Section 7 – Alternatives

List of Acronyms and Abbreviations – Section 7

ACC	air cooled condenser
BACT	Best Available Control Technology
CEA	Critical Environmental Area
ConEd	Consolidated Edison Company of New York
CVE	Cricket Valley Energy, LLC
DSM	Demand Side Management
GHG	greenhouse gases
gpd	gallons per day
gpm	gallons per minute
HRSG	heat recovery steam generator
Iroquois	Iroquois Gas Transmission
kV	kilovolt
LAER	Lowest Achievable Emission Rate
MGD	million gallons per day
MW	megawatt
NYSDEC	New York State Department of Environmental Protection
Property	131-acre property optioned by CVE
Project Development Area	The 57-acre portion of the 131-acre Property proposed for development
UA	unconsolidated aquifer
ULSD	Ultra-low sulfur diesel
USEPA	United States Environmental Protection Agency
ZLD	Zero liquid discharge

7. ALTERNATIVES

7.1 Introduction

This section discusses alternatives to the project that were considered, including the "no-action" alternative. The "no action" alternative describes likely circumstances if the project does not proceed. This section also explains Cricket Valley Energy, LLC's (CVE's) site and technology selection rationale and describes the alternative cooling and emissions control technologies that were considered. It also discusses facility design alternatives, including alternate facility sizes, fuel use alternatives, and alternative sources of water supply.

7.2 "No-Action" Alternative

The "no-action" alternative considers what would happen should the project not proceed. Under this assumption, the project's purpose and public need would not be met, and the benefits summarized here and more fully discussed in Section 1.1 would not accrue. Also, the short-term and long-term impacts associated with the construction and operation of the project as detailed in Sections 2 though 6 would not occur.

Without the project, there are no plans to proceed with the removal of the site's existing dilapidated structures and industrial debris, or the proposed site and wetland restoration activities. This industrially zoned parcel would continue to remain impaired, unutilized and unproductive for the foreseeable future. Therefore, the significant socioeconomic benefits discussed in Section 6.7, including construction and long-term jobs as well as significant tax revenue to the Town of Dover, Dutchess County and the State of New York would not accrue.

Without the project, the following benefits might not be achieved for New York State:

- Enhancing the reliability of the New York energy system
- Reducing greenhouse gas (GHG) and other air pollutant emissions
- Stabilizing energy costs and improving economic competitiveness

Without the project, the following benefits might not be achieved for the Town of Dover:

- Rehabilitating an inactive industrial site, currently in disrepair, and returning it to productive use
- Preserving a reach of the Swamp River and bordering wetlands
- Restoring existing previously damaged wetlands

- Stimulating economic growth without creating a significant burden on the community or significant adverse impact to the environment
- Creating approximately 750 construction jobs and, post construction, 25-30 full-time positions
- Increasing tax revenue
- Purchasing local materials and indirectly creating additional secondary employment, as discussed in Section 6.7

Under the "no-action" alternative, the electrical generating capacity of the project would need to be met through construction of additional generation capacity elsewhere. As described in Section 7.4, development of a comparable facility at another location with adequate access to natural gas supply and the bulk transmission system (i.e., with minimal off-site disturbance) and adequate buffer from other land uses would likely necessitate the use of a greenfield site instead of an inactive industrial site. Without the project or a similar new facility developed elsewhere within the region, the electrical output of the project would likely need to be met through continued and increased reliance on older, less efficient and higher emitting sources. Increased reliance on the current, older and less efficient fleet of power plants would result in:

- Higher emission rates of air pollution and GHG emissions in the region; and
- The loss of the regional air quality benefit that would be derived from the operation of the CVE plant, as quantified in Section 4.6.5 and explained below.

Because the proposed project is more efficient than the existing fleet of electric generating plants in the region, it will be called on to operate (dispatched) ahead of older, less efficient and higher emitting units. As a result, the operation of the project will have a significant net air quality benefit and result in a reduction in regional emissions of GHG. These emissions benefits are quantified in Section 4.6.5. Under the "no action" alternative, these benefits would not accrue.

Given the above factors, the "no-action" alternative was not considered a viable alternative to the project.

7.3 Demand Side Management

Demand Side Management (DSM) is an effective means of meeting future energy needs by optimizing supply and demand. DSM programs seek to both decrease energy consumption and optimize patterns of electricity usage through efficiency improvements in electrical appliances, more efficient use of electricity, and load interruptions during peak demand times. In the New York Independent System Operator (NYISO) system, “load interruptible” facilities are considered Special Case Resources and can participate in the NYISO process to meet demand in the same way as generators do.

