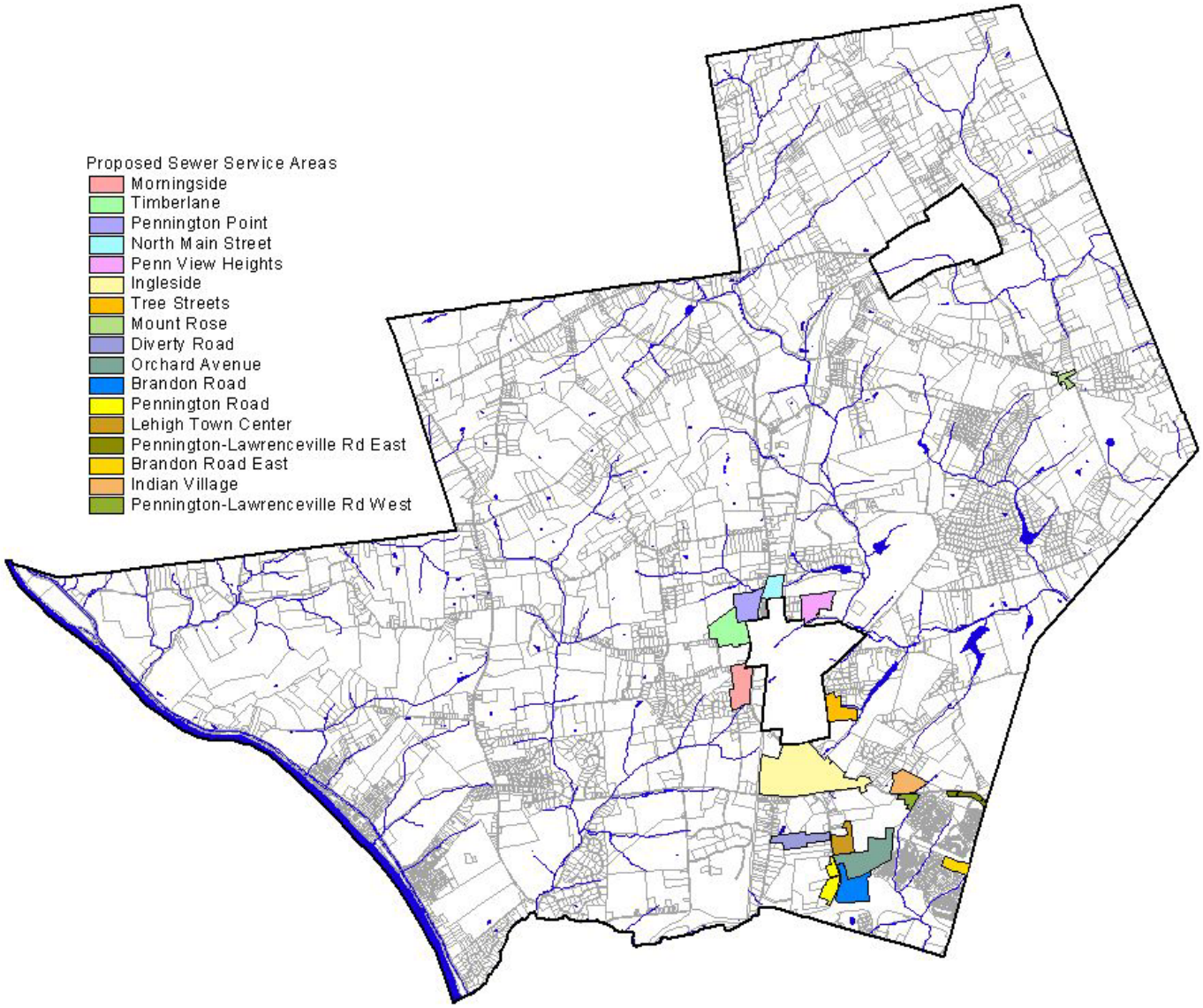
ASSESSMENT OF GROUNDWATER QUALITY AND QUANTITY IMPACTS FROM SEWER AREA EXPANSION IN HOPEWELL TOWNSHIP, MERCER COUNTY, NEW JERSEY



Water: A Natural Renewable Resource

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Water: A Natural Renewable Resource

ASSESSMENT OF GROUNDWATER QUALITY AND QUANTITY IMPACTS FROM SEWER AREA EXPANSION IN HOPEWELL TOWNSHIP, MERCER COUNTY, NEW JERSEY

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INTRODUCTION

In June 2002, M^2 Associates was retained by Hopewell Township to assess potential changes to groundwater quality and quantity from the installation of sewer systems in seventeen areas of concern within the Township. The areas of concern were identified in the April 27, 2001 report entitled "Hopewell Township, Feasibility Analysis for Selected Wastewater Alternatives Serving Areas of Concern" prepared by Van Cleef Engineering Associates of Robbinsville, New Jersey. The proposed sewer service areas are as follows:

1. Morningside
2. Timberlane
3. Pennington Point
4. North Main Street
5. Penn View Heights
6. Ingleside
7. Tree Streets
8. Mount Rose
9. Diverty Road
10. Orchard Avenue
11. Brandon Road
12. Pennington Road
13. Lehigh Town Center
14. Pennington-Lawrenceville Road East
15. Brandon Road East
16. Indian Village
17. Pennington-Lawrenceville Road West

The location of these proposed sewer service areas within Hopewell Township are shown on Figure 1.

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In addition to the Van Cleef April 27, 2001 report, the March 2, 2001 report prepared by M^2 Associates entitled "Evaluation of Groundwater Resources of Hopewell Township, Mercer County, New Jersey" and the data associated and compiled with this March 2, 2001 report were used to evaluate the potential impacts associated with installing sewers in the seventeen proposed sewer service areas.

BACKGROUND

HISTORY OF EVALUATION

Hopewell Township retained Cerenzio and Panaro, P.C. to assess wastewater requirements within the Township and on September 27, 2000, Cerenzio and Panaro presented the findings of their study in a report entitled "Wastewater Needs Analysis/Feasibility Study, Phase 1 Report". Within this Cerenzio and Panaro report, "Areas of Concern" (AOCs) were identified and further evaluation was recommended. These AOCs included Mount Rose, Timberlane, Ingleside, Diverty Road, and Morningside. Since Penn View Heights, Tree Streets, Indian Village, Orchard Avenue, and Brandon Road are existing developed areas physically similar and proximate to the five original AOCs, further evaluation of these areas was also recommended. Based on the findings of the Cerenzio and Panaro Phase 1 study, 10 AOCs were identified for further evaluation.

Based on the results of the Cerenzio and Panaro Phase 1 study and recommendations for further evaluation of the 10 AOCs, Van Cleef Engineering Associates conducted their feasibility analysis of selected wastewater alternatives. The results of the Van Cleef study are included in their April 27, 2001 report.

As part of their evaluation, Van Cleef Engineering Associates identified seven areas that were not included in the Cerenzio and Panaro Phase 1 study that because of their proximity and physical similarity to the AOCs required further assessment. These additional areas included Pennington Point and North Main Street in the Timberlane evaluation; Pennington Road, Lehigh Town Center, Pennington-Lawrenceville Road East, and Brandon Road East in the Orchard Avenue/Brandon Road evaluation; and Pennington-Lawrenceville Road West in the Indian Village assessment. The Van Cleef Engineering study identified 17 AOCs or proposed sewer service areas within Hopewell Township.

Although there are several similarities between the AOCs that could allow for grouping some of these areas with respect to installation of sewer systems, sufficient physical differences are available to warrant independent evaluation of each of the seventeen proposed sewer service areas with respect to changes in groundwater quality and quantity.

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PROPOSED SEWER SERVICE AREAS

Table 1 provides a summary of characteristics of the 17 proposed sewer service areas in Hopewell Township. These characteristics include the number of units and type of units used by Van Cleef Engineering to calculate daily discharge rates; size of the areas as determined from New Jersey Department of Environmental Protection (NJDEP) Geographic Information System (GIS) coverage, and the potential treatment alternatives identified by Van Cleef Engineering.

Based on Van Cleef Engineering's evaluation, eight of the 17 proposed sewer service areas are located within the Stony Brook Regional Sewerage Authority (SBRSA) service area and the remaining 9 areas are located within the Ewing-Lawrence Sewerage Authority (ELSA) service area. Nine of the proposed sewer service areas have local treatment alternative options. Four of these areas would be combined into one local option. Van Cleef Engineering determined that there were no local treatment system options available for eight of the 17 proposed sewer service areas (see Table 1).

The local options included construction of small community wastewater treatment plants that would discharge the treated effluent to groundwater. The regional systems are currently designed to discharge to surface water. Currently, any existing residence or commercial facility within these areas discharges wastewater to an on-site septic system. Apparently, Hopewell Township initiated the Cerenzio and Panaro, and Van Cleef Engineering evaluations because of complaints or problems with some of these septic systems.

WATERSHEDS

Figure 2 shows the location of the proposed sewer service areas within the Central Delaware and Millstone watersheds and within subwatersheds located within these two watersheds. Table 2 summarizes the areas of each proposed sewer service area within the two watersheds and four subwatersheds.

Six (Timberlane, Pennington Point, North Main Street, Penn View Heights, Tree Streets, and Mount Rose) of the proposed sewer service areas are located entirely within the Millstone Watershed. Five of these six areas are located entirely within the Stony Brook Subwatershed. Mount Rose is located in another portion of the Stony Brook Subwatershed and to a slight extent, extends into the Beden Brook Subwatershed.

Six (Orchard Avenue, Brandon Road, Pennington Road, Pennington-Lawrenceville Road East and West, and Brandon Road East) of the proposed sewer service areas are located entirely within the Central Delaware Watershed. Of these six, Brandon Road, Pennington-Lawrenceville Road East and West, and Brandon Road East are located entirely within the Shabakunk Creek

Subwatershed. Orchard Avenue and Pennington Road extend across a topographic divide and are located in both the Shabakunk Creek and Jacobs Creek Subwatersheds.

Five (Morningside, Ingleside, Diverty Road, Lehigh Town Center, and Indian Village) proposed sewer service areas extend across a topographic and surface-water divide and are located in both the Millstone and Central Delaware Watersheds. Morningside, Ingleside, Diverty Road, and Lehigh Town Center are located within the Jacobs Creek and Stony Brook Subwatersheds. Lehigh Town Center also extends partially into the Shabakunk Creek Subwatershed. Indian Village is nearly evenly divided between the Stony Brook and Shabakunk Creek Subwatersheds.

Timberlane, Pennington Point, North Main Street, Penn View Heights, Tree Streets, and the easternmost portion of Ingleside are all located downstream of the divides separating the watersheds and subwatersheds. The western portion of Ingleside and the remaining 11 proposed sewer service areas are all located across or very near topographic divides separating watersheds and/or subwatersheds.

Areas that extend across or are located near topographic divides are entirely dependent on precipitation falling on those lands to recharge groundwater and dilute contaminants from septic system discharges. In addition to the precipitation falling directly on the land surface, properties located at lower elevations within a watershed/subwatershed also have waters flowing (a.k.a. groundwater flux) from topographically upgradient portions of the basin that may be available to meet water-supply demands and dilute septic system discharges.

