State of New Jersey
Department of Environmental Protection

NEW JERSEY WATER SUPPLY PLAN 2017–2022

APPENDIX B

WATER SUPPLY OPTIONS, CONFINED AQUIFERS OF THE NEW JERSEY COASTAL PLAIN

The confined aquifers of the Coastal Plain are a major source of water supply for New Jersey, providing approximately 40% of the groundwater supply to the southern region of the state. The future availability of water from the confined aquifers of the New Jersey Coastal Plain is constrained by a number of factors, including:

- Regulations imposed in Water Supply Critical Areas 1 and 2 and any future revisions to those regulations.
- The threat of saltwater intrusion in seaward and bayward margins of the aquifers.
- Lack of stabilization of water levels within the aquifers.
- The potential for impacts to wetlands and surface water in the outcrop areas of the aquifers.
- Water-level interference with other users

Steadily increasing use of these aquifers over the past several decades has caused progressive declines in water levels in some areas and saltwater intrusion in other areas. Large cones of depression (cone-shaped water-level surfaces that point downward) centered on pumping wells occur in many areas of the coastal plain. Where these are near saltwater sources they increase the risk of saltwater intrusion into confined aquifers by lowering the pressure of fresh water that resists the intrusion of denser salt water. Sea-level rise also promotes saltwater intrusion, but this is a more gradual process. Saltwater intrusion has compromised confined aquifers in several places, including Raritan Bay, the Delaware River valley, the New Jersey Pine Barrens of Gloucester County, and Cape May County.

Hydrogeologic analysis of the confined aquifer systems of the New Jersey Coastal Plain has revealed the interconnected nature of the individual aquifers and their hydraulic connection to water-table systems. Water pumped from most confined aquifers of the New Jersey Coastal Plain comes principally from an overlying or underlying confined aquifer(s) and/or the water-table system. This emphasizes the need for a comprehensive, regional water-supply-planning perspective in assessing where additional supplies could be derived. Based on existing water-resource investigations and several analyses conducted as part of the Plan process it is clear that only limited supplies are available from confined aquifers without violating current regulatory restrictions or reaching non-sustainable levels of water extraction. Additional supplies may be available, depending on the level of tolerance for suppressed water-level elevations, impacts to the water-table system, and changes in water quality that are projected to take up to hundreds of years to occur.

Studies and associated projections are showing that many of the state's confined aquifers are approaching, have reached, or have exceeded sustainable levels of use. Evidence of rapidly or continually diminishing water levels, increased chloride and sodium concentrations, and increased recharge being induced from vulnerable water-table aquifers have given cause for concern over continuing to rely on confined aquifers for future supplies. The state has seen the installation of its first saltwater desalination well in Cape May City. Desalination may be a useful tool elsewhere in New Jersey in the future to increase supplies while dealing with increased saltwater intrusion. Studies of the water-supply options for Cape May County (Lacombe and others, 2009; Spitz, 1996) provide insights into need for desalination as a water supply option.

There is a growing interest in using confined aquifers as storage reservoirs to provide additional water to meet peak demands. Aquifer-storage-and-recovery (ASR) wells, which inject water from other sources, including other aquifers, treated surface water, and even treated wastewater, represent an option for conjunctive water use that increases the short-term availability of supply while avoiding long-term impacts to confined aquifers. The issues that tend to limit the viability of ASR wells relate to the contrasting geochemistry of water sources and its effect on well screens and the mechanics of well construction, development, and extraction. The net impact on groundwater quality is also a concern.

This present discussion of the characteristics, status and trends, and potential availability of water from the various confined aquifers of the New Jersey Coastal Plain is organized into four regions (fig. B1):

1. Atlantic Coastal Region
2. Cape May Peninsula
3. Water Supply Critical Area 1
4. Water Supply Critical Area 2 and Delaware Bay Region

