Petition No. 1222
Interrogatories
Set One
April 14, 2016
Windham Solar LLC (WS) Responses April 28, 2016

## General Questions

1. Windham Solar LLC (WS) included an abutters map under Exhibit D of its Petition (Petition) dated March 15, 2016 for the proposed project in Hampton. Please submit a properly-labeled abutters map identifying each parcel owner, including but not limited to, the abutters listed in Exhibit D of the petition.
   A revised Map has been attached identifying parcels, and the associated owners. – Exhibit A

2. Where is the nearest off-site residence from the center of the solar array adjacent to Route 138? Provide the distance, direction, and address of such off-site residence. Where is the nearest-off-site residence from the center of the larger set of arrays located southeast of Fisk Road? Provide the distance, direction, and address of such off-site residence.
   The overall site plan has been revised to show dimensions from the homes to the closest modules to the facility and parcels are identified. – Exhibit B

## Electrical / Energy Questions

3. The proposed project consists of three 2.0 megawatt (MW) and four 1.0 MW solar arrays totaling 10.0 MW. Is that 10.0 MW power output for the proposed solar project based on alternating current (AC)? If no, explain.
   The site plan has been revised per the site visit on April 21st, 2016, and the project footprint has been reduced. Output to the grid is calculated in AC and there are now three 2.0MW facilities and two 1.0MW facilities. The AC:DC ratio of the project is 1:1.17. – Exhibit B

4. Indicate which solar arrays on the Overall Site Plan (Sheet 4 of 17) are the 2.0 MW arrays and which arrays are the 1.0 MW arrays.
   The site plan has been revised per the site visit on April 21st, 2016 and boundaries have been added to the overall site plan, illustrating each array area. – Exhibit B

5. Page five of the Petition indicates that, "Each 2.0 MW Facility will consist of approximately 6,790 solar modules and the 1.0 MW Facilities will consist of approximately 3,395 solar modules (based on a module rating of 345 watts)." Thus, would the total number of solar modules be equal to 33,950?
   Boundaries have been added to the overall site plan illustrating each array area and total module counts. The total modules on the site plan is currently 31,086 – Exhibit B

6. Provide the total direct current (DC) power output in MW for the project based on the total number of modules and wattage of such modules.
   The Maximum DC power output for each project on the site is based on the use of a 345w module throughout the site:

Project 1 = 3564 Modules x 345W Module = 1,229,580 Watts DC
Project 2 = 3528 Modules x 345W Module = 1,217,160 Watts DC
Project 3 = 3528 Modules x 345W Module = 1,217,160 Watts DC
Project 4 = 3636 Modules x 345W Module = 1,254,420 Watts DC
Project 5 = 7812 Modules x 345W Module = 2,695,140 Watts DC
Project 6 = 4464 Modules x 345W Module = 1,540,080 Watts DC (Oversized)
Project 7 = 4554 Modules x 345W Module = 1,571,130 Watts DC (Oversized)
Total = 31,086 Modules

Each project may be reduced in overall DC by using a lower wattage module, or removal of modules due to additional detailed survey of the site, shading, or interconnection limitations.

7. In general, in the case of fixed solar panels, does orienting your solar panels to the south provide a sort of balance (in terms of sun exposure) between the sun rising in the east and setting in the west and ultimately result in optimizing (or attempting to maximize) your total annual energy production (in kilowatt-hours) and your capacity factor?
   This statement is correct for the WS project. There are situations in some parts of the country where a more westerly orientation is preferred in order to maximize energy production during peak demand periods, but this is usually only considered in situations where the power purchaser pays a time-of-use rate that is higher during peak demand periods than what is paid during shoulder or off-peak periods.

8. On page 8 of the Petition, WS notes that, according to the 2012 Integrated Resources Plan (IRP), the capacity factor for PV solar (and thus the proposed project) is approximately 13 percent. Is that based on the DC or AC side of the proposed solar facility?
   The 13% capacity factor stated in the 2012 Integrated Resources Plan for Connecticut is based on the DC nameplate of a solar facility.

9. How many 1,000-kilowatt inverters would be installed?
   (8) 1,000 kW inverters area planned to be installed, however, WS may elect to utilize a 60 kW string inverter design. In the case of a string inverter design, approximately 133 – 60 kW inverters would be installed throughout the projects.

10. Provide the specifications sheet for the inverters.
    Attached are two specifications of the PV inverters that are currently being considered for the project. - Exhibit C

11. Provide the specification sheet for the proposed solar photovoltaic modules/panels.
    Attached are two specification of the PV modules that are currently being considered for the project. – Exhibit D

12. What are the estimated heights of the transformers and inverters?
    The transformer is approximately 7' high. The 1,000 kW centralized inverter is approximately 7' high. The 60 kW string inverters would be mounted at a height of approximately 5' – 6' high and be located throughout the array field. A cut sheet of a typical inverter/transformer pad has been added (2-1000-kilowatt inverters and 1 2000KvA transformer) – Exhibit E

13. Does Eversource currently have three-phase overhead electrical distribution on Hartford Turnpike (Route 138)?
    Yes.

## Construction Questions

14. Would the tree clearing be performed in stages (e.g. five acres at a time), or would the clearing all be performed together as one stage of construction? (Note: Connecticut Department of Energy and Environmental Protection "DEEP" General Permit for the Discharge of Stormwater and Dewatering Wastewasters Associated with Construction Activities states that, "Whenever possible, the site shall be phased to avoid the disturbance of over five acres at a time…")
    Tree clearing will be phased per the DEEP requirements, and the federal NPDES requirements.

15. Estimate the amounts of cut and fill in cubic yards.
    1600 yards cut and 1600 yards fill, no export or import of soil is anticipated.

16. Approximately how tall would the poles be for the video cameras and meteorological equipment noted on page 12 of the Petition?
    Video and meteorological poles at the central skid will be 12' to 15' high. Approximately 6-10 perimeter fence posts per project limits will be installed at 12' high and will have motion detecting video mounted to atop the higher fence posts. These locations will be based on the final footprint, and camera sight lines. The cameras are battery powered, and run on an internal wireless project network.

17. How would the H-beams (that support the racking system) be driven into the ground?
    The intent is that a majority of the H-beams will be driven pile. However, an alternative grouted foundation is also designed if subsurface boulders or ledge is encountered. Rock outcroppings and walls interior to the site will also be avoided in the final design. All structural pile designs will be signed by a CT licensed Professional Engineer.

18. What are the estimated constructed hours (e.g. Monday through Friday 8 AM to 5 PM)?
    Local zoning code working hours will be adhered to which are as follows:
    Town of Hampton zoning Code 6.5.G.7.:
    Hours of operation are limited to Monday through Saturday between 7AM and 5PM, major holidays excluded.

19. Approximately what size mesh does WS anticipate utilizing for the chain link fence? While 2-inch mesh is a common size, would WS consider utilizing a mesh size less than two inches as an anti-climbing measure? Would the fence have barbed wire?
    7' chain link would be preferred. The sites security system will identify intruders or a breach in the perimeter on the site. WS would consider a smaller mesh, if costs are similar. The majority of our sites do not have barb wire given our planned security measures, and barb wire is not intended for this project.

## Environmental Questions

20. In the Petition, WS has included the January 26, 2016 response from the Connecticut Department of Energy and Environmental Protection (DEEP) regarding the Natural Diversity Database. While DEEP does not anticipate negative impacts to State-listed species, are any federally-listed species known in the vicinity of the proposed project? If yes, describe possible impacts to such species and mitigation measures.
    The response from DEEP is attached. – Exhibit H

    A search of the Federal Endangered Species highlights the following Species Occurrence on the project:

    Animals
        Northern long-eared Bat (Myotis septentrionalis)
        Piping Plover (Charadrius melodus)
    Plants
        Sandplain gerardia (Agalinis acuta)
        Small Whorled pogonia (Isotria medeoloides)

    A wildlife biologist will be contacted to perform a site visit and determine if the site possesses the appropriate habitat for the above plants and animals. The biologist will determine if mitigation measures are necessary, and to what extent.

21. Is the total tree clearing area for the proposed project about 39.7 acres? If no, provide the total tree clearing area.
    The revised site plan represents 35.2 Acres of tree clearing.

22. Provide the carbon debt payback period. Specifically, as an estimate, you may utilize the U.S. Environmental Protection Agency (EPA) number of 1.22 metric tons of carbon dioxide sequestered by one acre of average U.S. forest in one year. That number can be multiplied by the number of acres of trees to be cleared to estimate the annual loss of carbon dioxide sequestration in metric tons per year for the project. Then the total projected annual electrical production in kilowatt-hours for the solar facility can be multiplied by the EPA estimate of $6.89551 \times 10^{-4}$ metric tons of carbon dioxide displaced per kilowatt-hour in order to provide the annual carbon dioxide emissions avoided by the operation of solar plant. Based on this or a different analysis, compute the number of months or years it would take to "break even" with carbon dioxide or when the carbon dioxide emissions reductions would equal the sequestration loss. (Data source: http://www.epa.gov/energy/ghg-equivalencies-calculator-calculations-and-references)
    WS is proposing to clear 35.2 acres as part of the construction of the facility. Based on the formula provided above, the loss of carbon dioxide sequestration would be 42.944 tons per year. The WS facility is expected to generate 12,420,720 kWh during its first year of operation, degrading by 0.5% per year thereafter. Based on the EPA estimates provided above, the WS facility would off-set 8,564 metric tons of carbon dioxide during its first year of operation or approximately 23.46 tons per day. Therefore, the sequestration loss from clearing the trees would be off-set by the solar facility in 1.83 days of operation in the first year.

23. On page 12 of the Petition, WS estimates 577,000 tons of $CO_2$ equivalent offset or eliminated during the 45-year life of the facility. How was the 577,000 tons computed?
The carbon off-set estimates provided in the Petition for Declaratory Ruling were based off of an estimated carbon off-set rate of 1.645 lbs per kWh of generation. This figure was based on a generation mix of 50% coal (2.07 lbs per kWh) and 50% natural gas (1.22 lbs per kWh) (source: https://www.eia.gov/tools/faqs/faq.cfm?id=74&t=11). Windham Solar is willing to accept the calculations provided by the EPA above.

24. Has the Petitioner received a response from the State Historic Preservation Office to date? If yes, provide a copy of such correspondence.
An application was submitted to SHPO by WS in mid-February. WS is still awaiting a response from SHPO on the parcel.

25. Is the proposed project located within an aquifer protection area?
No, the town of Hampton has not adopted an aquifer protection Area, the overall state map has been attached and the site has been identified. - Exhibit F

26. Is any of the proposed project located within a 100-year or 500-year flood zone? If yes, indicate which portion(s) of the project area are located within flood zones, and provide a Federal Emergency Management Agency flood zone map that includes the subject property.
Yes, a portion of the eastern site is Zone A, no modules are proposed in the area.

27. In Exhibit F of the Petition, by letter dated February 2, 2016, Highland Soils, LLC indicated that a more detailed wetland report would be prepared following another site visit. Does the Petitioner have an updated Wetlands Report at this time? If yes, provide a copy of such full report. Were any vernal pools located as a result of such site visit? Are any additional wetland and/or vernal pool protective measures proposed at this time? If no visit has been made, provide an estimated timeframe for the visit and updated report.
Updated Wetland report with vernal pool analysis is attached –Exhibit G.

28. If vernal pools are identified as result of a site visit, include the following. Describe the methodologies used to evaluate the vernal pools and include the date(s) of his studies. Specifically detail how the egg masses were counted, how many visits over what period of time were made, and indicate if any other techniques such as minnow trapping were used, if applicable.
Updated Wetland report with vernal pool analysis is attached –Exhibit G.

29. If vernal pools are identified as a result of a site visit, include the following. Analyze the vernal pools using the Calhoun and Klemens methodology. While forested habitat is preferable, open habitat may be used and also can serve as areas that animals move through. Open habitat also over time can improve by regrowth. It cannot be merely discounted as developed habitat as one can have areas that have houses and roads. An excellent example of how to correctly analyze a habitat that has various components is that for Council Docket 455 (Tab 14 of that application) which clearly shows the correct treatment of wooded, open and grassed areas, versus developed areas. Only the developed areas are considered to be lost habitat. This document, as a sample wetlands and vernal pool analysis, has been attached for your convenience. The map at the end of the document is a useful template or reference.
Updated Wetland report with vernal pool analysis is attached –Exhibit G.

30. Would the solar panels "heat" rainwater and potentially thermally pollute wetlands?
    No. There is no evidence that this occurs given the short duration that rainwater is on the panels, furthermore, the panels would be clouded during the time of rainfall, so surface temperatures of the panels would be less than on a sunny day.

31. Would the proposed project meet the applicable DEEP noise standards at the boundaries of the subject properties? (Sources of noise might include but not be limited to inverters, transformers, etc.)
    Yes.

## Maintenance Questions

32. How would WS handle potential snow accumulation on the panels and its effects of blocking the sunlight?
    Snow soiling has been accounted for in our solar modeling, no cleaning of panels is contemplated.

33. Has WS done any analysis to determine structural limits of snow accumulation on the solar panels and steel support structures, assuming heavy, wet snow? What accumulation of snow could the structures handle? Would WS clear snow from the panels when it approached the limit?
    The project racking will be designed for the regions wind and snow loading, and will be stamped by a licensed structural engineer. No clearing of snow is contemplated.

