Warwick Solar Energy Facility Updates

February 27, 2020

Updated Staff Report

- Updated Conditions
- Map of Parcels
- Aerial View
- Future Land Use Map

Write up to address neighbor and County comments and concerns 02/07/2020

Updated Concept Plan dated 02/03/2020

Shaded Project Area dated 02/07/2020

Virginia Bald Eagle Nest Locator

Warwick Solar Project Environmental and Ecological Report

Health and Safety Impacts of Solar Photovoltaics

PLANNING COMMISSION
MEETING: FEBRUARY 27, 2020

SPECIAL EXCEPTION SE-19-11 & SUBSTANTIAL ACCORD DETERMINATION SA-19-02: Request of Warwick PV1, LLC, pursuant to § 90-103 (57) to permit a large-scale solar energy facility in a R-A, Residential—Agricultural Zoning District and a Substantial Accord Determination for 60 MW Solar Energy Facility. The request is located along Arwood Road in the Templeton Magisterial District on 1,071 +/- acres and known as Tax Maps 540(0A)00-042-0, 540(0A)00-043-0, 540(0A)00-049-0, 54A(01)0C-001-0, 54A(01)0C-002-0, 540(0A)00-058-0, 550(0A)00-008-0, 550(0A)00-009-0, 540(0A)00-041-A, 540(0A)00-041-B, 540(0A)00-041-C, 540(0A)00-050-0, 540(0A)00-052-0, 540(0A)00-053-0, 540(0A)00-054-0, 540(0A)00-038-0, 540(0A)00-039-0, 540(0A)00-040-0, 550(0A)00-013-0, and 550(0A)00-013-A. The Comprehensive Plan indicates the properties are suitable for agricultural or neighborhood commercial uses.

CASE NUMBER:	SE-19-11
APPLICANT:	Warwick PV1, LLC
ADDRESS:	Along Arwood Road and Alden Road
TAX MAP ID:	Multiple
SIZE OF PROJECT:	1071 ac
MAGISTERIAL DISTRICT:	Templeton
PLANNING DISTRICT:	Rural Conservation Area
UTILITIES:	Well and Septic
REAL ESTATE TAXES:	Taxes on all parcels paid as of 1/2/2020
PROPOSED USE(S):	Large Solar Energy Facility
CURRENT USE:	Silviculture, agriculture, residential
COMP PLAN FUTURE USE:	Agricultural & Neighborhood Commercial
EXISTING ZONING:	R-A Residential Agricultural
SURROUNDING ZONING:	R-A Residential Agricultural
MEETING INFORMATION:	
Community Meeting:	August 21, 2019 at 6:00 p.m.
Planning Commission:	January 23, 2020 at 6:30 p.m. – Public Hearing **postponed 7-0 until February 27, 2020** February 27, 2020
Board of Supervisors:	TBD
STAFF RECOMMENDATION:	Staff recommends a 30-day deferral for the Special Exception and the Substantial Accord Determination.

ATTACHMENTS:

1. GIS Location Map
2. Satellite View
3. Land Use Map
4. Application
5. Applicant Narrative

Special Exception Request:

Warwick PV1 LLC is proposing a 60 MW large-scale solar energy facility on 20 combined parcels totaling 1,071 acres in a Residential-Agricultural Zoning District. The County Zoning Ordinance permits an applicant to make an application for a Special Exception for a large-scale solar energy facility.

The applicant anticipates the project will encompass no more than 535 acres of the overall 1,071 acres with approximately 95,832 individual panels placed in rows and set on a single axis-tracking system. In addition to the solar panels, the equipment proposed on site are 15 inverters located throughout the project area, a 200 foot by 200 foot substation, which will act as point of interconnection, utility poles, fencing, and proposed vegetative buffers. Electric wiring, wherever possible will be buried. The solar panels will be placed on in aluminum frames and attached to steel posts and driven into the ground. The only concrete proposed for the site will be under inverters and similar equipment associated with the substation.

Proposed setbacks for the entire project are 100 feet from external property lines and a vegetative buffer width of 50 feet. Based on neighbor feedback, where there is currently limited or no existing vegetation between the residences along Arwood Road and the proposed solar facility, an enhanced vegetative buffer and a berm 3-foot tall berm with 24 shrubs and 10 overstory trees will be installed to create an immediate screening of 7-9 feet high to limit all visibility during construction and into site operation.

Solar panels do not make any noise, however inverters make a slight humming sound and because of this slight noise, will not be placed on the perimeter of the site. The sound can be heard 100m away from a standard inverter used by Ecoplexus, SMA 2750 kW.

For security purposes, a 7-foot tall fence is installed around the perimeter of all solar panels, inverters, and batteries. Ecoplexus proposes a 7-foot tall security fence without barbed wire to mitigate any harm to wildlife that may try to jump the fence and to lessen the institutional feeling often associated with barbed wire.

Publicly available environmental data has been reviewed for the site. In order to mitigate any potential threat to regional threatened or endangered species and wetland resources, a volunteered 50-foot setback from all streams, determined wetlands and swamps, to include Warwick Swamp located along the southern boundary of this site is proposed. Considering that the size of the project has the potential to impact wildlife movement, there are planned fence breaks in 6 separate locations to accommodate the free movement of wildlife through the site.

The project will have minimal impacts on the rural nature of the County and the immediate area. Environmental features will be preserved and utilized as wildlife corridors where possible. The quiet solar arrays will not be visible to passing drivers or neighbors around the majority of the site. After construction, the minimal amount of traffic associated with the operation of the site will be consistent with existing patterns. At the end of the life of this project (estimated 35 years) all equipment will be removed and the land will be able to return to its current use. A decommissioning plan with site specific decommissioning estimates to this effect has been included in the application submittal.

Proposed Use:

Based on the activities described by the applicant, the request fits the following use found in the Prince George County Zoning Ordinance:

Sec. 90-103. - Uses and structures permitted by special exception. (R-A District)
(57) Large-scale solar energy facility.

Sec 90-1 Definitions.
Large-scale solar energy facility means a photovoltaic system consisting of solar PV panels, modules, accessory structures and related equipment such as DC to AC inverters, wiring, electric transformers, control systems and storage areas that collect solar energy and convert it into electricity using ten acres or more.

Photovoltaic or PV means materials and devices that absorb sunlight and convert it directly into electricity by semiconductors.

Photovoltaic cell or PV cell means a solid state device that converts sunlight directly into electricity. PV cells may be connected together to form PV modules, which in turn may be combined and connected to form PV arrays (often called PV panels).

Photovoltaic system or PV system means PV cells, which may be connected into one or more PV modules or arrays, including any appurtenant wiring, electric connections, mounting hardware, power-conditioning equipment (inverter), and storage batteries.

Substantial Accord Requirement:

The Code of Virginia § 15.2-2232 was amended in 2018 to require that solar facilities be substantially in accord with the comprehensive plan. § 15.2-2232(H) was added and states:

A solar facility subject to subsection A shall be deemed to be substantially in accord with the comprehensive plan if (i) such proposed solar facility is located in a zoning district that allows such solar facilities by right or (ii) such proposed solar facility is designed to serve the electricity or thermal needs of the property upon which such facility is location, or will be owned or operated by an eligible customer-generator or eligible agricultural customer-generator under § 56-594 or by a agricultural generator under § 56-594.2. All other solar facilities shall be reviewed for substantial accord with the comprehensive plan in accordance with this section. However, a locality may allow for a substantial accord review for such solar facilities to be advertised and approved concurrently in a public hearing process with a rezoning, special exception, or other approval process.

Comprehensive Plan

The Comprehensive Plan Future Land Use Map identifies this area, including the request properties and surrounding properties, as appropriate for Agricultural and Neighborhood Commercial uses.

The Future Land Use Map serves as a general guide for the future development of Prince George County. The Planning Commission and Board of Supervisors can use this map as one resource when planning public facilities or evaluating land use requests. The Future Land Use map presents a generalized overview of desired locations for land uses in the County, and it is not intended to be parcel-specific. Actual proposed land uses will be individually reviewed by the Planning Commission and the Board of Supervisors with consideration for the proposed use's compatibility with surrounding land uses, both current and future, and the overall impact on the larger community. The Comprehensive Plan explains the intent of the future land uses planned for this area as follows:

> *Agricultural - Includes land areas in the rural portions of the County where agricultural and forestall land uses are, and should be, the dominant land use. Large lot single family development may exist within some of these areas. Future residential development of these properties is not encouraged.*
>
> *Neighborhood Commercial – Designates those areas where small scale commercial uses are encouraged. Such uses provide goods and services designed to meet the needs of the surrounding residential community.*

The Comprehensive Plan Recommends:

1. The Planning Commission and Board of Supervisors use the future land use map contained within the Comprehensive Plan as a general guide for determining the desired location of development.

2. Commercial and/or industrial developments that are approved in rural portions of the County should be small in scale and of a design character that is consistent with a rural environment.

Staff Review Comments:

Planning & Zoning Division:

1. Future Land Use
   The Future Land Use Map shows that the parcels should be used for Agricultural and/or Neighborhood Commercial uses, with 958.8 acres or 89.5% of the project area designated for Agricultural uses and 112.2 acres or 10.5% of the project area designated for Neighborhood Commercial uses. These designations should be considered when reviewing for conformance to the Comprehensive Plan

   The location proposed for the 1,071-acre solar-energy facility is in the County's Rural Conservation Area, where the County's policies are designed to achieve conservation and preservation objectives. Development that occurs in this portion of the County should be designed to incorporate significant open spaces and minimize environmental impacts

on the County's land, air, and water resources, according to the County Comprehensive Plan. The Planning Commission and the Board of Supervisors should also consider the economic and quality of life benefits for projects proposed to be located in the Rural Conservation area.

2. Setbacks

The County Zoning Ordinance addresses minimum setbacks for solar energy facilities in 90-16:

a. *The minimum setback for a ground-mounted solar energy facilities are required to meet a minimum of 75 -85feet from the right-of-way(depending on the width), and*
b. *A minimum of 50 feet from all other property lines.*

Minimum setbacks, as required by the ordinance, should be increased for this project due to the location of residential uses in the vicinity and should also be inclusive of landscape buffering to screen from adjacent property owners. Conditions of approval of the special exception should consider increased setbacks and required landscape buffers.

The applicant initially suggested a setback of 100 feet from all external property lines and a 30-foot vegetative buffer. The applicant has agreed to a 50-foot wide vegetative buffer instead of a 30-foot vegetative buffer as initially requested by the applicant.

Setbacks for inverters should be at least 150 feet from all external property lines. Setbacks for a substation in conjunction with the solar energy facility should be a significant increase from the required setbacks of the overall solar energy facility from adjacent property lines and the edge of right-of-way. Staff suggests a minimum of 300 feet from all external property lines.

3. Security Fencing

The applicant appropriately addresses perimeter fencing by proposing to use 7-foot tall security fence without barbed wire to mitigate harm to wildlife and to lessen the institutional feeling associated with barbed wire.

4. Wildlife Corridors

The applicant has considered that the project has the potential to impact wildlife movement and is proposing planned fence breaks in six (6) separate locations to accommodate the movement of wildlife through the site.

5. Community Meeting

The applicants held a community meeting with adjacent property owners on August 21, 2019. The concerns of the community were the visibility impact of the solar panels from adjoining properties and the possibility of declining property values as a result of the solar-energy facility. To respond to this concern, the applicant provided an appraisal report showing the solar farm as developed would not negatively impact the adjacent property values.

For the concerns about the visual impact, the applicant updated the design and moved the areas of the site located behind those properties to at least 1,500 feet from the rear property lines. In addition, the applicant added a berm and large landscape buffer and

have added visual renderings. In order to achieve the design update, the applicant had to search for additional property to put under lease option on the east side. By increasing the total amount of project area, the applicant stated they had to work with what they had to be a good neighbor and remove racking where it was in the viewshed of neighbors while still keeping the project viable.

6. Location of other proposed solar energy facility sites considered.
The applicant states that the Warwick PV landowner agreements and the interconnection position with PJM, were purchased from another solar developer. Ecoplexus is continuing to develop and intends to construct, own and operate this project for the long term. As such, they are not aware of the particular process by which this land was chosen for development. However, at Ecoplexus, on the majority of their projects, they do the initial land search and the land search process is quite standard. First, the land research team looks for parcels or a cluster of parcels that meet a particular size criteria based on insight from the utility and then parcels located within a half of a mile from an existing utility transmission line. Next, environmental criteria like the concentration of streams, wetlands or floodplains are considered. Parcels with a prohibitive amount of these features are removed from consideration. Then surrounding commercial or residential development is taken into careful consideration. Ecoplexus focuses on areas with limited residential or commercial development, even if on agricultural lands because solar may not be the highest and best use for that land. If a parcel or cluster of parcels meet the above criteria but do have some existing residential properties surrounding, which is common, they focus on the amount of existing screening to limit visual disturbance and proximity to existing highways to limit impact on roads and residences during construction.

   According to the applicant, the nature of the search conducted is classified as top-down. The search begins with the consideration of a large number of parcels in a region and then hones in on a few ideal properties or clusters of properties. Prior to the purchase of this project, Ecoplexus reviewed this project for conformance with their search criteria and it was deemed as a site with great potential for the development of a Solar Energy Project.

7. Photographic simulations that illustrate the relationship of the proposed facility in relation with the surrounding properties and uses.
The applicant has attached Exhibit A and B which show renderings of the relationship of the proposed facility to the surrounding properties and uses. Exhibit A shows existing view from 4 points along Arwood Road. The majority of land uses adjacent to Warwick PV1 are residential, agricultural or timberland. Special consideration to adjacent residential properties has been taking in enhanced vegetative screening as seen in Exhibit B. The applicant states that no new utility easement will be constructed; this project will only add a point of interconnection to the existing utility line. Regarding roadways, the applicant is using and enhancing an existing logging road on Alden Road adjacent to the Railroad that runs parallel to HWY 460. This is where the majority of construction traffic is planned. This road will be enhanced and a VDOT Driveway Permit will be obtained prior to the start of construction. The second planned site entrance will be located along Alden Road where there is an existing driveway on parcel 550(0A)00-013-0. This driveway will be enhanced and a VDOT driveway permit will be procured. This driveway will not be used heavily during construction to avoid passing residences. The third and final driveway will be located west, off of Arwood Road and will be used as

both a construction and regular maintenance road. This driveway does not currently exist and will be constructed following all DOT standards and guidelines. This is the only driveway proposed off of Arwood Road because of the residences located along this road and the challenging curves in this road. This portion of the site, located west along Arwood Road is important to the project and the applicant will work with VDOT regarding the road crossing which, considering the applicant has land control on either side of the road, is not anticipated as an obstacle.

8. Permit by Rule – DEQ verification
   The applicant has prepared a Notice of Intent for the Solar Permit by Rule approval for Warwick PV1. The applicant does not intend to submit the Notice to VA DEQ's representative Mary E. Major until the time when the special exception has been approved. Ecoplexus is currently in the process of acquiring all environmental and cultural surveys and reports to compile this application for approval.

9. Documentation justifying the need for the on-site substation and capacity of the transmission lines or other electrical infrastructure.
   The applicant has provided information that Queue Position AC2-078 will interconnect with the transmission system via a new three breaker ring bus switching station that connects on the Disputanta-Waverly 115kV line. The applicant has also provided information from a System Impact Study that indicates a Generation Substation, transmission lines (constructing line between the generation substation and a new switching station), and transformer upgrades are required.

10. Fiscal impacts to the County by evaluating the proposed land use in comparison with the current land use and the comprehensive plan future land use.
    The current use of the parcels being proposed for the development of a solar farm is agriculture and silviculture. Loblolly and Long-leaf pines are grown and corn and soybeans are cultivated on the land currently.

    The majority of the parcels encompassed by the proposed new development are in the Land Use tax program. In 2019, the revenue to Prince George County on all of the parcels equalled $11,510. If this land is developed for a solar use, the developer will owe the past 5 years and current year's Land Use Program roll back taxes which equals roughly $43,000 in the first year of development. The Real Property Taxes on these properties will then be taxed at full market value. Per discussion with the Prince George County Tax Assessorn be taxed at full market value. Per discussion with the Prince Geor solar land uses will likely change to a Commercial land use assessment rate which is to be determined. The real property taxes that will be paid to the County based on the current market rate and no longer including the Land Use program reduction will be $18,670. A difference of $7,160 annually in real property tax revenue (based on current market and taxable values for each parcel).

    Additionally, all of the equipment on the solar farm will be taxed as Machinery and Tools. Based on internal assessments on the value of all of the solar equipment, being taxed at the Prince George County e M&T tax rate, and including the Virginiaas Machinery and Tools. Based on internal ass George County will receive approximately $102,859 in tax from the solar equipment, each year from years 1-5. There is a state supported depreciation schedule that begins at year 6. The total 30 year estimated direct tax

revenue to Prince George County exclusively to Prince George County, including consideration of the State tax abatement and depreciation, is $1,742,945.

The market rate for a solar land lease runs on average between $600 and $1,000/acre annually, and is assumed high enough that the property owners are willing to consider the solar lease. All of our landowners are local to the County and that extra income will stay local.

Comprehensive Plan: Approximately 10% of the property proposed for the development of Warwick PV1 is currently in active timber production, but is listed as Neighborhood Commercial in the Comprehensive Plan or Future Land Use category. Per the Comprehensive Plan, Neighborhood Commercial Future Land Use category designates an area for the potential development of small scale commercial uses-such as providing goods and services designed to meet the needs of the surrounding residential community. This area of Neighborhood Commercial is located adjacent to residences and is not yet primed for commercial development. At the end of the approximate 30 year solar lease there is likelihood that the area near Disputanta is ready for additional commercial development and this area will be fully cleared for the next highest and best use. The other 90% of the property is proposed to stay in Agricultural use. Though solar is not an agricultural use, the day-to-day activity associated with a solar farm has less traffic, less noise, less odor, and less land disturbance than crop agriculture and is similar in time and disturbance to timber (the limited construction timeline to be compared to the activity of logging). Once the solar farm is decommissioned this land will be clear and safe to place back into agricultural or timber practices.

11. Planning Recommendation

Based on discussions with other County departments, P&Z staff recommends that conditions for the Special Exception should consider the surrounding parcels and should address: rollback taxes, site plan requirements, buffering, structure height, and decommissioning. In order to properly address these items and provide the Planning Commission with sufficient information to provide a recommendation to the Board of Supervisors, staff suggests the Planning Commission consider Staff's recommended Solar Energy Facility Policy prior to approval of the applicant's request.

Contact: Horace Wade III, Planner

Real Estate Assessor:

1. All Rollback taxes should be paid for all of the parcels as a condition of approval.

2. Parcels G-O are in the name of James L. Thacker Jr. Revocable Trust.

3. Parcels P-R were deeded to Samantha L. Felton, Trustee under the Thomas Woolridge and Dianna R. Woolridge Living Trust dated 22 August, 2003.

Contact: Rod Compton, Director

Utilities:

This site is located outside of the County's Planning Area. This development does not propose any water or sewer improvements. Should the development require water and/or

sewer services, it would need to install private facilities in accordance with the requirements of the local health department.

Contact: Frank Haltom, Director of Engineering and Utilities

Building Inspections Division:

This request has been evaluated under the provisions of the 2015 Virginia USBC and the 2015 Virginia SFPC. All structures that may be built on property that exceed 150 square feet will need to be permitted and meet all requirements of the 2015 Virginia USBC and the 2015 Virginia SFPC.

Contact: Dean Simmons, Building Official and Fire Official

Transportation (VDOT):

1. The submitted application did not include any information as to the number of permanent employees that would be accessing the facility after construction is complete. VDOT's experience with similar type facilities is that any proposed entrances would be classified as low volume commercial entrances. Low volume commercial entrances must demonstrate that stopping sight distance is available at the proposed entrance locations. Determination of the final entrance types will be made during the site plan review process when additional information is available. All entrances will be required to meet VDOT standards.

2. The proposed project will potentially impact several secondary VDOT maintained roadways during construction. These include SR 624 Allen Road, SR 624 Warwick Road, and SR 625 Arwood Road. It is recommended that the County consider requiring the development of a Construction Traffic Management Plan and mitigation measures similar to what has been required by the County for other Special Exception permits granted for other solar energy development projects.

3. It is anticipated that the applicant will want to cross VDOT maintained roadways to provide utility interconnections between the proposed pods of solar panels. VDOT has specific regulations concerning the crossing of VDOT roadways with utilities. It is likely that the applicant will have to be registered with the SCC as a utility company and enroll in the "Miss Utility" program as well in order to cross VDOT roadways.

Contact: Paul Hinson, Southern Region Land Use Engineer, VDOT

Fire Department:

1. During the construction phase of the operation, please adhere to the Fire Department Access chapter in the Statewide Fire Prevention Code.

2. During and once complete, training and education should be conducted on a variety of days for fire responders.

Contact: Shawn Jones, Firefighter/Medic

Environmental Division; Economic Development; Police Department; Health Department: No comments.

Public Notice:

Fifty-two (52) adjacent property owners were notified by mailing on 1/13/20.
A legal ad was run for the request on 1/8/20 and 1/15/20.

Public Comments (1/23/2020):

- Concern about home value decreasing.
- Concern about farmland being used up.
- Request for clarification about what the acreage numbers refer to (392 vs 1071 acres).
- Concern about wildlife impacted.
- Concern about views being negatively affected.
- Concern about traffic/safety on Arwood Road .
- Question about how the County benefits from the request.
- Request to offer input on the Solar Policy.

Applicant Update (2/7/2020):

1. Solar panels and all access points along Arwood Road have been removed as previously proposed Applicant update.
2. Limited project area, as a condition, to 535 acres mapped on "Shaded Project Area" dated February 7, 2020.
3. Applicant provided a copy of Wetland Report due to concern over threatened and endangered species, and the number of natural trees to be removed within the project area.
4. Applicant provided a copy of NC Clean Energy Technology Center to address concerns of equipment toxicity in addition to expert testimony at January 23, 2020 public meeting.

Substantial Accord Determination Recommendation:

Staff recommends approval of a Substantial Accord Determination of the requested large-scale solar energy facility. Staff finds the request of the Special Exception complies with the Comprehensive Plan's objective to maintain the rural character within the 90% agricultural future land use, and limit the overall scale of the solar energy facility by limiting the amount of the project by utilizing 392 of 1,071 acres.

Special Exception Recommendation:

Staff recommends approval of the proposed, large-scale solar energy facility land use after recommended approval of the County's Solar Facility Siting policy. Staff has proposed recommended conditions to ensure this use minimizes the impact on surrounding property owners and ensures the use complies with all applicable local, state and federal requirements:

1. This Special Exception is granted for a large-scale solar energy facility use to Warwick PV1, LLC and is located on Tax Maps 540(0A)00-042-0, 540(0A)00-043-0, 540(0A)00-049-0, 54A(01)0C-001-0, 54A(01)0C-002-0, 540(0A)00-058-0, 550(0A)00-008-0, 550(0A)00-009-0, 540(0A)00-041-A, 540(0A)00-041-B, 540(0A)00-041-C, 540(0A)00-050-0, 540(0A)00-052-0, 540(0A)00-053-0, 540(0A)00-054-0, 540(0A)00-038-0,

540(0A)00-039-0, 540(0A)00-040-0, 550(0A)00-013-0, and 550(0A)00-013-A. This Special Exception may be transferred provided that Condition 10(b) is met relative to the proper surety.

2. Limitation of a total of 535 acres on parcels listed above for the large –scale solar energy facility for buffering requirements, solar panels, and fencing, and subject to the concept plan dated February 4, 2020.

3. Payment of all rollback taxes for parcels enrolled in the Land Use program shall be a pre-condition of the County's issuance of a land disturbance permit pursuant to a site plan prepared for the solar energy facility.

4. Site Plan Requirements. In addition to all State and County site plan requirements, the Applicant shall provide the following plans for review and approval as a part of the site plan for the solar energy facility prior to the issuance of a building permit:

    a. Construction Management Plan. The applicant shall prepare a Construction Management Plan for each applicable site plan for the solar energy facility, which shall address the following:
        i. Construction Traffic Management Plan including mitigation measures shall be developed by the applicant, owner or operator and shall be submitted to the Virginia Department of Transportation (VDOT) and Planning Manager for review and approval. The Plan shall address traffic control measures, pre-and post-construction road evaluation, and any necessary repairs to the public roads that are required as a result of any damage from the solar energy facility construction and/or expansion. All VDOT permits must be received and be approved by VDOT prior to site construction occurring on the premises.
        ii. Site access plan. Directing employee and delivery traffic to minimize conflicts with local traffic.
        iii. A site parking and staging plan shall be submitted as a part of the Site Plan approval and be submitted for various stages of the site construction process. All subsequent construction processes shall also adhere to submitting a parking and staging plan prior to the commencement for expansion or decommissioning.
        iv. Fencing. The applicant shall install temporary security fencing prior to the commencement of construction activities occurring on the solar energy facility.
        v. Lighting. During construction of the solar energy facility, any temporary construction lighting shall be positioned downward, inward, and shielded to eliminate glare from all adjacent properties.

    b. Construction Mitigation Plan. The applicant shall prepare a Construction Mitigation Plan for each applicable site plan for the solar energy facility to the satisfaction of the Planning Manager. Each plan shall address, at a minimum:
        i. The effective mitigation of dust. All construction roads and construction areas shall remain dust-free by the use of a water truck or other approved method to keep sediment on the premises and not be of a general nuisance to the adjoining property owners during site construction and/or site expansion for a solar energy facility.

ii. Burning operations.
iii. Hours of construction. All pile driving shall be limited to the hours from sunrise to sunset Monday through Saturday. No Sunday pile driving shall occur during site construction, expansion, or operation of the facility. All other normal on-site construction activity is permitted Monday through Sunday in accordance with the provisions of the County Noise Ordinance, as amended from time to time, and as enforced by the Prince George County Police Department.
iv. Access and road improvements.
v. General construction complaints.

c. Grading Plan. The solar energy facility shall be constructed in compliance with the County-approved grading plan as approved by County staff prior to the commencement of any construction activities in coordination with the Erosion and Sediment Control Plan. The owner or operator shall construct, maintain, and operate the project in compliance with the approved plan. An E&S bond or letter of credit will be posted for the construction portion of the project. The grading plan shall:
   i. Clearly show existing and proposed contours;
   ii. Note the locations and amount of topsoil to be removed (if any) and the percent of the site to be graded;
   iii. Limit grading to the greatest extent practicable by avoiding steep slopes and lay out arrays parallel to landforms;
   iv. Require an earthwork balance to be achieved on-site with no import or export of soil;
   v. Require topsoil to first be stripped and stockpiled on-site to be used to increase the fertility of areas intended to be seeded in areas proposed to be permanent access roads which will receive gravel or in any areas where more than a few inches of cut are required;

d. Solar Facility Screening and Vegetation Plan. The owner or operator shall construct, maintain, and operate the facility in compliance with the approved plan. A separate surety shall be posted for the ongoing maintenance of the project's vegetative buffers in the amount of 120% of the installation cost of all planted vegetation.
   i. Site groundcover for the solar energy facility shall consist of a variety of native groundcovers that benefit birds, bees, and other insects.
   ii. Groundcover shall be expeditiously established following the completion of construction activities to minimize erosion and loss of soil.
   iii. Use of synthetic herbicides to control and maintain groundcover post-construction shall not be permitted.

e. The design, installation, maintenance, and repair of the solar energy facility shall be in accordance with the most current National Electrical Code (NFPA 70).

