Water: A Natural Renewable Resource

M² Associates Inc

Providers of Geologic, Environmental, & Groundwater Consulting Services

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Paul Pogorzelski, PE
Township Administrator/Engineer
Hopewell Township
201 Washington Crossing-Pennington Rd
Titusville, 08560-1410

Re: Hydrogeologic Evaluation of the Pennytown-Kooltronics Re-Development Site in Hopewell Township, Mercer County, New Jersey.

Dear Mr. Pogorzelski:

As requested, the report herein will serve as a final report regarding the hydrogeologic conditions beneath the proposed Pennytown-Kooltronics redevelopment site unless the Hopewell Township Committee and those representing Kooltronics' private interests in the property decide to modify site plans and open more of the site for water-supply exploration. To date, exploration of groundwater resources beneath the site has been limited to the southern portion for reasons to be discussed further in this report. Unless additional wells are installed to augment the limited supply in Test Well 2, the resources beneath the southern portion of the property are insufficient to meet the water-supply demands of the conceptual project as proposed to the Committee.

Based on the information and data collected to date, it is not cost effective for the Township to continue pursuing groundwater resources beneath the southern portion of the Kooltronics property. The scope of the project would need to be greatly reduced, perhaps by as much as 50 percent, and/or other portions of the property proposed for development need to be explored. If the hydrogeologic conditions in these other areas of the site are sufficient, then the conceptual site plans would have to be altered to prohibit development within a minimum of 50 feet of each well.

WATER DEMANDS

Existing concept plans of the proposed development encompassing the combined Pennytown and Kooltronics site were prepared by Minno & Wasko in September 2010 and later modified on two concept plans drafted by Clarke, Caton, Hintz in April 2012. Using the Minno & Wasko plans, in June 2011, Birdsall Services Group (Birdsall) prepared estimates of the volumes of water needed to meet the daily demands of the project. Birdsall estimated an average daily demand of nearly 71,000 gallons and a peak-day demand of 212,000 gallons for the proposed 65- single-family homes, 43-townhomes, 120-condominium units, 120- rental units, and 15,000-square feet of commercial space.

This June 2011 Birdsall estimate did not include a YMCA facility later added to the concept plans, and the existing Kooltronics facility, which each have an average daily demand of 5000 gallons. With these additions, the average daily demand is 81,000 gallons and the peak-day demand is 243,000 gallons.

The hydrogeologic evaluation of the site was implemented by the Township Committee to determine if sufficient groundwater resources were available to provide a minimum of 81,000 gallons per day (equivalent to approximately 60 gallons per minute) without any adverse impacts to the aquifer, nearby residents reliant on the same aquifer, and natural resources dependent on these supplies. It must be noted that the minimum yield of 60 gallons per minute is not sufficient to meet peak-day demands, and does not include the redundancy required to ensure adequate water is available in emergencies, during periods of extended dry weather, or as well efficiencies naturally decline with time. Given the proposed development plans and limited potential for interconnection for emergency supplies provided by other water purveyors, it is very likely that the NJDEP will require sufficient capacity to provide a minimum of 180 gallons per minute before approving the construction of a water-supply system.

