frequency of MTBE detections state wide has been observed, as well as a decrease in the median concentration of

MTBE. A decrease in the variety of pesticides detected has also been observed. This is an active monitoring network, and when applicable can be used to assist on other projects and monitoring needs.

Field practices

Guidelines for the collection of field measurements have been established by NJDEP (2005). USGS standards are generally used for collection of groundwater data from the backbone network sites.

Data management systems

Data from the backbone networks are stored either in the USGS NWIS, GWSI, ADAPS, and QWDATA systems. Data may also be stored in the NJDEP NJEMS or WQDE systems. Data may also be stored in USEPA systems.

Project personnel, key pilot partners

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Approach

The approach for this effort is broken into 6 tasks that follow the recommended course in the RSOI document.

Task 1: Evaluate potential monitoring points

Groundwater monitoring points, for water level and water-quality data collection purposes are available from a number of agencies in New Jersey. These include NJDEP, private and public water purveyors, USGS, and other land-use regulation entities such as the Pinelands Commission and the Highlands Council. The pilot project will assess the availability of data from each of these sources. NJDEP regulations require reporting of water-level, water-quality, and water-use information from private and public water purveyors. There are approximately 600 permitted water purveyors in New Jersey using groundwater as a source (2000-series and 5000-series permits). These data are stored in several NJDEP data systems, including NJEMS, and WQDE. These data points, together with those from the formal groundwater monitoring networks discussed above, will constitute the bulk of the data available for this pilot project. There are about 2,000 other permitted and registered groundwater users (commercial and agricultural) in New Jersey who are not required to submit data to NJDEP, but who may have made measurements. The use of these data will not be explored in this pilot project because of the large effort it would take to organize their assimilation. Additionally, groundwater data is also available from site remediation activities, but as recommended in the RSOI, these sources will not be explored. The primary result of this Task will be the completed compilation of data from these targeted sources

Task 2: Classify monitoring points as "stressed" or "unstressed"

The classification of each observation point as being in a stressed or unstressed situation, from a water level perspective, will be handled in several ways. First, where sufficient historical record exists, an analysis for trends, especially downward, could indicate proximity and influence from pumping stresses for that particular well. The identification of areas under stress has significant relevance to New Jersey regulatory programs. This will lead to additional approaches for this issue. These additional approaches are dependent on whether the well in question is confined or unconfined. This distinction relates to differences in prevailing NJDEP water management policy. As described above, NJDEP has developed a HUC-11 basin-scale accounting to determine possible stream-baseflow reductions. Consumptive unconfined ground-water withdrawals as well as direct surface-water withdrawals contribute to the possible baseflow reduction. An assessment by NJDEP as part of the Statewide Water Supply Master Plan has evaluated withdrawals and stream low-flow characteristics to classify those HUC-11 basins as being in water-supply surplus or deficit, both under present conditions and a maximum permitted use. A major objective of groundwater-level monitoring in New Jersey is to provide a metric to monitor this issue. Unconfined aquifer observation points located in basins classified as being in deficit will be considered to be stressed. Unconfined aquifer observation points located in basins classified as being in surplus will be considered to be unstressed.

An additional dimension to the classification of unconfined aquifer sites as stressed or unstressed will be relative to measuring drought effects. NJDEP maintains drought information from a selection of specific wells in the long-term water-level monitoring network. The information from these wells is factored into decisions about the declaration of drought emergency by the

Governor. The classification of a site being stressed during drought, and thus useful in tracking drought conditions, will be considered.

Changes in groundwater quality data collected in unconfined aquifers such as with purveyor data or from AGWQMN could also be used as the basis for stressed versus unstressed classification. This will be explored.

Confined aquifers exist throughout New Jersey. This pilot project, however, will focus only on monitoring associated with the confined aquifers of southern New Jersey's Coastal Plain. NJDEP has developed the concept of Water Supply Critical Areas that have guided the regulation and management of water supplies in these confined Coastal Plain aquifers. The key metrics for the designation of a Critical Area are groundwater levels that have declined to below 30 feet below sea level and are within 5 miles of a 250 mg/l chloride concentration interface. These metrics will provide the basis for the classification distinction between stressed versus unstressed. It is certainly of interest to not only classify based upon current conditions, but also to project the effects of future withdrawals. Groundwater-flow model results (Gordon, 2007) showing projected groundwater-level changes will be used in this regard.