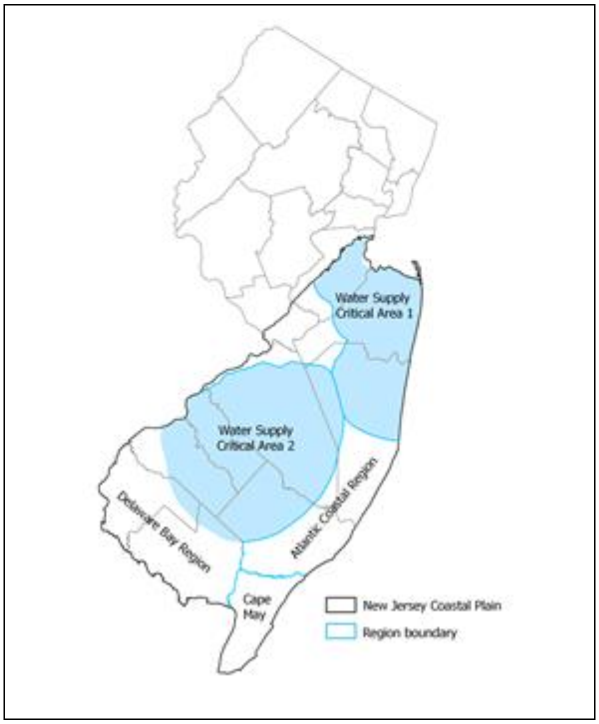

Figure B1 Regional delineation for discussion of water supply options.

ATLANTIC COASTAL REGION – AVAILABLE WATER SUPPLY FROM CONFINED AQUIFERS

Confined aquifers are the principal source of water supply along the Atlantic Coast and are heavily relied upon to supply water for the communities along the barrier island complex that borders the Atlantic Ocean. The principal confined aquifer source of supply to these communities is the Atlantic City 800-foot sand aquifer. Minor supplies are derived from the Rio Grande water-bearing zone within the Wildwood/Belleplain confining unit and the Piney Point aquifer.

ATLANTIC CITY 800-SAND AQUIFER

The Atlantic City 800-foot sand aquifer (800-foot sand) is found along the coast from Southern Ocean County to southern Cape May County and as far inland as central Atlantic County and the southernmost part of Burlington County. The aquifer is vital to the water-supply needs of barrier island communities in Ocean, Atlantic, and Cape May Counties. Withdrawals from the 800-foot sand have increased steadily over the past three decades, with the greatest use occurring in Atlantic County.

In western and central Ocean County the Atlantic City 800-foot sand aquifer is primarily recharged by water infiltration into its outcrop area to the west and by leakage from the overlying Kirkwood-Cohansey aquifer system. This results in pumping effects to be more localized. In the 800-foot sand's central and southern extent in Atlantic and Cape May Counties a higher percentage of well water comes from decompression of water in storage, causing pumping effects to extend more regionally. The balance of recharge to the aquifer in this region comes from the water-table system up-dip, leakage through the overlying confining unit, and offshore. Thus, the availability of water supply from the 800-foot sand in Atlantic County is related with that of Cape May County.

In 2004 the Department considered seven (7) requests for major increases in ground-water pumpage from the Atlantic County 800-foot sand aquifer along the coast totaling approximately 3.6 billion gallons per year. The Department commissioned the USGS to apply several ground-water models to evaluate the regional and cumulative impact of this proposed increase. The model results indicated that most of the diversions individually generated between an additional 5 and 20 feet of drawdown in the aquifer. Resulting water levels in the Atlantic City 800-foot sand aquifer after the final simulation were on the order of 140 to 150 feet below sea level, approximately 60 feet lower than water levels measured by USGS in 2003. The modeling effort included an analysis of the flow of water particles from the suspected 250-mg/l chloride line in the 800-foot sand in Cape May County. The study concluded that individual particles of salt water from this saltwater front would arrive at supply wells in northern coastal Cape May County and would be mixed with fresh water, resulting in increased sodium and chloride concentrations to unknown levels. The arrival time for particles from the 250-mg/l chloride line varied widely, depending on where the salt water originated. Travel times varied from over 700 years to 2,100 years.

The Atlantic City 800-sand aquifer presents significant challenges to future supply considerations. Hydrogeologic studies have revealed that continued increases in use will cause ground-water levels to continue to decline considerably. Predictions of water-level decline based on recently approved withdrawals and population projections within Atlantic County to the year 2010 cause water levels to exceed 180 feet below sea level at their deepest point. The last regional collection of ground-water levels from this aquifer under the USGS/NJDEP Synoptic Water-Level Program occurred in 2013 with a new synoptic planned for 2018

Recent ground-water modeling simulations performed by USGS for the NJSWSP (Gordon, 2007) using the USGS Coastal Plain Regional Aquifer Systems model (RASA) indicate that increased water use from the 800-foot sand will continue to lower water levels in the aquifer and will induce increased flow from the water-table system to the northwest and from saltwater sources to the southwest. Because of its regional extent pumpage from the aquifer in coastal Atlantic County can have significant impacts to water levels in Cape May County and vice-versa. The presence of a saltwater front (250 mg/l isochlor) with the aquifer in southern Cape May County raises the level of concern over this relationship. Many municipalities rely on this aquifer for water supply in Cape May.