5. Operations.
   a. Permanent Security Fence. The applicant shall install a permanent security fence, consisting of chain link, 2-inch square mesh (or comparable fencing), 7 feet in height, around the Solar Facility prior to the commencement of operations of the

Solar Energy Facility. Failure to maintain the fence in a good and functional condition will result in revocation of the special exception.

b. Lighting. Any on-site lighting shall be dark-sky compliant, shielded away from adjacent properties, and positioned downward to minimize light spillage onto adjacent properties.
c. Noise. Daytime noise will be under 67 dBA throughout the day with no noise emissions at night.
d. Ingress/Egress. Permanent access roads and parking areas will be stabilized with gravel, asphalt, or concrete to minimize dust and impacts to adjacent properties.
e. All newly installed utilities including but not limited to, electric, fiber, cable, and telephone lines serving the site which are visible from the ground-level view of adjacent properties zoned residential, agricultural and/or PUD Planned Unit Development, dwellings not owned by the owner of the subject property, and public rights-of-way, shall be screened from view or shall be placed underground, unless prohibited by the state/federal agency regulating them.
f. All solar energy facility structures, racks, and associated facilities shall have a non-reflective finish or appearance. The solar collectors shall be designed to maximize absorption and minimize glare outward towards adjoining properties and upward towards military and general aviation aircraft or other similar aircraft.

6. Buffers.
    a. Setbacks.
        i. A minimum 150-foot setback, which includes a 50-foot planted buffer as described in 5(b), shall be maintained from a principal Solar Energy Facility structure to the edge of the public right-of-way.
        ii. A minimum 150-foot-setback, which includes a 50-foot planted buffer as described in 5(b), shall be maintained from a principal Solar Energy Facility structure to any adjoining property line which is a perimeter boundary line for the project area.
        iii. A minimum 150-foot setback, shall be observed for the placement of all inverters for the project from the external property lines
        iv. A minimum 300-foot-setback, which includes a 50-foot planted buffer as described in 5(b), shall be maintained from a substation associated with a principal Solar Energy Facility structure from any adjoining property line or edge of the public right-of-way.

    b. Screening. A minimum 50-foot vegetative buffer (consisting of existing trees and vegetation) shall be maintained. If there is no existing vegetation or if the existing vegetation is inadequate to serve as a buffer as determined by the Planning Manager, a staggered triple row of evergreen trees and shrubs will be planted on approximately 10-foot centers in the 25 feet immediately adjacent to the security fence. New plantings of trees and shrubs shall be approximately 6 feet in height at time of planting. In addition, pine seedlings will be installed in the remaining 25 feet of the 50-foot buffer.

    c. Wildlife Corridors. The applicant shall identify an access corridor for wildlife to navigate through the Solar Energy Facility. The proposed wildlife corridor shall be shown on the site plan submitted to the County. Areas between fencing shall be kept open to allow for the movement of migratory animals and other wildlife.

d. Wetlands. The applicant shall provide a 50-foot minimum setback from all wetlands.

7. Height of Structures. Solar Energy Facility structures shall not exceed 15 feet, however, towers constructed for electrical lines may exceed the maximum permitted height as provided in the zoning district regulations, provided that no structure shall exceed the height of 25 feet above ground level, unless required by applicable code to interconnect into existing electric infrastructure or necessitated by applicable code to cross certain structures.

8. Inspections. The applicant will allow designated County representatives or employees access to the facility at any time for inspection purposes as set forth in their application.

9. The applicant, owner or operator shall coordinate directly with Fire, EMS and Emergency Management to provide solar energy materials, educational information and/or training to the respective personnel responding to the solar energy facility project in regards to how to safely respond to any emergencies that may occur on the premises.

10. Compliance. The Solar Facility shall be designed, constructed, and tested to meet relevant local, state, and federal standards as applicable.

11. Decommissioning.
    a. Decommissioning Plan. A decommissioning plan shall be developed by the applicant, owner or operator prior to the approval of a site plan being issued for a solar energy facility. The purpose of the decommissioning plan is to specify the procedure by which the applicant or its successor would remove the solar energy facility after the end of its useful life and to restore the property for prior usage. If the solar energy facility is inactive completely or substantially discontinuing the delivery of electricity to an electrical grid for a continuous twenty-four (24) month period it shall be considered abandoned. The applicant, owner or operator shall provide notice to Prince George County in writing once the property becomes inactive as a solar energy facility use. The decommissioning of the site shall commence within six (6) months of receipt of such notice from the applicant, owner or operator by Prince George County. This shall be known as the "Decommissioning Plan" under Zoning Ordinance Section 90-16 (ii) (e) which shall include the following:
        i. Anticipated life of the solar energy facility project;
        ii. The estimated cost of the decommissioning in the future as expressed in current dollars by a State licensed professional engineer;
        iii. Method estimate was determined;
        iv. The manner in which the project will be decommissioned; and
        v. The name and physical address of the person or entity responsible for the decommissioning plan and a performance bond for the life of the use.

    b. Surety. Unless the solar energy facility project is owned by a public utility within the Commonwealth of Virginia, the net costs of decommissioning shall be secured by an adequate surety in a form agreed to by the County Attorney, including but not limited to a letter of credit, cash or a guarantee by an investment grade entity, posted within thirty (30) days of the project receiving its occupancy permit or equivalent from Prince George County to operate the use. If an adequate surety is required, the cost estimates of the decommissioning shall be updated at least

every five (5) years by the applicant, owner or operator, and provided to the County. If the solar energy facility is sold to an entity that is not a public utility, the Special Exception shall not transfer to the purchaser until such time as adequate surety is provided for the solar energy facility. At its option, the County may require that a surety amount be increased based upon the net cost of decommissioning the use as approved by the County Attorney.

c. Applicant/Property Owner Obligation. Within six (6) months after the cessation of use of the solar energy facility for electrical power generation or transmission, the applicant or its successor, at its sole cost and expense, shall decommission the solar energy facility in accordance with the decommissioning plan approved by the County. If the applicant or its successor fails to decommission the solar energy facility within six (6) months, the property owners shall commence decommissioning activities in accordance with the decommissioning plan. Following the completion of decommissioning of the entire solar energy facility arising out of a default by the applicant or its successor, any remaining surety funds held by the County shall be distributed to the property owners in a proportion of the surety funds and the property owner's acreage ownership of the solar energy facility.

d. Applicant/Property Owner Default; Decommissioning by the County.
    i. If the applicant, its successor, or the property owners fail to decommission the solar energy facility within six (6) months, the County shall have the right, but not the obligation, to commence decommissioning activities and shall have access to the property, access to the full amount of the decommissioning surety, and the rights to the solar energy equipment and materials on the property.
    ii. If applicable, any excess decommissioning surety funds shall be returned to the current owner of the property after the County has completed the decommissioning activities.
    iii. Prior to the issuance of any permits, the applicant and the property owners shall deliver a legal instrument to the County granting the County (1) the right to access the property, and (2) an interest in the solar energy facility equipment and materials to complete the decommissioning upon the applicant's and property owner's default. Such instrument(s) shall bind the applicant and property owners and their successors, heirs, and assigns. Nothing herein shall limit other rights or remedies that may be available to the County to enforce the obligations of the applicant, including under the County's zoning powers.

e. Equipment/Building Removal. All physical improvements, materials, and equipment related to solar energy generation, both surface and subsurface components, shall be removed following disturbance cause in the removal process. Perimeter fencing will be removed and recycled or reused.

f. Infrastructure Removal. All access roads will be removed, including any geotextile material beneath the roads and granular material. The exception to removal of the access roads and associated culverts or their related material would be upon written request from the current or future landowner to leave all or a portion of these facilities in place for use by the landowner. Access roads will be removed

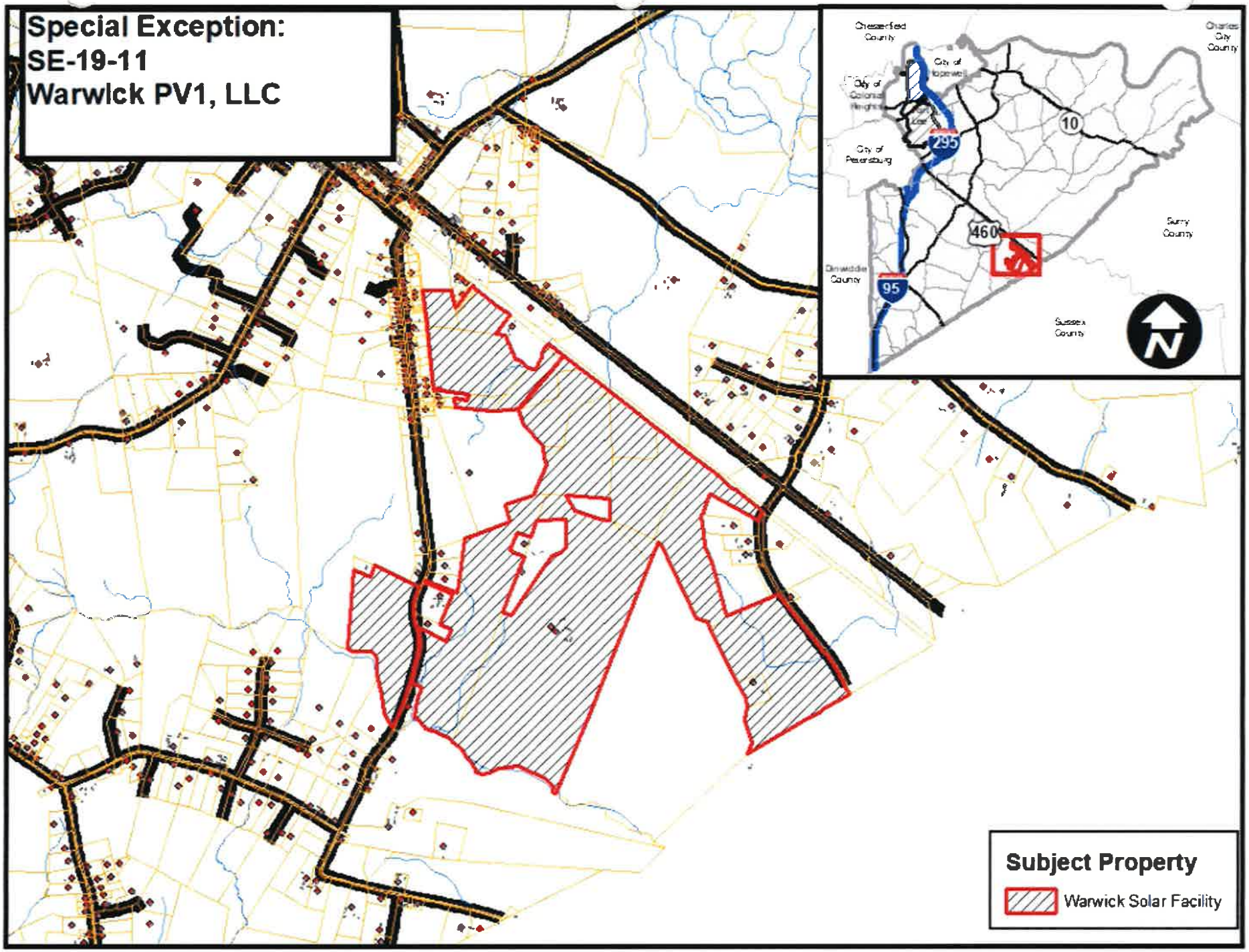
within areas that were previously used for agricultural purposes and topsoil will be redistributed to provide substantially similar growing media as was present within the areas prior to site disturbance.

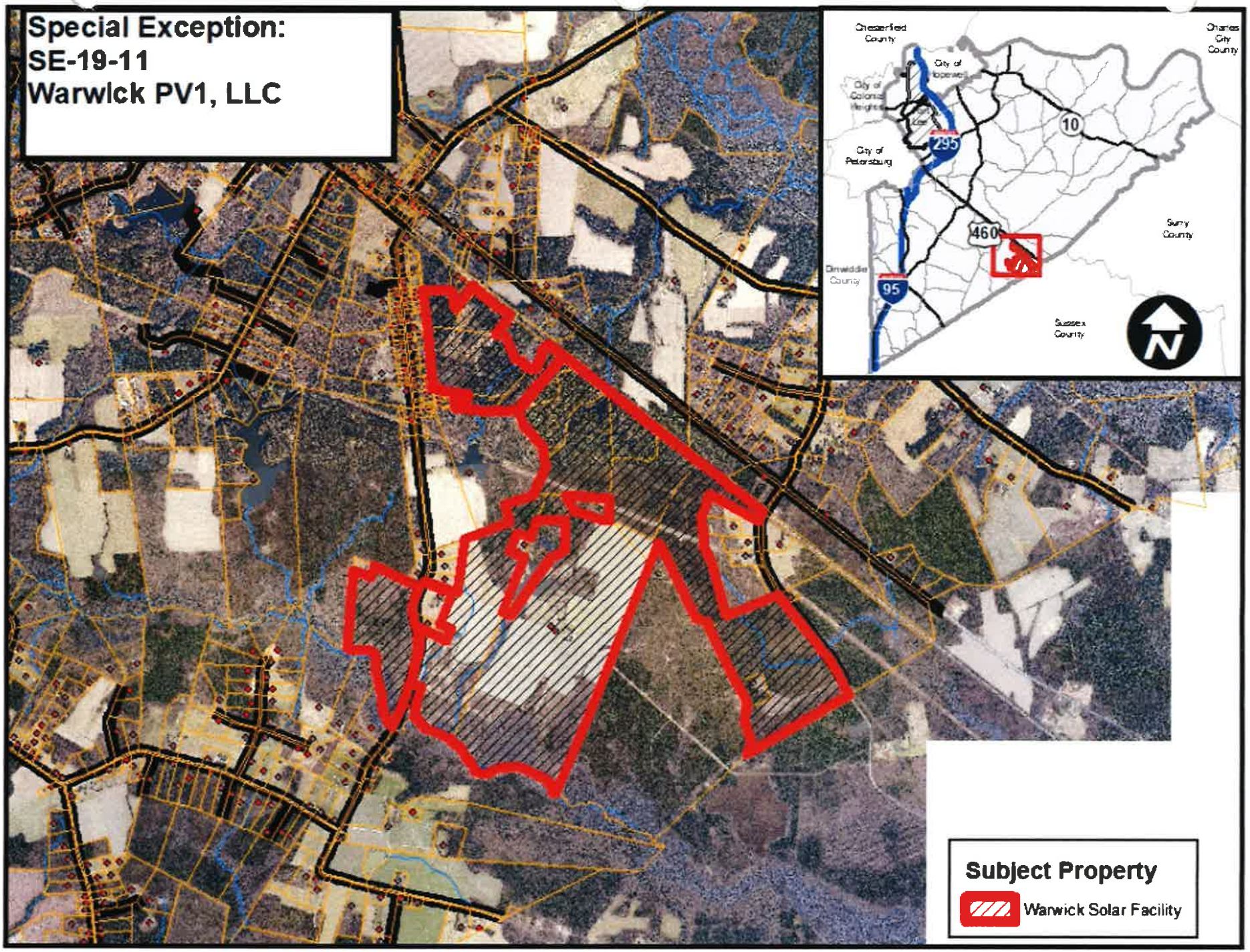
g. Partial Decommissioning. Any reference to decommissioning the solar energy facility shall include the obligation to decommission all or a portion of the solar energy facility whichever is applicable with respect to a particular situation. If decommissioning is triggered for a portion, but not the entire solar energy facility, then the applicant or its successor will commence and complete decommissioning, in accordance with the decommissioning plan, for the applicable portion of the solar energy facility; the remaining portion of the solar energy facility would continue to be subject to the decommissioning plan..

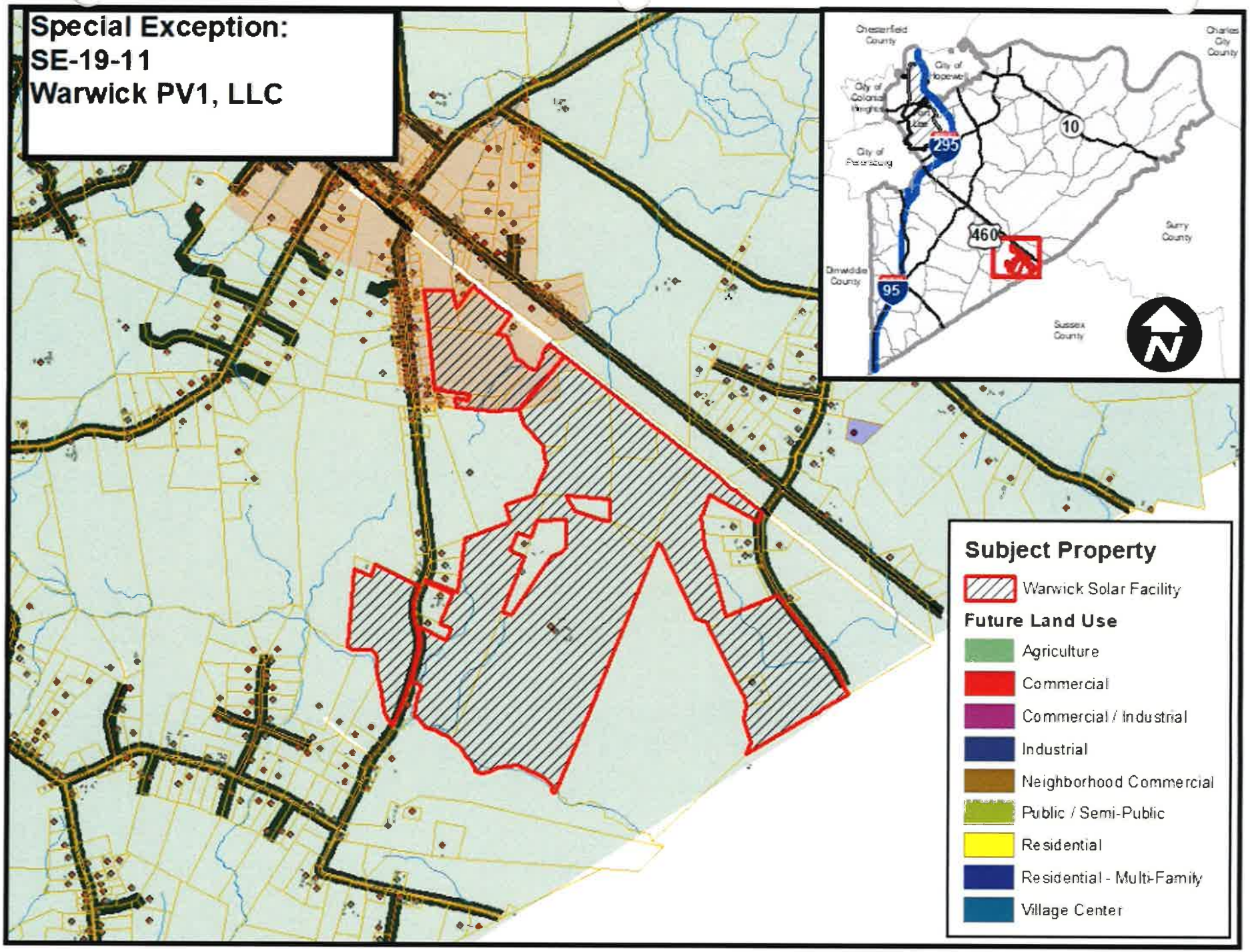
12. Power Purchase Agreement. At the time of the applicant's site plan submission, the applicant shall have executed a power purchase agreement with a third-party providing for the sale of a minimum of 80% of the solar energy facility's anticipated generation capacity for not less than 10 years from commencement of operation. Upon the County's request, the applicant shall provide the County and legal counsel with a redacted version of the executed power purchase agreement.

13. This Special Exception shall become null and void if the use of a large-scale solar energy facility is abandoned for a period of twenty-four (24) consecutive months.

14. This Special Exception may be revoked by Prince George County or by its designated agent for failure by the applicant, owner or operator to comply with any of the listed conditions or any provision of federal, state or local regulations.


Special Exception:
SE-19-11
Warwick PV1, LLC
Chesterfield County
Charles City County
City of Colonial Heights
City of Petersburg
Dinwiddie County
Surry County
Sussex County
295
10
460
95
N
Subject Property
Warwick Solar Facility


Special Exception:
SE-19-11
Warwick PV1, LLC
Chesterfield County
Charles City County
City of Colonial Heights
City of Petersburg
295
10
460
95
Sussex County
N
Subject Property
Warwick Solar Facility


Special Exception:
SE-19-11
Warwick PV1, LLC
Chesterfield County
Charles City County
City of Hopewell
City of Colonial Heights
City of Petersburg
295
10
460
95
Dinwiddie County
Surry County
Sussex County
N
Subject Property
Warwick Solar Facility
Future Land Use
Agriculture
Commercial
Commercial / Industrial
Industrial
Neighborhood Commercial
Public / Semi-Public
Residential
Residential - Multi-Family
Village Center

APPLICATION FOR SPECIAL EXCEPTION - CONDITIONAL USE PERMIT

Department of Community Development and Code Compliance
6602 Courts Drive
Prince George, VA 23875
Planning Division (804) 722-8678
www.princegeorgecountyva.gov

OFFICE USE ONLY
APPLICATION #: SE-19-11
DATE SUBMITTED: RECEIVED DEC 10 2019
ZONING ORDINANCE SECTION:

(PLEASE FILL-IN ALL BLANKS)

GENERAL PROPERTY INFORMATION

LEGAL OWNER(S) OF PROPERTY REQUESTED FOR PERMIT: *See Exhibit A*

ADDRESS: *See Exhibit A*

CITY:	STATE:	ZIP CODE:	PHONE NUMBER:
See Exhibit A			*See Exhibit A*

E-MAIL ADDRESS:

TAX MAP OF SUBJECT PARCEL: *See Exhibit A*

RECORDED IN THE CIRCUIT COURT CLERK'S OFFICE: *See Exhibit A*

DEED BOOK_____ **PAGE**_____ **Date** _____ **DEED RESTRICTIONS:**

ACREAGE:	PARTIAL PARCEL:	SUBDIVISION:
Total: 1,071	☒ YES ☐ NO	

PRESENT USE: Silviculture, agriculture, residential

ZONING CLASSIFICATION

LAND USE CLASSIFICATION:	PRESENT ZONING:
>100ac. vacant and <20ac. residential	R-A

OWNER AGENT/REP

AGENT OR REPRESENTATIVE OF PROPERTY OWNER(S), IF ANY (SPECIFY INTEREST): Warwick PV1, LLC

NAME: Warwick PV1, LLC c/o Forrest Melvin Coldren

ADDRESS: 600 Park Offices Dr. Suite 285 (physical address) PO Box 13092, Durham, NC 27709 (mailing)

CITY:	STATE:	ZIP CODE:	PHONE NUMBER:
Research Triangle Park	NC	27709	919-813-7990

E-MAIL: FMelvin@ecoplexus.com

PROJECT DESCRIPTION

PROVIDE A GENERAL DESCRIPTION OF THE PROJECT: (ATTACH A SEPARATE LETTER IF NECESSARY)

AFFIDAVIT

AFFIDAVIT

A. The undersigned (1) Property Owner or (7) duly authorized agent or representative certifies that this petition and the foregoing answers, statement, and other information herewith submitted are in all respect true and correct to the best of their knowledge and belief.

SIGNED: _____ DATE: 12-5-2019

MAILING ADDRESS: PO Box 13092

CITY/STATE/ZIP: Durham, NC 27709

PHONE NUMBER: 919-813-7990

E-MAIL ADDRESS: FMelvin@ecoplexus.com

STATE BELOW THE NAME, ADDRESS, AND PHONE NUMBER OF PERSON(S) TO BE CONTACTED REGARDING THIS APPLICATION IF OTHER THAN ABOVE PERSON(S):

NAME: _____

MAILING ADDRESS: _____

CITY/STATE/ZIP: _____

PHONE NUMBER: _____

E-MAIL ADDRESS: _____

~~STATE OF VIRGINIA~~ DC

COUNTY OF: PRINCE GEORGE

Subscribed and sworn before me this 5th day of December, 2019.

