PULLMAN & COMLEY 100 YEARS

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March 21, 2019

VIA HAND DELIVERY

Melanie Bachman
Executive Director/Staff Attorney
Connecticut Siting Council
10 Franklin Square
New Britain, CT 06051

Re: Petition No. 1339 – Petition of Wallingford Renewable Energy LLC for a Declaratory Ruling that no Certificate of Environmental Compatibility and Public Need is Required for a 19.99 MW AC Solar Photovoltaic Electric Generating Facility in Wallingford, Connecticut

Dear Ms. Bachman:

I am writing on behalf of my client, Wallingford Renewable Energy ("WRE") in connection with the above-referenced Petition. With this letter, I am enclosing an original and 15 copies of WRE's Responses to the Connecticut Siting Council's First Set of Interrogatories Related to the Development and Management Plan. I am also enclosing one compact disk containing the responses and attachments and three full-size sets of maps and drawings as well.

Should you have any questions concerning this submittal, please contact me at your convenience. I certify that copies of this submittal have been made to all parties on the Petition's service list.

Sincerely,

Lee D. Hoffman

Lee D. Hoffman

Enclosures

STATE OF CONNECTICUT
CONNECTICUT SITING COUNCIL

Petition of Wallingford Renewable Energy LLC for a Declaratory Ruling pursuant to C.G.S. §4-176 and § 16-50k, for the proposed construction, maintenance and operation of a 19.99 MW AC ground-mounted solar photovoltaic electric generating facility located on approximately158 acres of 3 contiguous parcels consisting of the former Wallingford Landfill and 2 parcels owned by the Materials Innovation and Recycling Authority west of Pent Road and associated electrical interconnection to Wallingford Electric Division's Wallingford Substation in Wallingford, Connecticut	**Petition No. 1339** **March 21, 2019**

WALLINGFORD RENEWABLE ENERGY LLC'S RESPONSES TO THE CONNECTICUT SITING COUNCIL'S FIRST SET OF INTERROGATORIES RELATED TO THE DEVELOPMENT AND MANAGEMENT PLAN

The petitioner, Wallingford Renewable Energy LLC ("WRE" or "the Petitioner"), respectfully submits this response to the Connecticut Siting Council's First Set of Interrogatories related to the Development and Management Plan in the above-referenced Petition. In response to the Siting Council's Interrogatories, WRE states as follows:

1. Referencing the cover letter of Wallingford Renewable Energy, LLC's (WRE) Development and Management Plan (D&M Plan), WRE notes that, "[C]opies of this submittal have been made to all parties on the Petition's service list." Did this include the Towns of Wallingford, Hamden and North Haven? If no, please submit a copy to those that did not receive a copy.

A copy of the D&M Plan was provided to all three towns, as reflected in Attachment A.

2. Referencing page 3 of WRE's D&M Plan, WRE notes that, "[T]he solar field would include a total of approximately 56,000 solar photovoltaic panels at 390 Watts DC each on fixed rack systems oriented to the south, for a total of about 21.8 MW DC." Please respond to the following.

a) Referencing Tab 1, Sheet PV00 of the D&M Plan, is it correct to say that WRE has updated its configuration to include approximately 45,812 solar panels of 400 Watts each? If yes, provide a specifications sheet for the 400 Watt solar panel per the "final solar panel design" required as part of Condition No. 1(a) of the Council's Declaratory ruling.

WRE is in final negotiations with two solar panel vendors for the purchase of modules that are of approximately the same dimensions. These are Hanwha Q Cells 395 Watt panels and Jinko Solar 400 Watt panels. In either case approximately 46,000 panels will be deployed as part of the project. Specification sheets for both panels are provided in Attachment B.

b) Is it also correct say that, on Sheet PV00, under System Specifications, "18,8324.8 KW DC" was intended to be "18,832.48 KW DC?"

Correct.

c) Why did WRE reduce its capacity from about 19.99 MW AC (as originally proposed) to 16.70 MW AC? Generally, in which areas are the reductions in solar panel footprint located?

The reduction in capacity is a direct result of the geotechnical investigation that was conducted on the site after the original Petition filing. The results of the geotechnical investigation determined that some of the steeper slopes of the landfill portion of the site were not usable.

d) Is this proposed power reduction permissible under the Small Scale RFP and/or the Power Purchase Agreements?

Yes, the project size can be reduced by this amount pursuant to the Power Purchase Agreements.

3. Condition No. 1(a) of the Council's Declaratory Ruling requires the "electrical interconnection." Sheet PV-40 refers to Electrical Interconnection Equipment Plans A through C and refers to Sheet PV-41 and PV-42. Provide a copy of Sheet PV-41 through PV-45. How many new wood poles would be installed to accommodate the interconnections (e.g. 150)? Approximately how tall would such poles be above grade? Referencing Sheet PV-40, does "medium voltage" refer to approximately 13.8-kilovolts for this project or a different line voltage?

Please see Sheets PV-41 through PV-45 included with this response. There are approximately five new wooden poles per Point of Interconnection (15 total) would be installed to accommodate electrical interconnection. The poles will be approximately 45 feet high. The medium voltage referenced in PV-40 is 13.8-kilovolts. An additional 105 wooden poles for overhead medium voltage line will be required within the site.

4. Referencing page 5 of the Council's Staff Report (attached to the Declaratory Ruling), has a system impact study been performed? If yes, provide the status. Would any modifications need to be performed at Wallingford Substation? If yes, would that part of a future filing?

Yes, a system impact study has been performed, and the study is included as Attachment C. There are no expected modifications that need to be performed at Wallingford substation that would require a future filing.

5. Referencing Sheet C-117 and page 3 of D&M Plan, would the proposed gap under the fence be typically four to five inches, with six inches (for wildlife) near wetland areas? Explain. Referencing page 3 of the D&M Plan, identify which solar arrays would feature perimeter fencing with a six inch (minimum) wildlife gap? Sheets C-107 to C-110 refer to a fence detail sheet C-116. Provide a copy of Sheet C-116.

All fenced areas will have a minimum gap of six inches for wildlife.

6. Referencing page 6 of the D&M Plan, WRE notes that, "The final seed mixture for this project includes a mix of Kentucky Bluegrass, Perennial Ryegrass and Fine Fescue." WRE listed a table of seven specific varietals that would be included in the seed mix. Identify which of the varietals are considered Kentucky Bluegrass, Perennial Ryegrass and Fine Fescue. Identify which of the varietals that are considered pollinator species.

The narrative intended to reference three distinct seed mixtures. The primary seeding and stabilization will use the seed mixtures specified on drawing number C-119 of the Stormwater Pollution Control Plan. As can be seen on that sheet, temporary vegetative cover adjusts the seeding based on the season in order to support optimum growth, using buckwheat or winter wheat, as applicable. Permanent vegetative cover is specified with the seed mixture using Kentucky Bluegrass, Perennial Ryegrass, and Fine Fescue, with mix percentages varying depending on whether the seeding occurs in sunny or shady areas. However, in addition to the standard seeding, WRE is committing to using a seeding mix that includes pollinators to supplement the permanent vegetative cover throughout the Project. The characteristics of the seeding mix that includes pollinators, specifically designed by New England Wetland Plants, Inc. (NEWP) for use at solar installations in the Northeast, are those specified in the table on page 6. The mix was designed for maximum flexibility of usage. Of the listed species in that mix, the partridge pea (Chamaecrista fasciculata) and the showy tick trefoil (Desmodium canadense) are specifically considered by NEWP to be pollinator species.

7. Referencing the Vernal Pool Survey Report (VPSR) dated June 14, 2018 and in light of the updated solar panel configuration (e.g. changes to Array PD1 on the east side), would Table 1 (on page 16) and Table 2 (on page 17) of the VPSR be materially affected? If yes, provide updates to those tables.

The Project's layout has remained predominantly the same within the vernal pool buffers, with the exception of the arrays located on the MIRA Parcel just north of VP 2A. In this location, what was two separate arrays has now been combined into a single array. The adjusted layout has been evaluated (adjusted figures are provided in Attachment D), and it has been confirmed that no change in impact to vernal pools or the 100-foot Vernal Pool Envelope will occur.

Impact within the Critical Terrestrial Habitat (CTH) buffer will change slightly as a result of the consolidated panels, but not in a material manner. The table below illustrates that CTH impacts are less than or the same as those reflected in Petition 1339, upon which the determination was made that habitat would be adequately protected.

VP #	Prior Layout			Proposed Layout		Comparison
	CTH Disturbance Area	CTH Affected – CSC Petition	CTH Affected – Vernal Pool Report	CTH Disturbance Area	CTH Affected	
1	4.8 acres	12%	12%	5.0 acres	12%	No change
2	8.9 acres	21%	19%	9.1 acres	20%	Less than in CSC Petition
2A	12. 5 acres	--	28%	12.5 acres	28%	No change
3	7.7 acres	20%	18%	7.9 acres	20%	Same as in CSC Petition
4	7.6 acres	19%	17%	7.8 acres	18%	Less than in CSC Petition
4A	6.5 acres	--	16%	6.7 acres	16%	No change
5	4.8 acres	12%	11%	5.0 acres	11%	No change
6	11.8 acres	28%	26%	11.8 acres	26%	No change
7	12.2 acres	29%	29%	12.2 acres	29%	No change
8	10.1 acres	24%	22%	10.1 acres	22%	No change

8. Identify the vernal pool protective measures per Condition 1c. of the Council's Declaratory Ruling. Page 18 of the VPSR ends with the conclusion that, "[I]t is our opinion that the obligate vernal pool amphibian population at the Study Area and the 10 confirmed breeding habitats will be conserved post-development." Would this conclusion be affected by the revised solar panel configuration? Explain.

As noted in the response to #7, this conclusion will not be affected by the revised solar panel configuration.

9. Would WRE comply with the final bat and turtle protection measures specified in the DEEP Natural Diversity Database letter dated March 9, 2018? If so, have these measures been incorporated into the site plan? Provide detail.

Yes, these measures are in the Stormwater Pollution Control Plan narrative, in Table 4.

10. Reference page 7 of the D&M Plan, provide the status of the DEEP General Permit. If approved, provide a copy of the General Permit.

The project's Stormwater Pollution Control Plan and General Permit application is under review by DEEP and expected no later than May 6, 2019 (filing was made February 4, 2019). The project will provide the General Permit to the Siting Council once it has been received. No construction activities will commence until the General Permit is received from DEEP.

Respectfully Submitted,
Wallingford Renewable Energy LLC

By: ______________________

Lee D. Hoffman
Pullman & Comley, LLC
90 State House Square
Hartford, CT 06103-3702
Juris No. 409177
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860-424-4370 (f)
lhoffman@pullcom.com
Its Attorneys

ATTACHMENT A

Attachment A

PULLMAN & COMLEY 100 YEARS

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www.pullcom.com

February 13, 2019

VIA U.S. MAIL

Mayor William W. Dickson, Jr.
Wallingford Town Hall
45 South Main Street, Room #310
Wallingford, CT 06492

Mayor Curt B. Leng
City of Hamden
2580 Dixwell Avenue
Hamden, CT 06518

Michael J. Freda
First Selectman
Town of North Haven
18 Church Street
North Haven, CT 06743

Re: Petition No. 1339 – Petition of Wallingford Renewable Energy LLC for a Declaratory Ruling that no Certificate of Environmental Compatibility and Public Need is Required for a 19.99 MW AC Solar Photovoltaic Electric Generating Facility in Wallingford, Connecticut

Dear Sirs:

I am writing on behalf of my client, Wallingford Renewable Energy ("WRE") in connection with the above-referenced Petition. Earlier today, copies of WRE's Development and Management Plan were filed with the Connecticut Siting Council. For your convenience, I am including a compact disk containing the Development and Management Plan for your review.

If you would prefer to have a paper copy of this submission, please let me know at your convenience.

Sincerely,

Lee D. Hoffman

Lee D. Hoffman

Enclosure

ACTIVE/79442.1/LHOFFMAN/7379905v1

ATTACHMENT B

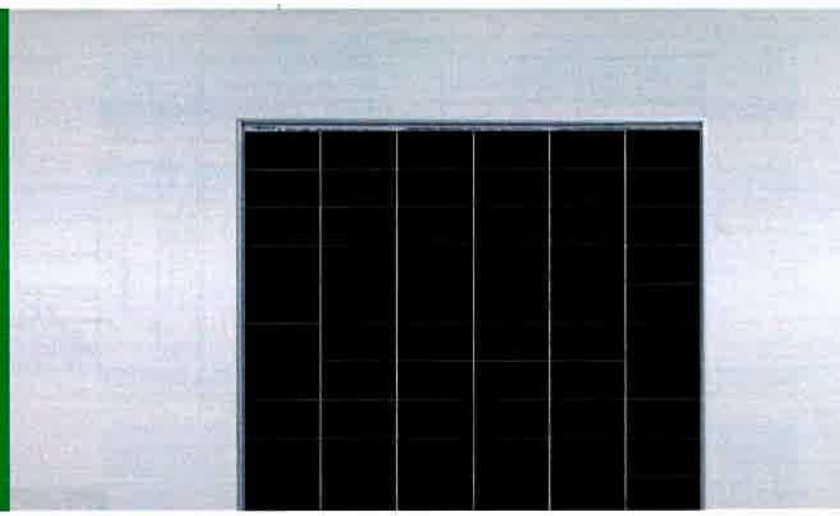
jinkosolar.us

JinKO Solar
Building Your Trust in Solar

Eagle HC 72M G2
380-400 Watt

MONO PERC HALF CELL MODULE

Positive power tolerance of 0~+3%



KEY FEATURES

Diamond Cell Technology
Uniquely designed high performance 5 busbar mono PERC half cell

High Voltage
UL and IEC 1500V certified; lowers BOS costs and yields better LCOE

PID Free
World's 1st PID-free module

Low-Light Performance
Advanced glass technology improves light absorption and retention

Strength and Durability
Certified for high snow (5400Pa) and wind (2400Pa) loads

Weather Resistance
Certified for salt mist and ammonia resistance

- ISO9001:2008 Quality Standards
- ISO14001:2004 Environmental Standards
- OHSAS18001 Occupational Health & Safety Standards
- IEC61215, IEC61730 certified products
- UL1703 certified products

Nomenclature:

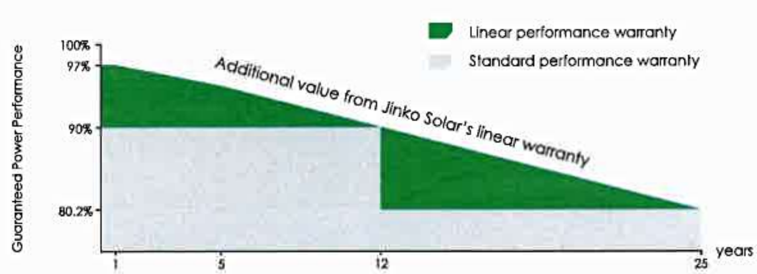
JKM400M-72HL-V

Code	Cell	Code	Cell	Code	Certification
null	Full	null	Normal	null	1000V
H	Half	L	Diamond	V	1500V

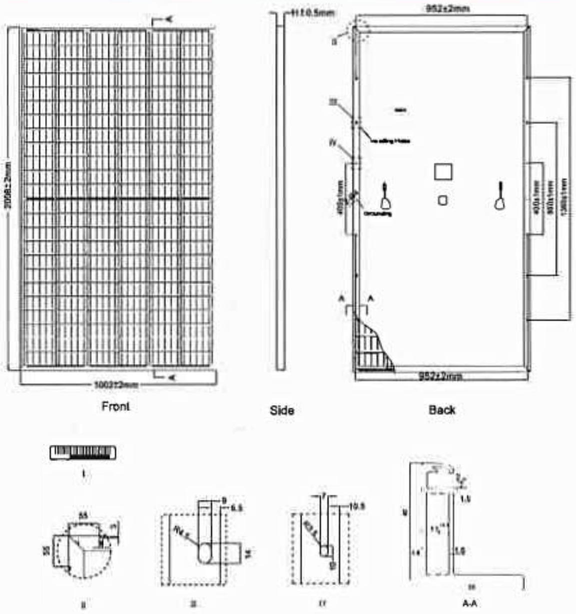
c UL us LISTED

LINEAR PERFORMANCE WARRANTY

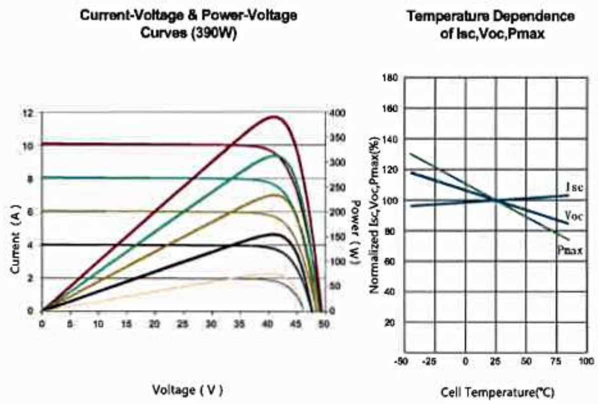
10 Year Product Warranty • 25 Year Linear Power Warranty



Engineering Drawings



Electrical Performance & Temperature Dependence



Packaging Configuration

(Two pallets = One stack)

26pcs/pallet, 52pcs/stack, 572pcs/40'HQ Container

Mechanical Characteristics

Cell Type	Mono PERC Diamond Cell (158.75 x 158.75 mm)
No.of Half-cells	144 (6×24)
Dimensions	2008×1002×40mm (79.06×39.45×1.57 inch)
Weight	22.5 kg (49.6 lbs)
Front Glass	3.2mm, Anti-Reflection Coating, High Transmission, Low Iron, Tempered Glass
Frame	Anodized Aluminium Alloy
Junction Box	IP67 Rated
Output Cables	12AWG, Anode 1400mm, Cathode 1400mm or Customized Length
Fire Type	Type 1

SPECIFICATIONS

Module Type	JKM380M-72HL-V		JKM385M-72HL-V		JKM390M-72HL-V		JKM395M-72HL-V		JKM400M-72HL-V	
	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax)	380Wp	286Wp	385Wp	290Wp	390Wp	294Wp	395Wp	298Wp	400Wp	302Wp
Maximum Power Voltage (Vmp)	40.5V	38.6V	40.8V	38.8V	41.1V	39.1V	41.4V	39.3V	41.7V	39.6V
Maximum Power Current (Imp)	9.39A	7.42A	9.44A	7.48A	9.49A	7.54A	9.55A	7.60A	9.60A	7.66A
Open-circuit Voltage (Voc)	48.9V	47.5V	49.1V	47.7V	49.3V	48.0V	49.5V	48.2V	49.8V	48.5V
Short-circuit Current (Isc)	9.75A	7.88A	9.92A	7.95A	10.12A	8.02A	10.23A	8.09A	10.36A	8.16A
Module Efficiency STC (%)	18.89%		19.14%		19.38%		19.63%		19.88%	
Operating Temperature (°C)	-40°C~+85°C									
Maximum System Voltage	1500VDC(UL)/1500VDC(IEC)									
Maximum Series Fuse Rating	20A									
Power Tolerance	0~+3%									
Temperature Coefficients of Pmax	-0.37%/°C									
Temperature Coefficients of Voc	-0.29%/°C									
Temperature Coefficients of Isc	0.048%/°C									
Nominal Operating Cell Temperature (NOCT)	45±2°C									

STC: Irradiance 1000W/m² | Cell Temperature 25°C | AM=1.5

NOCT: Irradiance 800W/m² | Ambient Temperature 20°C | AM=1.5 | Wind Speed 1m/s

* Power measurement tolerance: ± 3%

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

US-MKT-400M-72HL-V_1.0_rev2018

powered by Q.ANTUM DUO

Q.PEAK DUO L-G5.2 380-395

Q.ANTUM SOLAR MODULE

The new high-performance module Q.PEAK DUO L-G5.2 **is the ideal solution for commercial and utility applications thanks to a combination of its innovative cell technology** Q.ANTUM **and cutting edge cell interconnection. This 1500 V IEC/UL solar module with its 6 busbar cell design ensures superior yields with up to 395 Wp while having a very low LCOE.**

LOW ELECTRICITY GENERATION COSTS

Higher yield per surface area, lower BOS costs, higher power classes, and an efficiency rate of up to 19.9%.

INNOVATIVE ALL-WEATHER TECHNOLOGY

Optimal yields, whatever the weather with excellent low-light and temperature behavior.

ENDURING HIGH PERFORMANCE

Long-term yield security with Anti LID Technology, Anti PID Technology[1], Hot-Spot Protect and Traceable Quality Tra.Q™.

EXTREME WEATHER RATING

High-tech aluminum alloy frame, certified for high snow (5400 Pa) and wind loads (2400 Pa).

A RELIABLE INVESTMENT

Inclusive 12-year product warranty and 25-year linear performance warranty[2].

EUPD RESEARCH TOP BRAND PV MODULES EUROPE 2018

Q CELLS YIELD SECURITY

pv magazine award 2017 top innovation

Photon — Q CELLS Best polycrystalline solar module 2014 Q.PRO-G2 235 174 modules tested

[1] APT test conditions according to IEC/TS 62804-1:2015, method B (−1500 V, 168 h)

[2] See data sheet on rear for further information.

THE IDEAL SOLUTION FOR:

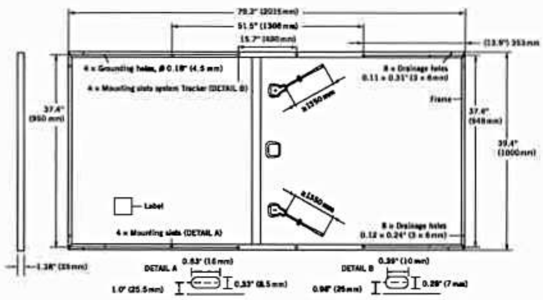
- Rooftop arrays on commercial/industrial buildings
- Ground-mounted solar power plants

Engineered in **Germany**

Q CELLS

MECHANICAL SPECIFICATION

Format	79.3 in × 39.4 in × 1.38 in (including frame) (2015 mm × 1000 mm × 35 mm)
Weight	51.8 lbs (23.5 kg)
Front Cover	0.13 in (3.2 mm) thermally pre-stressed glass with anti-reflection technology
Back Cover	Composite film
Frame	Anodized aluminum
Cell	6 × 24 monocrystalline Q.ANTUM solar half-cells
Junction box	2.76-3.35 in × 1.97-2.76 in × 0.51-0.83 in (70-85 mm × 50-70 mm × 13-21 mm), Protection class IP67, with bypass diodes
Cable	4 mm² Solar cable; (+) ≥53.1 in (1350 mm), (−) ≥53.1 in (1350 mm)
Connector	Multi-Contact MC4-EVO2, JMTHY PV-JM601A, IP68 or Renhe 05-8, IP67

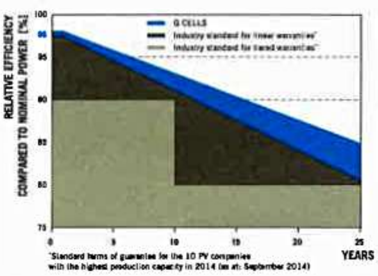


ELECTRICAL CHARACTERISTICS

POWER CLASS			380	385	390	395
MINIMUM PERFORMANCE AT STANDARD TEST CONDITIONS, STC[1] (POWER TOLERANCE +5 W / −0 W)						
Minimum — Power at MPP[1]	P_{MPP}	[W]	380	385	390	395
Minimum — Short Circuit Current[1]	I_{SC}	[A]	10.05	10.10	10.14	10.19
Minimum — Open Circuit Voltage[1]	V_{OC}	[V]	47.95	48.21	48.48	48.74
Minimum — Current at MPP	I_{MPP}	[A]	9.57	9.61	9.66	9.70
Minimum — Voltage at MPP	V_{MPP}	[V]	39.71	40.05	40.38	40.71
Minimum — Efficiency[1]	η	[%]	≥18.9	≥19.1	≥19.4	≥19.6
MINIMUM PERFORMANCE AT NORMAL OPERATING CONDITIONS, NMOT[2]						
Minimum — Power at MPP	P_{MPP}	[W]	283.9	287.6	291.3	295.1
Minimum — Short Circuit Current	I_{SC}	[A]	8.10	8.14	8.17	8.21
Minimum — Open Circuit Voltage	V_{OC}	[V]	45.12	45.37	45.62	45.87
Minimum — Current at MPP	I_{MPP}	[A]	7.53	7.57	7.60	7.64
Minimum — Voltage at MPP	V_{MPP}	[V]	37.69	38.01	38.33	38.64

[1]Measurement tolerances P_{MPP} ±3%; I_{SC}, V_{OC} ±5% at STC: 1000 W/m², 25±2 °C, AM 1.5G according to IEC 60904-3 · [2]800 W/m², NMOT, spectrum AM 1.5G

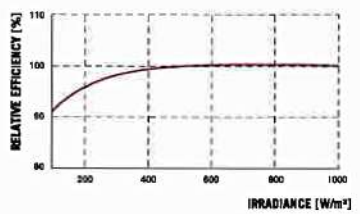
Q CELLS PERFORMANCE WARRANTY



At least 98 % of nominal power during first year. Thereafter max. 0.54 % degradation per year. At least 93.1 % of nominal power up to 10 years. At least 85 % of nominal power up to 25 years.

