Appendix 5-C: Site Water Budget Report

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October 6, 2010

Mr. Jeff Ahrens, P.E.
Advanced Power (NA)
31 Milk Street, Suite 1001
Boston, MA 02109

Re: Cricket Valley Energy Center
Water Budget Presentation
Chazen Job # 81001.00

Dear Mr. Ahrens,

The Chazen Companies (Chazen) have prepared this groundwater budget analysis for the proposed Cricket Valley Energy Center (CVE) to assess potential project impacts on the local aquifer and the Swamp River. As part of this work, we have reviewed a pumping test report prepared by SSEC Inc. (SSEC well report, dated August 2010) and various regional aquifer capacity reports and collected current stream flow data.

Groundwater withdrawals from wells typically cause two types of environmental impacts. The first involves immediate impacts to the pumped aquifer with drawdown impacts noted in nearby existing wells and sometimes in nearby wetlands and streams. The second relates to the long-term impacts of a continuous groundwater withdrawal. This evaluation looks at both categories of potential impacts starting with long-term regional impacts.

Water consumption rates proposed by CVE are briefly summarized here:

- Peak routine summer water requirements for the facility will average 60.4 gallons per minute (gpm) when summer temperatures reach a 24 hourly average of 83 degrees F. A substantial share of this requirement will be used for cooling combustion turbine air inlets. Water needs, which include the cooling mechanisms, will decrease as a function of temperature, down to 51.7 gpm as daily average temperatures drop to 59 degrees F.

- During other portions of the year when average daily temperatures drop below 59 degrees F (typically almost two-thirds of the year), the combustion turbine air inlet evaporative cooling system will not operate due to inlet air temperature limitations. Without the evaporative cooling operation, the peak routine water requirements will decrease to an approximate range of 13.6 to 14.4 gpm, based on temperature.

- A rooftop rainwater capture and storage system is planned. It is anticipated to capture sufficient water to contribute approximately 7.4 gpm in summer and 7.2 gpm throughout the winter.

- Minor water demand of approximately 0.5 gpm will be used to supply employee restrooms. Restroom wastewater will be discharged to an on-site septic system.

Based on the factors above, peak summertime water needs for this facility will reach approximately 60.4 gpm during periods when average daily temperatures reach 83 degrees F or above. Water consumption will fall to less than 14.4 gpm when average temperatures drop below 59 degrees F. Shoulder season (autumn and spring) water requirements will transition between the two consumption rate ranges. With the addition of rooftop water, the net annual demand for groundwater from this site would fall to an average of 20.9 gpm. Peak summertime groundwater use will be 52.4 gpm when rainwater is available and 60.4 gpm if the facility runs out of stored rainwater.

Regional & Long-Term Well Pumping Withdrawal Impacts

The CVE wells are drilled to intercept groundwater in the bedrock which would otherwise remain below ground and flow naturally toward aquifer discharge locations. This is part of the natural hydrogeologic cycle whereby a share of precipitation flows overland to streams as runoff, and another share of precipitation recharges underground soils and rock formations (e.g. aquifers) and migrates below ground as a kind of "underground runoff" towards streams. The natural point of aquifer release or discharge near the CVE Property is the Swamp River. Current rates of groundwater discharge into the Swamp River are defined by stream gauging data reviewed below.

Chazen 1998 "Water Resource Assessment for the Town of Dover".

The Chazen Companies and volunteers from Trout Unlimited gauged stream flows in several locations in the Town of Dover in 1997. All gauging took place after at least 3 rainless days so data reflect stream conditions supported by groundwater discharges rather than stormwater runoff. The gauging was conducted to examine where streams were gaining flow from aquifers in the Town. Strong gains indicated the presence of robust underlying aquifers which receive ample recharge during wet periods and have sufficient porosity and/or fractures to successfully transmit groundwater to wells or streams. Stream segments with little gain flow over lower-capacity aquifers or through areas with such extensive riparian wetlands that groundwater discharges are fully consumed by vegetations' evapotranspiration processes. Locations nearest CVE where stream gauging occurred as part of this study are shown on Figure 1. Figure 1 also identifies the CVE site, the complete Swamp River watershed, and portions of the watershed below the Chippewalla Road bridge crossing the Swamp River.