Determining the precise impact on any one well is complicated, as the relative contribution of recharge from these sources as well as overlying and underlying aquifers must be determined. The Department commissioned a detailed study of the water-table aquifers in this region that address the relationship between pumpage from the confined system and impacts to the unconfined system. This study, published as Pope and others (2012) provides insights into the relationship between withdrawals in the confined aquifer and impacts in the overlying unconfined aquifer. The results show that the impacts of confined aquifer withdrawals are spread out over both the overlying unconfined aquifer and in the confined aquifer's outcrop areas updip.

PINEY POINT AQUIFER

The Piney Point aquifer is found beneath the Atlantic City 800-foot sand and is correlative with several different geologic units; it is a minor confined aquifer in the New Jersey Coastal Plain. The Piney Point has no surface expression and relies entirely on leakage from overlying and underlying aquifers for replenishment; water levels appear to decline rapidly in response to relatively small volumes of use. The 250-mg/l isochlor (salt water front) within the aquifer is present onshore in Cape May and Atlantic County. The aquifer is thinnest in its central region and thickens toward the coast and toward Delaware.

The Piney Point aquifer is used at several localized pumping centers. The largest of these is in coastal area of Ocean County at Seaside Park and Barnegat Light. Additional use occurs inland in Atlantic County in Buena and more recently at Bridgeton in Cumberland County. According to the most recent water-level data collected by the USGS, water levels in the southern and western parts of the aquifer in Atlantic, Cumberland, and Southern Ocean County have not stabilized and continue to decline (DePaul and Rosman, 2015). In addition, a significant cone of depression is found in the coastal area of Atlantic County centered on Ventnor City that is attributable to pumpage in the overlying Atlantic City 800-foot sand aquifer. The 250 mg/l isochlor in the Piney Point aquifer is estimated to occur in northern Cape May and coastal Atlantic County (dePaul and others, 2009). Water levels in the northern reach of the aquifer in western Atlantic, Ocean and Burlington Counties are more stable. Water use in the State of Delaware can significantly impact water levels in the Piney Point in Cumberland County. A major cone of depression centered on Camden in Kent County, Delaware, extends into Cumberland County. Recent water-level trends in the Bridgeton area confirm that the aquifer cannot sustain large-scale water-supply development without a rapid, significant, and continuous decline in water levels.

The Piney Point aquifer provides sufficient yield in its northeastern extent for public supply, but is limited by its aesthetic quality. In its southeastern extent the aquifer has proved unreliable as a sustainable source of major supply. Although it is relied upon locally for water supply, the Piney Point aquifer appears to have limited long-term potential for additional major water supplies due to its limited extent and its rapid decline in water levels in reaction to pumping.

The Piney Point aquifer may continue to be a viable source of modest quantities of water within its northern extent areas, serving as a viable replacement supply or alternative to other aquifers where water quality is an issue. Its potential in coastal areas is limited by the position of the saltwater front. Interference from pumping in Delaware is an issue that must be factored in to the overall assessment of the aquifer's potential. The fact that the aquifer is completely confined suggests that water use from it comes at the expense of storage in overlying and underlying aquifers. Any future requests for use from the Piney Point aquifer will only be approved by the Department with great caution.

VINCENTOWN AQUIFER

The Vincentown aquifer is a minor source of water supply. It is a fairly reliable source that is limited by its geographic extent and instantaneous yield. The Vincentown serves as a minor aquifer in its outcrop area and where it is confined, up to 10 miles down dip of its outcrop (Zapecza, 1989). The Vincentown is capable of satisfying relatively small public supply demands. The Vincentown is thickest and most heavily used in Monmouth and parts of Ocean County, and is less well defined outside this area. In its down-dip area it acts as a confining unit.