BEDROCK GEOLOGY

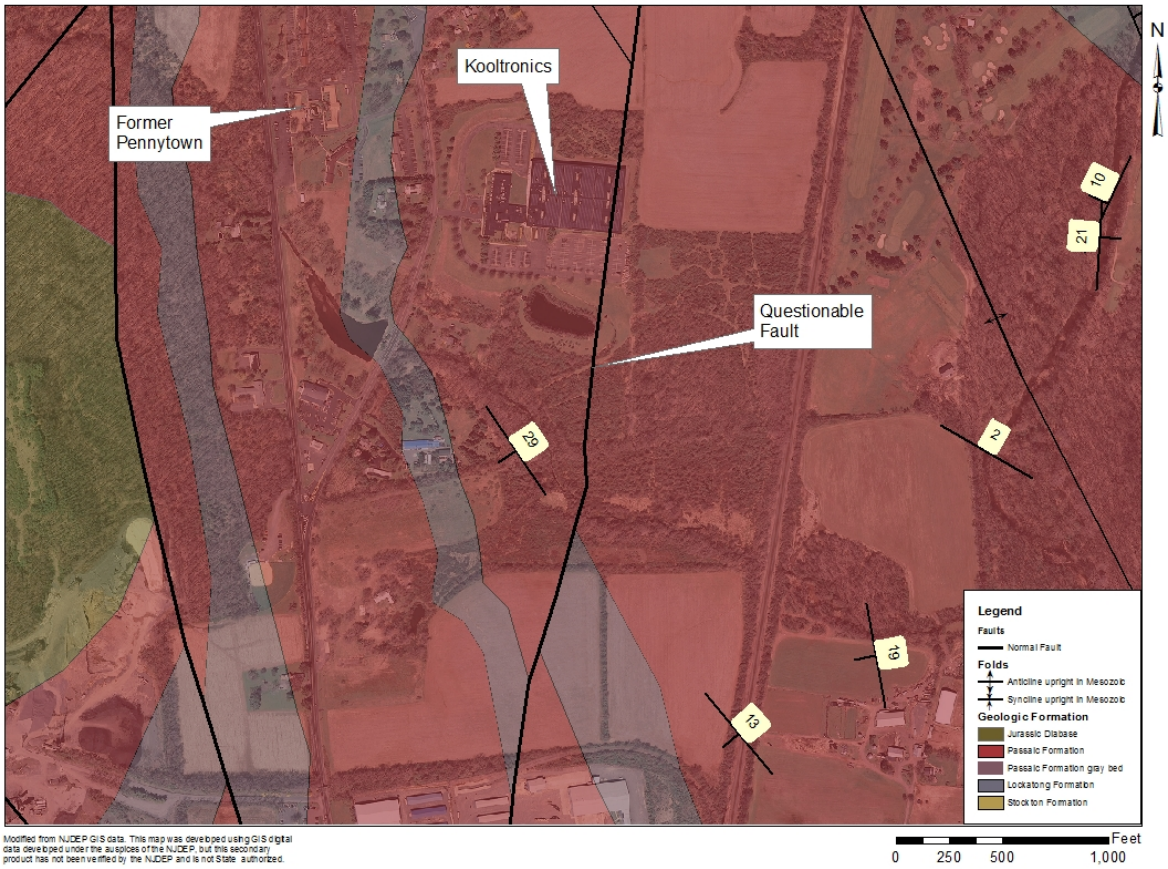
During a November 16, 2011 pre-application meeting with representatives of NJDEP-Bureau of Water Allocation and New Jersey Geological Survey (NJGS), those attending on behalf of the Township and Kooltronics were informed that some of the structural geologic information presented on the NJGS' "Bedrock Geologic Map of Central and Southern New Jersey" may not be accurate on a local scale. In particular, the NJGS representatives indicated that a fault mapped on the bedrock geologic map transecting the Kooltronics site may not exist. The location of this south-north trending fault, as depicted on the published geologic maps and the NJDEP geographic information system (GIS) database is shown on Figure 1.

Since groundwater is stored and transmitted in fractures and faults are zones of intense fracturing, the presence of a fault through the Kooltronics site suggested that it could be feasible to develop sufficient groundwater resources beneath the site to provide the needed water. If the fault was not at the location depicted on the geologic maps, then the potential for developing groundwater resources is lower.

After obtaining in-progress geologic mapping data from NJGS, the branch of Stony Brook immediately south of the site, the area along the railroad tracks east of the site, and preserved open space north of the site were inspected for outcrops of bedrock. Outcrops were only present along the stream. The fault trace was not directly observed in the bedrock along the stream but most of the stream bottom is covered with sediment and few outcrops are present. The fault could exist but simply was not evident in the available outcrops. Several fractures including three distinct sets of near-vertical joints and bedding parallel openings are present. In addition, stream flow patterns indicate fracture control.

Water: A Natural Renewable Resource

Figure 1: Composite Geologic Map of Pennytown-Kooltronics Site in Hopewell Township, New Jersey.



ALTERNATIVE PLANS

Given the November 2011 discussions with the NJGS representatives and the lack of direct observations confirming the presence of a fault, alternative plans were discussed with representatives of the Township and Kooltronics. The first alternative was to conduct a surficial geophysical survey to assess if the fault existed and identify potential water-bearing fractures before drilling wells. The second alternative was to drill two test wells and use the information from these wells to assess subsurface conditions.