_____
~~Notary Public~~

My Commission expires: 8/13th, 2020

DAWN ROWAN NOTARY PUBLIC ORANGE COUNTY, NC

Exhibit A

Parcel Assign.	Owner Name	Owner Address	Owner Phone	Tax Parcel	Deed Bk/Pg and Date	Acreage
A	JL Thacker Co Inc	PO Box 152, Disputanta, VA 23842	804-731-1233	540(0A)00-042-0		33.44
B	JL Thacker Co Inc	PO Box 152, Disputanta, VA 23842	804-731-1233	540(0A)00-043-0		6.25
C	JL Thacker Co Inc	PO Box 152, Disputanta, VA 23842	804-731-1233	540(0A)00-049-0		5.78
D	JL Thacker Co Inc	PO Box 152, Disputanta, VA 23842	804-731-1233	54A(01)0C-001-0		0.78
E	JL Thacker Co Inc	PO Box 152, Disputanta, VA 23842	804-731-1233	54A(01)0C-002-0		13.31
F	JL Thacker Co Inc	PO Box 152, Disputanta, VA 23842	804-731-1233	540(0A)00-058-0		12.43
G	James Thacker Revocable Trust	PO Box 152, Disputanta, VA 23842	804-731-1233	550(0A)00-008-0	07/4552; 09/07/2007	55
H	James Thacker Revocable Trust	PO Box 152, Disputanta, VA 23842	804-731-1233	550(0A)00-009-0	07/4552; 09/07/2007	73.6
I	James Thacker Revocable Trust	PO Box 152, Disputanta, VA 23842	804-731-1233	540(0A)00-041-A	07/4552; 09/07/2007	19
J	James Thacker Revocable Trust	PO Box 152, Disputanta, VA 23842	804-731-1233	540(0A)00-041-B	07/4552; 09/07/2007	55.8
K	James Thacker Revocable Trust	PO Box 152, Disputanta, VA 23842	804-731-1233	540(0A)00-041-C	07/4552; 09/07/2007	1.16
L	James Thacker Revocable Trust	PO Box 152, Disputanta, VA 23842	804-731-1233	540(0A)00-050-0	07/4552; 09/07/2007	56.6
M	James Thacker Revocable Trust	PO Box 152, Disputanta, VA 23842	804-731-1233	540(0A)00-052-0	07/4552; 09/07/2007	15.39
N	James Thacker Revocable Trust	PO Box 152, Disputanta, VA 23842	804-731-1233	540(0A)00-053-0	07/4552; 09/07/2007	1
O	James Thacker Revocable Trust	PO Box 152, Disputanta, VA 23842	804-731-1233	540(0A)00-054-0	07/4552; 09/07/2007	1.08
P	Thomas and Dianna Wooldridge	7209 Beefsteak Rd, Waverly, VA 23890	804-731-1888	540(0A)00-038-0	18/2793; 09/13/2018	320.005
Q	Thomas and Dianna Wooldridge	7209 Beefsteak Rd, Waverly, VA 23890	804-731-1888	540(0A)00-039-0	18/2793; 09/13/2018	292

R	Thomas and Dianna Wooldridge	7209 Beefsteak Rd, Waverly, VA 23890	804-731-1888	540(0A)00-040-0	18/2793; 09/13/2018	5
S	Jeffrey and Beverly Stotesberry-Living Trust	15770 Alden Rd, Disputanta, VA 23842	804-896-5068	550(0A)00-013-0	16/967; 04/06/2016	115.192
T	Jeffrey and Beverly Stotesberry	15770 Alden Rd, Disputanta, VA 23842	804-896-5068	55(0A)00-013-A	16/968; 04/06/2016	7.285
						Total Acreage: 1,071

ecoplexus

BILLING ADDRESS:
PO Box 2265
Mansfield, TX 76063

101 Second Street, Ste. 1250
San Francisco, CA 94105
T 415 626 1802
F 415 449 3466

PO Box 13092, Durham, NC 27709
Physical Address:
600 Park Offices Dr, Suite 285
Research Triangle Park, NC 27709

OWNER'S CONSENT FORM

Project: Warwick PV1

Submittal Date: 11/18/2019

OWNER'S AUTHORIZATION

I/We HEREBY GIVE MY CONSENT to Ecoplexus Inc. (by and through its affiliates, officers, directors, managers, employees and agents) to act on my/our behalf, to submit or have submitted any application and all required material and documents, and to attend and represent me/us at all meetings and public hearings pertaining to the application(s) indicated above. Furthermore, I/We hereby give consent to the party designated above to agree to all terms and conditions that may arise as part of the approval of this application.

I/we hereby certify that I/we have full knowledge of the property's anticipated use as a solar power generation facility and that I/we have an ownership interest in the subject of this application. I/we understand that any false, inaccurate or incomplete information provided by me/us or my/our agent will result in the denial, revocation or administrative withdrawal of this application, request, approval or permits. I/we acknowledge that additional information may be required to process this application. I/we further agree to all terms and conditions, which may be imposed as part of the approval of this application.

Signature of Owner	Print Name	Date
James L. Thacker, Jr	James L. Thacker, Jr Revocable Trust James L. Thacker, Jr	11/12/2019
James L. Thacker, Jr	President of J.L. Thacker Co, Inc. James L. Thacker, Jr	11/12/2019

I hereby certify the statements or information made in any paper or plans submitted herewith are true and correct to the best of my knowledge. I understand this application, related material and all attachments become official records of the Planning Department, and will not be returned.

Signature of Ecoplexus Inc.	Print Name	Date
E. Scott Piscitello	E. Scott Piscitello	11/21/2019

Ecoplexus Japan
2-28-4 Sendagaya
Inui Building 4th Floor
Shibuya-Ku, Tokyo, Japan

Ecoplexus Mexico
Paseo de la Reforma 350, 10th Floor
Colonia Juarez, CP 6600
Mexico City, Mexico

Ecoplexus Vietnam
16/F Saigon Tower
29 Le Duan Street, District 1
Ho Chi Minh City

ecoplexus

BILLING ADDRESS:
PO Box 2265
Mansfield, TX 76063

101 Second Street, Ste. 1250
San Francisco, CA 94105
T 415 626 1802
F 415 449 3466

PO Box 13092, Durham, NC 27709
Physical Address:
600 Park Offices Dr, Suite 285
Research Triangle Park, NC 27709

OWNER'S CONSENT FORM

Project: Warwick PV1

Submittal Date: 11/21/2019

OWNER'S AUTHORIZATION

I/We HEREBY GIVE MY CONSENT to Ecoplexus Inc. (by and through its affiliates, officers, directors, managers, employees and agents) to act on my/our behalf, to submit or have submitted any application and all required material and documents, and to attend and represent me/us at all meetings and public hearings pertaining to the application(s) indicated above. Furthermore, I/We hereby give consent to the party designated above to agree to all terms and conditions that may arise as part of the approval of this application.

I/we hereby certify that I/we have full knowledge of the property's anticipated use as a solar power generation facility and that I/we have an ownership interest in the subject of this application. I/we understand that any false, inaccurate or incomplete information provided by me/us or my/our agent will result in the denial, revocation or administrative withdrawal of this application, request, approval or permits. I/we acknowledge that additional information may be required to process this application. I/we further agree to all terms and conditions, which may be imposed as part of the approval of this application.

Signature of Owner	Dianna R Wooldridge *Print Name*	11.07.2019 *Date*
Signature of Owner	*Print Name*	*Date*
Signature of Owner	*Print Name*	*Date*

I hereby certify the statements or information made in any paper or plans submitted herewith are true and correct to the best of my knowledge. I understand this application, related material and all attachments become official records of the Planning Department, and will not be returned.

Signature of Ecoplexus Inc.	E. Scott Piscitello *Print Name*	11/21/2019 *Date*

Ecoplexus Japan
2-28-4 Sendagaya
Inui Building 4th Floor
Shibuya-Ku, Tokyo, Japan

Ecoplexus Mexico
Paseo de la Reforma 350, 10th Floor
Colonia Juarez, CP 6600
Mexico City, Mexico

Ecoplexus Vietnam
16/F Saigon Tower
29 Le Duan Street, District 1
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F 415 449 3466

PO Box 13092, Durham, NC 27709
Physical Address:
600 Park Offices Dr, Suite 285
Research Triangle Park, NC 27709

B

OWNER'S CONSENT FORM

Project: Warwick

Submittal Date: 11/24/19

OWNER'S AUTHORIZATION

I/We HEREBY GIVE MY CONSENT to Ecoplexus Inc. (by and through its affiliates, officers, directors, managers, employees and agents) to act on my/our behalf, to submit or have submitted any application and all required material and documents, and to attend and represent me/us at all meetings and public hearings pertaining to the application(s) indicated above. Furthermore, I/We hereby give consent to the party designated above to agree to all terms and conditions that may arise as part of the approval of this application.

I/we hereby certify that I/we have full knowledge of the property's anticipated use as a solar power generation facility and that I/we have an ownership interest in the subject of this application. I/we understand that any false, inaccurate or incomplete information provided by me/us or my/our agent will result in the denial, revocation or administrative withdrawal of this application, request, approval or permits. I/we acknowledge that additional information may be required to process this application. I/we further agree to all terms and conditions, which may be imposed as part of the approval of this application.

Signature of Owner	*Print Name*	*Date*
	Jeffery T Stotesberry	11/24/19
	Beverly W Stotesberry	11-24-2019

I hereby certify the statements or information made in any paper or plans submitted herewith are true and correct to the best of my knowledge. I understand this application, related material and all attachments become official records of the Planning Department, and will not be returned.

Signature of Ecoplexus Inc.	*Print Name*	*Date*
	E. Scott Piscitello	11/26/2019

Warwick PV1 Special Exception Application
Submitted by Warwick PV1, LLC
% Ecoplexus Inc. and Forrest Coldren, Permitting Specialist
600 Park Offices Drive, Suite 285
Research Triangle Park, NC 27709

Re: Narrative

Warwick Solar Introduction

Warwick PV1 Solar Facility is a proposed 60 MW of AC project with PJM Interconnection LLC. This project proposed is located in eastern Prince George County, near the town of Disputanta. The site is situated south of HWY 460 with Arwood Road to the west and Alden Road to the east. The area encompassed by this project is located in the R-A zoning district and not classified as a Future Development Site. The majority of this area is listed as Agricultural with a small portion to the northwest classified as Neighborhood Commercial per the Comprehensive Plan Land-use classification. There are a combined 20 land parcels with 4 separate local landowners totalling approximately 1,071 acres under site control. The solar facility is proposed to only utilize ±392 acres per the provided site plan. The site will be comprised of approximately ±95,832 individual panels placed in rows and set on a single axis-tracking system. Other than solar panels, the only other equipment proposed on site are 15 inverters located throughout the project area, a 200 foot by 200 foot substation which will act as point of interconnection, utility poles, fencing, and proposed vegetative buffers as described below. Electrical wiring, wherever possible, will be buried. The solar panels will be placed in aluminum frames and then attached to steel posts and driven into the ground. The only concrete proposed will be under inverters and similar equipment associated with the substation. The project applicant, Ecoplexus Inc. was founded in 2007 and its mission is to develop, own and operate utility-scale solar photovoltaic projects in the 10-300 MW range. Ecoplexus develops and operates solar energy facilities in the US, Mexico, Thailand, and Japan. In the US, Ecoplexus has been focused predominantly in the Southeast and West with development growing into the Mid-Atlantic, Central, and Northeast. Ecoplexus has US offices in Durham, NC and San Francisco, CA.

Traffic Impacts

Potential traffic impacts will be most noticeable during the construction period of the project. Once operational, traffic impacts will be negligible with trip generation from the site less than that of one single family home. The anticipated length of construction for this project is 9-11 months. This time frame includes civil site preparation; including clearing and minimal grading, mechanical installation of panels, set-up of inverters, connecting and placing of electrical wiring, and commissioning activities with the utility. During construction, a day with high volume transfer truck traffic will hit a maximum of 7 trucks per day. Peak number of on-site workers in a single day is roughly 100. The height of traffic will be during the mechanical phase which is up-to one-third of the total construction timeline. The remainder of the construction activities will see around 20 workers in a day and the number of trucks between 0 and 2 per day. To mitigate for the influx of traffic along Arwood Road due to the number of residences and challenging road

conditions there will not be a construction access on the east side of Arwood road to get to the majority of the site. All of the construction traffic for this portion of the site will enter from Alden Road where two site entrances are proposed. The one portion of land being utilized along Arwood Road will contain ±25 acres of panels, creating very minimal construction traffic along Arwood Road for this purpose.

Visual, Noise, and Light Impacts

Visual impacts of the project will be limited due to use of significant setbacks from adjacent right-of-ways, limited road frontage, use of natural topographic buffers in site design, and application of existing and new vegetative buffers. Setbacks of 100 feet from external property lines are proposed throughout the entire site to limit and disturbance or impact to neighbors or roadways. In the areas that have substantial mature vegetation existing within this setback, specifically in the in certain areas to the north and south of Arwood Road, a minimum of 100 feet of this mature healthy vegetation will be maintained. For images of existing vegetation conditions in these areas, please reference Figure 1. In areas behind residences and along roadways on Alden Road, a dense evergreen vegetative buffer will be planted within the setback, when existing vegetation is not sufficient. This vegetative buffer, as shown in the first section of Figure 2., is 30 feet deep and has a mixture of 13 low growing shrubs, 14 high growing shrubs, and 2 trees per 100 linear feet. Figure 3. shows a rendering of this vegetative buffer at planting and after 5 years of growth. Based on neighbor feedback, where there is currently limited or no existing vegetation between the residences along Arwood Road and the proposed solar facility, an enhanced vegetative buffer and a berm will be installed. In the second section of Figure 2., the enhanced berm planting is shown and includes 24 shrubs and 10 overstory trees planted on a 3 foot tall berm. This berm will create an immediate screening of 7-9 feet high to limit all visibility during construction and into site operation. A rendering of this buffer and berm is attached as Figure 4. No permanent lighting is proposed for this site.

The solar panels do not make any sounds however inverters units do make a slight humming sound and for this reason are not placed on the perimeter of the site. The sound that can be heard at just 100m away from a standard inverters used by Ecoplexus, SMA 2750 kW to use as an example, is the equivalent of a quiet library in decibels.

The operational facility will blend into the surrounding area with minimal visual, noise, light, odor, or traffic impacts on adjacent properties and right-of-ways.

Health and Safety

Solar panels have been used in the field for over 40 years and have been tested extensively and deemed harmless to both the natural environment and for human safety. The components of the panel racking include galvanized steel posts, aluminum framing, and electrical wiring, and

the panels are composed of glass, plexiglass, and silicon wafer cells. The panels have also been deemed safe by the EPA for disposal in landfills though Ecoplexus recycles panels when broken with either the manufacturer or one of the growing number of independent solar panel recycling facilities.

For security purposes, a 7ft tall fence is installed around the perimeter of all solar panels, inverters and batteries. Ecoplexus proposes a 7ft tall security fence without barbed wire to mitigate any harm to wildlife that may try to jump the fence and to lessen the institutional feeling often associated with barbed wire.

Water and Sewer Impacts

The proposed solar power electrical generation facility will not require water or sewer service during construction or during regular operation. A relatively small amount of water will be used during construction.

Water is typically needed for dust control during construction but given the wet climate and soils at the site, dust should not be a construction issue. Water will be needed on site for compaction purposes but will be very limited and can be brought on site via truck.

Environmental

Publicly available environmental data has been reviewed for the site including; USFWS National Wetland Inventory, FEMA Floodplain Data, VA State Historic Preservation Office, USFWS IPac for threatened and endangered species, USDA Soil Survey, and USGS Elevation data. to identify potential wetlands, streams, floodplains, soil and geotechnical, and topography constraints. Environmental features onsite are being avoided with only minor impacts for road and/or PV crossings. A detailed delineation and inventory of environmental features onsite has also been performed and incorporated into the site plan. Ecoplexus will submit this project to VA DEQ for the Permit by Rule process in the months following receipt of the Special Exception Permit from Prince George County. Ecoplexus will secure permits from the state and USACE for impacts, if required, prior to or as part of the Virginia Permit by Rule process.

In order to mitigate any potential threat to regional threatened or endangered species and wetland resources, a volunteered 50 foot setback from all streams, determined wetlands and swamps, to include Warwick Swamp located along the southern boundary of this site. Considering that the size of this project has the potential to impact wildlife movement there are planned fence breaks in 6 separate locations to accommodate the free movement of wildlife through the site.

Rural Nature

The Warwick Solar Project as outlined above will have minimal impacts on the rural nature of Prince George County and the immediate area. Environmental features will be preserved and utilized as wildlife corridors where possible. The quiet solar arrays will not be visible to passing drivers or neighbors around the majority of the site. After construction, the minimal amount of traffic associated with the operation of the site will be consistent with existing patterns. At the end of the life of this project (estimated 35 years) all equipment will be removed and the land will be able to return to its current use. A decommissioning plan with site specific decommissioning estimates to this effect has been included in this application package.

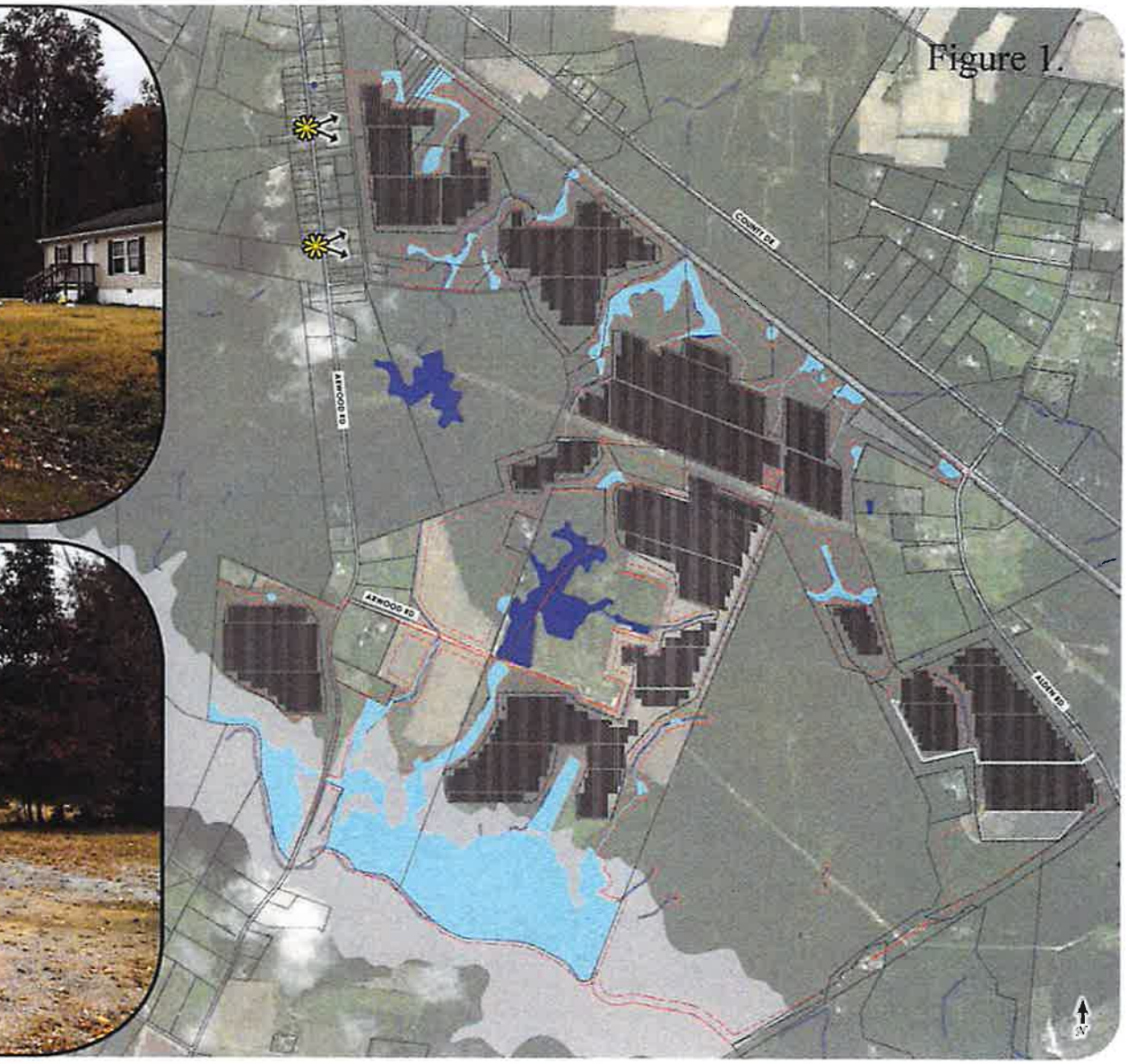


Figure 1.

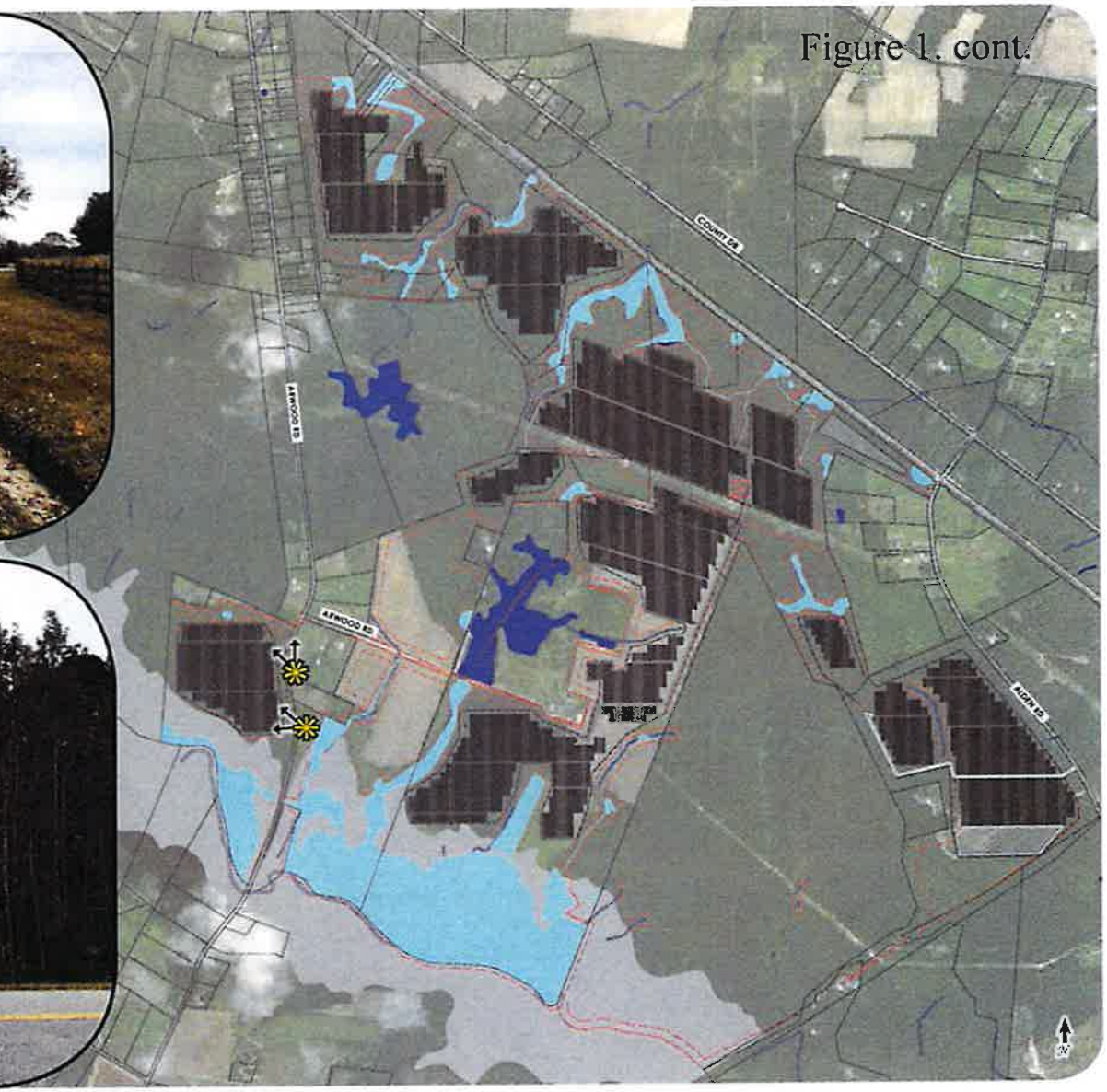
WARWICK SOLAR - Existing Vegetation East of Arwood Rd.

Prince George County, Virginia

November 2019

Kimley»Horn

Figure 1. cont.



WARWICK SOLAR - EXISTING VEGETATION WEST OF ARWOOD RD.

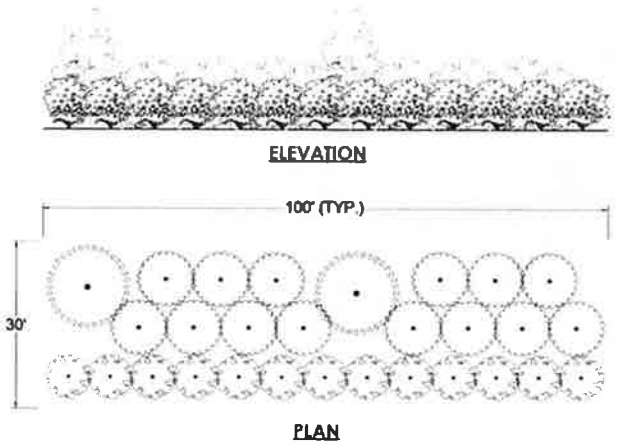
PRINCE GEORGE COUNTY, VIRGINIA

NOVEMBER 2019

Kimley»Horn

Figure 2.

ALDEN ROAD BUFFER



PLANT SCHEDULE

TREES	CODE	QTY	BOTANICAL NAME	COMMON NAME	CONT	CAL	HEIGHT
	MA LI	2	MAGNOLIA GRANDIFLORA 'LITTLE GEM'	DWARF SOUTHERN MAGNOLIA	B&B	2" MIN.	10'-12' HT.
SHRUBS	CODE	QTY	BOTANICAL NAME	COMMON NAME	CONT	HEIGHT	
	MY CE	14	MYRICA CERIFERA	WAX MYRTLE	5 GAL	36" MIN.	
	PR SC	13	PRUNUS LAUROCERASUS 'SCHIPKAENSIS'	SCHIPKA LAUREL	5 GAL	36" MIN.	