SOILS

Figure 3 depicts the soils as mapped by the U.S. Department of Agriculture, Natural Resources Conservation Service and published in the May 24, 1999 “Soil Survey Geographic (SSURGO) Database for Mercer County, New Jersey” and depicted by the NJDEP-Bureau of Geographic Information and Analysis in New Jersey GIS mapping. Table 3 lists the mapping label, soil name, and potential septic system limitations for the soils mapped beneath the proposed sewer service areas.

Nearly 56 percent of the land area within the proposed sewer service areas are underlain by Bucks silt loam. Almost 27 percent of these areas are underlain by a combination of the Readington and Abbottstown silt loam. The remaining 17 percent of the areas are underlain by several other soil types.

The soils beneath less than 0.5 percent of the proposed sewer service areas are considered by the Soil Conservation Service as having slight limitations for

disposal of wastewater from septic systems. The soils mapped beneath approximately 58 percent of the total area encompassed by the proposed sewer service areas have moderate limitations for septic system discharges. These moderate limitations are a result of the shallow (3 to 5 feet below ground surface) depth to bedrock beneath these soils. The soils beneath the remaining 41.5 percent of the proposed sewer service areas have severe limitations for septic systems because of potential flooding, shallow seasonal water, and/or very shallow depths (1 to 3 feet below ground surface) to bedrock.

Given the shallow bedrock and seasonal water limitations beneath more than 99 percent of the proposed sewer service areas, replacement or repair of septic systems is unlikely to result in significant improved operation. Although mounded systems or soil replacement systems can be installed in accordance with NJDEP regulations in N.J.A.C 7:9A, the native soils' limitations will continue to exist at the perimeters and beneath the reconstructed system. Discharges from mounded systems installed to increase the vertical distance from a seasonal water table or bedrock surface, will migrate laterally from the septic systems into the surrounding native soils along the top of bedrock or seasonal water table surface. Replacing soils within and immediately below the leaching fields will also serve very little purpose. The wastewater discharged to the replaced soils must eventually migrate through the surrounding native soils or it will backup to ground surface indicating failure.

In addition to the soils limitations, many of the single-family home lots within the proposed sewer service areas have insufficient size to permit multiple replacements or new systems. On many of these properties, if the existing system fails and a new system is required at another location, then required distances from wells and buildings will limit location options. Continued operations of septic systems in these areas are likely to result in continuing failures and installation of sewer systems may be the only currently available technology for removal of wastewater.

BEDROCK

Figure 4 depicts the bedrock geology beneath the seventeen proposed sewer service areas and Table 4 provides a listing of the acreage encompassed by each rock type within each proposed sewer service area. Morningside, Timberlane, Pennington Point, North Main Street, Penn View Heights, Ingleside, Tree Streets, and Diverty Road are entirely underlain by the red, brown shales, mudstones, siltstones, and fine-grained sandstones of the Passaic Formation. In Hopewell Township, the Passaic Formation rocks are generally good aquifers capable of transmitting sufficient water to meet most water-supply needs.

Approximately 90 percent of Mount Rose is underlain by Jurassic diabase and the remaining 10 percent is underlain by metamorphosed Passaic Formation

rocks, which have hydrogeologic characteristics similar to the diabase. The diabase and associated metamorphic rocks are very poor aquifers beneath Hopewell Township. In some cases, these igneous and metamorphic rocks are incapable of storing and transmitting sufficient groundwater to meet the needs of a single-family home.

Orchard Avenue, Brandon Road, Pennington Road, Pennington-Lawrenceville Road East, and Brandon Road East are entirely underlain by the Triassic-Jurassic Lockatong Formation. The dark gray to black, argillaceous mudstones and siltstones of this formation are generally poorly fractured beneath Hopewell Township. These rocks have limited capacity to store and transmit groundwater and in some areas of the Township, these capacities are barely sufficient to meet needs of a typical single-family home.

Lehigh Town Center, Indian Village, and Pennington-Lawrenceville Road West are underlain by a combination of Lockatong Formation and Passaic Formation. The hydrogeologic characteristics of these two formations indicate that the Passaic Formation has significantly greater capacity to store and transmit groundwater in comparison to the Lockatong Formation.

WATER AVAILIBILITY

CONTRIBUTING DRAINAGE AREA

The contributing drainage area of a groundwater and/or surface-water system is the extent of the lands topographically upgradient from which all water is flowing through the point of measurement. In either system, a point on a topographic divide has zero contributing drainage area. At a high elevation near a topographic divide, the contributing drainage area is small. At lower elevations near valley floors, the drainage area will be much larger because it includes all of the surrounding topographically upgradient lands.

In the twelve proposed sewer service areas including the western portion of Ingleside, which extend across or are located near a topographic divide, the contributing drainage area to these areas is approximately limited to the extent of the proposed sewer service areas. In the Timberlane, Pennington Point, North Main Street, Penn View Heights, Tree Streets and eastern portion of Ingleside, the contributing drainage areas extends beyond the proposed sewer service areas to include topographically higher lands within the watershed/subwatershed.

NATURAL REPLENISHMENT

The rate of natural replenishment to an aquifer system is directly dependent on the rate of groundwater recharge plus the flux of groundwater from upgradient portions of the contributing drainage area. If there is little or no water flowing into

an area from upgradient, then the rate of natural replenishment is almost entirely or completely dependent on the rate of groundwater recharge, which in turn is dependent on the amount of incident precipitation capable of infiltrating to the aquifer system.

Areas across or very near a topographic divide have very small if any, contributing drainage area and therefore, have little or no groundwater flux from upgradient areas. These topographically high zones are almost or entirely dependent on groundwater recharge. In these zones, if the rate of groundwater recharge is exceeded by withdrawals, then water will be removed from aquifer storage and groundwater levels will decline within the aquifer. At lower elevations, the flux of groundwater from upgradient areas can partially or totally offset or replace water removed from storage because of high rates of withdrawal and water levels within the aquifer will remain within the natural equilibrium range.

Groundwater Mining

Mining of groundwater or removal of water from aquifer storage because the rate of withdrawal exceeds the rate of replenishment will adversely impact the aquifer system and interconnected surface-water systems. These impacts may include but are not limited to changes in transmission capacity, natural water chemistry, decreased baseflow in streams, dewatering of wetlands, reduced aquifer yields, and increased well failures.

Septic System Recharge

Currently in the proposed sewer service areas that have been developed, septic systems are used to discharge wastewater and some if not all of this wastewater infiltrates to the underlying aquifer systems. The recycling of wastewater will limit the necessity for removing groundwater from storage to meet withdrawals that exceed rates of natural replenishment. However, the water returned to the aquifer system contains contaminants that require extensive dilution to ensure the water can be safely consumed. If the rate of withdrawals exceeds the rate of natural replenishment and septic system discharges are not adequately diluted, groundwater quality will become degraded and possibly not meet public health standards.

In areas where groundwater has or becomes degraded because withdrawals exceed natural replenishment, it may be necessary to install sewers to remove wastewater and restore groundwater quality. It may also be necessary to make public water available to ensure that sufficient water is available to meet the existing needs and that the water consumed by people within the area meets Federal and State water-quality standards. For those proposed sewer service areas in the Stony Brook Subwatersheds, replacing the water derived from the

domestic wells with water derived from public wells in the immediate Pennington vicinity may only serve to shift pumping stresses and may not significantly reduce or eliminate the potential for over-utilization of the aquifer beneath this area.

In lieu of providing water to some of the proposed sewer service areas, local wastewater treatment and disposal systems could be constructed. These local systems would fully treat wastewater to appropriate Federal and State regulatory levels and recycle all or most of this water to the aquifer. By recharging the treated water to the aquifer much like the current septic systems reinfiltrate contaminated water, the potential for removing water from aquifer storage and ultimately lowering of water levels is significantly reduced. Local treatment and recharge systems could be designed using conventional technologies to adequately reduce or eliminate contaminant concentrations and to return most if not all of the treated water to the aquifer. These systems would maintain the water balance and most likely, the water quality within the aquifer system and interconnected surface-water systems.

GROUNDWATER RECHARGE

To assess the availability of groundwater within the proposed sewer service areas and determine if rates of natural replenishment would be exceeded, groundwater recharge to the aquifer systems beneath the areas was determined. As indicated in M^2 Associates' March 2, 2001 report entitled "Evaluation of Groundwater Resources of Hopewell Township, Mercer County, New Jersey", the Passaic Formation receives approximately 610 gallons per day per acre (gpd/acre) of recharge during a year of normal or average precipitation, which for Hopewell Township is approximately 45.1 inches per year.

During a prolonged drought, the Passaic Formation beneath Hopewell Township is likely to receive approximately 410 gpd/acre. The dependable yield for these rocks within the Township is approximately 82 gpd/acre. The dependable yield is the amount of groundwater that can be safely extracted regionally for human consumption without causing adverse impacts during all weather conditions including a severe drought.

The Lockatong Formation, and diabase and associated metamorphic rocks beneath Hopewell Township receive approximately 235 gpd/acre during years of normal precipitation. During periods of prolonged drought, the Lockatong Formation and the Jurassic igneous and metamorphic rocks beneath Hopewell Township receive approximately 160 gpd/acre and have a dependable yield of approximately 32 gpd/acre.

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OPEN LAND AREA

Water Volumes

Recharge to the underlying aquifers during normal and drought years, and the resulting dependable yields of the aquifers were evaluated to determine if sufficient groundwater is or would be available within the aquifers to meet the demands of the existing or planned developments within the proposed sewer service areas. As a first step in this evaluation, it was assumed that all of the land areas within each proposed sewer service area were open to receiving recharge and that recharge to the aquifer would not be limited or reduced by the presence of impervious surfaces.

Table 5 summarizes the volumes of water recharging the aquifer during periods of normal precipitation and during drought, as well as the dependable yields for the aquifers beneath the proposed sewer service areas. The calculations made to determine the volumes listed in Table 5 are based on the areas mapped for each rock type (see Table 4) and assume that these entire areas are open to recharge. The water volumes summarized in Table 5 would be available for water-supply purposes and/or to dilute septic contaminants.

Water-supply demands in excess of dependable yields will likely result in less water available to maintain stream baseflow, wetlands, dependent ecosystems, and downstream consumers. Withdrawals in excess of groundwater recharge rates will result in short-term or long-term adverse impacts to the aquifer systems and associated surface-water systems including but not limited to the lowering of water levels, dewatering of wetlands, changes in natural water chemistry, and reduction or elimination of baseflows in streams.

Dependable Yield

As indicated in Table 5, even with the assumption that all of the land area within each proposed sewer service area is open to recharge, the water demands indicated by the anticipated daily discharges for 16 of the 17 proposed sewer service areas exceed the dependable yields within these areas. In all of these areas, the current, if already developed, or planned demands far exceed the water that can be safely removed for human consumption from the aquifer without causing adverse impacts to dependent ecosystems and/or downstream consumers.

The currently developed areas, and at some future time, the proposed developments, must rely on groundwater recharging elsewhere within the subwatersheds in which they are located, to replace the excess water taken within the 16 proposed sewer service areas to ensure that the dependable yield of the watershed/subwatershed is not exceeded. North Main Street is the only

proposed sewer service area in which, the water demands do not exceed the rate of groundwater recharge that can be safely extracted without causing adverse impacts to others or dependent ecosystems.