Stream gauging along the Swamp River on December 4, 1997 identified 29.67 cubic feet per second (cfs) (13,316 gallons per minute) of flow in the Swamp River at the Chippewalla Road bridge and a flow of 54.79 cfs (24,590 gpm) where the Swamp River flows under NYS Route 22 (Chazen, 1998, Table 6(a)). The flow increase between the two bridges was 25.12 cfs (11,274 gpm). The Swamp River flow at Route 22 on December 4, 1997 was similar to the historic "Q50" (aka 50%) flow condition of 43 cfs identified by USGS based on the 1931-1960 statistical period (Ayer & Pauszek, 1968). This means the flow

conditions documented in December of 1997 were typical of average flow conditions in the Swamp River and that significant flow increases were occurring along the stretch of the Swamp River passing the CVE site.

Chazen 1999 "Harlem Valley Watershed Investigation"

The Chazen Companies conducted additional stream gauging in the Ten Mile River watershed during 1998 but data collection was focused north of CVE in the Towns of Amenia and Northeast. The report uses the 1997 stream gauging data collected for the Dover report discussed above to develop the findings and planning recommendations summarized below. No further data were needed from along the Swamp River to complete the 1999 report.

An important conclusion of the 1999 report was the development of a framework for an intermunicipal protocol allocating suggested "safe yield" groundwater shares between the four Towns which occupy the majority of the Ten Mile River watershed. The plan was conceptually agreed to by stakeholders meeting regularly during preparation of the 1999 report. The groundwater consumption allocation assigned to the Town of Dover was 2.3 million gallons per day (mgd), equivalent to 1,597 gallons per minute. The allocation is a consumption (e.g. rather than use) goal. The distinction is important since, for example, an applicant proposing to withdraw 1,000 gpm from wells who returns 950 gpm to a wastewater plant uses 1,000 gallons but only consumes 50 gpm. The allocation assignment described in the 1999 report applies to water consumption, not to raw use.

Consumptive losses usually stem from evaporative processes, transpiration processes from vegetation, or product export processes (e.g. bottled water or other wet product manufacture). A large share of the water use proposed for the present CVE project will be consumed by evaporative processes.

Dover's recommended consumption limit of 2.3 mgd was developed to ensure that overall groundwater consumption in the Ten Mile River watershed would not be depleted by more than half of the drought level 7Q10 flow (e.g. the 7-day average drought flow occurring during a 10-year recurring drought). The stream gauging data conducted in 1997 and 1998 at municipal boundaries were used to identify to the satisfaction of a wide range of participating stakeholders that Dover's consumable share of the Ten Mile River's overall 7Q10 flow of 8.1 mgd (Ayer & Pauszek, 1968) was 2.3 mgd. Participants in negotiation and identification of this water budgeting plan included members of the Town Board and Conservation Advisory Councils from each Town (including Dover) as well as representatives from Dutchess County Water & Wastewater Authority, Dutchess County Soil & Water Conservation District, Dutchess County Healthy Department and the New York State Greenway.

Chazen 2002 and 2005 annual "County Groundwater Monitoring Report"

Chazen staff gauged streams throughout Dutchess County in late 2001, 2002 and 2005. During these events, flow in the Swamp River was recorded downstream of Route 22 where the Swamp River flows into the Ten Mile River by Route 6. Flow during early November 2001 was 5.05 cfs (2,266 gpm), flow during mid-August 2002 was 3.98 cfs (1,786 gpm), flow during late September 2002 was 2.27 cfs (1,019

gpm) and flow during early October 2005 was 1.66 cfs (745 gpm). For reference purposes, the historic Q90 and 7Q10 flow values for the Swamp River at Route 22 are 6.6 cfs and 1.6 cfs, respectively, suggesting that these recording events captured flow conditions lower than the Ayer & Pauszek's Q90 conditions and one event near Ayer & Pauszek's 7Q10 condition. The data confirm that during all recent droughty periods, discharge was maintained by the Swamp River into the Ten Mile River.