Since it would be problematic to conduct a reliable surficial geophysical survey through the heavily overgrown woods where a well or wells could be installed to the satisfaction of NJDEP, and the cost of such a survey would likely exceed the cost of drilling exploratory test wells, the decision was taken by the representatives to drill test wells. It should also be noted that the surficial geophysical survey was not included in the project budget. Although the geophysical survey may have been useful in identifying fractures, ultimately, it remained necessary to install the test wells to determine if sufficient groundwater resources were available to provide the water needed for the project. The first alternative was dismissed and it was decided by the representatives of the project to proceed in accordance with the Township Committee approved hydrogeologic evaluation and to install two test wells.

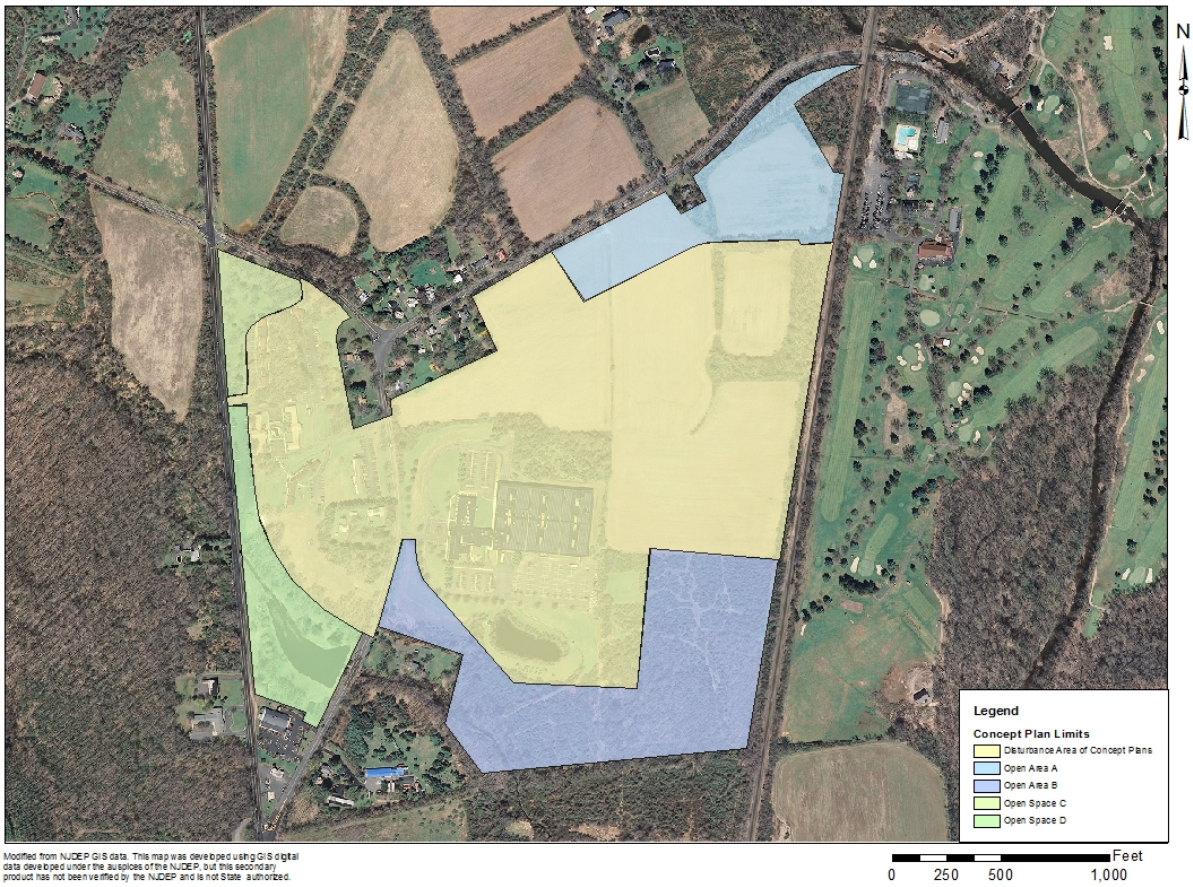
50-Foot Radius Required

N.J.A.C. 7:10 known as the “Safe Drinking Water Act Regulations” require that a water purveyor control all lands within 50 feet of a well used as a “Public Community” supply. These regulations indicate that no minor or major pollutant sources can be located within this radius. No roads, buildings, or other man-made infrastructure can be within this zone and NJDEP prefers that the lands remain in a naturally vegetated state. NJDEP imposes other distance requirements from elements of subsurface wastewater disposal systems that exceed the 50-feet radial distance.

Concept Plans Limit Well Location Options

Of the approximately 126 acres encompassed within the six parcels that combined comprise the Pennytown and Kooltronics site, the proposed development activities will encompass slightly more than 83 acres. Figure 2 depicts the section of the site proposed for development and the four areas proposed to serve as open space. Ten of the 43-acres of potential open space where a well or wells could be installed to meet the NJDEP regulatory criteria are located on the Pennytown section of the site. These two open space areas were previously assessed and excluded because of the proximity to historic wastewater treatment and disposal infrastructure on this section of the site.

Figure 2: Concept Plans Areas of Development and Open Spaces for Pennytown-Kooltronics Site.



Modified from 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.

Three wells were previously installed on the Pennytown site and one was tested. If any of these wells are to be used for this project, it would be necessary to modify the development plans to exclude disturbance within 50 feet.

Given the constraints imposed by the development plans and NJDEP regulations, four potential test wells sites were identified. Two potential sites were located in the open space in the northern portion of the Kooltronics property and two in the southern open space. Since one of these open spaces would likely be needed for wastewater operations, the northern area was temporarily set-aside from exploration because of its distance from the stream and potential for better soil conditions, to be assessed by Birdsall for disposal fields.

The southern open space was viewed more favorably for water-supply exploration because this area is naturally vegetated and therefore, would provide the buffers required by NJDEP around any wells. Several other reasons indicated a higher potential for groundwater resources beneath the southern space in comparison to the northern open space including but not limited to geologic conditions including proximity to the stream, the presence of fractures in outcrops along the stream; and that Kooltronics has two wells within this section. These Kooltronics' wells would be useful for monitoring water levels during required aquifer tests and thereby, reduce project costs by eliminating the need to install two observation wells in addition to the two test wells.