Drought

During a prolonged drought, the water demands indicated by the anticipated discharge rates would exceed groundwater recharge in eleven (Morningside, Pennington Point, Mount Rose, Diverty Road, Orchard Avenue, Brandon Road, Pennington Road, Lehigh Town Center, Pennington-Lawrenceville Road East, Brandon Road East, and Indian Village) of the seventeen proposed sewer service areas. In some of these areas such as but not limited to Pennington Point and Orchard Avenue, the daily deficits caused by withdrawing more water than is recharging the aquifer are substantial and most likely would result in significant adverse impacts to the underlying aquifer systems.

In 9 of the 11 areas with projected water resource deficits, more than 25 to as much as 78 percent of the water used daily would be removed from aquifer storage resulting in significantly declining water levels within the aquifer. For example, if an aquifer thickness of 300 feet and an effective porosity of 1 percent were assumed for the Passaic Formation rocks beneath Pennington Point, the total volume of water in storage beneath this 47.63 acre proposed sewer service area would be approximately 46.6 million gallons or 155,000 gallons per foot of aquifer. If on a daily basis, approximately 68,000 gallons were removed from aquifer storage to balance the difference between demand and groundwater recharge, every 2.3 days the water level in the aquifer could potentially decline 1-foot. Within 30 days, the aquifer water level could potentially decline by more than 13 feet.

Under current conditions in which, septic systems are used to discharge wastewater; the deficits are partially or possibly, entirely balanced by the septic system discharges. Although, the volume of water in storage may not significantly change because of the septic system discharges, the quality of the water within the aquifer most likely has become or after development is complete, is very likely to become significantly degraded by these same discharges.

Of the eleven areas in which the drought recharge rate is exceeded by the water-supply demands, ten are located across or very near the topographic divides separating watersheds and subwatersheds. In these 10 proposed sewer service areas (Morningside, Mount Rose, Diverty Road, Orchard Avenue, Brandon Road, Pennington Road, Lehigh Town Center, Pennington-Lawrenceville Road East, Brandon Road East, and Indian Village) it is very likely that water levels within the aquifer will decline at least for the term of the drought. Within these 10 areas, the rate of natural replenishment will be exceeded. Since demands exceed the

rates of natural replenishment, water will ultimately be removed from aquifer storage and therefore, the adverse impacts associated with groundwater mining are likely to occur for at least the term of drought.

Normal Conditions

During years of normal or average precipitation, the water demands of Pennington Point, Mount Rose, Orchard Avenue, Brandon Road, Pennington Road, Lehigh Town Center, Pennington-Lawrenceville Road East, and Brandon Road East will exceed the rate of recharge to the aquifer beneath these proposed sewer service areas. Within four of these eight areas (Pennington Point, Mount Rose, Orchard Avenue, and Pennington-Lawrenceville Road East), the difference between normal year recharge and the water-supply demands indicate that 25 percent or more of the water withdrawn will be removed from aquifer storage.

With the exception of Pennington Point, all of these areas in which the demands exceed recharge during years of normal precipitation, have very little contributing drainage area. Therefore, these seven areas rely almost entirely on groundwater recharge within the proposed sewer service areas to replenish water removed to meet demands and as indicated in Table 5, groundwater recharge is insufficient to meet these demands.

Pennington Point is located slightly downgradient from the topographic divide separating the Millstone and Central Delaware Watersheds. However, the planned demands for Pennington Point are three times greater than the normal year recharge to this proposed sewer service area and residual or unused recharge to upgradient properties such as Timberlane is unlikely to provide sufficient flux to compensate for these demands. Although Pennington Point is not completely reliant on groundwater recharge to meet demands, the rate of natural replenishment to this proposed sewer service area is likely to be exceeded, even during years of normal precipitation and therefore, adverse impacts to the underlying aquifer system and associated surface-water systems are highly probable.

If sewers are installed within these eight proposed sewer service areas, the quality of groundwater is likely to improve or when developed, not become degraded from wastewater discharges. However, since the volume of water removed exceeds the rate of natural replenishment, the aquifer systems beneath these areas are very likely to become adversely impacted as a result of declining water levels and removal of water in storage. These impacts are likely to be long term unless water is added to the aquifer to offset the exceedences.

Summary

As a first step in assessing groundwater availability it has been assumed in the calculations summarized in Table 5 that all of the land areas within the proposed sewer service areas are open to incident precipitation and that groundwater recharge is not prevented or limited by the presence of impervious surfaces. The results of this first step indicate that 16 of the 17 proposed sewer service areas cannot be self sustained and that the current or proposed demands exceed the dependable yields of the underlying aquifer systems.

Even with the assumption that all land areas within the proposed sewer service areas are open to receiving recharge, the water demands of 11 of the 17 proposed sewer service areas cannot be sustained during a drought and 8 of the 17 cannot be sustained during years of normal precipitation. The adverse impacts to the aquifer from drought withdrawal exceedences of groundwater recharge are likely to be short-term until the drought ends and increased precipitation replaces water removed from storage. The adverse impacts to the aquifer from annual withdrawal exceedences of natural replenishment are likely to be long-term unless water is added to the aquifer to replace the water removed from storage. Based on the locations of most of the proposed sewer service areas, it is highly unlikely that sufficient groundwater flux from upgradient areas is available to compensate for the high removal rates.

IMPERVIOUS SURFACE ADJUSTMENTS

Recharge Reduction

Recharge to aquifer systems can be substantially reduced by the construction of impervious surfaces. Roads, rooftops, driveways, and even some lawn areas can significantly reduce and/or prevent precipitation from infiltrating and recharging groundwater. Precipitation incident to an impervious surface will runoff this surface most likely to a stormwater collection and discharge system and ultimately a stream. By directing the water to a surface-water system, impervious surfaces increase runoff and decrease recharge. As a second step in evaluating available water within the aquifer systems beneath the proposed sewer service areas, recharge areas per proposed sewer service areas were modified to account for the presence of impervious surfaces.

As discussed above, adjustments were not made in Table 5 to account for impervious surfaces, steep slopes, bedrock outcrops, wetlands, and/or streams that would prevent or at a minimum, significantly reduce the volume of water entering the aquifer. Given topography, bedrock types, wetland locations, and streams, the largest influence on reducing groundwater recharge to the proposed sewer service areas is the presence of impervious surfaces. In some of the areas such as, Morningside, Timberlane, Penn View Heights, Ingleside, Tree Streets, Diverty Road, Orchard Avenue, Brandon Road, Pennington Road, Pennington-

Lawrenceville Road East and West, Brandon Road East, and Indian Village, existing development has covered a significant portion of these areas with impervious materials.

Average Lot Sizes

Table 6 summarizes the land area and number of single-family homes as indicated by Van Cleef Engineering in their April 27, 2001 report. Dividing the total land area per proposed sewer service area by the number of single-family units within the 14 proposed sewer service areas comprised primarily of these units, indicates average lot sizes per dwelling unit ranging from 0.53 to 1.76 acres. Use of the Trela-Douglas Nitrate Dilution Model indicates that these lot sizes are insufficient to provide adequate groundwater recharge to dilute septic-system contaminants to concentrations below Federal and State maximum contaminant levels.

The commercial properties within Ingleside and the church within Brandon Road have significantly more impervious surface coverage than a typical single-family home. However, in both of these proposed sewer service areas, 1995 aerial photographs indicate a few large, vacant lots without any impervious surfaces that may balance the higher percentage of impervious surfaces around the commercial properties and/or church. For purposes of the evaluation of available water, the increased impervious surfaces associated with the commercial properties in Ingleside and the church in Brandon Road were not included. Inclusion of these surfaces would likely further decrease the amount of water available to meet demands or dilute septic-system contaminants. However, given the overall lot size densities within these two proposed sewer service areas, the further reduction in recharge is likely to be small (less than 5 percent) and therefore, unlikely to significantly alter the results of the water availability evaluation.

Percent Impervious

The US Department of Agriculture Technical Release 55 “Urban Hydrology for Small Watersheds” (USDA TR-55 Method) indicates that for residential lot sizes ranging from 0.5 to 2 acres, the percentage of impervious surface coverage ranges from 25 to 12 percent, respectively. With the exception of Pennington Point, North Main Street, and Lehigh Town Center, the USDA TR-55 Method was used to assess the percentage of impervious surface coverage and the potential area of each proposed sewer service area that could be used for recharge after subtracting out the area of impervious coverage.

The impervious surface coverage for Pennington Point and Lehigh Town Center were not determined with USDA TR-55 Method because the Hopewell Township Land Development Ordinance or site-specific plans were available to determine

the impervious surface coverage in each of these two proposed sewer service areas. The Hopewell Township Land Development Ordinance, Chapter 17 indicates the permissible extent of impervious surface coverage for Pennington Point. Based on the Township ordinance, within the area available for residential apartments, impervious surface coverage may be as much as 55 percent. The ordinance indicates that for the Pennington Point commercial development, impervious surface coverage may be as much as 65 percent. For purposes of the assessment of water availability within the aquifer, it was assumed that 60 percent of Pennington Point would be covered with impervious surfaces.

Apparently, the Lehigh Town Center has been approved for development by the Hopewell Township Planning Board and the approved site plans indicate an average of 37 percent of the site will be covered with impervious surfaces. Based on this percentage of impervious surface coverage, the Lehigh Town Center will have approximately 63 percent of land surface within this proposed sewer service area open to incident precipitation for recharge to the underlying aquifer.

The percentage of impervious surface coverage of North Main Street could not be assumed equal to 2 single-family homes occupying lot sizes of 13.65 acres, since a large portion of this proposed sewer service area is the municipal garage. As a result, 1995 aerial photographs obtained from the NJDEP were used to assess the extent of coverage within this area. Based on these photographs and the apparent extent of the municipal garage operations, it appears that approximately 18 percent of this proposed sewer service area is covered with impervious surfaces and therefore, 82 percent is open to incident precipitation and potential recharge.

Dependable Yield

Table 7 summarizes the volume of water recharging the aquifer during normal and drought years, and the resulting dependable yield of the aquifer after reducing the potential recharge area per proposed sewer service area to account for impervious surfaces. Similar to the results of the first step, in which all land area within each proposed sewer service area was assumed open for recharge, the dependable yield of the aquifers beneath 16 of the 17 proposed sewer service areas was insufficient to meet the demands. The dependable yield of North Main Street after accounting for 18 percent impervious surfaces continues to exceed the anticipated demand indicated by Van Cleef Engineering in their April 27, 2001 report.

As discussed above in the first step of this evaluation, water demands in excess of the dependable yield may not result in significant adverse impacts to an aquifer system if increased demands in one portion of a watershed are balanced by lower demands elsewhere in the watershed. However, exceedences of the dependable yield are likely to result in decreased water availability to dependent

ecosystems and possibly downstream consumers, and increased septic-system contaminant concentrations since less water is available for dilution. The adverse impacts associated with dependable yield exceedences are likely to be much greater in areas with little or no contributing drainage and uncontaminated groundwater flux from upgradient lands. Twelve of the 16 proposed sewer service areas in which the dependable yield is exceeded by the water-supply demands have little contributing drainage area based on their locations within their respective watershed/subwatersheds.