BASED ON AVAILABILITY AT THE TIME OF CONSTRUCTION, THE FOLLOWING SPECIES MAY BE USED IN PLACE OF THE LANDSCAPE MATERIALS SELECTED UNDER PLANT SCHEDULE FINAL LANDSCAPE SELECTION WILL BE COMPLIANT AND WILL BE DETERMINED AT THE TIME OF SITE PLAN AND CONSTRUCTION DRAWING SUBMITTAL

DWARF MAGNOLIA ALTERNATIVES: AMERICAN HOLLY, EASTERN RED CEDAR

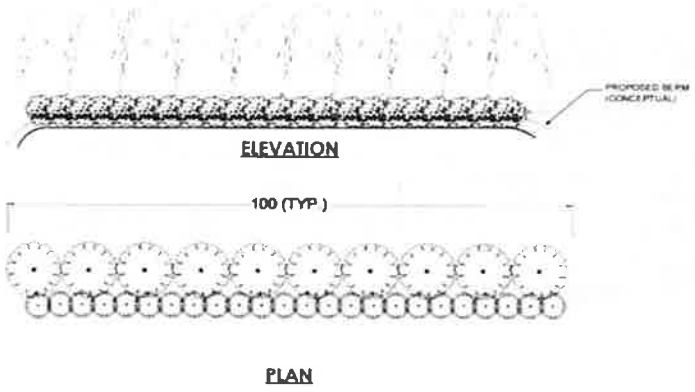
WAX MYRTLE ALTERNATIVES: NELLIE R. STEVEN'S HOLLY, RHODODENDRON MAXIMUM

SCHIPKA LAUREL ALTERNATIVES: LOROPETALUM, DWARF BURFORD HOLLY

NELLIE R. STEVENS ALTERNATIVE: WAX MYRTLE, ARBORVITAE 'EMERALD GREEN'

INKBERRY HOLLY: CAMELLIA, BURFORD HOLLY

BERM PLANTING



PLANT SCHEDULE

TREES	CODE	QTY	BOTANICAL NAME	COMMON NAME	CONT
	[illegible]	10	ILEX X 'NELLIE R. STEVENS'	NELLIE R. STEVENS HOLLY	B&B
SHRUBS	CODE	QTY	BOTANICAL NAME	COMMON NAME	CONT
	[illegible]	24	ILEX GLABRA 'SHAMROCK'	INKBERRY	5 GAL

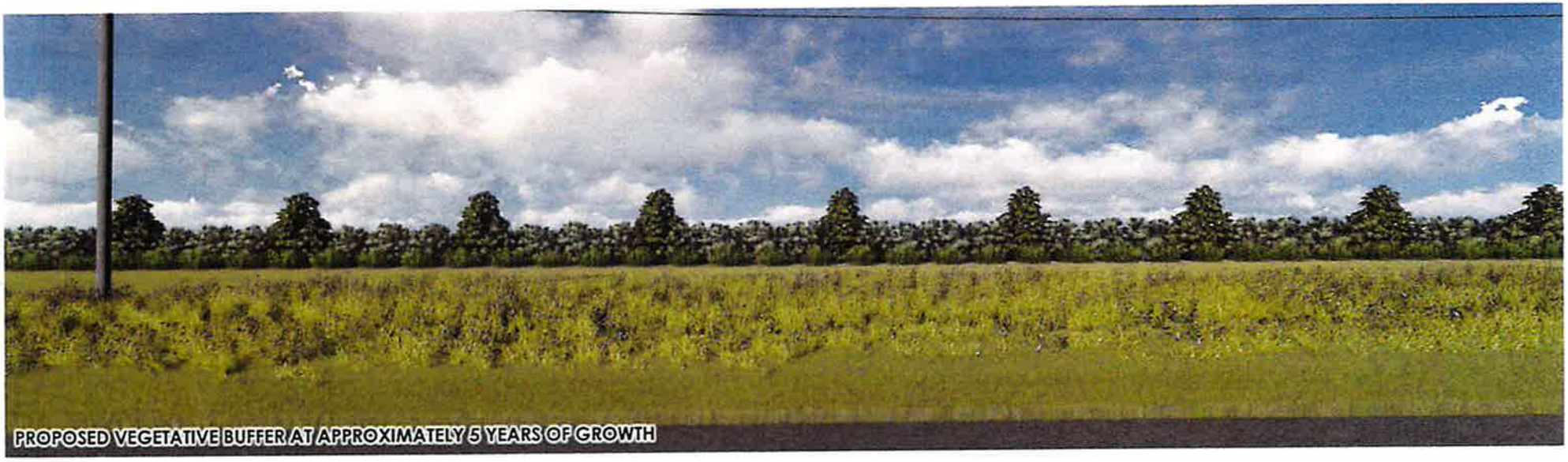
WARWICK SOLAR- PLANTED BUFFER EXHIBIT

PRINCE GEORGE COUNTY, VIRGINIA

NOVEMBER 2019

Kimley»Horn

Figure 3.



WARWICK SOLAR - VIEW ALONG ALDEN ROAD

PRINCE GEORGE COUNTY, VIRGINIA

NOVEMBER 2019

Kimley»Horn

Figure 4.

WARWICK SOLAR - VIEW ALONG ARWOOD ROAD

PRINCE GEORGE COUNTY, VIRGINIA

NOVEMBER 2019

Kimley»Horn

ecoplexus

2/7/2020

Warwick PV1-Solar Facility

Re: Write up to address neighbor and County comments and concerns

Concerns over Arwood Road:

- Concerns were voiced over the potential impacts of any traffic, either during construction or operation, associated with a Solar Farm. We have removed all solar panels and all access points along Arwood, as were previously proposed. There will be no traffic at all associated with the solar farm, either during construction or operation. Please see the Zoning Site Plan that has been provided with this package.

Concerns over area encompassed by Special Exception vs. actual "project area":

- Neighbors have voiced concerns with the fact that we are proposing a special exception for the entirety of the 20 proposed parcels though we cannot and will not use the entirety of all the parcels.
- To remedy this concern, the Applicant is proposing a condition to the Special Exception Permit that our project area proposed to be placed as an area not to exceed during the development process. The project area is defined as all equipment within the fence line and the setbacks and buffering required by PG County. The site plan proposes 363 acres within the fence line and the estimate of the acreage covered by setbacks and buffering is approximately 147 acres. To add a few acres for minor adjustments prior to site plan approval and to consider driveways and permitting wetland crossings as necessary we are proposing a total of 535 acres as an area not to exceed to be placed as a condition on our Special Exception Permit. If in the event, more land is required, the Applicant would have to apply for additional acreage.
- A map entitled "Shaded Project Area" has been provided in this package showing the proposed project area as defined above.

Concerns over Threatened and Endangered Species:

- A copy of the Wetland Report with associated Threatened and Endangered Species review has been provided with this package.
- Table 5 of the Wetland Report lists the 22 state- and/or federally listed threatened or endangered species have the potential to occur within the Project boundary based on VDCR, VaFWIS, and USFWS species occurrence data. The majority of the species listed are not likely to occur on-site due to a lack of suitable habitat. None were observed during the site visit. This table also lists

each species' potential to occur onsite and the reasoning behind the determination of not likely to impact ("not likely to impact" is language preferred by USFWS)

- Relating to concern over Bald Eagles, State and Federal eagle inventories have been checked and there is no recorded Bald Eagle Roost or Nest on or near the proposed project site. Please reference the Center for Conservation Biology for a map on identified and confirmed Bald Eagle Roosts and Nest in VA. https://ccbbirds.org/maps/#eagles

Concerns over wetlands and streams:

- Across the entire acreage under lease option, there are 159 acres of Federal Jurisdictional wetlands and 11,591 linear feet of streams or ditches. Please reference the Wetland Report provided for greater details.
- A 50 foot offset from all streams and wetlands is being volunteered by the applicant.
- Prince George County does not require a standard setback for streams or wetlands outside of the Chesapeake Bay and Resource Protection Areas. A 50-foot buffer off of streams is recommended by Prince George County and is being met by our proposed project.
- Streams and wetlands are kept out of the fenceline in all instances
- Stream and wetland features and the associated buffering act as natural wildlife corridors throughout the project.
- There are three locations on-site where a road and or conduit will need to cross wetlands. In these cases Nationwide Permit applications will be submitted to the Army Corp of Engineers and all associated approval and mitigations will be obtained before the Site Plan application is submitted to Prince George County.

Concerns over equipment toxicity:

- The components of solar panels, racks, and utility equipment include:
    - Silicon wafers cells (the core of the solar panel)
    - Glass
    - Plexiglass
    - Galvanized steel posts
    - Aluminum panel frames
    - Typical nuts, bolts, and screws
    - Typical electrical wiring
    - Standard electrical inverters and transformers with cooling fans

- A report produced by NC Clean Energy Technology Center, associated with NC State University has been provided in this package demonstrating facts about solar power generation and the equipment.
- We provided expert testimony to the health and safety of solar power generation and solar as a land-use at the Jan 23rd Planning Commission hearing. Testimony by this individual, not associated with the Applicant, and others like him have been accepted as factual evidence in quasi-judicial evidentiary hearings hundreds of times throughout the Country.

Concerns over the number of natural trees to be cut down for project:

- Referencing the Wetland Report, an on-site survey was performed and a tree species and land-use inventory was taken of the entirety of the parcels under lease option. Of the acreage in the proposed project area, there are approximately 45 acres, or 11% of the project area, that currently consists of natural growth of mixed hardwoods that would need to be removed for project development. The remainder of the project area includes planted pines, recently timbered pines with a few years of growth, or agricultural lands.

GENERAL PROJECT INFORMATION

PROJECT NAME:	WARWICK PV1
PROJECT ADDRESS:	
DEVELOPER NAME:	ECOPLEXUS, INC.
DEVELOPER ADDRESS:	101 2ND ST., STE. 1250, SAN FRANCISCO, CA 94105

GENERAL SYSTEM INFORMATION

MODULE:	HANWA Q.PEAK DUO L-G5.2 400 W
QUANTITY:	195,500
INVERTER:	SMA SUNNY CENTRAL 4000-EV-US
QUANTITY:	15
MOUNTING SYSTEM:	TBD
MOUNTING SYSTEM TYPE:	SINGLE-AXIS TRACKER, 60° TILT, 90° AZIMUTH, 40% GCR
SYSTEM SIZE (DC):	78.2 MW
SYSTEM SIZE (AC):	60.0 MW
UTILIZED AREA:	363.0 ACRES

GENERAL SITE NOTES

1. THE PURPOSE OF THIS PLAN IS TO PROVIDE PRINCE GEORGE COUNTY WITH ADEQUATE INFORMATION TO GRANT A SPECIAL EXCEPTION PERMIT FOR A SOLAR POWER PLANT.
2. THE PROJECT EXTENTS REFLECT THE PROPOSED LOCATION OF THE SOLAR FACILITY; HOWEVER, PERMITTING (STATE AND FEDERAL) AND EQUIPMENT AVAILABILITY MAY REQUIRE MODIFICATIONS TO THE SOLAR ARRAY WITHIN THE FENCED AREA. ANY CHANGES TO THE FENCE THAT INCREASE THE AREA WITHIN THE FENCE WILL BE SUBMITTED FOR STAFF LEVEL REVIEW. THE FINAL ISSUED FOR CONSTRUCTION (IFC) DRAWINGS WILL BE PROVIDED TO THE COUNTY.
3. CURRENT OWNER (S):

   JL THACKER CO, INC
   PO BOX 152, DISPUTANTA, VA 23842

   JAMES THACKER REVOCABLE TRUST PO BOX
   152, DISPUTANTA, VA 23842

   THOMAS AND DIANNA WOOLRIDGE 7209
   BEEFSTEAK RD, WAVERLY, VA 23890

   JEFFREY AND BEVERLY STOTESBERRY
   15770 ALDEN ROAD, DISPUTANTA, VA 23842
4. SETBACKS (FT): 100 FT PROPERTY BOUNDARY, 50 FT WETLANDS/FLOODPLAIN
5. AREAS WITHIN THE FENCE OF THE PROPOSED SOLAR ARRAY (ACRES): 383.4
6. STREAM BUFFERS INCLUDE: 50 FT SETBACK
7. PARCEL LINE DATA HAS BEEN OBTAINED FROM: PRINCE GEORGE COUNTY GIS DATA
8. WETLAND INFORMATION HAS BEEN OBTAINED FROM REPORT ON 08/20/2019, ENVIRONMENTAL CONSULTING & TECHNOLOGIES, INC; UNCONFIRMED BY THE US ARMY CORPS OF ENGINEERS.
9. SUBJECT PARCEL IS LOCATED WITHIN A FEDERALLY DESIGNATED FLOOD HAZARD AREA; HOWEVER, THE PROPOSED SOLAR ARRAY IS NOT LOCATED WITHIN THE FLOOD HAZARD AREA (COMMUNITY PANEL NUMBER 51149C0325B, EFFECTIVE DATE: MAY 16, 2012).
10. NO PERMANENT LIGHTING IS PROPOSED FOR THIS SITE.
11. ON-SITE STRUCTURES WILL NOT EXCEED 15-FEET IN HEIGHT EXCLUDING UTILITY POLES.
12. DURING REGULAR OPERATION THE SITE WILL BE UNMANNED AND MONITORED REMOTELY.
13. A DRIVEWAY PERMIT (OR PERMITS) WILL BE OBTAINED FROM DOT PRIOR TO CONSTRUCTION.
14. AN EROSION AND SEDIMENT CONTROL PERMIT WILL BE OBTAINED FROM DEQ PRIOR TO CONSTRUCTION.
15. BUILDING AND ELECTRICAL PERMITS WILL BE OBTAINED BY THE DEVELOPER.
16. A TEMPORARY STAGING AREA WILL BE ESTABLISHED DURING CONSTRUCTION. UPON COMPLETION OF CONSTRUCTION THIS AREA WILL BE REMOVED. ANY SOIL OR GRAVEL PATHS MAY REMAIN FOR LONG-TERM SITE ACCESS.
17. THE PROPOSED SOLAR ARRAY WILL BE ENCLOSED BY AN 8-FOOT TALL DEER BUSTER FENCE.
18. GATE CODES WILL BE PROVIDED TO LOCAL EMERGENCY PERSONNEL.
19. SIGNAGE WILL BE PLACED ON THE OUTSIDE OF THE FENCE PER CODE NEC 110.34 (C).

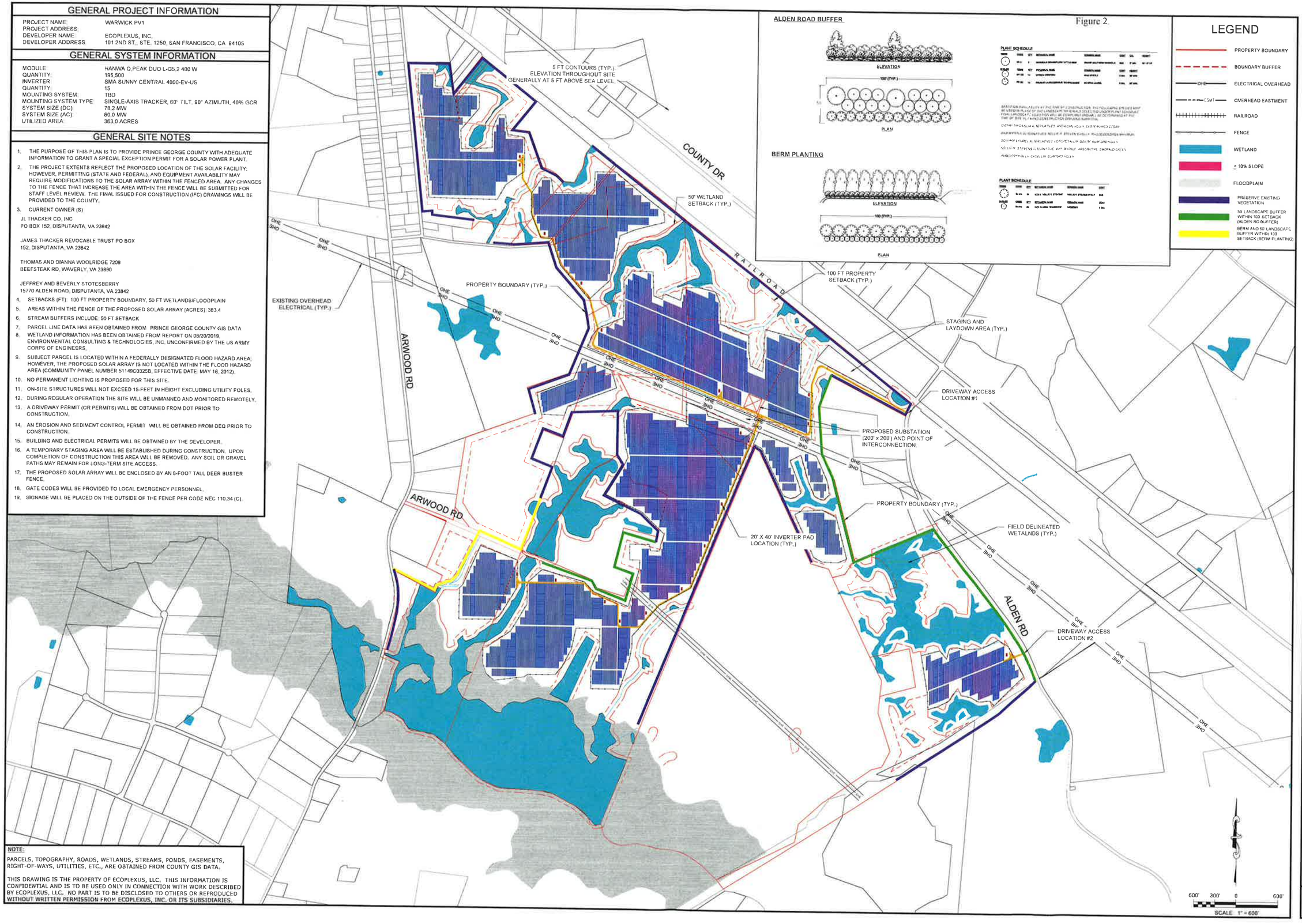


Figure 2.

ALDEN ROAD BUFFER

BERM PLANTING

LEGEND

- PROPERTY BOUNDARY
- BOUNDARY BUFFER
- OHE — ELECTRICAL OVERHEAD
- ESMT — OVERHEAD EASTMENT
- RAILROAD
- FENCE
- WETLAND
- > 10% SLOPE
- FLOODPLAIN
- PRESERVE EXISTING VEGETATION
- 50 LANDSCAPE BUFFER WITHIN 100 SETBACK (ALDEN RD BUFFER)
- BERM AND 50 LANDSCAPE BUFFER WITHIN 100 SETBACK (BERM PLANTING)

NOTE:

PARCELS, TOPOGRAPHY, ROADS, WETLANDS, STREAMS, PONDS, EASEMENTS, RIGHT-OF-WAYS, UTILITIES, ETC., ARE OBTAINED FROM COUNTY GIS DATA.

ecoplexus
ECOPLEXUS, Inc
101 Second Street, Ste. 1250
San Francisco, CA 94105
Ph: 415-629-1802
Fx: 415-449-3466
NC License No.: D-0392

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

REV	DATE	DESCRIPTION
A	09/06/2019	COUNTY SUBMITTAL
B	10/14/2019	ADDED SE PROPOERTY
C	10/15/2019	COUNTY SUBMITTAL

WARWICK PV1

VIRGINIA
PRINCE GEORGE COUNTY

CIVIL REVIEW	JMH
DEV REVIEW	
DESIGNED BY	CL
DRAWN BY	JAH
SCALE	1" = 600'
DATE	02/03/2020

DRAWING DESCRIPTION

CONCEPT PLAN

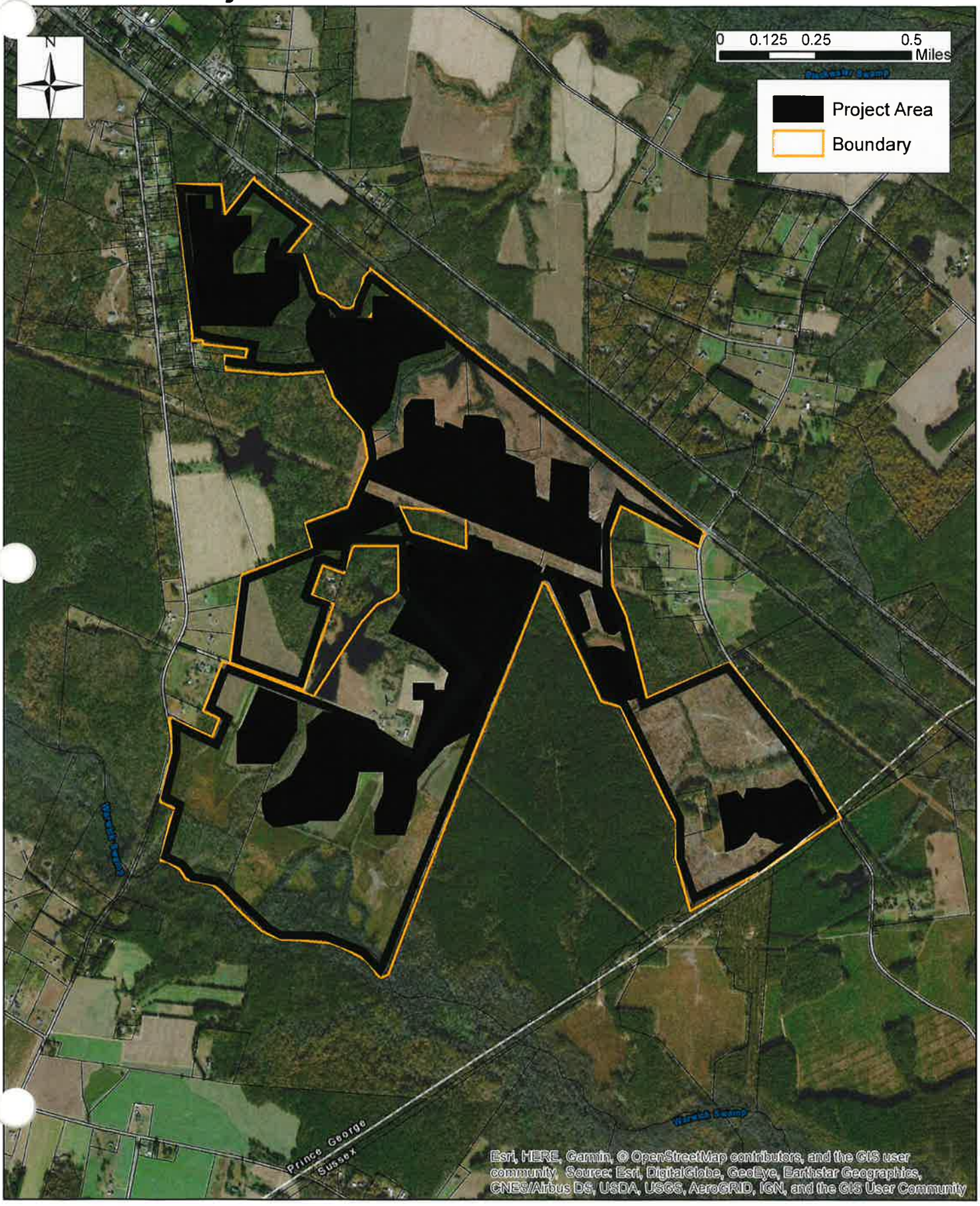
DRAWING No.

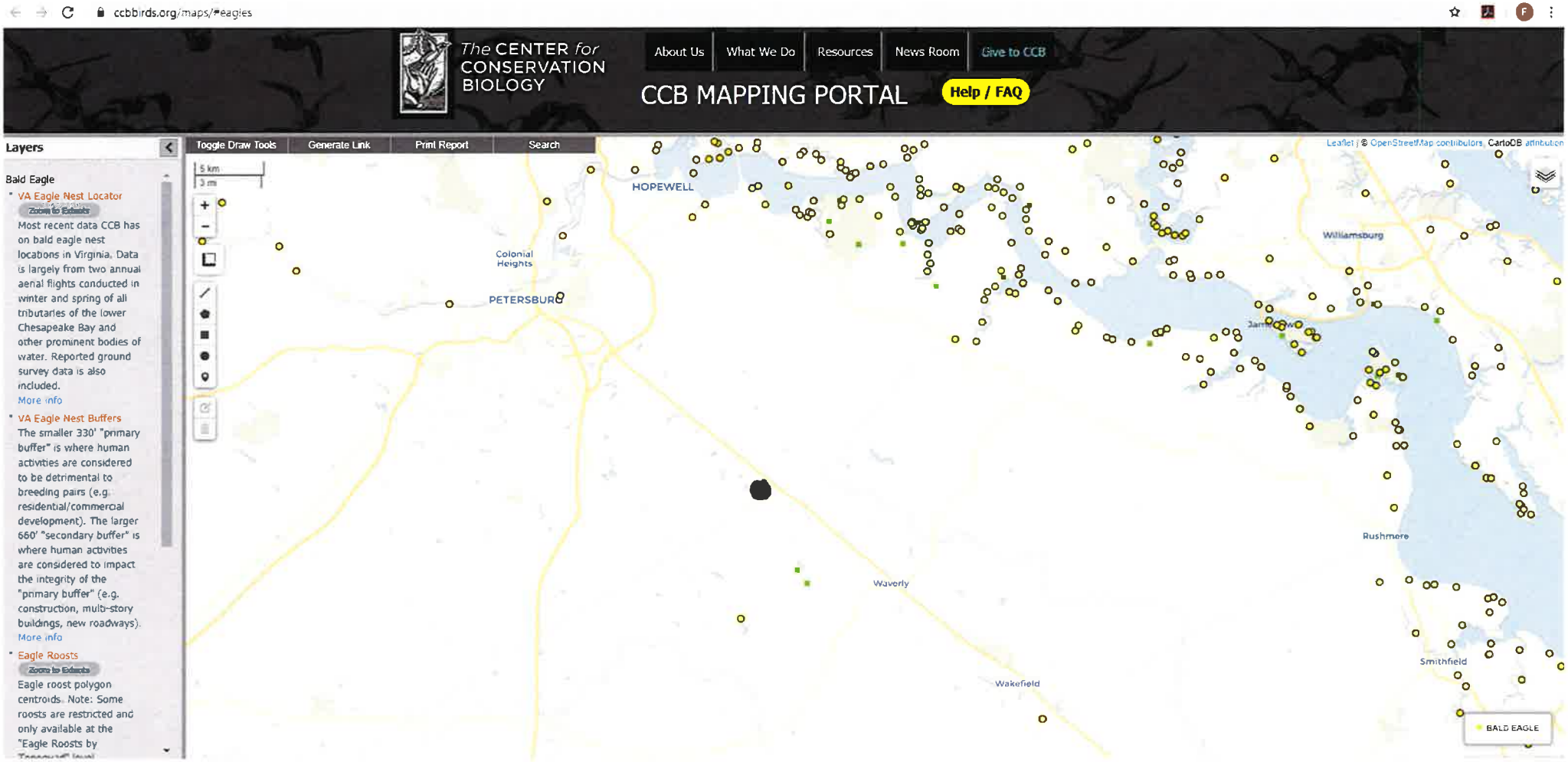
PV1.1

File: G:\My Drive\PROJECTS\WARWICK PV1\03 Design\Civil\CAD\Warwick - Concept Plan - 200203.dwg, Layout: Concept Plan, By: jahoward20, Plotted: Tue Feb 04, 2020 at 7:14pm, XREFs Used:

Warwick PV1
Shaded Project Area

Ecoplexus Inc
2/7/2020




ccbbirds.org/maps/#eagles
The CENTER for CONSERVATION BIOLOGY
About Us
What We Do
Resources
News Room
Give to CCB
CCB MAPPING PORTAL
Help / FAQ
Layers
Bald Eagle
VA Eagle Nest Locator
Zoom to Extents
Most recent data CCB has on bald eagle nest locations in Virginia. Data is largely from two annual aerial flights conducted in winter and spring of all tributaries of the lower Chesapeake Bay and other prominent bodies of water. Reported ground survey data is also included.
More info
VA Eagle Nest Buffers
The smaller 330' "primary buffer" is where human activities are considered to be detrimental to breeding pairs (e.g. residential/commercial development). The larger 660' "secondary buffer" is where human activities are considered to impact the integrity of the "primary buffer" (e.g. construction, multi-story buildings, new roadways).
More info
Eagle Roosts
Zoom to Extents
Eagle roost polygon centroids. Note: Some roosts are restricted and only available at the "Eagle Roosts by
Toggle Draw Tools
Generate Link
Print Report
Search
5 km
3 mi
Leaflet | © OpenStreetMap contributors, CartoDB attribution
HOPEWELL
Colonial Heights
PETERSBURG
Williamsburg
Rushmere
Waverly
Wakefield
Smithfield
BALD EAGLE

WARWICK SOLAR PROJECT
ENVIRONMENTAL AND
ECOLOGICAL REPORT
PRINCE GEORGE COUNTY, VIRGINIA

Prepared for:

ECOPLEXUS, INC.
Durham, North Carolina

Prepared by:

ECT Environmental Consulting & Technology, Inc.
7208 Falls of Neuse Road, Suite 102
Raleigh, North Carolina 27615-3244

ECT No. 190479-0100

December 2019

DOCUMENT REVIEW

The dual signatory process is an integral part of Environmental Consulting & Technology, Inc.'s (ECT's) Document Review Policy No. 9.03. All ECT documents undergo technical/peer review prior to dispatching these documents to any outside entity.