Aggressive DSM and deployment of new, higher efficiency, lower emitting base-load generating capacity are complementary energy strategies. This is recognized in the 2009 New York State Energy Plan, which among other things seeks to achieve its goals through “end-use efficiency” (for example through DSM) and “electric system efficiency” (for example through displacement of older, less efficient and higher emitting facilities with new, highly efficient, low emitting, state-of-the-art plants). Special Case (interruptible load) Resources best meet peak electric demands (typically the highest demand hours on the hottest days of the year). The proposed project is intended to meet base-load energy demand. As such, DSM and the proposed project serve different, and equally important, needs.

Clean, efficient, quick-start natural gas-fired generation plants are also needed as a physical hedge or safeguard against the failure of DSM resources. Experience in other states has shown that on peak energy consumption days, or in emergencies, DSM can only be relied on for a certain number of hours before the availability of DSM resources degrade, necessitating the use of physical generation.

The proposed project does not preclude or impede DSM measures such as interruptible load resources. Because DSM does not meet the project’s purpose and need, meeting growing base-load energy demands as summarized above and more fully discussed in Section 1.1, DSM was not considered a viable alternative to the project.

7.4 Alternate Project Sites

The 131-acre CVE site (the Property) was selected based on detailed criteria that included proximity to energy infrastructure (existing natural gas and electric transmission lines), appropriate industrial zoning, and sufficient land to create a natural buffer to minimize impacts to the surrounding community. A 57-acre portion of the Property that has largely been previously developed for industrial use (the Project Development Area), meets all of these criteria, specifically:

- It is adjacent to a 345-kilovolt (kV) electric transmission line owned by Consolidated Edison Company of New York (ConEd). No new off-site power lines will be built.

- It is adjacent to a high-pressure natural gas pipeline owned by Iroquois Gas Transmission (Iroquois). An approximately 500-foot-long 12-inch-diameter natural gas pipeline lateral will be constructed to connect the project with the 24-inch Iroquois gas pipeline.

- It is industrially zoned. The site is one of two areas in Dover zoned for manufacturing/industrial purposes. It is specifically designated in the Town of Dover Master Plan (referred to as the "Mica Plant") to be utilized for industrial purposes.

- It has a natural buffer. An approximate 300-foot buffer of vegetation will be maintained between the facility and New York State Route 22 to mitigate visual impacts. In addition, existing topography will be maintained as buffer.

In addition, the Project Development Area has been previously developed for industrial purposes and, therefore, is not a greenfield site. Further, the only site under CVE control is the Property.

Alternative sites were evaluated throughout the southeast region of New York State in addition to several local alternatives in the town of Dover, with the following results:

- The alternative sites did not adequately meet the four criteria outlined above.

- Alternative sites identified adjacent to the electric transmission lines and natural gas pipeline did not offer the appropriate zoning or buffer.

- Alternative sites identified with appropriate zoning were located away from energy infrastructure and, therefore, would require the construction of substantial off-site infrastructure improvements including new electric transmission lines and a natural gas pipeline. The impact to the surrounding community and natural resources resulting from the need for potentially significant off-site construction and infrastructure eliminated these sites from consideration.

- None of the other sites are owned or controlled by CVE.

The proposed site best meets the goals and objectives of the project in the most environmentally responsible manner. In addition, as an inactive industrial site, the project presents an opportunity to turn a potential environmental liability into a productive industrial site by replacing the existing dilapidated structures with a new state-of-the-art, low-impact electric generating facility.

7.5 Alternate Interconnections

The electrical and natural gas interconnections for the project will be to the immediately adjacent and abutting ConEd 345-kV electric transmission system and Iroquois interstate natural gas pipeline which shares the ConEd right-of-way, respectively. The interconnections are proposed to occur at their closest point with respect to the project. As such, no further electrical or natural gas interconnection alternative routes were considered.

7.6 Alternative Project and Cooling Technologies

7.6.1 Alternate Generation Technologies

Technology alternatives considered included renewable energy technologies, simple cycle combustion turbine technology and conventional boiler technology.