2010 Stream Gauging

As part of the present study, Chazen revisited previously-gauged Swamp River gauging locations near the CVE site on July 13, 2010. According to USGS gauging data, flow at the Ten Mile River gauging station at the Connecticut border (Figure 1) was 37 cfs on July 13, 2010, just exceeding Ayer & Pauszek's Q90 condition for the Ten Mile River.

Gauging conducted by Chazen on July 13, 2010 focused on the Chippewalla Bridge crossing and the Route 22 bridge crossing, replicating 1997 sampling under significantly drier conditions than the 1997 event. On July 13, 2010, flow at the Chippewalla Bridge was 2.20 cfs (987 gpm) and flow by the Route 22 bridge was 8.71 cfs (3,909 gpm), identifying a gain in flow of 6.51 cfs (2,922 gpm) along the stretch of the Swamp River passing the CVE site. Stated another way, seventy-five percent of the flow passing under Route 22 had entered the Swamp River between Chippewalla Road and Route 22. This finding points to robust aquifer baseflow contributions from the aquifer near CVE. It is expected that most of this gain comes from sediments and bedrock geologic formations under the valley bottom very near the CVE site since the geologic formations west of the site (e.g. the steep hillsides) consist of low-permeability and less easily recharged bedrock formations with little soil cover.

Discussion

Figure 1 shows the gauging locations discussed above, the overall Swamp River watershed and the lower portion of the watershed contributing most of the gain to steam flows. The 2010 flow data suggest that under low-flow conditions, 75% of Swamp River flow enters the river between the Chippewalla Road bridge and the Route 22 bridges. This stretch passes the proposed CVE project site.

The 7Q10 flow condition of the Swamp River, per Ayer & Pauszek, is 1.6 cfs (718 gpm) at Route 22. Based on the July gauging data, we estimate that 75% of the 7Q10 flow, or 538 gpm, would continue to be generated by the stretch of the river near the CVE site under extreme (10 year recurrence, 7Q10 conditions) drought conditions.

The proposed project withdraws groundwater from aquifers which otherwise naturally support baseflow entering the Swamp River. On the basis of the stream gauging data and discussion above, the stretch of river near the project site is judged capable of supporting the consumptive groundwater uses from the proposed project. Several supporting reasons are given:

1. Under all recorded flow conditions summarized above, significant fractions of Swamp River flow enter the river between the Chippewalla Road bridge and the Route 22 bridge, which is the

stream section adjoining the CVE site. This means significant water enters the river by the CVE site, offering direct and immediate mitigation for the project's water needs.

2. Under the approximate Q90 flow conditions recorded in July of 2010, the Swamp River gained 2,922 gpm along the stream stretch passing the CVE site which vastly exceeds CVE's consumptive water needs. The estimated annual average water consumption rate for CVE is 20.9 gpm, which comprises less than 1 percent of the 2,922 gpm gain, while the summertime peak average groundwater consumption rates of either 52.4 gpm (with rainwater) or 60.4 gpm (without rainwater) are both in the range of 2% of this local gain, and in the range of 1.5 percent of the total Swamp River flow of 3,909 recorded in 2010 at the Route 22 bridge. These factors all indicate that under flow conditions met or exceeded during 90 percent of all weather conditions, the proposed worst case water consumption rate of 60.4 gpm proposed by CVE is a small fraction of current natural flows in the Swamp River. These data and this conclusion are encouraging because they identify both considerable groundwater capacity available for the project and additional reserve capacity for other proposed projects known to be under evaluation by the Town in this same watershed.