Water levels in the Vincentown aquifer have remained relatively stable over the past ten years in response to water use. Modeling by the USGS (Gordon, 2007) show only a minor change in water levels on the order of two feet near a pumping center at the Monmouth-Ocean County border in response to increased demand. Increased pumpage near the outcrop of the aquifer would derive most of its water from recharge and stream leakage.

The Vincentown remains a minor option for future water supplies. The lithology, extent and in some areas the thickness of the aquifer is self-limiting in terms of its ability to meet significant demands. Because water-bearing sands only are found within approximately 10 miles of its outcrop area, impacts to stream flow are an issue of concern in some areas, especially in close proximity to unconfined parts of the aquifer. No estimate of the overall availability of supply from this aquifer can be easily made. Withdrawals would have to be evaluated on a case-by-case basis, with a significant issue being the potential for depletion of surface water.

CAPE MAY PENINSULA – AVAILABLE WATER SUPPLY FROM ALL AQUIFERS

Cape May County is a peninsula surrounded by salt water. Its freshwater aquifers are likely exposed beneath the Delaware Bay, which is salty. Water withdrawals from the semi-confined Cohansey and the confined Atlantic City 800-foot sand aquifers have lowered water levels and caused the intrusion of salt water inland. Supply wells in Wildwood, Cape May City, and Lower Township have already been abandoned due to saltwater intrusion. The Cape May City water department has reduced withdrawals from its confined Cohansey aquifer well field because of saltwater intrusion and now has a desalination plant to treat brackish water withdrawn from the Atlantic City 800-foot sand.

A recent ground-water study and models of the peninsula by the USGS (Lacombe and others, 2007) show that pumpage of ground water at current rates will cause the 250-mg/L chloride line to reach Lower Township's most productive well within the semi-confined Cohansey aquifer and reach or nearly reach the Borough of Wildwood's Rio Grande well field that draws from the Cohansey by 2050; this suggests that even current water-use patterns are not sustainable.

Because the semi-confined Cohansey aquifer in Cape May County is proving to have exceeded sustainable levels based on water quality data, risking saltwater intrusion, the 800-foot sand aquifer has been looked at as an alternative for Cape May. Ground-water-model simulations show that increased use of the 800-foot sand in Cape May can have a significant effect on ground-water levels within the regional cone-of-depression centered in Atlantic County, and may be available only in concert with desalination.

The 2007 USGS study and model examined nine water-supply scenarios for the confined aquifers of Cape May County. The basic scenarios examined included: creating a hydrologic barrier against saltwater intrusion in the Cohansey aquifer by injecting treated, reclaimed water; installing new wells into the Atlantic City 800-foot sand aquifer at the Lower Township and Rio Grande well fields in combination with desalination, and; installing wells in the 800-foot sand to the north in Middle Township and to the south of existing well fields, where, although it exists, the 800-foot sand has elevated chloride levels that would require desalination.

According to the model results increased pumpage from the 800-foot sand would cause significant drawdown in this aquifer. Regardless of where new wells were placed in the simulations, significant drawdown occurs both in Cape May and Atlantic Counties. When new 800-foot sand wells are simulated near the Cape May Airport and the Cape May City well field, drawdown on the order of 100 feet near the Cape May/Atlantic County boundary and as much as 120 feet in southern Cape May County occurs; drawdown of as much as 130 feet in southern Cape May County was projected to occur in one scenario. These outcomes are a source of concern when considered in combination with the results from modeling increased use from the 800-foot sand in Atlantic County.

USGS simulated the time required for particles of water at the saltwater front to arrive at supply wells under the various alternatives described above varied (Voronin and others, 1996). Arrival times ranged from 13 to over 1200 years depending on the location of the well in question. These results provide insight into when chloride levels would be expected to begin to increase as a result of recharge from saltwater sources. Such water-quality deterioration is an indication that the associated use scenarios may not be sustainable in the long term. USGS is continuing to evaluate optimum locations for aquifer injection to prevent the saltwater front in the Cohansey aquifer from reaching existing public supply wells.

In Cape May County each of the water-supply alternatives from confined groundwater aquifers examined by the U.S. Geological Survey resulted in additional saltwater intrusion, unless accompanied by injection of reclaimed, treated wastewater. Increased withdrawals from the Atlantic City 800-foot sand substantially lower water levels in the aquifer throughout Cape May County and into Atlantic County and required desalination to some degree. Other recent studies (Lacombe, 1996; Lacombe and Carlton, 2002; Lacombe and others, 2009; Spitz, 1996; Spitz, 1998) have provided significant insight into the hydrogeologic setting of Cape May and feasible alternatives. The NJDEP is currently conducting a comprehensive review of these options in conjunction with a localized monitoring effort. The goal is a unified strategy for water supply to Cape May while addressing the saltwater intrusion threats to production wells.