<u>Renewable Energy Technologies</u>

While CVE believes that renewable energy projects are an important part of the region's energy portfolio, they are not particularly well suited to meet the project's purpose and need, providing 1,000 megawatts (MW) of baseload power to the grid:

- Wind and solar projects generate electricity only when meteorological conditions allow and, therefore, cannot be relied on to meet base-load electric demand independent of such conditions.

- In this region, wind and solar projects can generate power only about 15 to 30 percent of the time, and not always coincident with peak energy demand. Therefore, backup with physical power generation is required to compensate for the intermittencies of wind and solar generation.

- The footprint that would be required to provide 1,000 MW of wind or solar power would constitute thousands of acres of land, greatly exceeding the available site area.

- A 1,000 MW biomass facility would greatly exceed the supply of waste biomass in the region, and would use considerably more water, produce more truck traffic, result in higher emissions of air pollutants, and generate considerably more solid waste than the proposed project.

Due to all of these factors, CVE rejected renewable energy technologies as not meeting the project's purpose and need.

Simple Cycle Combustion Technology

Simple cycle combustion turbines are not as efficient as combined cycle units in terms of both energy (amount of electricity generated per unit of fuel) and environmental (emissions per unit of electricity generated) efficiency.

Simple cycle combustion turbines can be turned on and off very quickly, making them very well suited to meet intermittent or peak electrical demand as opposed to base-load demand. The proposed CVE project is being developed to meet growing base-load electrical demand. As such, combined cycle technology is the superior alternative to meet the project's purpose and need due to its superior energy and environmental efficiency.

Conventional Boiler Technology

In addition to being less energy and environmentally efficient, all of the electrical output of conventional boiler technology is from the steam cycle, resulting in considerably greater water demand than for a combined cycle project, for which only about one third of the electrical output is from the steam cycle. For these reasons, combined cycle technology was determined to be the superior alternative.

7.6.2 Alternate Project Sizes

CVE proposes to develop a combined cycle power plant using three F-Class combustion turbines. The three units will operate independently, with each unit capable of generating approximately 334 MW (nominally). This will enable the project to respond to changing electric demand conditions. CVE considered alternate turbine sizes. Larger class turbines (G or H), because of their increased electrical output, provide less flexibility. Smaller turbines (aero-derivatives) cannot match F-Class turbines' superior environmental performance. Therefore, CVE proposes to use F-Class turbines.

CVE considered projects with fewer and greater numbers of units. A project with one or two units, while having commensurately lower emission levels and water demand, would not afford the economies of scale with respect to other environmental considerations (e.g., site development, aesthetics, and traffic) and would fail to take advantage of the existing electrical capacity on the adjacent ConEd 345-kV transmission line. A project with more than three units would exceed the transmission system's capacity without substantial upgrades and would exceed site space limitations without substantial wetland and other natural resource impacts. The proposed project, with three units, can be located almost entirely on previously developed portions of the site, and can be interconnected into the ConEd transmission system with minimal upgrades to the system. Therefore, alternate project sizes (smaller or larger) were not considered to be superior alternatives.

7.6.3 Alternative Cooling Technologies

Waste heat from the combustion turbine exhaust is captured in the heat recovery steam generators (HRSGs) and used to generate steam, which is routed to the steam turbine generators to generate additional electricity. After exiting the steam turbines, the steam must be condensed back into water before being reused in the steam cycle.

The project proposes to use a closed cycle air cooled system for condenser cooling (ACC). Discharged steam will enter a steam distribution manifold located on top of the ACC structure. The steam will be distributed into heat exchangers arranged in a "roof structure." Flowing down inside the heat exchanger tubes, steam will condense due to the cooling effect of ambient air drawn over the heat exchanger surface by fans. Condensate will drain from the heat exchanger tubes into condensate manifolds and return back to the process.

The advantages of air cooling include:

- Water use - no water is used in cooling, avoiding impacts associated with consumptive water use, water withdrawal, chemical handling and use and wastewater discharge.

- Visible plumes - because air cooling does not use water, no visible plumes are associated with this technology.

- Fogging and icing - because there are no water vapor plumes from an ACC, there is no associated risk of fogging or icing of nearby roadways.

- Particulate matter emissions – naturally occurring dissolved and suspended solids in cooling water used in wet cooling systems result in emissions of particulate matter from the cooling tower drift. These emissions are eliminated with the use of ACC.

The disadvantages of air cooling include:

- Efficiency - because air is a less efficient cooling medium than water, particularly at higher ambient temperatures, ACC systems cause a greater reduction in power plant output than water-based systems.