34. Would any mowing be required under or around the proposed solar panels/modules, and if so, approximately how often would mowing occur?
    Below is a typical operations and maintenance schedule, an operations and maintenance manual will be included in the projects final design.

    ### Monthly:
    Inspect the site vegetation growth, and establish a mowing schedule keeping vegetation between 6" and 18". Any growth above 18" begins shading lower elevation panels.
    Inspect the gravel roadways for washout locations or potential erosion issues, schedule maintenance as necessary
    Inspect the array field for any locations where excessive growth is identified, schedule maintenance as necessary

    ### Bi-Annually (April and October):
    Inspect vegetation during both the growing and non-growing seasons to ensure proper groundcover density.
    Identify stumps and areas within the array or at the perimeter, that have grown to create shading, schedule maintenance as necessary.
    Replant bare areas or areas with sparse growth with the project specific seed mix.
    Inspect perimeter landscaping screening, to ensure ongoing establishment of new plantings.

Petition No. 1222
Interrogatories
Set Two
April 26, 2016

General Questions

39. Please provide the most up to date Overall Site Plan Drawing (Sheet 4 of 17) taking into account any revisions that have been made to the number and locations of solar panels proposed, megawatts proposed, access proposed, etc.
A revised site plan is attached – Exhibit B

40. Explain in text the reasons for the changes to the site plan such as municipal comments and resident concerns and/or any environmental issues at the site.
Site plan changes were based off of town and abutter input from the site walk on April 21st, 2016 and an additional meeting held on the evening of April 21st, 2016 with the town of Hamptons planning and zoning department and conservation commission. The facility on Route 138 has been removed, at the request of the town of Hampton, the area is zoned Commercial, and is a potential location for an alternative use, given the roadway frontage.

The Facility has been pushed an additional 50' south from the property line abutting Fisk Road, for additional screening from residences to the north.

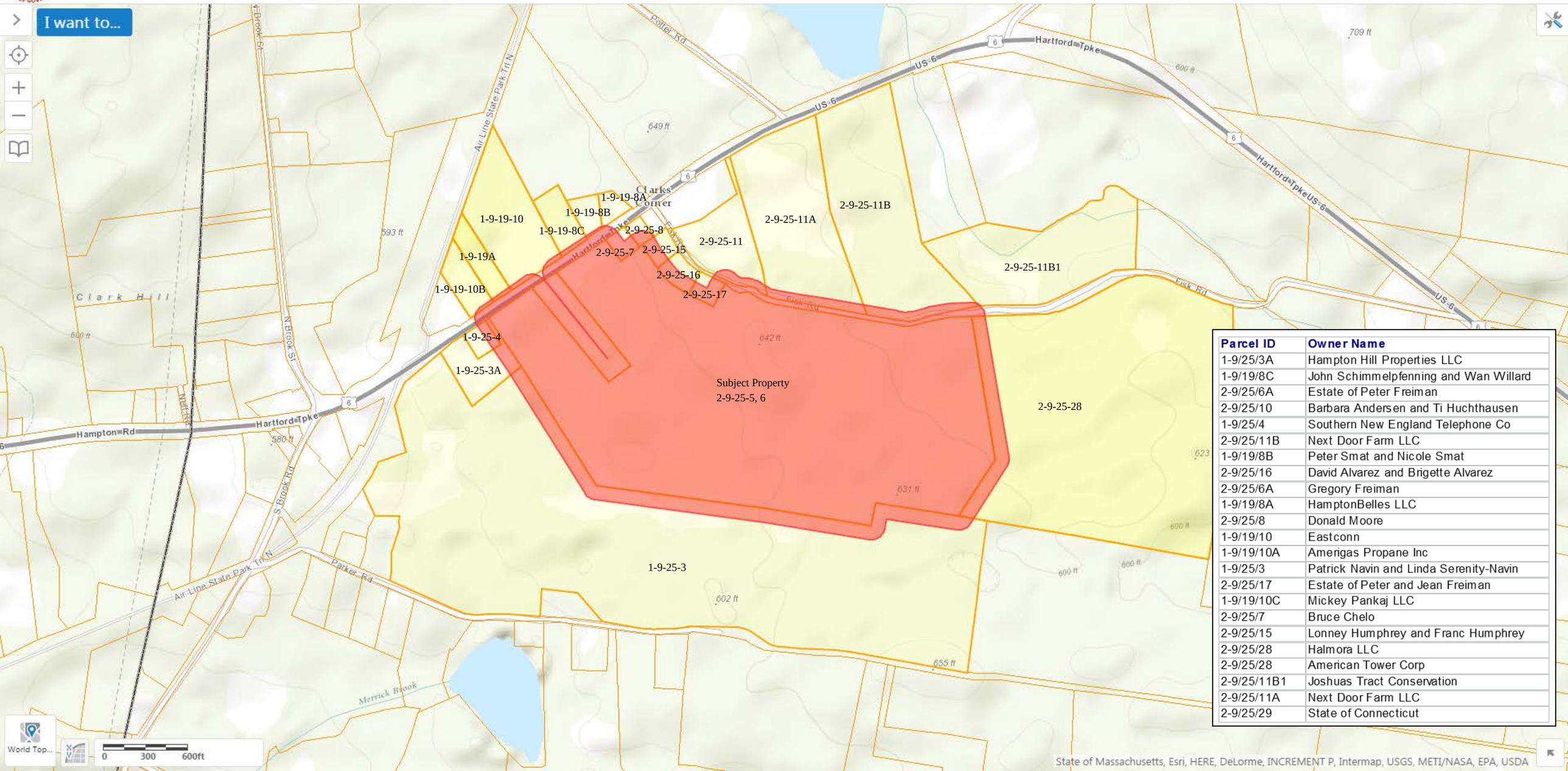
The site walk also showed several rock outcroppings, and agricultural rock walks internal to the project footprint. Those locations are currently being surveyed, for avoidance for final design. The project footprint illustrated in Exhibit B shows maximum footprint ignoring these constraints. Subsequent revisions will ultimately incorporate the rock walls and outcroppings and reduce the total project size. The oversizing of Project #6 and #7 allows for this flexibility.

Improvements to Fisk road will be necessary, the project is getting a much more detailed survey of the roadway area to produce a realistic design for a revised final access roadway alignment. Any widening of the roadway will be to the south, ensuring that the abutter to the norths land is not encroached upon.

The Hampton Conservation Commission also has concerns relating to the sites proposed hydrology. WS has discussed site hydraulic modeling theories with the Conservation Commission and will incorporate perimeter detention basins into the final design, ensuring that post construction runoff is less than pre-development conditions.

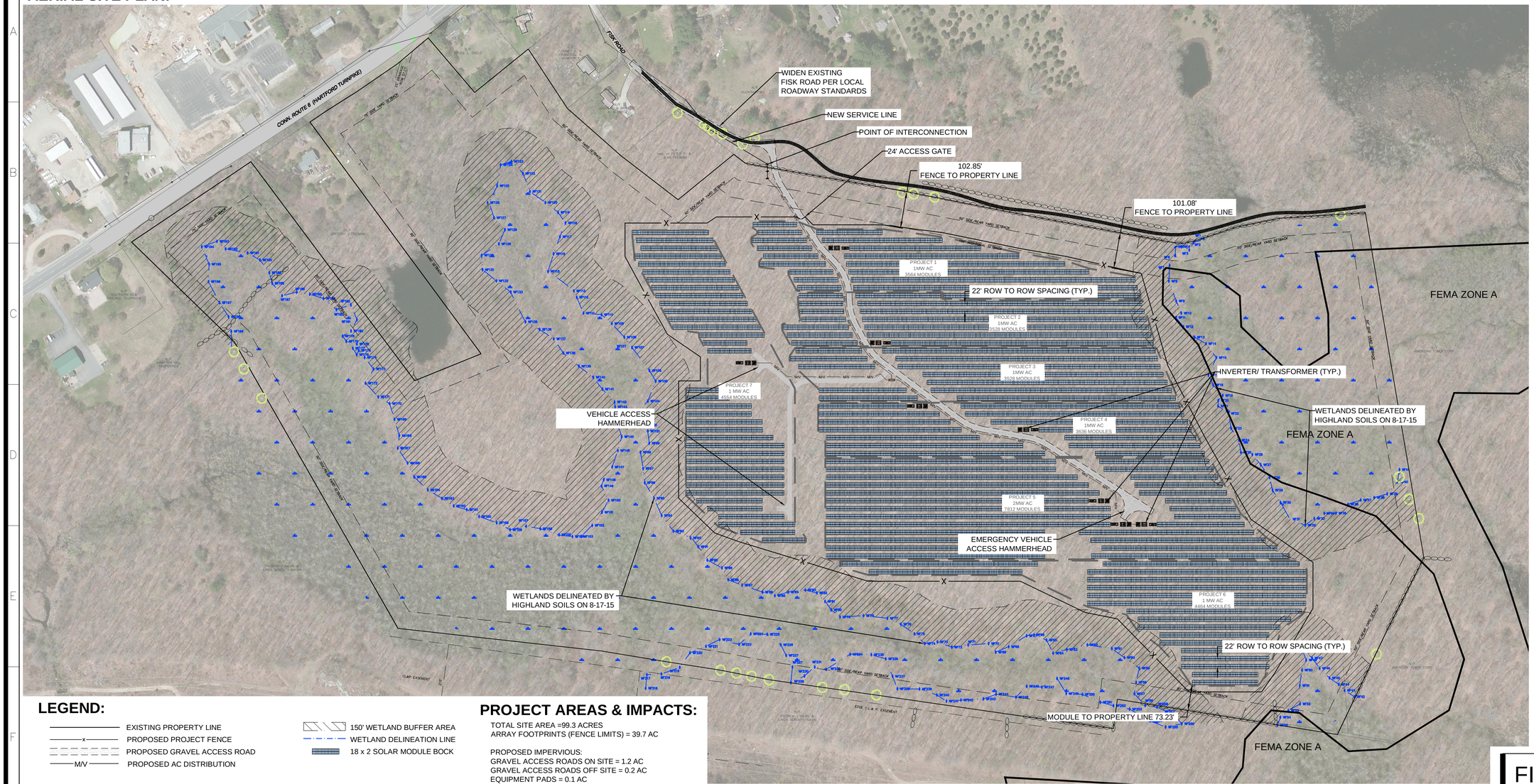
41. Please provide the revised total amounts of cut and fill for the project (as previously requested in an interrogatory) if it would materially change.
Calculations presented in set One Interrogatories are up to date.

42. Revise the total tree clearing area (in acres) and wetland clearing acreage, if applicable, and also recalculate the carbon debt payback based on the new acreage of tree clearing versus the updated annual electrical energy generated, if applicable.
Calculations presented in set One Interrogatories are up to date.




| Parcel ID | Owner Name |
|---|---|
| 1-9/25/3A | Hampton Hill Properties LLC |
| 1-9/19/8C | John Schimmelpfenning and Wan Willard |
| 2-9/25/6A | Estate of Peter Freiman |
| 2-9/25/10 | Barbara Andersen and Ti Huchthausen |
| 1-9/25/4 | Southern New England Telephone Co |
| 2-9/25/11B | Next Door Farm LLC |
| 1-9/19/8B | Peter Smat and Nicole Smat |
| 2-9/25/16 | David Alvarez and Brigette Alvarez |
| 2-9/25/6A | Gregory Freiman |
| 1-9/19/8A | HamptonBelles LLC |
| 2-9/25/8 | Donald Moore |
| 1-9/19/10 | Eastconn |
| 1-9/19/10A | Amerigas Propane Inc |
| 1-9/25/3 | Patrick Navin and Linda Serenity-Navin |
| 2-9/25/17 | Estate of Peter and Jean Freiman |
| 1-9/19/10C | Mickey Pankaj LLC |
| 2-9/25/7 | Bruce Chelo |
| 2-9/25/15 | Lonney Humphrey and Franc Humphrey |
| 2-9/25/28 | Halmora LLC |
| 2-9/25/28 | American Tower Corp |
| 2-9/25/11B1 | Joshuas Tract Conservation |
| 2-9/25/11A | Next Door Farm LLC |
| 2-9/25/29 | State of Connecticut |

# AERIAL SITE PLAN:




## LEGEND:

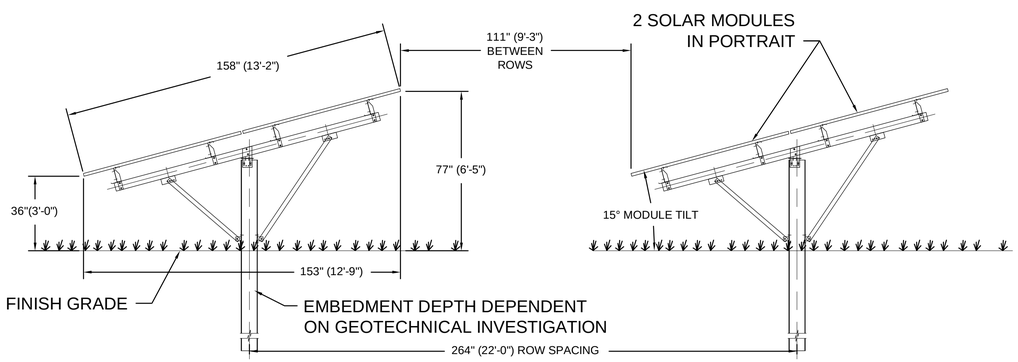
- EXISTING PROPERTY LINE
- PROPOSED PROJECT FENCE
- PROPOSED GRAVEL ACCESS ROAD
- M/V PROPOSED AC DISTRIBUTION
- 150' WETLAND BUFFER AREA
- WETLAND DELINEATION LINE
- 18 x 2 SOLAR MODULE BOCK