WATER SUPPLY CRITICAL AREA 1 - AVAILABLE WATER SUPPLY FROM CONFINED AQUIFERS

During the 1980’s and 90’s the State responded to progressive water-level declines and saltwater intrusion within confined aquifers in the northern and central coastal plain by declaring two areas of “critical waters supply concern.” Within these two regions, Water Supply Critical Areas 1 and 2, the state mandated reductions in use, imposed restrictions on future use, and offered surface-water alternatives to replace ground-water supply. The Water Supply Critical Area regulations provide for review of the program after 10 years, to allow for assessment of progress as a result of the management plan and the opportunity to restructure the plan in response to findings.

The Department began a re-examination of Critical Area 1 in 2001. As part of a technical reassessment of hydrologic conditions in the region the US Geological Survey updated and refined its ground-water-flow model of the New Jersey Coastal Plain (Voronin, 2005), using water-use and water-level data from 1999. The model was used to evaluate the potential effects of an increase in pumping from critical aquifers for short periods to alleviate drought stress, examine the effect of increasing pumpage in areas that did not have ready access to the surface-water alternative, and determine if additional supplies could be extracted from the confined aquifers without contravening the limiting thresholds that were the basis for the initial Critical Area declaration.

The results of the USGS modeling efforts, an evaluation of ground-water-level trends, and the availability of alternatives were used to develop the following discussions of future water-supply options for Critical Areas 1 and 2. The studies conducted lead to a conclusion that the regional water-supply alternatives identified in the 1996 NJSWSP will continue to be endorsed, that a small amount of additional ground water may be available from confined aquifers in Critical Area 1 at optimum locations, and that additional water may be available to meet seasonal water-supply needs through redistribution of annual pumping schemes and use of aquifer storage and recovery methods.

There is a region of considerable size in Mercer, northern Burlington, southwestern Middlesex, and western Monmouth Counties between the boundaries of the Water Supply Critical Areas 1 and 2. Withdrawals from confined aquifers in this region would be constrained principally by whether associated drawdown impacts extend into the Critical Areas themselves, as well as the broader concerns as to whether such withdrawals adversely impact other users, surface water, and known contaminated sites. Because much of this area is near the outcrop area for several confined aquifers the relationship with surface water and the water-table aquifer may be more direct in places, raising the level of concern over impacts to the shallow hydrologic system.

The principal confined aquifers in Critical Area 1 consist of the Potomac-Raritan-Magothy (PRM) aquifer system, the Englishtown aquifer system, the Wenonah-Mount Laurel aquifer, and the Vincentown aquifer. The Englishtown aquifer system is most prolific in its northern extent, within Water Supply Critical Area 1. It is more marginal from a hydrogeologic perspective outside this area, presenting naturally occurring limits to its water-supply potential. In contrast, the Wenonah -Mount Laurel aquifer is less productive in Critical Area 1, but increases in thickness and permeability to the southwest and is more productive in Critical Area 2. The Vincentown aquifer supplies localized needs, however it is constrained by its limited geographic extent, its yield potential and its potential to impact surface water.

The USGS was commissioned to evaluate future water-supply-management options for Critical Area 1. To address this issue USGS combined the existing ground-water-flow model of the Coastal Plain (Martin, 1998; Voronin, 2005) with a ground-water-optimization model that allows for the user to set management constraints and thresholds and determine the optimum pumping strategy to gain additional water without contravening the limits set in the model (Spitz and others, in prep.). The ground-water model permits several types of hydrologic constraints to be employed to determine available water use from the confined aquifers in Critical Area 1 within the limits established.

Based on the model assessment of existing (1999) and full allocation diversion rates, no additional water is available from the existing wells in the PRM, Englishtown and MLW aquifers. If wells were to be located in idealized locations, a very small amount (less than 1 MGD) of additional water may be available, but not enough to make a difference. Based on the results of the study, and the current amount of unused base allocation, the Department does not intend to make changes to critical area aquifer allocated amounts at this time (either to increase or implement further reductions). For additional information, please refer to Spitz and others (2008) and to Spitz (2009**).**

An important concern is that withdrawals outside of the Critical Area 1 may impact water levels inside. If significant cones of depression develop just outside the critical area then NJDEP may take action to prevent adverse impacts.