This document has been authored and reviewed by the following employees:

Rachel Kohnke	Christopher Wu
Author	Peer Review
Signature	Signature
December 23, 2019	December 23, 2019
Date	Date

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
CWA	Clean Water Act
DEQ	Virginia Department of Environmental Quality
ECT	Environmental Consulting and Technology
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act of 1973
GPS	global positioning system
IPAC	Information Planning and Conservation
MW ac	Megawatt alternating current
NHD	National Hydrography Dataset
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	NOAA National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
OHWM	ordinary high water mark
PEM	Palustrine Emergent
PFO	Palustrine Forested
PSS	Palustrine Scrub-Shrub
T&E	threatened and endangered
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
Va. Code	Code of Virginia
VaFWIS	Virginia Fish and Wildlife Information Service
VDACS	Virginia Department of Agriculture and Consumer Services
VDCR	Virginia Department of Conservation and Recreation
VDGIF	Virginia Department of Game and Inland Fisheries
VMRC	Virginia Marine Resources Commission
VWP	Virginia Water Protection permit

1.0 INTRODUCTION

Environmental Consulting & Technology, Inc. (ECT) was contracted by Ecoplexus, Inc. to conduct an ecological assessment and wetlands delineation of the Warwick Solar Project (Site) under consideration for construction of a ground-mounted solar array (Project) located approximately 13 miles southeast of Petersburg, Virginia, along State Route 625 in Prince George County (Figure 1). Warwick Solar plans to utilize photovoltaic solar modules and single-axis tracking technology to generate a net capacity of approximately 60 megawatt alternating current (MW ac). The Project boundary is approximately 957.91 acres.

As part of the ecological assessment, ECT characterized baseline ecological conditions of the proposed Project boundary, delineated jurisdictional wetlands and waterways, mapped vegetation and land use communities, and assessed habitats for the potential presence of threatened and endangered (T&E) species. The remainder of this report provides the data collection and survey methodologies employed, as well as a summary of the results.

FIGURE 1-1 - AERIAL MAP
WARWICK SOLAR
PRINCE GEORGE COUNTY, VA

Sources: NAIP Imagery, 2017; ECT, 2019.

ECT Environmental Consulting & Technology, Inc.

FIGURE 1-2 - AERIAL MAP
WARWICK SOLAR
PRINCE GEORGE COUNTY, VA

Sources: NAIP Imagery, 2017; ECT, 2019.

ECT Environmental Consulting & Technology, Inc.

2.0 METHODOLOGY

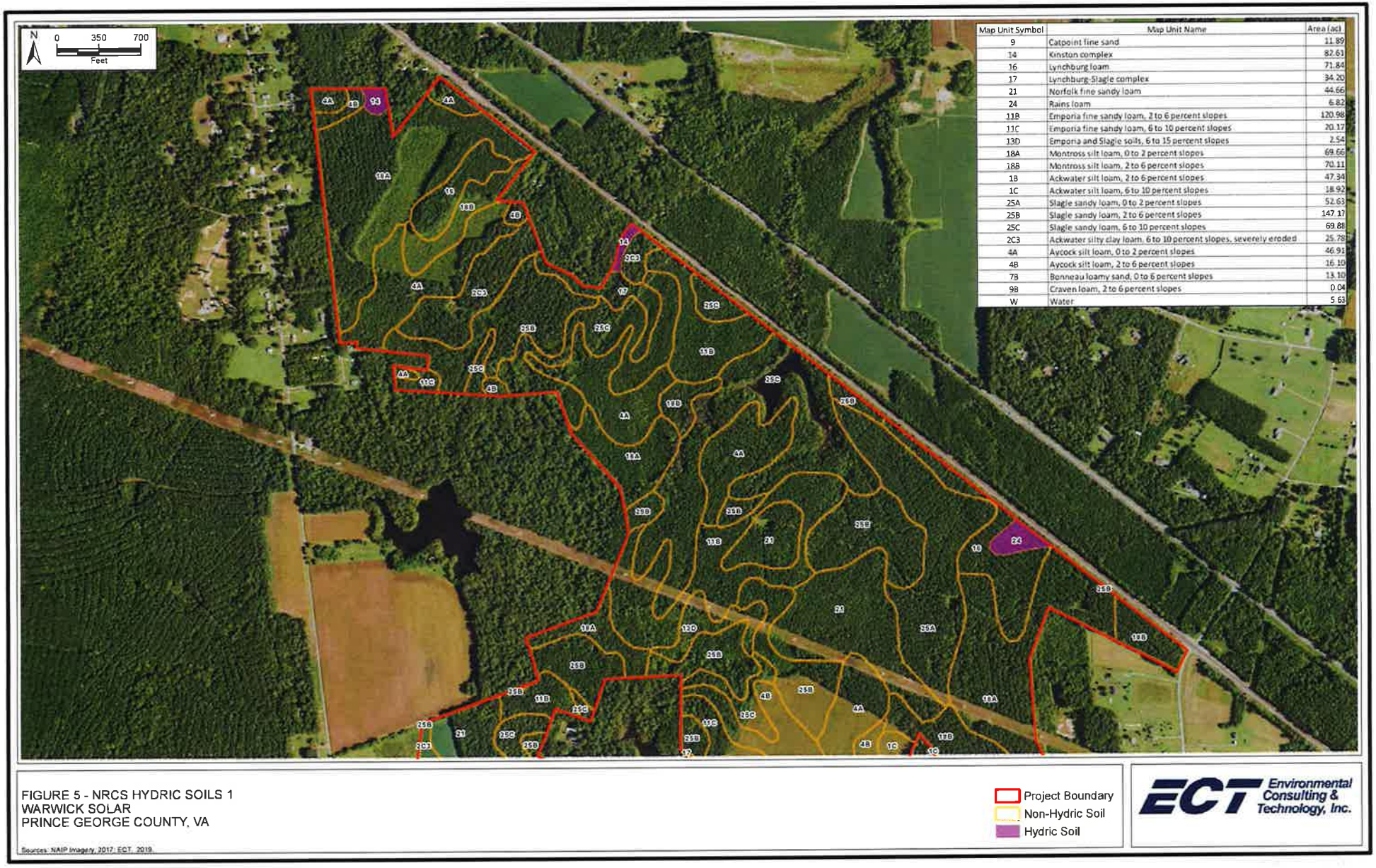
The ecological assessment was conducted through a combination of map and literature review and field surveys. The following subsections provide a description of the methodologies used.

2.1 MAP AND LITERATURE REVIEW

Prior to conducting the field survey, available literature and maps were collected and reviewed to determine the approximate extent of land use vegetation communities, wetlands and waters, and T&E species. Relevant data sources included local plants lists, soil survey data, state and federal regulations, and county ordinances. The following map and literature sources were examined:

- U.S. Geological Survey (USGS) topographic maps.
- Aerial photography.
- United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Wythe County Soil Survey (Figure 2).
- National Wetland Inventory (NWI) maps (Figure 3).
- National Hydrography Dataset (NHD, Figure 3).
- U.S. Army Corps of Engineers (USACE) guidance.
- Virginia surface water quality classifications.
- U.S. Fish & Wildlife Service (USFWS) lists of T&E species.
- Virginia Department of Game and Inland Fisheries (VDGIF) and Virginia Department of Conservation and Recreation (VDCR) species information databases.

These analyses were used for the planning and execution of field studies and determination of the potential jurisdictional status of wetlands and water bodies within the Project boundary.



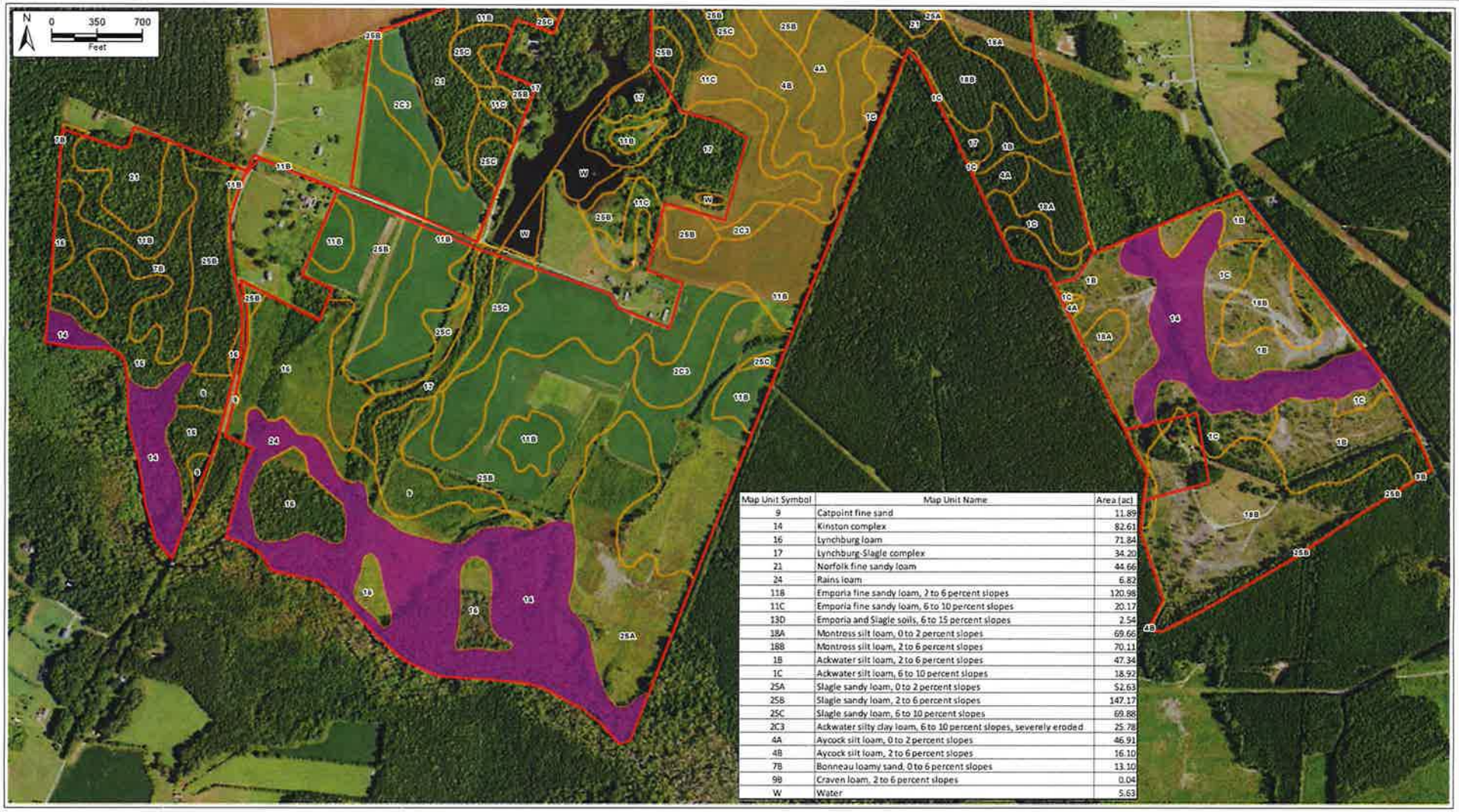
Map Unit Symbol	Map Unit Name	Area (ac)
9	Catpoint fine sand	11.89
14	Kinston complex	82.61
16	Lynchburg loam	71.84
17	Lynchburg-Slagle complex	34.20
21	Norfolk fine sandy loam	44.66
24	Rains loam	6.82
11B	Emporia fine sandy loam, 2 to 6 percent slopes	120.98
11C	Emporia fine sandy loam, 6 to 10 percent slopes	20.17
13D	Emporia and Slagle soils, 6 to 15 percent slopes	2.54
18A	Montross silt loam, 0 to 2 percent slopes	69.66
18B	Montross silt loam, 2 to 6 percent slopes	70.11
1B	Ackwater silt loam, 2 to 6 percent slopes	47.34
1C	Ackwater silt loam, 6 to 10 percent slopes	18.92
25A	Slagle sandy loam, 0 to 2 percent slopes	52.63
25B	Slagle sandy loam, 2 to 6 percent slopes	147.17
25C	Slagle sandy loam, 6 to 10 percent slopes	69.88
2C3	Ackwater silty clay loam, 6 to 10 percent slopes, severely eroded	25.78
4A	Aycock silt loam, 0 to 2 percent slopes	46.91
4B	Aycock silt loam, 2 to 6 percent slopes	16.10
7B	Bonneau loamy sand, 0 to 6 percent slopes	13.10
9B	Craven loam, 2 to 6 percent slopes	0.04
W	Water	5.63

FIGURE 5 - NRCS HYDRIC SOILS 1
WARWICK SOLAR
PRINCE GEORGE COUNTY, VA

Sources: NAIP Imagery, 2017; ECT, 2019.

Project Boundary
Non-Hydric Soil
Hydric Soil

ECT Environmental Consulting & Technology, Inc.



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7B	Bonneau loamy sand, 0 to 6 percent slopes	13.10
9B	Craven loam, 2 to 6 percent slopes	0.04
W	Water	5.63

FIGURE 5 - NRCS HYDRIC SOILS 2
WARWICK SOLAR
PRINCE GEORGE COUNTY, VA

Sources: NAIP Imagery, 2017, ECT, 2019

Project Boundary
Non-Hydric Soil
Hydric Soil

ECT Environmental Consulting & Technology, Inc.

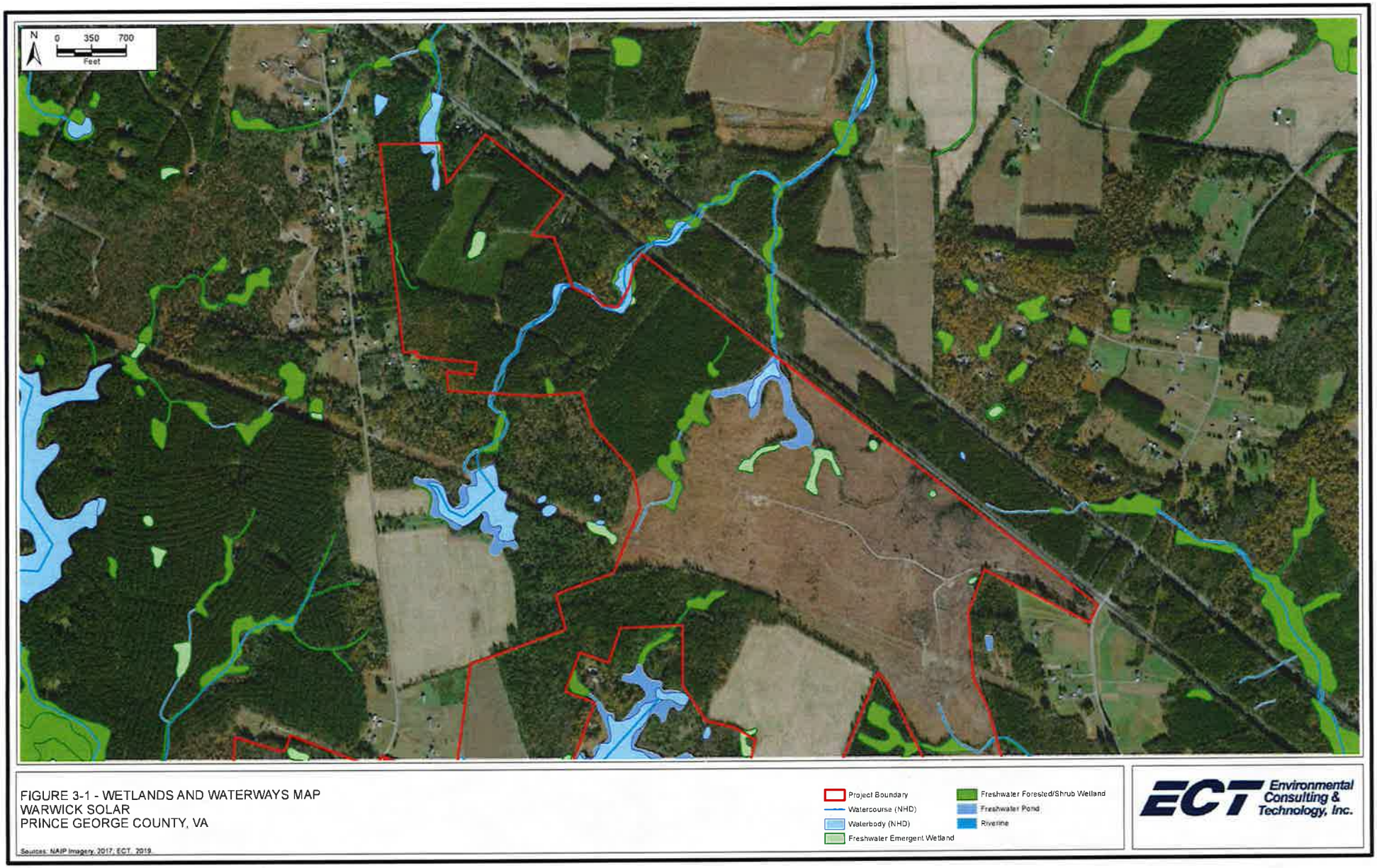


FIGURE 3-1 - WETLANDS AND WATERWAYS MAP
WARWICK SOLAR
PRINCE GEORGE COUNTY, VA

ECT Environmental Consulting & Technology, Inc.

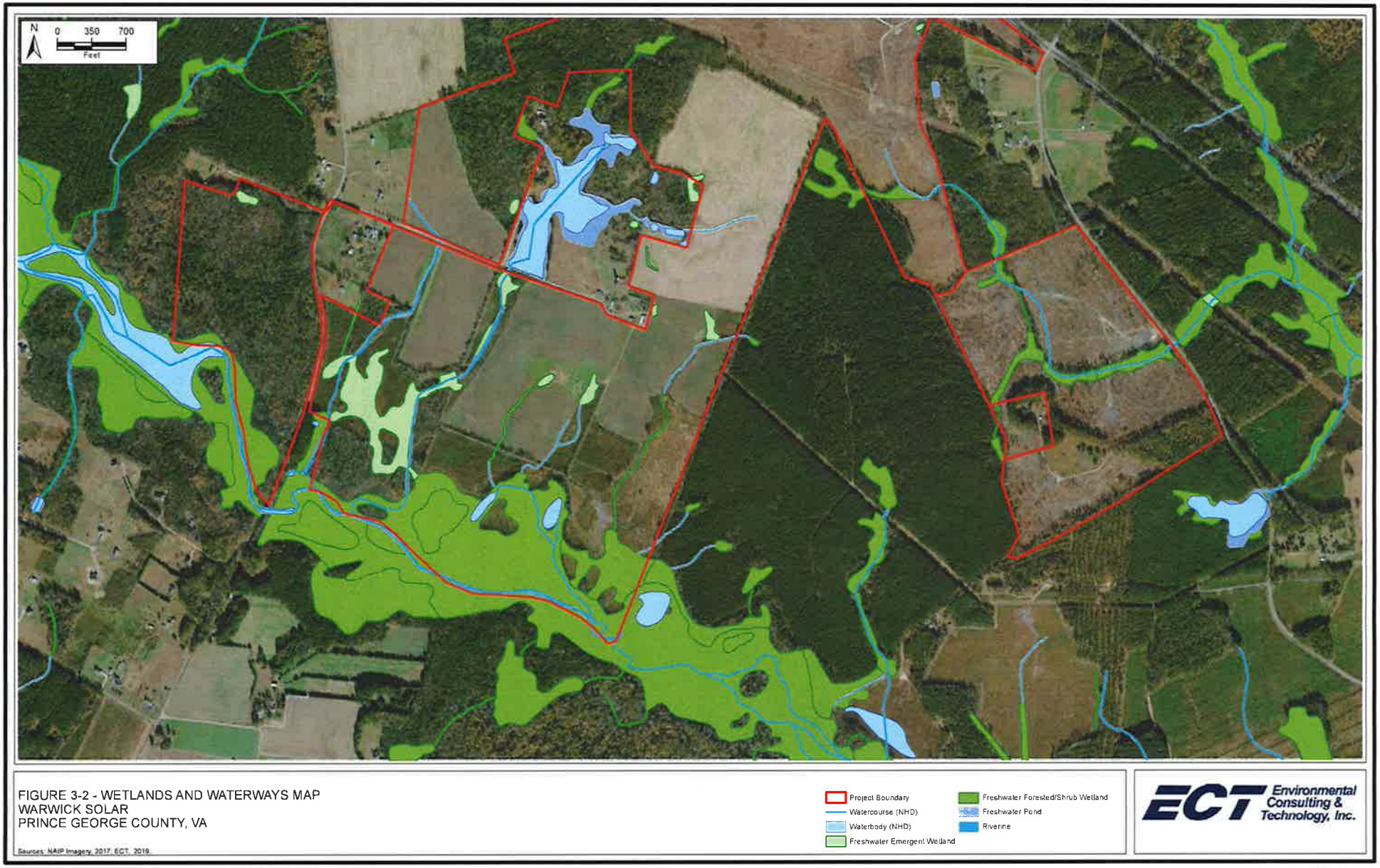


FIGURE 3-2 - WETLANDS AND WATERWAYS MAP
WARWICK SOLAR
PRINCE GEORGE COUNTY, VA

ECT Environmental Consulting & Technology, Inc.

2.2 WETLANDS DELINEATION

2.2.1 METHODOLOGY

ECT conducted a wetland delineation for the Project boundary from July 29th to 31st, 2019. Additionally, a second site visit was conducted to delineate an additional 123.77 acres on December 11th to 12th, 2019. The protocol for the wetland surveys was obtained from the 1987 USACE Wetland Delineation Manual (USACE, 1987) and the Atlantic and Gulf Coastal Plain Regional Supplement (USACE, 2010). These methods define characteristic hydrophytic vegetation, hydric soil, and hydrologic indicators that are normally present in wetlands.

For each wetland, ECT flagged the wetlands/uplands boundary using pink surveyor's tape labeled with the words "Wetlands Delineation." Wetland flags were sequentially numbered, and their locations were surveyed using a Trimble® Geo XH global positioning system (GPS) unit. Water bodies were not flagged but their extents were recorded using the GPS. ECT photographed representative wetlands and water bodies and completed the required USACE upland/wetland data forms.

2.2.2 WATERS OF THE UNITED STATES

USACE has jurisdiction over all defined "Waters of the United States." Certain activities in these waters are regulated by USACE under the authorities granted by Title 33, Part 40, Code of Federal Regulations (CFR), and Section 404 of the Clean Water Act (CWA). Waters of the United States include all wetlands and water bodies that meet USACE jurisdictional criteria.

Discharges of dredge or fill material to Waters of the United States, including wetlands, are regulated by CWA Sections 404 and 401. Section 404 requires a permit from USACE, and Section 401 is administered by the state through Virginia's Water Protection (VWP) Permit Program, either through the Virginia Department of Environmental Quality (DEQ) or Virginia Marine Resources Commission (VMRC) for tidal wetlands. In some cases, DEQ may take jurisdiction over wetlands or water bodies not considered jurisdictional by USACE. In Virginia, these permits are applied for with a joint permit application.

2.2.2.1 Wetlands

"Wetlands" is the collective term for swamps, bogs, marshes, wet meadows, and similar areas often located between open water and dry land. USACE and the U. S. Environmental Protection Agency (EPA) define a wetland as "an area that is inundated or saturated by surface or groundwater at a frequency and duration to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation." This definition takes into consideration three distinct environmental parameters: hydrology, soil, and vegetation.

According to the 1987 USACE Wetlands Delineation Manual (USACE, 1987), areas must exhibit these three distinct characteristics to be considered wetlands:

- Prevalent vegetation must consist of plants adapted to life in hydric soil conditions. These species, due to morphological, physiological, and/or reproductive adaptations, can and do persist in anaerobic soil conditions (Lichvar and Kartesz, 2012).
- Soils in wetlands must be classified as hydric or they must possess characteristics associated with reducing soil conditions.
- The area must be inundated either permanently or periodically at mean water depths less than 6.6 ft (2 meters), or the soil saturated at the surface at some time during the growing season of the prevalent vegetation.