## PROJECT AREAS & IMPACTS:

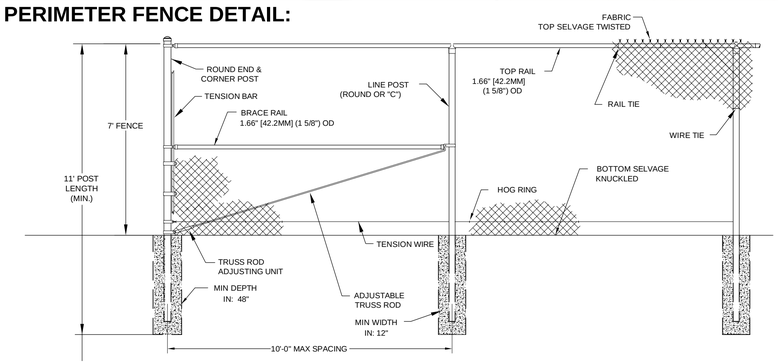
TOTAL SITE AREA =99.3 ACRES
ARRAY FOOTPRINTS (FENCE LIMITS) = 39.7 AC

PROPOSED IMPERVIOUS:
GRAVEL ACCESS ROADS ON SITE = 1.2 AC
GRAVEL ACCESS ROADS OFF SITE = 0.2 AC
EQUIPMENT PADS = 0.1 AC

## RACKING PROFILE DETAIL:




## PERIMETER FENCE DETAIL:




**Westwood**

Phone (480) 747-6558 6909 East Greenway Parkway, Suite 250
Fax (480) 376-8025 Scottsdale, AZ 85254
westwoodps.com

Westwood Professional Services, Inc.

Designed: ADC
Checked: SAW
Drawn: SJB
Record Drawing by/date:

Revisions:

| # | DATE | DESCRIPTION |
|---|---|---|
| - | 3/15/2016 | CT SITING BOARD SUBMISSION |
| - | 4/21/2016 | CT SITING BOARD SITE VISIT REVISIONS |

Prepared for:

ecos ENERGY
222 SOUTH 9TH STREET
SUITE 1600
MINNEAPOLIS, MN 55402

N

0' 150' 300' 450'

# FISK ROAD SOLAR

390 HARTFORD TURNPIKE
HAMPTON, CT 06247
WINDHAM COUNTY

# OVERALL SITE PLAN

SITING BOARD REVIEW

DATE: 3/15/2016
SHEET: 4 of 17

# NORTH AMERICA
# OUTDOOR UTILITY SCALE
## Solar Inverters

# HEC-US

## UTILITY SCALE SOLAR INVERTER

C US


EXTENDED MPPT
MPPt

AUTOMATIC REDUNDANT MODULAR MASTER SLAVE SYSTEM
ARM²S²

MULTIPLE MPPt
MPPt

REVOLUTIONAY COOLING

ADJUSTABLE POWER
DAY
NIGHT

OUTDOOR DURABILITY

INGRESS PROTECTION

## HEC-US

The HEC-US central inverter is an industry leading modular system designed for outdoor use with a NEMA 3R Stainless Steel enclosure, pre-engineered DC Recombiner, AC output circuit breaker and built-in ARM$^2$S$^2$ revolutionary filter-less cooling system.

The HEC–US inverter is certified to UL-1741 and IEEE-1547 and designed for utility scale PV plants located in the most demanding environments. Power-Electronics inverters include proven dynamic grid support features that enhance grid quality and PV plant management.

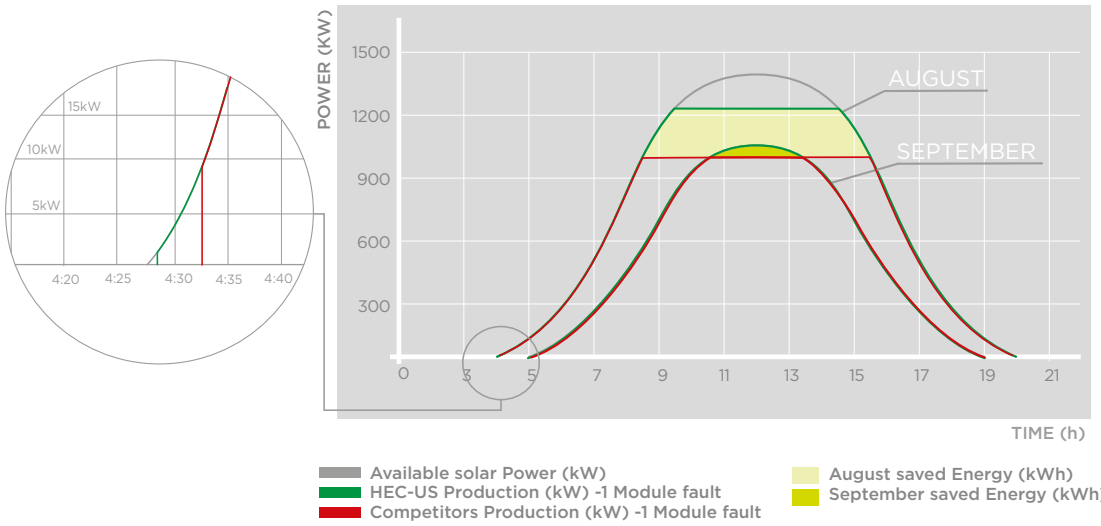
The HEC–US is available in a turnkey MW platform called the HEK Series. Delivered with factory tested Inverters, MV Pad-mounted transformer and auxiliary equipment, skid mounted solutions reduce installation and commissioning time and cost.

A MODULAR AND REDUNDANT SYSTEM MAXIMIZES UP-TIME AND PERFORMANCE

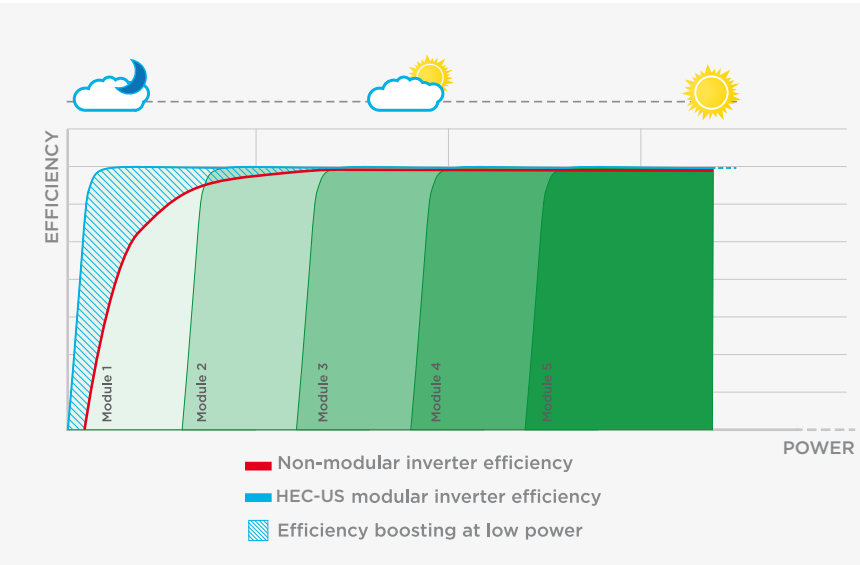
# AUTOMATIC REDUNDANT MODULAR MASTER SLAVE SYSTEM

HEC-US topology combines the advantages of a central inverter with the availability of string inverters. HEC-US inverters are designed using 80 to 170 KVA independent modules. Each module is self-contained with its own control board, an independent power platform and its own cooling system, coupled together to common DC and AC buses. Each day, the HEC-US inverter wakes up with a single module power on-line. As the available PV power increases more modules are added to maintain peak inverter efficiency.

If there is a fault in one module, the faulted module is taken off-line and the output power is distributed evenly among the remaining system modules. All power modules work in parallel controlled by the master module. The master is the main governor of the system and is responsible for the MPPt tracking, synchronization sequence and overall protection. The automatic mode shifts the master module every night by comparing the register of energy production of all the modules in the system. The module with the least energy produced (kWh) will act as the master on the following day.



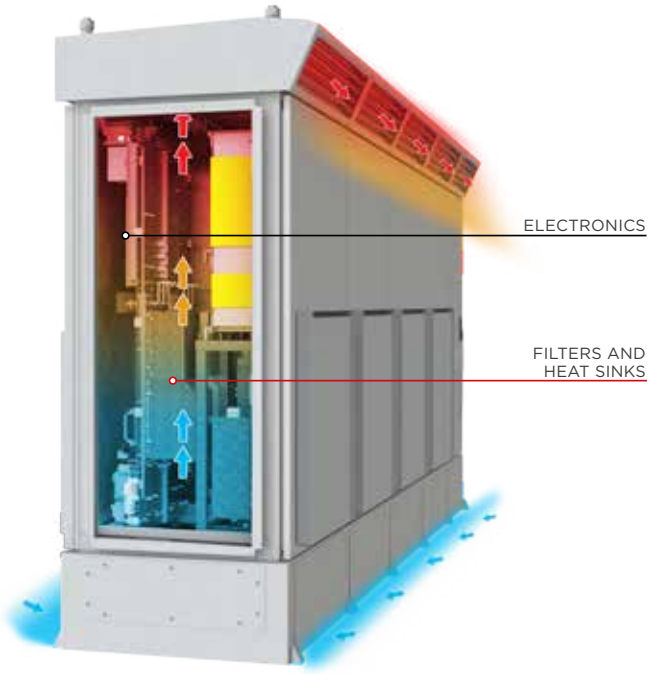

A modular inverter is more efficient than a central inverter. During low radiation conditions, a modular architecture uses the correct number of power modules to provide power while the central inverter must consume power internally to support the entire system. With lower losses, a modular inverter can begin to provide power earlier in the morning and stop later at the end of the day. As a result, throughout the entire service life of the PV plant, the HEC-US inverter generates higher yields than a central inverter with a higher reliability than string inverters.

## REVOLUTIONARY COOLING SYSTEM

The design philosophy for the HEC-US inverters is to oversize sensitive components (like IGBTs & DC bus capacitors) and provide sufficient margin so the HEC-US can operate at 122F (50°C) with no power derating. Power-Electronics equipment is installed in mines, water treatment plants and concentrated solar power facilities in the most demanding locations in the world.  Our expertise in harsh environments is the foundation for the perfect technical solution for our outdoor solar inverters.

The cooling systems on the HEC-US modules are divided into two main areas: the clean area (electronics) and the hot area (LC filters and heat sinks). The electronics are sealed in a NEMA 4 area and use a temperature control low flow cooling system that reduces filter maintenance. The hot area integrates independent speed controlled fans per each module that reduce stand-by consumption at low capacity, minimize audible noise and increase cooling capacity for PV installations located in hot environments or high altitudes.



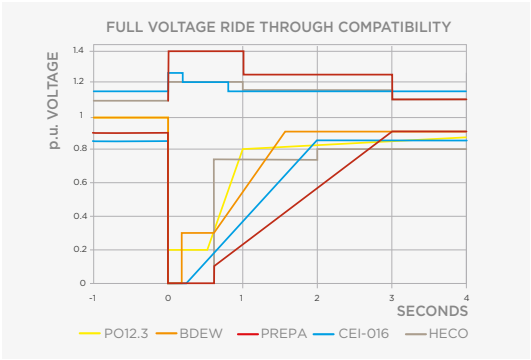



## VAR AT NIGHT

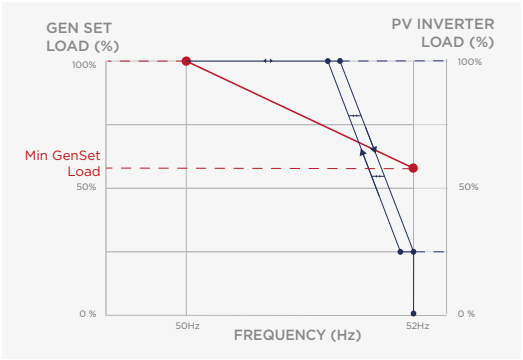
At night, the HEC-US inverter can shift to reactive power compensation mode. The inverter can respond to an external dynamic signal, a Power Plant Controller command or pre-set reactive power level (kVAr).

## DYNAMIC GRID SUPPORT

HEC-US firmware includes the latest utility interactive features (LVRT, OVRT, FRS, FRT, Anti-islanding, active and reactive power curtailment...), and is compatible with all the specific requirements of the utilities.