WATER SUPPLY AVAILABILITY – WATER SUPPLY CRITICAL AREA 2 AND DELAWARE BAY REGION

Concern over continuous declines in water levels in the confined aquifers of the coastal plain, along with the resulting potential threat of saltwater intrusion from seaward parts of the aquifers and the Delaware River, led to the establishment of Water Supply Critical Area 2, centered on the Camden metropolitan area. The Department established a policy of attempting to stabilize aquifer water levels through reductions in pumpage from the Potomac-Raritan-Magothy (PRM) aquifer system, the most prolific source of water in the region, and a prohibition on future annual increases in use from the PRM. Although other aquifers were not included in the Critical Area declaration in this region, water-level trends in the Wenonah/Mount Laurel aquifer were another source of concern. Since water-use restrictions were imposed ground-water levels have recovered in the Potomac-Raritan-

Magothy aquifer system in several locations. In addition, according the results of ground-water model simulations, pumping induced stream leakage to the aquifers in their outcrop areas has diminished, resulting in the potential for recovery to some degree of stream flow in those areas.

WENONAH-MOUNT LAUREL AQUIFER

There has been an increase in interest to use the Wenonah-Mount Laurel aquifer to meet increasing water demands and provide replacement sources due to the imposition of restrictions on use in the PRM aquifer system. Limitations to increased use from the Wenonah-Mount Laurel aquifer include excessive drawdown and localized well interference and depletion of streams and wetlands in up-dip outcrop areas.

The USGS examined changes in water levels and sources of water to wells in the Wenonah-Mount Laurel aquifer using the New Jersey Coastal Plain RASA model (Gordon, 2007), assessing changes that would occur as a result of projected demand at 2010. Modeling of increased use from the aquifer based on projected population increases and associated demands predicts that water-level declines will continue in central Burlington County and recovery that was taking place would slow in northern Salem and Burlington Counties. In addition, water levels that had previously declined would continue to recover despite increased use in a large area of the aquifer from western Burlington County to Salem County.

ENGLISHTOWN AQUIFER SYSTEM

Although it is capable of supplying significant quantities of ground water, the Englishtown aquifer system is less productive in Critical Area 2 and the Delaware Bay region than it is in the northeastern coastal plain. The Englishtown Formation thins toward the southwest, where it tends to be less than 40 feet thick (Zapecza, 1989), and its sands are finer with a higher percentage of silt and clay; these factors affect its ability to supply water in parts of Critical Area 2. The largest withdrawals from the Englishtown are in north-central Camden County. Lesser supplies are derived in Burlington County.

The Englishtown aquifer system is a significant source of recharge to the upper PRM aquifer. Increased withdrawals in both the upper and middle PRM aquifers resulted in an increase in leakage from the Englishtown. Ground-water-model simulations of population-driven increases in withdrawals in these aquifers show the greatest drawdown in the Englishtown occurring in south-central Gloucester County, where no major withdrawals from the Englishtown exist. This pattern is a reflection of the contribution the Englishtown makes to the underlying PRM aquifers by way of vertical leakage of ground water through the intervening Woodbury-Merchantville confining unit. The simulations also show that increased use in the Englishtown would lead to increased leakage from the overlying Wenonah-Mount Laurel aquifer. An examination of water-level trends indicates that ground-water in the Englishtown exhibit recovery due to mandated water-use reductions in the underlying PRM aquifer system.

The future availability of supplies from the Englishtown aquifer system in Critical Area 2, therefore, is constrained by the physical characteristics of the aquifer and the effect pumping of the Englishtown has on the overlying Wenonah-Mount Laurel aquifer and the underlying upper PRM aquifer. There are limited locations where the Englishtown in this region can supply large quantities of water.

POTOMAC-RARITAN-MAGOTHY (PRM) AQUIFER SYSTEM

As part of the Critical Areas program the Department reduced the amount of withdrawals permitted from the PRM and placed a moratorium on increased use from the aquifer within the designated depleted and threatened zones.