Because the critical area metrics involve a water-quality parameter, namely dissolved chloride, the inclusion of chloride data into the stressed versus unstressed classification is important. Where sufficient historical data allow, increasing chloride values, above a set threshold, will be considered stressed. These different factors will be integrated into an overall stress or unstressed classification for confined aquifer monitoring point.

The primary results of this Task will be (1) the development of a detailed approach for the classification, and (2) the addition of classification data to the compilation completed in Task 1.

Task 3: Identify data gaps

The focus of this task will be to overlay the backbone monitoring networks with the possible additional monitoring points developed in Task 1 to fill data gaps. Areas that have been designated as stressed will receive priority for a higher monitoring density. The aggregation of monitoring points that have been designated as stressed may help refine the areas that are designated as stressed. For the unconfined aquifers, the overlay process will use HUC-11 basins as the primary area unit. Because of the importance of streamflow information to the HUC-11 based regulation, an assessment could be made about identifying stressed basins without a stream gage.

A formulation for a similar area-based process will be developed for the confined Coastal Plain aquifers, possibly proceeding using the "budget areas" defined by the Statewide Water Supply Master Plan and Gordon (2007). This data gap assessment would proceed for the long-term water-level network as well as for the synoptic water level network.

The primary result of this task will be the identification of monitoring points originating from purveyor or others sources that could be used to enhance the existing backbone networks. Data gaps that cannot be filled with existing data will be identified and used to prioritize future network enhancements.

Task 4: Evaluate consistency of field practices and data management standards with NGWMN criteria.

The consistency of data provider's field practices as well as data management standards with NGWMN criteria will be evaluated. A summary table will be developed to highlight this evaluation.

Task 5: Evaluate the ability of the data management system to interface with a NGWMN data portal

Assistance from SOGW will be required to plan and execute an evaluation of the ability of the relevant data management systems to interface with a NGWMN data portal.

Task 6: Prepare report

The report will summarize the results of stressed-unstressed classification, data gaps analysis, and comparability to the NGWMN criteria. Additionally, as required, the report will include an estimation of the timeframe required to (a) meet NGWMN criteria; (b) identify ground-water monitoring points that would contribute data for the Pilot Project; (c) incorporate design, field, and data management features of the NGWMN into operating procedures and database structures and processing on a total and per well basis; and (d) Interface with the NGWMN data portal to routinely provide data.

References

Gordon, Alison D., 2007, Simulated Effects of Projected 2010 Withdrawals on Ground-Water Flow and Water Levels in the New Jersey Coastal Plain - A Task of the New Jersey Water Supply Plan, 2006 Revision: U.S. Geological Survey Scientific Investigations Report2007-5134, 116 p.

NJ Department of Environmental Protection, 2000, 1995/97 Land use/land cover update by Watershed Management Area.

NJ Department of Environmental Protection, 2005, Field Sampling Procedures Manual, Revised April 2009, available online at: http://www.state.nj.us/dep/srp/guidance/fspm/pdf/fsmp2005.pdf

Scott, J.C. 1990, Computerized stratified random site-selection approaches for design of a ground-water-quality sampling network, U.S. Geological Survey, WRI Report 90-4101.

Serfes, M., Bousenberry, R., Gibs, J., 2007, New Jersey Ambient Ground Water Quality Monitoring Network: Status of shallow ground-water quality, 1999-2004, NJ Geological Survey Information Circular.

U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, available online at http://pubs.water.usgs.gov/twri9A.

Zapecza, O.S., 1989, Hydrogeologic framework of the New Jersey Coastal Plain, Regional Aquifer-System Analysis--northern Atlantic Coastal Plain: U.S. Geological Survey Professional Paper 1404-B, 49 p.