Drought Recharge

Inclusion of the impervious surface coverage in the evaluation of available water within the aquifers indicates significant differences between the water available within the aquifer systems to meet demands and dilute septic-system contaminants, and the water demanded by the existing and planned developments. After accounting for the presence of impervious surfaces within the proposed sewer service areas, thirteen of the seventeen proposed sewer service areas are very likely to experience water deficits during a drought because the demands exceed recharge and most likely, natural replenishment. Prior to reducing the available recharge area per proposed sewer service area to account for the impervious surfaces, the water-supply demands of eleven proposed sewer service areas exceeded drought recharge.

Short-term exceedences of recharge to an aquifer may only result in short-term adverse impacts to the aquifer and associated surface-water systems if the water removed from storage during the drought is replaced by groundwater recharged during years of normal or above normal rainfall. However, in several of the proposed sewer service areas (Pennington Point, Mount Rose, Orchard Avenue, Lehigh Town Center, and Pennington-Lawrenceville Road East), sixty percent or more of the water withdrawn to meet demands will be removed from storage. The demands in six other proposed sewer service areas (Morningside, Diverty Road, Brandon Road, Pennington Road, Brandon Road East, and Indian Village) will require 25 to 50 percent of the water used to be derived from aquifer storage.

In the 13 proposed sewer service areas where demands exceed drought recharge, unless water is returned to the aquifer from a wastewater treatment plant or septic systems, or public water is provided from elsewhere in the region, water levels within the aquifers are very likely to significantly decline after sewers are installed. These water level declines could result in short-term or long-term impacts to the aquifers and associated surface-water systems.

Normal Precipitation

As shown in Table 7, the water supply demands of 9 of the 17 proposed sewer service areas will exceed the rate of groundwater recharge even during years of

normal precipitation. The 87,375 gallons per day demands of Pennington Point will exceed groundwater recharge to the open areas of this proposed sewer service area by nearly 76,000 gallons per day. Even with a residual groundwater flux from upgradient Timberlane of slightly more than 18,000 gallons per day, groundwater recharge to the combined 115 acres is insufficient to meet demands.

Based on the demands and the volume of water likely recharging the aquifer system beneath these proposed sewer service areas, 19 to as much as 87 percent of the water withdrawn to meet these demands will be derived from aquifer storage. The recharge rates to the aquifer systems are insufficient to meet the demands unless water after use is returned to the aquifer. If the water continues to be returned through the use of septic systems, it is likely to result in significant water-quality degradation since insufficient uncontaminated recharge is available for dilution.

Summary

Areas within the proposed sewer service areas open to recharge do not include impervious surfaces and therefore, as the second step in evaluating groundwater availability, impervious surface coverage in each proposed sewer service area was subtracted from the total area. Impervious surface coverage ranges from 13 to 60 percent and therefore, the areas open to recharge range from 40 to 87 percent (see Table 6).

After accounting for reduced recharge because of impervious surfaces, the dependable yields of the aquifer systems beneath 16 of the 17 proposed sewer service areas are substantially less than the demands for these existing or planned developments (see Table 7). Reinfiltration of contaminated groundwater from septic systems most likely balances current demand exceedences. In the 12 proposed sewer service areas in which the dependable yield is exceeded and the contributing drainage area is limited, the installation of sewers is likely to result in improved water quality but decreased water availability to streams, wetlands, and associated ecosystems.

After modifying recharge areas to account for impervious surfaces, during a drought, the water-supply demands for 13 of the 17 proposed sewer service areas will exceed the rate of natural replenishment. Short-term adverse impacts associated with declining aquifer water levels are very likely to occur beneath these areas after sewers are installed. Long-term impacts could be encountered in the aquifers beneath the proposed sewer service areas if subsequent normal or above normal precipitation does not replace the water removed from aquifer storage. While septic systems are used, wastewater discharged from the septic systems is very likely offsetting the deficits caused by withdrawals exceeding natural recharge. However, these wastewater discharges are very likely to result

in reduced water quality and potentially contaminant concentrations exceeding Federal and State maximum contaminant levels.

During years of average or normal precipitation, the water-supply demands of 9 of the 17 proposed sewer service areas will exceed groundwater recharge. Eight of these 9 areas extend across or are very near a topographic divide and therefore, rely almost entirely on groundwater recharge to naturally replenish the aquifers. The ninth proposed sewer service area (Pennington Point) has demands three times greater than the rate of groundwater recharge and groundwater flux from upgradient areas most likely is insufficient to balance the difference between demand and recharge. In all nine areas it is very likely that groundwater will be removed from storage to compensate for demands exceeding natural replenishment and the removal of water from storage in the aquifer will result in the lowering of water levels and inter-related adverse impacts.

Based on the results of the water availability evaluation, three options are available to these proposed sewer service areas. The first option is continued use of septic systems, which is likely to result in contamination of groundwater and degradation of water-quality in at least 16 out of 17 proposed sewer service areas.

The second option is the installation of sewers to improve water quality and the connection of these sewers to regional treatment plants. In at least 9 of the proposed sewer service areas, unless public water from sources outside of the immediate Pennington vicinity is provided to replace the domestic wells, demands will exceed the rates of natural replenishment during most years and aquifer systems and associated surface-water systems will be adversely impacted. It may be necessary to provide public water to at least 13 of the 17 proposed sewer service areas to ensure adequate water is available during a drought and to minimize potential short- and long-term adverse impacts.

The third option is the installation of local wastewater plants that use conventional treatment technologies to reduce contaminant concentrations and return the water to the underlying aquifer systems. The recycled water would significantly reduce if not entirely eliminate the potential to remove water from aquifer storage and therefore, maintain water levels and most likely, water quality within the aquifer system and interconnected surface-water systems.

Water: A Natural Renewable Resource

CONCLUSIONS

GENERAL

Based on the data and reports reviewed with respect to the proposed sewer service areas in Hopewell Township, the following general conclusions are made:

1. Seventeen proposed sewer service areas were identified as a result of Cerenzio and Panaro's Phase 1 study and Van Cleef Engineering Associates feasibility analysis of selected wastewater alternatives. Hopewell Township initiated these studies as a result of historical complaints with septic system operations within these areas.

2. Two wastewater collection and treatment options were evaluated by Van Cleef Engineering. Nine of the proposed sewer service areas had both a local option and a regional option available. The remaining eight proposed sewer service areas only had a regional option because of limited land availability and/or natural physical constraints.

3. The local options included small community wastewater treatment plants that would discharge to groundwater. The regional options are the SBRSA and ELSA facilities, which discharge to surface water. Eight proposed sewer service areas are located within the SBRSA service area and nine are located within the ELSA service area.

4. Six of the proposed sewer service areas are located entirely within the Millstone Watershed and six are located entirely within the Central Delaware Watershed. The remaining five proposed sewer service areas extend across the topographic divide separating these two watersheds and as a result, are located partially in both. Twelve, including the western portion of Ingleside, of the seventeen proposed sewer service areas are located across or very near topographic divides separating watersheds and/or subwatersheds. Areas that extend across or are located near topographic divides are entirely dependent on precipitation falling on those lands to recharge groundwater and dilute septic system contaminants. Areas at lower elevations have groundwater flowing from higher elevations to supplement recharge.

5. More than 99 percent of the soils beneath the 17 proposed sewer service areas are considered to have limitations for septic system discharges. These limitations include shallow bedrock, shallow seasonal water, and potential flooding. Given these limitations, the replacement and/or repair of septic systems in these areas is unlikely to result in improved operation. Many of single-family home lot sizes within some of the proposed sewer service areas are of insufficient

size to permit multiple replacement systems. Continued operations of septic systems in these areas are likely to result in continuing failures and problems and the installation of sewer systems may be the only currently available technology for removal of wastewater.

6. Eight of the 17 proposed sewer service areas are underlain by the Triassic-Jurassic Passaic Formation. Mount Rose is underlain by Jurassic diabase and associated metamorphic rocks. Five of the proposed sewer service areas are underlain entirely by Triassic Lockatong Formation and three areas are underlain by a combination of Lockatong Formation and Passaic Formation.

7. The contributing drainage area of 12 proposed sewer service areas including the western portion of Ingleside, is approximately limited to the extent of the proposed sewer service areas. Therefore, the rates of natural replenishment to the aquifer systems beneath these proposed sewer service areas are equal to the rates of groundwater recharge since few if any upgradient areas exist from which groundwater can flow to the proposed sewer service areas. In these proposed sewer service areas, if the rate of groundwater withdrawals exceeds the rate of groundwater recharge, then water levels will decline as groundwater is removed from storage resulting in adverse impacts to the aquifer and interconnected surface-water systems.

8. Five of the proposed sewer service areas and the eastern portion of Ingleside are located at slightly lower elevations and therefore, groundwater flux from upgradient areas could supplement groundwater recharge. Within these areas, the rate of natural replenishment is dependent on groundwater flux in addition to recharge. If water usage upgradient provides little if any groundwater flux, then the rates of natural replenishment beneath these proposed sewer service areas will be highly if not entirely, dependent on groundwater recharge. Provided that demands do not exceed natural replenishment, adverse impacts are not likely.

9. Current discharges to septic systems are very likely to supplement groundwater recharge within the developed proposed sewer service areas. In these areas, if water-supply demands exceed the rate of natural replenishment, the recycled wastewater would significantly minimize if not eliminate the potential for removing water from aquifer storage. While it is unlikely that water levels beneath these areas would decline, groundwater quality is very likely to become degraded because insufficient uncontaminated water is available to dilute the septic-system contaminants. Use of the Trela-Douglas Nitrate Dilution Model indicates that the current lot sizes in the 14 primarily residential

proposed sewer service areas are insufficient to provide adequate recharge to dilute septic-system contaminants to concentrations below Federal and State maximum contaminant levels.

10. In areas with soils with limited capacity to transmit septic-system discharges and/or in which, groundwater quality has become degraded as a result of water-supply demands exceeding rates of natural replenishment, the installation of sewers may be the only currently available technology to dispose of wastewater and restore groundwater quality. In these areas, it may be necessary to provide public water to ensure that sufficient water is available to meet demands as well as Federal and State water-quality standards.

11. In lieu of providing water to some of the proposed sewer service areas, local wastewater treatment and disposal systems could be constructed. These local systems would treat wastewater to appropriate Federal and State regulatory levels and recycle all or most of this water to the aquifer. By recharging the treated water to the aquifer much like the current septic systems reinfiltrate contaminated water, the potential for adverse impacts to the aquifer from demands exceeding replenishment is significantly reduced. Local treatment and recharge systems could be designed using conventional technologies to adequately reduce or eliminate contaminant concentrations and to return most if not all of the treated water to the aquifer. These systems would maintain the water balance and most likely, the water quality within the aquifer system and interconnected surface-water systems.

12. Assuming the entire land area of each proposed sewer service area is uncovered or open to recharge, the dependable yields of 16 of the 17 proposed sewer service areas will be exceeded by the water-supply demands of the existing or planned developments (see Table 5). Assuming all area within each proposed sewer service area is open to recharge, the water-supply demands of 11 proposed sewer service areas have or will exceed recharge during a drought and 8 of these 11 have or will exceed recharge during a year of normal or average precipitation. If sewers are installed in these areas in which, demands exceed natural replenishment, the underlying aquifer systems and interconnected surface-water systems will be adversely impacted unless either public water is provided to eliminate the need for pumping groundwater or used water is returned to the aquifer after treatment to Federal or State requirements.