3. Under 10-year drought flow conditions in the Swamp River, using 7Q10 data from Ayer & Pauszek, flow of the Swamp River under Route 22 downstream of the CVE site is 718 gpm, which exceeds the project's consumptive water needs. The facility's proposed peak daily average water withdrawal rates of 52.4 gpm (with rainwater) and 60.4 gpm (without rain) represent approximately 8 percent of this flow. Stream gauging work described above indicates that during such drought conditions, approximately seventy five percent of the 7Q10 flow, or 538 gpm, enters the Swamp River along the stream stretch passing the CVE site, so the project's worst-case summertime withdrawals will be imposed precisely where a majority of groundwater discharge is available to buffer the withdrawal and maintain most of the river flow. Chazen's 1999 report also describes community consensus that it is acceptable to consume up to 50% of 7Q10 flows during droughts as a realistic and acceptable planning goal. So even with the CVE proposed consumptive use of 8% of the 7Q10 flow, 42% of the 7Q10 flow or approximately 300 gpm will remain available for the Town to allocate to other new consumptive uses proposed in the Swamp River watershed. These reportedly include the Knolls of Dover project and up to seven additional projects. Referencing Knolls of Dover DEIS and SEQRA Findings documents, it appears that year-round water consumptive at the proposed Knolls of Dover project may be in the range of 31 gpm (10% of 311 gpm average daily domestic demand) and the year-round consumptive loss from seven other projects could collectively be in the range of 14 gpm (10% of 215,325 gpd consolidated water demand) (Saccardi & Schiff, Inc, 2009; Town of Dover SEQRA Findings, 2010). These consumptive losses can be readily factored into the approximate 300 gpm of remaining Swamp River watershed consumptive capacity. The Knolls of Dover project may also have a seasonal irrigation program requiring up to 151 gpm. If this is taken from groundwater resources rather than water stored in that site's reservoir, it can also be accommodated in the available Swamp River water consumption budget. The anticipated water consumption attributable to all these projects, including CVE, is also fully accommodated in Dover's town-wide water consumption limit of 1,597 gallons per minute.

4. CVE lies along a downstream section of the Swamp River into the Ten Mile River, so any stream depletion impacts will affect only the lowest and highest-flow section of the Swamp River. Most of the extensive riparian wetlands associated with the Swamp River lie upstream of the site, so any flow depletion by CVE will impose fewer regional riparian wetland ecosystem impacts than if the project were situated higher in the watershed.

5. The pumping test in the facility's prime well, Well 4, identified no immediate drawdown relationships between the groundwater resource and wetlands on the CVE site. The test suggested Well 4 draws water from such deep portions of the aquifer that there is a considerable delay, measured at least in days and likely measured in weeks, between when a peak pumping rate begins and when associated flow reductions could begin to reduce aquifer outflow rates entering the Swamp River. This delay is a buffering factor that will on some occasions allow peak pumping rate periods to reach the Swamp River after low-flow periods have ended because of summer-time thunderstorms or autumn replenishing rain falls. This delay can be thought of as an offset whereby withdrawal impacts reach the stream later than when the impact is applied. The precise delay (or offset) period is unknown, but its beneficial existence on some occasions is certain.

Local Water Budget Considerations

In 2006, Chazen published research identifying average aquifer recharge rates for soil groups throughout Dutchess County. According to USGS records, Dover typically receives 42 inches of precipitation per year (Chazen 2006). As reviewed above, varying shares of this precipitation return to the air as evaporation or plant transpiration, as runoff into rivers, and as aquifer recharge which flows slowly toward rivers. In Dover, the calculated recharge rates at which rainfall enters aquifers are 20.2 inches per year into soils assigned by the Soil Conservation Service to Hydrologic Soil Group A, 14.7 inches per year into soils assigned to hydrologic soil group B, 7.6 inches per year into soils assigned to hydrologic soil group C and 4.2 inches per year into soils assigned to hydrologic soil group D.

Figure 2 shows the distribution of Hydrologic soil groupings on non-wetland portions of the CVE site. Table 1 calculates recharge entering each of these acreages on the site. As a conservative evaluative factor, we have discounted any recharge that might occasionally enter site wetlands since riparian wetlands function during most seasons as groundwater discharge locations. We have also removed from consideration 3.4 acres of rooftop and containment area runoff which will be collected into the site water storage tank. Using the acreages of each remaining soil type on the site (Figure 2), average daily aquifer recharge is 35.5 gpm. This site recharge will meet 170% of the average annual water consumption demand of 20.9 gpm and 59% of the 60.4 gpm maximum peak summertime demand. Site recharge may be expected to drop to an average of 24.9 gpm during drought years using an estimated 30% drought reduction value. During drought years, site recharge will meet 119% of the average annual water consumption demand of 20.9 gpm and 41% of the 60.4 gpm maximum peak summertime demand.