All data within measurement tolerances. Full warranties in accordance with the warranty terms of the Q CELLS sales organization of your respective country.

PERFORMANCE AT LOW IRRADIANCE



Typical module performance under low irradiance conditions in comparison to STC conditions (25 °C, 1000 W/m²).

TEMPERATURE COEFFICIENTS

Temperature Coefficient of I_{SC}	α	[%/K]	+0.04	Temperature Coefficient of V_{OC}	β	[%/K]	−0.28
Temperature Coefficient of P_{MPP}	γ	[%/K]	−0.37	Normal Operating Module Temperature	NMOT	[°F]	109 ±5.4 (43 ±3 °C)

PROPERTIES FOR SYSTEM DESIGN

Maximum System Voltage V_{SYS}	[V]	1500 (IEC) / 1500 (UL)	Safety Class	II
Maximum Series Fuse Rating	[A DC]	20	Fire Rating	C (IEC) / TYPE 1 (UL)
Max. Design Load, Push / Pull (UL)[2]	[lbs/ft²]	75 (3600 Pa) / 33 (1600 Pa)	Permitted module temperature on continuous duty	−40 °F up to +185 °F (−40 °C up to +85 °C)
Max. Test Load, Push / Pull (UL)[2]	[lbs/ft²]	113 (5400 Pa) / 50 (2400 Pa)	[2] see installation manual	

QUALIFICATIONS AND CERTIFICATES

UL 1703; CE-compliant;
IEC 61215:2016, IEC 61730:2016 application class A

C US Certified UL 1703 (254141)

PACKAGING INFORMATION

Number of Modules per Pallet	29
Number of Pallets per 53' Trailer	26
Number of Pallets per 40' High Cube Container	22
Pallet Dimensions (L × W × H)	81.9 in × 45.3 in × 46.7 in (2080 mm × 1150 mm × 1185 mm)
Pallet Weight	1635 lbs (742 kg)

NOTE: Installation instructions must be followed. See the installation and operating manual or contact our technical service department for further information on approved installation and use of this product.

Hanwha Q CELLS America Inc.
300 Spectrum Center Drive, Suite 1250, Irvine, CA 92618, USA | **TEL** +1 949 748 59 96 | **EMAIL** inquiry@us.q-cells.com | **WEB** www.q-cells.us

ATTACHMENT C

WALLINGFORD ELECTRIC DIVISION

INTERCONNECTION AND SYSTEM IMPACT STUDY

20 MW SOLAR PHOTOVOLTAIC GENERATION
(TWO 5 MW ARRAYS & ONE 10 MW ARRAY)

DEVELOPED BY

WALLINGFORD RENEWABLE ENERGY

WALLINGFORD, CT

REVISION 0.1

JUNE 2018

PLM
ELECTRIC POWER ENGINEERING
35 MAIN STREET, HOPKINTON, MA 01748 TEL: (508) 435-0200 FAX: (508) 435-4491

WALLINGFORD ELECTRIC DIVISION

20 MW SOLAR PHOTOVOLTAIC GENERATION SYSTEM IMPACT STUDY

TABLE OF CONTENTS

Revision History

Rev 0.0 June 29, 2018 – Issued draft for client review

Rev 0.1 July 25, 2018 – Corrected report per client review

WALLINGFORD ELECTRIC DIVISION

INTERCONNECTION & SYSTEM IMPACT STUDY
20 MW SOLAR ARRAYS
WALLINGFORD, CT

1.0 EXECUTIVE SUMMARY

Wallingford Renewable Energy (WRE) is proposing to install 20 MW (nominal ac rated output) of solar generation (Facility), to be interconnected to the Wallingford Electric Division's (WED, Utility) #4, #14, and #18 distribution feeders. The three interconnection feeders have a nominal voltage of 13.8 kV and are supplied by the Wallingford 13M Substation (Exhibit 1).

A system impact study was performed and as a result of the analysis, PLM recommends the following:

- WED should modify the 4, 14, and 18 feeder protection according to Tables 4.5-3,4,5.
- WED will require WRE to install current and potential transformers for revenue metering in the customer's switchgear as indicated on the proposed one line diagram. PLM recommends that WED use a 75:5 CT with a rating factor of 3.0 for the 5MW arrays and a 150:5 CT with a rating factor of 3.0 for the 10MW array. WED should install 8,400/14,560Y:120V (70:1) two bushing PT's. WRE's one line diagram indicates that a 5kVA control power transformer will be utilized to feed station service loads. To capture station service consumption WED should install separate metering in accordance with WED standard practices and tariffs for 120/240V distribution customers.
- WED will furnish and install a pole top recloser on their side of the PCC at each interconnection site. The recloser will provide redundant (backup) protection for the Facility's equipment and will be remotely operable via the WED SCADA system. PLM recommends WED use the settings outlined in Tables 4.4-2,3.
- WED should ensure the proposed inverters meet IEEE-1547 and UL-1741 prior to interconnecting the Facility. The developer should provide WED with documentation, such as equipment cut sheets, that demonstrate compliance with the appropriate standard(s).
- WED should ensure the proposed panels meet UL-1703 prior to interconnecting the Facility. The developer should provide WED with documentation, such as equipment cut sheets, that demonstrate compliance with the appropriate standard(s).
- The developer-owned SEL 651R relay on the 13.8 kV side of each PV interconnection should be programmed with the settings outlined in Tables 4.4-2,3.
- The developer's proposed one line diagram did not indicate what rating surge arresters will be used. PLM recommends 10.2 kV MCOV arresters.
- The developer should set inverters to output power at unity power factor, with adjustments to be considered should any power factor or voltage related issues arise on the WED system. The developer should program the inverters with the voltage and frequency settings outlined in Table 4.4-1.

- Each feeder has enough generating capacity to exceed feeder load and will backfeed into the 13.8 kV buses at Wallingford 13M. In addition, 13M-1X will have enough generation installed to exceed to total "W" bus load during periods of light load. As a result, WED will backfeed into the 115 kV transmission system through 13M-1X. This backfeed will not result in protection related issues, but WED has indicated to PLM that existing contractual arrangements prevent them from back feeding into the transmission system. WED should consider the following alternatives to mitigate this issue
    1. Add load to feeders on the W bus. At least 3MW during periods of light load is required to prevent a backfeed under normal operating conditions.
    2. Change the interconnection feeder to a bus with higher load levels.
    3. Reduce the PV array size or add a fourth feeder from Bus V (13M-4X).
    4. Revisit the existing agreements that disallow WED from exporting power during light load periods.

In addition to the recommendations above, PLM notes the following:

- The Wallingford 13M feeders 4, 14, and 18 have sufficient capacity to carry the full rated output of the proposed generation.
- Steady state voltage on the #4 and #14 feeders will remain within ANSI C84.1 Range A after addition of the Facility.
- Modelling indicates the existing Wallingford EPS is effectively grounded at the point of common coupling (PCC) on each feeder. After the interconnection of PV, the system remains effectively grounded.
- The developer's proposed grounded wye – grounded wye generator step up transformers are acceptable to use for the interconnection. The developer should purchase generator step up transformers with primary winding taps, which are typically at 2.5% and 5% above and below the 13.8 kV center tap. The transformers should initially be set on the center tap with changes to be made if voltages outside of ANSI C84.1 Range A are observed at the developer's 800V equipment.

2.0 PROJECT DESCRIPTION

WRE is proposing to install 20 MW (nominal ac rated output) of solar photovoltaic generation in the vicinity of Ball St and Pent Rd. in Wallingford, CT (Exhibit 2). The solar generation will be interconnected through three 13.8 kV distribution feeders, #4, #14, and #18. A description of each interconnection is provided below:

- Feeder #4 – WRE has proposed interconnecting 5MW via WED's #4 feeder. The feeder will be tapped at or near pole 4296 on Ball St. where WED will install the following equipment to interconnect the Facility
    - 1 new pole with a gang operated loadbreak switch
    - 1 new pole with a pole top recloser
    - 1 new pole with a 13.8kV primary riser
    - Associated cable terminations, grounding and bonding provisions, guys and anchors, etc.
    - WRE's one line diagram indicates that a 5kVA control power transformer will be utilized to feed station service loads. To capture station service consumption WED

should install separate metering in accordance with WED standard practices and tariffs for 120/240V light commercial distribution customers.

WRE, as a commercial entity in the WED service territory, will be responsible for:

- A 13.8 kV primary riser on the designated pole.
- Underground cable to the developer's proposed outdoor switchgear.
- Current and potential transformers for revenue metering in the customer's switchgear as indicated on the one line diagram (Exhibit 2). PLM recommends that WED use a 75:5 CT with a rating factor of 3 and an 8,400/14,560Y:120V (70:1) two bushing PT.

- Feeder #14 – WRE has proposed interconnecting 5MW via WED's #14 feeder. The feeder will be tapped at or near pole 03341 at the intersection of South Cherry St. and Ball St. where WED will install the following equipment to interconnect the Facility
  - 1 new pole with a gang operated loadbreak switch
  - 1 new pole with a pole top recloser
  - 1 new pole with a 13.8kV primary riser
  - Associated cable terminations, grounding and bonding provisions, guys and anchors, etc.
  - WRE's one-line diagram indicates that a 5kVA control power transformer will be utilized to feed station service loads. To capture station service consumption WED should install separate metering in accordance with WED standard practices and tariffs for 120/240V light commercial distribution customers.

  WRE, as a commercial entity in the WED service territory, will be responsible for:
  - A 13.8 kV primary riser on the designated pole.
  - Underground cable to the developer's proposed outdoor switchgear.
  - Current and potential transformers for revenue metering in the customer's switchgear as indicated on the one-line diagram (Exhibit 2). PLM recommends that WED use a 75:5 CT with a rating factor of 3 and an 8,400/14,560Y:120V (70:1) two bushing PT.

- Feeder #18 – WRE has proposed interconnecting 10MW via WED's #18 feeder. This feeder will be constructed as part of the proposed interconnection and will be run express from the Wallingford 13M substation to the point of common coupling along the same pole line as feeder #4. The feeder will be tapped near the intersection of Pent St. and Ball St. where WED will install the following equipment to interconnect the Facility
  - 1 new pole with a gang operated loadbreak switch
  - 1 new pole with a pole top recloser
  - 1 new pole with a 13.8kV primary riser
  - Associated cable terminations, grounding and bonding provisions, guys and anchors, etc.
  - WRE's one line diagram indicates that a 5kVA control power transformer will be utilized to feed station service loads. To capture station service consumption WED

should install separate metering in accordance with WED standard practices and tariffs for 120/240V light commercial distribution customers.

WRE, as a commercial entity in the WED service territory, will be responsible for:

- A 13.8 kV primary riser on the designated pole.
- Underground cable to the developer's proposed outdoor switchgear.
- Current and potential transformers for revenue metering in the customer's switchgear as indicated on the one-line diagram (Exhibit 2). PLM recommends that WED use a 150:5 CT with a rating factor of 3 and an 8,400/14,560Y:120V (70:1) two bushing PT.

WRE will own and install a 15 kV class circuit breaker with SEL 651R relay at each site to provide primary protection for faults located between the WRE switchgear and generator step up transformers. Each generator step-up transformer will be 13,800Y/7970-800Y/462V, 1050 kVA with a nominal impedance of 5.75%. The transformers will be loop fed with 600 A bushings. The interconnections to feeders #4 and #14 will have five generators step up transformers each. The interconnection to feeder #18 will include ten generator step-up transformers.

3.0 WED SYSTEM DESCRIPTION

WED operates a 13.8 kV distribution system that serves approximately 25,000 customers in the towns of Wallingford and North Branford. The facility will interconnect through three WED 13.8kV feeders supplied from WED's Wallingford 13M substation.

3.1 WALLINGFORD 13M SUBSTATION

The Wallingford 13M Substation (Exhibit 1) is consists of a seven breaker, 115 kV ring bus. Voltage is stepped down through four transformers, 13M-1X, 13M-2X, 13M-3X, and 13M-4X. The transformers are rated as follows

- 13M-1X – 115,000-13,800Y/7970 V, 21/28/35 MVA, Z=9.1%
- 13M-2X – 115,000-13,800Y/7970 V, 27/36/45 MVA, Z=9.25%
- 13M-3X – 115,000-13,800Y/7970 V, 27/36/45 MVA, Z=9.24%
- 13M-4X – 115,000-13,800Y/7970 V, 18.75/31.25/35 MVA, Z=8.45%

The transformers are each equipped with load tap changers to regulate the 13.8 kV bus voltage. The transformers each supply a 13.8 kV bus (designated W, T, Z, V) within a metal-clad switchgear. Several distribution feeders are supplied from each bus. 13.8 kV bus tie circuit breakers operate normally open.

At present, there are no other large scale, inverter-based distributed generators connected to the Wallingford 13M substation.

3.2 WALLINGFORD 13M FEEDER #4

The #4 13.8 kV feeder utilizes a combination of underground and overhead conductors between the substation and the proposed PCC. The distance from the substation to the PCC is approximately 3,000 ft. Between the substation and PCC, the feeder is roughly comprised of the following:

1) Approximately 900 ft. of 750 kcmil copper underground getaway cable between the Wallingford 13M metalclad switchgear (bus T) and feeder riser pole.
2) Approximately 2,100 ft. of 556 kcmil aluminum overhead (spacer and open wire) conductor on public ways

The #4 feeder has two capacitor banks, each 1,200 kVAR, for power factor correction. Both capacitor banks are fixed (always on) but are occasionally switched off manually to improve power factor during periods of light load. The capacitor banks are located on Kondracki Ln. and Pond Hill Rd.

In addition to capacitors, the #4 feeder has one set of pole mounted voltage regulators on Woodhouse Ave. to improve end of line voltage for customers located further from the Wallingford 13M substation.

3.3 WALLINGFORD 13M FEEDER #14

The #14 13.8 kV feeder utilizes a combination of underground and overhead conductors between the substation and the proposed PCC. The distance from the substation to the PCC is approximately 2,900 ft. Between the substation and PCC, the feeder is roughly comprised of the following:

3) Approximately 900 ft. of 750 kcmil copper underground getaway cable between the Wallingford 13M metalclad switchgear (bus Z) and feeder riser pole.
4) Approximately 2,000 ft. of 556 kcmil aluminum overhead (spacer and open wire) conductor on public ways

The #14 feeder has two capacitor banks, each 1,200 kVAR, for power factor correction. Both capacitor banks are fixed (always on) but are occasionally switched off manually to improve power factor during periods of light load. The capacitor banks are located on Clintonville Rd. and Pond Hill Rd.

In addition to capacitors, the #14 feeder has one set of pole mounted voltage regulators on Village St. to improve end of line voltage for customers located further from the Wallingford 13M substation.

3.4 WALLINGFORD 13M FEEDER #18

The #18 13.8 kV feeder will be constructed prior to interconnection of the Facility. The feeder will be fed from the Wallingford 13M W bus, 13M-1X transformer. The feeder length, construction, and route will be approximately equal to the #4 feeder.

The #18 feeder will not have any capacitor banks or voltage regulators installed.

4.0 ANALYSIS

This review utilized IEEE Standard 1547, “Standard for Interconnecting Distributed Resources with Electric Power Systems” (dated 2018) and IEEE Standard 1547.7, “Guide for Conducting Distribution Impact Studies for Distributed Resource Interconnection” (dated 2013). The review also took into account WED’s current system configuration such as feeder configuration, relay settings, voltage regulator and LTC settings, and the existing capacitor sizes / settings.

The WED system was modeled using ASPEN DistriView (v10.3) and data extracted from the WED GIS system. The model includes the WED transmission system, the Wallingford 13M substation, the interconnection feeders, and the proposed Facility. The model was used to simulate the load flow, short circuit and voltage performance effects the Facility may have on various parts of the WED system.

4.1 LOAD FLOW ANALYSIS

Fifteen-minute interval demand load data for the Wallingford 13M substation 13M-1X, 13M-2X, and 13M-3X was obtained from WED's SCADA system from May 2017 through May 2018. The data was filtered to identify the summer peak demand and minimum daytime load. Anticipated hourly PV output from the Facility was then estimated using the National Renewable Energy Laboratory's (NREL) PVWatts calculator. The expected substation and feeder demand levels under peak and minimum daytime load, before and after interconnection of the Facility, are summarized below.

Table 4.1-1

Pre- and Post-Facility Feeder and Substation Demand (kW)

	DEMAND WITHOUT FACILITY		PROJECTED DEMAND WITH FACILITY	
	MIN. DAYTIME[1]	PEAK	MIN. DAYTIME[1]	PEAK
13M-1X (10MW PV via Feeder #18)	5,501 kW (9/10/2017, 7AM)	27,890 kW (9/25/2017, 2:30PM)	-2,253 kW (4/29/2018, 10:15AM)	25,523 kW (9/25/2017, 2:45PM)
13M-2X (5MW PV via Feeder #4)	7,129 kW (5/29/2017, 5:30AM)	39,460 kW (5/18/2017, 4:45PM)	5,921 kW (9/10/2017, 7:15AM)	38,598 kW (5/18/2017, 4:45PM)
13M-3X (5MW PV via Feeder #14)	6,292 kW (9/10/2017, 5:30AM)	40,249 kW (6/14/2017, 5 PM)	3,909 kW (9/9/2017, 7:30AM)	39,575 kW (6/14/2017, 5PM)

1. Daytime includes those hours where output from the facility is producing at least 10% of its max AC output.

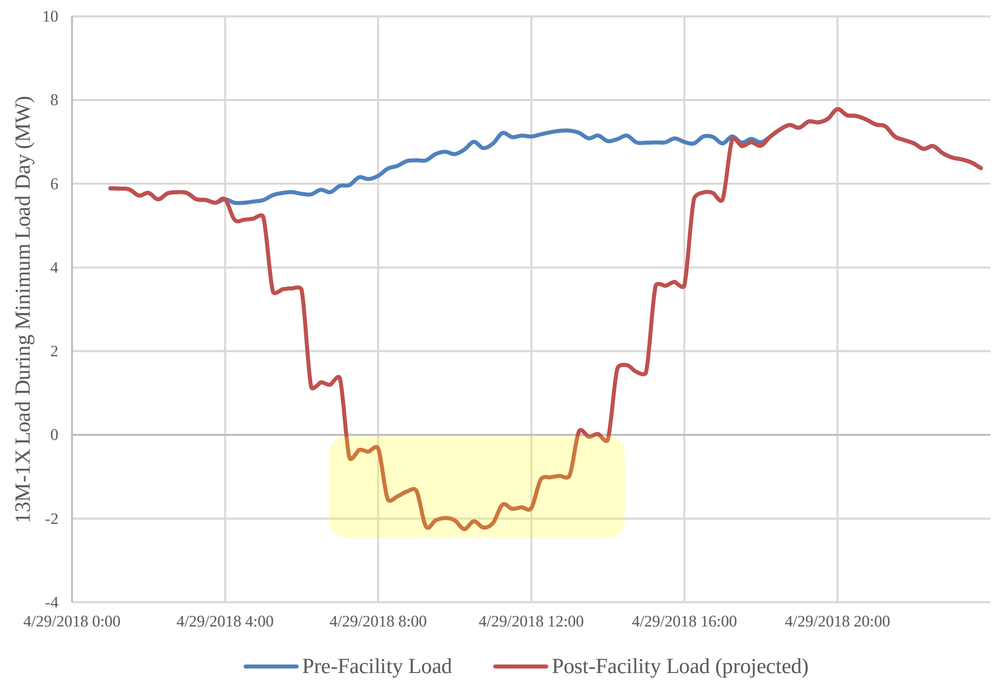
The above comparisons indicate that the Facility will result in a reverse power flow from Bus W through 13M-1X into the 115 kV ring bus. There are no directional protective elements affected by the reverse power flow, but existing agreements do not permit WED to export power into the 115 kV transmission system. To correct the reverse power flow issue, WED could consider the following alternatives:

1. Add load to feeders on the W bus. Load should be at least 3MW during periods of light load.
2. Change the interconnection feeder to a bus with higher load levels.
3. Reduce the PV array size or add a fourth feeder from Bus V (13M-4X).
4. Revisit the existing agreements that disallow WED from exporting power during light load periods.

Note that the existing load levels on the #4 and #14 feeders are lower than the anticipated peak solar output on each feeder. Therefore, the #4 and #14 feeders will backfeed into the substation 13.8 kV bus. The existing feeder protection does not include directional elements and the substation LTC's do not use line drop compensation so no changes are necessary to existing equipment or device settings.

Figures 4.1-1 depicts the simulated pre- and post-Facility demand loads on 13M-1X during minimum demand load periods.

Figure 4.1-1
13M-1X Hourly Load Pre & Post Facility – Light Load Day



4.1.1 Power Factor

The inverters can typically produce power at a fixed power factor ranging from 0.8 leading to 0.8 lagging. They are most often programmed to deliver power at unity power factor.

With the Facility set to generate at unity power factor, the overall power factor on the WED system may decrease. The effect of the Facility will be to reduce the real power demand as metered at Wallingford substations, but reactive power demand will be mostly unchanged. As an illustrative example,

Before PV – Real Power Demand = 50,000 kW, Reactive Power Demand = 7,000 kVAr lagging

$$Power\ Factor = \frac{50000}{\sqrt{50000^2 + 7000^2}} = 0.99\ lagging$$

After PV – Real Power Demand = 50000–20000 = 30000 kW, Reactive Demand = 7000 kVAr lagging (neglecting changes in reactive line losses)

$$Power\ Factor = \frac{30000}{\sqrt{30000^2 + 7000^2}} = 0.97\ lagging$$

It is recommended the power factor of the solar inverters initially be set to unity, with adjustments to the solar inverters' programmed power factors to be considered should any power factor or voltage related issues arise. The most recent ISO-NE power factor survey shows that Wallingford is well compensated during peak hours. However, during light load survey points WED's power factor is too leading to comply with ISO-NE power factor requirements. Historically the light load survey points have occurred between the hours of 3-6 AM, so the proposed PV is not expected to impact Wallingford's compliance during these hours. However, when PV output is near full capacity during daytime hours in the spring and fall, the power factor observed on WED feeders may be worsened. WED should consider replacing some fixed capacitor banks with switched units to better align reactive compensation with demand.