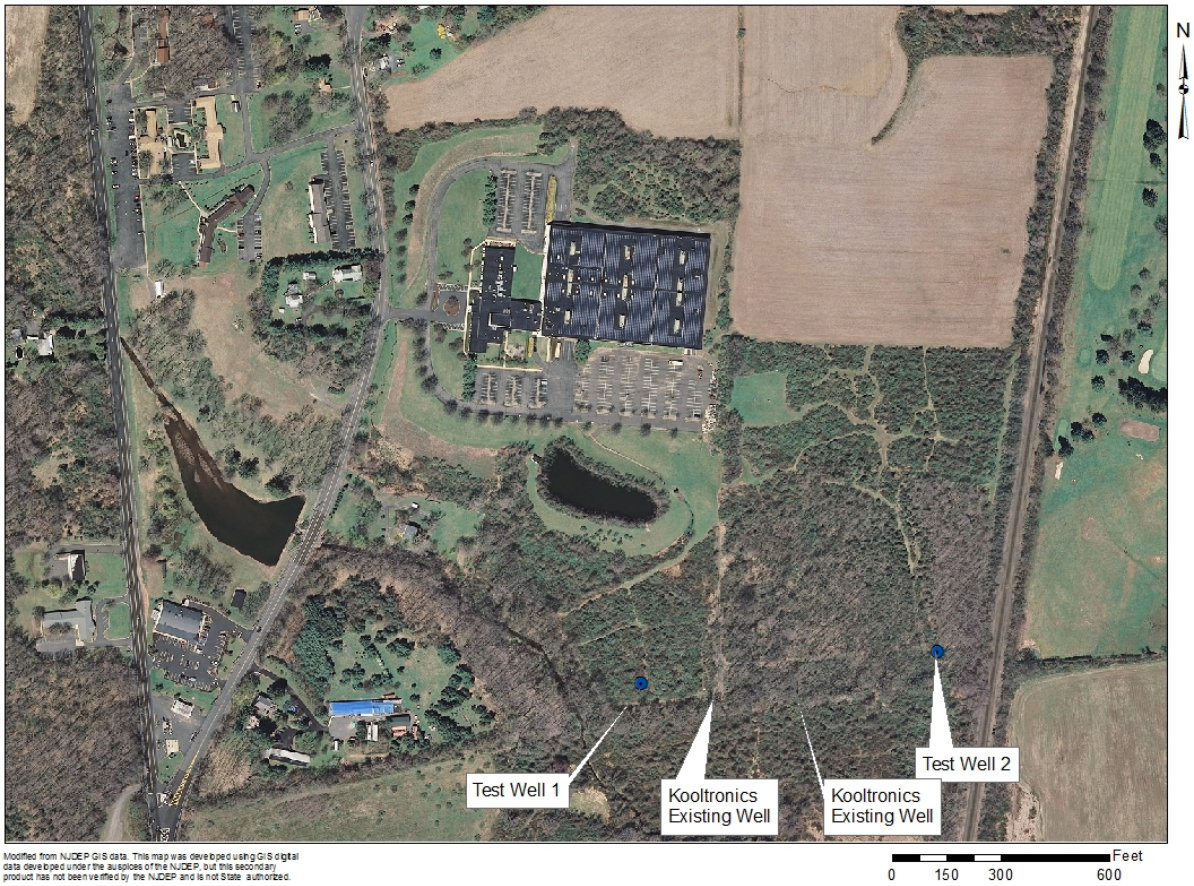
TEST WELL 1

The location of Test Well 1 was selected to intersect the fault as mapped on the historic geologic maps if this fault indeed did exist. Fracture traces observed along the stream located to the south of the well also suggested the presence of openings that could transmit groundwater to a well. Figure 3 depicts the location of this test well and Test Well 2 at the site.

Test Well 1 (NJDEP Permit No. E201204837) was completed to 300 feet below ground surface on May 25, 2012. The first 50 feet of geologic material encountered in this well boring is comprised of very soft-red and gray highly weathered shale. The NJGS used downhole geophysical techniques to further evaluate the geologic conditions encountered in this well and we are awaiting the results of that survey.

Essentially no groundwater was encountered to approximately 200 feet below ground surface. A small fracture was encountered at 200 feet below ground surface. No additional groundwater was encountered from 200 to 300 feet below ground surface.

Figure 3: Test Well Location at Pennytown-Kooltronics Site.



The yield of Test Well 1 was estimated by injecting air using the drill stem into the well to displace water. The estimated yield is 4 gallons per minute. As a result of the pumping, the water level in the well was lowered 175 feet from an initial static water level of 45 feet below ground surface. These results indicate that Test Well 1 intersects a very poorly transmissive zone of the Passaic Formation aquifer beneath the site. With a short-term specific capacity of 0.03 gallons per minute per foot of drawdown, it can be concluded that Test Well 1 does not have adequate production capacity to fully or partially meet the proposed project demands. While this well may be useful as an observation well for aquifer testing, it would not be useful as a production well.

TEST WELL 2

Test Well 2 (NJDEP Permit No. E201204838) was completed on June 4, 2012 to 360 feet below ground surface. Initially this location was selected for a test well because geologic mapping indicated that bedding planes were dipping less steeply in the eastern portion of the site than western portion or beneath the Pennytown site.

One of the limiting factors to developing the groundwater resources beneath the Pennytown site is that the steep nature of bedding planes greatly reduces the horizontal

extent of the aquifer recharge zone. For example, beneath the Pennytown site where bedding planes are dipping 32 degrees to the west, beds intersected in a Pennytown site well at 300 feet below ground surface are present at or near ground surface approximately 480 feet to the east. In the eastern section of the Kooltronics site beds are dipping 10 degrees to the west. Layers encountered in Test Well 2 at 300 feet below ground surface are present at ground surface approximately 1700 feet to the east. The intent of Test Well 2 was to intersect an aquifer with greater horizontal extent.