Vegetation, soils, and hydrology were assessed during field surveys to determine whether the three criteria were satisfied within each potential wetland area. In addition, wetlands were further characterized based on primary vegetative stratum (Cowardin, Carter, Golet, and LaRoe, 1979). Wetland classifications common in Prince George County, Virginia, include the following:

- Palustrine Emergent Wetlands (PEM)—Freshwater wetlands dominated by erect, herbaceous vegetation (e.g., grasslands or stands of reedy growth), generally with less than 20-percent coverage by shrubs or trees;

- Palustrine Scrub-Shrub Wetlands (PSS)—Freshwater wetlands dominated by woody vegetation less than 20 ft tall, generally with greater than 60-percent coverage by shrubs and less than 20-percent coverage by trees.
- Palustrine Forested Wetlands (PFO)—Freshwater wetlands dominated (i.e., greater than 50-percent coverage) by trees 20 ft or taller, often consisting of an overstory dominated by deciduous, broad-leaved tree species and an assortment of herbaceous plants and vines in the sub-canopy and ground cover.

Isolated wetlands are generally not considered jurisdictional by USACE but are considered Waters of the State.

2.2.2.2 Water Bodies

Water bodies are typically defined as an area that in a normal year has water flowing or standing above ground to the extent that evidence of an ordinary high water mark (OHWM) is established. This includes lakes, rivers, bays, tributaries, and also man-made features such as canals and ditches, which exhibit a distinguishable bed and bank. USACE defines the OHWM as, "that line on the shore coincident with the elevation contour that represents the approximate location of the line on the shore established by fluctuations of water and indicated by physical characteristics such as shelving, destruction of terrestrial vegetation, presence of litter or debris, or changes in the character of soil."

The USACE jurisdictional term, "Waters of the United States," includes navigable waters and all their tributaries and other waters where degradation or destruction could affect interstate or foreign commerce. Under this definition, any surface water connection that has a defined OHWM or is part of a continuum of wetlands, whether natural or man-made, is considered a jurisdictional tributary connection. Ditches and canals with weirs, culverts, or other water control structures, including pumping facilities, are also considered to have jurisdictional tributary connection, provided there is some conveyance of water from upstream to downstream. USACE claims jurisdiction on ditches or canals that fall under this definition at the OHWM. Exclusions from this rule generally include upland cut ditches and ditches that do not connect to navigable waters or wetlands, as well as erosional features that do not exhibit a distinguishable OHWM.

Water body types were further classified based on the frequency and duration of water within the banks. The following three classifications were used:

- Perennial—Has a well-defined channel that contains water throughout the year, except for infrequent periods of severe drought. These streams support biological, hydrological, and physical characteristics associated with continuous conveyances of water.
- Intermittent—Has a well-defined channel that contains water for only part of the year (typically winter and spring) but more than just after rainstorms and at snowmelt.
- Ephemeral—Normally are natural watercourses, including natural watercourses that have been modified by channelization or man-made drainage ditches, that, without the influent of point source discharges, flow only in direct response to precipitation or irrigation return-water discharge in the immediate vicinity and whose channels are normally above the groundwater table. These streams may contain a transient population of aquatic life during the portion of the year when there is suitable habitat for fish survival. Normally, aquatic habitat in these streams is not adequate to support a reproductive cycle for fish and other aquatic life. Typically, ephemeral streams do not have an OHWM and are typically not regulated by USACE or DEQ.

2.3 LISTED SPECIES

Federally listed T&E species and designated critical habitat are protected by the Endangered Species Act of 1973 (ESA) and subsequent amendments. The ESA is administered by two federal agencies: USFWS and the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries). NOAA Fisheries oversees marine species, and USFWS has responsibility over freshwater fish and all other terrestrial and aquatic species. State-listed wildlife species are protected by VDGIF (Code of Virginia [Va. Code] §§ 29.1-563 to -570), and plants and insects are protected by the Virginia Department of Agriculture and Consumer Services (VDACS) (Va. Code § 3.2-1000 to -1011.).

Information regarding the potential presence of state and federally protected plant and wildlife species or their critical habitats within the vicinity of the Project was obtained through a combination of literature review and field survey. ECT reviewed sources of information pertaining to protected species such as the Virginia Fish and Wildlife Information Service (VaFWIS) by the VDGIF, the Natural Heritage Data Explorer by the VDCR, USFWS's list of T&E species for Virginia and Prince George County, and the USFWS Information for Planning and Consultation (IPAC) tool.

Information collected from various databases was used to compile a list of protected plant and/or wildlife species potentially occurring within the vicinity of the Project. During field studies, ECT searched for the presence of species on this list and their potential habitats.

Field surveys consisted of pedestrian surveys conducted by ECT throughout the survey area. General habitats were characterized, and these habitats were compared to the preferred habitat for each identified species to determine the likelihood of these species occurring within the project location.

3.0 SURVEY RESULTS

This section presents the results of map and literature review and field surveys.

3.1 LAND USE AND VEGETATION COMMUNITIES

Six land use/vegetation community types were identified within the Project boundary. Table 1 presents the communities and their approximate acreages within the Project boundary, and Figure 4 provides a land use map depicting their approximate locations. Appendix A contains photographs of representative communities. The following subsections provide brief descriptions of the dominant land use or vegetation types as they occur within the site.

3.1.1 CROPS

The majority of the Project is comprised of cropland, and at the time of the delineation, the crops were planted with corn and soy.

3.1.2 OPEN FIELD

Several areas of open field are located throughout the southern portion of the Project and consist of mixed grasses including tall fescue (*Schedonorus arundinaceus*), dogfennel (*Eupatorium capillifolium*), and timothy (*Phleum pretense*), as well as blackberries (*Rubus* spp.), multiflora rose (*Rosa multiflora*), and wingstem (*Verbesina* spp.).

3.1.3 PLANTED PINE

The majority of the Project is comprised of planted loblolly pine (*Pinus taeda*) with sparse mid-story and herbaceous layer. Species observed in the herbaceous layer include poison ivy (*Toxicodendron radicans*), Japanese honeysuckle (*Lonicera japonica*), Virginia creeper (*Parthenocissus quinquefolia*), and blackberries (*Rubus* spp.).

3.1.4 HARVESTED PINE

The northwestern pines were harvested, and the ground was severely disturbed by machinery in this section. The majority of vegetation has been clear cut, sparse regrowth of early

colonizers such as blackberries (*Rubus* spp.), dogfennel (*Eupatorium capillifolium)*, horseweed (*Erigeron canadensis)*, and pigweed (*Amaranth* spp.).

3.1.5 MIXED HARDWOOD FOREST

Forested areas that occur within the Project boundary consist of a mix of hardwoods and planted loblloly pine. The mixed hardwood forest included sweetgum (*Liquidambar styraciflua*), tulip poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), shagbark hickory (*Carya ovata*), and mockernut hickory (*Carya tomentosa*). Saplings of these species were observed in the understory as well as: barberry (*Berberus* sp.), highbush blueberry (*Vaccinium corymbosum*), greenbriar (*Smilax rotundifolia*), and devil's walkingstick (*Aralia spinosa*). Species in the herbaceous layer include poison ivy (*Toxicodendron radicans)*, Virginia creeper (*Parthenocissus quinquefolia),* Christmas fern (*Polystichum acrosticoides*), violets (*Viola* spp.), and mayapple (*Podophyllum peltatum*).

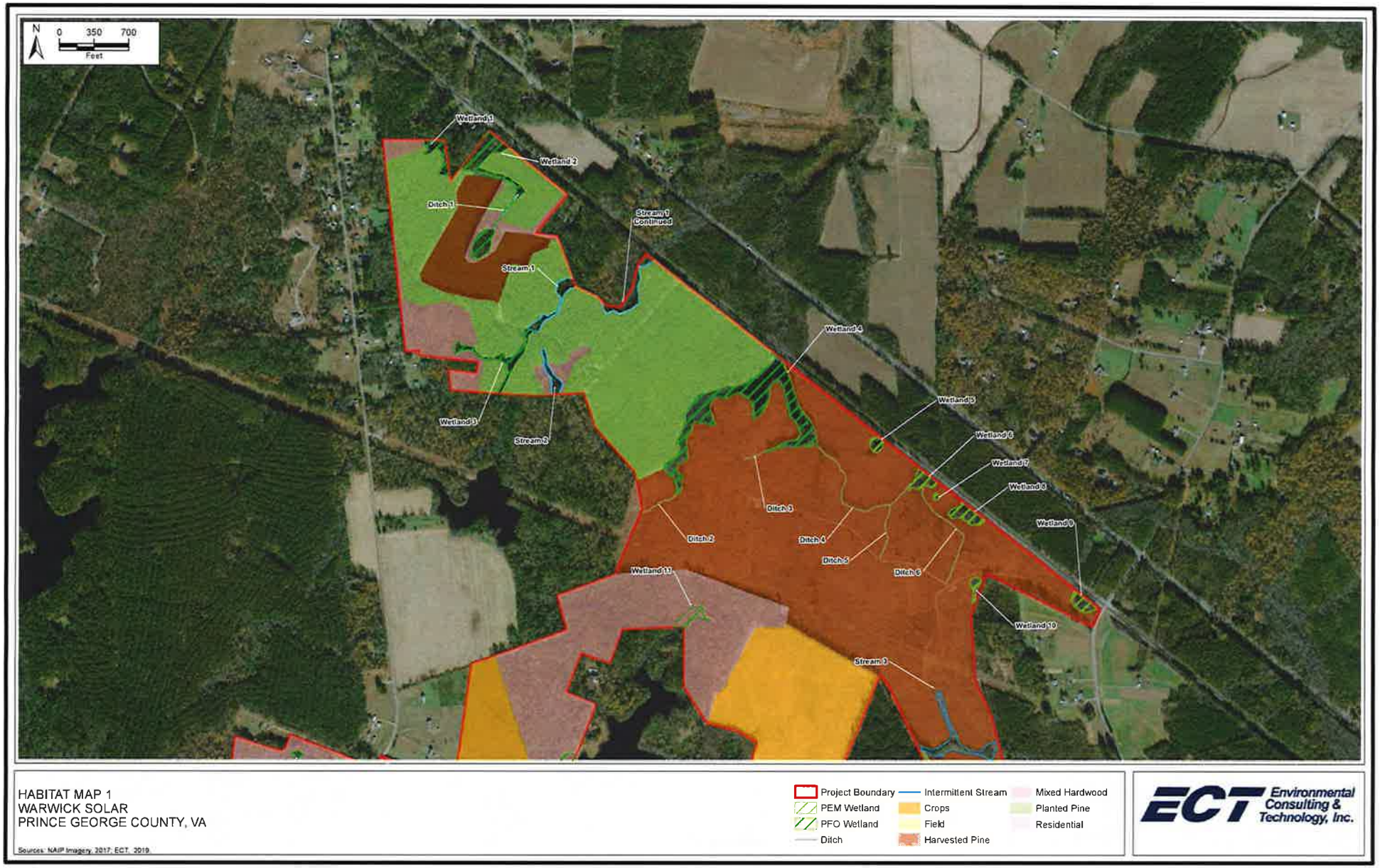
3.1.6 RESIDENTIAL

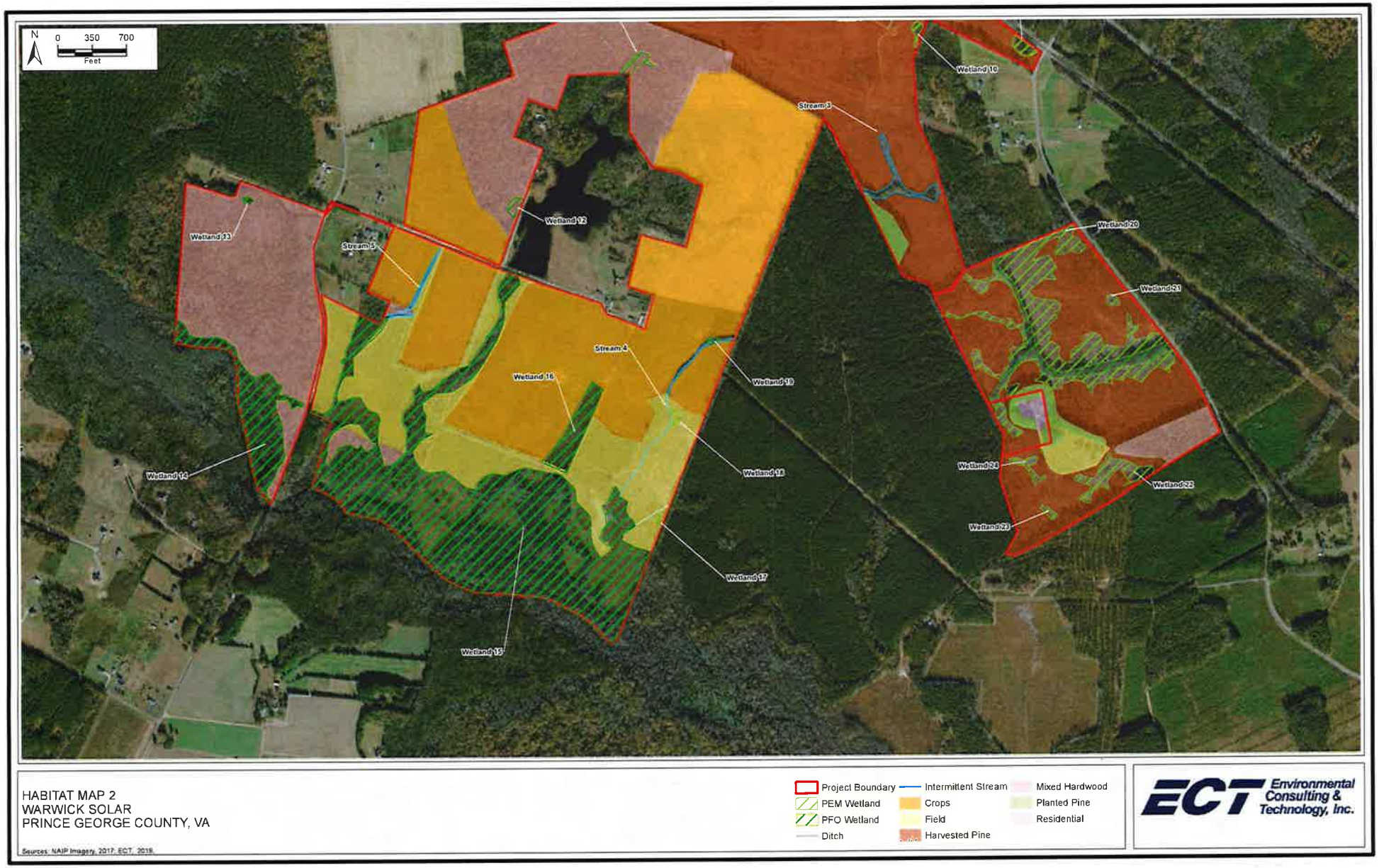
A residential structure and associated features such as a storage shed were identified during the additional survey. This area consisted of unvegetated bare ground with small clumps of various maintained grass species such as fescue. Species diversity is low and is not usually associated with habitat that would likely support listed species.

Table 1. Land Use/Vegetation Community Types on the Proposed Solar Facility Site

Land Use/Vegetation	Acreage	Percent of Survey Area
Crops	182.28	19.0
Field	72.38	7.6
Harvested Pine	277.10	28.9
Planted Pine	112.26	11.7
Mixed Hardwood	146.82	15.3
Residential	1.55	0.2
Wetland	158.80	16.6
Other Surface Waters	6.72	0.7
Total	**957.91**	

Source: ECT, 2019.


N
0 350 700
Feet
Wetland 1
Wetland 2
Ditch 1
Stream 1 Continued
Stream 1
Wetland 4
Wetland 5
Wetland 6
Wetland 7
Wetland 8
Wetland 9
Wetland 3
Stream 2
Ditch 3
Ditch 2
Ditch 4
Ditch 5
Ditch 6
Wetland 11
Wetland 10
Stream 3
HABITAT MAP 1
WARWICK SOLAR
PRINCE GEORGE COUNTY, VA
Sources: NAIP Imagery, 2017; ECT, 2019
Project Boundary
PEM Wetland
PFO Wetland
Ditch
Intermittent Stream
Crops
Field
Harvested Pine
Mixed Hardwood
Planted Pine
Residential
ECT Environmental Consulting & Technology, Inc.



HABITAT MAP 2
WARWICK SOLAR
PRINCE GEORGE COUNTY, VA

Sources: NAIP Imagery, 2017; ECT, 2019.

Project Boundary
PEM Wetland
PFO Wetland
Ditch
Intermittent Stream
Crops
Field
Harvested Pine
Mixed Hardwood
Planted Pine
Residential

ECT Environmental Consulting & Technology, Inc.

3.2 WETLANDS AND WATERWAYS

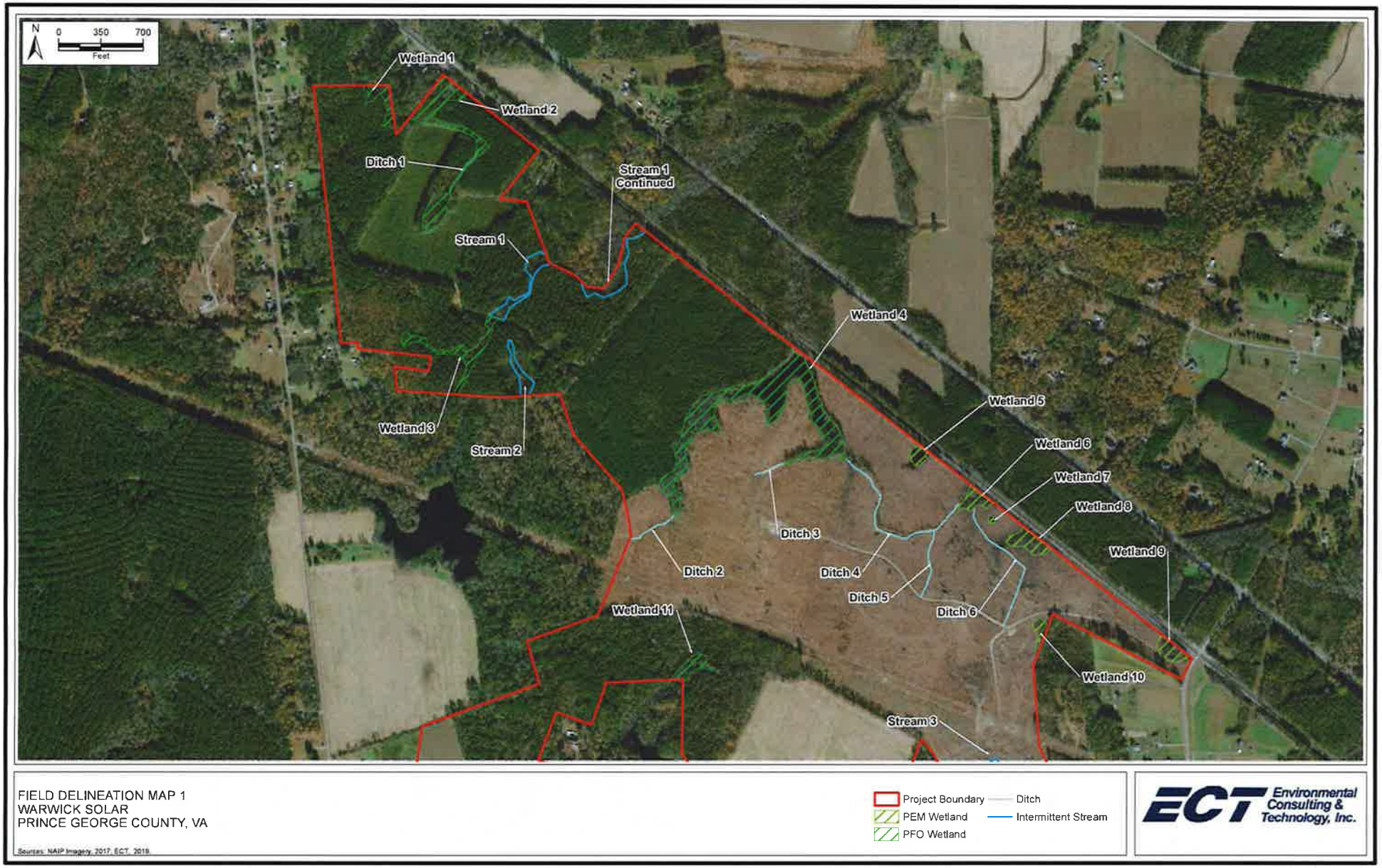
ECT delineated 24 wetlands and five streams within the Project boundary. Appendix A contains representative photographs and Appendix B includes datasheets for the wetlands. Figure 5 depicts the locations of the features on the Site.

3.2.1 WETLANDS

A total of 24 wetlands were located within the Project boundary. Wetland information is also summarized in Table 2 and locations are depicted on Figure 5. Wetland 1 is a forested depression at the northern end of the Project. Wetland 2 is a forested wetland that connects through a series of ditches and likely drains to Wetland 1. Wetland 3 drains north through a culvert under an access road to Stream 1. Wetland 4 is a forested wetland with some areas of emergent marsh, and several ditches drain into the wetland. This wetland is hydrologically connected to Wetlands 5, 6, 7, and 8 by additional ditches and a ditch outside the Project boundary that runs parallel to the railroad tracks to the north. Wetlands 5, 6, 7, 8, 9, and 10 are all depressional features with sparse emergent vegetation. The majority of them had standing water at the time of the field survey. Wetland 11 is a forested system that drains to the pond feature outside of the Project boundary. Wetland 12 is an isolated forested system but no culverts or connections to the pond to the east were identified in the field. Wetland 13 is an isolated depression at the western end of the boundary. Wetland 14 is a named feature called Warwick Swamp and is part of a larger stream system that expands northwest to southeast. Wetland 15 connects to Wetland 14 hydrologically under a bridge along State Route 625. This large feature spans the majority of the southern boundary. Streams 4 and 5 flow south to Wetland 15. Wetland 16 is a forested wetland adjacent to crops and field, and there are indications of surface flow south to Wetland 15. Wetland 17 is an emergent wetland that likely drains south to Wetland 15 offsite. Wetlands 18 and 19 are emergent and forested respectively and are both located along Stream 4 at the eastern end of the Project boundary. Wetland 20 is a large slough wetland that has expanded after harvesting the pines and is highly disturbed within the emergent portions of the wetland. Wetland 22 is located in a depression with the surrounding area draining to it which continues to drain offsite to the southeast. Wetlands 23 and 24 were identified in the southwestern portion of the additional acreage and were surrounded by disturbed areas from clearing the pines approximately two years ago.

3.2.2 STREAMS

ECT located five streams onsite which are listed and described in Table 3 and depicted in Figure 5. Appendix A presents representative photographs. Stream 1, an intermittent stream, flows from Wetland 3 and continues to drain north, and Stream 2 is an intermittent stream that drains south. Stream 3 is an intermittent stream that flows east outside the Project boundary. Stream 4 is an intermittent stream that drains south to Wetland 15 which is a large forested wetland complex. Stream 5 had a well-defined channel which also flows south to Wetland 15.

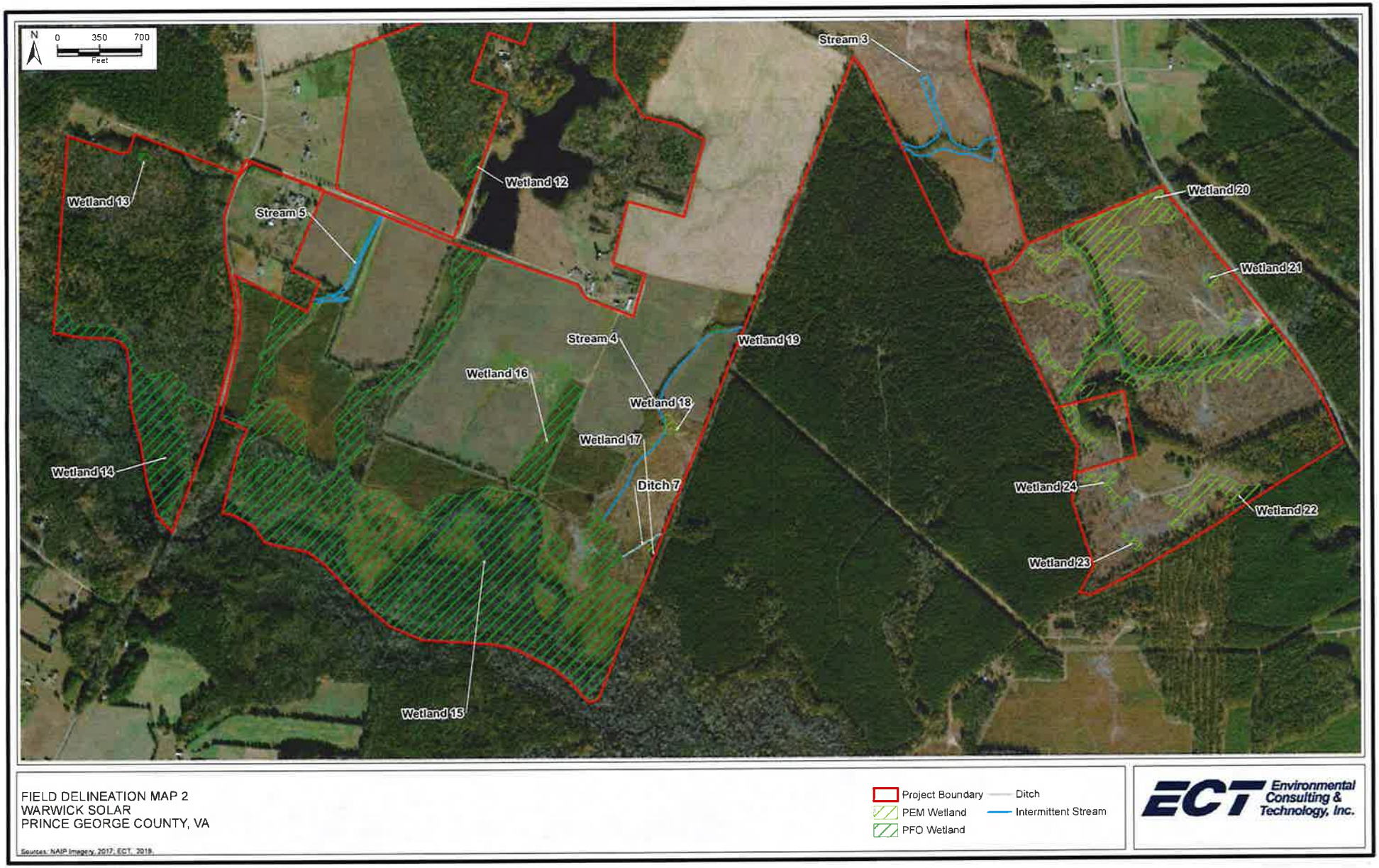


FIELD DELINEATION MAP 1
WARWICK SOLAR
PRINCE GEORGE COUNTY, VA

Sources: NAIP Imagery, 2017, ECT, 2019

Project Boundary
PEM Wetland
PFO Wetland
Ditch
Intermittent Stream

ECT Environmental Consulting & Technology, Inc.