While the management plan implemented in 1991 is still in progress, significant reductions in use have been achieved. The total reported water-supply diversions from the Potomac-Raritan-Magothy aquifer system in 1983 were approximately 38.6 billion gallons. Under modifications imposed by the management plan this dropped to 37.3 billion gallons in the year 1991 and 26 billion gallons in the year 2000.

While many purveyors are purchasing water from the Tri-County Project, an intake and treatment plant on the Delaware River at Delran, others have yet to contract for the water. As a result, as of May 2007 only 14 million gallons per day (mgd) of the 30-mgd capacity of the Tri-County Project is currently under contract. To operate the project's surface water treatment plant efficiently, the New Jersey American Water Company (NJAWC) has stopped the use of many of its wells within the Critical Area and is instead using water from the Tri-County Project to supply customers. This has resulted in approximately 2 billion gallons per year of NJAWC base allocation from the PRM going unused. Although water levels in the PRM aquifer system have shown a substantial increase, utilization of this unused ground-water base allocation would reverse the trend of increasing water levels seen in recent years.

Future water-supply withdrawals in the southwestern part of Critical Area 2 and the Delaware Bay region are constrained by the presence of the saltwater front (250-mg/l chloride line) that bulges nearly to the Delaware River in Gloucester County. Ground-water flow in this region is to the northeast, under the influence of the regional cone-of-depression in the aquifer in Camden County. Thus, areas of northwestern Gloucester County are either located in areas where the aquifer exceeds 250 mg/l chloride or immediately down gradient in the path of ground-water flow and therefore are at imminent risk of saltwater intrusion. Water-supply options from the aquifer are further constrained by the presence of the seawater front that is found beneath central Salem, Gloucester and Camden Counties. Withdrawals down dip in the aquifer risk mobilizing areas of elevated sodium and chloride found deep within the aquifer's seaward extent.

The availability of additional water supply from the lower PRM aquifer in Critical Area 2 and the Delaware Bay region is limited by the current Water Supply Critical Area 2 rules, the presence of the saltwater front (250-mg/l chloride line) beneath southern and western Gloucester County, the presence of the half-seawater line (10,000 mg/l chloride) down dip near the Salem/Cumberland and Gloucester/Atlantic County boundaries, and potential impacts from pumping in the State of Delaware.

The USGS, in cooperation with the NJDEP, used an existing Regional Aquifer-System Analysis (RASA) flow model of the New Jersey Coastal Plain to analyze the ground-water-flow system and provide information needed by water managers to make allocation decisions regarding the water supply. Model runs evaluated the hydrologic effects of 2003 reported withdrawal data and what would have occurred if withdrawals reached full allocation (also known as base allocation; a purveyor's portion of the safe or dependable yield of the water resource). While not at the same magnitude of the Critical Area 1 water level rebound, data for Critical Area 2 showed significant improvement over pre-designation levels. For example, two monitoring locations in Burlington and Camden counties show recoveries in water levels in the unconsolidated and middle portions of the PRM aquifer to approximately 50% of pre-1970 levels. The model results indicate that any reversal of current policy that would permit increased use from the upper PRM aquifer within Critical Area 2 poses a risk of reversing progress made in bringing about recovery of water levels in stressed aquifers, causing Critical Areas 1 and 2 to coalesce into a larger depleted region, and the lowering of ground-water levels near the 250-mg/l chloride line in Salem County, increasing the risk of saltwater intrusion at the periphery of Critical Area 2. Based on the results of the study, and the amount of unused base allocation, the Department does not intend to make changes to PRM allocated amounts at this time (either to increase or implement further reductions). Throughout Critical Area 2 additional supply may be available for some users in the form of base allocation transfers established under the Critical Area regulations. Geographical and institutional limitations constrain the volume of water available to any one user, but the option of trading base allocation under existing limits could solve local supply problems, such as replacing contaminated supplies or meeting short-term peak needs. For additional information, please refer to Spitz and DePaul (2008).