- Noise - because of the larger number of fans associated with an ACC compared to a wet cooling tower system, additional noise mitigation is often required to minimize noise impacts.

- Footprint - ACC systems are larger than water-based cooling systems and, therefore, occupy more space.

There are three basic condenser cooling technology alternatives to dry cooling:

- once-through cooling
- evaporative (wet) cooling towers
- hybrid (wet and dry) cooling towers

Each of these technologies is compared in Table 7-1 and described below.

Table 7-1. Alternative Cooling Technologies

Environmental Attribute	Air Cooled Condensers	Once-Through Cooling	Evaporative (Wet) Cooling	Hybrid Cooling
Water Use	None	In excess of 400 million gallons per day (MGD); although non-consumptive	7-10 MGD of consumptive water use	2-5 MGD of consumptive water use
Visible Plume	None	None	Can produce visible plumes during certain meteorological conditions	Can produce visible plumes during certain meteorological conditions, although less frequently and less extensive than wet cooling
Fogging and Icing	None	None	Under certain meteorological conditions fogging and/or icing conditions on Route 22 possible	Under certain meteorological conditions fogging and/or icing conditions on Route 22 possible, although less frequently than with wet cooling
Noise	ACCs are a noise source, but can be mitigated	Not a significant noise source	Wet cooling towers are a noise source, but can be mitigated	Hybrid cooling towers are a noise source, but can be mitigated
Particulate Matter Emissions	None	None	Cooling tower drift is a source of particulate matter emissions	Cooling tower drift is a source of particulate matter emissions
Footprint	ACCs occupy the largest footprint of the alternatives considered	Smallest footprint of the alternatives considered	Smaller footprint than ACCs, but greater than once-through cooling	Comparable footprint to ACCs
Plant Efficiency	Largest impact on plant efficiency of alternatives considered	Least impact on efficiency of alternatives considered	Greater impact on efficiency than once-through cooling, but less impact than ACCs	Comparable impact on efficiency as ACCs

Once-Through Cooling

Once-through cooling systems circulate water from an adjacent water body across the surface of the steam condensers, cooling the steam inside the condenser tubes back onto water. The same volume of water is then discharged back to the water body, at a higher temperature then when it was withdrawn, using the water body as a heat sink. The name of this technology is derived from the fact that cooling water is circulated through the condenser just one time before being returned to the water body. Advantages of once-through cooling include:

- Water use is non-consumptive - the same amount of water withdrawn is discharged back to the water source.
- Maximum efficiency - of the possible cooling technologies, once-through cooling has the least impact on plant electrical output.
- Minimal plant air emissions - increasing electricity output for the same amount of fuel consumed decreases plant emissions of air pollutants and GHG on a per-MW basis.
- Minimal noise impacts - without the fans associated with air cooling or the cascading water associated with wet cooling towers, once-through cooling systems are the quietest of the range of cooling technologies.
- Smaller footprint – once-through cooling systems have the smallest footprint of the range of cooling technologies.

Disadvantages of once-through cooling include:

- Water withdrawal volumes - although once-through cooling systems' water use is non-consumptive, the volumes of water needed to support these systems is very large, typically in the excess of 400 million gallons per day.
- Intake impacts - the withdrawal of large volumes of water result in the potential impingement and entrainment of large numbers of aquatic organisms.
- Thermal discharge - use of the water body as a heat sink can have thermal impacts on aquatic ecosystems and possibly block fish migration.
- Inconsistency with New York State Department of Environmental Conservation (NYSDEC) and United States Environmental Protection Agency (USEPA) policy - because of the intake and thermal discharge impacts discussed above, once-through cooling systems are not considered best available technology.

As discussed in greater detail in Section 7.9, the Swamp River is of insufficient size to support a once-through cooling system. Therefore, this technology was not considered to be feasible.

Evaporative (Wet) Cooling

A closed wet evaporative cooling system, also commonly referred to as a cooling tower system, would use water from the Swamp River or other substantial water source as an intermediary heat transfer medium between the steam surface condenser and the final heat sink, ambient air. Water would circulate through the condenser to cool the steam in the condenser tubes back into water in the same manner as a once through cooling system. The warm water would then be circulated to the top of a cooling tower where it would cascade down a medium, mixing with and being cooled by air that would be pushed through the cooling tower either by fans (mechanical cooling tower) or by natural draft (natural draft cooling tower). Water that did not evaporate would fall into the cooling tower basin and then be recirculated through the condensers. Wet cooling systems recycle the cooling water from five to ten times (cycles), evaporating about 80 percent of the water circulated. Since the evaporating water would leave behind the minerals and other solids dissolved or suspended in the cooling tower makeup water, the "concentrated" water must eventually be discharged (blown down) or routed to a zero liquid discharge (ZLD) system for further recycling.