4.1.2 STEADY-STATE VOLTAGE

The Wallingford St. 13M bus voltage is regulated by automatic load tap changing on the substation transformers. Line drop compensation is not used, meaning the bus voltage is not affected by the load on the transformers. The load flow model predicts that voltage at the PCC will typically range between the following values:

- 14.007 kV (1.015 per unit) and 14.090 kV (1.021 per unit) on Feeder #4
- 14.007 kV (1.015 per unit) and 14.090 kV (1.021 per unit) on Feeder #14
- 14.062 kV (1.019 per unit) and 14.145 kV (1.025 per unit) on Feeder #18

This includes any voltage rise effect due to the pole mounted power factor correction capacitors on the feeder (the temperature controlled capacitor bank is assumed off during non-peak periods). The addition of the Facility does alter the expected range of voltages in the vicinity of the PCC., specifically during periods of light load.

It is recommended that the generator step up transformers be purchased with taps at 2.5% and 5% above and below the 13.8 kV center tap. Computer modelling indicates that the optimum voltage regulation on the 380 V collector system (voltage maintained as close as possible to 800 Volts) at the Facility will be achieved by selecting the 14,145V primary (+2.5%) tap on the generator step up transformer.

Figures 4.1.2-1 and 4.1.2-2 depict the feeder voltage profile under light load conditions with all fixed capacitors in service and full distributed generation output. This is the condition that would be most likely to cause objectionable high voltage on the feeder. It is assumed that the pole mounted voltage regulators are in service with setting of float 1.025 per unit. A plot was not created for feeder #18 because it is express to the Facility and as indicated above, voltage at the PCC is expected to be within ANSI C84.1 Range A limits for service voltage.

Figure 4.1.2-1
Feeder #4 Voltage Profile – Light Load Day

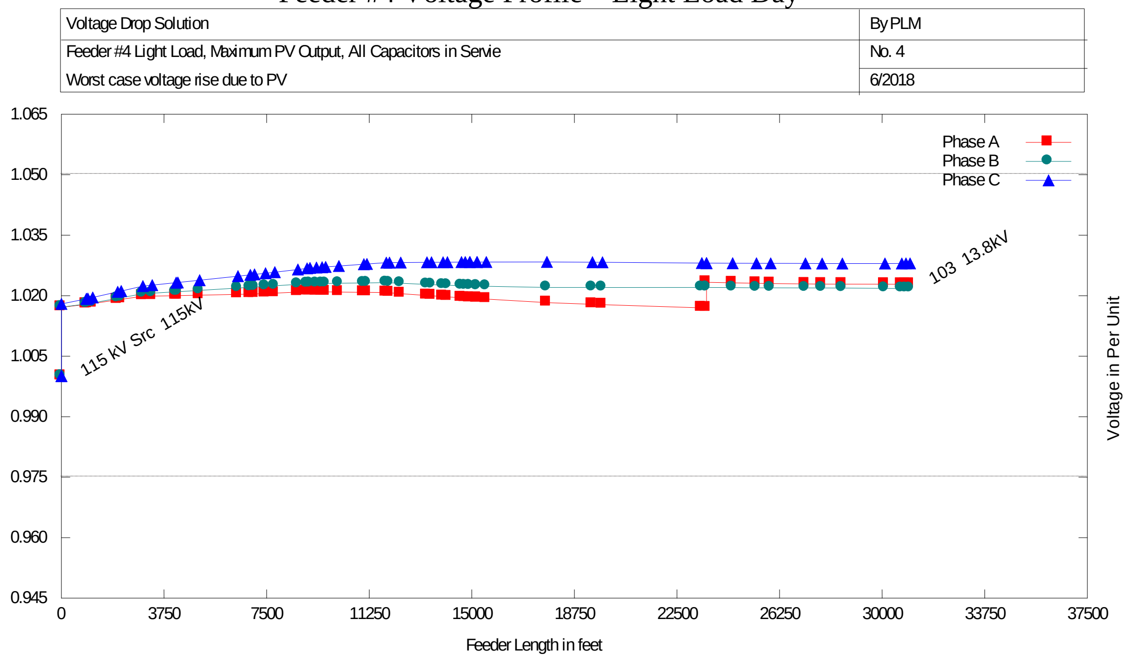
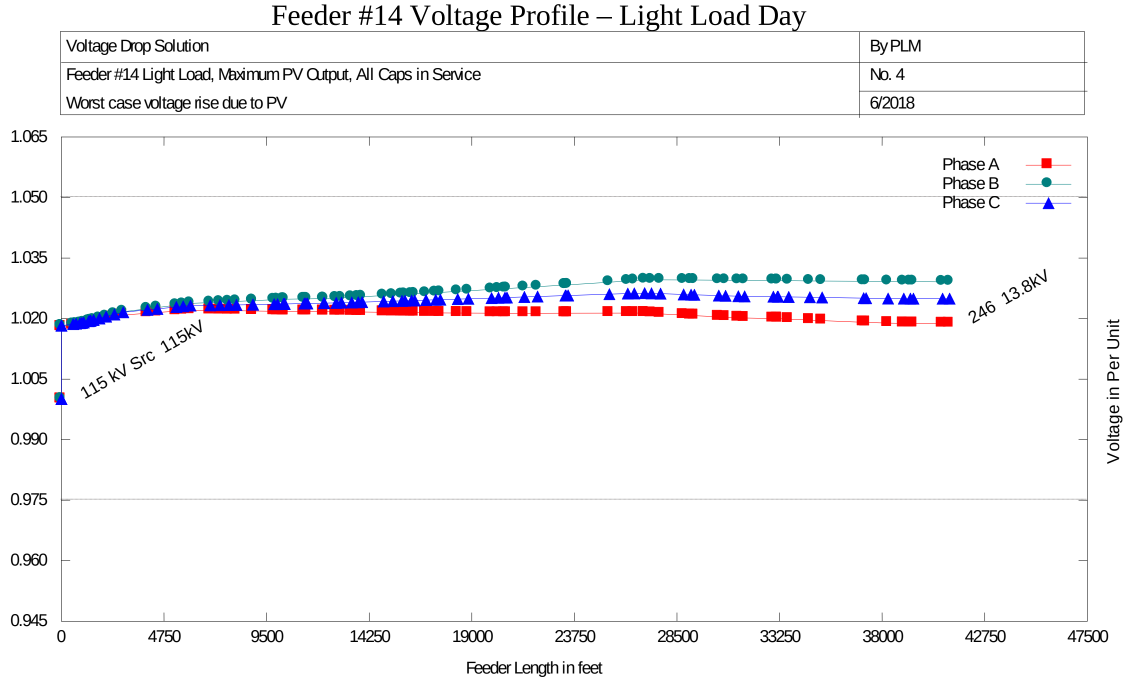


Figure 4.1.2-2
Feeder #14 Voltage Profile – Light Load Day



4.1.3 FLICKER

The limitation of acceptable voltage flicker induced by distributed energy resources (DER) is defined by IEEE Standard 1547, which states that flicker is only objectionable when it either causes a modulation of the light level of lamps sufficient to be irritating to humans or causes equipment misoperation per flicker standards IEEE 1453 and IEEE 519. To evaluate potential for voltage flicker, the effect of a rapid change from full output to 30% output (to simulate cloud shading) was considered. This is accomplished using the Aspen DistriView software by first solving load flow with the Facility generating at 100% output. Then, the power output of the Facility is reduced to 30% of nameplate and load flow is solved again, beginning from the previous solution, with load-tap-changers (LTCs) and switchable capacitors locked in their existing position. The change in voltage at the PCC before and after reducing the output from the Facility is used as the basis for the flicker analysis. The model produces a maximum expected voltage deviation due to cloud shading of 0.003 per unit.

Based on IEEE 1453-2015 (Table A.1 and Figure A.2) and the GE flicker curve of IEEE Std. 141, an anticipated 0.3% variation in voltage at the PCC is not expected to cause objectionable transient voltages in the form of dimming lights. However, if WED does receive complaints of flickering lights, after the Facility is put into service, a flicker meter should be used (in accordance with IEEE 1453-2015) to obtain the actual flicker contribution of the Facility. The Facility's contribution to flicker, measured at the PCC, shall not exceed the greater of the limits listed in Table 4.1.4-1 and the individual emission limits defined by IEC/TR 61000-3-7.

Table 4.1.4-1

Minimum Individual DG Flicker Emission Limits (Per IEEE 1547-2018)

E_{Pst}	E_{Plt}
0.35	0.25

4.2 LOADING LIMIT CALCULATIONS

Equipment was reviewed to determine the current carrying capacity of all equipment between the proposed photovoltaic (PV) generation and Wallingford 13M Substation (Exhibit 3). The following table summarizes the current carrying capacity by feeder. During a worst-case scenario where each interconnection is producing maximum output and no load is in service, there are no anticipated overloads.

Table 4.1.4-1

Feeder Ratings

	Summer Normal Rating	**Summer Rating Limiting Element**	**Winter Normal Rating**	**Winter Rating Limiting Element**
Feeder 4[1]	474 A	750 CU UG Cable	593 A	750 CU UG Cable
Feeder 14[2]	500 A	Riser Pole	600 A	Current Transformer
Feeder 18[3]	478 A	750 CU UG Cable	629 A	750 CU UG Cable

Assumptions used for equipment ratings

- Switches, transformers, and circuit breakers utilized nameplate ratings.

[1] Limiting UG Cable section is ductbank out of MH4A
[2] Limiting UG Cable section is ductbank out of MH32
[3] The New Feeder 18 will be routed through manhole 4A – this section is limiting.

- Overhead conductor is rated according to IEEE-738 and ISO NE Planning Procedure 07 (PP-07).
- Overhead spacer cable ratings are from Hendrix.
- Overhead lashed aerial cable ratings are from Kerite's high voltage cable catalog.
- Underground cable and riser pole ratings are calculated using a general-purpose ampacity software and Neher-McGrath equations.
- Risers are unvented, 35ft, RGS
- Riser solar heating based on geographic location and absorptivity of RGS (0.4)
- Riser poles receive no cooling from wind (0 fps velocity)
- Ambient temperatures for underground cable and riser pole calculations
    - Summer = 28°C
    - Winter = 10°C
- Avg ductbank depth to center = 36"
- Thermal resistivity
    - Native soil = 90 °C-cm/W
    - Concrete = 55 °C-cm/W
- $Loss\ factor\ =\ 0.3 \times (Load\ Factor) + 0.7 \times (Load\ Factor)^2$
- Where load factor was unknown a value of 0.75 was assumed

4.3 SHORT CIRCUIT ANALYSIS

Using data furnished by the Wallingford Electric Division (WED), an electrical model (Exhibit 4) was constructed in Aspen Distriview V10.3 to evaluate the short circuit impact of proposed photovoltaic (PV) facilities.

Short circuit current magnitudes and X/R ratios were calculated for 3PH and 1LG fault types with and without the proposed PV in service. Values were recorded at each of the following locations.

- The Wallingford 13M 115 kV bus
- The 13.8 kV W, T, Z, and V buses
- The 13.8 kV point of common coupling at each proposed PV site.
- The 800V secondary bushings of each 1.05 MVA interconnection transformer.

Results were compiled in a table format (Exhibit 4). In general, positive sequence fault contribution from the PV generators during symmetrical faults is small relative to the existing available fault current. Therefore, modeling indicates the short circuit contribution from proposed generation does not require any equipment or protective device setting changes.

4.4 SOLAR FACILITY PROTECTION & CONTROL

The Facility's proposed inverters must comply with IEEE Standard 1547 and UL Standard 1741, including the increased stability requirements of UL 1741 SA, and NEC 2014 with respect to arc fault and rapid shutdown. The proposed panels must comply with UL Standard 1703.

In addition to the above, IEEE 1547 defines protection requirements for the Facility. Protection criteria include anti-islanding, ceasing to energize a circuit when the circuit is de-energized, and ceasing to operate after a time delay when the voltage and/or system frequency are outside preset limits. Table 4.4-1 contains PLM's recommended voltage and frequency settings for the inverters. As shown in the table, the proposed settings comply with IEEE 1547-2018 and ISO-NE's "Implementation of the Revised IEEE Standard 1547" guidelines.

Table 4.4-1
Recommended Inverter Settings

Protective Element	**Proposed** [1,2]	**ISO-NE Settings** [1,2,3,4,5]
Undervoltage Fast Pickup	V ≤ 50%	V ≤ 50%
Undervoltage Fast Total Clearing	1.1 seconds	1.1 seconds
Undervoltage Slow Pickup	V ≤ 88%	V ≤ 88%
Undervoltage Slow Total Clearing	2.0 seconds	2.0 seconds
Overvoltage Slow Pickup	V ≥ 110%	V ≥ 110%
Overvoltage Slow Total Clearing	2 seconds	2 seconds
Overvoltage Fast Pickup	V ≥ 120%	V ≥ 120%
Overvoltage Fast Total Clearing	0.16 seconds	0.16 seconds
Overfrequency Fast Pickup	62 Hz	62 Hz
Overfrequency Fast Total Clearing	0.16 seconds	0.16 seconds
Overfrequency Slow Pickup	61 Hz	61 Hz
Overfrequency Slow Total Clearing	300 seconds	300 seconds
Underfrequency Fast Pickup	56.5 Hz	56.5 Hz
Underfrequency Fast Total Clearing	0.16 seconds	0.16 seconds
Underfrequency Slow Pickup	58.5 Hz	58.5 Hz
Underfrequency Slow Total Clearing	300 seconds	300 seconds
79 (Reclosing)	Enable on voltage and frequency disturbances only. 5-minute delay (300s) for reclosing upon good quality voltage.	

1. *Percent of the nominal voltage.*
2. *Amperes are at 13,800 volts.*
3. *ISO-NE settings are within the acceptable ranges of IEEE 1547-2018.*
4. *Underfrequency settings comply with NERC's PRC-006-NPCC-1.*

With regards to their operation, the inverters are designed to utilize the maximum amount of power generated at any given time, which is driven by the amount and brightness of sunlight on their PV arrays, as well as the PV cell temperatures. This approach is known as maximum power point tracking. The inverters react to gradual changes of the sun exposure and PV cell temperatures, which in turn varies the amount of power produced and minimizes cycling on and off during intermittent conditions. The inverters are typically set to shut off at a user-selectable threshold of minimal light exposure on their PV arrays.

The Facility's generation step-up transformer will be equipped with internal fusing. These fuses provide primary overcurrent protection for transformer internal faults and 800 V phase faults. A series combination consisting of a 65-ampere rated user-replaceable bay-o-net fuse (to sense low current faults) and a non-serviceable current limiting fuse (to more rapidly sense and isolate catastrophic faults internal to the transformer) will be used.

To interconnect generator step-up transformers to the WED system, the Facility will own a 15 kV switchgear lineup at each interconnection. Each switchgear will contain a disconnect switch, production meter, and circuit breaker with SEL 651R relay package. PLM recommends that the relays be programmed with the settings provided in Tables 4.4-2 and 4.4-3. These settings will provide time-current coordination with the overcurrent relaying on the Wallingford feeder breaker(s) and transformer internal fusing at the Facility. In addition, the relay shall provide backup frequency and voltage elements for the inverters. Exhibit 5 contains plotted time-current curves depicting the recommended primary overcurrent protection.

Table 4.4-2
Customer Owned SEL 651R Recommended Settings

Protective Element	Proposed [1,2]	ISO-NE Settings [1,2,3,4,5]
Undervoltage Fast Pickup	V ≤ 50%	V ≤ 50%
Undervoltage Fast Total Clearing	1.1 seconds	1.1 seconds
Undervoltage Slow Pickup	V ≤ 88%	V ≤ 88%
Undervoltage Slow Total Clearing	2.0 seconds	2.0 seconds
Overvoltage Slow Pickup	V ≥ 110%	V ≥ 110%
Overvoltage Slow Total Clearing	2 seconds	2 seconds
Overvoltage Fast Pickup	V ≥ 120%	V ≥ 120%
Overvoltage Fast Total Clearing	0.16 seconds	0.16 seconds
Overfrequency Fast Pickup	62 Hz	62 Hz
Overfrequency Fast Total Clearing	0.16 seconds	0.16 seconds
Overfrequency Slow Pickup	61 Hz	61 Hz
Overfrequency Slow Total Clearing	300 seconds	300 seconds
Underfrequency Fast Pickup	56.5 Hz	56.5 Hz
Underfrequency Fast Total Clearing	0.16 seconds	0.16 seconds
Underfrequency Slow Pickup	58.5 Hz	58.5 Hz
Underfrequency Slow Total Clearing	300 seconds	300 seconds
Phase OC Time Delayed Pickup	See Table 4.4-3	n/a
Phase OC Time Delayed Time Dial	See Table 4.4-3	n/a
Phase OC Time Delayed Curve	See Table 4.4-3	n/a
Ground OC Time Delayed Pickup	See Table 4.4-3	n/a
Ground OC Time Delayed Time Dial	See Table 4.4-3	n/a
Ground OC Time Delayed Curve	See Table 4.4-3	n/a
79 (Reclosing)	Enable on voltage and frequency disturbances only. 5-minute delay (300 s) for reclosing upon good quality voltage.	

1. *Percent of the nominal voltage.*
2. *Amperes are at 13,800 volts.*
3. *ISO-NE settings are within the acceptable ranges of IEEE 1547-2018.*
4. *Underfrequency settings comply with NERC's PRC-006-NPCC-1.*

Table 4.4-3
Customer Owned SEL 651R Recommended Settings

		Inst	Pickup	Time Dial	Curve
Feeder 4 SEL-651R	Phase	-- A	360 A	1	U3
	Ground	-- A	120 A	4	U4
Feeder 14 SEL-651R	Phase	-- A	360 A	1	U3
	Ground	-- A	120 A	4	U4
Feeder 18 SEL-651R	Phase	-- A	600 A	1	U3
	Ground	-- A	180 A	4	U4

4.5 WALLINGFORD ELECTRIC DIVISION PROTECTION & CONTROL

Existing protection for feeder phase and ground faults located on the 4 and 14 distribution feeders are provided by relayed circuit breakers at the 13M substation. The existing overcurrent relay settings are shown in Table 4.5-1 and 4.5-2. Feeder 18 is a new express feeder that does not have existing settings.

Table 4.5-1

Existing Feeder 4 Relay Settings

	Inst	Inst Delay	Pickup	Time Dial	Relay/Curve
Phase (50/51)	NIS[1]	NIS[1]	600 A	2.5	SEL 751A U3
Ground (50N/51N)	NIS[1]	NIS[1]	192 A	10	SEL 751A U2
Underfrequency Load Shed	NIS[1]				
Reclosing	2s / 10s				

1. NIS = Not in Service

Table 4.5-2

Existing Feeder 14 Relay Settings

	Inst	Inst Delay	Pickup	Time Dial	Relay/Curve
Phase (50/51)	NIS[1]	NIS[1]	720 A	2.5	SEL 751A U3
Ground (50N/51N)	NIS[1]	NIS[1]	240 A	10	SEL 751A U2
Underfrequency Load Shed	58.9 Hz – 0.2 seconds				
Reclosing	2s / 10s				

1. NIS = Not in Service

PLM recommends WED implement the feeder relay setting changes outlined in Tables 4.5-3, 4.5-4, and 4.5-5. These settings will provide time-current coordination between the feeder breaker and Facility protection. Setting changes are highlighted in yellow.

Table 4.5-3

WED Feeder 4 Recommended Settings

	Inst	Inst Delay	Pickup	Time Dial	Relay/Curve
Phase (50/51)	NIS[1]	NIS[1]	600 A	2.5	SEL 751A U3
Ground (50N/51N)	NIS[1]	NIS[1]	192 A	10	SEL 751A U2
Underfrequency Load Shed	NIS[1]				
Reclosing	3s / 10s				

1. NIS = Not in Service

Table 4.5-4

WED Feeder 14 Recommended Settings

	Inst	Inst Delay	Pickup	Time Dial	Relay/Curve
Phase (50/51)	NIS[1]	NIS[1]	780 A	3	SEL 751A U3
Ground (50N/51N)	NIS[1]	NIS[1]	240 A	6	SEL 751A U2
Underfrequency Load Shed	NIS[1]				
Reclosing	3s / 10s				

1. NIS = Not in Service

Table 4.5-5
WED Feeder 18 Recommended Settings

	Inst	Inst Delay	Pickup	Time Dial	Relay/Curve
Phase (50/51)	NIS[1]	NIS[1]	720 A	3	SEL 751A U3
Ground (50N/51N)	NIS[1]	NIS[1]	240 A	6	SEL 751A U2
Underfrequency Load Shed	NIS[1]				
Reclosing	3s / 10s				

1. *NIS = Not in Service*

The aggregate distributed resource production is substantial relative to feeder loading. The expected output from solar generation may meet or exceed the amount of load on the feeders under certain operating conditions. Therefore, it may be possible to support an island when generation output and load levels are closely matched. However, the UL 1741 listed inverters are equipped with anti-islanding protective functions (per IEEE 1547) which are designed to detect loss of the utility source and trip within two seconds. To further prevent reclosing into the feeder while still energized by the PV, direct transfer trip (DTT) or voltage supervised reclosing (reclose blocking) can be implemented. PLM's experience has shown that increasing the first shot reclose to be at least three (3) seconds, which allows for an additional one second of margin for the inverter's anti-islanding protection to detect a loss of the utility supply and trip, has proven to be adequate. The existing feeder breakers at Wallingford 13M are currently programmed with a first shot reclose interval of 2 seconds. Therefore, it is recommended this value be increased to at least three (3) seconds.

Feeders selected for inclusion in the mandatory underfrequency load shedding scheme are set to operate as determined by the aggregate load of the WED distribution system and by NERC's PRC-006-NPCC-1 (formally known as NPCC's Directory 12). To guard against contributing to system instability, feeders with significant generation resources should generally not be selected for automatic underfrequency load shedding. Following interconnection of the Facility, it is recommended that WED not select the 4, 14, or 18 feeders for underfrequency load shedding.

In addition to the protection provided by solar Facility equipment and WED feeder overcurrent devices, WED will install a pole top recloser on their side of the PCC at each interconnection. PLM recommends the WED recloser have the same settings as the developer's SEL-651R (Tables 4.4-2 and 4.4-3). The WED recloser will be remotely operable via the WED SCADA system.

4.6 EFFECTIVE GROUNDING:

The design of the 13.8 kV system is predicated on effective grounding. The IEEE C62.91.1 definition of effective grounding states that a system is effectively grounded if the coefficient of grounding (COG) is less than 0.8. The COG is defined as:

$$\frac{V_{L-N}}{V_{L-L\ (nominal)}} = COG$$

Using the model, a comparison of effective grounding with and without the PV in service was performed at the 13.8 kV point of common coupling.

Table 4.6-1
Effective Grounding Pre & Post Facility

Feeder	C.O.G. Pre-Facility	C.O.G. Post-Facility
4	65.9%	66.5%
14	68.1%	68.8%
18	64.5%	65.9%

Computer modelling indicates the proposed interconnections will not result in the EPS becoming ineffectively grounded while operating in parallel with the utility supply. However, on a typical four-wire, multi-point grounded, radial distribution feeder, neutral shift can occur during a ground fault which subsequently causes a utility side circuit breaker or recloser to open. For a brief period of time after the utility protective device has opened, the PV generation remains energized on the islanded part of the feeder. Generators connected through transformers that do not provide a path for zero-sequence current flow can continue to supply the feeder from an ungrounded source, causing the voltage on unfaulted phases to rise significantly and rapidly until anti-islanding or overvoltage protection operates to disconnect the Facility. This overvoltage has the potential to exceed the maximum continuous operating voltage of surge arresters and damage customer equipment. Loads connected line-neutral can see voltage as high as the rated line-line voltage (1.73 times nominal). If an overvoltage of this magnitude persists for an extended period of time it will fall outside of the CBEMA curve and damage to customer equipment becomes highly likely. The Facility will use generator step-up transformers with wye grounded primary and wye grounded secondary winding connections. Because of the solidly grounded primary winding, significant neutral shift on the 13.8 kV system is not a concern.