These budget calculations indicate that the site is fully capable of supporting its proposed average water consumption budget under both average and drought conditions. The site's overall water budget needs are therefore self-sufficient and would generate no permanent off-site drawdown impacts of any type.

Review of the site's topographic setting suggests that groundwater recharged on higher-elevation lands northeast of the project site is expected to migrate naturally toward and under the site, contributing to available groundwater available to CVE (Figure 3). We should be clear that the SSEC pumping test results indicated site pumping does not lower groundwater levels in these areas but natural rates of groundwater migration will bring water from these areas onto the site. Using the acreages of each soil type found on these upgradient areas, and again removing from consideration 3.4 acres of roof top and containment area captured stormwater runoff, average daily aquifer recharge flow on and onto the site is 54.9 gpm. Calculations are included on Table 1. This recharge meets 263% of the average annual water consumption demand of 20.9 gpm, 91% of the 60.4 gpm maximum peak summertime demand and 105% of peak summertime demand of 52.4 gpm when stored rainwater is available to supplement water demand. Anticipated recharge on the expanded area drops to approximately 38.4 gpm during drought years using an estimated 30% drought reduction value. During drought years, this recharge value equals 184% of the average annual water consumption demand of 20.9 gpm, 64% of the 60.4 gpm maximum peak summertime demand and 73% of the peak summertime demand when stored rainwater is available.

These budget calculations for the expanded recharge area indicate that groundwater flowing toward the site from upgradient areas contributes to an overall available site groundwater budget whereby peak daily demand with stored rainfall can be met with little drawdown impact beyond the site since groundwater flowing naturally onto the site makes up a substantial share of necessary water unavailable from direct on-site recharge.

Both water budget calculations indicate that during peak groundwater withdrawal periods with no stored water available, under drought conditions, the capture area (radius of influence) of the site wells are likely to temporarily extend either to the Swamp River or to a wider capture radius than the site boundaries to meet water demands. Any off-site impacts are expected to be occasional and acceptable, based on pumping test results presented by SSEC Inc.

Long-term Well Pumping Withdrawal Impacts

Chazen reviewed the pumping test results prepared by SSEC Inc for the new wells drilled and tested on the CVE property. Two tests were conducted during June of 2010, one at 120 gallons per minute (gpm) and one at 100 gpm. During the test period, flow recorded downgradient of the site at the USGS gauging station on the Ten Mile River fluctuated around 60 cubic feet per second (cfs), which is approximately the Q80 flow condition for the watershed (interpreted from Figure 10 from Ayer & Pauszek), meaning that flow in the Ten Mile was below normal flow levels and that wetter conditions occur approximately 80% of the time. The test was therefore conducted during a period when the river, its tributaries (including the Swamp River), and the underlying aquifers were moderately dry.

The SSEC report indicates that no significant impacts were recorded in off-site domestic wells. A reasonable number of off-site wells were monitored, suggesting that these results can be anticipated to be representative for other surrounding wells. The dry test conditions, the test duration, and pumping rates up to twice the anticipated future withdrawal rate, and the water budget calculations presented in the paragraphs above all contribute to a firm conclusion that no significant offsite impacts to domestic wells are to be anticipated by this project in the future.

Summary

This analysis of water budget factors associated with the proposed CVE project has considered likely water consumption impacts on the Swamp River under Q90 (very dry) and 7Q10 (drought) conditions. The report finds, on the basis of stream gauging and other data, that the withdrawal impacts are minor under Q90 conditions and within planning goals under 7Q10 conditions, and that under both conditions significant flow capacity remains available for other projects currently under review by the Town of Dover. The CVE site lies in an advantageous watershed location both because flow reduction to the Swamp River will be imposed on a low reach of the river (far downstream) very near its outfall into the larger Ten Mile River, and because the section of the Swamp River abutting the CVE site has been identified by stream gauging to experience the most robust stream gain of the entire river.