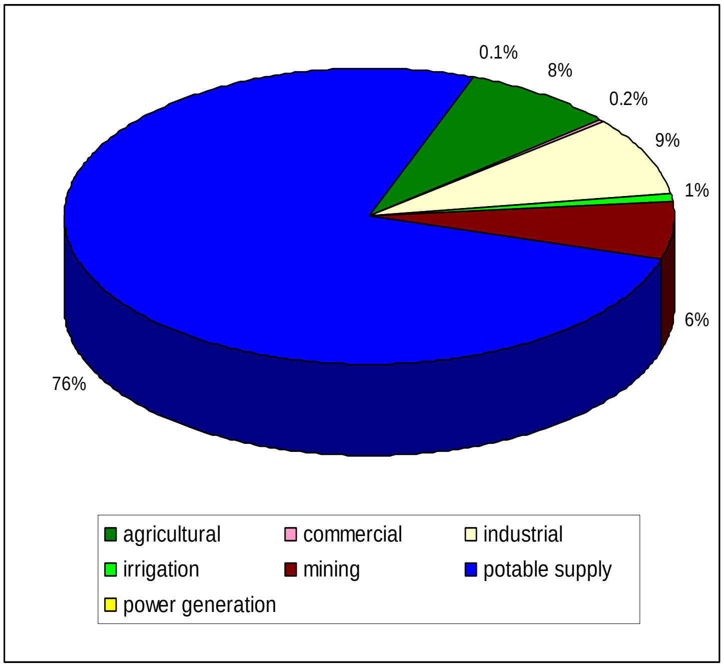

Figure 1. Average Ground Water Withdrawal by Use Category for the 1990s.

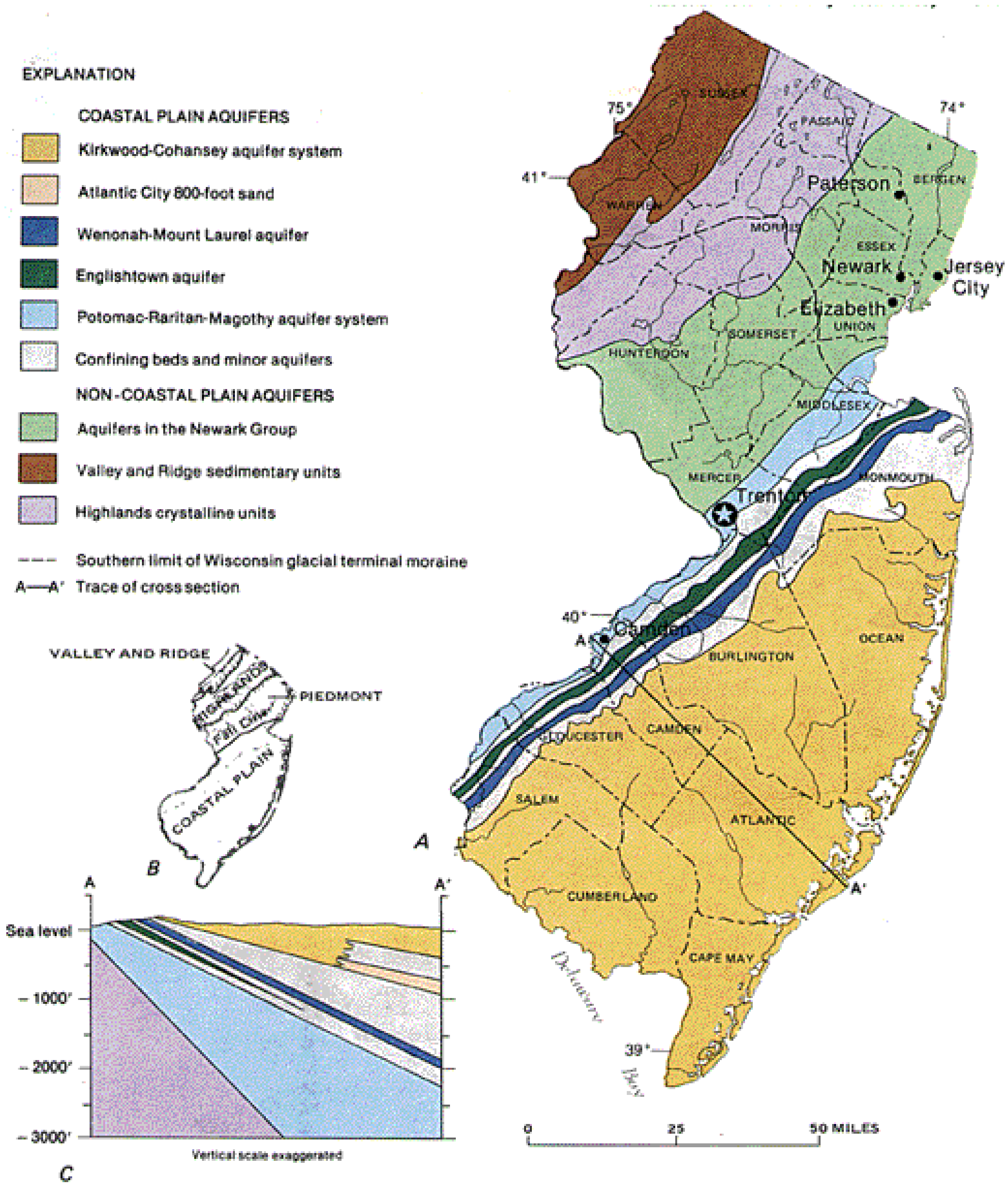

Figure 2. Principal aquifers in New Jersey. A, Geographic distribution. B, Physiographic Diagram and divisions. C, Generalized cross section (A-A') of the Coastal Plain.