5.0 CONCLUSIONS AND RECOMMENDATIONS

PLM has reviewed the proposed interconnection of photovoltaic generation to the Wallingford distribution system. As a result of the analysis performed, PLM recommends the following:

- WED should modify the 4, 14, and 18 feeder protection according to Tables 4.5-3,4,5.
- WED will require WRE to install current and potential transformers for revenue metering in the customer's switchgear as indicated on the proposed one line diagram. PLM recommends that WED use a 75:5 CT with a rating factor of 3.0 for the 5MW arrays and a 150:5 CT with a rating factor of 3.0 for the 10MW array. WED should install 8,400/14,560Y:120V (70:1) two bushing PT's. WRE's one line diagram indicates that a 5kVA control power transformer will be utilized to feed station service loads. To capture station service consumption WED should install separate metering in accordance with WED standard practices and tariffs for 120/240V distribution customers.
- WED will furnish and install a pole top recloser on their side of the PCC at each interconnection site. The recloser will provide redundant (backup) protection for the Facility's equipment and will be remotely operable via the WED SCADA system. PLM recommends WED use the settings outlined in Tables 4.4-2,3.
- WED should ensure the proposed inverters meet IEEE-1547 and UL-1741 prior to interconnecting the Facility. The developer should provide WED with documentation, such as equipment cut sheets, that demonstrate compliance with the appropriate standard(s).

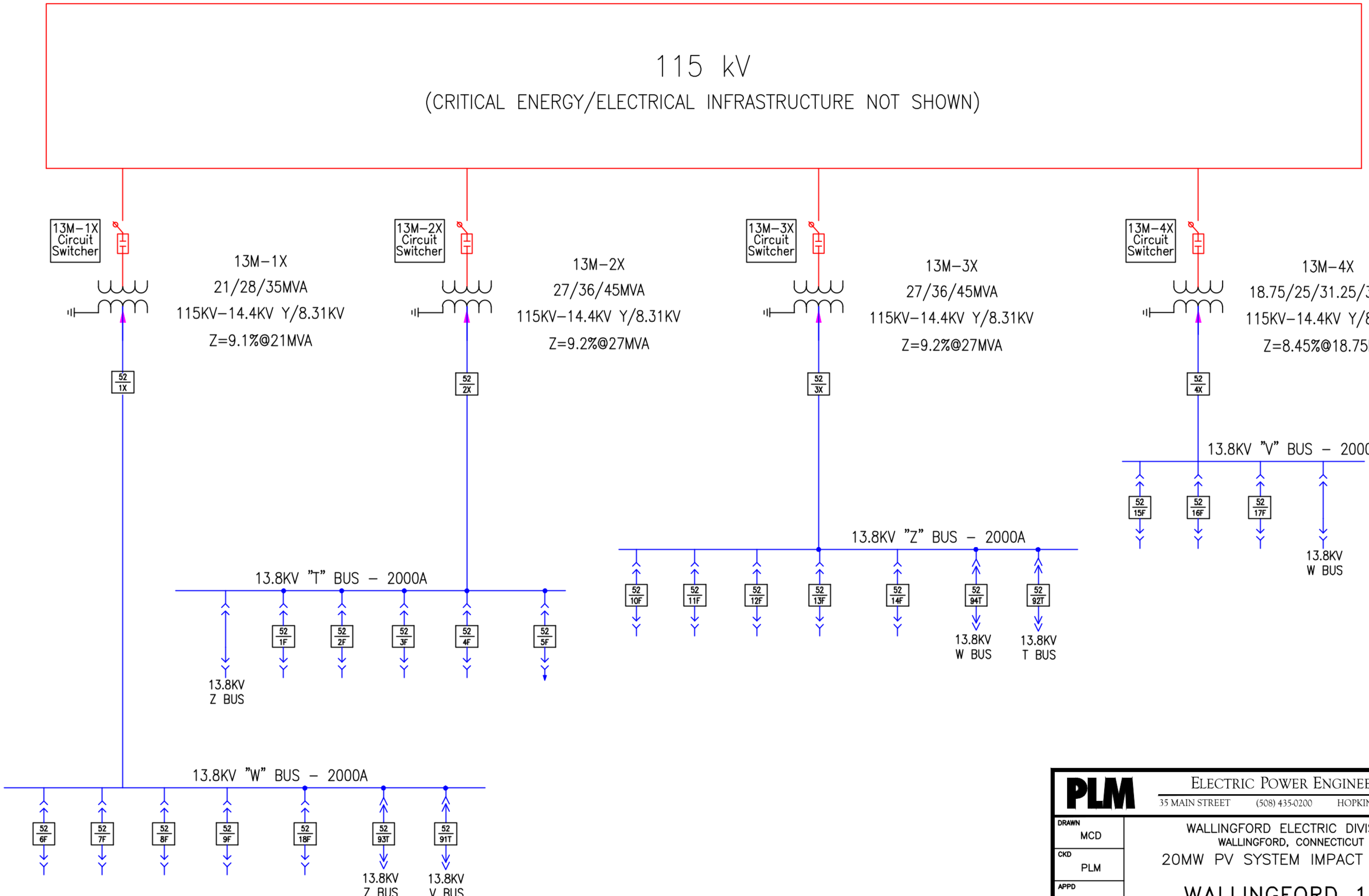
- WED should ensure the proposed panels meet UL-1703 prior to interconnecting the Facility. The developer should provide WED with documentation, such as equipment cut sheets, that demonstrate compliance with the appropriate standard(s).
- The developer-owned SEL 651R relay on the 13.8 kV side of each PV interconnection should be programmed with the settings outlined in Tables 4.4-2,3.
- The developer's proposed one line diagram did not indicate what rating surge arresters will be used. PLM recommends 10.2 kV MCOV arresters.
- The developer should set inverters to output power at unity power factor, with adjustments to be considered should any power factor or voltage related issues arise on the WED system. The developer should program the inverters with the voltage and frequency settings outlined in Table 4.4-1.
- Each feeder has enough generating capacity to exceed feeder load and will backfeed into the 13.8 kV bus at Wallingford 13M. In addition, 13M-1X will have enough generation installed to exceed to total "W" bus load during periods of light load. As a result, WED will backfeed into the 115 kV transmission system. This backfeed will not result in protection related issues, but WED has indicated to PLM that existing arrangements prevent them from back feeding into the transmission system. WED should consider the following alternatives to mitigate this issue
    1. Add load to feeders on the W bus. At least 3MW during periods of light load is required to prevent a backfeed under normal operating conditions.
    2. Change the interconnection feeder to a bus with higher load levels.
    3. Reduce the PV array size or add a fourth feeder from Bus V (13M-4X).
    4. Revisit the existing agreements that disallow WED from exporting power during light load periods.

In addition to the recommendations above, PLM notes the following:

- The Wallingford 13M feeders 4, 14, and 18 have sufficient capacity to carry the full rated output of the proposed generation.
- Steady state voltage on the #4 and #14 feeders will remain within ANSI C84.1 Range A after addition of the Facility.
- Modelling indicates the existing Wallingford EPS is effectively grounded at the point of common coupling (PCC) on each feeder. After the interconnection of PV, the system remains effectively grounded.
- The developer's proposed grounded wye – grounded wye generator step up transformers are acceptable to use for the interconnection. The developer should purchase generator step up transformers with primary winding taps, which are typically at 2.5% and 5% above and below the 13.8 kV center tap. The transformers should initially be set on the center tap with changes to be made if voltages outside of ANSI C84.1 Range A are observed at the developer's 800V equipment.

EXHIBIT 1

WALLINGFORD 13M SUBSTATION
SINGLE LINE DIAGRAM & COMPUTER MODEL



PLM ELECTRIC POWER ENGINEERING
35 MAIN STREET (508) 435-0200 HOPKINTON, MA 01748

DRAWN MCD	WALLINGFORD ELECTRIC DIVISION WALLINGFORD, CONNECTICUT 20MW PV SYSTEM IMPACT STUDY
CKD PLM	
APPD	WALLINGFORD 13M SINGLE LINE DIAGRAM
DATE 6/20/18	
SCALE NONE	NO. 9095–05 EXHIBIT 1

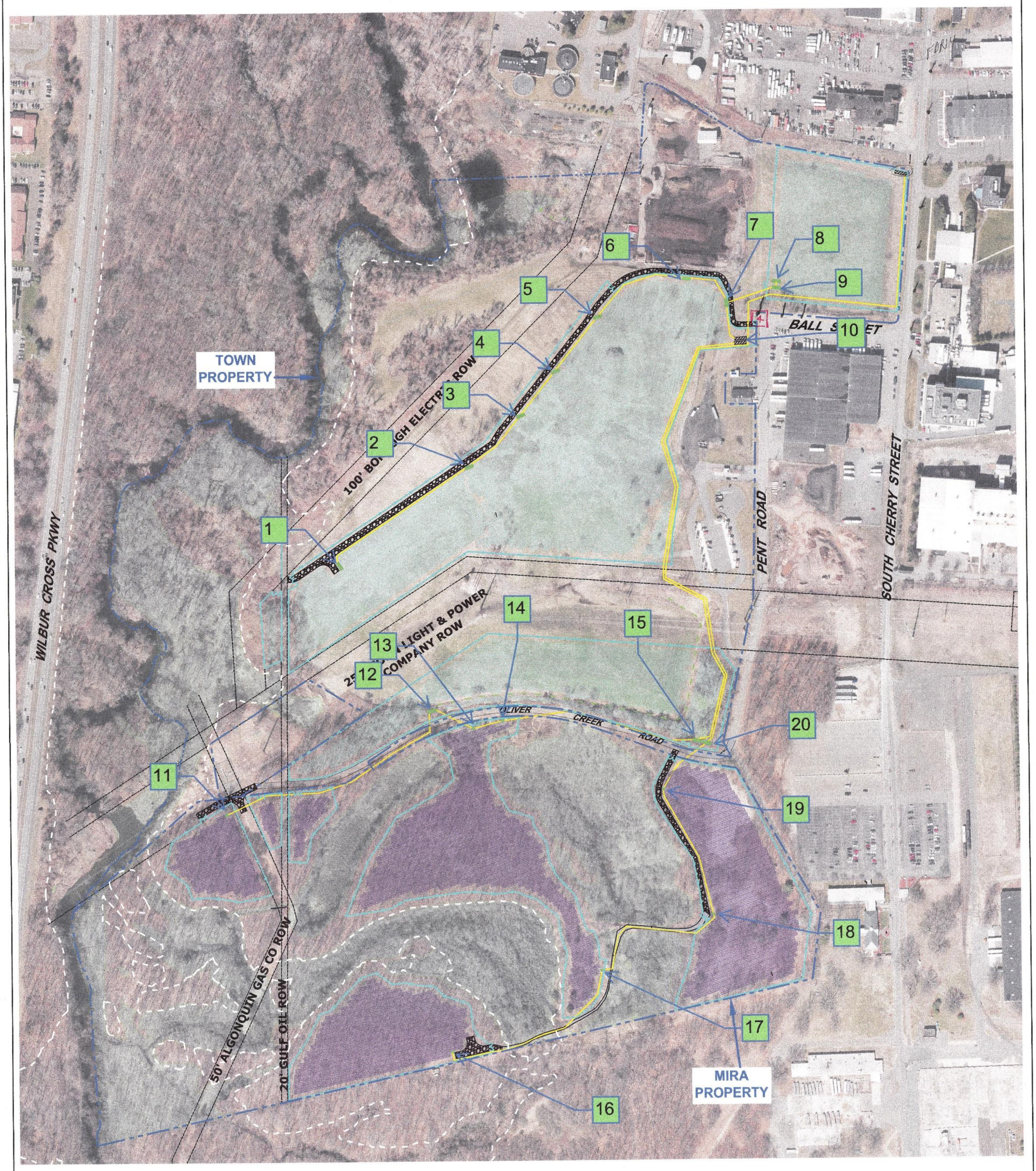

115 kV Src
13M-1X
13M-2X
13M-3X
13M-4X
WALLINGFORD 13M SUBSTATION
W_Bus
T_Bus
Z_Bus
V_Bus
FDR18_Riser
BUS1
FDR18_PV
FDR4_Riser
FDR14_PV
FDR4_PV
WOODHOUSE AVE
S ELM ST
ROUTE 5
POND HILL RD
KONDRACKI LN
NORTHFIELD RD
POND HILL RD
WOODHOUSE AVE
HARRISON RD
POND HILL RD
WOODHOUSE AVE
W DAYTON HILL RD
WOODHOUSE AVE
VILLAGE ST
CLINTONVILLE RD
CLINTONVILLE RD
VILLAGE ST
MIDDLETOWN AVE
VILLAGE ST
PARSONAGE HILL RD
246

EXHIBIT 2

WALLINGFORD RENEWABLE ENERGY

20 MW SOLAR GENERATING FACILITY
(2X5MW, 1X10MW ARRAYS)
WALLINGFORD, CT

SITE PLAN AND SINGLE-LINE DIAGRAM,



4 Tow Express For 4

LEGEND

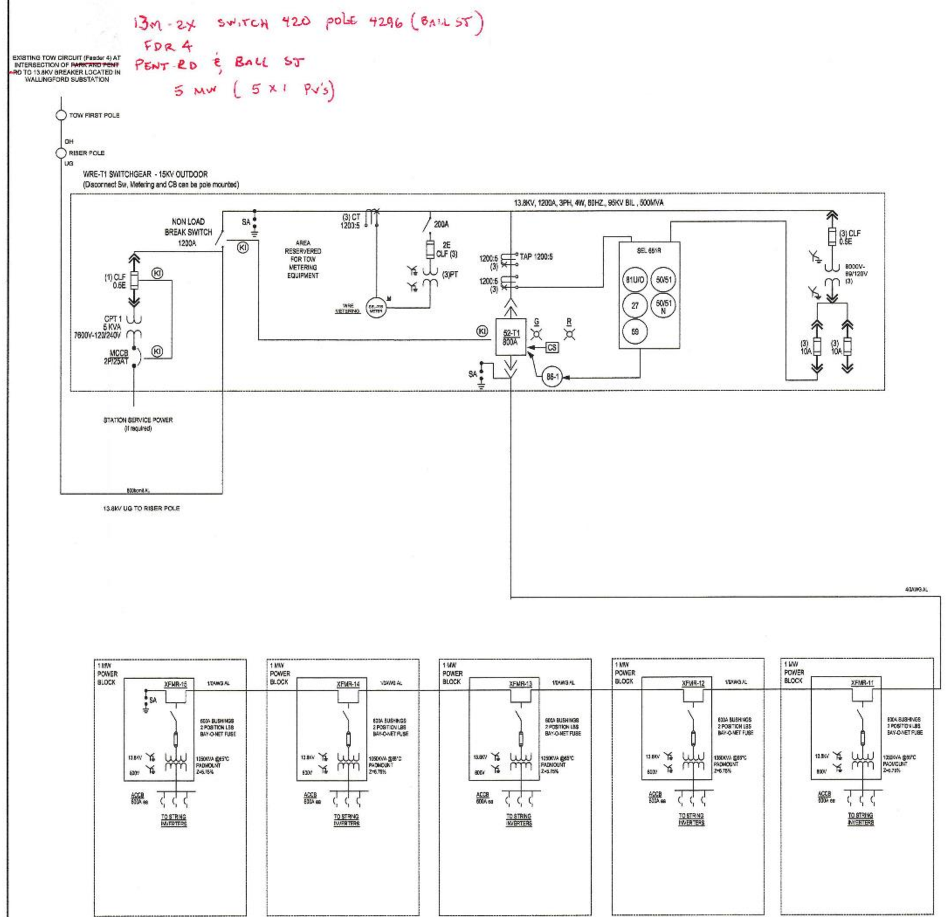
- SITE BOUNDARY
- FEMA 100 YEAR FLOODLINE
- SWALE
- WETLAND
- EXISTING ROAD
- PROPOSED ROAD
- PROPOSED FENCE LINE
- PROPOSED MEDIUM VOLTAGE ROUTING
- PAD FOR TRANSFORMER, INVERTERS AND SWITCHGEAR
- PADS FOR TRANSFORMER
- SOLAR PANELS - DRIVEN PILE
- SOLAR PANELS - BALLAST

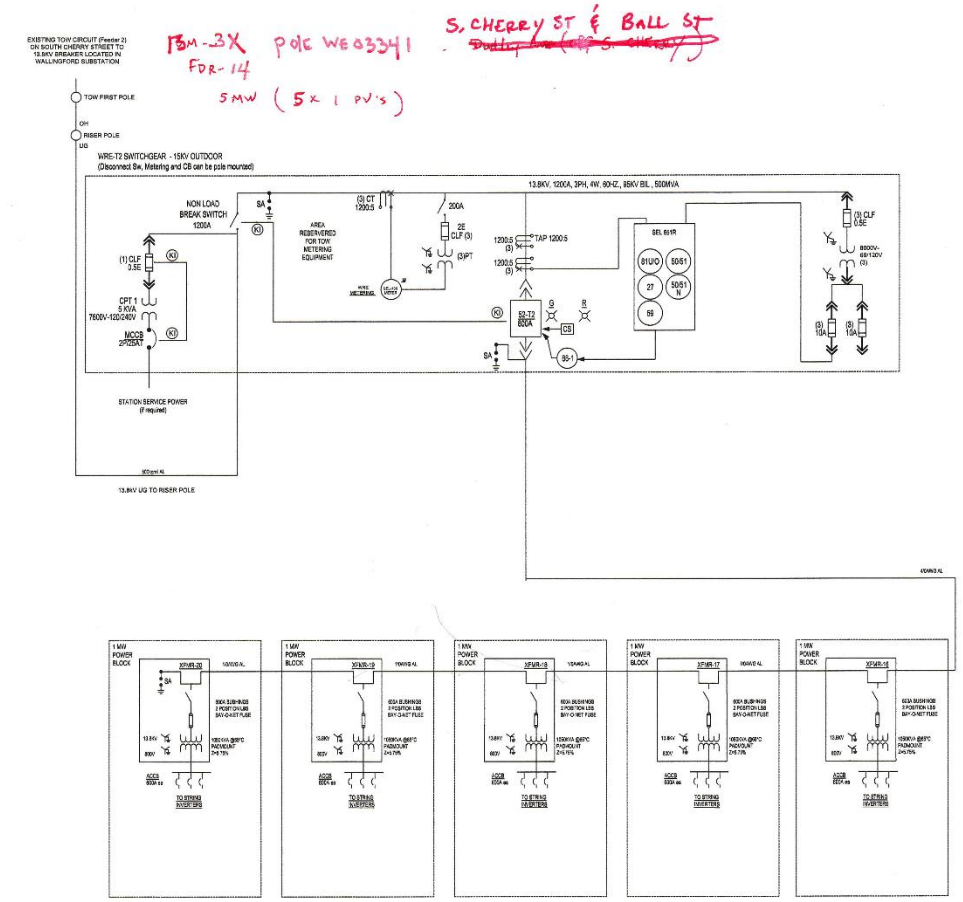
N

0 150 300
SCALE IN FEET

Figure 6
Proposed Project Layout

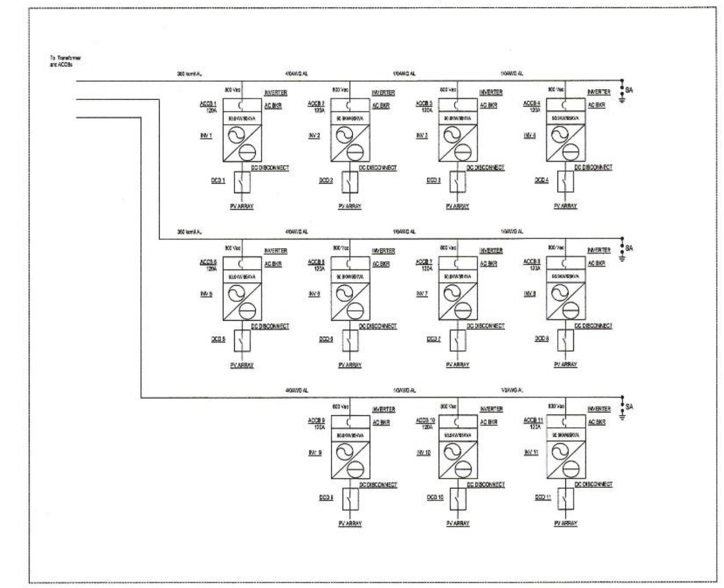
Wallingford Renewable Energy
Wallingford, CT

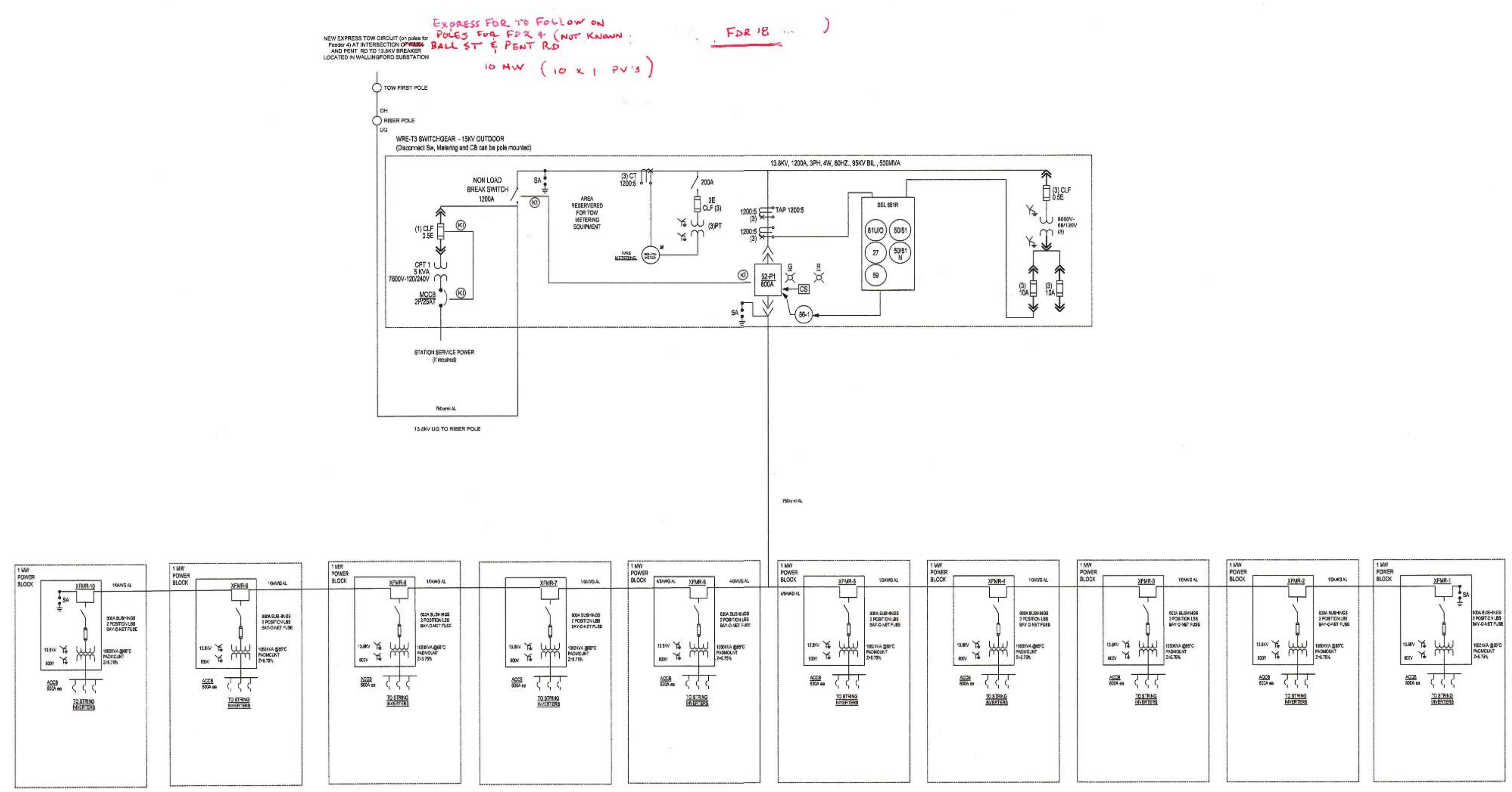




TYPICAL STRING INVERTER ARRANGEMENT PER 13.8/0.800kV TRANSFORMER

Thus 999.9kW per Transformer and for 20 transformers a project total of 19.99MWac





GENERAL NOTES

1. TYPICAL SCHEME TO INCLUDE 27–UNDER VOLTAGE, 59–OVERVOLTAGE, 81–OVER/UNDER FREQUENCY, 46–REVERSE/BALANCE PHASE, 50/51–INSTANTANEOUS/OVERCURRENT PROTECTION RELAY, BUT PROTECTION SCHEME FOR PV FACILITY TO BE DEVELOPED DURING DETAILED DESIGN WITH RESULTS OF IMPACT AND SYSTEM STUDIES.
2. AC VOLTAGE DROP TARGET LESS THAN 2% FROM INVERTER TO SWITCHGEAR LOCATION.
3. TRANSFORMER FUSE SIZE PER MANUFACTURER'S RECOMMENDATION DETERMINED DURING DETAILED DESIGN.
4. 1MW SKID CONSISTS OF ONE (1) 1050kVA TRANSFORMER AND FEEDS FROM UP TO ELEVEN (11) 800V UL1741 COMPLIANT STRING INVERTERS.
6. INVERTER POWER FACTOR IS VARIABLE TO MEET UTILITY REQUIREMENTS.
7. CLIENT REVENUE METER SPECIFIED AS A SEL–735 ADVANCED POWER QUALITY METER TO MONITOR AND CAPTURE ANY HARMONIC DISTURBANCE AND VOLTAGE/POWER RAMP DURING STARTUP OR SHUT DOWN.