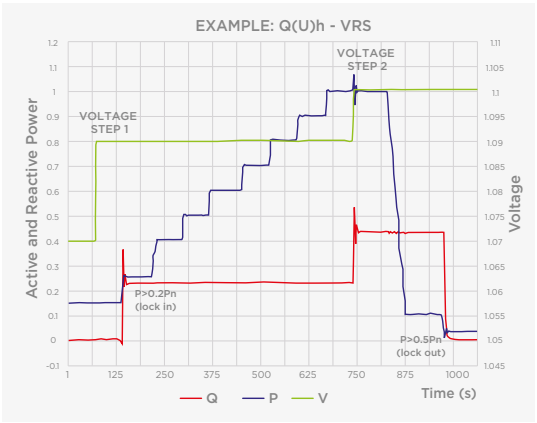


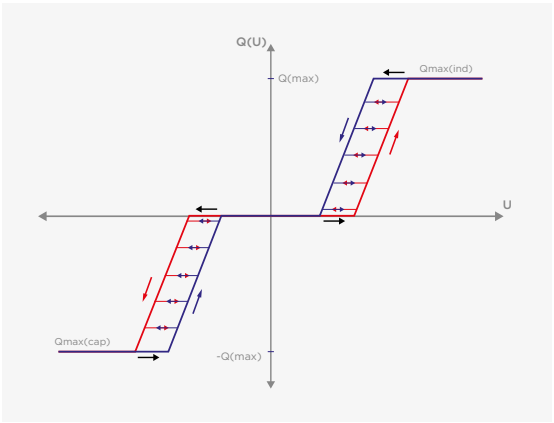

▲ **LVRT or ZVRT (Low Voltage Ride Through).** Inverters can withstand any voltage dip or profile required by the local utility. The inverter can immediately feed the fault with full reactive power, as long as the protection limits are not exceeded.

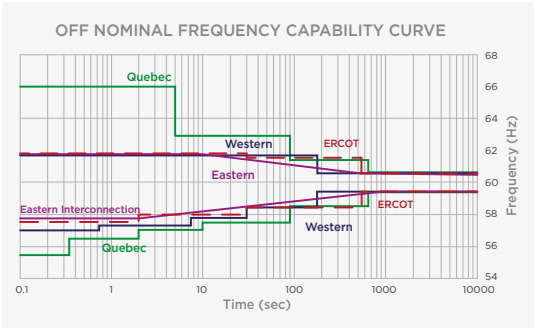



▲ **FRS: Frequency Regulation System.** Frequency droop algorithm curtails the active power along a preset characteristic curve supporting grid stabilization.

The advanced control allows the inverter to support the grid through reactive power injection or phase shift control by programming a wide range of fixed or dynamic power functions based on voltage and frequency inputs.




◀ **Frequency Ride Through:** Power Electronics inverters have flexible frequency protection settings and can be easily adjusted to comply with future requirements.

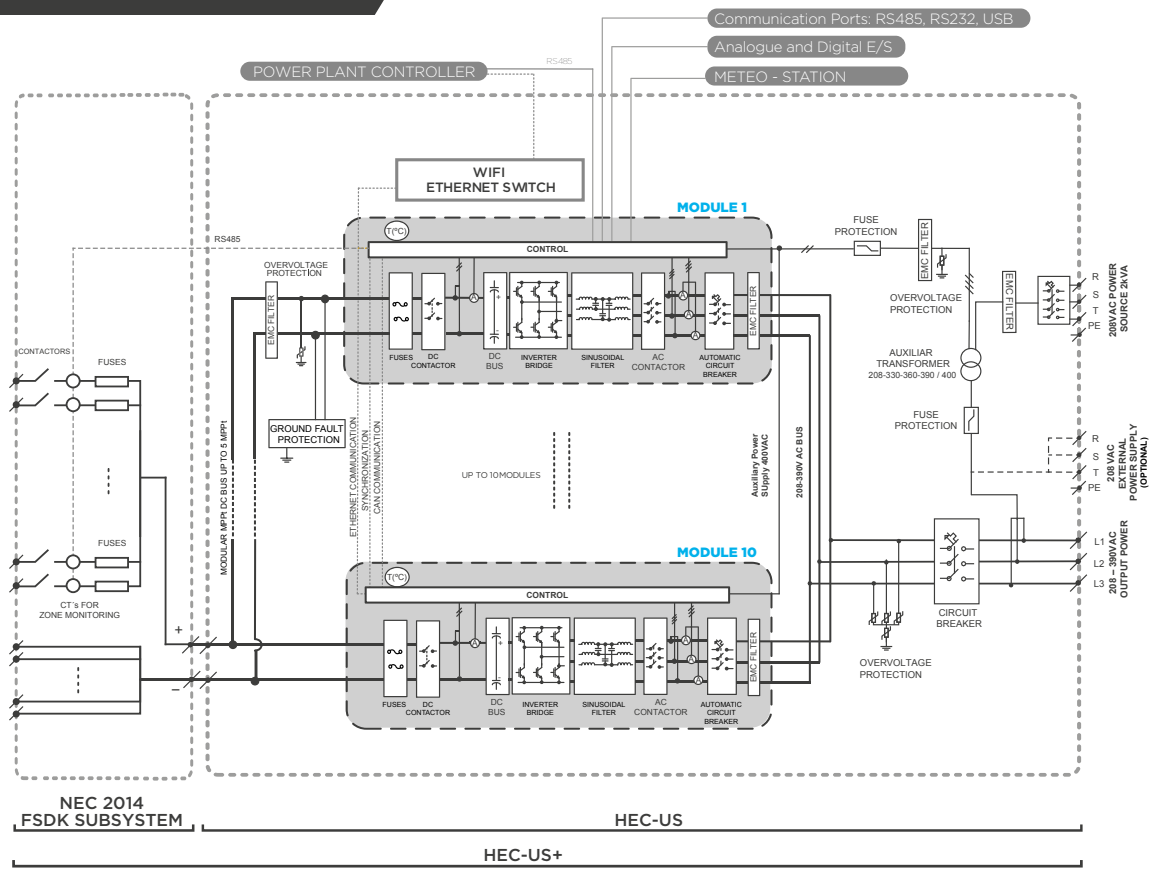
The HEC-US inverter has a unique anti-islanding protection that combines passive and active methods that eliminate nuisance tripping and reduce grid distortion. The inverter is certified to IEC 62116 and IEEE1547.

Power Electronics offers a **POWER PLANT CONTROLLER** that will allow both the PV plant operator and the utility to perform active and reactive power curtailment, voltage regulation and frequency regulation based on feedback from a power meter at the point of interconnection.

# HEC-US

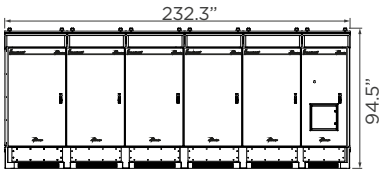
## TECHNICAL CHARACTERISTICS

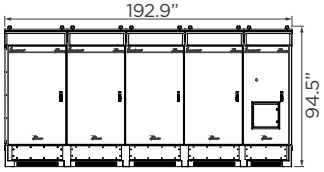
## OPERATIONAL DIAGRAM

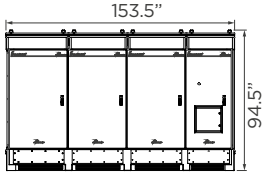



## DIMENSIONS

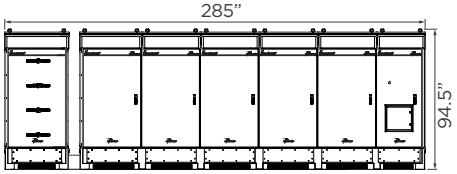
### HEC-US

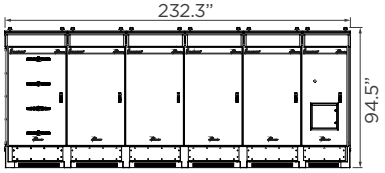


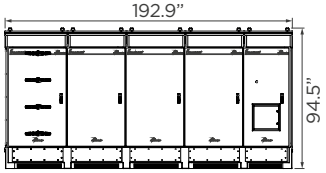



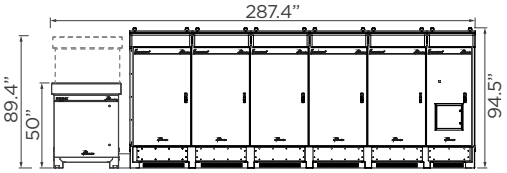

### HEC-US+ NEC2011

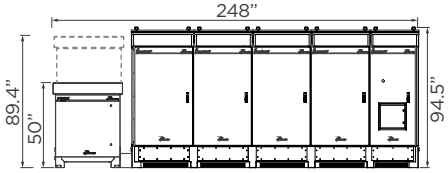


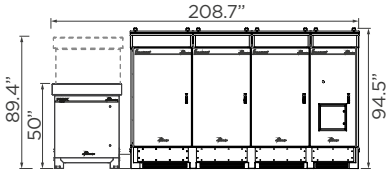




### HEC-US+ NEC2014




NOTE Depth of all units is 40.12”.
Please consult hardware and installation manual for additional information on dimensions and weights.

# HEC-US

## TECHNICAL CHARACTERISTICS

| | | 390VAC | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | FRAME 1 | FRAME 2 | | FRAME 3 | | FRAME 4 | |
| **NUMBER OF MODULES** | | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **MODEL NUMBER** | | FS0600CU | FS0751CU | FS0900CU | FS1050CU | FS1250CU | FS1350CU | FS1500CU |
| OUTPUT | Maximum Power (kW/kVA) @PF=1; 50°C | 680 | 850 | 1020 | 1190 | 1360 | 1530 | 1700 |
| | Maximum Power (kW) @PF=0.9; 50°C | 600 | 750 | 900 | 1050 | 1250 | 1350 | 1500 |
| | Max. Output Current(A) | 1007 | 1259 | 1510 | 1762 | 2014 | 2268 | 2520 |
| | Operating Grid Voltage(VAC) | 390Vac ±10% | | | | | | |
| | Operating Range, Grid Frequency | 60Hz (59.3Hz - 60.5Hz) | | | | | | |
| | Power Factor [1] | 0.9 leading... 0.9 lagging | | | | | | |
| | Current Harmonic Distortion (THDi) | < 3% at nominal power | | | | | | |
| INPUT | MPPt Window | 552V - 900V | | | | | | |
| | Maximum DC voltage | 1000V | | | | | | |
| | Rated DC current | 1200A | 1500A | 1800A | 2100A | 2400A | 2700A | 3000A |
| | Maximum. short circuit DC current | 1560A | 1950A | 2340 | 2730A | 3120A | 3510A | 3900A |
| EFFICIENCY & AUX. SUPPLY | Max. Efficiency / CEC (η) | 98.6% / 98.0% | | | | | | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | | |
| | Aux. Power Supply (208VAC) | 6100VA | 5300VA | 4600VA | 3800VA | 3000VA | 1800VA | 1000VA |
| | Maximum Power Consumption (W) | 1840W | 2300W | 2760W | 3220W | 3680W | 4140W | 4600W |
| ENVIRON-MENT | Degree of protection | NEMA 3R | | | | | | |
| | Cooling system | Forced air intake through bottom and exhausted through upper exhaust hood | | | | | | |
| | Permissible Ambient Temperature[2] | -22°F to +122°F / -30°C ...+50°C ; >50°C/ 122°F power derating | | | | | | |
| | Relative Humidity | 4% to 100%, Active heating and humidity control | | | | | | |
| | Max. Altitude (above sea level)[2] | 4000m; >1000m power derating 1% Sn (kVA) per 100m | | | | | | |
| CONTROL INTERFACE | Interface | Alphanumeric display, ON-OFF Selector, ON/OFF pushbutton (Optional) | | | | | | |
| | Communication | RS232 / RS485 / USB / Ethernet, (Modbus RTU Protocol, Modbus TCP/IP) | | | | | | |
| | Analogue Inputs | 1 programmable and differential inputs; (0-20mA or ± 10mV to ± 10V) and PT100 | | | | | | |
| | Digital Outputs | 1 electrically-isolated programmable switched relays (250VAC, 8A or 30 VDC, 8A) | | | | | | |
| PROTECTIONS | Ground Fault Protection | Floating PV array: Isolation Monitoring per MPP<br>NEC2011 Grounded PV array: GFDI protection<br>NEC2014 Grounded PV array: GFDI protection and isolation monitoring (requires 1 Digital Output) | | | | | | |
| | NEC2011 Recombiner[3] | Max. 4x700A switches. Max. 32 inputs (70-200A fuse). Max. 28 (400A fuse)<br>Max. 3x1250A switches. Max. 24 inputs (70-200A fuse). Max. 21 inputs (400A fuse) | | | | | | |
| | NEC2014 Recombiner[3] | Max. 40 inputs (70-400A fuse) | | | | | | |
| | Overvoltage Protection | DC and AC Inverter sides (Type 4) and Auxiliary Supply type 2 - Internal Standard | | | | | | |
| CERTI-FICA-TIONS | Safety | UL 1741; CSA 22.2 No.107.1-01 | | | | | | |
| | Utility Interconnect | IEEE 1547 | | | | | | |

NOTES [1] Power factor adjustable from pure leading to pure lagging.
[2] Below -20°C equipped with extended Active Heating + Heating Resistor. Other characteristics consult with Power Electronics.
[3] Check maximum shortcircuit DC current of the inverter to assure full recombiner compatibility.