FIELD DELINEATION MAP 2
WARWICK SOLAR
PRINCE GEORGE COUNTY, VA

Project Boundary
PEM Wetland
PFO Wetland
Ditch
Intermittent Stream

ECT Environmental Consulting & Technology, Inc.

Sources: NAIP Imagery, 2017, ECT, 2019.

Table 2. Wetlands within the Survey Area

ID	Classification	Description	USACE Status	Size (acres)
Wetland 1	PFO	Small depressional slough	Jurisdictional	0.87
Wetland 2	PFO	Depressional slough	Jurisdictional	3.44
Wetland 3	PFO	Depressional slough	Jurisdictional	1.49
Wetland 4	PFO	Forested slough system	Jurisdictional	9.25
Wetland 5	PEM	Small rounded depression	Jurisdictional	0.37
Wetland 6	PEM	Small depression	Jurisdictional	0.67
Wetland 7	PEM	Small rounded depression	Jurisdictional	0.07
Wetland 8	PEM	Small rounded depression	Jurisdictional	0.97
Wetland 9	PEM	Small rounded depression	Jurisdictional	0.67
Wetland 10	PEM	Small depression	Jurisdictional	0.34
Wetland 11	PFO	Depressional slough	Jurisdictional	0.74
Wetland 12	PFO	Small depression	Non-jurisdictional	0.45
Wetland 13	PFO	Small depression	Non-jurisdictional	0.14
Wetland 14, (Warwick Swamp)	PFO	Large slough	Jurisdictional	12.15
Wetland 15 (Warwick Swamp)	PFO	Large slough	Jurisdictional	89.77
Wetland 16	PFO	Large depression	Jurisdictional	4.28
Wetland 17	PEM	Small slough	Jurisdictional	0.13
Wetland 18	PEM	Small wet meadow	Jurisdictional	0.25
Wetland 19	PFO	Small forested depression	Jurisdictional	0.10
Wetland 20	PFO	Wetland slough	Jurisdictional	21.90
Wetland 20	PEM	Wetland fringe	Jurisdictional	6.47
Wetland 21	PEM	Small depression	Jurisdictional	0.28
Wetland 22	PEM	Small depression	Jurisdictional	3.01
Wetland 23	PEM	Small depression	Jurisdictional	0.27
Wetland 24	PEM	Small sloped wetland	Jurisdictional	0.72
			Total Jurisdictional	**158.21**
			Total Non-jurisdictional	**0.59**
			Total	**158.80**

Source: ECT, 2019.

Table 3. Streams within the Survey Area

Stream ID	Stream Name	Flow Type	Channel (ft)		Stream Length (ft)
			Width	Depth	
Stream 1	Unnamed tributary	Intermittent	10	dry	1,431.94
Stream 2	Unnamed tributary	Intermittent	15	dry	492.38
Stream 3	Unnamed tributary	Intermittent	25	dry	1,431.94
Stream 4	Unnamed tributary	Intermittent	5	dry	2,210.90
Stream 5	Unnamed tributary	Intermittent	20	dry	1,164.16
				Total	**6,731.31**

Source: ECT, 2019.

Table 4. Jurisdictional Ditches within the Survey Area

Ditch ID	Channel (ft)		Ditch Length (ft)
	Width	Depth	
Ditch 1	5	dry	444.98
Ditch 2	8	dry	439.79
Ditch 3	5	dry	264.55
Ditch 4	5-10	dry	1,525.92
Ditch 5	5	dry	584.12
Ditch 6	5	dry	1,197.97
Ditch 7	5	dry	401.84
		Total	**4,859.17**

Source: ECT, 2019.

3.3 LISTED SPECIES

Based on VDCR Natural Heritage Database, VaFWIS species occurrence data, and USFWS data, there are 22 state- and/or federally listed T&E species that may occur on or near the proposed Project (Table 4). VaFWIS lists animal species within 3 miles of a point. USFWS and VDCR lists species by county.

Table 4 includes habitat information and listing details for each of the species. The majority of the species listed are not likely to occur onsite due to a lack of suitable habitat. There is the potential for some of the listed bat species to occur in the forested areas of the Project. Wetlands 14 and 15 are part of the named complex Warwick Swamp which could which provides potential habitat and foraging areas for the bats, however, the rest of the forested areas are highly fragmented and generally not close to a major source of water which is preferred by bats. The barking treefrog has the slight potential to occur onsite, however, the continuously disturbed nature of the majority of the site and low quality of plants is unlikely to provide suitable habitat for this species. The loggerhead shrike could occur onsite but were not observed during the survey and would likely be transient if they did occur. The red cockaded woodpecker, eastern black rail, Bachman's sparrow, and Henslow's sparrow have a slight potential to be identified on site but the area is continuously disturbed by agricultural practices and none of these species were observed on site. There is a slight potential for New Jersey rush to occur in the planted pine, but no seeps or permanent water sources were identified within the pines, and ECT did not observe any during its field investigation.

Species observed during surveys of the site include: indigo bunting, red-winged blackbird, black vulture, turkey vulture, barn swallow, tree swallow, great blue heron, mallard, eastern bluebird, song sparrow, field sparrow, tufted titmouse, white-tailed deer, raccoon (tracks), eastern gray squirrel, groundhog, and field mouse.

Table 5. State and Federally Listed Species Potentially Occurring on or Near the Project Area

Scientific Name	Common Name	Federal Status	State Status	Preferred Habitat	Likelihood of Occurrence
Hyla gratiosa	Barking treefrog		T	Sandy areas in pine savannas and in low wet woods and swamps (e.g., willow oak-blackgum, cypress swamps). When inactive during cold or dry season, burrows under tree roots, vegetation, or in soil; otherwise mostly arboreal and thus dependent on trees near water. Eggs and larvae develop in shallow water of ponds, swamps, and bayheads; in Virginia, breeding sites were temporary ponds dominated by graminoids, beneath open canopies.	Slight potential – Several wetland systems occur onsite and the majority of them are dry in the summer.
Ambystoma mabeei	Mabee's salamander		T	Tupelo and cypress bottoms in pine woods, open fields, and lowland deciduous forest. Pine savannas, low wet woods, and swamps. Usually in burrows near breeding ponds. In Virginia, breeds in fish-free vernal pond in a large clearcut area and in ephemeral sinkhole ponds up to 1.5 m deep, within bottomland hardwood forest mixed with pine.	Unlikely – There are several wetland depressions that are likely vernal pools, however, the majority of them are shallow and the surrounding wooded areas/open field are continuously disturbed by agricultural practices.
Corynorhinus rafinesquii macrotis	Rafinesque's eastern big-eared bat		E	This species roosts singly, in small clusters, or groups to 100 or more in hollow trees, under loose bark, houses, unoccupied buildings and culverts. It hibernates in the northern part of the range.	Slight Potential - forested areas onsite may provide foraging areas and/or roosting trees. However, the forested areas are highly fragmented.
Myotis septen-trionalis	Northern long-eared bat	T	T	Inhabits forested regions, and will forage mainly on hillsides, and ridge forests rather than riparian and flood-plain forests. Frequent areas under the forest canopy just above shrub level. Males occur in caves in the spring and summer but females shun caves and roost under tree bark.	Slight Potential - forested areas onsite may provide foraging areas and/or roosting trees. However, no known roosts within ~70 miles of site, and forested areas are highly fragmented.
Myotis lucifugus	Little brown bat		E	Will roost in caves, buildings, rocks and trees, under bridges, in mines and in tunnels. Hibernate mostly in caves, mine shafts and abandoned tunnels. Found in all forested regions. Water is an important component of the foraging habitat.	Slight Potential - forested areas onsite may provide foraging areas and/or roosting trees. However, the forested areas are highly fragmented.
Perimyotis subflavus	Tri-colored bat	Under Review	E	Found in caves, trees/vegetation, sometimes buildings in both wooded and cleared areas. Throughout the range, hibernates in caves. Roost in caves in the winter and in caves, trees, cliffs and barns in the summer months.	Slight Potential - forested areas onsite may provide foraging areas and/or roosting trees. However, the forested areas are highly fragmented.
Picoides borealis	Red-cockaded woodpecker	E	E	Habitat consists of open, mature pine woodlands, rarely deciduous or mixed pine-hardwoods located near pine woodlands. Optimal habitat is characterized as a broad savanna with a scattered overstory of large pines and a dense groundcover containing a diversity of grass, forb, and shrub species. Mid-story vegetation is sparse or absent.	Slight potential – There are several areas of planted pines and hardwoods, however, the understory is sparse, and no records were identified within the project area.

Scientific Name	Common Name	Federal Status	State Status	Preferred Habitat	Likelihood of Occurrence
Calidris canutus rufa	Red knot	T	T	Primarily seacoasts on tidal flats and beaches, less frequently in marshes and flooded fields. On sandy or pebbly beaches, especially at river mouths; feeds on mudflats, loafs and sleeps on salinas and salt-pond dikes.	None – Project area is not near any tidal flats or beaches. .
Laterallus jamaicensis jamaicensis	Eastern black rail	FP	E	Salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy "swamps." Secretive, but may emerge from cover in early morning. Nests in or along edge of marsh, in area with saturated or shallowly flooded soils and dense vegetation, usually in site hidden in marsh grass or at base of Salicornia; on damp ground, on mat of previous year's dead grasses.	Slight potential - may occur in wetland marshes but these were surrounded by planted pine and recently disturbed. Not likely to provide sufficient habitat.
Peucaea aestivalis	Bachman's sparrow		T	Habitats include dry open pine (southern states) or oak woods (e.g., western portion of range) with an undercover of grasses and shrubs, hillsides with patchy brushy areas, overgrown fields with thickets and brambles, grassy orchards, and large clear-cuts (usually at least 20 ha in Virginia). Very occasionally breeds along the edges of wheat or corn fields.	Slight potential - may occur in wooded areas or open fields, however, the majority of these areas are routinely disturbed by agricultural practices.
Ammodramus henslowii	Henslow's sparrow		T	Open fields and meadows with grass interspersed with weeds or shrubby vegetation, especially in damp or low-lying areas, adjacent to salt marsh in some areas. Uses un-mowed hayfields (abandoned if cut). Found in a variety of habitats that contain tall, dense grass and herbaceous vegetation.	Slight potential - may occur in open fields, however, no salt marshes are within the vicinity of the project area.
Falco peregrinus	Peregrine falcon		T	Found in terrestrial inland, aquatic and coastal areas. Habitat also includes bridges/underpasses, utility poles, buildings, fences/hedgerows, farm ponds, standing snags, rocky outcrops, cliffs/ledges and islands. Almost exclusively nests on rocky cliffs of varying sizes (usually associated with water) or on manmade structures such as unfinished bridge piers, bridges or skyscrapers.	Unlikely but transient, unlikely to nest onsite.
Lanius ludovicianus	Loggerhead shrike		T	Prefers areas of grassland that are grazed or mowed occasionally to keep the grass short. An abundance of perching sites, such as fences, woody vegetation or hedgerows is also important. Usually nests in eastern redcedar or hawthorn.	Unlikely but transient, unlikely to nest onsite.
Lanius ludovicianus migrans	Loggerhead shrike, migrant		T	See above.	Unlikely but transient, unlikely to nest onsite.
Acipenser oxyrinchus	Atlantic sturgeon	E	E	Primarily marine, but close to shore, when not breeding; migrates to rivers for spawning, moves downstream afterward (may stay upstream in winter in some northern areas).	None - no perennial streams were identified on site.

Scientific Name	Common Name	Federal Status	State Status	Preferred Habitat	Likelihood of Occurrence
Enneacanthus chaetodon	Blackbanded sunfish		E	This fish is largely restricted to quiet, shallow, heavily vegetated, non-turbid, darkly stained, slightly to very acidic waters of sand- and mud-bottomed creeks, small to medium rivers, ponds, lakes, and roadside drainage ditches.	None - no perennial streams were identified on site.
Percina rex	Roanoke logperch	E	E	Habitat includes gravel and boulder runs of small to medium rivers. Typically, this species occurs in warm, usually clear, small to medium rivers of moderate or somewhat low gradient; in riffles, runs, and pools with sandy to boulder-strewn bottoms.	None - no perennial streams were identified on site.
Alasmidonta heterodon	Dwarf wedgemussel	E	E	Typically, this species is found in shallow to deep quick running water on cobble, fine gravel, or on firm silt or sandy bottoms. It requires areas of slow to moderate current, good water quality, and little silt deposits.	None - no perennial streams were identified on site.
Elliptio lanceolata	Yellow lance	T		This species is found in sandy substrates, rocks and in mud, in slack water areas, but apparently is absent from lakes. This species is found in the main channels of drainages down to streams as small as a meter across.	Unlikely - no perennial streams with sandy substrate were identified on site.
Aeschynomene virginica	Sensitive joint vetch	T	T	Fresh to slightly brackish tidal river shores and estuarine-river marsh borders. Usually grows within 2 m of low water mark on raised banks. Peaty, sandy or gravelly substrates.	None - no tidal marshes or river marshes.
Isoetes virginica	Virginia quillwort		E	Known from sinkhole ponds of the Shenandoah Valley and from woodland streams, woodland ponds, low, wet wooded areas, and upland depression wetlands of the southeastern Mountains and Piedmont.	None – not located in Shenandoah Valley or southeastern Mountains and Piedmont region.
Juncus caesariensis	New Jersey rush		T	Very acidic, sphagnous, extremely wet spring or seep areas with a stable source of flowing water, but without standing water. Occurs in open to shaded stream banks, seepy pond margins, swales, pine barren savannas, edges of bogs, and Atlantic white cedar (*Chamaecyparis thyoides*) swamps, frequently within pine barrens. Often associated with sphagnum species.	Potential - may occur near the wetland sloughs but no seeps or permanent water sources were identified.

Note: E = endangered ("in danger of extinction throughout all or a significant portion of its range").
T = threatened ("likely to become endangered within the foreseeable future throughout all or a significant portion of its range").
Sources: VDCR, 2019; VaFWIS, 2019. NatureServe, 2019. USFWS, 2019. ECT, 2019.

4.0 SUMMARY

ECT conducted an ecological assessment, site reconnaissance, and wetlands delineation for the proposed Project in Prince George County, Virginia. ECT characterized the baseline ecological conditions of the survey area, delineated jurisdictional wetlands, mapped vegetation and land use communities, and assessed habitats for the potential presence of T&E species.

The site consists mainly of harvested pine (28.9%), planted crops (19.0%), mixed hardwood (15.3%), planted pine (11.7%), open field (7.6%), and residential (0.2%). There are 24 wetlands which totaled 158.8 acres (16.6% of the site), and other surface waters including the five intermittent streams (6,731.31 linear feet), and the jurisdictional ditches (4,859.17 linear feet) for a total of 6.72 acres (0.7% of the site). The harvested pine areas were clear cut with some regeneration of species with a high tolerance of disturbance. The crop areas were planted with corn and soy at the time of the survey. The planted pine mainly consisted of loblolly pine. The mixed hardwood forest contained a multitude of species with some loblolly and white pine and sparse understory. The open fields are mainly unmaintained mix of grasses, blackberries, multiflora rose, and other wildflowers.

Based on VDCR, VaFWIS, and USFWS species occurrence data, 22 state- and/or federally listed threatened or endangered species have potential to occur within the Project boundary (Table 4). The majority of the species listed are not likely to occur onsite due to a lack of suitable habitat. None were observed during the site visit.

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NC CLEAN ENERGY TECHNOLOGY CENTER

Health and Safety Impacts of Solar Photovoltaics

MAY 2017

NC CLEAN ENERGY TECHNOLOGY CENTER

NC STATE UNIVERSITY

Health and Safety Impacts of Solar Photovoltaics

The increasing presence of utility-scale solar photovoltaic (PV) systems (sometimes referred to as solar farms) is a rather new development in North Carolina's landscape. Due to the new and unknown nature of this technology, it is natural for communities near such developments to be concerned about health and safety impacts. Unfortunately, the quick emergence of utility-scale solar has cultivated fertile grounds for myths and half-truths about the health impacts of this technology, which can lead to unnecessary fear and conflict.

Photovoltaic (PV) technologies and solar inverters are not known to pose any significant health dangers to their neighbors. The most important dangers posed are increased highway traffic during the relative short construction period and dangers posed to trespassers of contact with high voltage equipment. This latter risk is mitigated by signage and the security measures that industry uses to deter trespassing. As will be discussed in more detail below, risks of site contamination are much less than for most other industrial uses because PV technologies employ few toxic chemicals and those used are used in very small quantities. Due to the reduction in the pollution from fossil-fuel-fired electric generators, the overall impact of solar development on human health is overwhelmingly positive. This pollution reduction results from a partial replacement of fossil-fuel fired generation by emission-free PV-generated electricity, which reduces harmful sulfur dioxide (SO_2), nitrogen oxides (NO_x), and fine particulate matter ($PM_{2.5}$). Analysis from the National Renewable Energy Laboratory and the Lawrence Berkeley National Laboratory, both affiliates of the U.S. Department of Energy, estimates the health-related air quality benefits to the southeast region from solar PV generators to be worth 8.0 ¢ per kilowatt-hour of solar generation.[1] This is in addition to the value of the electricity and suggests that the air quality benefits of solar are worth more than the electricity itself.

Even though we have only recently seen large-scale installation of PV technologies, the technology and its potential impacts have been studied since the 1950s. A combination of this solar-specific research and general scientific research has led to the scientific community having a good understanding of the science behind potential health and safety impacts of solar energy. This paper utilizes the latest scientific literature and knowledge of solar practices in N.C. to address the health and safety risks associated with solar PV technology. These risks are extremely small, far less than those associated with common activities such as driving a car, and vastly outweighed by health benefits of the generation of clean electricity.

This paper addresses the potential health and safety impacts of solar PV development in North Carolina, organized into the following four categories:

(1) Hazardous Materials
(2) Electromagnetic Fields (EMF)
(3) Electric Shock and Arc Flash
(4) Fire Safety

1. Hazardous Materials

One of the more common concerns towards solar is that the panels (referred to as "modules" in the solar industry) consist of toxic materials that endanger public health. However, as shown in this section, solar energy systems may contain small amounts of toxic materials, but these materials do not endanger public health. To understand potential toxic hazards coming from a solar project, one must understand system installation, materials used, the panel end-of-life protocols, and system operation. This section will examine these aspects of a solar farm and the potential for toxicity impacts in the following subsections:

(1.2) Project Installation/Construction
(1.2) System Components
    1.2.1 Solar Panels: Construction and Durability
    1.2.2 Photovoltaic technologies
        (a) Crystalline Silicon
        (b) Cadmium Telluride (CdTe)
        (c) CIS/CIGS
    1.2.3 Panel End of Life Management
    1.2.4 Non-panel System Components
(1.3) Operations and Maintenance

1.1 Project Installation/Construction

The system installation, or construction, process does not require toxic chemicals or processes. The site is mechanically cleared of large vegetation, fences are constructed, and the land is surveyed to layout exact installation locations. Trenches for underground wiring are dug and support posts are driven into the ground. The solar panels are bolted to steel and aluminum support structures and wired together. Inverter pads are installed, and an inverter and transformer are installed on each pad. Once everything is connected, the system is tested, and only then turned on.

Figure 1: Utility-scale solar facility (5 MW_{AC}) located in Catawba County. Source: Strata Solar

1.2 System Components

1.2.1 Solar Panels: Construction and Durability

Solar PV panels typically consist of glass, polymer, aluminum, copper, and semiconductor materials that can be recovered and recycled at the end of their useful life.[2] Today there are two PV technologies used in PV panels at utility-scale solar facilities, silicon, and thin film. As of 2016, all thin film used in North Carolina solar facilities are cadmium telluride (CdTe) panels from the US manufacturer First Solar, but there are other thin film PV panels available on the market, such as Solar Frontier's CIGS panels. Crystalline silicon technology consists of silicon wafers which are made into cells and assembled into panels, thin film technologies consist of thin layers of semiconductor material deposited onto glass, polymer or metal substrates. While there are differences in the components and manufacturing processes of these two types of solar technologies, many aspects of their PV panel construction are very similar. Specifics about each type of PV chemistry as it relates to toxicity are covered in subsections a, b, and c in section 1.2.2; on crystalline silicon, cadmium telluride, and CIS/CIGS respectively. The rest of this section applies equally to both silicon and thin film panels.

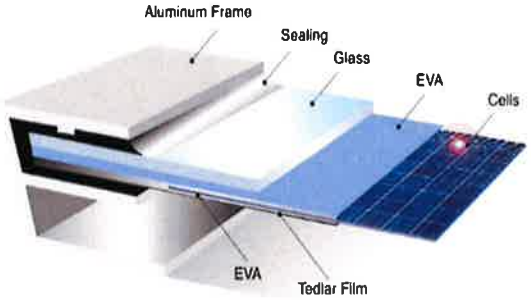

Figure 2. Components of crystalline silicon panels. The vast majority of silicon panels consist of a glass sheet on the topside with an aluminum frame providing structural support. Image Source: www.riteksolar.com.tw

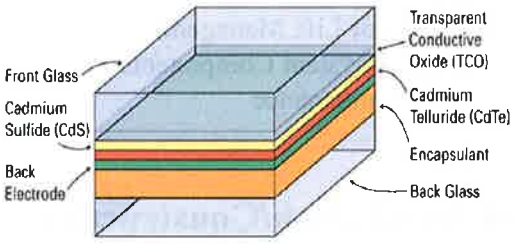

Figure 3. Layers of a common frameless thin-film panel (CdTe). Many thin film panels are frameless, including the most common thin-film panels, First Solar's CdTe. Frameless panels have protective glass on both the front and back of the panel. Layer thicknesses not to scale. Image Source: www.homepower.com

To provide decades of corrosion-free operation, PV cells in PV panels are encapsulated from air and moisture between two layers of plastic. The encapsulation layers are protected on the top with a layer of tempered glass and on the backside with a polymer sheet. Frameless modules include a protective layer of glass on the rear of the panel, which may also be tempered. The plastic ethylene-vinyl acetate (EVA) commonly provides the cell encapsulation. For decades, this same material has been used between layers of tempered glass to give car windshields and hurricane windows their great strength. In the same way that a car windshield cracks but stays intact, the EVA layers in PV panels keep broken panels intact (see Figure 4). Thus, a damaged module does not generally create small pieces of debris; instead, it largely remains together as one piece.

Figure 4: The mangled PV panels in this picture illustrate the nature of broken solar panels; the glass cracks but the panel is still in one piece. Image Source: http://img.alibaba.com/photo/115259576/broken_solar_panel.jpg

PV panels constructed with the same basic components as modern panels have been installed across the globe for well over thirty years.[3] The long-term durability and performance demonstrated over these decades, as well as the results of accelerated lifetime testing, helped lead to an industry-standard 25-year power production warranty for PV panels. These power warranties warrant a PV panel to produce at least 80% of their original nameplate production after 25 years of use. A recent SolarCity and DNV GL study reported that today's quality PV panels should be expected to reliably and efficiently produce power for thirty-five years..[4]

Local building codes require all structures, including ground mounted solar arrays, to be engineered to withstand anticipated wind speeds, as defined by the local wind speed requirements. Many racking products are available in versions engineered for wind speeds of up to 150 miles per hour, which is significantly higher than the wind speed requirement anywhere in North Carolina. The strength of PV mounting structures were demonstrated during Hurricane Sandy in 2012 and again during Hurricane Matthew in 2016. During Hurricane Sandy, the many large-scale solar facilities in New Jersey and New York at that time suffered only minor damage.[5] In the fall of 2016, the US and Caribbean experienced destructive winds and torrential rains from Hurricane Matthew, yet one leading solar tracker manufacturer reported that their numerous systems in the impacted area received zero damage from wind or flooding.[6]

In the event of a catastrophic event capable of damaging solar equipment, such as a tornado, the system will almost certainly have property insurance that will cover the cost to cleanup and repair the project. It is in the best interest of the system owner to protect their investment against such risks. It is also in their interest to get the project repaired and producing full power as soon as possible. Therefore, the investment in adequate insurance is a wise business practice for the system owner. For the same

reasons, adequate insurance coverage is also generally a requirement of the bank or firm providing financing for the project.

1.2.2 Photovoltaic (PV) Technologies

a. Crystalline Silicon

This subsection explores the toxicity of silicon-based PV panels and concludes that they do not pose a material risk of toxicity to public health and safety. Modern crystalline silicon PV panels, which account for over 90% of solar PV panels installed today, are, more or less, a commodity product. The overwhelming majority of panels installed in North Carolina are crystalline silicon panels that are informally classified as Tier I panels. Tier I panels are from well-respected manufacturers that have a good chance of being able to honor warranty claims. Tier I panels are understood to be of high quality, with predictable performance, durability, and content. Well over 80% (by weight) of the content of a PV panel is the tempered glass front and the aluminum frame, both of which are common building materials. Most of the remaining portion are common plastics, including polyethylene terephthalate in the backsheet, EVA encapsulation of the PV cells, polyphenyl ether in the junction box, and polyethylene insulation on the wire leads. The active, working components of the system are the silicon photovoltaic cells, the small electrical leads connecting them together, and to the wires coming out of the back of the panel. The electricity generating and conducting components makeup less than 5% of the weight of most panels. The PV cell itself is nearly 100% silicon, and silicon is the second most common element in the Earth's crust. The silicon for PV cells is obtained by high-temperature processing of quartz sand (SiO_2) that removes its oxygen molecules. The refined silicon is converted to a PV cell by adding extremely small amounts of boron and phosphorus, both of which are common and of very low toxicity.