DEVICE FUNCTION NUMBERS LEGEND:

- 27 UNDERVOLTAGE
- 50/51 INSTANTANEOUS & INVERSE TIME OVERCURRENT
- 59 OVERVOLTAGE
- 81U/O UNDER/OVERFREQUENCY
- 86 LOCKOUT SWITCH

ISSUE NO.	DATE	DESIGN	DRWN	CHKD	APP'D	ISSUED FOR

Wallingford Renewable Energy LLC

Suite 260, 909 Lake Carolyn Parkway, Irving, TX 75039

WRE 19.99MWac PV Solar

DRAWING

PRELIMINARY ONE LINE DIAGRAM

DESIGNED	DATE	DRAWING NO.	REV
	Jan 2018	SL-001	-
DRAWN	APPROVED		

SHEET 1 OF 1

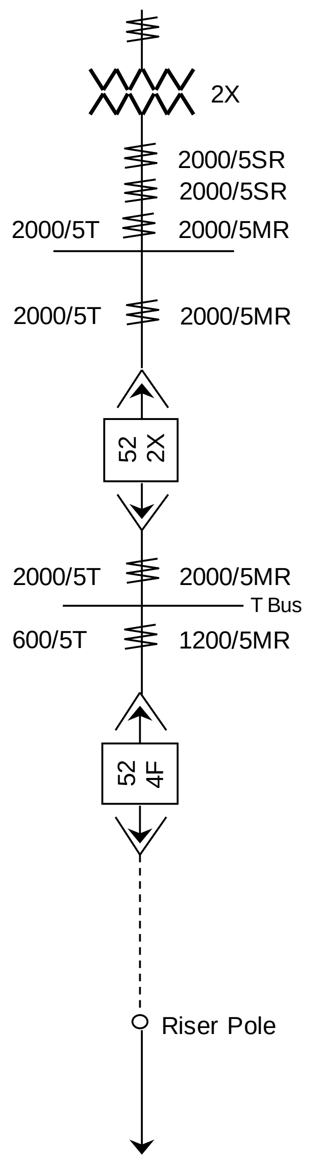
EXHIBIT 3

FEEDER RATINGS

WALLINGFORD ELECTRIC DIVISION

Substation	Wallingford 13M		
Feeder	Feeder #4	**Name**	PLM
Bus Voltage	13.8 kV	**Date**	8/28/2017

ONELINE



DEVICE	NAMEPLATE SIZE	CAPABILITY Normal S	CAPABILITY Normal W
Current Transformer	400 (CT)	3333	3333
Transformer	13M-2X	1883	1883
Current Transformer	2000 (CT)	2000	2000
Current Transformer	2000 (CT)	2000	2000
Current Transformer	2000 (CT)	2000	2000
Bus Conductor	2000 Amp Bus	2000	2000
Current Transformer	2000 (CT)	2000	2000
Circuit Breaker	2000A (BRK)	2000	2000
Current Transformer	2000 (CT)	2000	2000
Current Transformer	600 (CT)	600	600
Circuit Breaker	1200A (BRK)	1200	1200
UG Cable	750 CU EPR MV-105 (MH4A)	474	593
Other	Feeder 4 Riser Pole	500	676
OH Line	556 Al Spacer Cable - 15kV	639	639

Remarks:

Riser Pole & UG Cable Rating Assumptions:

- Unvented, RGS, 35ft riser
- Riser solar heating based on geographic location and absorbtivity of RGS conduit
- No cooling from wind (0 fps velocity) for the riser
- Ambient temps: Summer = 28C, Winter = 10C (ISO-NE PP07)
- No MH Survey data available for feeders #12&15, assumed worst case of 2x3 ductbank with each duct occupied by a single feeder
- Avg ductbank depth to center = 36"
- Thermal resistivity of soil = 90, concrete = 55 (units=C-cm/W)
- Loss factor = 0.3*(Load Factor) + 0.7*(Load Factor)^2
- Where load factor was unknown a value of 0.75 was assumed

Feeder Limits:

Normal Rating

Summer	Winter
474 A	**593 A**

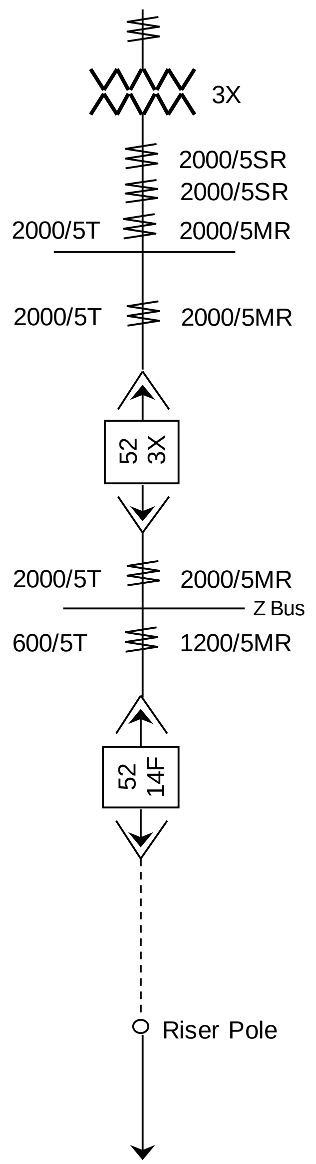
	Phase	Ground
Relay Safe Carry (90% of pick up values)	702	172.8

WALLINGFORD ELECTRIC DIVISION

Substation Wallingford 13M
Feeder Feeder #14
Bus Voltage 13.8 kV

Name PLM
Date 3/15/2018

ONELINE



DEVICE	NAMEPLATE SIZE	CAPABILITY Normal S	W
Current Transformer	400 (CT)	3333	3333
Transformer	13M-2X	1883	1883
Current Transformer	2000 (CT)	2000	2000
Current Transformer	2000 (CT)	2000	2000
Current Transformer	2000 (CT)	2000	2000
Bus Conductor	2000 Amp Bus	2000	2000
Current Transformer	2000 (CT)	2000	2000
Circuit Breaker	2000A (BRK)	2000	2000
Current Transformer	2000 (CT)	2000	2000
Current Transformer	600 (CT)	600	600
Circuit Breaker	1200A (BRK)	1200	1200
UG Cable	750 CU EPR MV-105 (MH32)	642	713
Other	Feeder 14 Riser Pole	500	676
OH Line	556 Al Spacer Cable - 15kV	639	639

Remarks:

Riser Pole & UG Cable Rating Assumptions:
- Unvented, RGS, 35ft riser
- Riser solar heating based on geographic location and absorbtivity of RGS conduit
- No cooling from wind (0 fps velocity) for the riser
- Ambient temps: Summer = 28C, Winter = 10C (ISO-NE PP07)
- No MH Survey data available for feeders #9&15, assumed worst case of 2x3 ductbank with each duct occupied by a single feeder
- Avg ductbank depth to center = 36"
- Thermal resistivity of soil = 90, concrete = 55 (units=C-cm/W)
- Loss factor = 0.3*(Load Factor) + 0.7*(Load Factor)^2
- Where load factor was unknown a value of 0.75 was assumed

Feeder Limits:

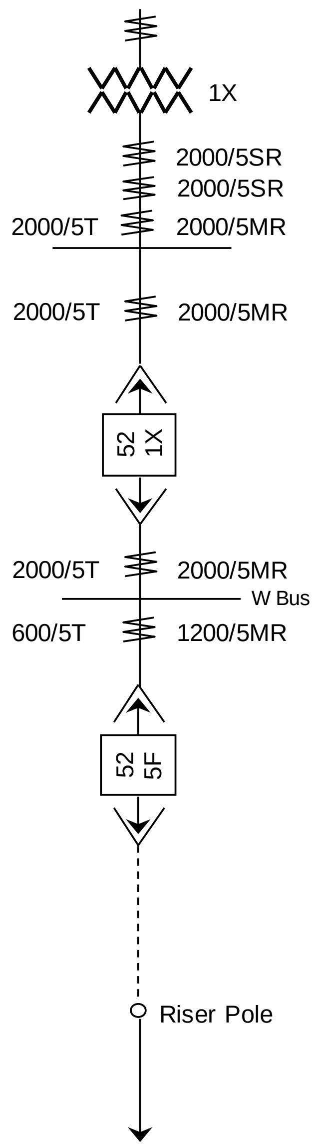
Normal Rating

Summer	Winter
500 A	**600 A**

Relay Safe Carry (90% of pick up values)	Phase	Ground
	648	216

WALLINGFORD ELECTRIC DIVISION

Substation Wallingford 13M
Feeder Feeder #18 — **By** PLM
Bus Voltage 13.8 kV — **Date** 2/4/2018



DEVICE	NAMEPLATE SIZE	CAPABILITY Normal Summer	CAPABILITY Normal Winter
Current Transformer	400 (CT)	3333	3333
Transformer	13M-2X	1883	1883
Current Transformer	2000 (CT)	2000	2000
Current Transformer	2000 (CT)	2000	2000
Current Transformer	2000 (CT)	2000	2000
Bus Conductor	2000 Amp Bus	2000	2000
Current Transformer	2000 (CT)	2000	2000
Circuit Breaker	2000A (BRK)	2000	2000
Current Transformer	2000 (CT)	2000	2000
Current Transformer	600 (CT)	600	600
Circuit Breaker	1200A (BRK)	1200	1200
UG Cable	750 CU EPR MV-105 (MH4A)	478	629
Other	Feeder 15 Riser Pole	500	676
OH Line	556 Al Spacer Cable - 15kV	639	639

Remarks:

Riser Pole & UG Cable Rating Assumptions:
- Unvented, RGS, 35ft riser
- Riser solar heating based on geographic location and absorbtivity of RGS conduit
- No cooling from wind (0 fps velocity) for the riser
- Ambient temps: Summer = 28C, Winter = 10C (ISO-NE PP07)
- No MH Survey data available for feeders #9&15, assumed worst case of 2x3 ductbank with each duct occupied by a single feeder
- Avg ductbank depth to center = 36"
- Thermal resistivity of soil = 90, concrete = 55 (units=C-cm/W)
- Loss factor = 0.3*(Load Factor) + 0.7*(Load Factor)^2
- Where load factor was unknown a value of 0.75 was assumed

Feeder Limits:

Normal Rating

Summer	Winter
478 A	**600 A**

Relay Safe Carry (90% of pick up values)	Phase	Ground
	864	288

EXHIBIT 4

SHORT CIRCUIT MAGNITUDES PRE & POST FACILITY

Wallingford Electric Division

Yg–Yg Interconnection Transformers

Fault Location	Fault Type	Existing Fault Magnitudes I (kA)	Existing Fault Magnitudes X/R	PV in Service Fault Magnitudes I (kA)	PV in Service Fault Magnitudes X/R	Fault contribution from PV (Amps @ 13.8 kV)	Available Fault Current % Increase
115 kV A1 Bus	3LG	24.921	12.4	25.064	12.5	285A from Feeder 2 PV 285A from Feeder 4 PV 566A from Feeder 18 PV	0.57%
115 kV A1 Bus	1LG	22.207	11.6	22.245	11.6	84A from Feeder 2 PV 84A from Feeder 4 PV 168A from Feeder 18 PV	0.17%
115 kV A2 Bus	3LG	24.921	12.4	25.064	12.5	285A from Feeder 2 PV 285A from Feeder 4 PV 566A from Feeder 18 PV	0.57%
115 kV A2 Bus	1LG	22.207	11.6	22.245	11.6	84A from Feeder 2 PV 84A from Feeder 4 PV 168A from Feeder 18 PV	0.17%
13.8 kV "W" Bus	3LG	9.226	279.8	9.852	268.2	625A from Feeder 18 PV	6.79%
13.8 kV "W" Bus	1LG	9.364	413.5	9.570	409.3	202A from Feeder 18 PV	2.20%

Wallingford Electric Division

Yg–Yg Interconnection Transformers

		Existing Fault Magnitudes		PV in Service Fault Magnitudes			
13.8 kV "T" Bus	3LG	11.534	223.8	12.161	222.5	312A from Feeder 2 PV 314A from Feeder 4 PV	5.44%
13.8 kV "T" Bus	1LG	11.751	329.5	11.961	331.3	102A from Feeder 2 PV 103A from Feeder 4 PV	1.79%
13.8 kV "Z" Bus	3LG	11.065	223.6	11.065	223.6	negligible	0.00%
13.8 kV "Z" Bus	1LG	11.274	329.2	11.274	329.2	negligible	0.00%
13.8 kV "V" Bus	3LG	8.516	290.5	8.516	290.5	negligible	0.00%
13.8 kV "V" Bus	1LG	8.639	429.5	8.639	429.5	negligible	0.00%

Wallingford Electric Division

Yg–Yg Interconnection Transformers

		Existing Fault Magnitudes		**PV in Service Fault Magnitudes**			
13.8 kV PCC Feeder 2 Solar	3LG	7.531	6.1	8.083	5.7	317A from Feeder 2 PV 206A from Feeder 4 PV	7.33%
13.8 kV PCC Feeder 2 Solar	1LG	5.173	4.3	5.238	4.1	68A from Feeder 2 PV 45A from Feeder 4 PV	1.26%
13.8 kV PCC Feeder 4 Solar	3LG	9.178	11.1	9.689	10.1	247A from Feeder 2 PV 317A from Feeder 4 PV	5.57%
13.8 kV PCC Feeder 4 Solar	1LG	7.330	8.1	7.435	7.6	63A from Feeder 2 PV 81A from Feeder 4 PV	1.43%
13.8 kV PCC Feeder 18 Solar	3LG	7.660	12.4	8.291	13.5	633A from Feeder 18 PV	8.24%
13.8 kV PCC Feeder 18 Solar	1LG	6.331	8.9	6.467	9.0	165A from Feeder 18 PV	2.15%

Wallingford Electric Division

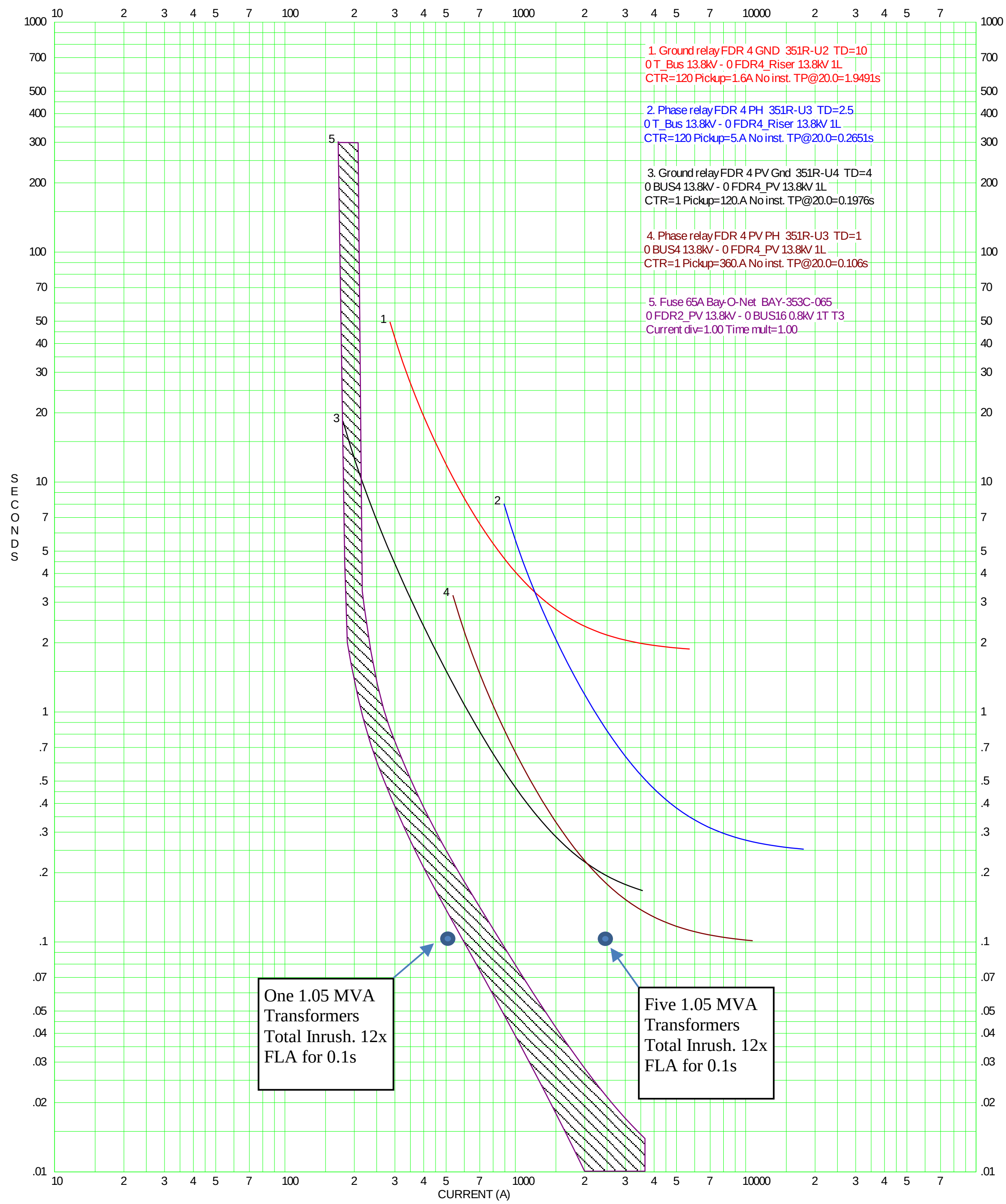
Yg–Yg Interconnection Transformers

		Existing Fault Magnitudes		**PV in Service Fault Magnitudes**			
Feeder #2 800 V Transformer Secondary	3LG	--	--	13.236 (800V)	79.4	--	--
Feeder #2 800 V Transformer Secondary	1LG	--	--	11.874 (800V)	33.2	--	--
Feeder #4 800 V Transformer Secondary	3LG	--	--	13.403	155.5	--	--
Feeder #4 800 V Transformer Secondary	1LG	--	--	12.313	83.1	--	--
Feeder #18 800 V Transformer Secondary	3LG	--	--	13.251	165.6	--	--
Feeder #18 800 V Transformer Secondary	1LG	--	--	12.145	84.0	--	--