Competent or hard red-shale bedrock was encountered at approximately 4 feet below ground surface and continued to the completed depth of the well. The highly weathered materials encountered in Test Well 1 were not present in Test Well 2, which is located approximately 825 feet east of the fault depicted on the historic geologic maps.

While the bedrock encountered in Test Well 2 was harder than the bedrock encountered in Test Well 1, little water was encountered to 295 feet below ground surface. Water-bearing fractures were encountered at 170, 210, 230, and 238 feet below ground surface and the yield was estimated at 10 gallons per minute.

Initially it was planned to complete Test Well 2 similar to Test Well 1 at 300 feet below ground surface because typically few if any, additional water-bearing fractures are encountered at depths greater than 300 feet below ground surface. However, in Test Well 2 at 295 feet below ground surface, evidence of a significant fracture was observed in the cuttings from the boring.

The well boring was extended and at approximately 305 feet below ground surface, a large fracture was encountered and provided an estimated 40 gallons per minute to the well. Geologic conditions below this fracture suggested additional water-bearing fractures may be encountered but no additional yield was obtained and drilling of Test Well 2 was completed at 360 feet below ground surface. The total yield of this well was estimated at 50 gallons per minute with approximately 34 feet of drawdown from the initial static level of 50 feet below ground surface. Attempts by NJGS to complete geophysical logs within Test Well 2 have not been successful because the well cannot be accessed.

The yield of Test Well 2 was estimated by “blowing” water from the well by injecting air through the drill stem. It will be necessary to conduct proper aquifer tests to determine the actual safe-yield of the well. Even if the safe-yield of Test Well 2 is 50 gallons per minute, this yield is not sufficient to meet all of the demands imposed by the proposed project depicted on the conceptual plans. It is likely that the actual safe yield of this wells ranges between 25 and 35 gallons per minute.

CONCLUSIONS

Test Well 1 did not intersect a section of the aquifer capable of transmitting sufficient water to fully or partially meet the project demands, which range from 81,000 gallons on an average day to 243,000 gallons on a peak-demand day.

Water: A Natural Renewable Resource

Test Well 2 may have a yield of 50 gallons per minute but further testing will be necessary to determine the actual safe yield of this well. It is unlikely that the safe yield will exceed 50 gallons per minute and will more likely range between 25 and 35 gallons per minute. While this well may serve to partially meet the project demands, the yield is not sufficient to sustain the proposed project.

Either it will be necessary to explore the groundwater resources of other areas of the site to determine if additional wells can be installed to supplement Test Well 2 or concept plans will need to be altered to reduce the project water-supply demands.

To reduce potential interference effects, wells must be adequately spaced. If it is assumed that the minimum spacing between wells for the Kooltronics site is 500 feet, it is possible that additional wells can be installed at the site but given NJDEP requirements for buffers around each well; each well would reduce the development potential of the project. Furthermore, each additional well that is installed will reduce the available area for wastewater disposal. It must be noted that the actual spacing between the wells needed to minimize the potential for adverse interference may be greater than 500 feet and cannot be determined without conducting aquifer tests.

The two existing Kooltronics wells, as constructed in 1971, do not meet the NJDEP's current requirements for public community water-supply wells and although, these wells have not been adequately tested to determine long-term safe yields, the limited available data indicate that they do not have sufficient capacity to serve the project.

If additional areas of the site were opened to exploration, a surficial geophysical survey could be conducted. Given the heavily wooded nature of the southern section of the property, such a survey would be problematic. But in the open agricultural fields or open areas around the Kooltronics building, a survey using electromagnetic methods could be completed. Such a survey will indicate anomalies in the conductivity of the rocks beneath the site that are likely associated with water-bearing fractures.

Test wells could be installed to intersect these anomalies. If these test wells are drilled, it would be necessary to change the concept plans for the project to ensure that no infrastructure is located within 50 feet and no elements of the wastewater system are located within 100 feet of the well.

We appreciate the opportunity afforded by the Township Committee to evaluate the water-supply development potential of the Pennytown-Kooltronics site. If you have any questions, please call Matt Mulhall at (908) 238-0827.

Respectfully submitted,
M^2 Associates Inc.

Matthew J. Mulhall, P.G.