The other minor components of the PV cell are also generally benign; however, some contain lead, which is a human toxicant that is particularly harmful to young children. The minor components include an extremely thin antireflective coating (silicon nitride or titanium dioxide), a thin layer of aluminum on the rear, and thin strips of silver alloy that are screen-printed on the front and rear of cell.[7] In order for the front and rear electrodes to make effective electrical contact with the proper layer of the PV cell, other materials (called glass frit) are mixed with the silver alloy and then heated to etch the metals into the cell. This glass frit historically contains a small amount of lead (Pb) in the form of lead oxide. The 60 or 72 PV cells in a PV panel are connected by soldering thin solder-covered copper tabs from the back of one cell to the front of the next cell. Traditionally a tin-based solder containing some lead (Pb) is used, but some manufacturers have switched to lead-free solder. The glass frit and/or the solder may contain trace amounts of other metals, potentially including some with human toxicity such as cadmium. However, testing to simulate the potential for leaching from broken panels, which is discussed in more detail below, did not find a potential toxicity threat from these trace elements. Therefore, the tiny amount of lead in the grass frit and the solder is the only part of silicon PV panels with a potential to create a negative health impact. However, as described below, the very limited amount of lead involved and its strong physical and chemical attachment to other components of the PV panel means that even in worst-case scenarios the health hazard it poses is insignificant.

As with many electronic industries, the solder in silicon PV panels has historically been a lead-based solder, often 36% lead, due to the superior properties of such solder. However, recent advances in lead-free solders have spurred a trend among PV panel manufacturers to reduce or remove the lead in their panels. According to the 2015 Solar Scorecard from the Silicon Valley Toxics Coalition, a group that tracks environmental responsibility of photovoltaic panel manufacturers, fourteen companies (increased from twelve companies in 2014) manufacture PV panels certified to meet the European Restriction of

Hazardous Substances (RoHS) standard. This means that the amount of cadmium and lead in the panels they manufacture fall below the RoHS thresholds, which are set by the European Union and serve as the world's de facto standard for hazardous substances in manufactured goods.[8] The Restriction of Hazardous Substances (RoHS) standard requires that the maximum concentration found in any homogenous material in a produce is less than 0.01% cadmium and less than 0.10% lead, therefore, any solder can be no more than 0.10% lead..[9]

While some manufacturers are producing PV panels that meet the RoHS standard, there is no requirement that they do so because the RoHS Directive explicitly states that the directive does not apply to photovoltaic panels..[10] The justification for this is provided in item 17 of the current RoHS Directive: "The development of renewable forms of energy is one of the Union's key objectives, and the contribution made by renewable energy sources to environmental and climate objectives is crucial. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources (4) recalls that there should be coherence between those objectives and other Union environmental legislation. Consequently, this Directive should not prevent the development of renewable energy technologies that have no negative impact on health and the environment and that are sustainable and economically viable."

The use of lead is common in our modern economy. However, only about 0.5% of the annual lead consumption in the U.S. is for electronic solder for all uses; PV solder makes up only a tiny portion of this 0.5%. Close to 90% of lead consumption in the US is in batteries, which do not encapsulate the pounds of lead contained in each typical automotive battery. This puts the lead in batteries at great risk of leaching into the environment. Estimates for the lead in a single PV panel with lead-based solder range from 1.6 to 24 grams of lead, with 13g (less than half of an ounce) per panel seen most often in the literature..[11] At 13 g/panel.[12], each panel contains one-half of the lead in a typical 12-gauge shotgun shell.. This amount equates to roughly 1/750th of the lead in a single car battery. In a panel, it is all durably encapsulated from air or water for the full life of the panel..[14]

As indicated by their 20 to 30-year power warranty, PV modules are designed for a long service life, generally over 25 years. For a panel to comply with its 25-year power warranty, its internal components, including lead, must be sealed from any moisture. Otherwise, they would corrode and the panel's output would fall below power warranty levels. Thus, the lead in operating PV modules is not at risk of release to the environment during their service lifetime. In extreme experiments, researchers have shown that lead can leach from crushed or pulverized panels..[15, 16] However, more real-world tests designed to represent typical trash compaction that are used to classify waste as hazardous or non-hazardous show no danger from leaching..[17, 18] For more information about PV panel end-of-life, see the Panel Disposal section.

As illustrated throughout this section, silicon-based PV panels do not pose a material threat to public health and safety. The only aspect of the panels with potential toxicity concerns is the very small amount of lead in some panels. However, any lead in a panel is well sealed from environmental exposure for the operating lifetime of the solar panel and thus not at risk of release into the environment.

b. Cadmium Telluride (CdTe) PV Panels

This subsection examines the components of a cadmium telluride (CdTe) PV panel. Research demonstrates that they pose negligible toxicity risk to public health and safety while significantly reducing the public's exposure to cadmium by reducing coal emissions. As of mid-2016, a few hundred MWs of

cadmium telluride (CdTe) panels, all manufactured by the U.S. company First Solar, have been installed in North Carolina.

Questions about the potential health and environmental impacts from the use of this PV technology are related to the concern that these panels contain cadmium, a toxic heavy metal. However, scientific studies have shown that cadmium telluride differs from cadmium due to its high chemical and thermal stability.[19] Research has shown that the tiny amount of cadmium in these panels does not pose a health or safety risk.[20] Further, there are very compelling reasons to welcome its adoption due to reductions in unhealthy pollution associated with burning coal. Every GWh of electricity generated by burning coal produces about 4 grams of cadmium air emissions.[21] Even though North Carolina produces a significant fraction of our electricity from coal, electricity from solar offsets much more natural gas than coal due to natural gas plants being able to adjust their rate of production more easily and quickly. If solar electricity offsets 90% natural gas and 10% coal, each 5-megawatt (5 MW_{AC}, which is generally 7 MW_{DC}) CdTe solar facility in North Carolina keeps about 157 grams, or about a third of a pound, of cadmium *out of* our environment.[22, 23]

Cadmium is toxic, but all the approximately 7 grams of cadmium in one CdTe panel is in the form of a chemical compound cadmium telluride, [24] which has $1/100^{th}$ the toxicity of free cadmium.[25] Cadmium telluride is a very stable compound that is non-volatile and non-soluble in water. Even in the case of a fire, research shows that less than 0.1% of the cadmium is released when a CdTe panel is exposed to fire. The fire melts the glass and encapsulates over 99.9% of the cadmium in the molten glass.[27]

It is important to understand the source of the cadmium used to manufacture CdTe PV panels. The cadmium is a byproduct of zinc and lead refining. The element is collected from emissions and waste streams during the production of these metals and combined with tellurium to create the CdTe used in PV panels. If the cadmium were not collected for use in the PV panels or other products, it would otherwise either be stockpiled for future use, cemented and buried, or disposed of.[28] Nearly all the cadmium in old or broken panels can be recycled which can eventually serve as the primary source of cadmium for new PV panels.[29]

Similar to silicon-based PV panels, CdTe panels are constructed of a tempered glass front, one instead of two clear plastic encapsulation layers, and a rear heat strengthened glass backing (together >98% by weight). The final product is built to withstand exposure to the elements without significant damage for over 25 years. While not representative of damage that may occur in the field or even at a landfill, laboratory evidence has illustrated that when panels are ground into a fine powder, very acidic water is able to leach portions of the cadmium and tellurium,[30] similar to the process used to recycle CdTe panels. Like many silicon-based panels, CdTe panels are reported (as far back ask 1998[31]) to pass the EPA's Toxic Characteristic Leaching Procedure (TCLP) test, which tests the potential for crushed panels in a landfill to leach hazardous substances into groundwater.[32] Passing this test means that they are classified as non-hazardous waste and can be deposited in landfills.[33, 34] For more information about PV panel end-of-life, see the Panel Disposal section.

There is also concern of environmental impact resulting from potential catastrophic events involving CdTe PV panels. An analysis of worst-case scenarios for environmental impact from CdTe PV panels, including earthquakes, fires, and floods, was conducted by the University of Tokyo in 2013. After reviewing the extensive international body of research on CdTe PV technology, their report concluded, "Even in the worst-case scenarios, it is unlikely that the Cd concentrations in air and sea water will exceed the environmental regulation values."[35] In a worst-case scenario of damaged panels abandoned on the ground, insignificant amounts of cadmium will leach from the panels. This is because this scenario is

much less conducive (larger module pieces, less acidity) to leaching than the conditions of the EPA's TCLP test used to simulate landfill conditions, which CdTe panels pass.[36]

First Solar, a U.S. company, and the only significant supplier of CdTe panels, has a robust panel take-back and recycling program that has been operating commercially since 2005.[37] The company states that it is "committed to providing a commercially attractive recycling solution for photovoltaic (PV) power plant and module owners to help them meet their module (end of life) EOL obligation simply, cost-effectively and responsibly." First Solar global recycling services to their customers to collect and recycle panels once they reach the end of productive life whether due to age or damage. These recycling service agreements are structured to be financially attractive to both First Solar and the solar panel owner. For First Solar, the contract provides the company with an affordable source of raw materials needed for new panels and presumably a diminished risk of undesired release of Cd. The contract also benefits the solar panel owner by allowing them to avoid tipping fees at a waste disposal site. The legal contract helps provide peace of mind by ensuring compliance by both parties when considering the continuing trend of rising disposal costs and increasing regulatory requirements.

c. CIS/CIGS and other PV technologies

Copper indium gallium selenide PV technology, often referred to as CIGS, is the second most common type of thin-film PV panel but a distant second behind CdTe. CIGS cells are composed of a thin layer of copper, indium, gallium, and selenium on a glass or plastic backing. None of these elements are very toxic, although selenium is a regulated metal under the Federal Resource Conservation and Recovery Act (RCRA).[38] The cells often also have an extremely thin layer of cadmium sulfide that contains a tiny amount of cadmium, which is toxic. The promise of high efficiency CIGS panels drove heavy investment in this technology in the past. However, researchers have struggled to transfer high efficiency success in the lab to low-cost full-scale panels in the field.[39] Recently, a CIGS manufacturer based in Japan, Solar Frontier, has achieved some market success with a rigid, glass-faced CIGS module that competes with silicon panels. Solar Frontier produces the majority of CIS panels on the market today.[40] Notably, these panels are RoHS compliant,[41] thus meeting the rigorous toxicity standard adopted by the European Union even thought this directive exempts PV panels. The authors are unaware of any completed or proposed utility-scale system in North Carolina using CIS/CIGS panels.

1.2.3 Panel End-of-Life Management

Concerns about the volume, disposal, toxicity, and recycling of PV panels are addressed in this subsection. To put the volume of PV waste into perspective, consider that by 2050, when PV systems installed in 2020 will reach the end of their lives, it is estimated that the global annual PV panel waste tonnage will be 10% of the 2014 global e-waste tonnage.[42] In the U.S., end-of-life disposal of solar products is governed by the Federal Resource Conservation and Recovery Act (RCRA), as well as state policies in some situations. RCRA separates waste into hazardous (not accepted at ordinary landfill) and solid waste (generally accepted at ordinary landfill) based on a series of rules. According to RCRA, the way to determine if a PV panel is classified as hazardous waste is the Toxic Characteristic Leaching Procedure (TCLP) test. This EPA test is designed to simulate landfill disposal and determine the risk of hazardous substances leaching out of the landfill.[43,44,45] Multiple sources report that most modern PV panels (both crystalline silicon and cadmium telluride) pass the TCLP test.[46,47] Some studies found that some older (1990s) crystalline silicon panels, and perhaps some newer crystalline silicon panels (specifics are not given about vintage of panels tested), do not pass the lead (Pb) leachate limits in the TCLP test.[48,49]

The test begins with the crushing of a panel into centimeter-sized pieces. The pieces are then mixed in an acid bath. After tumbling for eighteen hours, the fluid is tested for forty hazardous substances that all must be below specific threshold levels to pass the test. Research comparing TCLP conditions to conditions of damaged panels in the field found that simulated landfill conditions provide overly conservative estimates of leaching for field-damaged panels.[50] Additionally, research in Japan has found no detectable Cd leaching from cracked CdTe panels when exposed to simulated acid rain.[51]

Although modern panels can generally be landfilled, they can also be recycled. Even though recent waste volume has not been adequate to support significant PV-specific recycling infrastructure, the existing recycling industry in North Carolina reports that it recycles much of the current small volume of broken PV panels. In an informal survey conducted by the NC Clean Energy Technology Center survey in early 2016, seven of the eight large active North Carolina utility-scale solar developers surveyed reported that they send damaged panels back to the manufacturer and/or to a local recycler. Only one developer reported sending damaged panels to the landfill.

The developers reported at that time that they are usually paid a small amount per panel by local recycling firms. In early 2017, a PV developer reported that a local recycler was charging a small fee per panel to recycle damaged PV panels. The local recycling firm known to authors to accept PV panels described their current PV panel recycling practice as of early 2016 as removing the aluminum frame for local recycling and removing the wire leads for local copper recycling. The remainder of the panel is sent to a facility for processing the non-metallic portions of crushed vehicles, referred to as "fluff" in the recycling industry.[52] This processing within existing general recycling plants allows for significant material recovery of major components, including glass which is 80% of the module weight, but at lower yields than PV-specific recycling plants. Notably almost half of the material value in a PV panel is in the few grams of silver contained in almost every PV panel produced today. In the long-term, dedicated PV panel recycling plants can increase treatment capacities and maximize revenues resulting in better output quality and the ability to recover a greater fraction of the useful materials.[53] PV-specific panel recycling technologies have been researched and implemented to some extent for the past decade, and have been shown to be able to recover over 95% of PV material (semiconductor) and over 90% of the glass in a PV panel.[54]

A look at global PV recycling trends hints at the future possibilities of the practice in our country. Europe installed MW-scale volumes of PV years before the U.S. In 2007, a public-private partnership between the European Union and the solar industry set up a voluntary collection and recycling system called PV CYCLE. This arrangement was later made mandatory under the EU's WEEE directive, a program for waste electrical and electronic equipment.[55] Its member companies (PV panel producers) fully finance the association. This makes it possible for end-users to return the member companies' defective panels for recycling at any of the over 300 collection points around Europe without added costs. Additionally, PV CYCLE will pick up batches of 40 or more used panels at no cost to the user. This arrangement has been very successful, collecting and recycling over 13,000 tons by the end of 2015.[56]

In 2012, the WEEE Directive added the end-of-life collection and recycling of PV panels to its scope.[57] This directive is based on the principle of extended-producer-responsibility. It has a global impact because producers that want to sell into the EU market are legally responsible for end-of-life management. Starting in 2018, this directive targets that 85% of PV products "put in the market" in Europe are recovered and 80% is prepared for reuse and recycling.

The success of the PV panel collection and recycling practices in Europe provides promise for the future of recycling in the U.S. In mid-2016, the US Solar Energy Industry Association (SEIA) announced that they are starting a national solar panel recycling program with the guidance and support of many

leading PV panel producers..[58] The program will aggregate the services offered by recycling vendors and PV manufacturers, which will make it easier for consumers to select a cost-effective and environmentally responsible end-of-life management solution for their PV products. According to SEIA, they are planning the program in an effort to make the entire industry landfill-free. In addition to the national recycling network program, the program will provide a portal for system owners and consumers with information on how to responsibly recycle their PV systems.

While a cautious approach toward the potential for negative environmental and/or health impacts from retired PV panels is fully warranted, this section has shown that the positive health impacts of reduced emissions from fossil fuel combustion from PV systems more than outweighs any potential risk. Testing shows that silicon and CdTe panels are both safe to dispose of in landfills, and are also safe in worst case conditions of abandonment or damage in a disaster. Additionally, analysis by local engineers has found that the current salvage value of the equipment in a utility scale PV facility generally exceeds general contractor estimates for the cost to remove the entire PV system..[59, 60, 61]

1.2.4 Non-Panel System Components (racking, wiring, inverter, transformer)

While previous toxicity subsections discussed PV panels, this subsection describes the non-panel components of utility-scale PV systems and investigates any potential public health and safety concerns. The most significant non-panel component of a ground-mounted PV system is the mounting structure of the rows of panels, commonly referred to as "racking". The vertical post portion of the racking is galvanized steel and the remaining above-ground racking components are either galvanized steel or aluminum, which are both extremely common and benign building materials. The inverters that make the solar generated electricity ready to send to the grid have weather-proof steel enclosures that protect the working components from the elements. The only fluids that they might contain are associated with their cooling systems, which are not unlike the cooling system in a computer. Many inverters today are RoHS compliant.

The electrical transformers (to boost the inverter output voltage to the voltage of the utility connection point) do contain a liquid cooling oil. However, the fluid used for that function is either a non-toxic mineral oil or a biodegradable non-toxic vegetable oil, such as BIOTEMP from ABB. These vegetable transformer oils have the additional advantage of being much less flammable than traditional mineral oils. Significant health hazards are associated with old transformers containing cooling oil with toxic PCBs. Transfers with PCB-containing oil were common before PCBs were outlawed in the U.S. in 1979. PCBs still exist in older transformers in the field across the country.

Other than a few utility research sites, there are no batteries on- or off-site associated with utility-scale solar energy facilities in North Carolina, avoiding any potential health or safety concerns related to battery technologies. However, as battery technologies continue to improve and prices continue to decline we are likely to start seeing some batteries at solar facilities. Lithium ion batteries currently dominate the world utility-scale battery market, which are not very toxic. No non-panel system components were found to pose any health or environmental dangers.

1.4 Operations and Maintenance – Panel Washing and Vegetation Control

Throughout the eastern U.S., the climate provides frequent and heavy enough rain to keep panels adequately clean. This dependable weather pattern eliminates the need to wash the panels on a regular basis. Some system owners may choose to wash panels as often as once a year to increase production, but most in N.C. do not regularly wash any PV panels. Dirt build up over time may justify panel washing a few times over the panels' lifetime; however, nothing more than soap and water are required for this activity.

The maintenance of ground-mounted PV facilities requires that vegetation be kept low, both for aesthetics and to avoid shading of the PV panels. Several approaches are used to maintain vegetation at NC solar facilities, including planting of limited-height species, mowing, weed-eating, herbicides, and grazing livestock (sheep). The following descriptions of vegetation maintenance practices are based on interviews with several solar developers as well as with three maintenance firms that together are contracted to maintain well over 100 of the solar facilities in N.C. The majority of solar facilities in North Carolina maintain vegetation primarily by mowing. Each row of panels has a single row of supports, allowing sickle mowers to mow under the panels. The sites usually require mowing about once a month during the growing season. Some sites employ sheep to graze the site, which greatly reduces the human effort required to maintain the vegetation and produces high quality lamb meat.[62]

In addition to mowing and weed eating, solar facilities often use some herbicides. Solar facilities generally do not spray herbicides over the entire acreage; rather they apply them only in strategic locations such as at the base of the perimeter fence, around exterior vegetative buffer, on interior dirt roads, and near the panel support posts. Also unlike many row crop operations, solar facilities generally use only general use herbicides, which are available over the counter, as opposed to restricted use herbicides commonly used in commercial agriculture that require a special restricted use license. The herbicides used at solar facilities are primarily 2-4-D and glyphosate (Round-up®), which are two of the most common herbicides used in lawns, parks, and agriculture across the country. One maintenance firm that was interviewed sprays the grass with a class of herbicide known as a growth regulator in order to slow the growth of grass so that mowing is only required twice a year. Growth regulators are commonly used on highway roadsides and golf courses for the same purpose. A commercial pesticide applicator license is required for anyone other than the landowner to apply herbicides, which helps ensure that all applicators are adequately educated about proper herbicide use and application. The license must be renewed annually and requires passing of a certification exam appropriate to the area in which the applicator wishes to work. Based on the limited data available, it appears that solar facilities in N.C. generally use significantly less herbicides per acre than most commercial agriculture or lawn maintenance services.

2. Electromagnetic Fields (EMF)

PV systems do not emit any material during their operation; however, they do generate electromagnetic fields (EMF), sometimes referred to as radiation. EMF produced by electricity is non-ionizing radiation, meaning the radiation has enough energy to move atoms in a molecule around (experienced as heat), but not enough energy to remove electrons from an atom or molecule (ionize) or to damage DNA. As shown below, modern humans are all exposed to EMF throughout our daily lives without negative health impact. Someone outside of the fenced perimeter of a solar facility is not exposed to significant EMF from the solar facility. Therefore, there is no negative health impact from the EMF

produced in a solar farm. The following paragraphs provide some additional background and detail to support this conclusion.

Since the 1970s, some have expressed concern over potential health consequences of EMF from electricity, but no studies have ever shown this EMF to cause health problems.[63] These concerns are based on some epidemiological studies that found a slight increase in childhood leukemia associated with average exposure to residential power-frequency magnetic fields above 0.3 to 0.4 μT (microteslas) (equal to 3.0 to 4.0 mG (milligauss)). μT and mG are both units used to measure magnetic field strength. For comparison, the average exposure for people in the U.S. is one mG or 0.1 μT, with about 1% of the population with an average exposure in excess of 0.4 μT (or 4 mG).[64] These epidemiological studies, which found an association but not a causal relationship, led the World Health Organization's International Agency for Research on Cancer (IARC) to classify ELF magnetic fields as "possibly carcinogenic to humans". Coffee also has this classification. This classification means there is limited evidence but not enough evidence to designate as either a "probable carcinogen" or "human carcinogen". Overall, there is very little concern that ELF EMF damages public health. The only concern that does exist is for long-term exposure above 0.4 μT (4 mG) that may have some connection to increased cases of childhood leukemia. In 1997, the National Academies of Science were directed by Congress to examine this concern and concluded:

> "Based on a comprehensive evaluation of published studies relating to the effects of power-frequency electric and magnetic fields on cells, tissues, and organisms (including humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects."[65]

There are two aspects to electromagnetic fields, an electric field and a magnetic field. The electric field is generated by voltage and the magnetic field is generated by electric current, i.e., moving electrons. A task group of scientific experts convened by the World Health Organization (WHO) in 2005 concluded that there were no substantive health issues related to *electric* fields (0 to 100,000 Hz) at levels generally encountered by members of the public.[66] The relatively low voltages in a solar facility and the fact that electric fields are easily shielded (i.e., blocked) by common materials, such as plastic, metal, or soil means that there is no concern of negative health impacts from the electric fields generated by a solar facility. Thus, the remainder of this section addresses magnetic fields. Magnetic fields are not shielded by most common materials and thus can easily pass through them. Both types of fields are strongest close to the source of electric generation and weaken quickly with distance from the source.

The direct current (DC) electricity produced by PV panels produce stationary (0 Hz) electric and magnetic fields. Because of minimal concern about potential risks of stationary fields, little scientific research has examined stationary fields' impact on human health.[67] In even the largest PV facilities, the DC voltages and currents are not very high. One can illustrate the weakness of the EMF generated by a PV panel by placing a compass on an operating solar panel and observing that the needle still points north.

While the electricity throughout the majority of a solar site is DC electricity, the inverters convert this DC electricity to alternating current (AC) electricity matching the 60 Hz frequency of the grid. Therefore, the inverters and the wires delivering this power to the grid are producing non-stationary EMF, known as extremely low frequency (ELF) EMF, normally oscillating with a frequency of 60 Hz. This frequency is at the low-energy end of the electromagnetic spectrum. Therefore, it has less energy than

other commonly encountered types of non-ionizing radiation like radio waves, infrared radiation, and visible light.

The wide use of electricity results in background levels of ELF EMFs in nearly all locations where people spend time – homes, workplaces, schools, cars, the supermarket, etc. A person's average exposure depends upon the sources they encounter, how close they are to them, and the amount of time they spend there..[68] As stated above, the average exposure to magnetic fields in the U.S. is estimated to be around one mG or 0.1 μT, but can vary considerably depending on a person's exposure to EMF from electrical devices and wiring..[69] At times we are often exposed to much higher ELF magnetic fields, for example when standing three feet from a refrigerator the ELF magnetic field is 6 mG and when standing three feet from a microwave oven the field is about 50 mG..[70] The strength of these fields diminish quickly with distance from the source, but when surrounded by electricity in our homes and other buildings moving away from one source moves you closer to another. However, unless you are inside of the fence at a utility-scale solar facility or electrical substation it is impossible to get very close to the EMF sources. Because of this, EMF levels at the fence of electrical substations containing high voltages and currents are considered "generally negligible"..[71], [72]

The strength of ELF-EMF present at the perimeter of a solar facility or near a PV system in a commercial or residential building is significantly lower than the typical American's average EMF exposure..[73],[74] Researchers in Massachusetts measured magnetic fields at PV projects and found the magnetic fields dropped to very low levels of 0.5 mG or less, and in many cases to less than background levels (0.2 mG), at distances of no more than nine feet from the residential inverters and 150 feet from the utility-scale inverters..[75] Even when measured within a few feet of the utility-scale inverter, the ELF magnetic fields were well below the International Commission on Non-Ionizing Radiation Protection's recommended magnetic field level exposure limit for the general public of 2,000 mG..[76] It is typical that utility scale designs locate large inverters central to the PV panels that feed them because this minimizes the length of wire required and shields neighbors from the sound of the inverter's cooling fans. Thus, it is rare for a large PV inverter to be within 150 feet of the project's security fence.

Anyone relying on a medical device such as pacemaker or other implanted device to maintain proper heart rhythm may have concern about the potential for a solar project to interfere with the operation of his or her device. However, there is no reason for concern because the EMF outside of the solar facility's fence is less than 1/1000 of the level at which manufacturers test for ELF EMF interference, which is 1,000 mG..[77] Manufacturers of potentially affected implanted devices often provide advice on electromagnetic interference that includes avoiding letting the implanted device get too close to certain sources of fields such as some household appliances, some walkie-talkies, and similar transmitting devices. Some manufacturers' literature does not mention high-voltage power lines, some say that exposure in public areas should not give interference, and some advise not spending extended periods of time close to power lines..[78]

3. Electric Shock and Arc Flash Hazards

There is a real danger of electric shock to anyone entering any of the electrical cabinets such as combiner boxes, disconnect switches, inverters, or transformers; or otherwise coming in contact with voltages over 50 Volts..[79] Another electrical hazard is an arc flash, which is an explosion of energy that can occur in a short circuit situation. This explosive release of energy causes a flash of heat and a shockwave, both of which can cause serious injury or death. Properly trained and equipped technicians and electricians know how to safely install, test, and repair PV systems, but there is always some risk of