EXHIBIT 5

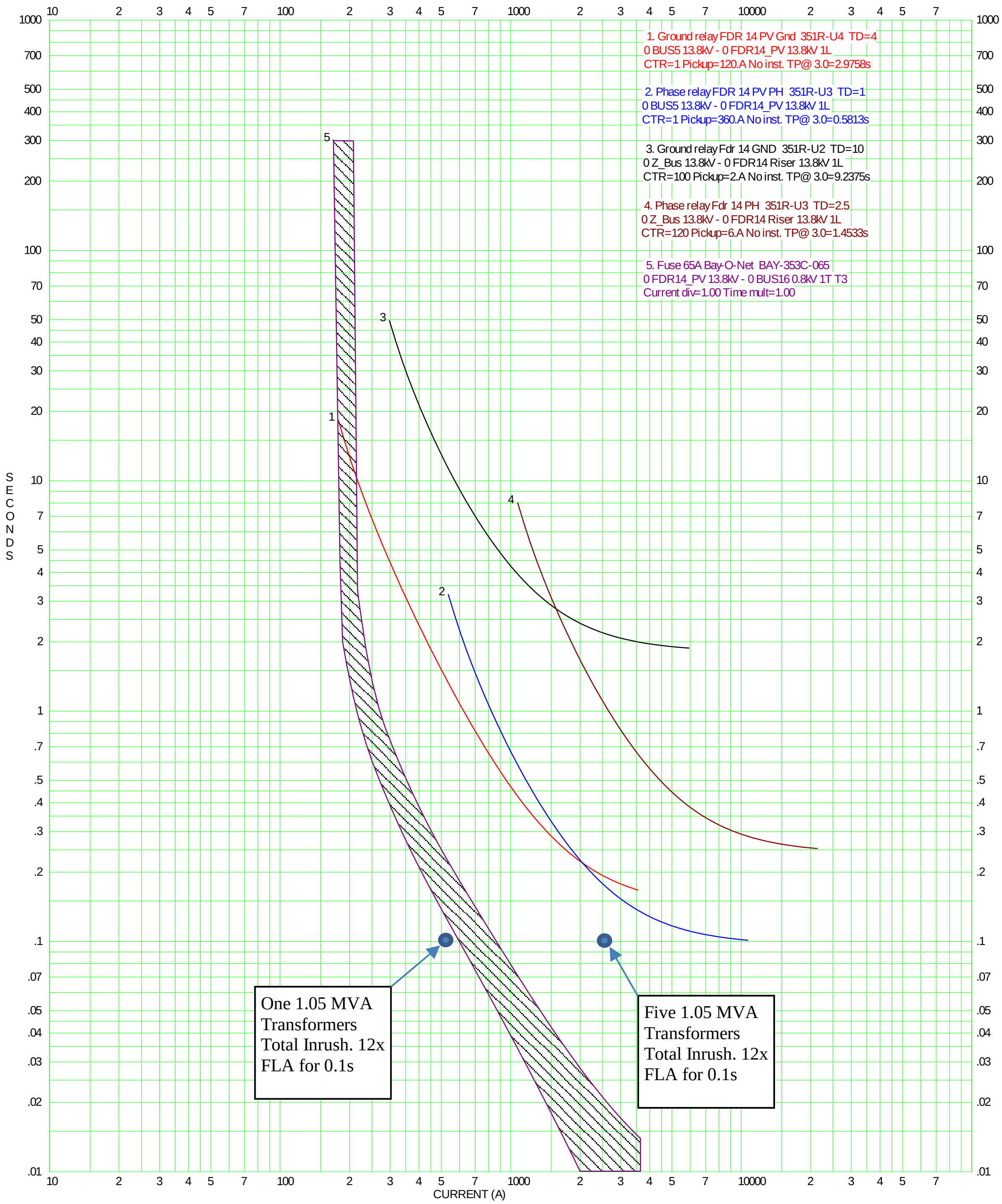
TCC PLOTS

Feeder #4 Proposed Overcurrent Settings – TCC Plot



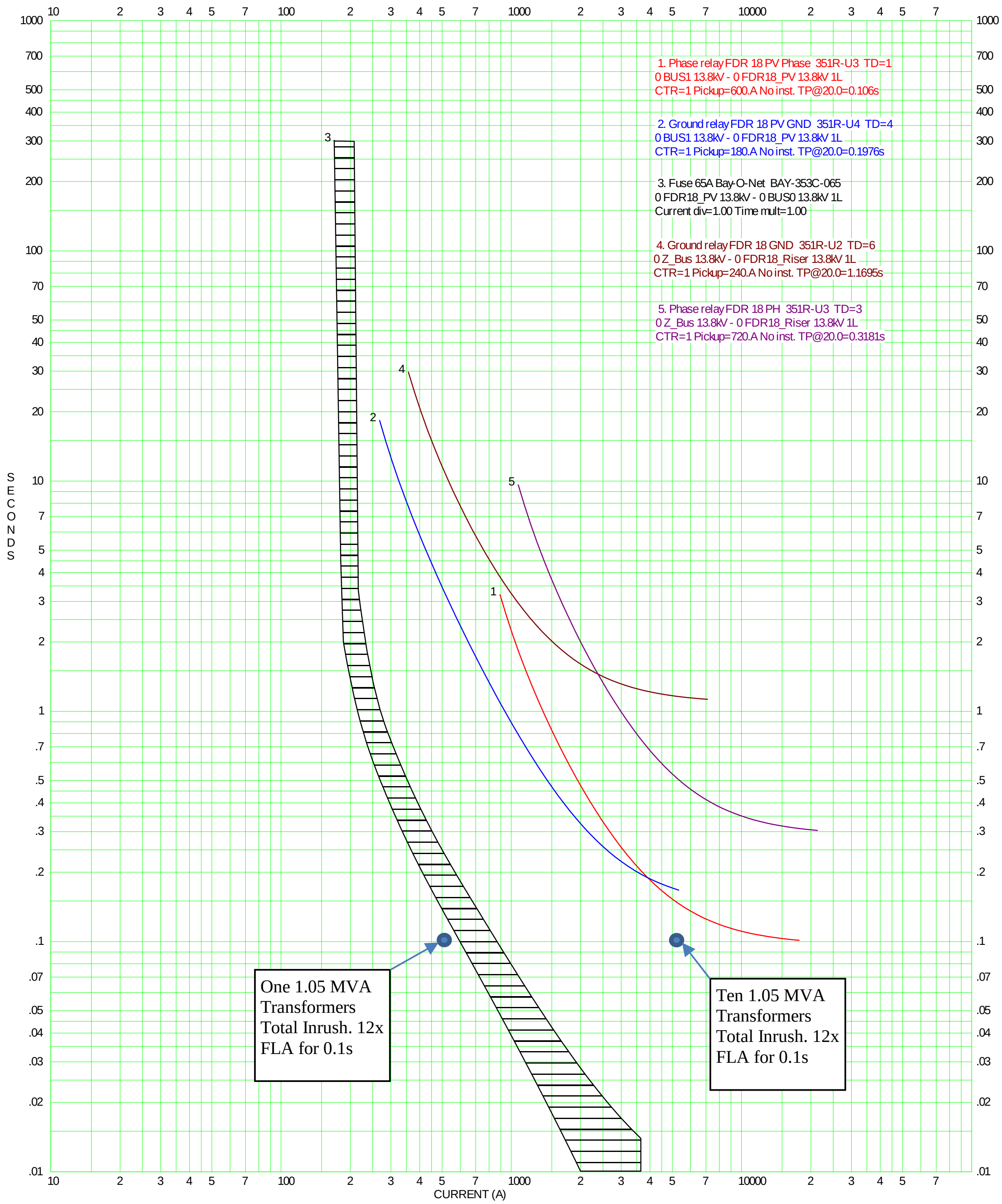
TIME-CURRENT CURVES @ Voltage 13.8 kV	By PLM
For WALLINGFORD ELECTRIC DIVISION	No. FDR 4
Comment PROPOSED FEEDER 4 OVERCURRENT COORDINATION	Date 2/2018

Feeder #14 Proposed Overcurrent Settings – TCC Plot



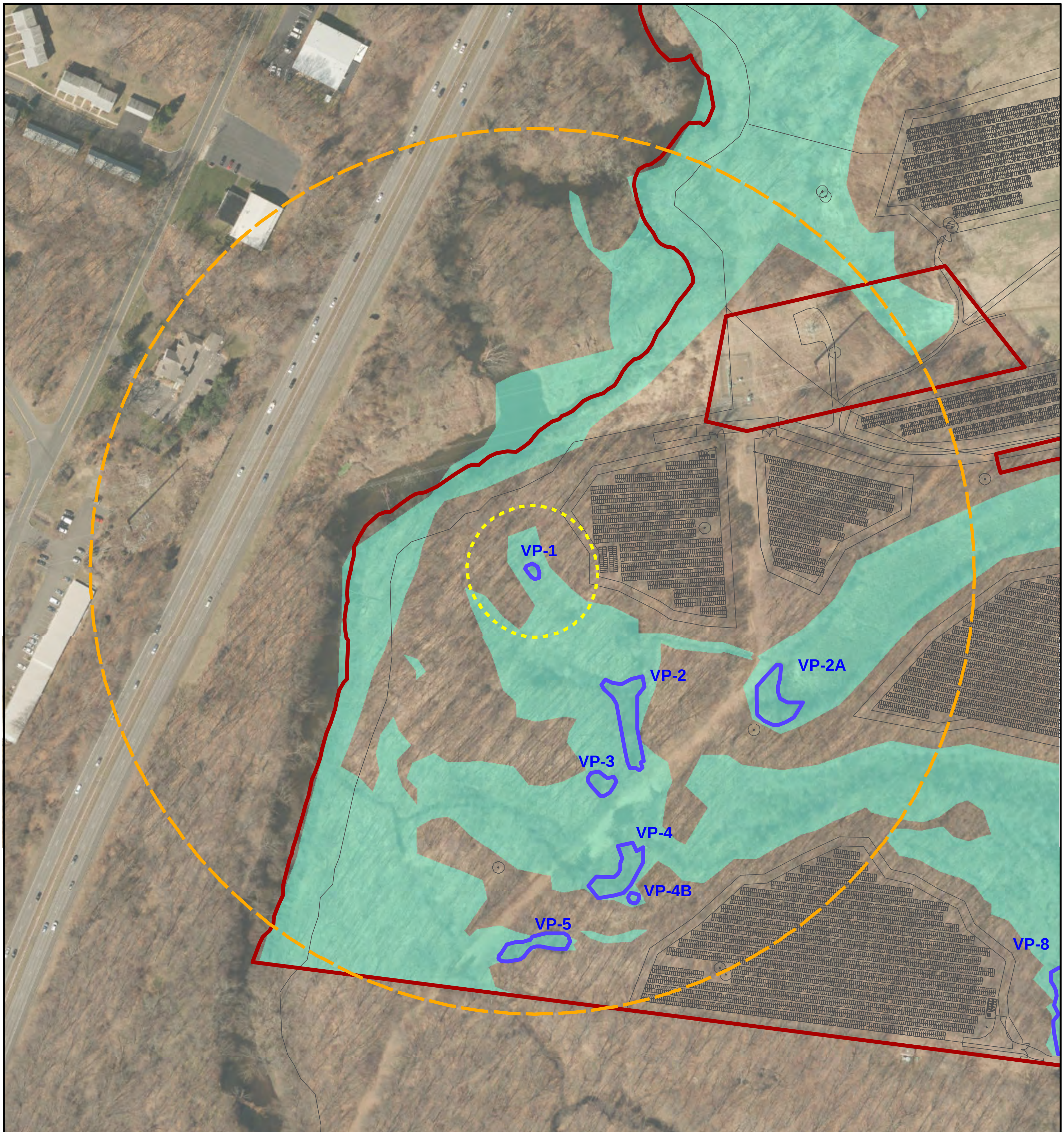
TIME-CURRENT CURVES @ Voltage 13.8 kV		By	PLM
For	WALLINGFORD ELECTRIC DIVISION	No.	FDR 14
Comment	PROPOSED FEEDER 14 OVERCURRENT COORDINATION	Date	3/2018

FEEDER #18 PROPOSED OVERCURRENT SETTINGS – TCC PLOT



TIME-CURRENT CURVES @ Voltage 13.8 kV		By PLM
For	WALLINGFORD ELECTRIC DIVISION	No. FDR 18
Comment	PROPOSED FEEDER 18 OVERCURRENT COORDINATION	Date 2/2018

ATTACHMENT D



Project Area
Vernal Pool Habitat
Vernal Pool Envelope (100-foot buffer)
Critical Terrestrial Habitat (750-foot buffer)
Delineated Wetland

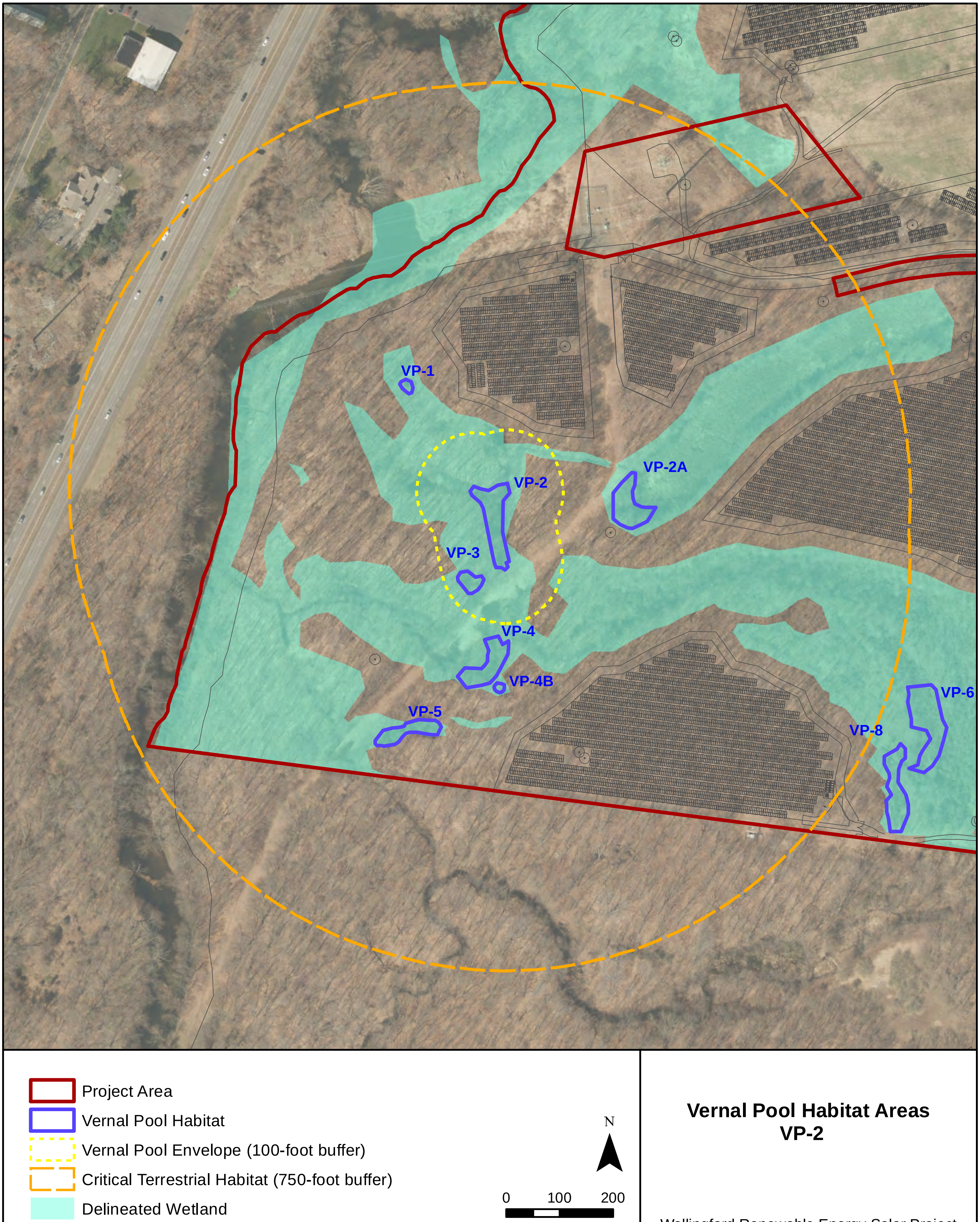
N

0 100 200
Feet

Vernal Pool Habitat Areas
VP-1

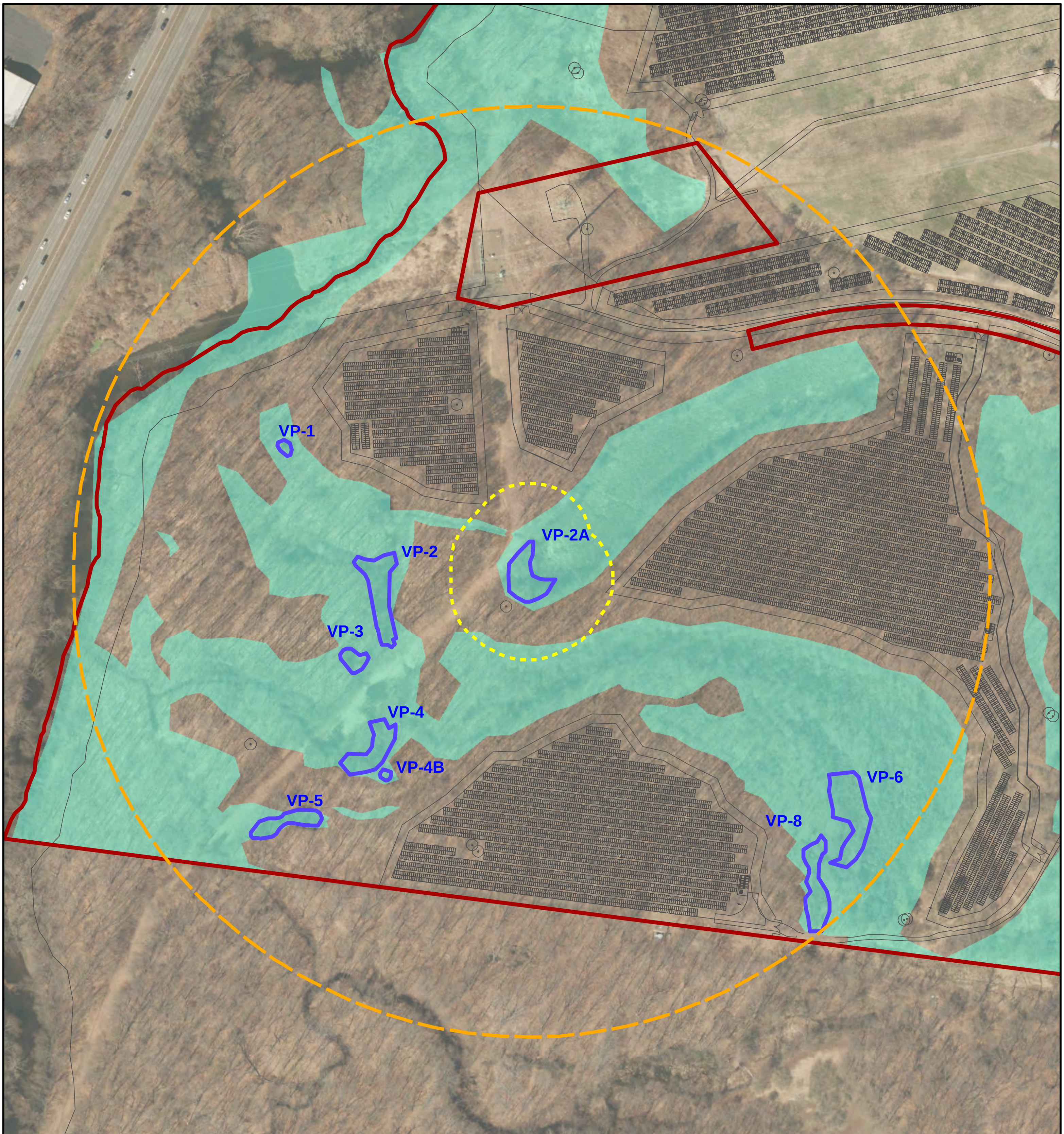
Wallingford Renewable Energy Solar Project
Wallingford, CT

R:\PROJECTS\WALLINGFORD_9002\GENERAL\MAPS\Vernal_Pools_mapbook_20190318.mxd



Vernal Pool Habitat Areas
VP-2

Wallingford Renewable Energy Solar Project
Wallingford, CT



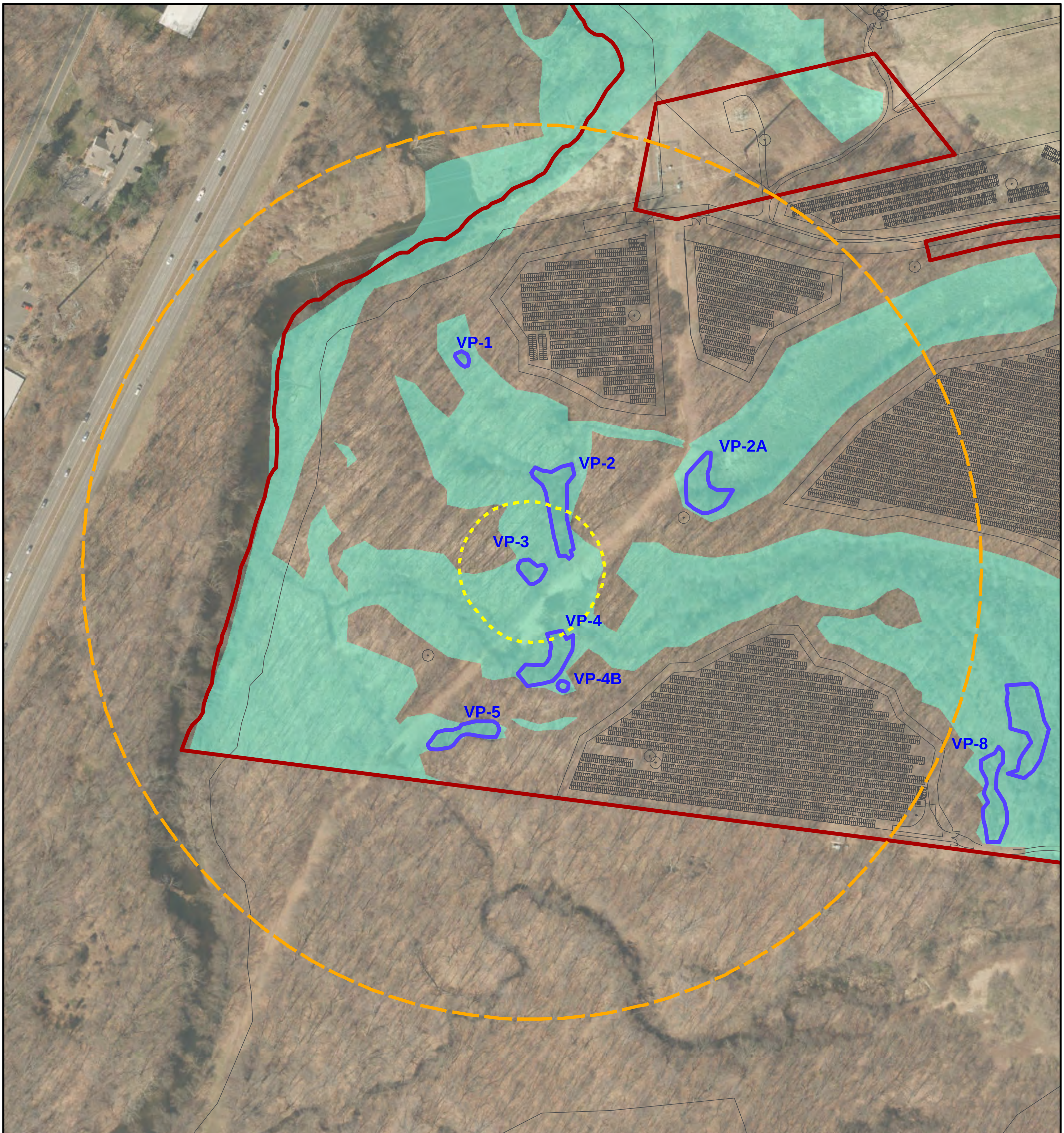
Project Area
Vernal Pool Habitat
Vernal Pool Envelope (100-foot buffer)
Critical Terrestrial Habitat (750-foot buffer)
Delineated Wetland

N
0 100 200
Feet

Vernal Pool Habitat Areas
VP-2A

Wallingford Renewable Energy Solar Project
Wallingford, CT

R:\PROJECTS\WALLINGFORD_9002\GENERAL\MAPS\Vernal_Pools_mapbook_20190318.mxd



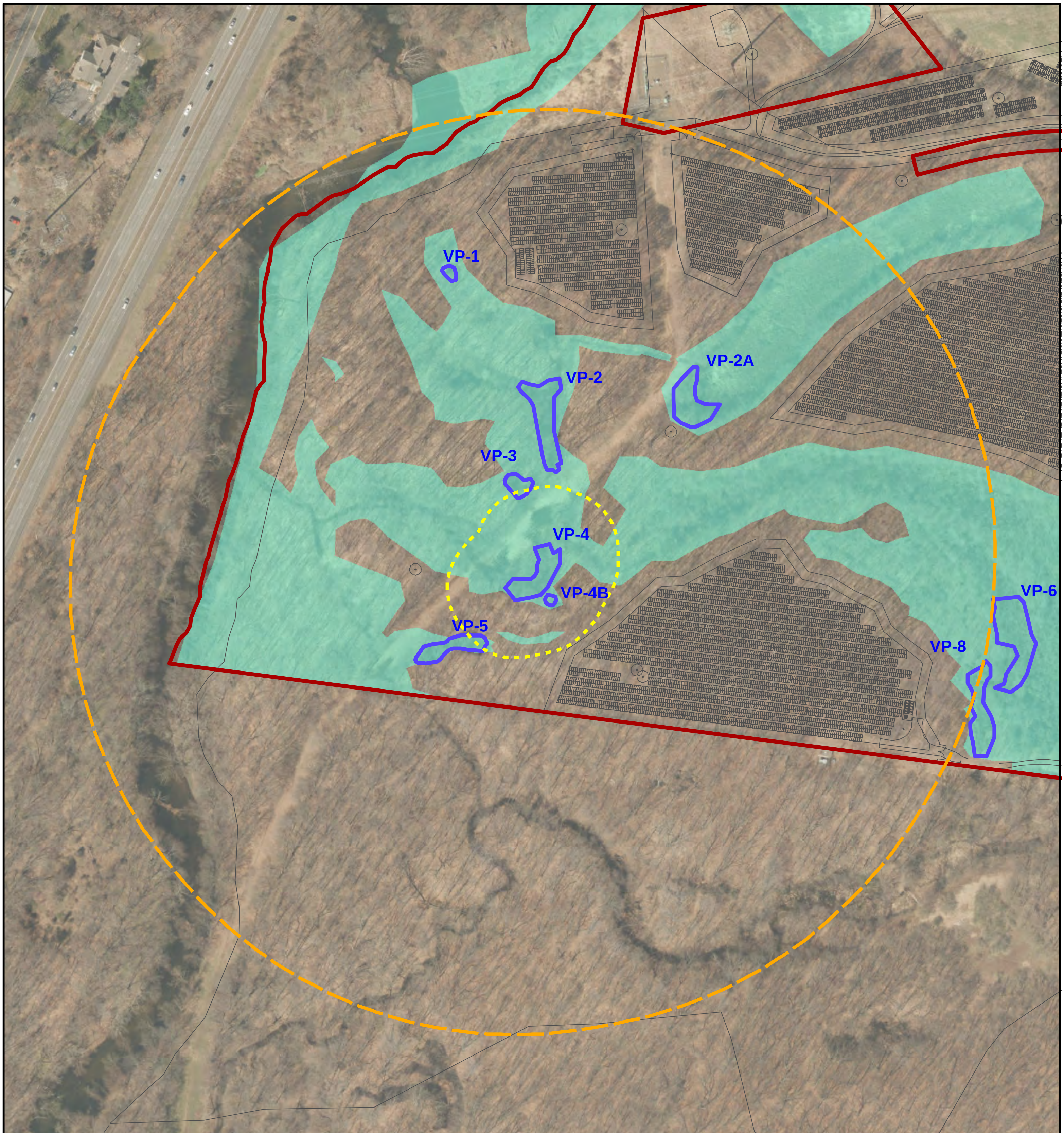
Project Area
Vernal Pool Habitat
Vernal Pool Envelope (100-foot buffer)
Critical Terrestrial Habitat (750-foot buffer)
Delineated Wetland