13. After subtracting impervious surface coverage, which minimizes or prevents water from infiltrating to the underlying aquifer, from the total land area of each proposed sewer service area, calculations of water

recharging the aquifers and comparisons of these calculations to water-supply demands indicate that the dependable yield of the aquifers beneath 16 of 17 proposed sewer service areas will be exceeded (see Table 7). These calculations further indicate that adverse impacts to the aquifers beneath 13 of the proposed sewer service areas will occur for at least the duration of drought and will occur in most years of normal or average precipitation in 11 areas if used water is not reinfiltrated.

14. Based on the results of the water availability evaluation, three options are available to these proposed sewer service areas. The first option is continued use of septic systems, which is likely to result in contamination of groundwater and degradation of water-quality in at least 16 out of 17 proposed sewer service areas. The second option is the installation of sewers to improve water quality and the connection of these sewers to regional treatment plants. In at least 9 of the proposed sewer service areas, unless public water from sources outside of the immediate Pennington vicinity is provided to replace the domestic wells, demands will exceed the rates of natural replenishment during most years and aquifer systems and associated surface-water systems will be adversely impacted. It may be necessary to provide public water to at least 13 of the 17 proposed sewer service areas to ensure adequate water is available during a drought and to minimize potential short- and long-term adverse impacts. The third option is the installation of local wastewater plants that use conventional treatment technologies to reduce contaminant concentrations and return the water to the underlying aquifer systems. The recycled water would significantly reduce if not entirely eliminate the potential to remove water from aquifer storage and therefore, maintain water levels and most likely, water quality within the aquifer system and interconnected surface-water systems.

AREA SPECIFIC

Based on the results of the evaluation of potential impacts to groundwater quality and quantity from the proposed sewer service area expansions, the following area specific conclusions are made and are summarized in Table 8:

1. Morningside – The dependable yield of the Passaic Formation aquifer system beneath this area is exceeded by the existing water-supply demands of these homes. Installation of sewers should not result in adverse impacts to the aquifer system during most years but is likely during drought since demands exceed drought recharge. Connection to the regional SBRSA system would most likely result in aquifer water levels declining during drought with possible slow recovery during

subsequent years of normal precipitation. Given the small difference between demands and normal year recharge for this area, provision of public water to eliminate local groundwater withdrawals would further reduce the potential for adverse impacts. Interconnection of this proposed sewer service area to a local system near Pennington Point as suggested by Van Cleef Engineering would provide several advantages including recycling used water, maintaining water within the aquifer from which it was derived, maintaining stream baseflow, potentially replacing water removed from storage at Pennington Point, and minimizing drought impacts to the aquifer system. Since current septic system discharges are very likely to be inadequately diluted, dilution with treated water will likely improve water quality.

2. Timberlane – While the dependable yield of the aquifer beneath this proposed sewer service area is exceeded by the water-supply demands, installation of sewers within this area is unlikely to result in adverse impacts to the aquifer system since these demands are less than recharge during drought and years of normal precipitation. However, there is little margin of safety between the volume of water recharging the aquifer and the daily demands during drought and therefore, monitoring of water levels and reduction in demands early in a drought may be warranted. Interconnection to the SBRSA regional system is not likely to result in lowered water levels during most years since adequate recharge would be available. However, interconnection of this proposed sewer service area to a local system associated with the Pennington Point proposed sewer service area will result in the same advantages as the interconnection of the Morningside area to this local option. A connection to public water may be necessary if water quality has been impacted from existing septic-system contaminants discharges and to ensure adequate groundwater recharge reserves are maintained for other users.

3. Pennington Point – The water-supply demands of this planned development will far exceed the dependable yield, drought recharge, and even recharge during years of normal precipitation. Using an on-site well or possibly, a local public water service and the installation of sewers will very likely result in adverse impacts to the aquifer and inter-related surface-water systems. Interconnection of this proposed sewer service area to the SBRSA system and provision of public water from outside the Pennington vicinity would minimize if not eliminate potential adverse impacts to the underlying aquifer system and interconnected surface-water systems by eliminating the local withdrawals from the Passaic Formation aquifer system. Construction of a local wastewater plant that returns the treated water to the aquifer beneath or upgradient of this proposed sewer service area would also minimize the potential

for adverse impacts to the aquifer and surface-water systems. The local treatment facility would provide several other advantages including recycling used water, maintaining the water within the subwatershed from which it was derived, minimizing the need to remove water from aquifer storage, and minimizing drought impacts to the aquifer system.

4. North Main Street – The water-supply demands of this proposed sewer service area do not exceed the dependable yield, drought recharge, or normal year recharge. Installation of sewers in this area provided that demands are not increased is unlikely to result in adverse impacts to the underlying aquifer system. Interconnection to the regional SBRSA system should not result in any significant impacts to the aquifer system. Interconnection to a local system at Pennington Point would provide the same advantages as the interconnection of Morningside and Timberlane to this system.

5. Penn View Heights - The dependable yield of the Passaic Formation aquifer system beneath this area is exceeded by the existing water-supply demands. Installation of sewers should not result in adverse impacts to the aquifer system during most years but are very likely during drought since demands exceed drought recharge. Even during most years, there is little groundwater recharge in reserve beneath this proposed sewer service area after water is withdrawn to meet demands and therefore, the potential exists for adverse impacts resulting from lowered water levels. If the sewers are connected to the regional SBRSA system, water levels are very likely to decline during drought and may slowly recover during subsequent years of normal precipitation. If the regional sewer system option is selected, given the small difference between demands and normal year recharge, provision of public water to eliminate local groundwater withdrawals may further reduce the potential for adverse impacts to the groundwater system. Construction of a local wastewater treatment plant that discharges to groundwater would minimize potential adverse impacts and the need for public water. Although not suggested by Van Cleef Engineering, if it is possible to interconnect this proposed sewer service area to a local system near Pennington Point, the same advantages that would be provided by the interconnection of Morningside, Timberlane, and North Main Street would be provided by interconnecting Penn View Heights.

6. Ingleside - The dependable yield of the Passaic Formation aquifer system beneath this proposed sewer service area is exceeded by the water-supply demands. Installation of sewers is likely to improve groundwater quality since inadequate recharge area is available to

dilute septic-system contaminants. Provided that water-supply demands do not increase, the sewers are unlikely to result in adverse impacts to the underlying aquifer system since groundwater recharge during drought and normal years exceed demands. However, the difference between the demands and recharge may not provide sufficient margin of safety or recharge in reserve for others. Interconnection of this area to SBRSA should not result in lowered water levels and therefore, it may not be necessary to provide public water if sufficient groundwater reserves are maintained. However, public water may be necessary to remove water-quality impacts from current septic-system operations. A local option as suggested by Van Cleef Engineering in their April 27, 2001 report would provide several advantages including maintaining the water balance within the Stony Brook Subwatershed and most likely, improved water quality.

7. Tree Streets - The dependable yield of the aquifer system beneath this proposed sewer service area is exceeded by the water-supply demands. Installation of sewers is likely to improve groundwater quality since inadequate recharge area is available to adequately dilute septic-system contaminants. Since this proposed sewer service area appears fully built out, it is unlikely that demands will increase and therefore, the installation of sewers is unlikely to result in adverse impacts to the aquifer system. Interconnection of this proposed sewer service area to the SBRSA system is unlikely to result in adverse lowering of water levels within the aquifer system. Similar to Ingleside, provision of public water may not be warranted for supply purposes if sufficient groundwater recharge is maintained in reserve for uses other than consumption within this proposed sewer service area. Public water may be necessary for water-quality reasons. Since the difference between the water-supply demands and drought recharge is very small, it may be advisable to monitor water levels and assess the need for water-use reductions in this area during periods of dry weather.

8. Mount Rose – Installation of sewers is likely necessary to improve groundwater quality and ensure wastewater is appropriately disposed within this area. However, since water-supply demands exceed the dependable yield, drought recharge, and normal year recharge, the installation of sewers is likely to result in the lowering of water levels within the underlying aquifer system. Therefore, if sewers are installed, public water is likely necessary to eliminate or reduce demands on this aquifer system and prevent or reduce potential adverse impacts. In lieu of public water and to supplement groundwater recharge to the properties within this proposed sewer service area, preservation of a minimum of 14 acres of the adjoining and upgradient farm fields as open space could possibly provide sufficient groundwater flux to

supplement groundwater recharge in meeting water-supply demands. Van Cleef Engineering indicated in their April 27, 2001 report that no local option is available for this proposed sewer service area and therefore, either the provision of public water or preservation of upgradient open space is likely necessary to ensure adequate water is available to meet demands and improve existing water quality.

9. Diverty Road - The dependable yield and recharge volumes of the Passaic Formation aquifer system beneath this area are exceeded by the existing water-supply demands of these homes. Installation of sewers would very likely result in adverse impacts to the aquifer system during most years and especially during drought. If the sewers are connected to the regional ELSA system, water levels are likely to decline within the aquifer and inter-related surface water. If the regional option is selected, provision of public water to eliminate local groundwater withdrawals is very likely necessary to reduce the potential for adverse impacts to the groundwater system. Construction of a local wastewater treatment plant that discharges to groundwater would minimize potential adverse impacts and the need for public water. Although not suggested by Van Cleef Engineering, an interconnection to a local facility in combination with other proposed sewer service areas in this area of the Township would provide several advantages including maintaining the water balance in local aquifer systems, improving water quality, and reducing the potential for mining groundwater in this area of the municipality.

10. Orchard Avenue, Brandon Road, Pennington Road, Lehigh Town Center, Pennington-Lawrenceville Road East – These five proposed sewer service areas are combined because of their proximity, lack of local option as indicated by Van Cleef Engineering in their April 27, 2001 report, and because the water demands of each exceed the dependable yields and recharge rates. Installation of sewers in these areas is necessary to improve water quality and remove wastewater. However, in all of these areas, unless public water is provided in lieu of groundwater from the underlying aquifer systems, continued groundwater withdrawals to meet water-supply demands will very likely result in adverse impacts to the aquifer systems. These impacts are likely to include but not be limited to those associated with the lowering of aquifer water levels including well failures, dewatering of wetlands, reduction or elimination of stream baseflow, and changes in natural water chemistry. Although not included in Van Cleef Engineering's results, if it is possible to include a wastewater treatment plant that discharges to groundwater as part of the Lehigh Town Center development, several advantages would be provided including recycling used water, maintaining the water within the watershed from

which it was derived, replacing water removed from storage, and minimizing potential impacts to aquifer systems. Installation of a local treatment system interconnected to all of these proposed sewer service areas would likely eliminate the need for public water.

11. Brandon Road East – This proposed sewer service area is not immediately adjacent to the five proposed sewer service areas located near Lehigh Town Center and as a result may not be readily combined with these others. The water-supply demands of this proposed sewer service area exceed the dependable yield, and drought and normal year recharge rates to the underlying aquifer system. As a result, it is very likely that the installation of sewers will result in adverse impacts including those associated with lowering of aquifer water levels. Van Cleef Engineering indicated in their April 27, 2001 report that a local wastewater treatment plant option is not available for this proposed sewer service area. Since it is very likely that withdrawals to meet existing demands from the underlying aquifer would result in mining of groundwater, provision of public water is very likely a necessity to prevent or eliminate these adverse impacts.