# HEC-US

## TECHNICAL CHARACTERISTICS

| | | 360VAC | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | FRAME 2 | | | FRAME 3 | | FRAME 4 | |
| **NUMBER OF MODULES** | | 5 | 6 | 6 | 7 | 8 | 9 | 10 |
| **MODEL NUMBER** | | FS0701CU | FS0752CU | FS0830CU | FS1003CU | FS1110CU | FS1251CU | FS1400CU |
| **OUTPUT** | Maximum Power (kW/kVA) @PF=1; 50°C | 780 | 930 | 930 | 1100 | 1250 | 1400 | 1550 |
| | Maximum Power (kW) @PF=0.9; 50°C | 700 | 750 | 830 | 1000 | 1110 | 1250 | 1400 |
| | Max. Output Current(A) | 1251 | 1492 | 1492 | 1765 | 1989 | 2246 | 2486 |
| | Operating Grid Voltage(VAC) | 360Vac ±10% | | | | | | |
| | Operating Range, Grid Frequency | 60Hz (59.3Hz - 60.5Hz) | | | | | | |
| | Power Factor[1] | 0.9 leading... 0.9 lagging | | | | | | |
| | Current Harmonic Distortion (THDi) | < 3% at nominal power | | | | | | |
| **INPUT** | MPPt Window | 510V - 900V | | | | | | |
| | Maximum permissible DC voltage | 1000V | | | | | | |
| | Rated DC current | 1500A | 1800A | 1800A | 2100A | 2400A | 2700A | 3000A |
| | Maximum short circuit DC current | 1950A | 2340 | 2340 | 2730A | 3120A | 3510A | 3900A |
| **EFFICIENCY & AUX. SUPPLY** | Max. Efficiency / CEC (η) | 98.6% / 98.0% | | | | | | |
| | Max. Standby Consumption (Pnight) | < approx. 40W/per module | | | | | | |
| | Aux. Power Supply (208VAC) | 5300VA | 4600VA | 4600VA | 3800VA | 3000VA | 1800VA | 1000VA |
| | Maximum Power Consumption (W) | 2300W | 2760W | 2760W | 3220W | 3680W | 4140W | 4600W |

NOTES

[1] Power factor adjustable from pure leading to pure lagging.
[2] Below -20°C equipped with extended Active Heating + Heating Resistor. Other characteristics consult with Power Electronics.
[3] Check maximum shortcircuit DC current of the inverter to assure full recombiner compatibility.

# SG 60KU-M

SUNGROW

www.sungrowpower.com

## Efficient and flexible

- High flexibility for complex configurations due to 4 MPP trackers and a wide input voltage range
- High yields due to efficiency up to 98.9% and CEC efficiency of 98.5%
- Output power up to 66kVA / 66kW at power factor of 1
- Can be installed at any angle

## Grid-friendly

- Active power continuously adjustable (0~100%)
- Fulfill a variety of reactive power adjustment requirments with power factor 0.8 overexited ~ 0.8 underexited
- Integrated LVRT and HVRT function
- Includes RS-485 and Ethernet interface, compatible with all common monitoring systems

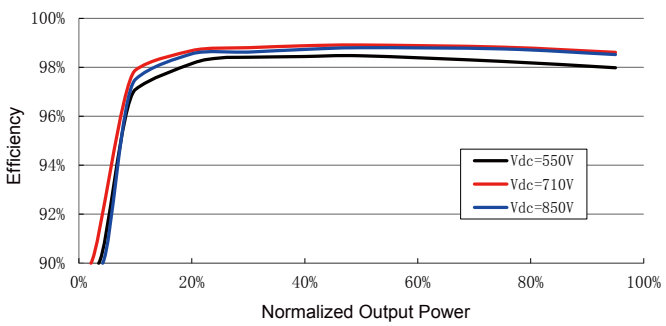
## Intelligent design

- Integrated combiner box: 16 x Screw terminal pairs with DC string fuses (both positive and negative), Type II overvoltage protection(both DC and AC), DC and AC switch, more safety and lower the system cost
- Integrated string detection function and arc fault detection

## Reliable

- Product certification: UL 1741, IEEE 1547, IEEE1547.1, CSA C22.2 107.1-01-2001, FCC Part 15 Sub-part B Class B Limits
- Manufacturer certification: ISO 9001, ISO 14001, OHSAS 18000

## Efficiency Curve



## Input Data

| | |
|---|---|
| Max. PV input voltage | 1000V |
| Startup voltage | 300V |
| Stop Voltage | 280V |
| MPP voltage range | 300~950V |
| MPP voltage range for nominal power | 550~850V / 513~850V |
| String Fuse | Positive and Negative |
| No. of MPPTs | 4 |
| Max. number of PV strings per MPPT | 4 |
| Max. PV input current | 112A |
| Maximum DC short circuit current | 200A |
| Max. current for input connector | 12A |
| Max. Cable Size | 10AWG, Cu or Al |
| Arc Flash Detection | Yes |
| DC Switch | Yes |
| Insulation Detection | Yes |
| DC Surge Arrestor | Type II DIN rail surge arreste |

## Output Data

| | |
|---|---|
| Nominal AC output power | 60000W / 56000W |
| Max AC output power (PF=1) | 66000W |
| Max. AC output apparent power | 66000VA |
| Max. AC output current | 80A |
| Nominal AC voltage | 3Ø/3W +Ground, 480Vac |
| AC voltage range | 422~528Vac |
| Nominal grid frequency | 60Hz |
| Grid frequency range | 55~65Hz |
| THD | <3% (Nominal power) |
| DC current injection | <0.5%In |
| Power factor | >0.99@default value at nominal power, (adj. 0.8 eading ~ 0.8 lagging) |
| Max. Cable Size | 70m², Cu or Al |
| AC Surge Arrestor | Type II DIN rail surge arreste (40kA) |

## Protection

| | |
|---|---|
| Anti-islanding protection | Yes |
| Low Voltage Ride Through | Yes |
| DC reverse connection protection | Yes |
| AC short circuit protection | Yes |
| Leakage current protection | Yes |
| Overvoltage protection | Type II DIN rail surge arrester |
| AC switch | Yes |

## Mechanical Data

| | | |
|---|---|---|
| Dimensions (W*H*D) | 665*915*276 mm | 26.2*36*10.9inch |
| Mounting method | Wall bracket | |
| Weight | 70kg | 154lbs |

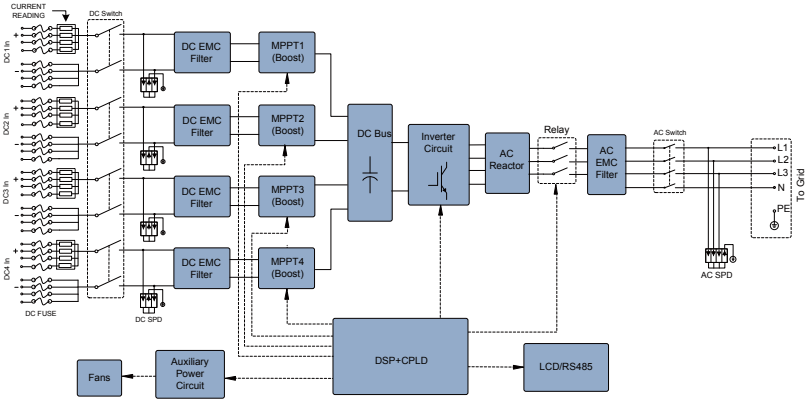
## System Data

| | | |
|---|---|---|
| Max. efficiency | 98.90% | |
| CEC efficiency | 98.50% | |
| Isolation method | Transformerless | |
| Ingress protection rating | NEMA4X | |
| Tare Loss | <1W | |
| Operating ambient temperature range | -25~60℃ (>50℃ derating) | -13…+140℉ (>122℉ derating) |
| Allowable relative humidity range | 0~100% | |
| Cooling method | Smart forced air cooling | |
| Max. operating altitude | 4000m (>3000m derated) | 13,000ft (>9,800ft derated) |
| Display | Graphic LCD | |
| Communication | RS485 / Ethernet | |
| DC connection type | Screw terminals | |
| AC connection type | Screw clamp terminal | |
| Certification | cCSAus | |
| Safety and EMC Standard | UL 1741, IEEE 1547, IEEE1547.1, CSA C22.2 107.1-01-2001, FCC Part 15 Sub-part B Class B Limits | |

## Communication

| | |
|---|---|
| RS485 | Standard |
| Ethernet | Standard |
| I/O dry contact | Standard |
| Protocol | Modbus |

## Circuit Diagram



# Sunmodule®
# SW 340-350 XL MONO

SOLARWORLD
REAL VALUE

TUV Power controlled:
Lowest measuring tolerance in industry

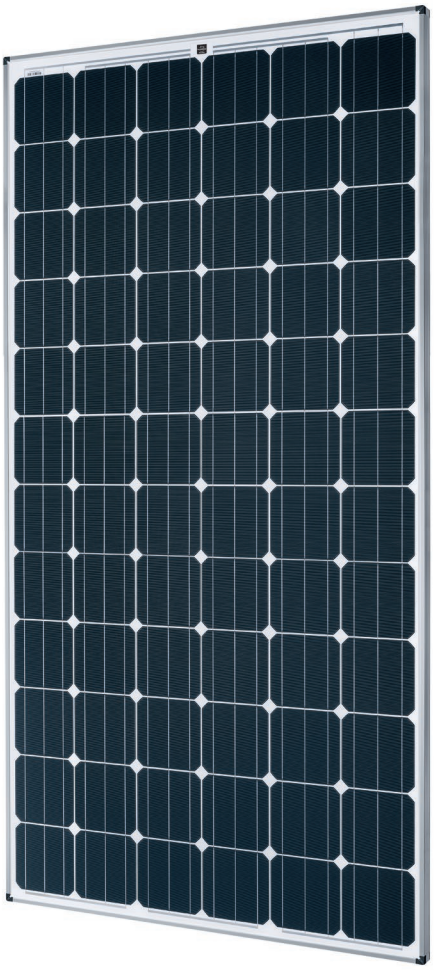
Every component is tested to meet
3 times IEC requirements

Designed to withstand heavy
accumulations of snow and ice

Sunmodule
Positive performance tolerance

25-year linear performance warranty
and 10-year product warranty

Glass with anti-reflective coating



**World-class quality**
Fully-automated production lines and seamless monitoring of the process and material ensure the quality that the company sets as its benchmark for its sites worldwide.

**SolarWorld Plus-Sorting**
Plus-Sorting guarantees highest system efficiency. SolarWorld only delivers modules that have greater than or equal to the nameplate rated power.

**25-year linear performance guarantee and extension of product warranty to 10 years**
SolarWorld guarantees a maximum performance digression of 0.7% p.a. in the course of 25 years, a significant added value compared to the two-phase warranties common in the industry, along with our industry-first 10-year product warranty.*

*in accordance with the applicable SolarWorld Limited Warranty at purchase.
www.solarworld.com/warranty

• Qualified, IEC 61215
• Safety tested, IEC 61730
• Blowing sand resistance, IEC 60068-2-68
• Ammonia resistance, IEC 62716
• Salt mist corrosion, IEC 61701
• Periodic inspection

• Periodic inspection
• Power controlled

UL 1703

ISO 9001
ISO 14001
Certified

Home Innovation
NGBS GREEN CERTIFIED

solarworld.com

# Sunmodule®
# SW 340-350 XL MONO

SOLARWORLD
REAL VALUE

## PERFORMANCE UNDER STANDARD TEST CONDITIONS (STC)*

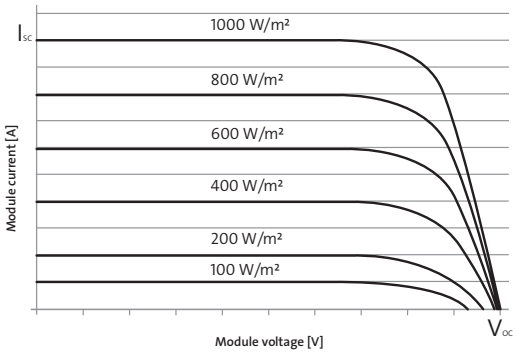
| | | SW 340 | SW 345 | SW 350 |
|---|---|---|---|---|
| *Maximum power* | $P_{max}$ | 340 Wp | 345 Wp | 350 Wp |
| *Open circuit voltage* | $V_{oc}$ | 47.6 V | 47.8 V | 48.0 V |
| *Maximum power point voltage* | $V_{mpp}$ | 38.0 V | 38.2 V | 38.4 V |
| *Short circuit current* | $I_{sc}$ | 9.69 A | 9.75 A | 9.82 A |
| *Maximum power point current* | $I_{mpp}$ | 9.01 A | 9.10 A | 9.17 A |
| *Module efficiency* | $\eta_m$ | 17.04 % | 17.29 % | 17.54 % |

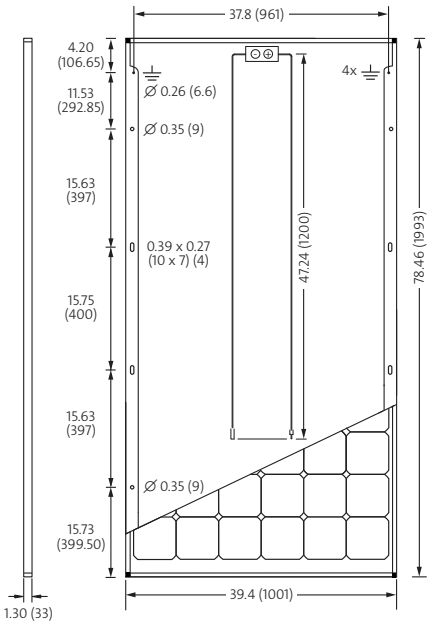
*STC: 1000W/m², 25°C, AM 1.5

## PERFORMANCE AT 800 W/M², NOCT, AM 1.5

| | | SW 340 | SW 345 | SW 350 |
|---|---|---|---|---|
| *Maximum power* | $P_{max}$ | 259.3 Wp | 263.8 Wp | 267.2 Wp |
| *Open circuit voltage* | $V_{oc}$ | 41.5 V | 41.8 V | 42.0 V |
| *Maximum power point voltage* | $V_{mpp}$ | 34.9 V | 35.2 V | 35.4 V |
| *Short circuit current* | $I_{sc}$ | 8.05 A | 8.10 A | 8.16 A |
| *Maximum power point current* | $I_{mpp}$ | 7.42 A | 7.50 A | 7.56 A |

Minor reduction in efficiency under partial load conditions at 25° C: at 200 W/m², 100% of the STC efficiency (1000 W/m²) is achieved.