N

0 100 200
Feet

Vernal Pool Habitat Areas
VP-3

Wallingford Renewable Energy Solar Project
Wallingford, CT



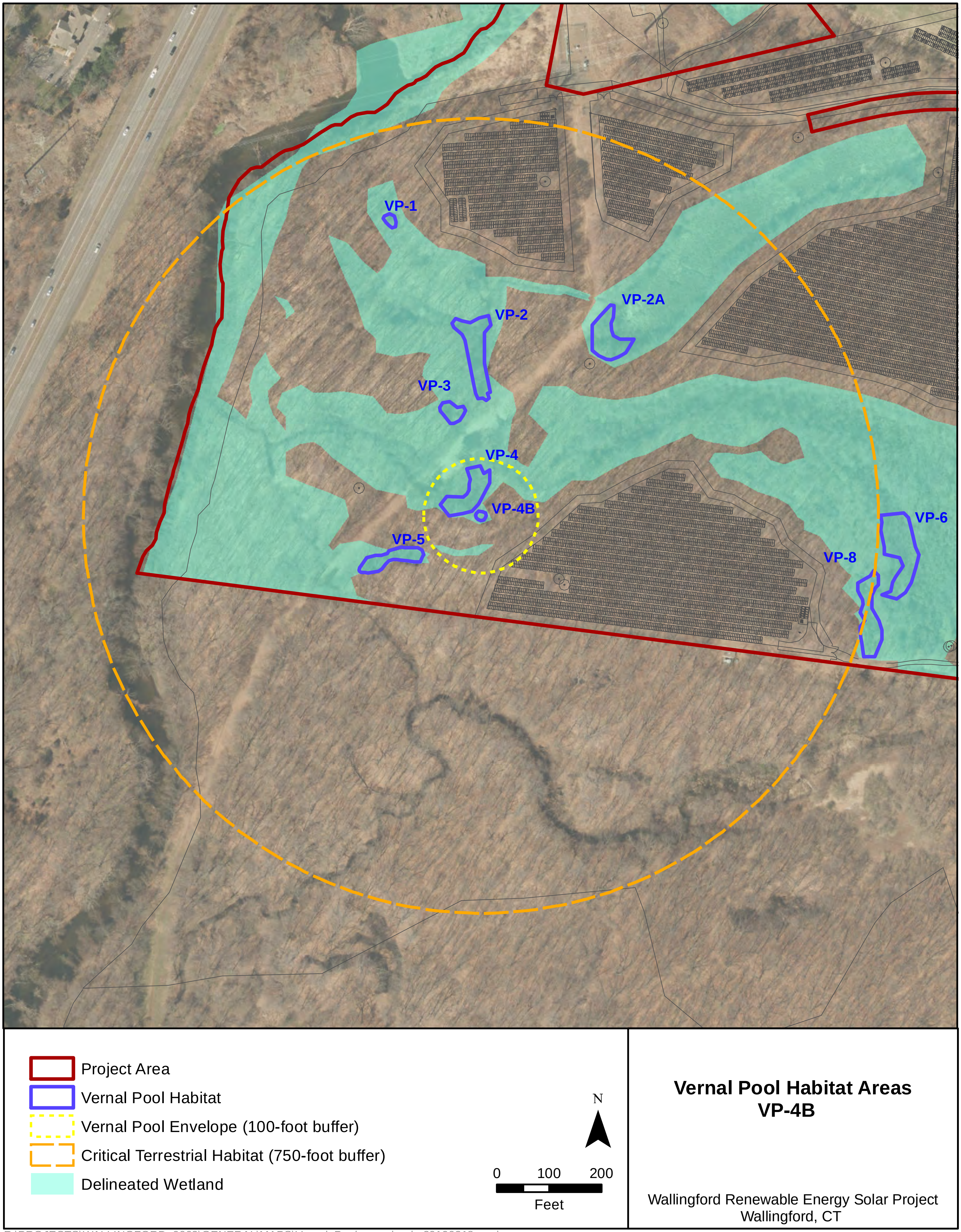
Project Area
Vernal Pool Habitat
Vernal Pool Envelope (100-foot buffer)
Critical Terrestrial Habitat (750-foot buffer)
Delineated Wetland

N
0 100 200
Feet

Vernal Pool Habitat Areas
VP-4

Wallingford Renewable Energy Solar Project
Wallingford, CT

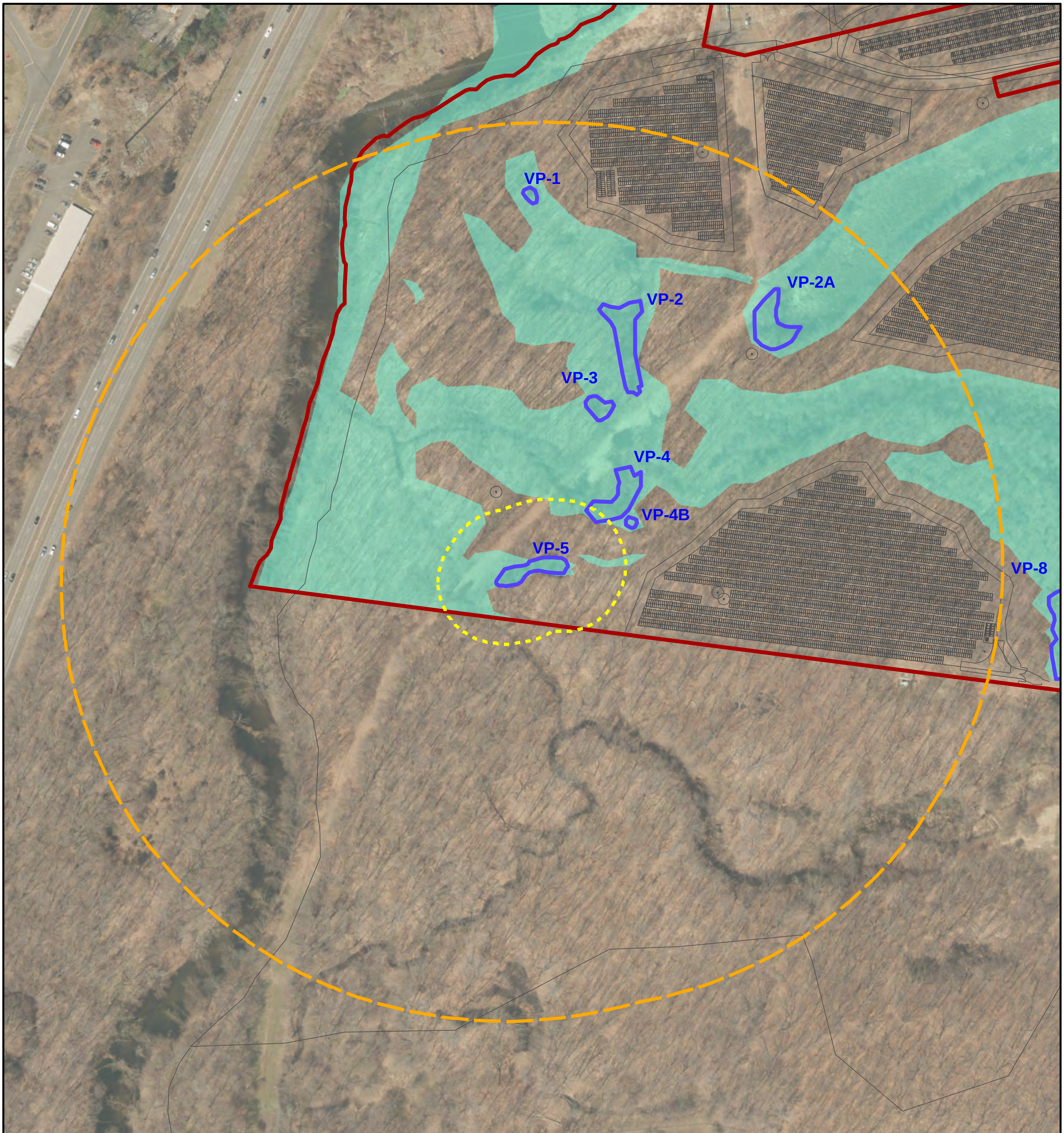
R:\PROJECTS\WALLINGFORD_9002\GENERAL\MAPS\Vernal_Pools_mapbook_20190318.mxd



Vernal Pool Habitat Areas
VP-4B

Wallingford Renewable Energy Solar Project
Wallingford, CT

R:\PROJECTS\WALLINGFORD_9002\GENERAL\MAPS\Vernal_Pools_mapbook_20190318.mxd



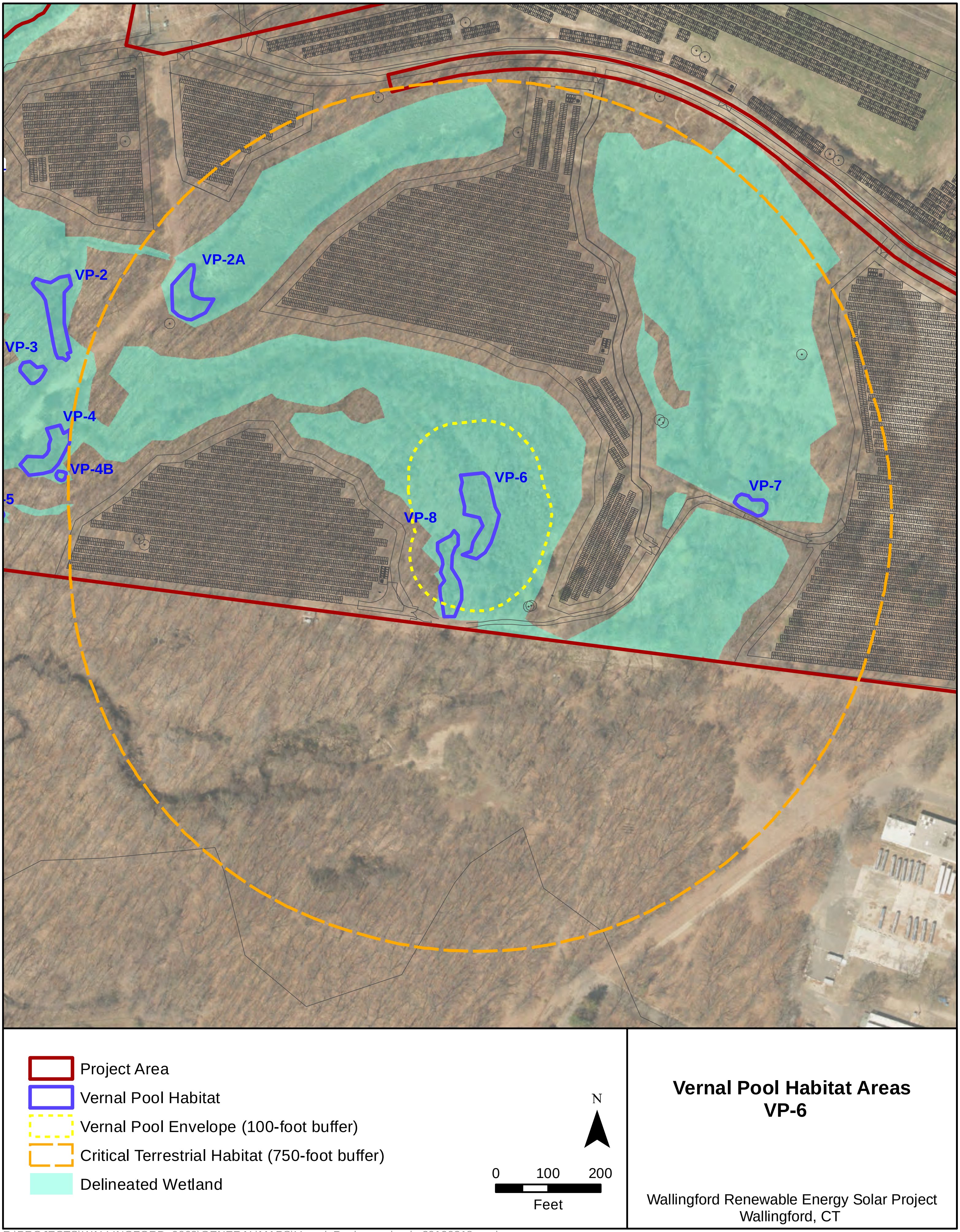
Project Area
Vernal Pool Habitat
Vernal Pool Envelope (100-foot buffer)
Critical Terrestrial Habitat (750-foot buffer)
Delineated Wetland

N

0 100 200
Feet

Vernal Pool Habitat Areas
VP-5

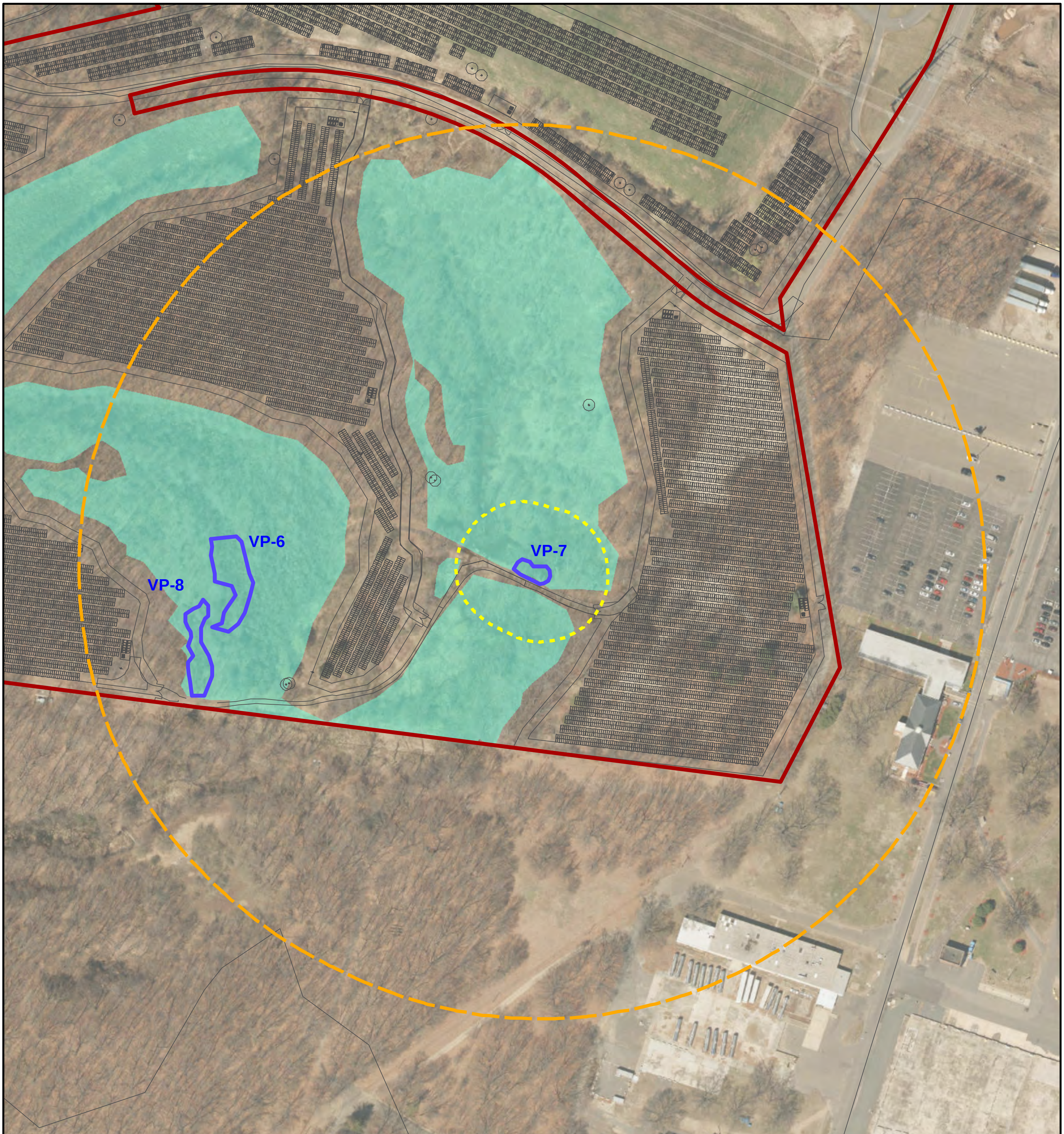
Wallingford Renewable Energy Solar Project
Wallingford, CT



Vernal Pool Habitat Areas
VP-6

Wallingford Renewable Energy Solar Project
Wallingford, CT

R:\PROJECTS\WALLINGFORD_9002\GENERAL\MAPS\Vernal_Pools_mapbook_20190318.mxd



Project Area
Vernal Pool Habitat
Vernal Pool Envelope (100-foot buffer)
Critical Terrestrial Habitat (750-foot buffer)
Delineated Wetland

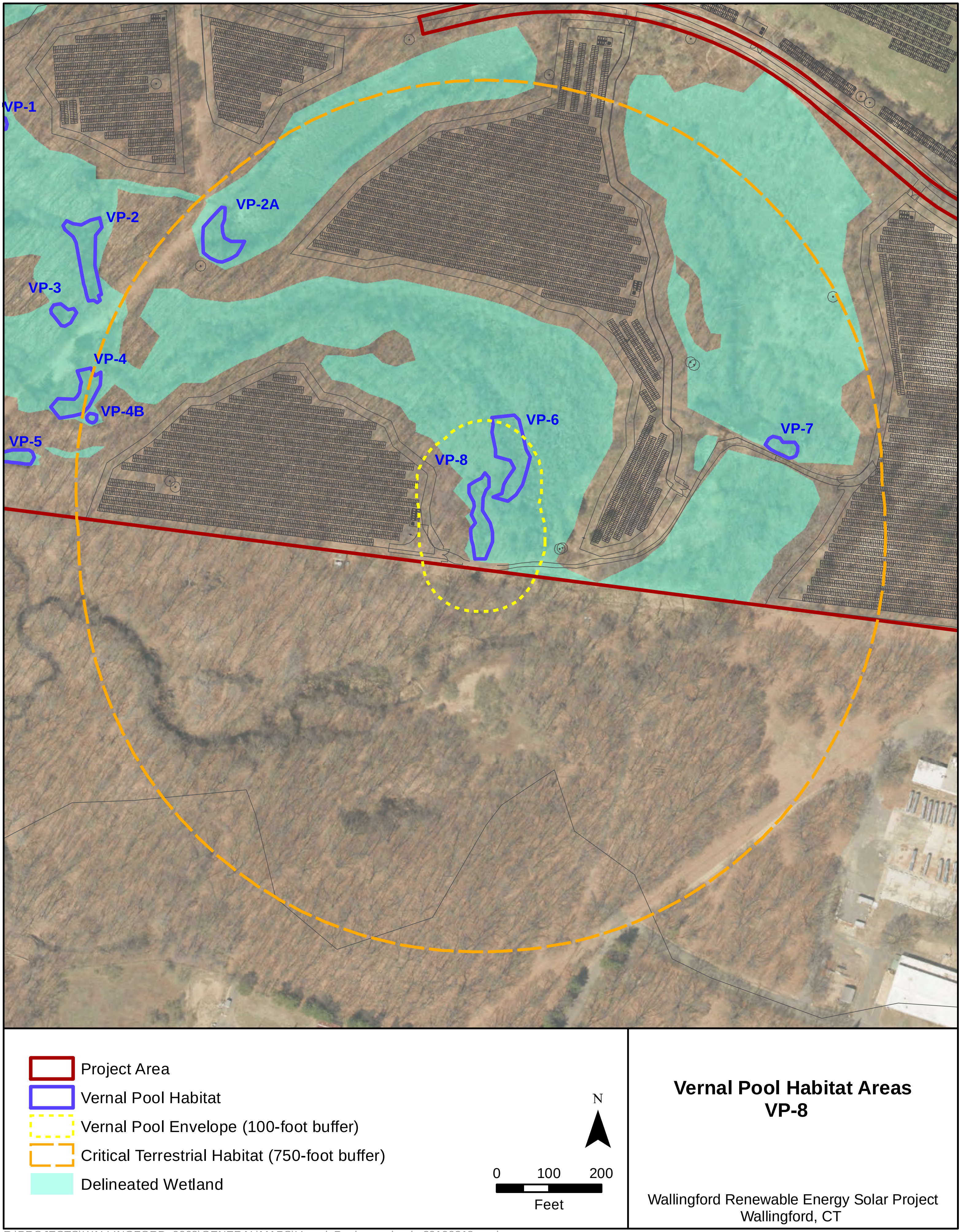
N

0 100 200
Feet

Vernal Pool Habitat Areas
VP-7

Wallingford Renewable Energy Solar Project
Wallingford, CT

R:\PROJECTS\WALLINGFORD_9002\GENERAL\MAPS\Vernal_Pools_mapbook_20190318.mxd



Vernal Pool Habitat Areas
VP-8

Wallingford Renewable Energy Solar Project
Wallingford, CT

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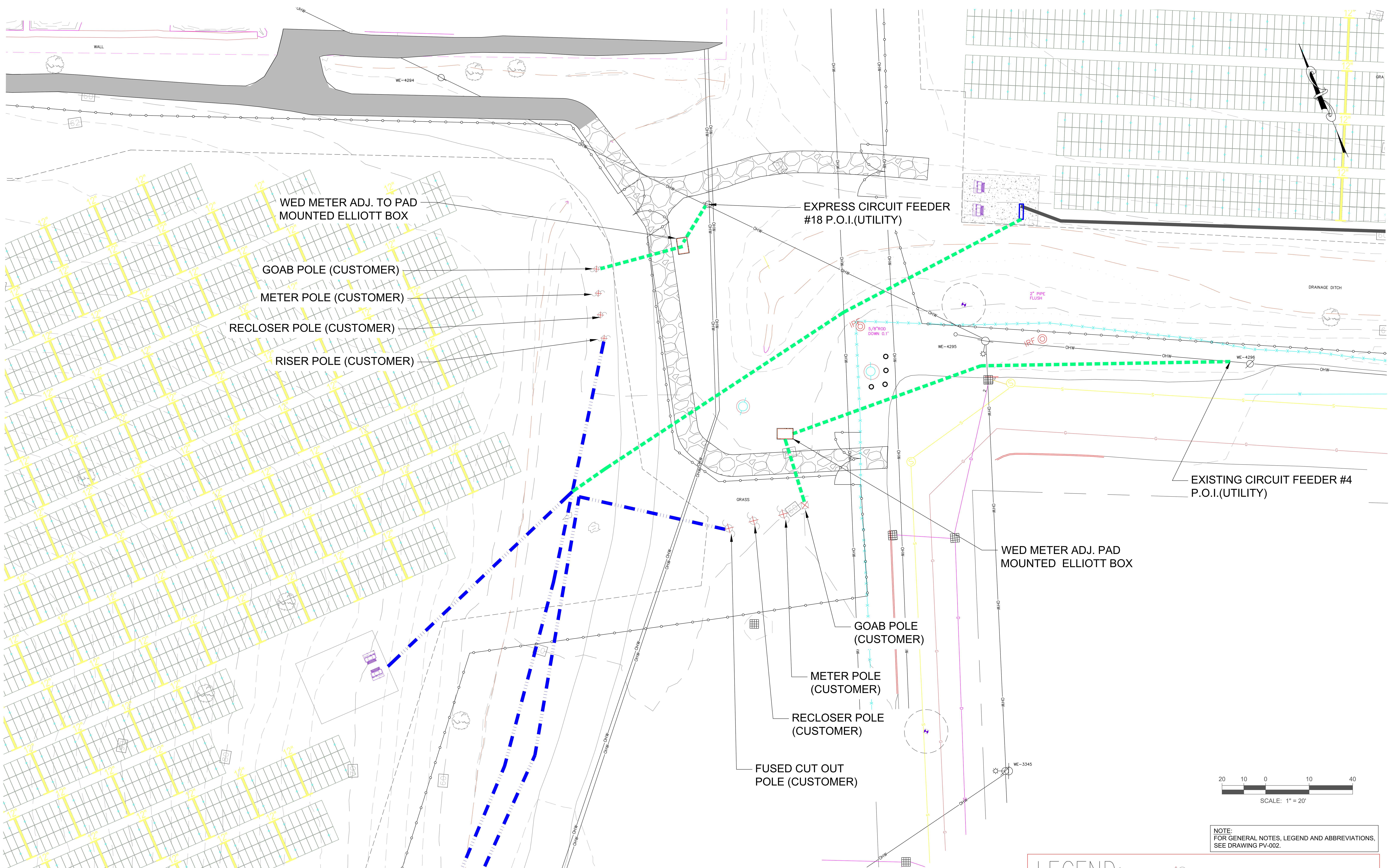

NOTE:
FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS, SEE DRAWING PV-002.