Advantages of wet cooling include:

- Water is a more efficient heat transfer medium than air, thereby having less impact on the plant's electrical output than an air cooled system.

- Increasing electricity output for the same amount of fuel consumed (compared to air cooling) decreases emissions of air pollutants and GHG on a per-MW basis.

Disadvantages of wet cooling include:

- Consumptive use of significant volumes of water - for a 1,000 MW combined cycle power plant, a wet cooling tower system would, depending on water quality, be expected to consume between 7 and 10 million gallons per day of water.

- Visible water vapor plume - under certain meteorological conditions, wet cooling towers will have a visible water vapor plume.

- Fogging and icing - under certain meteorological conditions the visible water vapor plume may reach ground level and cause fogging. If the temperature is cold enough, ice may form under these conditions. Given its proximity, the rail line west of the Project Development Area may be particularly susceptible to fogging and icing. Also since the elevation of Route 22 is somewhat higher than the site elevation, this roadway could be particularly susceptible to fogging and icing from a wet cooling tower.

- Particulate matter emissions – naturally occurring dissolved and suspended solids in cooling water used in wet cooling systems result in emissions of particulate matter from the cooling tower drift.

The proposed site does not have access to a water supply sufficient to support a wet cooling system. For this reason, wet cooling was eliminated from consideration as infeasible for this site.

<u>Hybrid Cooling</u>

Hybrid cooling towers combine an ACC with a wet cooling tower, sharing the cooling load. The advantages of a hybrid tower include reduced water consumption from a wet-only cooling tower with slightly less impact on plant electrical output than an ACC-only cooling system. The project site is not proximate to a sufficient water source to support even a hybrid wet-dry cooling system. Therefore, hybrid cooling was eliminated from consideration as infeasible for this site.

For the reasons cited above, air cooling was selected as the preferred condenser cooling alternative.

7.7 Alternative Emission Control Technologies

The proposed project represents the state-of-the-art in air pollution control systems. The combination of dry low nitrogen oxides combustors, selective catalytic reduction and oxidation catalyst systems, as described in Section 4.3, along with the exclusive use of natural gas as the sole fuel for the project's turbines represents the most effective state-of-the-art methods to minimize air emissions.

As discussed in Section 4.1 the project is subject to Best Available Control Technology (BACT) and Lowest Achievable Emission Rate (LAER) emissions controls. A detailed analysis of alternative emissions controls in support of BACT and LAER determinations is presented in Section 4.3.

7.8 Fuel Use Alternatives

The project proposes to utilize clean-burning natural gas as the sole fuel for the project's combustion turbines, HRSG duct burners and auxiliary boiler. Ultra-low sulfur diesel (ULSD) fuel will be used in the emergency fire pump and black-start generators. These are the cleanest fuels available for each respective equipment type given their intended use, and, as such, no alternative fuels were considered.

7.9 Water Supply Alternatives

The project has been planned to significantly minimize water demand through the use of air cooling and a ZLD system (which eliminates the need for wastewater discharge by maximizing water recycling and reuse). It is anticipated that the project's water demand will range from an average of 10 gallons per minute (gpm) in the winter to 60 gpm in the summer (14,400 - 86,400 gallons per day [gpd]).

In order to identify a feasible water source, CVE reviewed available analyses regarding historical water use at the project site and examined secondary data sources to identify potential alternatives. Alternatives considered in this review were:

- Municipal or other existing water supply sources;
- Treated effluent from existing wastewater treatment plants;
- Surface water from the Swamp River;
- Surface water from other potential sources; and
- Groundwater.

7.9.1 Municipal or Other Existing Water Supply Sources

No public water supply exists in the vicinity of the site; residents and businesses typically rely on groundwater wells. No significant businesses or industries were identified in the immediate area as potential targets for requesting shared use of an existing developed water supply. Therefore, these options were not considered further.