Local impacts on existing domestic wells from the planned long-term site groundwater use are expected to be minimal to non-existent on the basis of pumping test data, aquifer recharge budget evaluations, and based on flow tests conducted by SSEC at twice the proposed long-term pumping rate during a relatively dry period of year. Site water budgets using recharge factors for site and offsite soils show that the site is "self-sufficient" in its ability to recharge all groundwater necessary to meet annual average daily water demand, and that site recharge and recharge entering areas upgradient of the site can even meet most peak water demand flows. Only during drought conditions are the radial drawdown effects of groundwater pumping expected to either directly draw a portion of water demand from the Swamp River or reach off-site aquifer areas. These factors, all together, suggest with a high level of confidence that the project water withdrawal needs are locally sustainable.

Please direct any questions or comments to me at 845 486-1551 or rum@chazencompanies.com

Sincerely,

Russell Urban-Mead, CPG
Senior Hydrogeologist

Enclosures – Figures 1, 2, 3

cc: file

References:

Ayer, G.R., Pauszek, F.H., 1968, Streams in Dutchess County, USGSS Bulletin 63, NYS Conservation Department Water Resources Commission.

Chazen Companies, 2006, Dutchess County, Aquifer Recharge Rates & Sustainable Septic System Density Recommendations, Dutchess County Water & Wastewater Authority.

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Chazen Companies, 2002, Dutchess County Groundwater Monitoring Report. Dutchess County Water & Wastewater Authority.

Chazen Companies, 1999, Harlem Valley Watershed Investigation, Dutchess County, NY.

Chazen Companies, 1998, Water Resource Assessment for the Town of Dover, NY.

Dover, SEQRA Findings of the Town Board of the Town of Dover Respecting the Knolls of Dover Project. As adopted 5/12/10.

Saccardi & Schiff, Inc., May 12, 2009, Draft Environmental Impact Statement, Knolls of Dover, Infrastructure & Energy Comments and Responses.

NOTE: The Swamp River watershed encompasses approximately 31,400 acres while the upper watershed, which contains the subject property, encompasses approximately 18,400 acres.

Route 6 Bridge

Route 22 Bridge

Chippewalla Road Bridge

USGS Tenmile River Gauge

Tenmile River

Swamp River

N
W E
S

Legend

- Energy Center Site
- Swamp River Watershed
- Lower Watershed Boundary
- Stream Gauging Location

Feet
0 1,250 2,500 5,000 7,500 10,000

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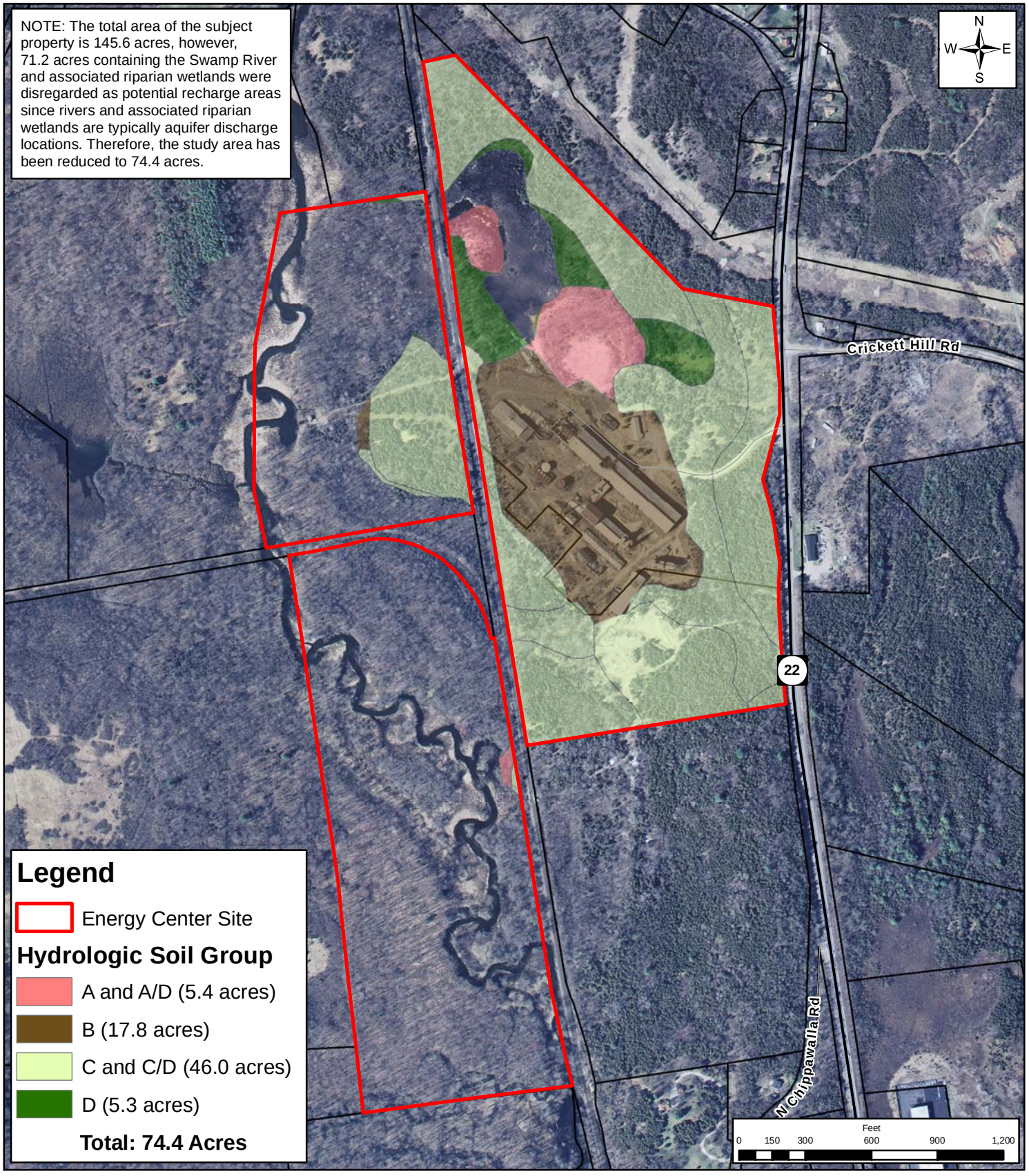
Cricket Valley Energy Center