LEGEND:

OVERHEAD POLE	M.V. IN TRAY
PV MODULES	
TRANSFORMER	
OVH. M.V.	
FENCE	
EASEMENTS	
UNDRGRD M.V.	

SEAL

REV.#	DESCRIPTION	DATE
A	ISSUED FOR CLIENT REVIEW	01/08/2019
B	REISSUED FOR REVIEW	01/08/2019
C	ISSUED FOR UTILITY REVIEW	02/07/2019

conEdison Solutions
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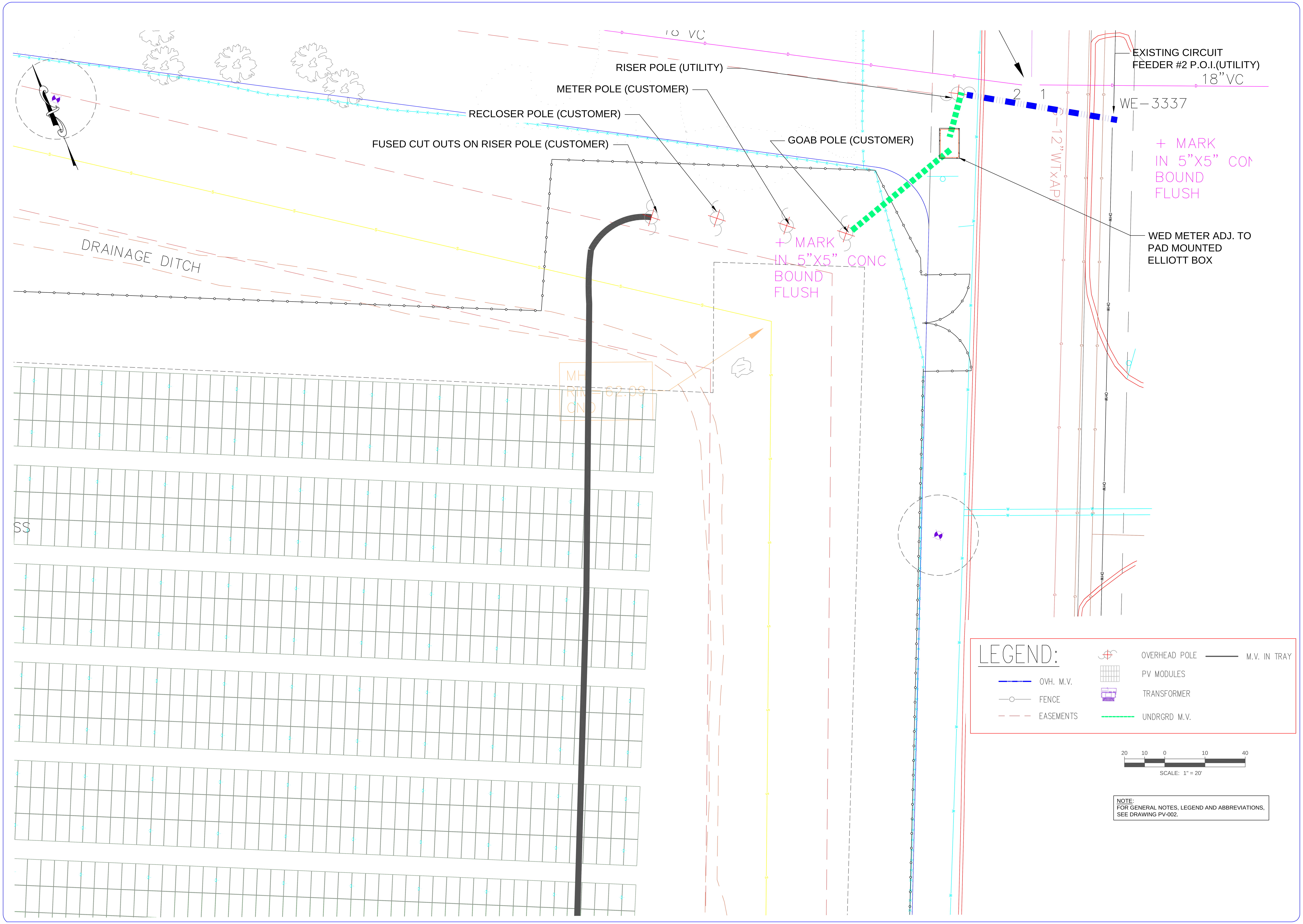
100 SUMMIT LAKE DRIVE, SUITE 200
VALHALLA, NY 10595
OFFICE: (914) 286-7000 FAX: (914) 448-0057
CERTIFICATE OF AUTHORIZATION #4479

WALLINGFORD RENEWABLE ENERGY LLC

25 Pent Road, Wallingford, CT

DRAWING TITLE:
MEDIUM VOLTAGE INTERCONNECT A& B EQUIPMENT PLAN

FILE:	PV40.dwg
JOB NO.:	N/A
DATE :	01/08/19
PLOT SIZE:	
DRAWN BY:	NG
CHECKED BY:	GN
SHEET No.:	PV41



NOTE:
FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS, SEE DRAWING PV-002.

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VALHALLA, NY 10595
OFFICE: (914) 286-7000 FAX: (914) 448-0057
CERTIFICATE OF AUTHORIZATION #4479

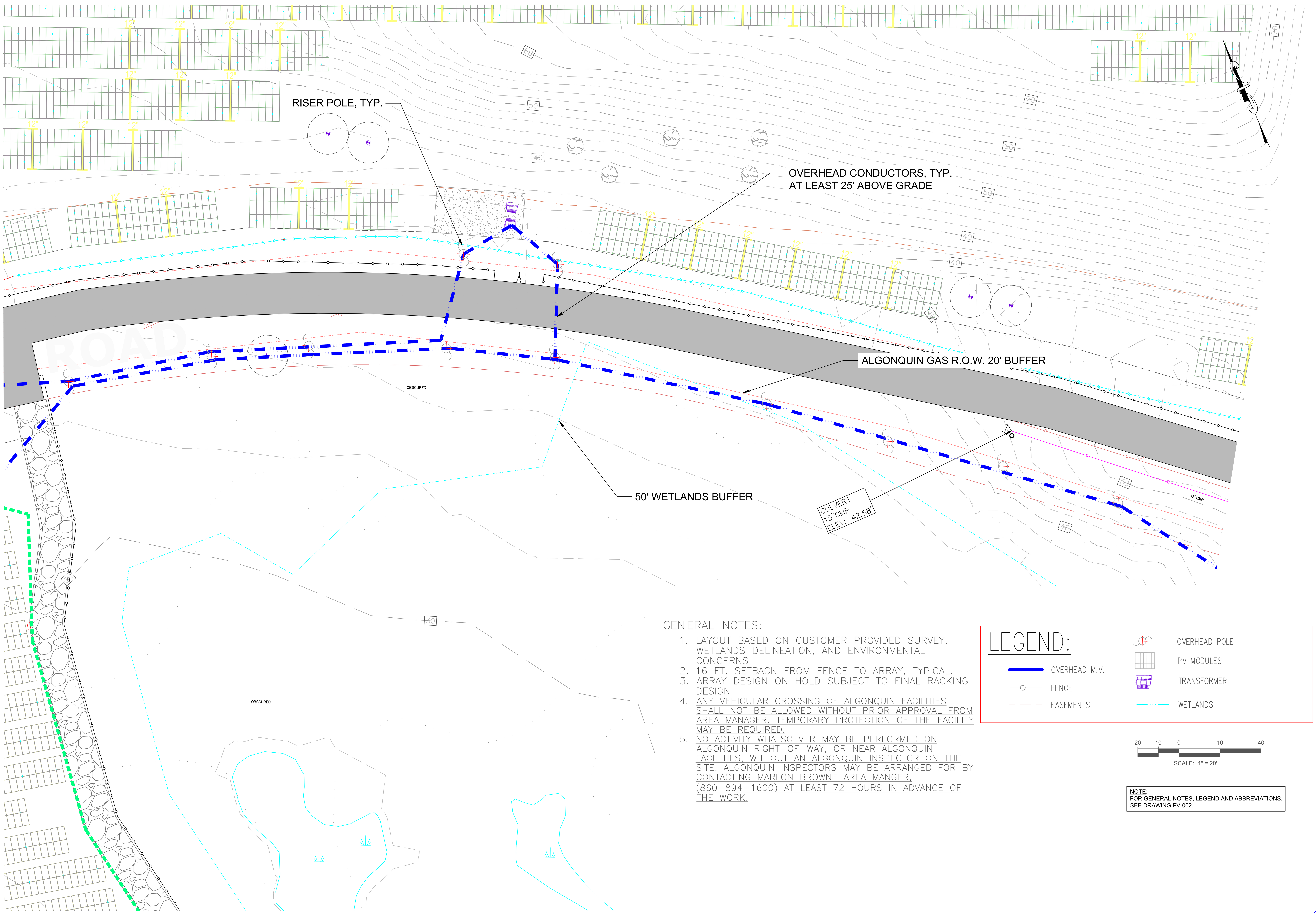
REV.#	DESCRIPTION	DATE
A	ISSUED FOR CLIENT REVIEW	01/08/2019
B	UPDATED PER UTILITY COMMENTS	01/15/2019
C	ISSUED FOR UTILITY REVIEW	02/07/2019
D	UPDATED PER CUSTOMER COMMENTS	02/12/2019

WALLINGFORD RENEWABLE ENERGY LLC
25 Pent Road, Wallingford, CT

DRAWING TITLE:
MEDIUM VOLTAGE INTERCONNECT EQUIPMENT PLAN -C

FILE:	PV40.dwg
JOB NO.:	N/A
DATE :	01/08/19
PLOT SIZE:	
DRAWN BY:	NG
CHECKED BY:	GN

SHEET No.:
PV42



GENERAL NOTES:

1. LAYOUT BASED ON CUSTOMER PROVIDED SURVEY, WETLANDS DELINEATION, AND ENVIRONMENTAL CONCERNS
2. 16 FT. SETBACK FROM FENCE TO ARRAY, TYPICAL.
3. ARRAY DESIGN ON HOLD SUBJECT TO FINAL RACKING DESIGN
4. ANY VEHICULAR CROSSING OF ALGONQUIN FACILITIES SHALL NOT BE ALLOWED WITHOUT PRIOR APPROVAL FROM AREA MANAGER. TEMPORARY PROTECTION OF THE FACILITY MAY BE REQUIRED.
5. NO ACTIVITY WHATSOEVER MAY BE PERFORMED ON ALGONQUIN RIGHT-OF-WAY, OR NEAR ALGONQUIN FACILITIES, WITHOUT AN ALGONQUIN INSPECTOR ON THE SITE. ALGONQUIN INSPECTORS MAY BE ARRANGED FOR BY CONTACTING MARLON BROWNE AREA MANGER, (860-894-1600) AT LEAST 72 HOURS IN ADVANCE OF THE WORK.

LEGEND:

- OVERHEAD M.V.
- FENCE
- EASEMENTS
- OVERHEAD POLE
- PV MODULES
- TRANSFORMER
- WETLANDS

20 10 0 10 40
SCALE: 1" = 20'

NOTE:
FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS, SEE DRAWING PV-002.

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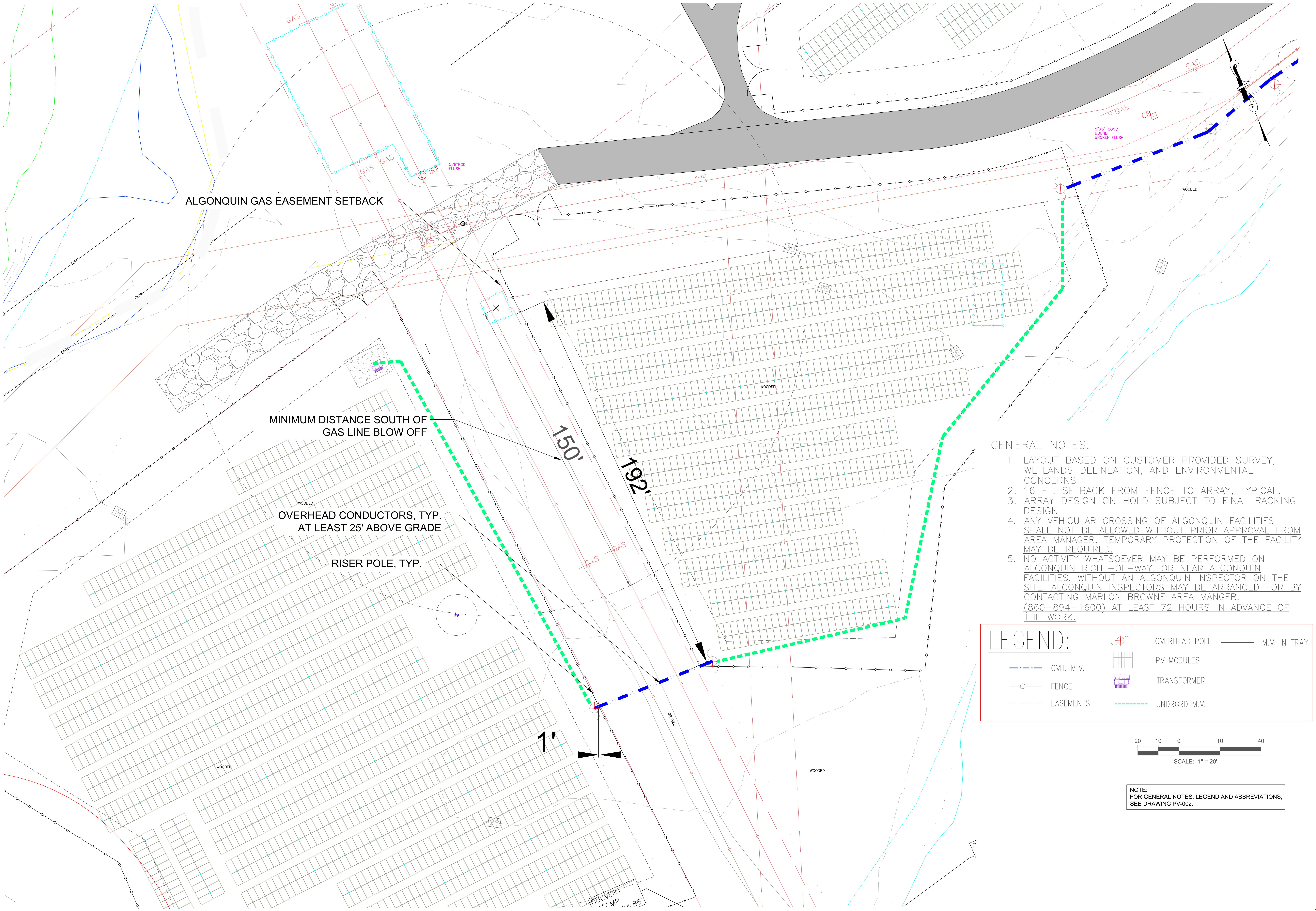
CERTIFICATE OF AUTHORIZATION #4479

REV.#	DESCRIPTION	DATE
A	ISSUED FOR CLIENT REVIEW	01/08/2019
B	UPDATED PER UTILITY COMMENTS	01/23/2019

WALLINGFORD RENEWABLE ENERGY LLC
25 Pent Road, Wallingford, CT

DRAWING TITLE:
MEDIUM VOLTAGE ROAD CROSSINGS

FILE:	PV40.dwg
JOB NO.:	N/A
DATE :	01/08/19
PLOT SIZE:	
DRAWN BY:	NG
CHECKED BY:	GN
SHEET No.:	PV43



GENERAL NOTES:

1. LAYOUT BASED ON CUSTOMER PROVIDED SURVEY, WETLANDS DELINEATION, AND ENVIRONMENTAL CONCERNS
2. 16 FT. SETBACK FROM FENCE TO ARRAY, TYPICAL.
3. ARRAY DESIGN ON HOLD SUBJECT TO FINAL RACKING DESIGN
4. ANY VEHICULAR CROSSING OF ALGONQUIN FACILITIES SHALL NOT BE ALLOWED WITHOUT PRIOR APPROVAL FROM AREA MANAGER. TEMPORARY PROTECTION OF THE FACILITY MAY BE REQUIRED.
5. NO ACTIVITY WHATSOEVER MAY BE PERFORMED ON ALGONQUIN RIGHT-OF-WAY, OR NEAR ALGONQUIN FACILITIES, WITHOUT AN ALGONQUIN INSPECTOR ON THE SITE. ALGONQUIN INSPECTORS MAY BE ARRANGED FOR BY CONTACTING MARLON BROWNE AREA MANGER, (860-894-1600) AT LEAST 72 HOURS IN ADVANCE OF THE WORK.

LEGEND:

- OVH. M.V.
- FENCE
- EASEMENTS
- OVERHEAD POLE
- PV MODULES
- TRANSFORMER
- UNDRGRD M.V.
- M.V. IN TRAY

20 10 0 10 40

SCALE: 1" = 20'

NOTE:
FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS, SEE DRAWING PV-002.

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CERTIFICATE OF AUTHORIZATION #4479

REV.#	DESCRIPTION	DATE
A	ISSUED FOR CLIENT REVIEW	01/08/2019
B	UPDATED PER UTILITY COMMENTS	01/15/2019
C	UPDATED SCALE AND NOTES	01/23/2019
D	UPDATED SCALE AND NOTES	02/07/2019

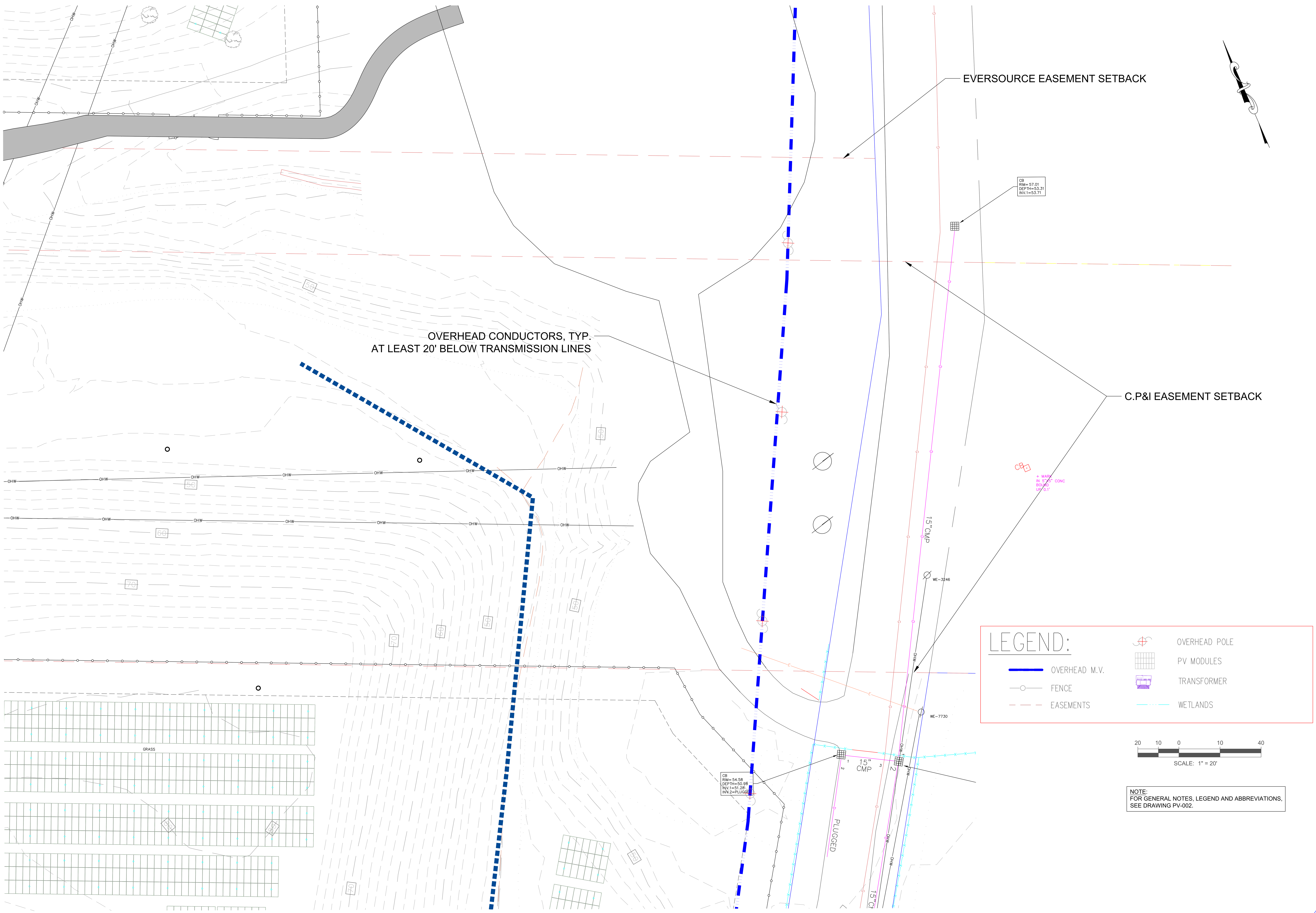
WALLINGFORD RENEWABLE ENERGY LLC

25 Pent Road, Wallingford, CT

DRAWING TITLE:
MEDIUM VOLTAGE EASEMENT CROSSINGS

FILE:	PV40.dwg
JOB NO.:	N/A
DATE :	01/08/19
PLOT SIZE:	
DRAWN BY:	NG
CHECKED BY:	GN

SHEET No.:
PV44



NOTE:
FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS, SEE DRAWING PV-002.

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CERTIFICATE OF AUTHORIZATION #4479

REV.#	DESCRIPTION	DATE
A	ISSUED FOR CLIENT REVIEW	01/08/2019
B	UPDATED PER UTILITY COMMENTS	01/15/2019
C	ISSUED FOR CITING COUNCIL	03/19/2019

WALLINGFORD RENEWABLE ENERGY LLC

25 Pent Road, Wallingford, CT

DRAWING TITLE:
MEDIUM VOLTAGE ELECTRIC EASEMENT CROSSINGS

FILE:	PV40.dwg
JOB NO.:	N/A
DATE :	01/08/19
PLOT SIZE:	
DRAWN BY:	NG
CHECKED BY:	GN
SHEET No.:	PV45