## COMPONENT MATERIALS

| | | | |
|---|---|---|---|
| *Cells per module* | 72 | *Front* | Low-iron tempered glass with ARC (EN 12150) |
| *Cell type* | Monocrystalline | *Frame* | Clear anodized aluminum |
| *Cell dimensions* | 6.17 in x 6.17 in (156.75 x 156.75 mm) | *Weight* | 47.6 lbs (21.6 kg) |

## THERMAL CHARACTERISTICS

| | |
|---|---|
| *NOCT* | 46 °C |
| *$TCI_{sc}$* | 0.042 % / °C |
| *$TCV_{oc}$* | -0.304 % / °C |
| *$TCP_{mpp}$* | -0.43 % / °C |
| *Operating temp* | -40 to +85 °C |

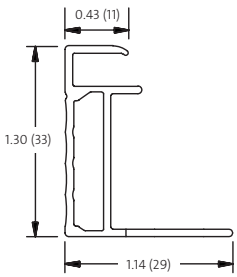
## ADDITIONAL DATA

| | |
|---|---|
| *Power sorting* | -0 Wp/+5 Wp |
| *J-Box* | IP65 |
| *Connector* | PV wire per UL4703 with H4/UTX connectors |
| *Module fire performance* | (UL 1703) Type 1 |

## PARAMETERS FOR OPTIMAL SYSTEM INTEGRATION

| | | |
|---|---|---|
| *Maximum system voltage SC II / NEC* | | 1000 V |
| *Maximum reverse current* | | 25 A |
| *Number of bypass diodes* | | 3 |
| *Design loads** | *Two rail system* | 113 psf downward, 64 psf upward |
| *Design loads** | *Edge mounting* | 178 psf downward, 23 psf upward |

* Please refer to the Sunmodule installation instructions for the details associated with these load cases.




- Compatible with both "Top-Down" and "Bottom" mounting methods
- ⏚ Grounding Locations:
  – 4 locations along the length of the module in the extended flange.

All units provided are imperial. SI units provided in parentheses.
SolarWorld AG reserves the right to make specification changes without notice.

# THE TALLMAX MODULE

## 72 CELL
MULTICRYSTALLINE MODULE

## 305-320W
POWER OUTPUT RANGE

## 16.5%
MAXIMUM EFFICIENCY

## 0~+5W
POSITIVE POWER TOLERANCE

As a leading global manufacturer of next generation photovoltaic products, we believe close cooperation with our partners is critical to success. With local presence around the globe, Trina is able to provide exceptional service to each customer in each market and supplement our innovative, reliable products with the backing of Trina as a strong, bankable partner. We are committed to building strategic, mutually beneficial collaboration with installers, developers, distributors and other partners as the backbone of our shared success in driving Smart Energy Together.

**Trina Solar Limited**
www.trinasolar.com

Trinasolar
Smart Energy Together

### Ideal for large scale installations
- High powerful footprint reduces installation time and BOS costs
- 1000V UL/1000V IEC certified

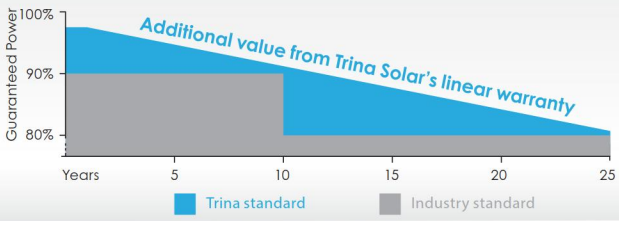
### One of the industry's most trusted modules
- Field proven performance

### Highly reliable due to stringent quality control
- Over 30 in-house tests (UV, TC, HF, and many more)
- In-house testing goes well beyond certification requirements
- PID resistant

### Certified to withstand challenging environmental conditions
- 2400 Pa wind load
- 5400 Pa snow load
- 35 mm hail stones at 97 km/h

## LINEAR PERFORMANCE WARRANTY

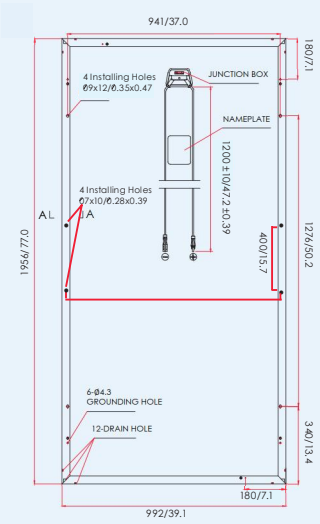
**10 Year Product Warranty • 25 Year Linear Power Warranty**



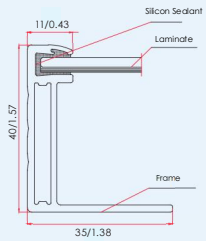
# THE TALLMAX MODULE

# TSM-PD14

## DIMENSIONS OF PV MODULE
unit:mm/in

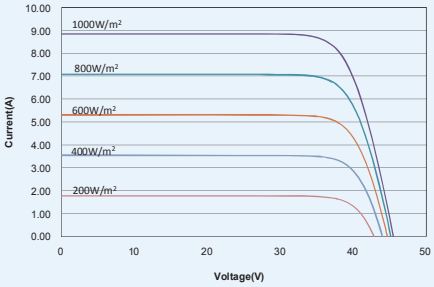



Back View




A-A

## I-V CURVES OF PV MODULE(310W)




## CERTIFICATION

## ELECTRICAL DATA (STC)

| | | | | |
|---|---|---|---|---|
| Peak Power Watts-$P_{MAX}$ (Wp) | 305 | 310 | 315 | 320 |
| Power Output Tolerance-$P_{MAX}$ (W) | 0 ~ +5 | | | |
| Maximum Power Voltage-$V_{MPP}$ (V) | 36.6 | 37.0 | 37.1 | 37.1 |
| Maximum Power Current-$I_{MPP}$ (A) | 8.33 | 8.38 | 8.51 | 8.63 |
| Open Circuit Voltage-$V_{OC}$ (V) | 45.5 | 45.5 | 45.6 | 45.8 |
| Short Circuit Current-$I_{SC}$ (A) | 8.81 | 8.85 | 9.00 | 9.10 |
| Module Efficiency $\eta_m$ (%) | 15.7 | 16.0 | 16.2 | 16.5 |

STC: Irradiance 1000 W/m², Cell Temperature 25°C, Air Mass AM1.5.

## ELECTRICAL DATA (NOCT)

| | | | | |
|---|---|---|---|---|
| Maximum Power-$P_{MAX}$ (Wp) | 227 | 230 | 234 | 238 |
| Maximum Power Voltage-$V_{MPP}$ (V) | 34.0 | 34.3 | 34.3 | 34.4 |
| Maximum Power Current-$I_{MPP}$ (A) | 6.68 | 6.72 | 6.83 | 6.91 |
| Open Circuit Voltage-$V_{OC}$ (V) | 42.2 | 42.2 | 42.3 | 42.5 |
| Short Circuit Current-$I_{SC}$ (A) | 7.11 | 7.15 | 7.27 | 7.35 |

NOCT: Irradiance at 800 W/m², Ambient Temperature 20°C, Wind Speed 1 m/s.

## MECHANICAL DATA

| | |
|---|---|
| Solar cells | Multicrystalline 156 × 156 mm (6 inches) |
| Cell orientation | 72 cells (6 × 12) |
| Module dimensions | 1956 × 992 × 40 mm(77.0 × 39.1 × 1.6 inches) |
| Weight | 22.5 kg (50 lb) |
| Glass | 3.2 mm,High Transmission, AR Coated Tempered Glass |
| Backsheet | White |
| Frame | Silver Anodized Aluminium Alloy |
| J-Box | IP 65 or IP 67 rated |
| Cables | Photovoltaic Technology cable 4.0mm² (0.006 inches²), 1200mm (47.2 inches) |
| Connector | UTX Amphenol |
| Fire Type | Type 1 or 2 |

## TEMPERATURE RATINGS

| | |
|---|---|
| Nominal Operating Cell Temperature (NOCT) | 44°C (±2°C) |
| Temperature Coefficient of $P_{MAX}$ | - 0.41%/°C |
| Temperature Coefficient of $V_{OC}$ | - 0.32%/°C |
| Temperature Coefficient of $I_{SC}$ | 0.05%/°C |

## MAXIMUM RATINGS

| | |
|---|---|
| Operational Temperature | -40~+85°C |
| Maximum System Voltage | 1000VDC (IEC) 1000VDC(UL) |
| Max Series Fuse Rating | 15A |

## WARRANTY

10 year Product Workmanship Warranty

25 year Linear Power Warranty

(Please refer to product warranty for details)

## PACKAGING CONFIGURATION

Modules per box: 26 pieces

Modules per 40' container: 572 pieces

*The mechanical loading is dependent upon the mounting method. The mounting method described in the Installtion Manual section 6.1-C can pass 2400Pa wind load and 2400Pa snow load.

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**Towns with Aquifer Protection Areas**

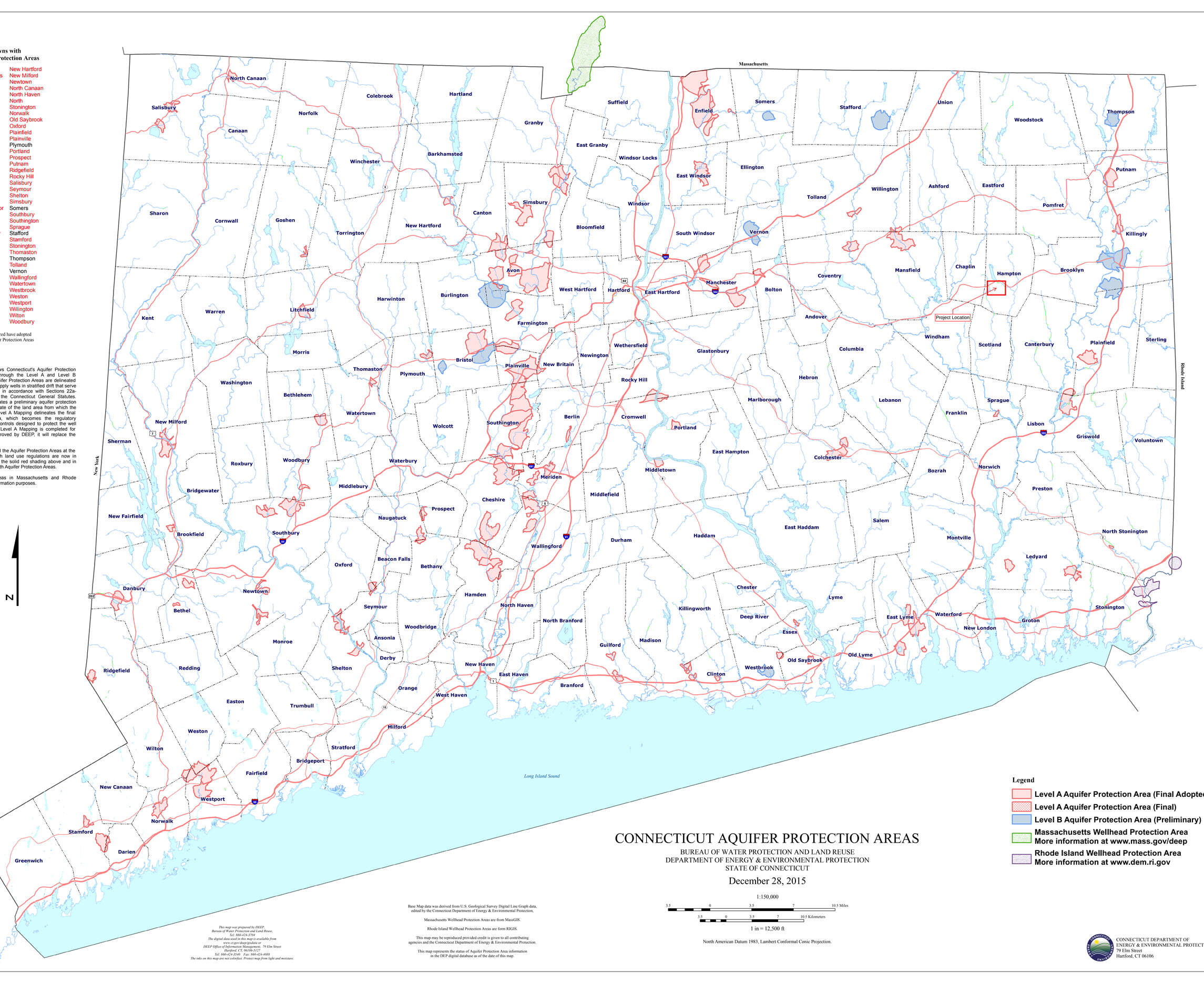
| | |
|---|---|
| Avon | New Hartford |
| Beacon Falls | New Milford |
| Berlin | Newtown |
| Bethany | North Canaan |
| Bethel | North Haven |
| Bethlehem | North |
| Bolton | Stonington |
| Bristol | Norwalk |
| Brookfield | Old Saybrook |
| Brooklyn | Oxford |
| Burlington | Plainfield |
| Canterbury | Plainville |
| Canton | Plymouth |
| Cheshire | Portland |
| Clinton | Prospect |
| Colchester | Putnam |
| Coventry | Ridgefield |
| Cromwell | Rocky Hill |
| Danbury | Salisbury |
| Darien | Seymour |
| Derby | Shelton |
| East Lyme | Simsbury |
| East Windsor | Somers |
| Enfield | Southbury |
| Essex | Southington |
| Farmington | Sprague |
| Glastonbury | Stafford |
| Goshen | Stamford |
| Griswold | Stonington |
| Guilford | Thomaston |
| Hamden | Thompson |
| Killingly | Tolland |
| Ledyard | Vernon |
| Litchfield | Wallingford |
| Madison | Watertown |
| Manchester | Westbrook |
| Mansfield | Weston |
| Meriden | Westport |
| Middletown | Willington |
| Naugatuck | Wilton |
| New Britain | Woodbury |