Figure 1 - Site Layout, Watershed Boundary and Gauging Location Map

Town of Dover, Dutchess County, New York

Source: U.S.G.S. Topographic Maps (9 Quadrangles) Dated between 1960 and 1998, 7.5-Minute Series; Dutchess County Real Property Services 2009 Tax Parcel Data.

Drawn:	EJO
Date:	August 2010
Scale:	1:60,000
Project:	81001.00
Figure:	1



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Cricket Valley Energy Center

Figure 2 - Hydrologic Soil Groups Within On-Site Areas of Aquifer Recharge

Town of Dover, Dutchess County, New York

Source: N.Y.S. Office of Cyber Security and Critical Infrastrture Coordination 2004 Orthoimagery; U.S.D.A. Soil Survey of Dutchess County, 2004; N.Y.S. Department of Transportation 2007 Roads dataset; Dutchess County Office of Real Property Services 2009 Tax Parcel Data.

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Date:	August 2010
Scale:	1:7,200
Project:	81001.00
Figure:	2

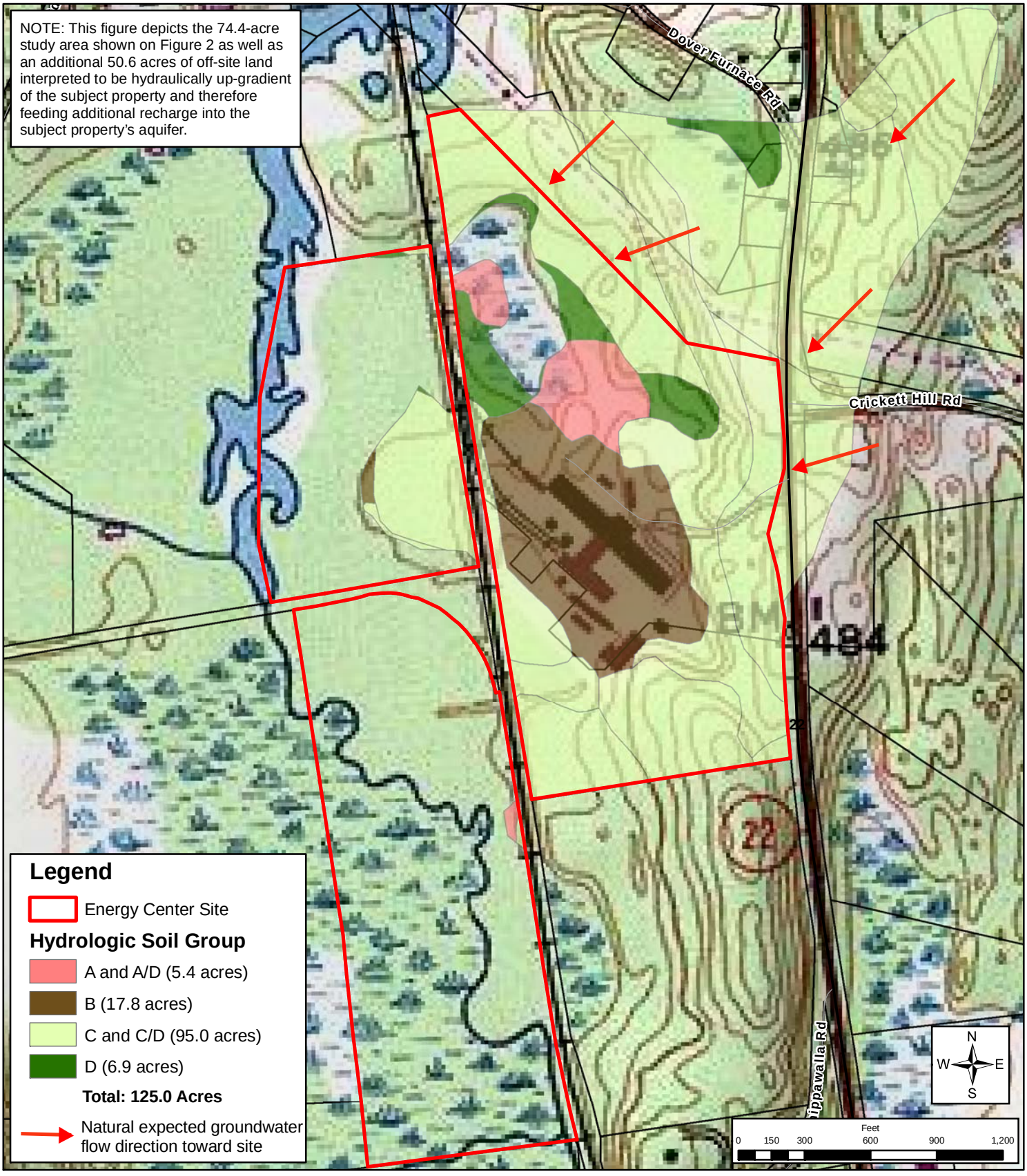

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Figure 3 - Hydrologic Soil Groups Within On-Site and Off-Site Areas of Aquifer Recharge

Town of Dover, Dutchess County, New York