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Planning Region	Aquifer	Availability	Limitations
Water Supply Critical Area 1	General	Users should investigate the selected Critical Area water-supply alternatives, which are the Manasquan Reservoir and the Middlesex County pipeline. Also, transfer of base allocation within Critical Aquifers.	Remaining availability of safe yield from Manasquan Reservoir. Geographic feasibility of connecting to pipeline. Transfer of base allocation requires DEP approval, conditioned on need in growth area, lack of available alternatives, or resulting environmental improvement.
	All aquifers	Up to 1 mgd additional water may be available from Englishtown, Wenonah-Mount Laurel, and middle PRM aquifer, depending location of proposed withdrawal	Availability dependent of location of proposed well and impact in relation to environmental limitations, including drawdown near Raritan Bay, drawdown elevation, and drawdown within the Critical Area.
	Vincentown aquifer	Additional small-scale public supplies	Availability constrained by limited geographic distribution, low yields in places, and interaction with surface water near outcrop.
	Wenonah-Mount Laurel Aquifer	Less than 5 mgd available at optimum locations.	Not available in some geographic areas. Depends on additional withdrawals from other available aquifers.
	Englishtown Aquifer	Less than 5 mgd available at optimum locations.	Not available in some geographic areas. Depends on additional withdrawals from other available aquifers.
	Middle PRM aquifer	Less than 2 mgd available at optimum locations.	Geographic availability highly limited. Depends on additional withdrawals from other available aquifers.
Water Supply Critical Area 2	General	Users should investigate the selected Critical Area water-supply alternative, which is surface water from Tri-County Pipeline. Possible groundwater available as unused allocation.	Geographic location of user may affect feasibility of Tri-County supply.
	Piney Point aquifer	Availability limited to current use levels	Thinness of aquifer in region and lack of adequate recharge causes excessive drawdown at high and sustained pumping rates.
	Vincentown aquifer		Availability significantly constrained by limited geographic distribution, low yields in places, and interaction with surface water near outcrop.

Planning Region	Aquifer	Availability	Limitations
		Additional small-scale public supplies in places.	
	Englishtown Aquifer System	Limited supplies may be available locally	Availability constrained by limited geographic extent and effect on other aquifers from large-scale use.
	Wenonah-Mount Laurel Aquifer	Limited supplies may be available locally	Available where significant interference, depletion of surface water in outcrop area, or impacts on wetlands in outcrop area do not occur.
	PRM aquifer system	Transfer of base allocation from PRM aquifers and purchase of credits through Burlington County "Credit Bank".	Base allocation transfers in accordance with the rules. The Burlington County Credit Bank has 6.53 mgd of Credits available for use within the Water Allocation Credit Receiving Area in Burlington County.
Delaware Bay Region	General	Limited number of aquifers in region that are not subject to saltwater intrusion	
	Piney Point aquifer	Limited supplies may be available locally	Regional impacts from Delaware pose future problem. Lack of stabilization of water levels at high pumping rater are limiting factor. Chlorine line onshore.
	Wenonah-Mount Laurel Aquifer	Limited supplies may be available locally	Available where significant interference, depletion of surface water in outcrop area, or impacts to wetlands in outcrop area do not occur.
	Lower PRM aquifer	Supplies may be available in outcrop area and just down dip.	Potential for saltwater intrusion in close proximity to Delaware River. Numerous known contaminated sites in outcrop area.
Cape May Peninsula	General	Modeled scenarios of the recent studies are being evaluated and implemented.	Saltwater intrusion is a concern in all aquifers.
	Estuarine sand aquifer	Limited availability for small-scale supplies	High chlorine levels in coastal areas. Connection to water-table aquifer in some areas.
	Semi-Confined Cohansey aquifer	Limited availability due to saltwater intrusion along Delaware Bay	Aquifer injection to stabilize saltwater front could extend current supplies and make additional water available.

Planning Region	Aquifer	Availability	Limitations
	Atlantic City 800-foot sand aquifer	Supplies may be available in northern peninsula pending regional impacts; additional supplies may be available in lower peninsula accompanied by desalination.	Sustainability of desalination wells needs to be addressed. Policy needs to be formulated relative to allowing saltwater intrusion as a water-supply option.
	Rio Grande water-bearing zone	Minor aquifer for limited public supply	Limited by yield capabilities. Additional evaluation of sustainable yield needed.
Atlantic Coastal Region	Atlantic City 800-foot sand aquifer	Future withdrawals will be evaluated on a case-by-case basis due to potential regional impacts in Atlantic and Cape May Counties	Department is evaluating impacts of increased use on water-table systems within Pinelands region and impacts on saltwater front movement in Cape May Peninsula.
	Piney Point aquifer	Limited supplies are available locally along coast where aquifer is thick and water levels are generally stable	Limited yield and water quality may be limiting factor in places.