12. Indian Village, Pennington-Lawrenceville Road West – These two areas have been combined because of their proximity and potential for construction of a local wastewater treatment facility. The water-supply demands of these two proposed sewer service areas exceed the dependable yields of the underlying aquifers. The demands of Indian Village exceed the volume of water recharging the aquifer during a drought. Although the demands in Pennington-Lawrenceville Road West do not exceed the volume of water recharging during a drought, there is only approximately 300 gallons remaining or approximately 14 percent of the daily demand in reserve as a margin of safety or for other consumers. Similarly, there is not much groundwater recharge in reserve as a factor of safety or for other users during most years beneath both of these proposed sewer service areas. If this area is connected to the ELSA facility, provision of public water would very likely be required to minimize the potential for adverse impacts to the aquifer system and inter-related surface-water systems. Furthermore, public water may be necessary if the current septic-system operations have adversely impacted groundwater quality. A combined local wastewater treatment facility that discharges to groundwater would provide several advantages including maintaining the water balance within the subwatershed, maintaining aquifer storage, and possibly improving water quality.

Table 1: Anticipated Discharge Rates, Areas, and Wastewater Treatment Alternatives for Proposed Sewer Service Areas in Hopewell Township, Mercer County, New Jersey.

Proposed Sewer Service Areas	Number of Units	Type of Units	Anticipated Discharge Rate (gpd)	Anticipated Discharge (gpd)	Total Area (ft2)	Total Area (acres)	Potential Treatment Alternative	
1 Morningside	75	Single Family	300	22,500	2,286,257.14	52.49	Regional-SBRSA	Local combined with
2 Timberlane	54	Single Family	300	16,200	2,937,373.96	67.43	Regional-SBRSA	Timberlane and
3 Pennington Point		Mixed			2,074,550.16	47.63	Regional-SBRSA	Pennington Point
Existing Offices-Pennington Point West	17,500	square feet	0.1	1,750				
Existing Offices-Pennington Point	17,500	square feet	0.1	1,750				
Existing Montessori School	1	School	2000	2,000				
Proposed Market Apartments	245	Apartments	265	64,925				
Proposed COAH Apartments	43	Apartments	200	8,600				
Proposed Retail/Office Building	1	Retail/Office	3270	3,270				
Proposed Drug Store	12,300	square feet	0.1	1,230				
Proposed Bank	1	Retail	450	450				
Proposed Restaurant	1	Retail	3400	3,400				
4 North Main Street					1,188,775.65	27.29	Regional-SBRSA	Local combined with
Single Family	1	Single Family	300	300				Timberlane and
Municipal Garage	1		300	300				Pennington Point
5 Penn View Heights	60	Single Family	300	18,000	1,985,020.98	45.57	Regional-SBRSA	Local
6 Ingleside		Mixed			10,797,940.54	247.89	Regional-SBRSA	Local
Single Family	219	Single Family	300	65,700				
Commercial	128,405	square feet	0.1	12,841				
7 Tree Streets	46	Single Family	300	13,800	1,671,637.45	38.38	Regional-SBRSA	No local option
8 Mount Rose	14	Single Family	300	4,200	519,109.81	11.92	Regional-SBRSA	No local option
9 Diverty Road	78	Single Family	300	23,400	1,790,858.06	41.11	Regional-ELSA	Local
10 Orchard Avenue	102	Single Family	300	30,600	4,012,522.21	92.11	Regional-ELSA	No local option
11 Brandon Road		Mixed			2,433,674.60	55.87	Regional-ELSA	No local option
Single Family	43	Single Family	300	12,900				
Church	1	Church	1109	1,109				
12 Pennington Road	25	Single Family	300	7,500	1,347,482.80	30.93	Regional-ELSA	No local option
13 Lehigh Town Center	138,960	square feet	0.1	13,896	1,355,286.13	31.11	Regional-ELSA	No local option
14 Pennington-Lawrenceville Road East	21	Single Family	300	6,300	573,424.32	13.16	Regional-ELSA	No local option
15 Brandon Road East	16	Single Family	300	4,800	811,224.87	18.62	Regional-ELSA	No local option
16 Indian Village	57	Single Family	300	17,100	1,697,781.28	38.98	Regional-ELSA	Local
17 Pennington-Lawrenceville Road West	7	Single Family	300	2,100	537,528.75	12.34	Regional-ELSA	Local

Table 2: Areas of Proposed Sewer Service Areas in Watersheds and Subwatersheds of Hopewell Township, Mercer County, New Jersey.

	Watershed		Subwatershed			
			Central Delaware		Millstone	
Proposed Sewer Service Areas	Central Delaware (acres)	Millstone (acres)	Jacobs Creek (acres)	Shabakunk Creek (acres)	Stony Brook (acres)	Beden Brook (acres)
Morningside	28.82	23.67	28.82		23.67	
Timberlane		67.43			67.43	
Pennington Point		47.63			47.63	
North Main Street		27.29			27.29	
Penn View Heights		45.57			45.57	
Ingleside	58.26	189.62	58.26		189.62	
Tree Streets		38.38			38.38	
Mount Rose		12.00			11.80	0.20
Diverty Road	30.82	10.29	30.82		10.29	
Orchard Avenue	92.11		3.84	88.28		
Brandon Road	55.87			55.87		
Pennington Road	30.93		2.44	28.50		
Lehigh Town Center	11.31	19.80	8.32	2.99	19.80	
Pennington-Lawrenceville Road East	13.16			13.16		
Brandon Road East	18.62			18.62		
Indian Village	19.04	19.94		19.04	19.94	
Pennington-Lawrenceville Road West	12.34			12.34		

Table 3: Soils Beneath Proposed Sewer Service Areas in Hopewell Township, Mercer County, New Jersey.

Map Label (see Figure 3)	Soil Name	Septic Limitations	Percent of Areas Underlain By Soil Type
BhnB	Birdsboro silt loam, 3 to 8 percent slopes	Slight	0.35%
Boy	Bowmansville silt loam	Severe-flooding	1.92%
BucA	Bucks silt loam, 0 to 3 percent slopes	Moderate-shallow depth to bedrock	4.03%
BucB	Bucks silt loam, 3 to 8 percent slopes	Moderate-shallow depth to bedrock	44.96%
BucB2	Bucks silt loam, 3 to 8 percent slopes, eroded	Moderate-shallow depth to bedrock	3.86%
BucC2	Bucks silt loam, 8 to 12 percent slopes, eroded	Moderate-shallow depth to bedrock	3.09%
ChcA	Chalfont silt loam, 0 to 3 percent slopes	Severe-shallow seasonal water	0.04%
ChcB	Chalfont silt loam, 3 to 8 percent slopes	Severe-shallow seasonal water	1.03%
ChcB2	Chalfont silt loam, 3 to 8 percent slopes, eroded	Severe-shallow seasonal water	0.27%
DOZA	Doylestown silt loam and Reaville Variant silt loam, 0 to 3 percent slopes	Severe-hydric, shallow seasonal water, shallow bedrock	5.42%
DOZB	Doylestown silt loam and Reaville Variant silt loam, 3 to 8 percent slopes	Severe-hydric, shallow seasonal water, shallow bedrock	0.73%
KkoC	Klinesville channery loam, 8 to 15 percent slopes	Severe-very shallow pervious shale bedrock	0.05%
LDXA	Lawrenceville and Mount Lucas silt loams, 0 to 3 percent slopes	Severe-shallow seasonal water	0.05%
LDXB	Lawrenceville and Mount Lucas silt loams, 3 to 8 percent slopes	Severe-shallow seasonal water	0.57%
LegD	Legore gravelly loam, 15 to 25 percent slopes	Severe-steep slopes	0.07%
NehB	Neshaminy silt loam, 3 to 8 percent slopes	Moderate-shallow depth to bedrock	0.44%
NehC2	Neshaminy silt loam, 8 to 15 percent slopes, eroded	Moderate-shallow depth to bedrock	0.14%
PHF	Pits, gravel		0.15%
PeoB	Penn channery silt loam, 3 to 8 percent slopes	Severe-very shallow shale bedrock	1.44%
PeoC	Penn channery silt loam, 8 to 15 percent slopes	Severe-very shallow shale bedrock	1.83%
QukB	Quakertown silt loam, 3 to 8 percent slopes	Moderate-shallow depth to bedrock	1.16%
QukC2	Quakertown silt loam, 8 to 15 percent slopes, eroded	Moderate-shallow depth to bedrock	0.26%
REFA	Readington and Abbottstown silt loams, 0 to 3 percent slopes	Severe-shallow seasonal water	8.46%
REFB	Readington and Abbottstown silt loams, 3 to 8 percent slopes	Severe-shallow seasonal water	17.32%
REFB2	Readington and Abbottstown silt loams, 3 to 8 percent slopes, eroded	Severe-shallow seasonal water	1.13%
RehA	Reaville silt loam, 0 to 3 percent slopes	Severe-shallow seasonal water, very shallow bedrock	0.62%
RehB	Reaville silt loam, 3 to 8 percent slopes	Severe-shallow seasonal water, very shallow bedrock	0.24%
Ror	Rowland silt loam	Severe-very frequent flooding	0.26%
Was	Watchung silt loam	Severe-shallow seasonal water	0.10%

Table 4: Geology Beneath Proposed Sewer Service Areas Within Hopewell Township, Mercer County, New Jersey.

Proposed Sewer Service Areas	Lockatong Formation (acres)	Passaic Formation (acres)	Diabase and Metamorphic Rocks (acres)
Morningside		52.49	
Timberlane		67.43	
Pennington Point		47.63	
North Main Street		27.29	
Penn View Heights		45.57	
Ingleside		247.89	
Tree Streets		38.38	
Mount Rose			11.92
Diverty Road		41.11	
Orchard Avenue	92.11		
Brandon Road	55.87		
Pennington Road	30.93		
Lehigh Town Center	17.24	13.87	
Pennington-Lawrenceville Road East	13.16		
Brandon Road East	18.62		
Indian Village	0.22	38.76	
Pennington-Lawrenceville Road West	9.19	3.15	

Table 5: Potential Water Budgets for Proposed Sewer Service Areas Within Hopewell Township, Mercer County, New Jersey.

Proposed Sewer Service Areas	Available Water in Normal Year (gpd)	Available Water in Drought Year (gpd)	Dependable Yield (gpd)	Anticipated Water-Supply Demand (gpd)
Morningside	32,019	21,521	4,304	22,500
Timberlane	41,132	27,646	5,529	16,200
Pennington Point	29,054	19,528	3,906	87,375
North Main Street	16,647	11,189	2,238	600
Penn View Heights	27,798	18,684	3,737	18,000
Ingleside	151,213	101,635	20,327	78,541
Tree Streets	23,412	15,736	3,147	13,800
Mount Rose	2,801	1,907	381	4,200
Diverty Road	25,077	16,855	3,371	23,400
Orchard Avenue	21,646	14,738	2,948	30,600
Brandon Road	13,129	8,939	1,788	14,009
Pennington Road	7,269	4,949	990	7,500
Lehigh Town Center	12,512	8,445	1,689	13,896
Pennington-Lawrenceville Road East	3,093	2,106	421	6,300
Brandon Road East	4,376	2,979	596	4,800
Indian Village	23,695	15,927	3,185	17,100
Pennington-Lawrenceville Road West	4,081	2,762	552	2,100

Notes:

Normal Year Recharge =	610	gpd/acre for the Passaic Formation.
	235	gpd/acre for the Lockatong Formation and diabase.
Drought Year Recharge =	410	gpd/acre for the Passaic Formation.
	160	gpd/acre for the Lockatong Formation and diabase.
Dependable Yield =	82	gpd/acre for the Passaic Formation.
	32	gpd/acre for the Lockatong Formation and diabase.