Figure 3. NJDEP/USGS long-term water-level monitoring network

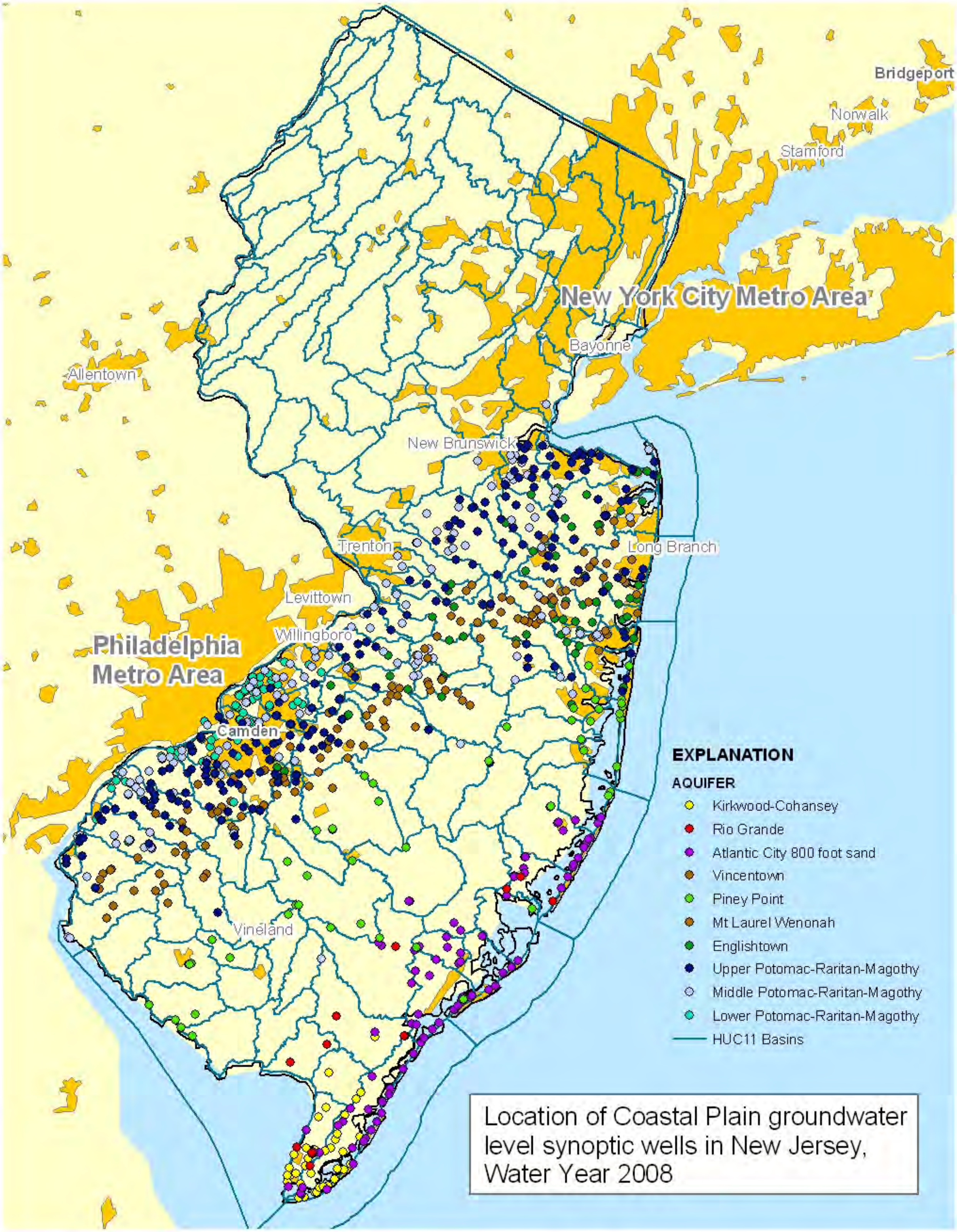

Figure 4. NJDEP/USGS Coastal Plain aquifer synoptic water level monitoring network.

Figure 5. NJDEP/USGS groundwater chloride network.

Figure 6. NJDEP/USGS Ambient Ground Water Quality Monitoring Network (AGWQMN).