Note: Towns in red have adopted the Final Aquifer Protection Areas

NOTE: This map shows Connecticut's Aquifer Protection Areas, as delineated through the Level A and Level B Mapping Processes. Aquifer Protection Areas are delineated for active public water supply wells in stratified drift that serve more that 1000 people, in accordance with Sections 22a-354c and 22a-354z of the Connecticut General Statutes. Level B Mapping delineates a preliminary aquifer protection area, providing an estimate of the land area from which the well draws its water. Level A Mapping delineates the final Aquifer Protection Area, which becomes the regulatory boundary for land use controls designed to protect the well from contamination. As Level A Mapping is completed for each well field and approved by DEEP, it will replace the Level B Mapping.

Towns that have adopted the Aquifer Protection Areas at the local level and for which land use regulations are now in place are designated by the solid red shading above and in red in the list of Towns with Aquifer Protection Areas.

Wellhead protection areas in Massachusetts and Rhode Island are shown for information purposes.




## Legend

- Level A Aquifer Protection Area (Final Adopted)
- Level A Aquifer Protection Area (Final)
- Level B Aquifer Protection Area (Preliminary)
- Massachusetts Wellhead Protection Area
  More information at www.mass.gov/deep
- Rhode Island Wellhead Protection Area
  More information at www.dem.ri.gov

# CONNECTICUT AQUIFER PROTECTION AREAS

BUREAU OF WATER PROTECTION AND LAND REUSE
DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION
STATE OF CONNECTICUT

December 28, 2015

1:150,000

3.5 0 3.5 7 10.5 Miles

3.5 0 3.5 7 10.5 Kilometers

1 in = 12,500 ft

North American Datum 1983, Lambert Conformal Conic Projection.


*This map was prepared by DEEP,*
*Bureau of Water Protection and Land Reuse,*
*Tel: 860-424-3704*
*The digital data used in this map is available from*
*www.ct.gov/deep/gisdata or*
*DEEP Office of Information Management, 79 Elm Street*
*Hartford, CT, 06106-5127*
*Tel: 860-424-3540 Fax: 860-424-4088*
*The inks on this map are not colorfast. Protect map from light and moisture.*


Base Map data was derived from U.S. Geological Survey Digital Line Graph data, edited by the Connecticut Department of Energy & Environmental Protection,

Massachusetts Wellhead Protection Areas are from MassGIS.

Rhode Island Wellhead Protection Areas are form RIGIS.



This map represents the status of Aquifer Protection Area information in the DEP digital database as of the date of this map.


CONNECTICUT DEPARTMENT OF
ENERGY & ENVIRONMENTAL PROTECTION
79 Elm Street
Hartford, CT 06106

HIGHLAND SOILS LLC

# WETLAND REPORT

# FISK ROAD SOLAR
# HARTFORD TURNPIKE & FISK ROAD
# HAMPTON, CONNECTICUT

**PREPARED FOR**
**ECOS ENERGY, LLC**

**BY**
**JOHN P. IANNI**
**PROFESSIONAL SOIL SCIENTIST**

**APRIL 27, 2016**

P.O Box 337, Storrs, CT 06268 · 860-742-5868 · Highlandsoils@aol.com

## INTRODUCTION

The subject property is located on the south side of Hartford Turnpike, CT Route 6, and west of Fisk Road in Hampton, CT. The property is currently wooded and lies within two watersheds. The majority of the property is within the watershed of Merrick Brook which lies to the east of the site. The remainder of the site drains to the northeast toward the Cedar Swamp Brook. Both brook systems are within the Shetucket River regional drainage basin.

The inland wetland delineation on the subject property was completed on September 2, 2015. The wetlands were field delineated in accordance with the standards of the National Cooperative Soil Survey and the definition of wetlands as found in the Connecticut General Statutes, Chapter 440, Section 22A-38. I have reviewed the prepared plans have found the representation of the field delineated wetlands to be substantially correct.

Additionally, the wetland boundaries also conform to the jurisdictional wetlands definition (Federal or Army Corps wetlands) as based on:

> Environmental Laboratory. 1987. "Corps of Engineers Wetlands Delineation Manual," Technical Report Y-87-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Additional field data was collected on March 23 and April 13, 2016.

## EXISTING CONDITIONS

The site contains just less than one hundred acres and is currently wooded. Three wetland areas were mapped on the site with the largest wetland area located in the southern and southwestern portion of the site. A small area of wetland extends onto the property in the southeastern corner of the site. Both of these systems drain toward Merrick Brook.

The third wetland system is located in the northeastern portion of the site and this system is in the Cedar Swamp Brook watershed. As stated earlier, all of the land is within the Shetucket River Region Basin.

The upland areas on the site extend from a high point along Fisk Road. The land slopes to the east, south and west toward the wetlands. The uplands are wooded with mixed hardwood species. The eastern half of the site was logged recently, and most of the mature species of oak were removed. The previous timber removal operation did not remove or reduce the slash, and tree tops and the material is scattered throughout the site.

The upland areas are fairly typical of the area with an even-age mature forest consisting of mainly Oak, Hickory and Maple. The understory in the unlogged areas is open and contains saplings of the fore mentioned species. The composition of the forest changes as the soils transition from well-drained and moderately well-drained soils over a friable glacial till to the wetlands. The dominant soil types in the uplands are the well-drained Charlton and Chatfield



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Series, with smaller areas of the shallow to bedrock Hollis Series and the moderately well-drained Sudbury Series also present.

## WETLAND RESOURCES

Three wetland areas were noted on the property and are identified based on the relative location on the property.

### SOUTHEASTERN WETLAND

This is the smallest area of on-site wetlands and is in the southeastern corner of the property. The wetland continues off-site and drains into Merrick Brook. The wetland contains poorly drained soils of the Leicester series that grade to very poorly drained soils of the Whitman Series. The wetland is wooded with Red maple and Grey birch in the canopy. The understory is strikingly thick with Highbush blueberry, Sweet pepperbush and Winterberry as the dominant shrub species. The shrub layer is extremely dense and Cinnamon fern, Skunk cabbage and Sphagnum moss comprise the dominant species in the herbaceous layer.

In the interior of the on-site wetland, the soils are saturated to the ground surface but little to no surface water was present. Surface flow is very diffuse and no defined surface water flow patterns were discernible.

### NORTHEASTERN WETLAND

This wetland system is larger and lies along the northeastern property line. At the time the wetland delineation was conducted the property line was not apparent. Upon completion of the boundary survey the property line was identified and areas of upland soils were noted, but not delineated. The area of upland is approximately one to two acres in size, is irregularly shaped, and appears to be within one hundred feet of the wetlands.

This system is also wooded with Red maple, and Grey birch is the dominant species in the canopy. Highbush blueberry and Sweet pepperbush are the dominant shrub species. The wetland contains poorly drained soils of the Leicester Series and very poorly drained soils of the Whitman Series. Both soils overlay a friable and coarse glacial till.

The interior of the wetland is saturated to the ground surface and the surface flow within the wetland is diffuse until nearer the property lines where more defined flow occurs. The wetland outlets in two locations, one outlet is to the north near Fisk Road and the other outlet is along the southern limits of the wetland. The southern outlet shows signs of channelization of the surface flow from human activity. This wetland drains to the north and east across Fisk Road and into the Cedar Swamp Brook watershed.

### SOUTH-SOUTHWESTERN WETLAND

This is the largest of the three on-site wetland systems and contains the most diversity in vegetation and functions and values. The system contains three fingers that extend westerly,



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northerly and easterly from the main body of the wetlands. The main body of the wetland consists of an area of very poorly drained organic soils located at the deflection point in the southerly boundary line and where the three fingers of wetlands converge. This area of wetlands is permanently saturated and contains organic soils to a depth of over four feet. The canopy is open and the shrub layer is very thick. Red maple is the dominant tree species, but forms a very open canopy. Red elm saplings were noted and the shrub layer is dominated by Highbush blueberry and Sweet pepperbush. The ground surface contains many hummocks, which the trees and shrubs have colonized, and Cinnamon fern and Skunk cabbage were also present. Sphagnum moss dominates the ground cover in this portion of the wetland system.

Defined water course channels enter the main body of the wetland from the three fingers; however, the flow in the main body of the wetlands is diffuse and poorly defined. Small areas of shallow surface water are located throughout this portion of the wetland, and well defined surface flow paths could be distinguished.

The westerly finger of this wetland system extends towards Route 6. Nearest Route 6 the area is dominated by pole-sized Red maples with Highbush blueberry in the understory. This area appears to have been cleared in the not too distant past. A stone wall separates the upper part of the wetland finger from the remaining system and the soils get increasingly wetter as the finger transitions to the main body of the wetland. The vegetative community also changes with the canopy becoming sparser as the soils get wetter and the understory gets increasingly thicker with Sweet pepperbush being more dominant. Surface flow becomes less well defined and the soils start to transition from mineral to organic. Winterberry and Highbush blueberry become the dominant shrub species in the wetter areas where the organic soils are more prevalent.

The northerly finger of this wetland complex also extends out from the main wetland body. This finger of wetlands extends uphill toward the intersection of Fisk Road and Route 6 in a more northerly direction. This wooded wetland is dominated by Red maple and Grey birch and transitions to a pole-sized stand of young Red maple at its terminus. The surface flow is diffuse in the upper reaches of the wetland and becomes better defined as the topographic gradient increases. A defined water course channel flows through the wetland until the transition into the organic soils in the main wetland body. The vegetation also transitions and the transitions coincide with changes in hydrology.

The largest finger extends southerly from the main wetland body and parallels the property line. This wooded wetland contains a Red maple, Grey birch canopy and the understory contains Japanese barberry, which was noticeably absent in most of the other wetlands. Most of this portion of the wetland has been impacted by the previous logging operation, with some removal of trees along the perimeter and quite a bit of slash left within the wetlands. There is enough of a topographic gradient in the wetland finger to produce minor channelized flow, however, the soils are seasonally saturated and a fluctuating water table does not support long duration saturation of the soil surface. The accumulated slash from the logging operation has resulted in the formation of micro pools of shallow standing water where surface flows have been temporarily blocked.



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The surface of the wetland is stony and there are areas where diffuse surface flows dominate. The poorly drained soils of the Leicester Series dominate the finger until the transition to the organic soils.

## VERNAL POOL HABITAT

A field survey was conducted on March 23, 2016. The temperatures ranged from 45 degrees F. to 60 degrees F. Mostly cloudy skies gave way to mostly sunny by late afternoon. All wetland and upland areas were surveyed for breeding amphibians.

A second field survey was conducted on April 13, 2016. Temperatures ranged from 50 degrees F. to 60 degrees F. and skies were sunny.

No isolated Vernal Pools were noted on the property. However, breeding amphibians were noted within two areas of the wetlands and the likelihood of an additional breeding area occurs just off-site.

It should be noted that Vernal Pool Assessments (Assessment Sheets attached) were conducted in accordance with the methodology contained in the following publication, hereafter referred to as the BDP (Best Development Practices):

> *Calhoun, A. J. K. and M. W. Klemens. 2002. Best development practices: Conserving pool-breeding amphibians in residential and commercial developments in the northeastern United States. MCA Technical Paper No. 5, Metropolitan Conservation Alliance, Wildlife Conservation Society, Bronx, New York.*

The first breeding area was encountered in the northern finger of wetlands that are part of the large wetland complex described in the South-Southwestern Wetland section of this report. Ten Spotted Salamander egg masses were noted thirty feet east of wetland flag #151. A large tree was blown down and a small pool of standing water has accumulated where the root ball of the downed tree has created a small depression. The water was one foot or less in depth and the total area of standing water was within a ten-foot circle. This breeding area is rated as Tier I according to the methodology. The hydrology of the breeding site appears to be marginal for life cycle completion and further study will be conducted.