Table 6: Average Lot Sizes and Potential Impervious Surface Coverage for Proposed Sewer Service Areas Within Hopewell Township, Mercer County, New Jersey.

Proposed Sewer Service Areas	Land Area (acres)	Number of Single-Family Units	Average Lot Size for Residential Development (acres)	Potential Impervious Coverage (percent)	Potential Recharge Area (percent)
Morningside	52.49	75	0.70	21.5%	78.5%
Timberlane	67.43	54	1.25	16.0%	84.0%
Pennington Point	47.63			60.0%	40.0%
North Main Street	27.29			18.0%	82.0%
Penn View Heights	45.57	60	0.76	21.5%	78.5%
Ingleside	247.89	219	1.13	17.0%	83.0%
Tree Streets	38.38	46	0.83	20.0%	80.0%
Mount Rose	11.92	14	0.85	19.0%	81.0%
Diverty Road	41.11	78	0.53	25.0%	75.0%
Orchard Avenue	92.11	102	0.90	19.0%	81.0%
Brandon Road	55.87	43	1.30	15.5%	84.5%
Pennington Road	30.93	25	1.24	16.0%	84.0%
Lehigh Town Center	31.11			37.0%	63.0%
Pennington-Lawrenceville Road East	13.16	21	0.63	23.5%	76.5%
Brandon Road East	18.62	16	1.16	16.5%	83.5%
Indian Village	38.98	57	0.68	21.5%	78.5%
Pennington-Lawrenceville Road West	12.34	7	1.76	13.0%	87.0%

Notes:

1. Excluding Pennington Point, North Main Street, and Lehigh Town Center, percentages of impervious surface coverage for single family home areas were obtained from USDA Technical Release 55 "Urban Hydrology for Small Watersheds.
2. Percentage of impervious surface for Pennington Point was estimated from Hopewell Township Land Development
3. Percentage of impervious surface coverage for North Main Street was estimated from aerial photographs.
4. Percentage of impervious surface coverage for Lehigh Town Center were determined from existing site plans.

Table 7: Potential Water Budgets Adjusted for Impervious Surface Coverage for Proposed Sewer Service Areas Within Hopewell Township, Mercer County, New Jersey.

Proposed Sewer Service Areas	Available Water in Normal Year (gpd)	Available Water in Drought Year (gpd)	Dependable Yield (gpd)	Anticipated Water-Supply Demand (gpd)
Morningside	25,135	16,894	3,379	22,500
Timberlane	34,551	23,223	4,645	16,200
Pennington Point	11,622	7,811	1,562	87,375
North Main Street	13,650	9,175	1,835	600
Penn View Heights	21,821	14,667	2,933	18,000
Ingleside	125,507	84,357	16,871	78,541
Tree Streets	18,729	12,589	2,518	13,800
Mount Rose	2,269	1,545	309	4,200
Diverty Road	18,808	12,641	2,528	23,400
Orchard Avenue	17,533	11,937	2,387	30,600
Brandon Road	11,094	7,554	1,511	14,009
Pennington Road	6,106	4,157	831	7,500
Lehigh Town Center	7,883	5,320	1,064	13,896
Pennington-Lawrenceville Road East	2,366	1,611	322	6,300
Brandon Road East	3,654	2,488	498	4,800
Indian Village	18,601	12,503	2,501	17,100
Pennington-Lawrenceville Road West	3,551	2,403	481	2,100

Table 8: Conclusions Matrix for Proposed Sewer Service Areas Within Hopewell Township, Mercer County, New Jersey.

Proposed Sewer Service Areas	Dependable Yield Exceeded	Drought Recharge Exceeded	Normal Year Recharge Exceeded	Regional Option Available	Potential Need for Public Water	Local Option Advantages
Morningside	Yes	Yes	Probable	Yes	Very Likely	CAWIDP
Timberlane	Yes	Possible	No	Yes	Likely	CAWIDP
Pennington Point	Yes	Yes	Yes	Yes	Yes	CAWIDP
North Main Street	No	No	No	Yes	No	CAWID
Penn View Heights	Yes	Yes	Probable	Yes	Very Likely	CAWIDP
Ingleside	Yes	Probable	Possible	Yes	Most Likely	AWIDP
Tree Streets	Yes	Yes	Probable	Yes	Very Likely	Not available
Mount Rose	Yes	Yes	Yes	Yes	Yes	Not available
Diverty Road	Yes	Yes	Yes	Yes	Yes	AWIDP, possibly C
Orchard Avenue	Yes	Yes	Yes	Yes	Yes	CAWIDP
Brandon Road	Yes	Yes	Yes	Yes	Yes	CAWIDP
Pennington Road	Yes	Yes	Yes	Yes	Yes	CAWIDP
Lehigh Town Center	Yes	Yes	Yes	Yes	Yes	CAWIDP
Pennington-Lawrenceville Road East	Yes	Yes	Yes	Yes	Yes	CAWIDP
Brandon Road East	Yes	Yes	Yes	Yes	Yes	Not available
Indian Village	Yes	Yes	Probable	Yes	Very Likely	CAWIDP
Pennington-Lawrenceville Road West	Yes	Probable	Possible	Yes	Most Likely	CAWIDP

Notes:

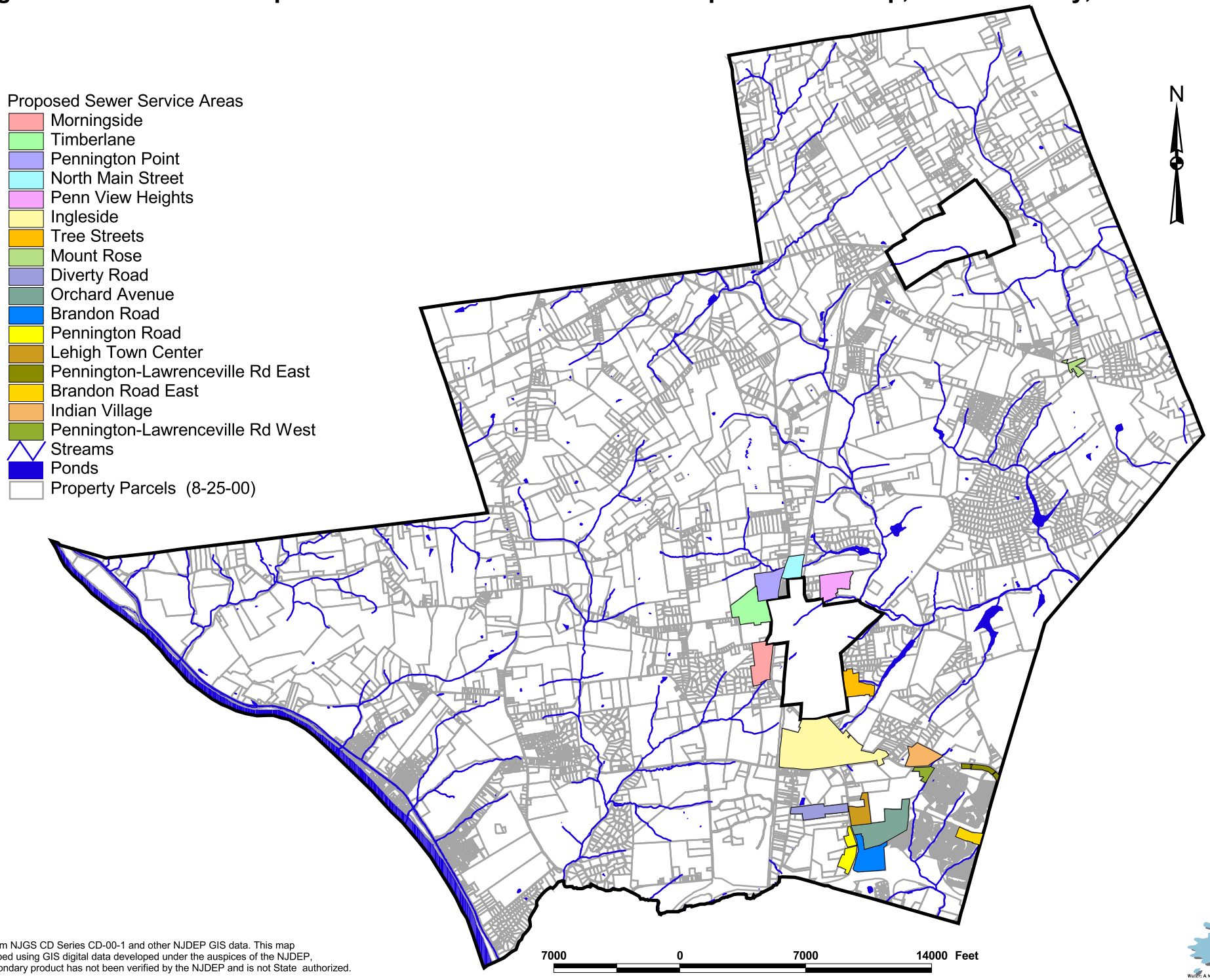
The volume of recharge in reserve was calculated by subtracting the recharge volume from the anticipated demand as listed in Tables 5 and 7. Based on the results of these calculations, exceedences were rank as follows:

No if more than 100 percent of the daily demand remained as recharge reserve.
Possible if more than 25 percent of the daily demand remained as recharge reserve.
Probable if less than 25 percent of the daily demand remained as recharge reserve.
Yes if daily demand exceeded recharge rate.

The need for public water is based on the potential presence of existing groundwater impacts from septic-system contaminants and/or the potential for adverse impacts to aquifer systems and interconnected surface-water systems because of likely groundwater mining.

Local option advantages include the following: C = combined with other areas, A = Water remains within aquifer system, W = water remains within watershed, I = improve existing groundwater quality through additional dilution, D = reduced impacts from droughts, P = reduced or eliminated potential

Figure 1: Locations of Proposed Sewer Service Areas Within Hopewell Township, Mercer County, New Jersey.



Modified from NJGS CD Series CD-00-1 and other NJDEP GIS data. This map was developed using GIS digital data developed under the auspices of the NJDEP, but this secondary product has not been verified by the NJDEP and is not State authorized.

Figure 2: Watersheds and Subwatersheds Beneath Proposed Sewer Service Areas Within Hopewell Township, Mercer County, New Jersey.