7.9.2 Treated Effluent

A review of USEPA databases did not indicate the location of any substantial wastewater treatment plants (which could be a potential source of treated effluent as water supply) discharging within a reasonable distance from the site. Therefore, this option was not considered further.

The proposed Knolls of Dover project is planned to have a wastewater treatment plant that could, at some future point, provide treated effluent to meet all or a portion of the project's water needs. Approval of that project is still pending. In addition, until that project and its associated wastewater treatment plant is built, the reliability of the quantity and quality of effluent remains uncertain. Therefore, at this time, this option was not further considered.

7.9.3 Swamp River Withdrawal

The Swamp River extends through the CVE Property, flowing northward, and has historically provided a portion of the site's water needs. Its proximity and historical use for fire protection water via an existing pump house resulted in some additional consideration as a potential water source for the project.

Based upon a review of available information, consideration of direct withdrawal from the Swamp River was eliminated from consideration for the following reasons:

- The Swamp River flows north to its confluence with the Ten Mile River just south of Dover Plains. Portions of the river, including the reach immediately proximate to the site, are located within the Great Swamp Critical Environmental Area (CEA).

- No pumping records are available that document site use. However, reports indicate that withdrawals may have been limited to fire protection storage.

- United States Geological Survey stream flow gauging (downstream of the site) for the period from 1960 – 1968 indicates that mean monthly flows range from 108 cfs in March to 6.2 cfs in September, with some summer days where flows were recorded on the order of 1.0 cfs. Although there is no set regulatory standard for surface water withdrawals in New York, withdrawal of less than 5 percent of the 7Q10[1] is generally

[1] The lowest stream flow for seven consecutive days that would be expected to occur once in ten years, representing a "low flow" characteristic used in hydrology and water resource assessment.

considered acceptable. Larger withdrawals have the potential to reduce aquatic habitat and could adversely affect bordering wetland hydrology. The project's average summertime water demand would exceed this amount. It is, therefore, very unlikely that a withdrawal of this magnitude would be considered acceptable.

7.9.4 Other Surface Water Sources

The project region has been quarried for marble since the mid-1800s. Several quarry ponds have been identified in the project area that reportedly maintain substantial water volumes even in dry conditions. The marble formations are somewhat more fractured than any of the surrounding upland geologic formations. The marble is also often in direct contact with overlying saturated glacial sediments. The fractures and glacial sediments together offer highly permeable conduits for groundwater. For this reason, groundwater in the marble formation that underlies the region has a high potential for groundwater supply. The quarry ponds are replenished with direct rainfall, surface runoff and groundwater from their interception of the fractures in the marble layers.

While the quarries represent a potentially sustainable source of water, this option was not considered for the following reasons:

- Since the largest source of water into the quarries is likely to be groundwater from the bedrock aquifer, conventional wells would likely be a more efficient approach.

- The Town of Dover's Master Plan references a strong desire to phase out mining and quarrying operations and reclaim closed quarries and mines with clean fill (Town of Dover, 1999).

- An open quarry pond presents potential contamination liabilities that may be more difficult to manage than conventional bedrock wells.

- The technical investigations necessary to accurately predict a quarry pond's sustainable yield are considerably more complex and more uncertain than for conventional bedrock wells.

- Use of quarry ponds would introduce an additional linear feature (water pipeline), with its associated costs, potential natural resources impacts, and easement issues, to the project, as well as the need for agreements with the quarry owner(s).

For the above reasons, this option was not considered further.

7.9.5 Groundwater Sources

Groundwater is anticipated to be the most feasible source of water for the project. The potential for meeting the project's water demand through development of either bedrock or surficial aquifer wells was considered through review of literature and mapping.

Geologic Mapping

The bedrock of the site has been mapped as the Stockbridge Marble, a gray marble formed from the metamorphism of fine-grained marine deposits. A bedrock contact with the Walloomsac Formation, a metasedimentary formation of slate, phyllite, and schist, lies in the vicinity of the Swamp River. Because significant groundwater yield from bedrock is associated with secondary features in the rock such as fractures, faults and contact zones between rock units, the best places for developing bedrock water supplies with significant yield are in areas where the rock has been fractured and the fractures are well connected. No mapped faults are proximate to the site, although two thrust faults are located to the west. Mapping indicates two linear traces, which may be indicative of fracturing in the Stockbridge Marble bedrock, east of the site. One fracture trace parallels Route 22 and the second is east of Route 22.