Source: N.Y.S. Office of Cyber Security and Critical Infrastrture Coordination 2004 Orthoimagery; U.S.D.A. Soil Survey of Dutchess County, 2004; N.Y.S. Department of Transportation 2007 Roads dataset; Dutchess County Office of Real Property Services 2009 Tax Parcel Data.

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Date:	August 2010
Scale:	1:7,200
Project:	81001.00
Figure:	3

Table 1 - Cricket Valley Energy Center
Aquifer Recharge Rate Estimates

Site Aquifer Recharge Rates

	Acres	Recharge Rate (inches/year)	Unit correction factor	Recharge Rate (average gpm)
Soil Group A	5.4	20.2	0.052	5.6
Soil Group B	14.4	14.7	0.052	11.0
Soil Group C	46	7.5	0.052	17.8
Soil Group D	5.3	4.2	0.052	1.1
Total - Average Year				35.5
Total - Dry year @ 70%				24.9

Site with Watershed Recharge Area Recharge Rates

	Acres	Recharge Rate (inches/year)	Unit correction factor	Recharge Rate (average gpm)
Soil Group A	5.4	20.2	0.052	5.6
Soil Group B	14.4	14.7	0.052	11.0
Soil Group C	95	7.5	0.052	36.8
Soil Group D	6.9	4.2	0.052	1.5
Total				54.9
Total - Dry year @ 70%				38.4

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