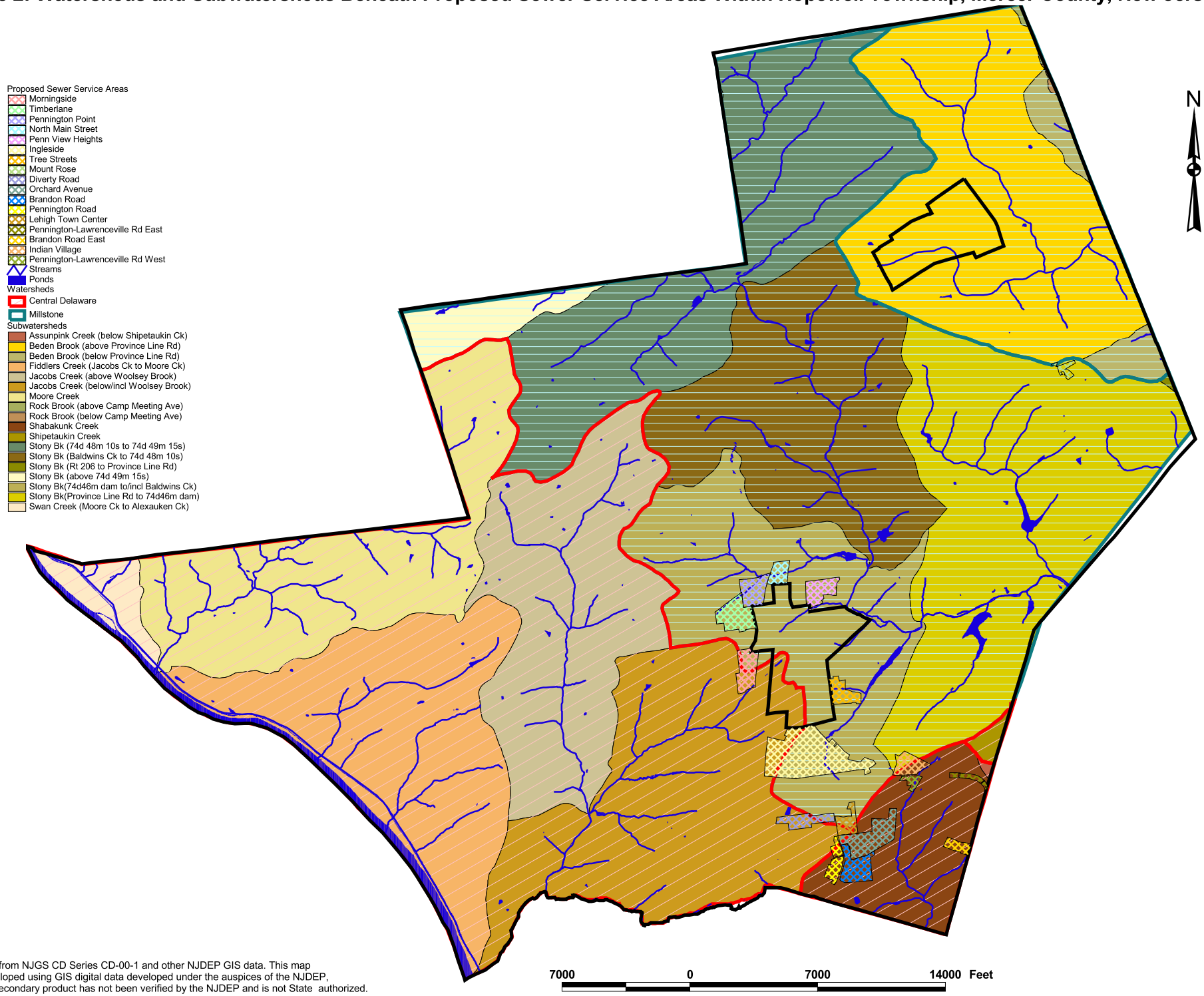


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Figure 3: Soils Beneath Proposed Sewer Service Areas in Hopewell Township, Mercer County, New Jersey.

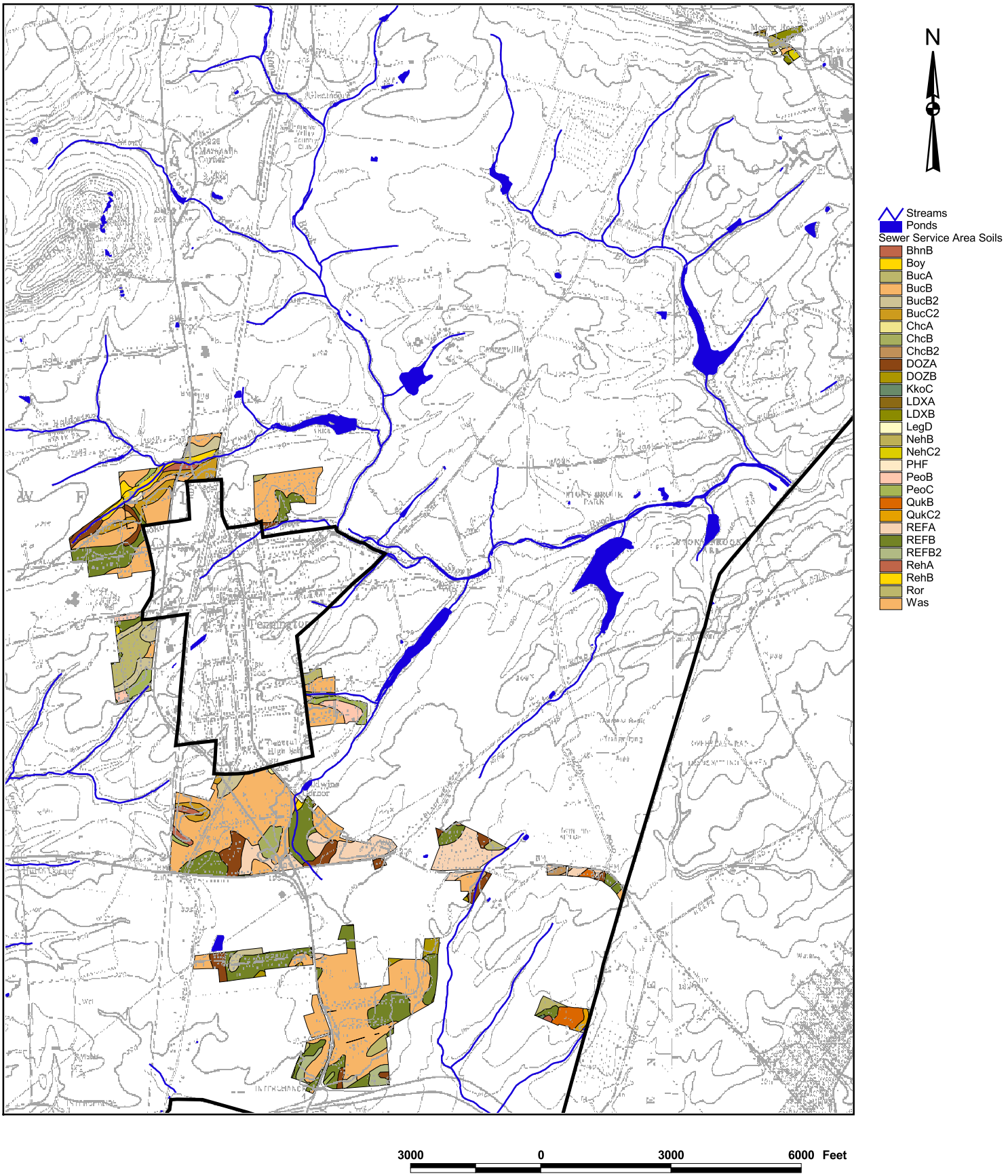

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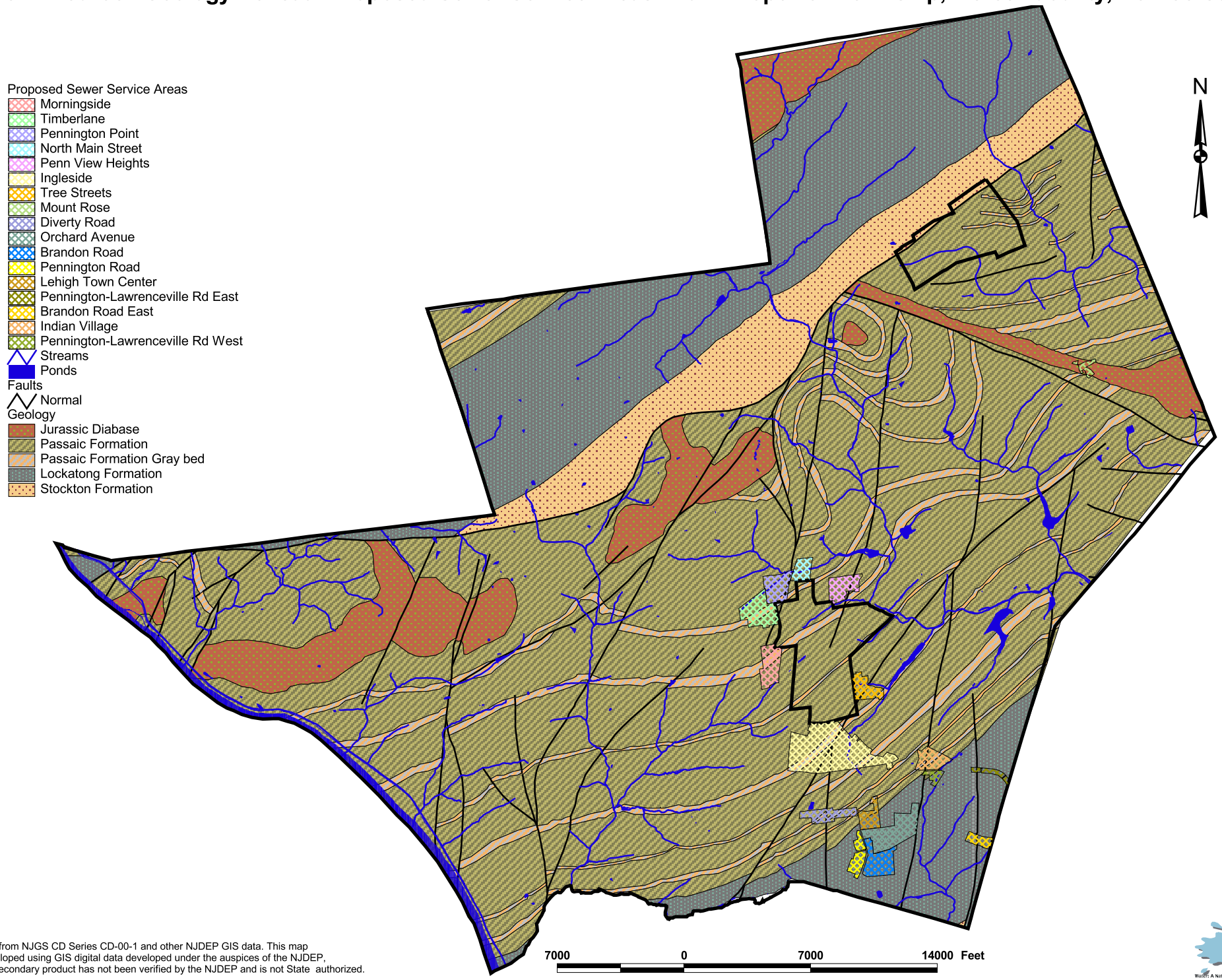
Figure 4: Bedrock Geology Beneath Proposed Sewer Service Areas Within Hopewell Township, Mercer County, New Jersey.



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