The second breeding area was noted in the eastern finger of this same wetland complex. At wetland flag #75 a small pool of surface water has formed due to the blockage of surface water from slash that was left in the wetland from a previous logging operation. The surface flow has been partially blocked and a small area of surface water approximately 20 feet by 50 feet and up to twelve inches deep has formed. In this area three Wood Frog and one Spotted Salamander egg masses were found. Again, the hydrology appears marginal, as this may be a temporary condition due to the accumulated slash. Surface flow through the breeding area was noticed, so the location of the egg masses was a bit of a surprise. The area will be monitored further into the season. This breeding area is ranked as Tier I according to the methodology.



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The main body of the South-Southwestern wetland contains numerous pools of shallow standing water. Due to the thickness and complexity of the wetland it was not possible to visually search the entire area. Breeding activity cannot be ruled out in this portion of the wetland.

## WETLAND FUNCTIONS

The functions and values of the wetlands will be described in a qualitative manner modeled after the method used by the US Army Corps of Engineers. The information is from *The Highway Methodology Workbook Supplement*. This publication uses a descriptive approach to assessing functional values, versus the CT D.E.P. approach, which uses a quantitative or numerical approach to ranking wetland functions and values.

Ground Water Recharge/Discharge - This function considers the potential for a wetland to serve as a ground water recharge and/or discharge area. It refers to the fundamental interaction between wetlands and aquifers, regardless of the size or importance of either.

> The wetland systems are underlain by glacial till, although not hardpan, the wetlands are not associated with stratified drift (sand and gravel). Seepage zones were apparent adjacent to all of the wetland systems and shallow ground water flows appear to be the main source of water for the wetlands. The on-site wetlands are discharge wetlands with recharge of shallow ground water and the maintenance of base flows also being present. This is a principle function of the on-site wetlands.

Floodflow Alteration - This function considers the effectiveness of the wetland in reducing flood damage by water retention for prolonged periods following precipitation events and the gradual release of flood waters. It adds to the stability of the wetland ecological system or its buffering characteristics and provides social or economic value relative to erosion and/or flood prone areas.

> The on-site wetlands are at the upper portion of the individual watersheds and generally have diffuse surface flows except where topographic gradients allow for concentrated surface flows. Although not associated with constricted outlets, the presence of very poorly drained and/or organic soils within the wetlands allows for the accumulation of surface water for short periods. The wetlands are not associated with floodplains but the well-drained soils in the adjacent uplands contribute steady ground water flows to the wetlands. The most active area for this function occurs in areas where the topography is flat and the organic soils have developed. This function is well represented in the wetlands, but is not a principal function.

Fish and Shellfish Habitat - This function considers the effectiveness of seasonal or permanent watercourses associated with wetland in question for fish and shellfish habitat.

> The on-site wetlands are not associated with a water course that is capable of supporting fish or shellfish habitat. This function is not present on-site.



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Sediment/Toxicant/Pathogen Retention - This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens in runoff water from surrounding uplands, or upstream eroding wetland areas.

The watershed of the on-site wetlands is mainly wooded and no signs of significant erosion were present. Route 6 is a potential sediment source and accumulations of road sand were noted near the headwaters for the wetland. The presence of deep organic soils in the South-Southwestern wetland produce diffuse flows capable of sediment retention. Flat topography and diffuse surface flows indicate this function is present in the wetlands, but with the lack of sediment and/or toxicant sources this function is underutilized. This function is present and is a principle function for the on-site wetlands.

Nutrient Removal/Retention/Transformation - This function considers the effectiveness of the wetland as a trap for nutrients in runoff water from surrounding uplands or contiguous wetlands, and the ability of the wetlands to process these nutrients into other forms or trophic levels. One aspect of this function is to prevent ill effects of nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers or estuaries.

The presence of sediment trapping functions and fine grained and organic soils are positive indicators for this function. Diffuse flows in much of wetlands also add to the ability of the wetlands to perform this function. The lack of deep water habitat limits the ability of the wetlands to perform the function and the lack of sources of excess nutrients also limit the ability of the wetlands to perform this function. The presence of thick woody vegetation and organic soils are positive qualifiers. Overall, this function is present in the on-site wetlands and is a principle function.

Production Export - This function relates to the effectiveness of the wetland to produce food or usable products for human, or other living organisms.

Portions of the wetlands are capable of producing large quantities of organic matter, however, flushing of the wetlands generally does not occur and the diffuse flows and presence of high organic matter soils indicates attenuation of organic matter. The wetlands lack diversity of cover but the density of cover is good. Overall this function is present but is not a principle function.

Sediment/Shoreline Stabilization - This function evaluates the effectiveness of a wetland to stabilize stream banks and shorelines against erosion.

The on-site wetlands are not associated with a shoreline or stretch of open water. The wetlands are all wooded with seasonal or intermittent water courses, or flat topography and organic soils, which promote sheet flow. This function is not present in the wetlands.



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Wildlife Habitat - This function considers the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and wetland edges. Both resident and/or migrating species are considered.

The wetlands have many positive indicators for this function including the dominant wetland type (wooded swamp), the lack of development near the wetlands, good water quality, high abundance of vegetation and connectivity to other wetlands. They generally lack: species diversity and the presence of marsh habitat, flowering plants and open water habitat. The subject property is contiguous with large tracts of undeveloped land and wildlife utilization of the property is typical for wooded habitat. For this to be a principle function the methodology indicates that greater diversity in plant species and cover types, along with deeper water habitats should be available. This function is present but it is not a principle function.

Recreation – (Consumptive and Non-Consumptive) This value considers the suitability of the wetland and associated watercourses to provide recreational opportunities such as hiking, canoeing, boating, fishing, hunting and other active or passive recreational activities.

This function is centered on water-based recreation such as fishing, canoeing and other activities. The property is not suitable for water-based recreation and consumptive values such as hunting are limited by private property rights. The lack of water-based recreational opportunities limits this value to passive recreation. This is not a primary value.

Educational/Scientific Value - This function considers the suitability of the wetland as an "outdoor classroom" or for scientific research.

The wetlands generally are a single cover class (wooded) that limits the potential for educational study. There are no good access points near the wetlands and there are no ponds or perennial water courses. The access to the property is controlled and the wetlands are typical for the area. The wetlands are not high quality wildlife habitat and viewing locations into the wetlands are limited. Overall, few positive qualifiers are present for this value.

Uniqueness/Heritage - This value considers the effectiveness of the wetland for special values such as archeological sites, rare and endangered species habitat or uniqueness for its location.

The on-site wetlands exhibit few of the qualifiers for this value. The wooded wetlands are very typical for the area and lack a perennial water course, open water or low growing vegetation. The absence of large flowering plants and wildlife habitat reduce the potential for this value. This value is not present on the site.



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Visual Qualities/Aesthetics - This value relates to the visual qualities of the wetlands.

The wetlands are within a large tract of relatively undisturbed land and do not show signs of pollution. However, the fact that the wetlands are a single cover class reduces the importance for this value. There are multiple viewing locations that afford relatively unobstructed views to the wetlands; however, the views are not present into the wetlands due to thick vegetation along the edges.

Endangered Species Habitat – This value considers the suitability of the wetland to support threatened or endangered species.

A letter has been issued for the project from the Connecticut Department of Energy and Environmental Protection. The letter indicated no adverse impacts from the project.

## WETLAND IMPACTS

The project has been designed to avoid all direct wetland impacts. The 100-foot upland review area is to remain mostly intact with only minor clearing and no grading occurring. The perimeter fencing generally follows the URA and in many areas is well away from the wetlands and review area.

The two areas where breeding amphibians were found are well protected with no activity proposed near the Spotted Salamander breeding area near wetland flag #151 and no activity within the 100-foot envelope of the second breeding area near flag #75.

Additionally, all of the access roads are well away from the wetlands and upland review areas and no indirect wetland impacts are anticipated.



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Fisk Road Pool #1 Wetland Flag #151

# VERNAL POOL ASSESSMENT SHEET

## A. Biological Value of the Vernal Pool

(1) Are there *any* state-listed species (Endangered, Threatened, or Special Concern) present or breeding in the pool?
Yes_____ No__X__

(2) Are there two or more vernal pool indicator species breeding (i.e., evidence of egg masses, spermatophores [sperm packets], mating, larvae) in the pool?
Yes_____ No__X__

(3) Are there 25 or more egg masses (regardless of species) present in the pool by the conclusion of the breeding season?
Yes_____ No__X__

## B. Condition of the Critical Terrestrial Habitat

(1) Is at least 75% of the vernal pool envelope (100 feet from pool) undeveloped?
Yes__X__ No_____

(2) Is at least 50% of the critical terrestrial habitat (100-750 feet) undeveloped?
Yes__X__ No_____

NOTE: For these purposes, "undeveloped" means open land largely free of roads, structures, and other infrastructure. It can be forested, partially forested, or open agricultural land.

### Cumulative Assessment

| Number of questions answered YES in category A | Number of questions answered YES in category B | Tier Rating |
|---|---|---|
| 1-3 | 2 | Tier I |
| 1-3 | 1 | Tier II |
| (0) | (1-2) | (Tier III) |
| 1-3 | 0 | Tier III |

**CAUTION** *This rating system is designed strictly as a planning tool, not as an official assessment tool.* It will enable you to determine the relative ecological value of pools within your community. A Tier I rating—which will most likely apply to only a minority of sites—denotes exemplary pools; Management Recommendations should be applied at these sites. For pools rated as Tier II, proceed with care; you need more information! Tier II pools will probably constitute the majority of your vernal pool resources; Management Recommendations should be applied at these sites to the maximum extent practicable. Tier II pools might also be likely candidates for restoration efforts (e.g., reforestation of the critical terrestrial habitat).

Fisk Road Pool #2 Wetland Flag #75

# VERNAL POOL ASSESSMENT SHEET

## A. Biological Value of the Vernal Pool

(1) Are there *any* state-listed species (Endangered, Threatened, or Special Concern) present or breeding in the pool?
Yes_____ No__X__

(2) Are there two or more vernal pool indicator species breeding (i.e., evidence of egg masses, spermatophores [sperm packets], mating, larvae) in the pool?
Yes__X__ No_____

(3) Are there 25 or more egg masses (regardless of species) present in the pool by the conclusion of the breeding season?
Yes_____ No__X__

## B. Condition of the Critical Terrestrial Habitat

(1) Is at least 75% of the vernal pool envelope (100 feet from pool) undeveloped?
Yes__X__ No_____

(2) Is at least 50% of the critical terrestrial habitat (100-750 feet) undeveloped?
Yes__X__ No_____

NOTE: For these purposes, "undeveloped" means open land largely free of roads, structures, and other infrastructure. It can be forested, partially forested, or open agricultural land.

### Cumulative Assessment

| Number of questions answered YES in category A | Number of questions answered YES in category B | Tier Rating |
|---|---|---|
| (1-3) | (2) | (Tier I) |
| 1-3 | 1 | Tier II |
| 0 | 1-2 | Tier III |
| 1-3 | 0 | Tier III |

**CAUTION** *This rating system is designed strictly as a planning tool, not as an official assessment tool.* It will enable you to determine the relative ecological value of pools within your community. A Tier I rating—which will most likely apply to only a minority of sites—denotes exemplary pools; Management Recommendations should be applied at these sites. For pools rated as Tier II, proceed with care; you need more information! Tier II pools will probably constitute the majority of your vernal pool resources; Management Recommendations should be applied at these sites to the maximum extent practicable. Tier II pools might also be likely candidates for restoration efforts (e.g., reforestation of the critical terrestrial habitat).

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

Bureau of Natural Resources
Wildlife Division
Natural History Survey – Natural Diversity Data Base

January 26, 2016

Mr. Blake Nicholson
Windham Solar LLC
222 South 9th Street, Suite 1600
Minneapolis, MN 55402

Regarding: Fisk Road Solar, Hampton, CT - Natural Diversity Data Base 201509305

Dear Mr. Nicholson:

I have reviewed Natural Diversity Data Base (NDDB) maps and files regarding the area delineated on the map provided for the Fisk Road Solar Project in Hampton, Connecticut. I do not anticipate negative impacts to State-listed species (RCSA Sec. 26-306) resulting from your proposed activity at the site based upon the information contained within the NDDB. The result of this review does not preclude the possibility that listed species may be encountered on site and that additional action may be necessary to remain in compliance with certain state permits. This determination is good for one year. Please re-submit an NDDB Request for Review if the scope of work changes or if work has not begun on this project by January 26, 2017.

Natural Diversity Data Base information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Department of Energy and Environmental Protection's Natural History Survey and cooperating units of DEEP, private conservation groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Consultations with the Data Base should not be substitutes for on-site surveys required for environmental assessments. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the Data Base as it becomes available.

Thank you for consulting the Natural Diversity Data Base. If you have further questions, I can be reached by email at Elaine.hinsch@ct.gov or by phone at (860) 424-3011.

Sincerely,
/s/
Elaine Hinsch
Program Specialist II
Wildlife Division