Extensive outwash sand and gravel deposits exist on either side of the Swamp River valley, while the surface deposits of the valley center have been mapped as alluvial deposits. An "unconsolidated aquifer" (UA) is mapped within the Swamp River valley, which indicates alluvial deposits could be underlain by glacial outwash deposits. The degree to which substantial water yield could result would depend upon the sedimentary composition and saturated thickness of the deposits. These deposits are located in areas of the site west of the railroad track and proximate to the Swamp River.

Historic Site Groundwater Indicators

Previous environmental site assessment documents for the site indicate that groundwater is located within 5 feet of the ground surface. Monitoring wells had previously been developed at the site, at depths ranging from 25 – 35 feet. Although none were sufficiently tested to indicate groundwater source viability (since the program had a different purpose), the drilling logs provided useful confirmation of subsurface characteristics. All of the observation wells, however, were located east of the railroad track. Because potential areas for UA development are all indicated as west of the railroad track, no confirmatory information was available in that regard.

Except for fire protection, most water demand at the site had historically been met with potable water from a single on-site well. Reports indicate the well is 420 feet deep, with an 8-inch casing. The original 20 horsepower deep well pump was replaced later by a 5 horsepower submersible pump. Estimated yield from pump tests in 1995 was 9 gpm, which would not be sufficient to support project needs. Because there was some indication that well adjustments could improve this yield, the pump test data from the Mid-Hudson Water Supply Study were reviewed to determine the likelihood of greater long-term yields. Based upon this additional review, CVE determined the well's maximum specific capacity (the well's ability to produce water in gpm per foot of drawdown in the well) to be 0.06 gpm/foot, which would not come close to supplying the needed water for the project.

Additionally, the DEIS for the proposed Knolls of Dover project, a residential development south of the site in Dover, which seeks over 700,000 gpd of water (8 to 50 times more than the CVE project), reported a well testing program that has included the drilling of 17 borings, 16 of which were developed as test wells. Eleven of these wells were developed in the Stockbridge Marble formation (Knolls of Dover, 2009). Pump tests were conducted on six wells, five of which were in the Stockbridge Marble formation, with projected yields ranging from 40-250+ gpm. This indicated that significant yield potential exists, but that yield is highly variable depending on the exact location where the well is developed. During the pumping tests, potential impact to the Swamp River was monitored using high-sensitivity pressure transducers. The analyses indicated that withdrawals from the Stockbridge Marble formation, in the assessed locations, would have no measurable impact on the Swamp River.

Anticipated Groundwater Potential

Two possibilities for developing a groundwater supply that would meet project needs at the site are the UA that has been mapped as underlying the site and the Stockbridge Marble bedrock unit that is also mapped as underlying the site. Generically speaking, a UA would be expected to have a better potential for providing the supply than the marble; however, site-specific information on thickness and permeability of the mapped UA is lacking and would be needed to evaluate its yield potential. The best place to investigate (drill) to evaluate the UA would be west of the railroad track.

Environmental Impact and Permitting Considerations

The UA, where the greatest yield potential appears to exist, is located in jurisdictional wetlands, which requires special consideration. Wetland impact would be a factor for access, testing and well development. The wetlands west of the railroad track are mapped as Class 1 wetlands by the NYSDEC, and are located within the mapped Great Swamp CEA. As defined by the NYSDEC, Class 1 wetlands provide the most critical of the state's wetland benefits, and permits for activities in Class 1 wetlands will only be issued if it is determined that the proposed activity satisfies a compelling economic or social need that clearly and substantially outweighs the loss of or detriment to the benefits of the wetland. NYSDEC's wetland regulations (Part 633) cite presumed levels of compatibility for regulated activities within wetlands. Drilling of a well for water withdrawal, except to serve an individual residence, is specifically designated in the regulations as being incompatible with wetland functions and benefits.

For the above reasons, CVE chose to evaluate use of bedrock wells in preference to exploration of the surficial aquifer for project water supply.

As discussed in Section 5, the installed bedrock wells have been demonstrated to provide sufficient water for project needs without adversely affecting other water users in the area. Further, the maximum anticipated water withdrawal has been shown to not have an appreciable effect on the hydrology of the Swamp River or associated wetland systems.

7.10 References

Knolls of Dover, 2009. Draft Environmental Impact Statement. Knolls of Dover. Town of Dover New York. April 2009.

Town of Dover, 1999. Town Master Plan, as amended. April 28, 1999.